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CONTABILITÀ AMBIENTALE E PRESSIONI SULL'AMBIENTE NATURALE: DAGLI SCHEMI ALLE REALIZZAZIONI

SISTEMA STATISTICO NAZIONALE

ISTITUTO NAZIONALE DI STATISTICA

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Introduzione

In concomitanza con l'affermarsi dell'impegno degli istituti nazionali di statistica e degli organismi internazionali nel campo della contabilità ambientale, manifestatosi a partire dall'ultimo ventennio del secolo scorso, l'interesse per questa disciplina è cresciuto in Italia fino a catturare l'attenzione degli organi di governo e di un ampio ventaglio di istituzioni pubbliche.

Coerentemente con un'indicazione già presente nel Piano nazionale per l'attuazione dell'Agenda XXI deliberato dal CIPE nel 1993, negli anni più recenti si è andata consolidando la convinzione che la messa a punto di un sistema nazionale di contabilità ambientale sia una delle azioni necessarie per concretizzare una strategia di sviluppo sostenibile. Il sistema dei conti ambientali viene così annoverato tra gli strumenti da utilizzare in maniera sistematica per poter raggiungere gli obiettivi connessi con una strategia di sostenibilità. Una esperienza particolarmente significativa a tale riguardo è rappresentata dalle iniziative legislative che sono state avviate al fine di introdurre nella pubblica amministrazione, ai vari livelli di governo, un sistema di contabilità e bilancio ambientale: dal disegno di legge approvato dal Senato della Repubblica nel 1999 all'iniziativa governativa approdata in Parlamento nel 2007 (proposte cui è mancata l'approvazione definitiva per fine legislatura, rispettivamente la XIII e la XV) fino all'iniziativa parlamentare avviata nel 2008 con la XVI legislatura.

In effetti, i conti ambientali esprimono un importante valore aggiunto rispetto ai dati di base utilizzati nella loro costruzione, presentano significativi vantaggi rispetto ad altri tipi di informazione e costituiscono una componente di specifico rilievo nel panorama della rappresentazione statistica dei fenomeni in gioco, fornendo un supporto conoscitivo particolarmente valido per le scelte e le decisioni dei vari soggetti coinvolti sul sentiero dello sviluppo sostenibile.

Il sistema dei conti satellite dell'ambiente sviluppato in Istat è orientato a rispondere alle esigenze conoscitive del Paese, espresse dai cittadini, dalle imprese, dalle pubbliche amministrazioni, nonché ai bisogni informativi degli organismi internazionali e in particolare dell'Unione europea, e viene sviluppato nel rispetto dei requisiti fondamentali propri dell'informazione statistica ufficiale. Alcuni di questi requisiti sono orientati ad assicurare un'elevata qualità dell'informazione sotto il profilo dei contenuti, per cui è necessario, in particolare, garantire non solo la rilevanza dell'informazione, che deve conformarsi alle esigenze conoscitive circa i fenomeni indagati, ma anche la completezza, perché un'informazione parziale può risolversi in un'informazione orientata. L'informazione fornita con i conti ambientali, inoltre, per poter essere utilizzata proficuamente deve essere raccordabile con altre statistiche – attraverso l'adozione di un quadro comune di definizioni, classificazioni e schemi teorici di riferimento – e sufficientemente flessibile da poter essere utilizzata in differenti contesti problematici e di analisi. Vi è poi, così come per la generalità delle statistiche ufficiali, un requisito cruciale da garantire, finalizzato ad agevolare in concreto l'uso e la corretta comprensione dell'informazione: la trasparenza, assicurata attraverso la documentazione relativa al processo di produzione e in generale la "metainformazione". Il presente volume risponde a questa ultima finalità.

Una parte rilevante dell'impegno dell'Istat in materia di contabilità ambientale è dedicata, coerentemente con i programmi statistici degli organismi internazionali, alla tematica delle interazioni tra economia e ambiente naturale in termini di flussi fisici. A tale tematica ovvero alla

descrizione quantitativa dei flussi che costituiscono tali interazioni, si riferiscono i lavori raccolti nel presente volume.

L'individuazione delle tematiche di interesse della contabilità ambientale della statistica ufficiale è ampiamente condivisa a livello internazionale e trova riscontro, in particolare, nei programmi dell'Eurostat. Una visione sintetica di tali tematiche e dei relativi strumenti statistico-contabili è offerta dalla figura 1. Tale figura fornisce un quadro di riferimento in cui si inseriscono i lavori dell'Istat oggetto dei capitoli che seguono, come pure quelli considerati nell'altro volume della stessa collana dal titolo *Contabilità ambientale e "risposte" del sistema socio-economico: dagli schemi alle realizzazioni*.

Come si vede dallo schema riportato nella figura 1, ciascuna tematica può essere affrontata mediante diversi strumenti statistico-contabili, pervenendo a differenti forme di rappresentazione statistica dell'informazione; diversi possono essere gli strumenti privilegiati nelle varie sedi.

I lavori oggetto del presente volume trovano riscontro nella seconda tematica, che riguarda le interazioni tra economia e ambiente in termini di flussi fisici considerate sotto il profilo quantitativo, e, più specificamente, le voci poste in evidenza nella figura: il sistema degli indicatori settoriali di pressione ambientale (ISPA), i bilanci di materia (Conti dei Flussi di Materia a livello di Intero sistema Economico - Economy-wide Material Flow Accounting - EW-MFA), le tavole Input-Output in termini fisici (Physical Input-Output Tables - PIOT) e le matrici di conti economici nazionali integrate con conti ambientali (National Accounts Matrix including Environmental Accounts - NAMEA). Le altre tematiche includono le transazioni economiche connesse all'esigenza di salvaguardare l'ambiente naturale (tematica 1) e aspetti dell'interazione in termini fisici tra il sistema antropico e l'ambiente naturale diversi da quelli trattati nell'ambito della seconda tematica. In particolare, le tematiche 3 e 4 riguardano le conseguenze dei fenomeni di flusso – sia a danno sia a favore dell'ambiente naturale – rispettivamente sulla disponibilità quantitativa e su quella qualitativa delle risorse naturali, la quinta tematica considera l'ambiente non limitatamente alle relazioni con il sistema economico, ma secondo un'ottica più esaustiva che fa riferimento anche ad aspetti ecologici, territoriali e qualitativi. La sesta tematica, infine, riguarda la valutazione monetaria del danno all'ambiente naturale conseguente all'uso dell'ambiente stesso.

Le tematiche e gli strumenti della contabilità ambientale possono essere utilmente inquadrati anche alla luce di quello che è il modello concettuale più diffuso a livello internazionale per la rappresentazione delle relazioni tra il sistema antropico e l'ambiente naturale: il modello "DPSIR" – "Driving Forces, Pressures, State, Impacts, Responses" – particolarmente utile come schema interpretativo sul versante dell'utilizzo di informazioni e dati di rilevanza ambientale. La figura 2 mostra come gli strumenti della contabilità ambientale oggetto del presente volume si collocano rispetto al modello.

Lo schema DPSIR evidenzia l'esistenza di forze motrici, o fattori di pressione, consistenti nelle attività e processi antropici che danno origine alle pressioni sull'ambiente naturale. Queste rappresentano le sollecitazioni dirette del sistema antropico sull'ambiente naturale – ad esempio in termini di emissioni di sostanze inquinanti – e costituiscono in linea generale una causa di danno all'ambiente a meno che non siano di intensità tale da essere controbilanciate dalle capacità rigenerative della natura. A "valle" delle pressioni si osserva lo stato della natura, che si modifica in seguito alle sollecitazioni umane a tutti i livelli, da quello microscopico a quello planetario. Il modificarsi dello stato della natura comporta impatti sul sistema antropico, per lo più negativi, chiudendosi in tal modo un primo circuito di causazione con la retroazione negativa dello sviluppo su se stesso attraverso il deterioramento dell'ambiente naturale che lo sostiene. Il sistema antropico, di fronte a tale retroazione negativa, reagisce ponendo in essere risposte dirette sia alle

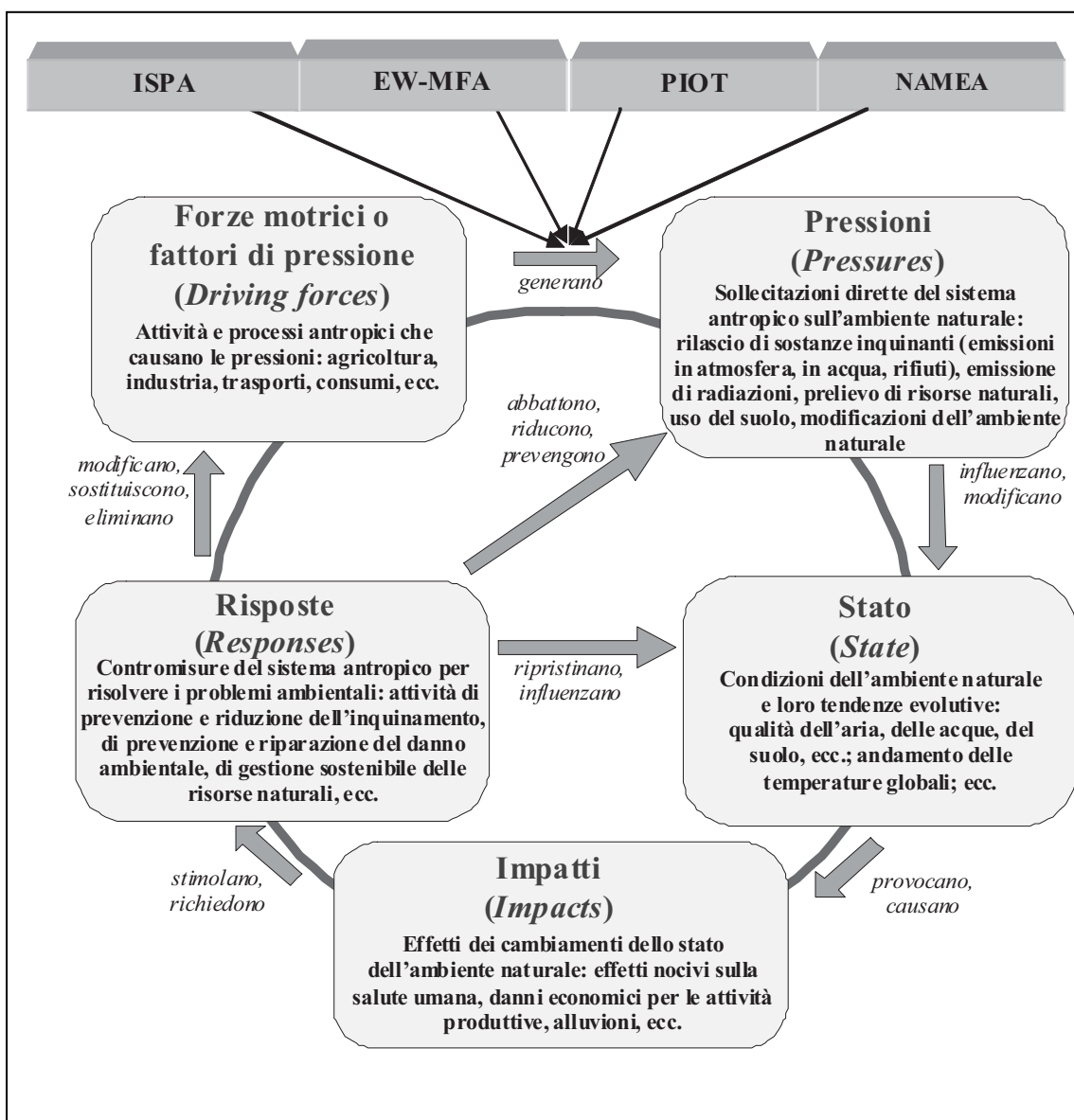
cause immediate degli impatti – i cambiamenti dello stato – sia alle loro cause più profonde, risalendo “a monte” fino alle pressioni stesse e ai fattori che le generano. Il cerchio così si chiude nuovamente, con la retroazione consapevole della società alle conseguenze negative del suo stesso sviluppo. Nella figura 2 sono in evidenza i circuiti di causazione in questione ed alcune importanti relazioni tra le entità del modello che costituiscono oggetto dei conti ambientali e sono di particolare interesse per gli utilizzatori.

Figura 1 - La contabilità ambientale della statistica ufficiale (a)

TEMATICHE DI INTERESSE	PRINCIPALI STRUMENTI STATISTICO-CONTABILI
1. Transazioni economiche connesse all'ambiente (disaggregazione e riorganizzazione dei conti economici nazionali)	1.1. Indicatori di risposta del sistema economico ai problemi ambientali
	1.2. Conti satellite delle informazioni economiche sull'ambiente ottenuti per disaggregazione delle tavole dei conti economici
	<u>1.3. Conti satellite basati su schemi ad hoc (SERIEE)</u>
2. Interazioni tra economia e ambiente in termini di flussi fisici – aspetti quantitativi	2.1. Indicatori settoriali di pressione ambientale (ISPA)
	2.2. Bilanci di materia e/o di energia
	2.3. Tavole input/output in termini fisici
	2.4. Matrici di conti economici nazionali integrati con conti ambientali (NAMEA)
3. Stock di risorse naturali presenti nell'ambiente – aspetti fisici quantitativi	3.1. Bilanci fisici delle risorse naturali
4. Flussi e stock di risorse naturali – aspetti fisici qualitativi	4.1. Indicatori di stato o di cambiamento di stato dell'ambiente a seguito delle pressioni e delle risposte del sistema economico
5. Interazione fra economia e ambiente in termini fisici, inclusi aspetti ecologici e socio-culturali	5.1. Indicatori di stato o di cambiamento di stato dell'ambiente a seguito delle pressioni e delle risposte del sistema economico
	5.2. Bilanci fisici delle risorse naturali, con disaggregazione territoriale
	5.3. Descrizione di ecosistemi attraverso conti di ecozone, identificate rispetto a classi di qualità
6. Danno all'ambiente conseguente all'uso quantitativo e qualitativo dell'ambiente naturale – valutazione monetaria	6.1. Valutazioni di mercato per le attività non finanziarie (SNA 93)
	6.2. Stime dei costi di mantenimento della disponibilità e delle condizioni attuali delle risorse naturali
	6.3. Stime basate sul metodo della valutazione contingente
	6.4. Modelli e indicatori basati sull'integrazione delle transazioni monetarie, dei flussi fisici e dei bilanci delle risorse naturali

(a) Nella colonna relativa ai “Principali strumenti statistico-contabili” sono indicati in grassetto quelli oggetto del presente volume; quelli sottolineati sono oggetto del volume Istat *Contabilità ambientale e “risposte” del sistema socio-economico: dagli schemi alle realizzazioni*.

Figura 2 - Lo schema DPSIR e gli strumenti contabili per la descrizione degli aspetti quantitativi delle interazioni tra economia e ambiente in termini di flussi fisici



All'interno dello schema DPSIR, gli strumenti della contabilità ambientale oggetto del presente volume si inquadrano nel contesto della descrizione dei "fattori di pressione" e delle "pressioni" del sistema socio-economico, nonché delle relazioni che legano questi due elementi del modello.

Così come per i paesi dell'Ue all'avanguardia su questa materia, l'interesse dell'Istat per i sistemi statistico-contabili di rappresentazione dei rapporti fisici tra economia e ambiente naturale risale alla seconda metà degli anni Novanta, quando, in attuazione di quanto previsto da una Comunicazione della Commissione delle Comunità europee del 1994, i primi schemi fondamentali per lo sviluppo dei conti ambientali nell'ambito della contabilità nazionale sono stati adottati nei

programmi statistici comunitari. Da allora, alcuni schemi, tra i quali quelli relativi alla EW-MFA ed alla NAMEA, sono stati sviluppati fino ad assumere una forma altamente definita, e sono oggi adottati in maniera standardizzata a livello europeo; altri schemi, come il sistema degli ISPA e le PIOT sono ancora nella fase di sviluppo e precisazione delle definizioni e delle convenzioni contabili. Nell'ambito dei processi di sviluppo delle rispettive aree, i lavori dell'Istat qui presentati – così come quelli relativi al SERIEE, oggetto del volume sulle “risposte” del sistema socioeconomico – si sono posti e si pongono come contributi in grado di spostare in avanti la frontiera della ricerca non solo nel campo delle applicazioni ma anche in quello delle metodologie.

Il volume è articolato in quattro sezioni (Prospetto 1), ciascuna delle quali è relativa a una delle categorie di strumenti individuate nella figura 1 per la descrizione delle interazioni tra sistema antropico e sistema naturale in termini di flussi fisici per quanto attiene agli aspetti quantitativi.

Prospetto 1 - Struttura del volume

- | |
|---|
| <p>A - INDICATORI SETTORIALI DI PRESSIONE AMBIENTALE (ISPA)
 Capitolo 1 - Environmental Pressure Indicators - Sectoral Indicators Project: Harmonisation of the SIP results</p> |
| <p>B - CONTABILITÀ DEI FLUSSI DI MATERIA A LIVELLO DI INTERO SISTEMA ECONOMICO (EW-MFA)
 Capitolo 2 - Economy-wide Material Flow Accounts and Balance for Italy, 1997
 Capitolo 3 - Economy-wide Material Flow Indicators for Italy, 1980-2001</p> |
| <p>C - TAVOLE INPUT-OUTPUT IN TERMINI FISICI (PIOT)
 Capitolo 4 - Physical Input-Output Table of the Italian economy: feasibility study and aggregate prototype</p> |
| <p>D - MATRICE DI CONTI ECONOMICI INTEGRATA CON CONTI AMBIENTALI (NAMEA)
 Capitolo 5 - The 1990 Italian NAMEA
 Capitolo 6 - Italian NAMEAs: 1991, 1992; enlarged and revised 1990 data
 Capitolo 7 - Italian NAMEA: air emission accounts for the year 1999
 Capitolo 8 - Italian NAMEA: 1990-2000 air emission accounts</p> |

La sezione A è relativa alla definizione del sistema europeo di indicatori settoriali di pressione ambientale (ISPA). Obiettivo di tale sistema è fornire una descrizione analitica delle relazioni che intercorrono tra il sistema antropico, i fattori di pressione e le pressioni sull'ambiente naturale. Elemento essenziale nell'architettura del sistema ISPA è la partizione del sistema economico in macrosettori individuati come di specifico interesse per le politiche, la cui definizione e delimitazione rimanda a concetti propri della statistica economica e della contabilità nazionale. L'approccio seguito muove dalla osservazione puntuale dei fenomeni identificabili come pressioni, classificati secondo dieci “temi ambientali”. Tali fenomeni – ad esempio l'emissione di sostanze

inquinanti e il prelievo di risorse – consistono per lo più in scambi di materia tra il sistema antropico e il sistema naturale, ma includono anche pressioni di natura differente quali ad esempio le emissioni sonore e l'esistenza di strutture che alterano il territorio. Ciascuno dei fenomeni identificati come pressioni è misurato separatamente e secondo le sue specifiche unità di misura. All'interno di ciascuno dei dieci "temi ambientali" e separatamente per ciascuno dei sei macrosettori individuati come di interesse per le politiche (Energia, Agricoltura, Trasporti, Industria, Gestione dei rifiuti, Turismo) è individuato un insieme di indicatori particolarmente significativo.

Lo sviluppo del sistema ISPA è stato avviato con la realizzazione, da parte di istituti statistici e di ricerca di vari paesi europei, di dodici progetti finanziati dall'Ue; in tale contesto l'Istat ha realizzato, in cooperazione con l'Istituto nazionale di statistica svedese, il progetto relativo al Turismo, il cui rapporto finale è stato pubblicato in questa stessa collana (Annali di statistica, serie X, volume 18, 1999). Il capitolo 1 del presente volume riporta uno studio che l'Istat ha successivamente realizzato per conto dell'Eurostat, teso ad armonizzare i risultati dei dodici progetti iniziali a partire dall'impostazione proposta dallo stesso Istat con il progetto sul Turismo. L'operazione di armonizzazione effettuata dall'Istituto si è articolata in due parti: una di natura concettuale generale e una mirata alla applicazione dei concetti elaborati nella prima parte. Uno dei concetti di fondo che hanno ispirato la proposta di armonizzazione, dei quali si dà conto nella parte I del capitolo, è quello della rispondenza della definizione/delimitazione dei settori al "raggio di azione" delle politiche settoriali, ovvero quello della massima rispondenza dell'informazione potenzialmente fornita dal sistema rispetto all'impostazione e alle esigenze delle decisioni politiche. Analogo concetto è stato sviluppato per la definizione dei "temi ambientali". La parte II riguarda più specificamente la definizione e la delimitazione puntuali dei temi e dei settori, nonché l'identificazione del *set* di indicatori più appropriato per ciascun tema/settore. Il lavoro ha natura puramente metodologica e si ferma laddove l'ulteriore operazionalizzazione delle definizioni degli indicatori risulta possibile solo nel contesto di una effettiva sperimentazione della loro costruzione/applicazione.

La sezione B riguarda i metodi di contabilizzazione onnicomprensiva degli scambi materiali tra il sistema naturale e il sistema antropico. L'approccio della EW-MFA è diverso e in un certo senso addirittura opposto a quello del sistema ISPA: laddove quest'ultimo è caratterizzato da specificità dell'analisi e ricchezza di dettaglio, la EW-MFA si fonda sulla considerazione del sistema antropico come organismo unitario e sulla ricerca di misure della dimensione complessiva del metabolismo di tale organismo. Tali misure si propongono come "sintetiche a priori" in quanto non poggiano su una sintesi di misure specifiche quali per esempio quelle potenzialmente fornite da un sistema ISPA, bensì sulla identificazione di un carattere comune a quasi tutte le interazioni tra sistema antropico e sistema naturale, che permette di astrarre dalla varietà di forme che tali interazioni assumono di volta in volta. Questo carattere comune è rappresentato dal fluire di materie, materiali, sostanze ed elementi, tutti dotati di massa fisica. Lunghi dal volersi sostituire a strumenti ben più analitici, la contabilità dei flussi materia a livello di intero sistema economico e gli indicatori da essa derivati intendono fornire un tipo di informazione aggiuntivo e complementare, relativo alle dimensioni complessive del sistema antropico e delle pressioni da esso potenzialmente generate, supposte in stretta relazione con le quantità di materie che passano attraverso il sistema economico.

In particolare, il capitolo 2, dopo aver fornito una introduzione generale non solo ai conti ma anche agli indicatori dei flussi di materia a livello di intera economia, focalizza l'attenzione sul sistema europeo dei conti, applicato per la prima volta all'Italia per l'anno 1997. Vengono mostrati innanzitutto i risultati ottenuti, evidenziando come nell'ambito di un sistema di conti "in cascata", vengano introdotte incrementalmente, a partire dal nucleo iniziale degli input

effettivamente utilizzati, le diverse quantità di materia complessivamente movimentate dal sistema antropico, pervenendo a misure che illustrano diversi aspetti del fenomeno. Le misure sono relative di volta in volta al prelievo, al consumo apparente e alla restituzione al sistema naturale della materia, e ad accezioni via via più ampie di “utilizzo della materia”. Il sistema contabile culmina nella compilazione di un bilancio di massa complessivo dei flussi attivati dall’economia italiana, la cui completezza costituisce un valore aggiunto dell’approccio, oltre a quello rappresentato dal fatto che vengono contabilizzati flussi usualmente ignorati quali quelli di materiali inutilizzati nonché quelli attivati indirettamente. Tale completezza consente di stabilire una prima connessione tra prelievi di materia vergine e restituzione di residui inquinanti, nonché di sottoporre a verifica l’ipotesi di coerenza tra i diversi dati (l’ipotesi è falsa ove la necessaria equivalenza tra input e output del sistema, dettata dalla legge di conservazione della materia, risulti contraddetta dai dati disponibili). Nel capitolo si dà anche dettagliatamente conto delle modalità di costruzione di ciascuna delle voci che appaiono negli schemi contabili, dei limiti di alcune stime e delle possibilità di miglioramento, oggetto di uno specifico sforzo da parte dell’Istituto.

Le misure che emergono a saldo dei vari conti trattati nel capitolo 2 corrispondono ad altrettanti indicatori derivabili dai conti stessi, ciascuno dei quali illustra un aspetto particolare dell’uso delle risorse naturali. L’analisi di tali indicatori in un’ottica di lungo periodo è particolarmente interessante, in quanto permette di conoscere l’entità complessiva della domanda di risorse naturali da parte del sistema antropico, nonché di studiare il rapporto tra l’andamento del volume delle attività economiche e quello dell’uso di risorse (analisi dell’accoppiamento/disaccoppiamento tra PIL e potenziale di pressione sull’ambiente). Per i principali indicatori relativi al prelievo e al consumo apparente è presentata la serie storica 1980-2001, i cui risultati sono interpretati e commentati nel capitolo 3, nel quale sono anche discusse le metodologie utilizzate per effettuare le stime degli indicatori ove non già discusse nel capitolo 2.

La sezione C include il solo capitolo 4, nel quale è riportato uno studio di fattibilità per la costruzione della tavola Input-Output dell’economia italiana in termini fisici. La PIOT ha in comune con il bilancio complessivo dei flussi di materia il fatto di fornire una descrizione dei flussi completa e relativa all’intera economia, ma a differenza del bilancio non guarda al sistema antropico come a un insieme indifferenziato. Essa è parallela alle tavole Input-Output monetarie (MIOT), e descrive la circolazione della materia allo stesso modo in cui le MIOT descrivono la circolazione dei valori economici, distinguendo nell’uso di materia le fasi della produzione e quella degli utilizzi finali secondo le categorie della contabilità nazionale. Lo studio di fattibilità qui riportato poggia in parte sui risultati del bilancio costruito per il 1997, e al tempo stesso rivisita alcune questioni concettuali ancora aperte nonché le possibili fonti di dati e metodologie di stima utilizzabili nella costruzione della PIOT, in una situazione in cui le realizzazioni in campo internazionale sono ad oggi molto poco numerose e fortemente differenziate quanto agli schemi adottati. Il capitolo riporta infine i risultati di un primo esercizio di effettiva costruzione delle tavole Supply-Use e PIOT a un livello altamente aggregato.

Complementare e non alternativa agli approcci fin qui introdotti è anche la NAMEA, oggetto della sezione D del presente volume, che documenta il percorso compiuto dall’Istat per giungere alla produzione su base regolare di questo modulo della contabilità ambientale.

Alla NAMEA è stata assegnata elevata priorità da parte degli organismi internazionali e di numerosi istituti nazionali di statistica. Ciò è connesso soprattutto alla possibilità, fornita da questo schema contabile, di porre a confronto dati monetari relativi alle attività produttive e di consumo e dati fisici relativi alle pressioni ambientali cui tali attività danno origine. Alla base di tale possibilità di confronto sta il fatto che le grandezze socioeconomiche e quelle ambientali sono

di volta in volta accuratamente riferite alle stesse attività (attività economiche e consumi finali delle famiglie). Nel caso delle imprese, il confronto tra i risultati economici delle diverse attività produttive e le pressioni ambientali ad esse ascrivibili è ottenuto attraverso la considerazione di due differenti risultati congiunti di ciascuna attività produttiva: da un lato i valori economici creati e dall'altro le pressioni sull'ambiente naturale generate per creare tali valori. Nel caso delle famiglie, invece, partendo dalle pressioni ambientali generate nella fase del consumo, vengono ad esse associate le spese sostenute dalle famiglie stesse per acquistare i prodotti il cui uso è all'origine delle pressioni ambientali in questione; tali spese sono presentate secondo la classificazione funzionale dei consumi delle famiglie (COICOP). Sia nel caso delle attività economiche sia in quello dei consumi, le pressioni ambientali vengono attribuite ai soggetti che risultano direttamente – ossia a causa dei propri processi produttivi o delle proprie attività di consumo – responsabili della generazione delle pressioni stesse. Ciò viene fatto allo stesso livello di disaggregazione delle attività proprio della PIOT e con un livello di dettaglio nella descrizione delle pressioni selezionate che è quello proprio degli ISPA.

Dopo un primo studio di fattibilità, lo sviluppo della NAMEA in Istat tra il 1999 e il 2004 è avvenuto in quattro passaggi principali che hanno coinciso con la realizzazione di una serie di progetti co-finanziati dall'Eurostat. I capitoli 5-8 inclusi nella sezione D consentono di ricostruire l'evoluzione della NAMEA in Istat attraverso i rapporti consegnati dall'Istituto all'Eurostat a conclusione dei vari progetti.

Durante l'intero percorso di sviluppo della NAMEA sono state rappresentate, dal lato dei dati ambientali, le pressioni per le quali il patrimonio informativo di base è in Italia maggiormente ricco e consolidato: le emissioni di inquinanti e il prelievo delle risorse naturali. Un'evoluzione c'è stata per quanto riguarda il numero di inquinanti considerati, la metodologia utilizzata per produrre i dati e la struttura degli schemi contabili.

La prima matrice di tipo NAMEA per l'Italia, prodotta dall'Istat nel 1999 con anno di riferimento 1990, contiene nel modulo economico il conto dei beni e servizi e il conto della produzione, e nel modulo ambientale le emissioni di sei inquinanti atmosferici nonché il prelievo diretto di risorse dall'ambiente naturale (cfr. Capitolo 5).

Nel corso della seconda realizzazione della NAMEA, completata nel 2001, sono state prodotte matrici NAMEA per gli anni 1990-1992 (cfr. Capitolo 6). La parte della matrice contenente i conti economici è stata ampliata fino ad includere i seguenti conti: equilibrio dei beni e servizi, produzione, generazione dei redditi primari, distribuzione del reddito, utilizzazione del reddito disponibile, consumi delle famiglie, capitale, resto del mondo. I conti delle emissioni atmosferiche sono stati costruiti per un totale di otto inquinanti.

Con la terza e la quarta realizzazione della NAMEA (cfr. rispettivamente i Capitoli 7 e 8), l'Istat ha perfezionato ulteriormente la metodologia per la costruzione dei conti NAMEA delle emissioni atmosferiche e ha portato a dieci il numero degli inquinanti atmosferici considerati (saliti successivamente a diciotto). Gli anni di riferimento sono il 1999 per la terza realizzazione e il periodo 1990-2000 per la quarta.

Dai capitoli della sezione D emerge che da un punto di vista metodologico lo sforzo principale richiesto dalla costruzione della matrice NAMEA è quello di assicurare la coerenza tra i dati statistici che figurano nel modulo ambientale e la struttura del modulo economico. Tale coerenza in generale non si riscontra a priori, dal momento che i dati di base sulle pressioni ambientali vengono prodotti utilizzando definizioni e classificazioni diverse da quelle proprie della contabilità nazionale. Pertanto, se da un lato la costruzione di dati di tipo NAMEA fa leva sull'utilizzo di dati ambientali ed economici esistenti, dall'altro l'inserimento di statistiche ambientali nello schema NAMEA implica un lavoro di

omogeneizzazione di queste con gli aggregati economici. Nell'ambito delle pressioni ambientali considerate nella NAMEA italiana il problema si pone soprattutto per quanto riguarda le emissioni atmosferiche calcolate a partire dai dati dell'inventario CORINAIR, che costituisce la fonte ufficiale di dati su tali emissioni. A partire da tali dati è necessario operare alcune modifiche che incidono, in un primo passaggio, sul totale delle emissioni. Un secondo passaggio riguarda la conversione dei dati di emissione dalla struttura tipica del CORINAIR, in cui le emissioni di ciascun inquinante sono calcolate e riportate in base al processo che le ha generate, alla classificazione per "attività NAMEA", che comprende attività economiche disaggregate in modo coerente con la Ateco e con i consumi delle famiglie per finalità di consumo.

Nel caso dei prelievi di risorse naturali dall'ambiente, invece, l'omogeneizzazione con i dati economici è immediata – sotto il profilo delle definizioni e classificazioni di riferimento – in quanto i dati di base in genere consistono in quantità prelevate da alcune specifiche attività economiche.

Oltre alla descrizione della metodologia utilizzata dall'Istat per la costruzione dei conti delle emissioni atmosferiche NAMEA, la sezione D contiene anche alcuni dati forniti all'Eurostat in occasione delle prime tre realizzazioni della NAMEA. Ciò testimonia la crescente importanza assegnata dall'Eurostat alla standardizzazione dei dati NAMEA.

Dati aggiornati, per la NAMEA come per gli altri prodotti della contabilità ambientale, sono reperibili sul sito Internet dell'Istat.

Cesare Costantino – Aldo Femia – Angelica Tudini



INDICATORI SETTORIALI DI PRESSIONE AMBIENTALE
(ISPA)

Capitolo 1

Rapporto ad Eurostat

Environmental Pressure Indicators – Sectoral Indicators Project: harmonisation of the SIP results

Cesare Costantino, Aldo Femia

PREFACE

Among the projects on environmental pressure indicators that Eurostat launched in the second half of the nineties, a group was devoted to the sectoral aspect of the pressure indicators. Six projects, known as the SIPs, covered the sectors Transport, Energy, Agriculture, Industry, Tourism and Waste Management, identified as main sectors of interest starting from the “Fifth Environmental Action Program” of the EU.

The different SIPs were carried out by a number of member country statistical and research institutions. Istat, together with Statistics Sweden, was in charge of developing a study for the Tourism sector.

The work carried out within the SIPs suffered from a degree of lack of coherence, harmonisation and methodological soundness, which, at the time, seemed difficult to resolve.

Since that time Istat has established a set of fundamental concepts, in an attempt to improve the approach to some of these problems. The main concepts have tentatively been applied to the tourism SIP. Subsequently Eurostat acknowledged the usefulness of applying these concepts to the other five sectors and supported a study which is the subject of the present report.

The sectors dealt with in the present report are Energy, Agriculture, Transport, Industry and Waste Management. Some consideration concerning the Tourism sector are also contained in the report, to the extent that this is required by possible connection with the other five sectors.

Il testo riportato riproduce integralmente il rapporto originale consegnato all'Eurostat nel 2002. In esso è riportato quanto segue:

The project was coordinated by Cesare Costantino. The different paragraphs were authored as follows: Cesare Costantino was responsible for §§ I.1, I.2, I.4.1, I.5.1, I.5.3 of Part I; Aldo Femia for §§ I.3, I.4.2, I.4.3, I.4.4, I.4.5, I.5.2, I.5.4, I.5.5, I.6 of Part I and for the whole Part II.

The authors wish to thank Angelica Tudini (Istat, Environmental Accounting Unit).

The work built on the achievements obtained with the project “Creazione e sviluppo di un sistema di contabilità ambientale”, for which a report was delivered by Istat to the Ministry of the Environment in 1999. Gelindo Bergagna, Alessandra Fino, Rosa Gilio, Isabella Maldera, Maria Marchionni, co-authors of this report, are also acknowledged.

PART I - METHOD FORMULATION FOR THE DEFINITION OF SECTORS AND FOR THE SELECTION OF INDICATORS

I.1 Introduction

Part I of this report presents the overall methodological framework of the research work carried out and some concepts that are set as common reference points for the specific sections concerning the single sectors taken into consideration; the main solutions adopted are summarised within a general overall view. The main specific aspects of each sector – Energy, Agriculture, Transport, Industry and Waste Management – are looked into more thoroughly in Part II, where the delimitations set for each sector are described in greater detail, identifying the pressures typically caused by each sector with reference to the various “environmental problem areas”, and arriving at a selection of the indicators found to be – at this stage – especially suitable for representing the pressures at issue.

In the chapters below, we start from some basic reference points, deemed essential for defining the system of sectoral environmental pressure indicators, in order to illustrate the rationale behind the definition of the sectors and the selection of the indicators. These reference points are made up of ideas and proposals that have been developed in previous projects on this topic within the European Statistical System (chapter I.2); on a more general level, they stem from the purposes for which the system of sectoral environmental pressure indicators is developed, i.e. mainly the need to provide the sectoral “ecological sustainability” policies with suitable knowledge support (chapter I.3). The logic and the reasons behind the solutions adopted with regard to the definition of the sectors and the selection of indicators are presented respectively in chapters I.4 and I.5. These chapters also contain “synoptic tables” which, in addition to providing a summary of the main conclusions reached, are also in themselves an expression of the methodological foundations of the work, as they arise from the following main needs:

- to highlight the existing links between the sectors, making their delimitations consistent with some general common principles;
- to harmonize the definitions of “environmental problem areas” and those of the indicators that are common to several sectors;
- to rationalise the list of indicators selected as priority ones.

This part ends with the outline of the main developments needed in official statistics for the further development of sectoral environmental pressure indicators (Paragraph I.6).

I.2 Eurostat projects on sectoral environmental pressure indicators

I.2.1 Policy directions and the development of statistical information on a European scale on the subject of “environmental indicators and green national accounting”

Article 2 of the European Union treaty introduced the principle according to which sustainable and environmentally friendly growth is one of the main elements that must inform the European Community policies. In relation to this need, the “Community programme of policy and

action in relation to the environment and sustainable development”¹ – also known in the European Union as the “Fifth Environmental Action Program” (5EAP) – emphasised, in particular, the need to increase the necessary knowledge support by developing new statistical tools. As specified in the part devoted to the need to expand the available tools, the programme stated that maximum priority should be given to “exploiting and strengthening the experiences and capacities of the European statistical system to deliver environmentally relevant statistics on a regular basis, which will be comparable to and linked to the traditional official statistics in the economic and social fields”².

Further to the recommendations arising from the 5EAP, a follow-up process started within the European Union Commission services, including Eurostat, which was ended in December 1994 by the Communication COM (94) 670 that the Commission itself addressed to Council and the European Parliament³. This document contained the identification of two main approaches that are complementary to each other:

- 1) development, in the mid term, of a harmonised European system of integrated economic and environmental indicators, through which statistical representation of economic results and of environmental pressures in the various sectors can be integrated directly and in a comparable manner;
- 2) the carrying out of necessary work for the “greening” of national accounts, according to a satellite type configuration (singling out environmental expenditure, introducing accounts for natural resources, improving methodological knowledge for the evaluation of damage to the environment and monetary calculation).

In order to implement what was set out with the general approach as above, in the same Communication, the Commission identified six actions, including ESEPI (European System of Environmental Pressure Indices – Action 2). The essential target assigned to ESEPI was that of providing a (possibly) comprehensive description in physical units of phenomena caused by environmentally harmful human activities, according to the model Pressure-State-Response (PSR). This description is accomplished in practice by the statistical measurement of environmental pressures at the aggregation level of the “environmental problem areas”. Ten specific “environmental problem areas” have been identified starting from the 5EAP: Air pollution, Climate change, Loss of biodiversity, Marine environment and coastal zones, Ozone layer depletion, Resource depletion, Dispersion of toxic substances, Urban environmental problems and noise, Waste, Water pollution and water resources.

Among the goals assigned to ESEPI, there was first the need to set, for each “problem area”, the priorities for collecting indicators, in order to be able then to carry out this collection⁴.

¹ Commission of the European Communities (1993b).

² See Commission of the European Communities (1993b). This approach can be found, on a worldwide scale, in Agenda 21 (the final document from the United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992).

³ See Communication from the Commission to the Council and the European Parliament on “Directions for the EU on Environmental Indicators and Green National Accounting” (COM (94) 670 final, 21.12.94). In a sense, this document is a technical specification of the 5EAP with regards to the development of statistical information in terms of indicators and environmental accounting.

⁴ Among the objectives initially identified, there was also the aggregation of the indicators chosen for each “environmental problem area” so as to obtain ten indices of environmental pressure (one for each “environmental problem area”), using weights to be selected on the basis of the results of surveys to be carried out among experts.

The implementation of ESEPI started with thirty sub-projects grouped into three modules:

- eight “Environmental Pressure Information System” projects (EPIS);
main objective: preparation of an information system that can provide the environmental pressure indicators required; the system integrates physical and economic data;
- ten “Pressure Indicators Pilot Projects” (PIP);
main objective: to identify the “demand” for indicators, making reference to the different “environmental problem areas”;
- twelve “Sectoral Infrastructure Projects” (SIP);
main objective: keeping in mind the demand, to identify the “supply” of indicators, making reference to the different sectors.

1.2.2 The Environmental Pressure Information System (EPIS)

The EPIS projects aim at creating a methodological and organisational benchmark, so that databases can be made available in an easily accessible format and entered into an information system that has the purpose of calculating the environmental pressure indicators.

The layout of the work carried out on a European scale, provided with the first projects that were promoted by Eurostat for the development of EPIS, is based on four fundamental steps⁵:

- a) selection of the most important processes from an environmental pressure point of view;
- b) collection of input and output coefficients for the selected processes;
- c) calculation of the pressures of each production and consumption process, based on their input and output coefficients;
- d) calculation of environmental pressure indicators, referring to sets of production and consumption processes.

1.2.3 The Environmental Pressure Indicators Pilot Projects (PIP)

Through the PIP module, a project was launched for each of the ten “environmental problem areas” aiming at identifying a favoured set of environmental pressure indicators.

The main stages carried out in the implementation of the ten projects were:

- a) the selection of ten research institutes with coordination functions (a “specialised institute” for each “environmental problem area”);
- b) the selection of more than two thousand experts throughout Europe, divided into groups corresponding to the ten “environmental problem areas” (named Scientific Advisors Groups – SAG); the selection was under the responsibility of the ten “specialised institutes” in charge of the ten “environmental problem areas” and involved the main stakeholders (non-governmental organisations, ministries of the environment, etc.);
- c) preliminary identification of the indicators believed to be the most important ones, using a first questionnaire submitted to the SAG: on average, about two hundred indicators were suggested for each “environmental problem area”;
- d) reduction in the number of indicators to less than thirty per problem area;

⁵ See e.g. the EPIS project carried out by Istat (Istat, 1997).

- e) identification, via a second consultation with the SAG, of a core set of indicators (ten indicators for each “environmental problem area”, considered to be the most important ones); for each of them, Eurostat drew up a “methodology sheet⁶”. Based on the results of the consultation, Eurostat also selected, for each problem area, six indicators, which were given the highest levels of preference, and calculated the same indicators for the fifteen countries belonging to the European Union⁷.

When selecting the indicators to be included in the final core set, Eurostat took the following elements into account:

- a) policy relevance: the importance – for each “environmental problem area” – that may be attributed to each indicator by a hypothetical “policy maker” (for example by a minister for the environment);
- b) analytical soundness: the degree of correlation existing among the changes in the values of each indicator and real changes in environmental pressures that may involve a given problem area;
- c) response elasticity: the ease (or difficulty) with which, given the technical and economical constraints, an action could be undertaken that would considerably reduce the extent of the environmental pressure notified by each indicator;
- d) “core” indicators: the five indicators considered by the SAG to be the most suitable ones for describing the total environmental pressure for each “environmental problem area”. The choice of these indicators is ideally correlated to the answers given to the three previous questions.

Data availability was not an element of evaluation.

1.2.4 The Sectoral Infrastructure Projects (SIP)

The purpose given to the SIP projects was to define the statistical base necessary for measuring the contribution to environmental pressures that can clearly be put down to six economic sectors that are considered to be strategically important for ecological sustainability policies.

The sectors considered are:

- 1) Energy;
- 2) Agriculture;
- 3) Transport;
- 4) Industry;
- 5) Tourism;

⁶ See Eurostat (1998a); six Methodology Sheets for each problem area are available at <http://www.e-m-a-i-l.nu/tepi/methodol.htm>. These Methodology Sheets, by supplying detailed information on the pressures represented through the indicators, are a precious help for analysing the indicators themselves; each methodology sheet is subdivided into four parts: a) definition of the indicator and of the measurement unit; b) “position” of the indicator: this refers to how it is connected to the 5EAP, the “Agenda 21” and conventions and international agreements; it also refers to the importance given to it by the SAG and to its link with state indicators; c) significance: contains the aim, the relevance, the link with other pressure indicators and the objectives of the European Union policy, deriving either from the 5EAP, or from directives and regulations, or from international agreements in force etc.; d) methodological description and basic definitions: it contains key definitions and concepts, methods of measurement, indicator limits and possible alternative definitions.

⁷ See Eurostat (1998). This document provided a first real picture of pressures with reference to the ten “environmental problem areas”. The data refers to human activities as a whole (for the individual member states or the entire EU), but in some cases they are supplied with information on the origins of pressures for each sector. In general this document showed how in the EU’s fifteen countries both the source of data for the indicators and the methods used for their calculation are often different, not harmonised and sometimes not at all clear.

6) Waste Management;

The first five sectors were identified by the 5EAP, while the sector “Waste Management” was added at a later stage due to its growing importance in environmental policy.

For each of the six sectors a report was produced by the National Statistical Institutes and other research bodies that took part in individual projects⁸; each of these reports discussed the following main aspects:

- a) the importance for the specific sector of the environmental pressure indicators considered in the PIP module, their availability and the methods needed to calculate them;
- b) the basic data needed to construct the indicators considered and their availability.

From each report, therefore, interesting elements concerning the following points can be derived:

- a) the definition and delimitation of the sector being examined;
- b) the identification of the relevant environmental pressures of the sector being examined;
- c) the identification of the indicators suitable to express these pressures;
- d) the identification of the available and missing data;
- e) the quality of existing data;
- f) the identification of the main data sources of data;
- g) the role of non-statistical data (for example technical coefficients).

1.2.5 The need to make consistent the delimitation of the sectors and the selection of the indicators proposed in the European projects

In the work carried out within the context of the SIP projects, there was a lack of explicit criteria common to the various studies carried out for defining the sectors and for selecting the indicators; it was felt, therefore, at Eurostat as well as at Istat, that there was a need to make the main results of this work more consistent, without questioning their general principles. Therefore, starting from the reports compiled for Eurostat upon completion of the SIP projects, the definition of sectors and the selection of the indicators proposed in them have been critically reconsidered.

One preliminary consideration, of a general nature, concerns the reference conceptual frame adopted in the European projects, originally made up of the PSR model – developed by the OECD – and now become the DPSIR model (“Driving forces - Pressures - State - Impacts - Responses”). The environmental pressure indicators proposed in the European projects cover the field of pressures in the wider meaning of the former PSR model, which includes both the pressures in a strict sense and the driving forces⁹. As, though indirectly, the latter supply information – often impossible to substitute – which is useful also as far as pressures in a proper sense are concerned, they have not been excluded from the analysis, although in principle they should generally be considered as “second best” compared to those specific ones referring “tout-court” to pressures. The difference has been systematically kept in mind, nevertheless, pointing out for each of the selected indicators which of the two elements of the model (driving forces or actual pressures) it belonged to.

With regards to the need to bring the definitions of the sectors to consistency, the following has been done:

⁸ Istat produced, together with Statistics Sweden, the report on the Tourism sector (Eurostat, 1999b).

⁹ At the time when the SIP projects were set up, the distinction between the two elements at issue had not yet been introduced.

- for the individual sectors, the significant activities that remained unsuitably excluded were inserted and those that appeared to be superfluous were eliminated. It should be taken into account that some overlapping among the sectors corresponds to the actual overlapping of the contexts of influence of the sectoral policies. This is not a problem from the accounting point of view, as it can be pointed out which activities are included in more than one sector;
- on a general level, the whole group of human activities not to be included in the six sectors considered in the European projects was pointed out so that it may be possible, where suitable, to define any subgroups of activity as further sectors, significant for new policies; this group, in fact, is rather large. Moreover the existing overlaps between the explicitly defined sectors were highlighted so as to eliminate the risk of double counting in case of aggregation of the sectors. Together, the emphasis given to these aspects, allows to reproduce the general picture correctly.

While delimiting the sectors, reference was systematically made to the standard classification of economic activities¹⁰, in this way creating the basis to be able to construct environmental pressure indicators that match economic and social indicators such as value added, production, employment, etc.¹¹.

Also, while delimiting the sectors, the following were also taken systematically into account:

- the fact that the standard classification of economic activities, while being the exhaustive reference for the analysis of production activities in official statistics, may be incomplete compared to the needs for the definition of sectors as areas of interest of sectoral policies; as a matter of fact these areas may also include activities that do not belong to the production domain, but rather constitute final consumption of goods and services, that generates direct pressures on the environment separate from those originated at the production stage, which come before such consumption;
- the existence, in each economic activity, of varied and composite processes, for which it is necessary to explain the sectors to which the activities belong to in a different manner depending on whether the activities are carried out as principal, secondary or ancillary activities. This differentiation makes the delimitation of the sectors much closer to what would be obtained by defining them in terms of processes rather than as activities, thus helping the task of calculating the environmental pressure indicators¹².

With regards to the selection of the indicators, the reference are the preferences expressed by the panels of experts consulted by Eurostat within the projects described above; furthermore the experts' recommendations were integrated with the analysis of the available literature on the environmental pressures to be represented and on the proposed indicators.

¹⁰ The classification referred to is the international classification NACE Rev.1. The Italian one, i.e. ATECO 91, which is consistent with NACE Rev.1 while allowing a higher level of breakdown, is used in some cases. See Eurostat (1996) and Istat (1991).

¹¹ This stage of theoretical definition of the sectors places the emphasis on the need to extend and detail the basic statistical knowledge on environmental deterioration phenomena, and in particular on the economic features of the activities that are the "source" of it. As a matter of fact the existing information on pressures often refers to aggregates whose link to specific economic activities – and therefore to the sectoral policy contexts – need to be reconstructed and are still to be explored.

¹² By contrast, defining the sectors in terms of activity makes, as previously mentioned, the calculation of economic and social indicators easier.

I.3 The definition of the sectors and the selection of the sectoral environmental pressure indicators: an approach that starts from environmental policy

I.3.1 The central role of the sectoral environmental pressure indicators in the model representing the relations between the anthropic system and the natural system

The DPSIR model is an important reference conceptual frame for the study of environmental issues and for political intervention on these issues. This model leans on the description of a strong connection between the elements that form it: man, with all his activities (driving forces), causes stress (pressures) to the natural environment, whose condition (state) tend to be modified as a consequence of this stress¹³. Wherever these modifications to environmental conditions turn out to be dangerous or harmful for man (impact), the anthropic system tends, in turn, to react (response) to the environmental change, to eliminate the causes or the consequences. In turn, when these responses are intended to eliminate the causes, they retroact more or less effectively on the pressures carried out by man on nature.

The adoption of this model for descriptive and analytical purposes is an essential starting point for being able to clarify discussion about “environmental issues”, and make it less vague. This conceptual frame, however, is not defined in itself to the extent that it can be immediately filled with appropriate contents, which are also potentially extremely varied; the definition of a model really capable of representing reality is indeed only obtained by specifying the components of each element in the frame and their reciprocal boundaries, i.e.: the human actions which cause the pressures and the subjects who undertake them; the specific pressures; the components of the natural system that are subject to variations in state as a consequence of pressures; the consequences of these variations on the human system and the subjects that are exposed to them; the actions that provide a response to the impacts and the subjects who enact them, etc. It is also necessary to specify the inter-relations between these components – and in particular those of cause and effect (which pressures act on which components of the natural system and in which way, which responses act on which pressures etc.). The indicators can only be defined with reference to the components and their interaction, after having specified the model in a sufficiently detailed manner¹⁴. Definition of the indicators constitutes, therefore, the last step of a long and complex conceptual path, whose stages are all important as they all contribute – though in different ways – to determining the resulting representation of reality. Only once the phenomena corresponding to the key concepts have been identified with sufficient precision for practical measurements, then it can be said that a representational model of reality is available and, based on it, an approach to environmental policy is possible which relies on the development of adequate statistical information.

Within the DPSIR conceptual frame, the actions complying with environmental protection policy are placed among society’s response to the environmental crisis. Since the responses act on the state of the environment more or less via the same chain of phenomena indicated by the DPSIR model, the latter, seen from a normative rather than a positive point of view becomes R-DPSI¹⁵. In this form, the

¹³ The fact that the conditions of the natural environment are the result of the combined effect of stress produced by the anthropic system and the spontaneous evolution of the natural system is not looked into here.

¹⁴ In this context the distinction between phenomena of interest (i.e. the pressures) and the indicators with which it is intended to measure them, must be underlined, as the shift from the first to the second is not always straightforward.

¹⁵ All the responses that wish to have long lasting results must act on the state of the environment via this chain of phenomena. The responses may act directly on the state of the environment, as for example when one tries to remedy environmental deterioration already ongoing, but only the responses aimed at eliminating (also) the causes of these phenomena are the most effective from the ecological sustainability viewpoint.

model suggests a distinction between instruments, intermediate objectives and final objectives of environmental policy. The latter can be defined as objectives concerning the state of the environment¹⁶. Intermediate objectives are those that refer to driving forces and to the pressures themselves; the latter are further from the instruments and closer to the final objective, and therefore any change in them is more significant, but also more difficult to control. The instruments comprise the activities and the actions that the Public Administration can adopt directly to protect the environment, and also the incentives that it can provide as well as the constraints that it can impose on the actions of other subjects. The quantitative use of a normative model, as we know, starts from the desired values of the final objectives¹⁷ and continues, going back along the chain of phenomena indicated by the positive model, by setting values for the intermediate objectives, ever more distant from the final objectives, until reaching the values to set for the instruments, which are - by definition - variables under the control of policies¹⁸.

In the current formulation of environmental policy, both nationally and internationally, the objectives are primarily determined for the environmental pressures rather than for the state of the environment (international negotiations on the emissions of air pollutants are a well-known example). Deriving the values that the intermediate objectives (and therefore the instruments) must have from the desired values of the final objectives is impossible when not much more than the quality (existence and sign) of the relationship between the first and the second is known. Actually, the fact that the objectives are set in terms of immediate causes of environmental deterioration, i.e. the pressures rather than the state of the environment¹⁹, corresponds to the actual range of action – though indirect – of the policy²⁰.

1.3.2 Definition of the environmental pressures and basic criteria for quantifying them

The pressures caused by man on the natural environment can be generally defined as flows of material and/or energy between the natural system and the anthropic system and changes in the use of space (in land use, in particular) due to human activity.

The identification of flows (and ways of using space) that are then considered as pressures on nature, is dual to the definition of the “boundary” between the natural sphere and the sphere of human action²¹: pressures are only the flows that cross this boundary, and wherever a flow is considered a pressure, at the same time the boundary line that has been crossed is defined, even if

¹⁶ The “good” state of health of the natural environment can be considered as a value in itself, or at the extreme opposite, only the impact that the deterioration of its state has on society can be of interest; different interpretations are possible, but in both cases it is in relation to the state and its changes that the objective is defined, which if reached or not shows the final efficiency of the environmental policy.

¹⁷ In practice, the values of the indicators referring to these objectives; the objectives, considered in themselves and for themselves, may not easily be quantified – think for example of biodiversity, or social well-being.

¹⁸ In all this the existing relations between the various links in the causal chain that goes from the instruments to the final objectives are assumed to be sufficiently well known. The longer the chain and the more risky the intermediate relations, the more uncertain the final effects of the policies will be.

¹⁹ This can be traced back to various factors, including the insufficient scientific knowledge available on many processes, characterised by a high degree of complexity, that occur in nature. It is instead possible to use the quantitative relationships between driving forces and pressures – mostly known or easily recognisable as determined by technology, i.e. by human control of natural processes – in order to quantify the second ones starting from the first (it is for example what is done with the CORINAIR calculation system for the emission of air pollutants).

²⁰ It is important to point out, however, that the use of environmental pressure indicators as instruments for the monitoring of the effectiveness of societies efforts towards sustainability must actually be accompanied by the use of other planning instruments such as state indicators, which tell how much more efforts are still needed, and driving force indicators, which are subject to the direct influence of policy (response). A system of driving force and state indicators should therefore be set-up, parallel and connected to that of pressure indicators, in order to create a coherent reference for action.

²¹ Natural phenomena that have undesired effects on the state of the environment but are not under the control of man (as for example the volcanic emissions of greenhouse gases) must not be included in the definition of environmental pressure indicators.

only implicitly. This boundary must be univocal at the system level, and therefore consistent among the various sectors, which goes to say that, in principle, the whole of possible pressures can only be the same for all the sectors; in practice, for each sector the most important pressures need to be chosen.

When reference is made to the pressures of a given group of activity, unless expressly indicated otherwise, it is a reference to the flows crossing the boundary with the environment that are directly generated by the activities belonging to that group (and to the occupation of space that is directly due to them); pressures indirectly generated by these activities via activities not belonging to the sector at issue – that are either “up-stream” or “down-stream”, in an organisational or technical sense – are excluded²².

One important asymmetry between the environmental protection policy instruments (and more generally society’s responses to the environmental crises) on one hand, and the final objectives on the other hand, is represented by the unit of measurement used to represent them: environmental protection policy instruments are easily traced, conceptually, to monetary units (basically, to the costs incurred by the public administration to carry out or stimulate activities and actions for the protection of the natural environment and to prevent or discourage activities that are harmful to the environment, as well as to the additional costs imposed on those who carry out polluting activities and actions), and it is therefore natural that the accounting for these instruments be of a financial kind; at the extreme opposite end, the state of the environment, considered in itself, requires a representation in physical terms, similarly to the pressures. The latter, in particular, are measured by physical units as physical flows and material changes to the environment; they can also be linked in a useful way to monetary measures, as occurs in integrated environmental and economic accounting²³.

1.3.3 The plurality of objectives of public policy and the need for an approach consistent with environmental accounting schemes for the definition of the sectors

A suitable link between pressure variables and monetary items constitutes in itself a valuable response to the cognitive needs of policy. It is clear that political ruling of socio-economic development must also answer to a number of objectives of different kinds, including that of a good state of health for the natural environment; the same concept of sustainability is inherently multidimensional and necessitates that political objectives in relation to a wide range of economic and social and ecological aspects be defined. Consequently, the need to keep under control at the same time target-variables that pertain to different areas, but which involve the same group of activities, constitutes an important feature of the demand for statistical information that comes from public politics.

It is the systematic search for indicators relevant to political objectives of a different nature but which refer to the same group of human activities that characterises the approach of environmental accounting to the description of the relations between the economy and the

²² Similarly, for example, the value added or the employment of a given group of activity, in national accounting, are those directly generated by it. As for value added and employment, the pressures that are indirectly due to a given number of activities are important from an analytical and normative point of view; they can be calculated starting from direct pressures, if these are known for all the relevant intermediate steps (e.g. via the vertical integration of sectors with the Input-Output technique, at the branch-of-activity level, and with the analysis of the life cycle at the product level).

²³ This link can be made in the form of matching, for example between the quantity of emissions due to a certain production, the monetary value of the production itself, the employment created by it and the revenue of taxation on the polluting discharges.

environment by means of indicators²⁴. In addition to searching for the maximum significance of the indicators with respect to the phenomena that are to be described, the accounting approach aims at building up a group of indicators that concern different dimensions, brought together to form an organic framework. A basic requirement in order to ensure the significance of this framework is that the entities (the groups of activities and actions) to which the indicators refer are always defined, for all the measurements and estimations for the different dimensions covered, in the same way.

It is particularly important to identify properly the groups of activities and actions to which the indicators refer if the variables that they represent are political objectives that are potentially in conflict with one another. The presence of trade-offs between the objectives also makes it absolutely necessary that the groups of indicators have maximum significance, in relation to the phenomena that they represent and also in terms of the correspondence between the group of activities to which the indicators refer and the group of activities on which the public decision maker exerts his influence, given the instrument available to him and on the basis of the way he sets out his own actions. Basically, each sector, for which the indicators must “measure” the pressures, must be defined and delimited, aside from what its name immediately tells us, in such a way that the specific realm of influence of public policy to which that sector refers can be covered. It is the fact that policy has been conceived as organic and united that acts as a connection factor for many activities, which are often much different from one another from a technical and economic point of view, and makes them significant as a whole. The inclusion in this group, of activities that are totally outside the reach of political action or which only concern a realm of political action that is different from the one that defines the group’s activity – or, vice versa, the exclusion of activities under the influence of this policy – would imply a risk that the indicators, calculated with reference to badly delimited sectors, would supply distorted signals when considered for policy making, since the policy at issue would refer to a different set of activities and environmental effects²⁵.

For the same reasons, the pressures to be attributed to each sector are only those directly generated from the activities that belong to it.

In a European context, the formulation of the environmental policy is significantly sectoral: the indication in the 5EAP of some sectors of economic activity as being of the greatest importance from an environmental point of view, is a clear expression of this type of formulation, while the Communication COM (94) 670 previously quoted, that expresses the consequences of such a formulation for the development of a statistical information system that meets European policy’s needs, finds a strategic element of such development in the sectoral environmental pressure indicators.

In the light of what is reported above, in defining the sectors and indicators, the following has therefore been taken into account:

- the need to define the sectors in such a way as to maximise:
 - their significance in relation to political instruments and policy programmes;

²⁴ In this sense it should be pointed out that the approach of “sustainability indicators” – in which the juxtaposition is between the indicators referring to the social, institutional, ecological and economic dimensions, without a very well structured connection with the sectors dealt with in this report – is compliant with the needs of overall direction and monitoring, but does not provide sufficient information for the European sectoral policies.

²⁵ Here one speaks of “first-order effects” and of influence that policies exert directly, while being aware, nevertheless, that there is no context of economic life that is completely untied to anything else, and therefore not influenced, even indirectly, by the relevant policies.

- comparability between the environmental pressure indicators and the politically relevant economic and social variables to which they refer;
- the need to maximise the significance of the indicators compared to the phenomena they represent.

In addition to these aspects, the need to ensure comparability of the indicators on an international scale was considered as a constraint, a need that has strong implications for both the definition of the sectors and for the selection of the indicators. The choices made for this purpose are, therefore, largely bound to the recommendations prevailing in the European context, from which it was never found advisable to diverge, unless very strong, founded reasons were present.

I.4 The definition of the sectors in terms of activities

Compared to the delimitations proposed for the various sectors identified on a European scale as specific areas of interest of sectoral policies aimed at reducing environmental pressures, some possible methodological adjustments have been considered with the purpose of ensuring the necessary consistency among the sectors²⁶. With the aim of arriving, in this phase of further methodological progress, at a theoretical delimitation of the domains at issue – which, as has been said, must tend to match the realms of influence of policies – the path followed was a systematic analysis of all the human activities that generate pressures on the natural environment, based on a number of steps as reported below²⁷.

I.4.1 Activities recorded in the national accounting system and the other human activities to be taken into consideration

A first important distinction which in practise is to be taken into account in the phase of identifying the human activities that generate pressures on the natural environment was introduced by the SIP report on the Tourism sector. As can be seen from a basic scheme taken from the SIP Tourism²⁸, different sets of activities have been distinguished with reference to the activities which form the Tourism sector: on one side there are the production activities at the service of tourism and on the other side there are tourists' activities; within the latter, furthermore, activities that take place "in the economic system" and other important activities (the so called "informal activities") have been distinguished²⁹.

This distinction is basically tantamount to identifying on one hand the production activities recorded in the national accounts system and on the other hand other possible activities that may

²⁶ Note how the sectors at issue are to be considered separately but not necessarily unlinked.

²⁷ It must be pointed out, for completeness, that not all dimensions of the definition of a sector can be reduced to the allocation of activities. Besides the physical flows in which the current functioning of the economic system is substantiated, indeed, there are in each sector accumulated stocks (machinery, vehicles, roads and other infrastructure). In general terms, the following criterion has been followed: when it is the existence of stocks that is a cause of environmental pressure, it is only the sectors using them that should be held as responsible for the same environmental pressure, even if the economic units that own them do not belong to the sector (one such case could be that of roads); when it is their construction or dismantling that is a cause of environmental pressure, both the user and the producer (of the construction or dismantlement service) sector should be considered responsible.

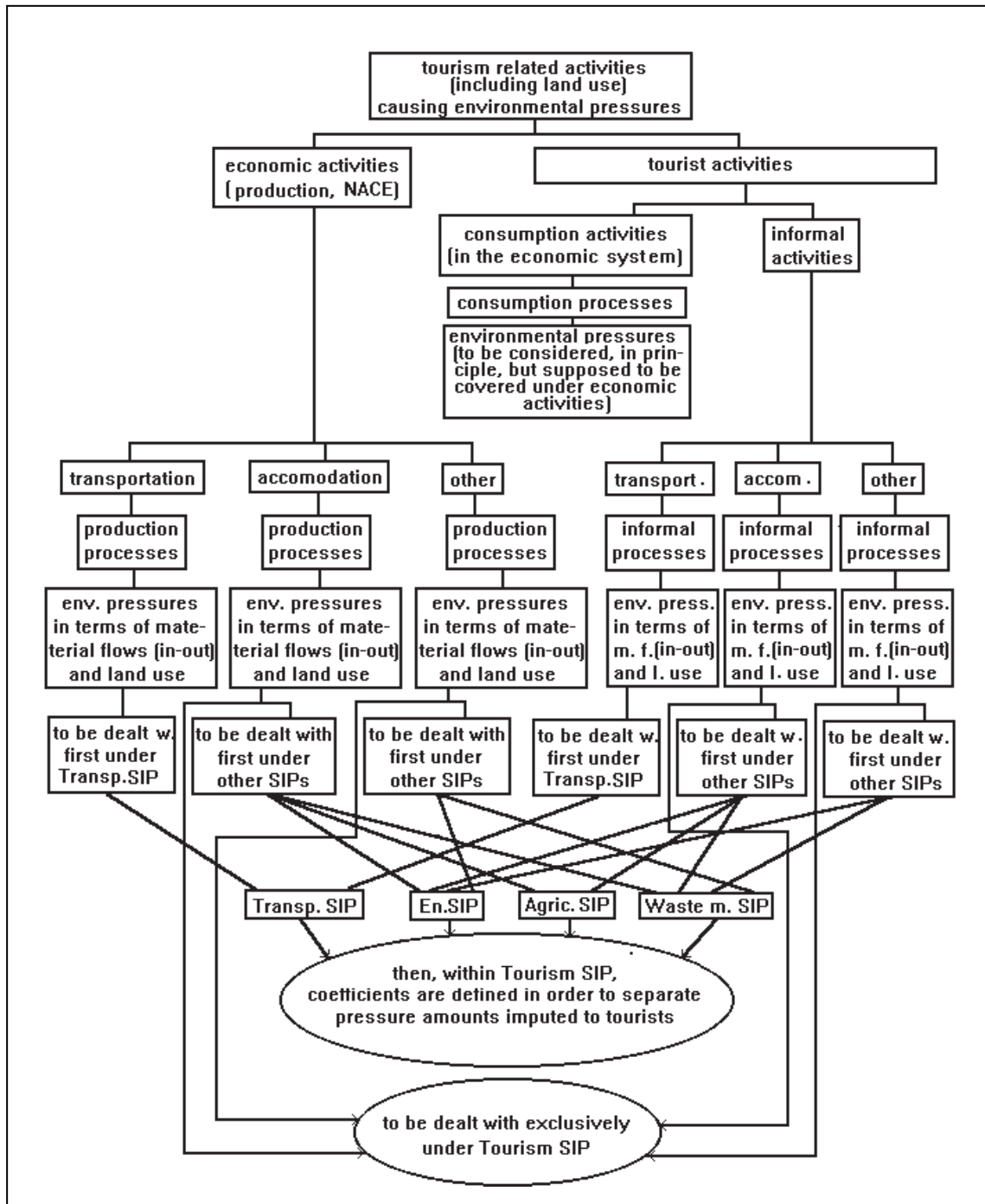
²⁸ See "Figure I.1. Delimitation and schematic representation of the environmental pressures due to the sector tourism", reported below.

²⁹ By "in the economic system" we mean that there is concomitance between the purchase and the use by tourists of the products supplied to them by economic activities. In practice, this happens whenever a service is purchased, whereas the use of material goods bought as such can be deferred in time with respect to the act of purchasing them; moreover there are tourists' activities whose relevance under the environmental profile does not depend on the use of any particular product such as for instance the lighting of fires in forests. In these cases the activities at issue are named "informal activities", as a juxtaposition to activities which immediately involve economic transactions, whose environmental pressures remain therefore attributed to production activity.

or may not have a counterpart in transactions recorded in this system, but which create environmental pressures to be considered in addition to those already associated to production activities. The practical implication of the distinction shown here relates to the fact that the identification of those activities that are not identified as taking place “in the economic system”, may be not immediate and may require “ad hoc” investigations.

By maintaining the approach adopted for the Tourism sector, for the examination of anthropic activities in order to identify environmental pressures caused by them, the distinction described above has been adopted systematically and applied to all the sectors considered. The suitability of including each activity in a given sector was assessed for each individual case in light of the criteria behind the definition of each sector examined.

Figure I.1 - Delimitation and schematic representation of the environmental pressures due to the Tourism sector



1.4.2 Production activities, principal, secondary and ancillary

The first step, in defining the boundaries of the sectors, was identifying the production activities to be considered. The reference for this purpose was provided by the European classification of economic activities (NACE Rev.1³⁰), which is the official and exhaustive nomenclature suited for the analysis of European production activities. Items were considered at the maximum level of detail possible, proceeding with allocating each of them (or fractions thereof) to one, or more than one, or none of the six sectors identified on a European level, in consideration of the influence that the corresponding policies can have on the activity at issue and therefore on the pressures that it creates.

The classification must ideally be applied with reference to “homogeneous” production units. This means, with reference to a generic economic production unit, that it is first of all necessary to identify, out of the activities carried out within it, the ones that provide the principal output. This allows to identify the activities that are typical of each sector, i.e. to identify its core, formed by the set of principal activities, which come under the influence of the corresponding sectoral public policies. Then, for each sector the secondary activities that are homogeneous to the principal ones, must be added to the core set of activities³¹. Thus, each sector constitutes, at this stage, an ideal group of homogeneous activities.

Some production activities that belong – when carried out as principal or secondary – to one of the six sectors considered on a European level, can also appear as ancillary activities in other sectors. It is advisable to identify these as well and define their status with respect to belonging or less to the various sectors. These are, indeed, the activities that can most frequently cause overlapping between the sectors, which would then remain unclear if they were not shown and considered separately³².

The separate consideration of secondary and ancillary activities is necessary for a correct application of the basic criterion underlying the delimitation of the sectors: for example it is impossible not to consider waste transport – an activity that is explicitly included in division 90 of the NACE Rev.1, “Disposal of solid waste, wastewater and similar” – in the Transport sector as well as in the sector of Waste Management³³.

The separate consideration of secondary and ancillary activities, however, brings both advantages and disadvantages from the point of view of statistical processing. The disadvantages are in the greater difficulty in calculating the economic and social aggregates for the sectors, such as output and employment; the data concerning these aggregates, in fact, are generally referred to groups of economic-legal units that have the same principal activity or the same type of products (homogeneous branches of production, that gather together similar activities carried out as principal or secondary activities). This difficulty mostly occurs for ancillary activities, as one cannot identify, according to national accounting rules, an output that is separate from that of the

³⁰ See Eurostat (1996). The NACE Rev.1 classification, arranged for the main purpose of specifying the groups of economic activities that is necessary to refer economic statistics to, is articulated according to the activities carried out by the production units and meets the need to have a language and standardised classifications available.

³¹ The approach described is the same applied, for example, for the construction of the Input-Output tables for homogeneous branches of economic activity.

³² Some processes that do not constitute separate “activities” according to the definitions of the National Accounting System of the United Nations (SNA 93), can be assimilated to ancillary activities for the purpose of delimiting the sectors. However these are clearly identifiable and distinguishable from the rest of the production cycle as working phases to which output is due (principal or secondary).

³³ Whatever the role (principal, secondary or ancillary) of this transport activity in the economic units in which it is carried out, it is under the direct and determining influence of transport policy; environmental pressure coming from this activity should therefore be accounted (also) in the Transport sector. Note that transport of waste is expressly mentioned in the chapter “Transport” in the 5EAP.

entire production process. This greater difficulty in calculation does not however also exist necessarily for the environmental pressures linked to the various activities, whose quantification should, instead, be easier. This is because building up the sectors according to the stated criteria, implies joining together into the same sector all the activities that are relatively homogenous from a technical point of view, thereby turning the contents of each sector into a less complex (more homogeneous) group of processes of transformation of energy and matter than that which would have resulted from a definition of the same sectors in terms of economic-legal units. This is an advantage from the point of view of the “feasibility” of the sectoral environmental pressure indicators, as the quantification of the pressures – typically based on information about the material input and output and via the use of technical coefficients³⁴ – is often easier for a grouping of similar processes rather than of similar activities. Naturally, given this “trade-off” between economic data and pressure data concerning the respective possibilities of calculation, the sector delimitation according to the criteria above favours first of all the actual construction of environmental pressure indicators, which is the final objective to which the methodological approach proposed here aims³⁵.

1.4.3 Households' activities

In order to complete the delimitation of the sectors – in addition to identifying the production activities for goods and services classified according to the ATECO 91, which form their central elements – in some cases the analysis explicitly took into account some activities carried out by households that come under the realm of sectoral policies but that are not economic activities.

These are activities generating environmental pressures additional to those that can be put down to production activities recorded by national accounts. They comprise the final consumption of material goods and energy supplied to households by economic units – in this case the most important aspect considered is provided by the fact that the pressures generated during the consumption phase of certain products are different from those generated during their production³⁶ – but also in activities that as such do not have any counterpart in terms of production, although their execution contributes – as for example in the case of some recreational activities – to satisfying households' needs.

Pressures deriving from households' activities have become a part of a given sector when the activity as such is a part of that sector.

With regards to the existence of activities of households that can be seen as own-production activities (that is, of production for own-consumption), the production phase has been split in concept from that of consumption, since the criteria set for the definition of the sectors have to be applied separately to production activities recorded in the national accounts and to consumption activities respectively.

³⁴ This is the case, for example, of air emissions calculated according to the CORINAIR system. Note that the discussion carried out here is the basis of the EPIS projects named above.

³⁵ The possible convergence towards a delimitation that is substantially adequate and feasible from all points of view (even if probably not optimal from any of them) – necessary for ending up to indicators referring to different dimensions but linkable, inasmuch as referring to the same groups of activity and actions – may only emerge from later further studies, in which the availability of data and the features and degree of their breakdown will play a fundamental role.

³⁶ The consumption of services provided by the activities included in the NACE Rev.1 do not create separate pressures, and therefore are not considered independently for the delimitation of the sectors, as – differently from the case of tangible assets and energy, that are consumed in a different time/place than that of their production – the pressure generated at the time of use of a service (for example, a trip in a taxi) coincides with the one due to its production, already accounted for among those in the relevant sector (in the example, that of Transport).

1.4.4 The attribution of principal production activities and households' activities to sectors: a unitary framework

1.4.4.1 General approach

The method used for attributing the activities to sectors is characterised by two main features:

- the specific identity of each sector is maintained – with a clear meaning for the pertinent indicators – through the consistent application of the defining principles;
- international comparability – an essential objective of the projects coordinated by Eurostat – is ensured.

As has already been mentioned, one of the basic criteria adopted is that of defining the boundaries of each sector in such a way that corresponds to the limits of sectoral policies; therefore the simultaneous presence, in full or in part, of the same activity (or process) in more than one sector has been without a doubt admissible each time such an overlap proved to be justified due to the range of influence of the respective sectoral policies; therefore an absolute value has not been given to the criterion – apparently adopted in some SIP projects³⁷ – of avoiding overlaps between sectors as far as possible and therefore the dual or multiple registration of the same pressures. Some overlaps cannot however be avoided, to the extent that they are present also in the delimitations adopted in the SIP projects that intended avoiding them. Overlaps between sectors, as already explained, do not constitute a problem as, if they are clear and explicit, it is possible to reconstruct the grouping conditions under which the indicators referred to the various sectors can be summed³⁸.

The NACE Rev.1 classification, to which reference has been made, in addition to being official and exhaustive with regards to production activities, has also allowed a good level of detail in the analysis. The breakdown made possible by NACE Rev.1 has however resulted to be insufficient in some cases, given the need, at times, to distinguish particular aspects of processes that are part of the individual activities. A further limit has also emerged in relation to the need to differentiate some environmental pressures also with respect to dimensions not considered in the NACE Rev.1 and belonging to the logic that forms the definition of this or that sector, as for example when it was necessary to enucleate a particular class of users or a particular type of demand for products of a given sector. Alongside production activities households' activities to be included in the various sectors were also considered, as previously stated.

The harmonised framework that has been defined for making the attributions of activities to the sectors consistent, incorporates the benefits, as already discussed, deriving from the introduction of some modifications of the definitions of the individual sectors proposed in the final reports of the SIP projects³⁹.

The framework for attributing the activities to sectors has also allowed to point out all the economic activities that cannot be associated, or can only be partly associated to the six sectors considered on a European scale. Among these there are surely many that generate considerable pressure on the natural environment (think for example of the important pressures generated by

³⁷ A substantial lack of agreement between the criteria adopted by the SIP for the various sectors, should be noted, but in some cases simply the absence of explicit criteria or the lack of consistency in their application.

³⁸ This is naturally a reference to indicators common to several sectors, referring to identical pressures.

³⁹ Some modifications can be traced to the greater analysis allowed by the ATECO 91, the Italian standard activities classification, compared to NACE Rev. 1, used on a European scale.

the health sector). These activities have been grouped, for the time being, into a further residual sector.

1.4.4.2 Activities carried out as principal activities and households' activities

On the basis of the criteria discussed previously, and therefore of the general approach outlined in the previous sub-paragraph, the harmonised framework of attribution to the sectors of production activities carried out as a principal activity and of households' "informal" activities contained in Table I.1 has been defined.

The columns of the table are headed with the six sectors of interest⁴⁰ – Agriculture, Energy, Industry, Waste Management, Transport and Tourism – plus a residual sector named "activities not attributed", that includes the activities that cannot be covered by any of the six sectors considered in the SIP projects.

The rows of the table contain, for the production activities, the economic activities according to the NACE Rev.1⁴¹ classification, specified each time at the lowest level of breakdown that is compatible with the univocal attribution; for example, the row is headed by a division when all the activities of that division belong to one or more sectors, while the groups are specified if at least one of them belongs to a different sector than the one to which the others belong, or is not attributed to any sector while the others are.

With regards to households' activities, the rows constitute a breakdown of the relevant entries/items, built "ad hoc" for the purpose of delimiting the sectors according to the general approach previously discussed with reference to this institutional sector. This presentation is the result of a breakdown of the entries/items, carried out by taking into account each time the activities identified as of interest for the various sectors considered⁴². The symbols, the labels and the shading used in Table I.1 have the following meaning:

- "x": indicates that all the activities included in the row entry fall within the sector to which the column is headed, and therefore all the pressures generated by them are pressures of that sector. When the activities are involved in more than one sector, there is more than one "x" on the same row;
- "pro-quota": indicates that the activities included in the row entry, and therefore each of the pressures generated by them, are only attributed to the sector for a quota. This quota is linked to a variable not considered in the NACE Rev.1, which corresponds, in broad terms, to a particular category of "users". In particular, in the case of Tourism, this occurs in all the cases in which the activity can concern tourists or not, as only the "quota" of activity carried out for this category of "users" belongs to the sector. Similarly, in the case of the Energy sector, the transport activity that belongs to the sector is the transportation of fuels;

⁴⁰ In addition to the five sectors covered in this report, in this and the following tables referring to the delimitation of the sectors (tables I.1-I.2), the Tourism sector is also included – for which it is necessary to refer to Eurostat (1999b) – in order to highlight also the overlaps (and minor changes) that involve this sector.

⁴¹ In the NACE Rev.1 the economic activities are grouped, from general to specific, into sections, subsections, divisions, groups and classes. The classification includes 17 sections, two of which produce 16 subsections, 60 divisions, 222 groups and 503 classes. The sections and the subsections are shown by an alphabetical code made up respectively of one and two capital letters, named tabulation codes and generally used in the publication of data. The divisions, groups and classes of activity are distinguished by a numerical code, independent of the alphabetical tabulation code. The classes are encoded with a four-figure number, the first two numbers identify the division, the first three figures identify the group.

⁴² The entries included stem in general from the recommendations in the SIP reports, suitably revised.

- “in part”: indicates that only some of the pressures generated by the activities included in the row entry are considered as pressures of the sector. This can occur as only some of the activities included in the entry come under the sector, or because they only involve some processes that take place in such activities;
- “residual quota” (only in the column “Activities not attributed”): stems from the fact that the activities included in the row entry can be attributed to the six sectors defined on a European level only for a quota part⁴³;
- “residual part” (only in the column “Activities not attributed”): stems from the fact that only some of the pressures generated by the activities included in the row specified entry can be considered as pressures of the six sectors defined on a European level;
- “quota of residual part” (only in the column “Activities not attributed”): indicates the simultaneous presence of the two types of “partial cover” defined in the two previous points;
- shaded cells: the shading signals that the attributions made are not totally compliant to the indications from the SIP reports. This is due to the need to introduce some adjustments compared to the results shown in those reports, due to, as already mentioned, the lack of harmonisation between the criteria used while carrying out the SIP projects for the various sectors and the consequent lack of homogeneity – starting with the definitions of the sectors – among the results achieved by these projects.

⁴³ This case only happens with some household activities other than energy consumption, since in all other cases also a “in part” attribution is found in the same row.

Table I.1 - Synoptic table of the allocation of principal activities to the sectors

1) Production activities		SIP SECTORS						Activities not attributed
		Agriculture	Energy	Industry	Waste Management	Transport	Tourism	
A	Agriculture, hunting and forestry							
01.1	Growing of crops; market gardening; horticulture	x	In part					
01.2	Farming of animals	x	In part					
01.3	Growing of crops combined with farming of animals (mixed farming)	x	In part					
01.4	Agricultural and animal husbandry service activities, except veterinary activities; landscape gardening	x	In part					
01.5	Hunting, trapping and game propagation, including related service activities	x	In part				Pro-quota	
02	Forestry, logging and related service activities	x	In part					
B	Fishing							
05.01	Fishing	x	In part				Pro-quota	
05.02	Fish farming	x	In part					
CA	Mining and quarrying of energy producing materials							
10	Mining of coal and lignite; extraction of peat		x					
11.10	Extraction of crude petroleum		x					
11.11	Extraction of natural gas		x					
11.12	Extraction of bituminous shale and sand		x					
11.2	Service activities incidental to oil and gas extraction, excluding surveying		x					
12	Mining of uranium and thorium ores		x					
CB	Mining and quarrying, except of energy producing materials							
13	Mining of metal ores		In part	x				
14	Other mining and quarrying		In part	x				
D	Manufacturing							
15	Manufacture of food products and beverages		In part	x				
16	Manufacture of tobacco products		In part	x				
17	Manufacture of textiles		In part	x				
18	Manufacture of wearing apparel; dressing and dyeing of fur		In part	x				

(continues)

Table I.1 (continued) - Synoptic table of the allocation of principal activities to the sectors

1) Production activities		SIP SECTORS						Activities not attributed
		Agriculture	Energy	Industry	Waste Management	Transport	Tourism	
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear		In part	x				
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials		In part	x				
21	Manufacture of pulp, paper and paper products		In part	x				
22	Publishing, printing and reproduction of recorded media		In part	x				
23.10	Manufacture of coke oven products		x	In part				
23.20	Manufacture of refined petroleum products - refineries		x	In part				
23.30	Processing of nuclear fuel		x					
24	Manufacture of chemicals and chemical products		In part	x				
25	Manufacture of rubber and plastic products		In part	x				
26	Manufacture of other non-metallic mineral products		In part	x				
27	Manufacture of basic metals		In part	x				
28	Manufacture of fabricated metal products, except machinery and equipment		In part	x				
29	Manufacture of machinery and equipment n.e.c.		In part	x				
30	Manufacture of office machinery and computers		In part	x				
31	Manufacture of electrical machinery and apparatus n.e.c.		In part	x				
32	Manufacture of radio, television and communication equipment and apparatus		In part	x				
33	Manufacture of medical, precision and optical instruments, watches and clocks		In part	x				
34	Manufacture of motor vehicles, trailers and semi-trailers		In part	x				
35	Manufacture of other transport equipment		In part	x				
36	Manufacture of furniture; manufacturing n.e.c.		In part	x				
37	Recycling		In part	x	x			
E	Electricity, gas and water supply							
40.1	Production and distribution of electricity		x					

(continues)

Table I.1 (continued) - Synoptic table of the allocation of principal activities to the sectors

1) Production activities		SIP SECTORS						Activities not attributed
		Agriculture	Energy	Industry	Waste Management	Transport	Tourism	
40.2	Manufacture of gas; distribution of gaseous fuels through mains		x					
40.3	Steam and hot water supply		x					
41	Collection, purification and distribution of water		In part	x			Pro-quota	
F	Construction							
45	Construction		In part	x				
G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods							
50.1	Sale of motor vehicles		In part					<i>residual part</i>
50.2	Maintenance and repair of motor vehicles		In part					<i>residual part</i>
50.3	Sale of motor vehicle parts and accessories		In part					<i>residual part</i>
50.4	Sale, maintenance and repair of motorcycles and related parts and accessories		In part					<i>residual part</i>
50.5	Retail sale of automotive fuel		x					
51.1 (excl. 51.12)	Wholesale on a fee or contract basis		In part					<i>residual part</i>
51.12	Agents involved in the sale of fuels, ores, metals and industrial chemicals		In part and pro-quota					<i>quota of residual part</i>
51.2	Wholesale of agricultural raw materials and live animals		In part					<i>residual part</i>
51.3	Wholesale of food, beverages and tobacco		In part					<i>residual part</i>
51.4	Wholesale of household goods		In part					<i>residual part</i>
51.51	Wholesale of solid, liquid and gaseous fuels and related products		x					
51.52 to 51.56	Wholesale of non-agricultural intermediate products, waste and scrap		In part					<i>residual part</i>
51.57	Wholesale of waste and scrap		In part		x			
51.6	Wholesale of machinery, equipment and supplies		In part					<i>residual part</i>
51.7	Other wholesale		In part					<i>residual part</i>
52.1	Retail sale in non-specialized stores		In part					<i>residual part</i>
52.2	Retail sale of food, beverages and tobacco in specialized stores		In part					<i>residual part</i>

(continues)

Table I.1 (continued) - Synoptic table of the allocation of principal activities to the sectors

1) Production activities		SIP SECTORS					Activities not attributed	
		Agriculture	Energy	Industry	Waste Management	Transport		Tourism
52.3	Retail sale of pharmaceutical and medical goods, cosmetic and toilet articles		In part					<i>residual part</i>
52.4 (excl. 52.48)	Other retail sale of new goods in specialized stores		In part					<i>residual part</i>
52.48	Retail sale of fuels for household use		In part and Pro-quota					<i>quota of residual part</i>
52.5	Retail sale of second-hand goods in stores		In part					<i>residual part</i>
52.6	Retail sale not in stores		In part					<i>residual part</i>
52.7	Repair of personal and household goods		In part					<i>residual part</i>
H	Hotels and restaurants							
55.1	Hotels		In part				x	
55.2	Camping sites and other provision of short-stay accommodation		In part				x	
55.3	Restaurants		In part				Pro-quota	<i>quota of residual part</i>
55.4	Bars		In part				Pro-quota	<i>quota of residual part</i>
55.5	Canteens and catering		In part				Pro-quota	<i>quota of residual part</i>
I	Transport, storage and communication							
60.1	Transport via railways		In part and pro-quota			x	Pro-quota	
60.21	Other scheduled passenger land transport		In part			x	Pro-quota	
60.22	Taxi operation		In part			x	Pro-quota	
60.23	Other land passenger transport		In part			x	Pro-quota	
60.24	Freight transport by road		In part and pro-quota			x		
60.3	Transport via pipelines		x			x		
61	Water transport		In part and pro-quota			x	Pro-quota	

(continues)

Table I.1 (continued) - Synoptic table of the allocation of principal activities to the sectors

1) Production activities		SIP SECTORS					Activities not attributed	
		Agriculture	Energy	Industry	Waste Management	Transport		Tourism
62.1	Scheduled air transport		In part and pro-quota			x	Pro-quota	
62.2	Non-scheduled air transport		In part and pro-quota			x	Pro-quota	
62.3	Space transport		In part			x		
63.11	Cargo handling		In part and pro-quota			x		
63.12	Storage and warehousing		In part and pro-quota					<i>quota of residual part</i>
63.2	Other supporting transport activities		In part			x	Pro-quota	
63.3	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.		In part				x	
63.4	Activities of other transport agencies		In part			x		
64	Post and telecommunications		In part					<i>residual part</i>
J	Financial intermediation							
65	Financial intermediation, except insurance and pension funding		In part					<i>residual part</i>
66	Insurance and pension funding, except compulsory social security		In part					<i>residual part</i>
67	Activities auxiliary to financial intermediation		In part					<i>residual part</i>
K	Real estate, renting and business activities							
70.1	Real estate activities with own property		In part					<i>residual part</i>
70.2	Letting of own property		In part				Pro-quota	<i>quota of residual part</i>
70.3	Real estate activities on a fee or contract basis		In part					<i>residual part</i>
71.1	Renting of automobiles		In part			x	Pro-quota	
71.2	Renting of other transport equipment		In part			x	Pro-quota	
71.3	Renting of other machinery and equipment		In part					<i>residual part</i>
71.4	Renting of personal and household goods n.e.c.		In part					<i>residual part</i>
72	Computer and related activities		In part					<i>residual part</i>

(continues)

Table I.1 (continued) - Synoptic table of the allocation of principal activities to the sectors

1) Production activities		SIP SECTORS						Activities not attributed
		Agriculture	Energy	Industry	Waste Management	Transport	Tourism	
73	Research and development		In part					<i>residual part</i>
74	Other business activities		In part					<i>residual part</i>
L	Public administration and defence; compulsory social security							
75 (excl. 75.12)	Public administration and defence; compulsory social security		In part					<i>residual part</i>
75.12	Regulation of activities of agencies that provide health care, education, cultural services and other social services, excluding social security		In part		In part			<i>residual part</i>
M	Education							
80	Education		In part					<i>residual part</i>
N	Health and social work							
85	Health and social work		In part					<i>residual part</i>
O	Other community, social and personal service activities							
90	Sewage and refuse disposal, sanitation and similar activities		In part		x	In part	Pro-quota	
91	Activities of membership organizations n.e.c.		In part					<i>residual part</i>
92.1	Motion picture and video activities		In part					<i>residual part</i>
92.2	Radio and television activities		In part					<i>residual part</i>
92.31	Artistic and literary creation and interpretation		In part					<i>residual part</i>
92.32	Operation of arts facilities		In part				Pro-quota	<i>quota of residual part</i>
92.33	Fair and amusement park activities		In part				Pro-quota	<i>quota of residual part</i>
92.34	Other entertainment activities n.e.c.		In part				Pro-quota	<i>quota of residual part</i>
92.4	News agency activities		In part					<i>residual part</i>
92.5	Library, archives, museums and other cultural activities		In part				Pro-quota	<i>quota of residual part</i>
92.6	Sporting activities		In part				Pro-quota	<i>quota of residual part</i>

(continues)

Table I.1 (continued) - Synoptic table of the allocation of principal activities to the sectors

1) Production activities		SIP SECTORS						Activities not attributed
		Agriculture	Energy	Industry	Waste Management	Transport	Tourism	
92.7	Other recreational activities		In part				Pro-quota	<i>quota of residual part</i>
93.01	Washing and dry-cleaning of textile and fur products		In part				Pro-quota	<i>quota of residual part</i>
93.02	Hairdressing and other beauty treatment		In part				Pro-quota	<i>quota of residual part</i>
93.03	Funeral and related activities		In part					<i>residual part</i>
93.04	Physical well-being activities		In part				Pro-quota	<i>quota of residual part</i>
93.05	Other service activities n.e.c.		In part					<i>residual part</i>
P	Activities of households							
95	Activities of households as employers of domestic staff		In part					<i>residual part</i>
Q	Extra-territorial organizations and bodies							
99	Extra-territorial organizations and bodies		In part					<i>residual part</i>
2) Household activities		Agriculture	Energy	Industry	Waste Management	Transport	Tourism	
2.1) Use/final consumption of material goods and energy produced in the formal economy								
	a) Use/consumption of material goods			In part			Pro-quota	<i>quota of residual part</i>
	b) Energy Consumption		x				Pro-quota	
2.2) Own production of goods and services not recorded in the national accounts and consumption thereof								
	a) Own production and consumption of agricultural goods; hunting and fishing not for sale	x					Pro-quota	
	b) Own production and consumption of energy		x					
	c) Own production and consumption of other goods						Pro-quota	<i>residual quota</i>
	d) Own production and consumption of transport services					x	Pro-quota	
	e) Own production and consumption of housing services						Pro-quota	<i>residual quota</i>
	f) Own production and consumption of waste disposal services				x		Pro-quota	
	g) Own production and consumption of other services						Pro-quota	<i>residual quota</i>

1.4.4.3 Attributions of the activities to the sectors different from those proposed in the SIP reports

In addition to the results summarised in Table I.1, the approach outlined above to the definition of the sectors – whose distinctive feature is the unitary character of the procedure of attribution of the selected activities – has also the effect of producing some specific differences compared to the SIP report proposals as far as the sets of activities that have to be considered characteristic of the sectors are concerned; such differences, highlighted by a grey background of cells in Table I.1, are summarised hereafter by sector.

Energy

The following entries in the NACE Rev.1, selected on the basis of the approach proposed here (see the Energy chapter in Part II), do not explicitly appear in the SIP report, but are actually consistent with the European project as they refer to the distribution of energy products: “50.50 – Retail sale of automotive fuel”; “51.12 – Agents involved in the sale of fuels, ores, metals and industrial chemicals” (in this case, the attribution to the Energy sector is pro-quota for the part referring to fuels); “51.51 – Wholesale of solid, liquid and gaseous fuels and related products.

The following transport and storage activities, selected on the basis of the approach proposed here, do not appear in the SIP report, but are consistent with the logic on the basis of which the sector is defined in the European project, which includes similar sea and waterway transport and via pipelines: “60.10 – Transport via railways”; “60.24 – Freight transport by road”; “62.20 – Non-scheduled air transport”; “63.11 – Cargo handling”; “63.12 – Storage and warehousing”. These activities are included for the part referring to transport and storage of energy materials.

Finally, on the basis of the approach proposed here, a “part” of all the activities included in other sectors – concerning energy consumption – has been attributed to the Energy sector, (attribution shown in Table I.1 with the caption “in part” in the column headed “Energy”).

Agriculture

The list of activities included in the sector Agriculture is not different from the one proposed in the SIP report.

Transport

On the basis of the approach proposed here (see the Transport chapter in Part II), it was decided to include, in addition to the units that belong to the NACE categories 60-62, some supporting and auxiliary transport activities belonging to the NACE 63 that are necessary for carrying out actual transport activities, such as, for example, the handling of goods (excluded are “Storage and warehousing” (63.12), and “Activities of travel agencies and tour operators; tourist assistance activities n.e.c.” (63.3)). Also the activities contained in the groups 71.1 and 71.2, concerning the renting of vehicles, have been included in the Transport sector. Finally, the consideration of waste transport activities resulted in the partial inclusion of class 90.00.

Industry

On the basis of the approach proposed here (see the Industry chapter in Part II), the Industry sector has been attributed parts of the classes “23.10 Manufacture of Coke oven products” and “23.20 – Manufacture of refined petroleum products”, which belong to the subsection “DF – Manufacture of coke, refined petroleum products and nuclear fuels” (entirely part of the Energy sector); these activities are included to the extent that the classes in question concern materials

used as such in strictly industrial processes (e.g. road construction), and not exclusively for their energy content.

Division “41 – Collection, purification and distribution of water” has been included in the Industry sector as it includes activities that make it possible to use a good such as water which would otherwise not be accessible: the collection and distribution of drinking water, in particular, has been assimilated to the production of mineral waters and soft drinks (class 15.99), an activity that the SIP report placed in the Industry sector⁴⁴.

Tourism

The following groupings of activities belong to section “H – Hotels and restaurants” in the NACE Rev.1, which is entirely attributed to the Tourism sector in the SIP report: “55.3 - Restaurants”; “55.4 - Bars”; “55.5 – Canteens and catering”. On the basis of the approach proposed here, these activities have been attributed “pro-quota” to the same sector as they are not exclusively for the benefit of tourists. This is consistent with the distinction used in the SIP report between tourists and other users/consumers, on the basis of which a quota of several other activities (transport, placement, recreational-cultural etc.) have been attributed to the sector.

Waste Management

Class “37.10 – Recycling of metal waste and scrap” includes the processing of waste and metal scrap and of used or new metal objects, for the purpose of transforming them into raw materials. This is considered as a true waste management activity, even if it is not intended to dispose of materials, but instead to use them again. The recovery and treatment activities carried out by public and private subjects are explicitly included in the definition of the Waste Management sector in the SIP report, even if the delimitation in terms of NACE categories is not consequential.

The activities in the class “37.20 – Recycling of non metal waste and scrap” – identical to the previous one with the only difference that it refers to different materials – are also included in the sector.

1.4.5 The attribution to sectors of production activities carried out as secondary and ancillary activities: a systematic description of the overlaps between sectors

In the SIP reports, the problem of how to consider, for the calculation of the sectoral indicators, the ancillary or secondary activities was not handled in a harmonised manner. This issue needs to be examined systematically as well, in a similar way to what shown above for the principal activities and for households’ activities.

1.4.5.1 Secondary activities

With regards to the secondary activities, they should in principle be selected together with the respective homogeneous principal activities and included in the sector to which the latter belong. This also implies, with reference to a given economic unit – say, of a local kind-of-activity unit (LKAU) – the exclusion of these secondary activities from the sector to which the principal activity of the unit belongs. However, in some cases it may be appropriate to derogate from this rule, in order to take into account, for example, that, in the case of a close technical and/or

⁴⁴ The purification activity is different from treatment as in division “90 – Sewage and refuse disposal, sanitation and similar activities”, as it is the depuration not of wastewater, but of water coming from the natural environment that can be thus used by man.

organisational inter-dependence between the various activities carried out by an economic unit, the sector policy referring to the principal activity can directly influence a secondary activity as well.

In Table I.2, the possible attributions of the secondary production activities to sectors are presented in a structured framework. In this table, each cell represents a possible combination of principal and secondary activities in an economic unit (LKAU). However, many of the associations that are theoretically possible among the principal and secondary activities, in reality may or may not occur or may be considered as insignificant. Therefore, as showing the attributions explicitly for all cases would overburden the presentation, we explicitly wrote in the cell the name of the sectors to which the activity is attributed, only when there are reasons to think that the association actually exists and is relevant (for instance because something is said about this association in a SIP report)⁴⁵. The general principle set out above implies that the activities carried out as secondary activities in an economic unit – whose principal activity is included in a sector identified in the row – are always attributed (and therefore so are the pressures deriving from them) to the sectors identified in the columns. As for the mentioned hypothesis of exceptions to the general rule of excluding secondary activities from the sectors in the rows, these correspond to the cells in which, in addition to the sector corresponding to the column heading, also the sector indicated in the row heading appears as well.⁴⁶

Table I.2 - Synoptic picture of the sectors of attribution for the secondary activities

Sector to which the principal activity of the unit belongs	Sector to which the secondary activities are homogenous						Activities not attributed
	Agriculture	Energy	Industry	Transport	Tourism	Waste Management	
Agriculture	-	Energy	Industry		<i>Tourism, Agriculture</i>	Waste Management	Not attributed
Energy		-				<i>Waste Management Energy</i>	Not attributed
Industry		Energy	-			Waste Management	Not attributed
Transport		m		-		Waste Management	Not attributed
Tourism	<i>Agriculture Tourism</i>			<i>Transport Tourism</i>	-		Not attributed
Waste Management		<i>Energy Waste Management</i>	Industry			-	Not attributed
Activities not attributed	Agriculture	Energy	Industry	Transport	Tourism	Waste Management	Not attributed

⁴⁵ On this matter, the precise identification of the cases to be taken into account should indeed be carried out on the basis of suitable quantitative information on the actual association between principal and secondary activities. Nevertheless, it is possible to hypothesise “a priori”, on the basis of qualitative reasoning, which are the combinations of principal and secondary activities that are not to be considered (in table I.2 those indicated by the empty boxes).

⁴⁶ In table I.2 these hypotheses are shown in italics.

1.4.5.2 Ancillary activities

According to national accounting schemes⁴⁷, an output for ancillary activities which is separate from that of the activity (principal and/or secondary) that they support “is not explicitly recognised and recorded separately”, differently from the case of secondary activities. Moreover all the inputs of a given ancillary activity “are treated as inputs into the principal or secondary activity which it supports” (§ 3.13 ESA). This would suggest the inclusion of these activities only in the sector that covers the principal activity they serve⁴⁸.

Adopting a similar conventional rule would eliminate complications of a practical nature when calculating the indicators for the economic dimension. However, this would not only distance each given sector even more from being made up only of technically homogeneous activities (as the ancillary activities that would be included are not usually homogeneous to the ones they serve), but would also be in contrast with the criterion of “range of influence of the policy” previously recommended, which would instead require an attribution of the ancillary activities to the sectors to which they are technically homogeneous⁴⁹.

Let us consider, in particular, the case of the choice by an economic unit to begin carrying out some ancillary activities (or specific phases of processing) themselves, rather than continuing appointing the work to specialised units that belong to another of the six sectors considered⁵⁰. In this case, if the activities at issue – which by their nature fall under the influence of the sectoral policy of their origin sector but are now carried out as ancillary activities – were to be excluded from the sector to which they are technically homogeneous, the corresponding environmental pressures would not only appear in the sector of the activities that they support, but also disappear from the sector to which the specialised units belong. In reality, whilst there would be no real change in the relationship between production and environmental pressures, there would be a mere move of the activity – and of the environmental pressures that they generate – from one sector to another, with consequent distorted signals by the sectoral environmental pressure indicators: these in fact would record, in the face of a deterioration in the “environmental performance” of the sector to which belongs the production activity that the activities that are now ancillary support an improvement of the sector to which the specialised units belong.

It therefore seemed appropriate to include the ancillary activities – or even the single processing phases that cannot be considered activities – in both the sector to which the production activity to which they give support belongs, and in the sector to which they are technically homogeneous⁵¹. Such a methodological choice, indeed, appears to have been regularly adopted, though not openly, in the SIP reports, with the exception of ancillary transport activities carried out by industrial and agricultural units out of their production sites, which is justified in the light

⁴⁷ See United Nations, 1993, §§ 5.9 – 5.16.

⁴⁸ As already mentioned, alongside the activities that respond exactly to the definition of “ancillary” activities, we can also place working processes and phases that a) are at the source of the finished product that characterises the production activity; b) though being typical of other sectors, they are maintained within the economic unit for mostly economic reasons (vertical integration; see Eurostat, 1996, page 17). For these working phases and processes too, it is not possible to identify a distinct output from the unit’s final one. If the products of these activities or processing stages are only partly internally used, and for the remaining part supplied to third parties, an autonomous activity is defined for the latter part (principal or secondary, according to the contribution to overall added value), subject to the rules already set up.

⁴⁹ In fact although the ancillary activities are influenced by the policies concerning the activities that they support, it is probable that they are even more so by those policies relative to the sector in which they would be inserted if carried out as a principal or secondary activity.

⁵⁰ Similar changes in the industrial structure are rather common in the mid-long term, the typical timeline for sustainability policies.

⁵¹ The appearance of this “double inclusion” is in no way disturbing, since it is a fact that the range of influence of policies, and their mutual interaction, depend on institutional settings such as the industrial structure of the economy. The overlapping in the system of sectoral pressure indicators have to take this fact into account, not to ignore it.

of the “reach-of-policy” criterion. The most relevant ancillary activities remaining, for which overlaps of the sectors arise, are therefore waste management activities.

I.5 The selection of indicators

I.5.1 The identification of a priority set of sectoral environmental pressure indicators: a preliminary step to assessing the basic information needs

The next step after the detailed definition of the sectors via the specification of anthropic activities included in them consisted in the identification of the most important environmental pressure indicators for each sector. This step, while allowing one to concentrate on the indicators to which priority must be given in constructing a system of sectoral environmental pressure indicators, also has the function of better defining the basic information needs, highlighting the ones to which responses must be given most urgently.

The problem of selecting the most important indicators was therefore faced, as had been done with the Eurostat projects carried out previously, with which however, it had not been possible to draft a tentative harmonised framework that could systematically organise the selected indicators for the various sectors.

While proceeding to the selection of the indicators, the completeness and exhaustiveness of the information provided by them was a specific objective to aim at, in order to avoid that the influence that the indicators can have on policies – given their role in the planning of these – may lead to a distorting form of limitation of attention to some aspects, ignoring others that should be considered.

Achieving the objective of completeness via a selection of sectoral environmental pressure indicators is a task that is made especially difficult, at the moment, by the still existing gaps in the basic information, and also by the limits pointed out by theoretical speculation about which is the group of ideal indicators for each sector and for each “environmental problem area”⁵².

It was decided, however, that the limits of the existing basic information should not constitute too strict a limit to the study about which are the indicators to favour. Moreover the analysis of availability of data needed to calculate the indicators was not undertaken – similarly to what was done in the PIP projects –, the goal being that of creating the basis, for the cases in which the data will actually turn out to be available, for the construction of indicators which are strong from an analytical point of view; for the cases in which, by contrast, data will be found not to be available, the output of the work will be a clear reference for the identification of the demand for basic information⁵³.

I.5.2 Guideline criteria for the selection of the indicators

The criterion of “analytical soundness”, previously mentioned with reference to the European PIP projects, constitutes – as an absolutely essential and irreplaceable requisite of any statistical

⁵² It appears immediately from the results of the PIP projects, that there are gaps due to which it is difficult to foresee the possibility of finding satisfactory solutions, except in the long term. These lacks appear not only in terms of lack of availability of data broken down so as to reconstruct the pressures of the six sectors taken into consideration, but in some cases they also comprise in the pure and simple inexistence, in any form and grouping level, of data referring to the phenomena of interest.

⁵³ Given the current degree of coverage of official statistical data on material, energy and “spatial” flows between economy and the environment, it is probable that numerous actual pressure indicators may be replaced by indicators referring to the driving forces that are at the source of them, or calculated in an indirect manner, starting from these, with the use of estimation techniques. This cannot however be considered satisfactory in the mid-long term, in which the need to increase the information basis should prevail.

variable to be taken on as an indicator for the analysis of a phenomenon – a prerequisite for the application of any other possible criterion to follow in the selection of sectoral environmental pressure indicators.

In order to identify a group of indicators that is quite limited and especially significant, attention must be placed above all on the criterion of importance of the indicators with respect to the “environmental problem areas” and the sectors considered.

This criterion comprises two aspects. The first concerns the size of the specific effect of the environmental pressure considered for the particular environmental problem that the indicator represents; in fact, many phenomena contribute to a given environmental problem, but only some of them have a significant effect⁵⁴. The second aspect concerns the total contribution of the sector to the generation of the environmental pressure under examination. In other terms, a phenomenon, in order to be selected as an indicator of environmental pressure for a given sector, in addition to having an important effect in general, must be able to be ascribed to a significant degree to the activities that belong to the sector. Let's take, for example, the “environmental problem area” of climate change. Various air emissions are responsible for the greenhouse effect, but the specific contribution of some of these emissions is higher than others; if we only took into account the specific effects of the various substances on the “environmental problem area” at issue, some indicators would be selected for a given sector even if the share of the total emissions of those substances that could be attributed to that sector were insignificant; on the contrary, other indicators would not be selected even if the share of the total emissions that could be attributed to the sector were significant. As the example shows, if we took into account only one aspect, it would be difficult to reach a result that would be useful in providing the sought-after information about environmental pressure of the sector under examination, referring to the “environmental problem area” considered. Only a selection that is based on an adequate consideration of both aspects can in fact allow the identification of an indicator that can be used successfully for describing the environmental pressure of a given sector in quantitative terms⁵⁵.

Both the aspects mentioned above were taken into consideration when carrying out the selection of the indicators, giving each a weight reflecting to the purpose of wishing to combine the two dimensions considered as essential in the 5EAP, i.e. the main “environmental problem areas” identified and the sectors of intervention that are considered to be strategic.

In the European PIP projects, as previously mentioned, in addition to “analytical soundness”, a criterion adopted here, “political relevance”⁵⁶ and “elasticity of response”⁵⁷ were also identified as guideline criteria for the selection of indicators.

With regards to this last criterion, in principle it should have an important role in a development phase of the sectoral environmental pressure indicators system that would involve not only National statistical institutes or other research institutes, but also policy players having the capacity of defining and undertaking the necessary “response” actions, in the various significant territorial contexts. Even if this criterion in itself does not allow us to obtain a selection of

⁵⁴ Note how the size of the pressure is different from the “degree of correlation”, an element that is at the base of the “analytical soundness” criterion (see what was previously said about the European PIP projects).

⁵⁵ On a European scale, the second consultation of the SAG (see what was previously said about the PIP projects) has produced important information, that is limited to the importance of the indicators for the various “environmental problem areas”; it is necessary, instead, that this information be used in combination with an assessment of specific importance of the pressures in relation to each sector.

⁵⁶ I.e. the importance that could be attributed to a certain indicator (in relation to the “environmental problem areas”) by a hypothetical decision-maker.

⁵⁷ I.e. the possibility of undertaking an action that considerably reduces the extent of the environmental pressure shown by a certain indicator.

indicators that is better from the point of view of their capacity to describe the situation, it will be suitable in relation to the need to identify those contexts for which it is possible, not only to acknowledge the situation, but to take effective action to considerably reduce the environmental pressure shown by the indicators themselves.

With regards to “policy importance”, this is a criterion that had a clear meaning in the PIP projects, within which an attempt was made – using this criterion – to consider the point of view of a hypothetical decision maker. At this stage of research, however, the objective is to identify, technically speaking, which information is the most representative of the problems that have already been identified as priority ones on a policy level, starting with the 5EAP⁵⁸.

1.5.3 Taking stock of the European projects results and their harmonisation

The criteria for selecting the indicators discussed in the previous paragraph were not applied within the context of a study that was set up “ex-novo”, but within one in which the task was grafted onto the applications already carried out on a European scale by means of the projects that were mentioned previously.

Practically, taking into account the issues that characterised the development of these projects, the further steps that appeared to be necessary consist in the systematic reconsideration of:

- the applicability to each sector, and the importance for it, of each of the indicators submitted to the SAG in the second consultation;
- the applicability to each sector and the importance for it, of the indicators considered by Eurostat – following the second consultation with the SAG – as the most relevant for each “environmental problem area”⁵⁹;
- the ability of the individual indicators proposed for the various sectors in the respective SIP reports to actually represent the contribution of the sector to the “environmental problem area”.

The three groups of indicators that are referred to in the three points listed above – considered, as stated above, for each sector – are not independent and show substantial intersections. The source list of the last two groups (with the exception of the indicators proposed “ex novo” in the SIP reports) is in fact the same, i.e. the one indicated in the first point⁶⁰.

It is also necessary to take into account that, as the drafting of the SIP reports took place before the second SAG consultation was concluded, these reports not necessarily reflect the results of the consultation itself; therefore the indicators considered to be the most important for each sector in relation to each “environmental problem area”, may not always come under the final ones considered to be the most important by European experts for the same problem area.

⁵⁸ As in the PIP projects, no attempt has been made here to specify the individual indicators as to make them actually computable with existing data. Rather it is the reason why they may or may not be relevant (i.e. the importance of the pressures or driving forces expressed) that have been investigated. This clearly provides guiding indication for a better specification, as this must be done vis-à-vis the available data in a way that keeps as much as possible the meaning of the theoretical indicator.

⁵⁹ For these indicators Eurostat has drawn up the “Methodology Sheets”, as mentioned previously.

⁶⁰ The selection of the indicators produced by the SIP reports with specific reference to the sectors is mostly based on the list of about 300 indicators selected by Eurostat to be submitted to the SAG for the second consultation, even though in this selection there are some “new” indicators as well. Moreover, in the SIP projects, several indicators are redefined to maximise the significance for the specific sector concerned, as the indicators included in the SAG list had not been conceived by making a systematic reference to the sectors. With regards to the indicators in the “Methodology Sheets”, these have undergone in some cases some slight alterations in the definition compared to the original list.

One element that deserves special attention is the fact that in the European projects carried out previously, the indicators of the list submitted to the SAG in the second consultation, though assessed under both aspects, as above, of the criterion of importance (in relation to “environmental problem areas” and the sectors under consideration), were done so separately, or from different viewpoints in the two different contexts (mainly in relation to the “environmental problem areas” in the case of the PIP projects, and above all in relation to the sectors in the case of the SIP projects).

From the overlaps between the separate lists defined on a European level, it has however been possible to draw some important approximate elements for the selection made within the project carried out at Istat: in particular, it was possible to take into account the implicit assessments stemming from the inclusion or exclusion of various indicators in the lists of the “Methodology Sheets” and of the SIP reports: those included in both lists could be considered as a “core set” of indicators especially significant⁶¹; for those that were instead included in only one of these two lists, special attention has been paid, keeping in mind the asymmetry between the two different contexts within which they were selected, so that, depending on the list that they were not included in, the aspect of importance in relation to the “environmental problem area” or that of the importance in relation to the sector was reconsidered.

These elements were only assigned a relative value, proceeding with an independent evaluation of each indicator’s correspondence to the criteria set out above, independently of the presence or not-of the indicator in the various lists.

In general, as indeed for the delimitation of the sectors, the consistency of the choices in selecting the indicators referring to the various sectors is not guaranteed from the juxtaposition of results of independent assessments, but can only emerge from a process of comparison between the definitions and the consequent adjustment of the choices.

Also, the problem of consistency, particularly in some cases, occurred for the definition of the “environmental problem areas” even before that of the single indicators⁶².

With regards to the possible differences from the results of the European projects carried out beforehand, practically speaking, the following possibilities were considered:

- to include certain pressures in some sectors – not included in the SIP reports – even more so if included in the “Methodology Sheets”;
- to exclude certain pressures from some sector/”environmental problem area” combinations, to the extent that they appeared to be not significant in the light of the definitions adopted for the latter or of the actual contribution of the sector;
- to represent the same pressures with slightly different indicators, to the extent that it appeared that more suitable formulations or units of measurement could be proposed.

⁶¹ Although few, there are cases in which an indicator included in both lists has not been selected, as it was not consistent with the definition of the corresponding “environmental problem area”.

⁶² The reference point for the harmonisation of the way the “environmental problem areas” are conceived for the different sectors are the TEPI publications (Eurostat 1999a, b, c and 2001) and the Methodology Sheets (Eurostat 1998a); some specifications that seem necessary are reported in paragraph I.5.4 below.

1.5.4 Some observations on the definition of the “environmental problem areas”

On a very general level of analysis, it can be pointed out that the definition of the “environmental problem areas” does not respond to a single criterion, but rather to various different criteria. In some cases the focus is on a quite specific and well-identified ecological problem (Climate Change; Ozone Layer Depletion); in some others on more general categories of undesired qualitative and/or quantitative changes of the natural environment (Loss of Biodiversity; Resource depletion); some “environmental problem areas” are identified by making reference to specific environmental media being deteriorated (Air pollution; Water pollution and water resources); some others are identified in terms of territorial entities suffering as a whole the negative consequences of human activities (Marine environment and coastal zones; Urban environmental problems and noise); others represent classes of pressures and driving forces that cross-cut all geographical and environmental media classifications (Dispersion of toxic substances; Waste)⁶³.

Indeed, given the heterogeneity and complexity of the natural environment itself and the relations that the anthropic system has with it, the lack of a single criterion for defining “environmental problem areas” is due to a large extent to the very nature of the matter and probably just unavoidable.. Unlike the case of the sectors, it seems to be simply not possible to identify – for the sake of harmonisation – a criterion that makes the “environmental problem areas” correspond to e.g. a systemic partition of the natural environment in the same way as sectors are a systemic partition of anthropic activities that generate pressures⁶⁴. What appeared to be important, nevertheless, is that this complexity should not prevent the interpretation itself of the “environmental problem areas” from being as straightforward as possible.

It was noted, in particular, that the universe on which the “environmental problem areas” insist is not always the very natural environment, as there are some, like Waste, Urban environmental problems and noise, Resource depletion and Dispersion of toxic substances, that are to some extent focused on the anthropic side of the economy-environment interface.

An attempt has been made, therefore, to clarify these aspects, starting, first of all, from consideration of the TEPI publications (Eurostat 1999a, b, c and 2001) and the Methodology Sheets (Eurostat 1998a), which have been looked at, as mentioned above, as the main reference for the harmonisation of the results of the SIP projects. In addition to this, the main criterion has been followed of trying to distinguish as much as possible human from ecological problems; to that end, clear reference has been made to the fact that the distinction between economic sectors and “environmental problem areas” ideally corresponds to the conceptual boundary between the anthropic system – definitely divided into sectors – and the environmental system – partitioned into not so strictly defined “environmental problem areas”.

The following remarks aim at making the interpretation of the “environmental problem areas” clearer, in view of arriving at a more systematic selection of indicators throughout the sectors and the “environmental problem areas”.

⁶³ Going further in an attempt to find more appropriate criteria for defining “environmental problem areas”, one could observe, for instance, that Loss of biodiversity is “per se” much more an ecological problem than Resource depletion is, that urban areas produce more than suffer environmental pressures, that Dispersion of toxic substances is one of the possible consequences of the existence of waste which make the latter a problem (and perhaps the two should not appear, from this point of view, in the same list), etc..

⁶⁴ The latter partition, based on the reach-of-policy criterion, is not such, however, as to define sets that are mutually exclusive and exhaustive of the whole, as already pointed out.

Resource depletion

Resource use, from extraction to final consumption, generates a wide range of environmental pressures that concern all “environmental problem areas”. Indicators of the intake of resources belonging to the ecosystems have a meaning as general indicators of driving forces, as it is physically impossible to use these natural resources without implying qualitative changes in the ecosystems from which they are taken and the ones to which they will return – sooner or later – in different forms from the original ones. In a context where actual pressures on the environment are described as much as possible in a detailed way, however, such aggregate and indirect measures would not add much.

Therefore, the problem area of Resource depletion was understood in the present study as referring in particular to the availability of natural resources, both renewable and non-renewable, for human utilisation, and hence mostly to the quantitative aspect of their depletion. The problem of resource use, put this way, is a problem of sustainability of economic development with regards to the physical input flows – materials, energy and space – needed to carry out economic activities; the qualitative aspects can however be relevant for example for the water resource and for soil as the changes in the quality of these resources imply changes in their availability for specific uses⁶⁵.

The set of indicators present in the “Methodology Sheets” was found as substantially consistent with this interpretation of the “environmental problem area” at issue; for instance, the use of renewable resources is considered as being relevant only to the extent to which their depletion exceeds regeneration (e.g. “timber balance”)⁶⁶. However, the choice of defining some indicators (energy consumption, water consumption), as ratios of the quantities of the resources used or consumed to the size of the country’s population appeared to be not corresponding to this approach: consumption should be related, instead, to the local availability of the resources themselves (specifically, to their ability to regenerate, in the case of the renewable resources⁶⁷). Our solution was therefore to express the indicator in absolute quantities rather than per capita, as these can still be compared with indicators significant for the renewal of the resource (e.g., in the case of groundwater, rainfall).

Another useful clarification concerns the distinction between “direct intake” and “consumption” indicators⁶⁸. There are two main reasons why the consumption of a given natural resource by a national sector can be different from its direct intake by the same sector⁶⁹:

⁶⁵ For example, soil degradation has consequences on its availability for agricultural use.

⁶⁶ The same should not apply to indicators referring to quantitative use of resources relevant for other “environmental problem areas”, such as for instance in the case of the “overfishing” indicator defined for the “Marine environment and coastal zone” problem area, which has appropriately been redefined as “fishing pressure” in TEPI (Eurostat 2001).

⁶⁷ This is acknowledged also in TEPI: “a more meaningful indicator would compare abstraction of water to the rate at which water, and in particular ground water, is renewed, but the necessary data is not available” (Eurostat 2001, p.8). It can be noted that the same would be even more valid if our aim were to maximise the significance of the indicators from a purely ecological point of view, as the number of persons who use a given quantity of a resource is fully independent from the ecological relevance of that quantity.

⁶⁸ For example, we can make reference to water abstraction, which we interpret as defined on the basis of the source (i.e. referring to direct intake from nature only) and indifferent as to what it is done with it (i.e. whether finally consumed or passed on to other parts of the anthropic system), or to water consumption, which is indifferent with respect to the provenience of the water but depending on the destiny.

⁶⁹ Consumption may be greater or also smaller than direct intake depending on the way it is defined. Consumption could e.g. be understood as total throughput, or also as final use only, where the latter would be, for a sector that directly takes the resource from the natural environment, what remains after it has passed part of the same resource on to other sectors. Only in the latter case consumption can be added through sectors without double counting. It is quite important that in the formulation of indicators the meaning given to this word be specified.

- exchanges between national sectors: some sectors produce – i.e. take from nature – resources for others to consume;
- international openness of the economy: most resources are traded internationally;

of course, the first reason disappears when the whole of a national economy is considered.

Only the indicators expressing direct intake give information on the immediate pressure on natural resources by a sector or a nation; this information however might not be very significant from the point of view of the responsibility of a national sector from a global availability of resources point of view; on the contrary, for user sectors, consumption indicators are particularly interesting from this point of view. Therefore, it was found advisable, when talking about resource depletion, always to keep the two aspects distinct, and possibly represent both, thoroughly specifying the notion of consumption adopted, since the significance of the indicators, in general, depends on how consumption is defined.

Dispersion of toxic substances

The world economy produces tens of thousands of synthetic chemical substances, and each year, hundreds of new substances are created⁷⁰. Many of these substances, sooner or later, end up in the natural environment, where they are diffused and/or concentrated, producing effects in many different ecosystems. Many return to man through water, air and food, and can thus have serious consequences for human health.

In order to reduce the number of indicators, the substances emitted are not usually considered individually, but are instead collected into more or less homogeneous groups (e.g. pesticides, heavy metals, radioactive materials, etc), so that for this “environmental problem area” indices are more often used than simple indicators. As TEPI states, however, “describing this complex policy field with a handful of indicators is an almost impossible task”. “Most of the indicators [...] can only give a rough indication of the amount of key toxic substances present in our economy. Such indicators can rarely be weighted by toxicity, nor can they take account of cumulative effects. Problems of data availability and the lack of consensus on weighting schemes do not yet allow indicators describing the risk posed to human health and ecosystems by these groups of chemicals to be calculated in a way that is beyond scientific debate” (Eurostat 2001, p. 39).

The complexity of the matter suggested some general reflections, that appeared to be useful in order to better specify this “environmental problem area”⁷¹.

It was noted that existing aggregate indices considered for this “environmental problem area” are mostly based on knowledge concerning the effects of the different substances on human health. This is not surprising, as sufficient knowledge may be more easily available for such a specific (and well-studied) range of effects than for general consequences on the natural environment⁷². Indeed, for representing the latter kind of consequences by means of aggregate indices, not only enough knowledge about whether and to what extent toxic substances reach and affect species and

⁷⁰ For a discussion of the meaning of “toxic” reference can be made to TEPI (Eurostat 1999c). It seems useful here to recall that no substance can be called toxic in general, irrespective of the quantities and the organisms concerned and that all substances may be lethal after a certain quantity.

⁷¹ These reflections seem to be helpful also with reference to other “environmental problem areas” and for the definition and selection of environmental indicators in general.

⁷² Similarly, valid synthetic environmental pressure indices can be and have indeed been defined with reference to quite specific environmental problems, for which sufficient knowledge on their causes is available; examples of this, concerning “environmental problem areas” other than the one dealt with here, are the indices developed for global warming and for stratospheric ozone depletion. Nevertheless, also for these specific indices there are uncertainties.

ecosystems would be needed, but also a universally agreed evaluation of the ecological importance of each of the species and ecosystems affected by the pollutants at issue.

It was also noted that many negative direct and indirect ecological effects of the discharge of toxic substances into the environment are or can be quite well represented with respect to “environmental problem areas” that focus on specific environmental problems or ecosystems; indeed, environmental pressures due to the dispersion of toxic substances are, at least partly, already represented by indicators proposed (or which, if necessary can be defined ad hoc) with reference to other “environmental problem areas”.

For these reasons, it seemed advisable that the issue of the dispersion of toxic substances and their effects be tackled and developed in the future in a way structured according to the following pillars:

- that the “environmental problem area” Dispersion of toxic substances concern mainly the danger for human health indirectly or directly deriving from the diffusion of highly toxic substances into the natural environment. The search for indices based on weighting coefficients that represent the toxicity of various substances for the human body is thus not only justified but encouraged. This should simplify the task from a practical point of view. Besides, it does not seem useful to duplicate the information already contained in aggregate indices with the adoption of specific indicators for individual substances, even when the particular importance of the contribution of a specific sector to the emissions of a specific substance is known⁷³;
- that aggregate weighted indices meant to represent the general significance for the natural system of the dispersion of toxic substances be not the main focus of research, and resources be dedicated instead to try and define, in relation to the problem areas for which the dispersion of toxic chemicals is a relevant pressure, the specific problems due to this family of phenomena for which it may be appropriate to look for aggregate indices based on scientific knowledge. The same should be done for the area “Dispersion of toxic substances”, for problems other than human health, not covered by other “environmental problem areas”;
- more in general, not to adopt synthetic indices for environmental pressures that are not specific enough for the problem of aggregation to be solvable on a purely scientific basis. When the problem area is too encompassing (e.g. Loss of biodiversity, Marine environment and coastal zones) it seems advisable to keep as much as possible separate all possible pressures⁷⁴.

Urban environmental problems and noise

Eurostat’s selection of the most significant indicators for this “environmental problem area” includes both indicators concerning the pressures on the urban environment (mainly caused by activities carried out within it) and indicators that refer to the pressures that urban settlements produce on the natural environment in general.

⁷³ This applies for example to heavy metals, but also to persistent organic pollutants.

⁷⁴ This approach, indeed, has been followed whenever possible, given the constraints provided by the proposed lists of indicators, when dealing with other “environmental problem areas” for which the dispersion of some toxic chemicals proved to be a relevant environmental pressure. An example is the case of the discharge of heavy metals, for which indices have been adopted only for this “environmental problem area”, while for the others the indicators are “by metal”.

In reality, the main environmental pressures that the urban environment suffers are generated within its boundaries, while not all the pressures produced by urban settlements remain within these boundaries, but are instead widely transferred to the outside natural environment. Given the necessary distinction between the two aspects, the concept of “pressures suffered” was found as the appropriate basis for the definition of this “environmental problem area”. The approach followed has been driven by the basic distinction between economic sectors and “environmental problem areas”. Indeed, cities as a whole, as producers of pressures on the natural environment, are closer to a sector rather than to an “environmental problem area” and the environmental pressures that they generate can be related to several “environmental problem areas”⁷⁵; vice versa, the urban environment as a recipient of these pressures can be characterised in geographic terms (similarly to the problem area “Marine environment and coastal zones”), as a space of special interest as it is particularly “sensitive” to environmental deterioration, due to the greater population density and the cultural and artistic heritage present in it.

One example of what this entails for the selection of the indicators is that the emissions of carbon dioxide from urban areas, included in the “Methodology Sheets” as an indicator of the contribution by the urban environment to the greenhouse effect, are not to be considered relevant for the “environmental problem area” at issue, similarly to the case of “Air pollution”.

Waste

For a correct definition of this “environmental problem area”, it was found essential to take into account the definition adopted in the Directive 75/442/EEC, according to which waste is any substance or object which the holder discards or intends or is required to discard. Generally speaking, waste is not necessarily identified, in this definition, as direct flows to the natural system; as a matter of fact, the overall regulation tends to transform what is commonly understood to be useless waste into a resource and aims at maintaining reusable materials and energy within economic system cycles, for example favouring the possibility of recovering resources even in the final disposal stage, as in the case of energy obtained from the incineration of waste.

Another key-reference considered was the fact that “Waste Management”⁷⁶ was one of the sectors in which the economic system was divided and for which sectoral environmental pressure indicators were to be developed. In identifying the environmental pressures of this sector with reference to the “environmental problem area” Waste, the SIP Waste Management has defined waste as “solid or liquid, useless, bulky and generally non-hazardous materials that must be thrown away and stored permanently in specific sites”; in other words, the focus here is on materials that are discharged in dumps without further treatment other than that possibly already undergone, and the environmental pressure that is associated to this “environmental problem area” is, consequently, referred to the space occupied by final solid residuals in management operations. As a matter of fact, in the SIP reports the depositing in the dumps has been considered as a flow towards the natural environment, a form of return to it.

It is consistent with the European Community legislation, however, and seemed recommendable from a methodological point of view, to characterise waste as flows (or stocks, for the waste accumulated in managed landfills) within the anthropic system, generated by human activities and directed at elements of the anthropic system itself that have the task to manage them

⁷⁵ As a matter of fact, the environmental pressures generated by urban activities are mostly covered by the sectoral indicators, which, however, do not highlight the specific contribution of cities is not.

⁷⁶ See Part II.

(being specialised or not in doing that). Flows towards the natural environment only occur at the stage of final disposal, where waste ceases to exist as such and the materials they are made from are transformed into emissions, effluents, ashes, percolate, rubbish, etc., i.e. actual pressures to be related to the specific “environmental problem areas” involved.

It seemed preferable, then, to consider waste as flows of materials within the anthropic system. In this sense, an approach according to which the “environmental problem areas” represent a partition of the natural environment could hardly be applied to Waste. Nor could Waste be likened (unlike Waste Management) to a sector, since waste are not a group of activities; they are, instead, flows that are generated by all the sectors, including the Waste Management one⁷⁷).

In reality, the generation of waste is rather a “driving force”, of particular significance, to the point that the fact that a specific “environmental problem area” is dedicated to it is justified. The sector Waste Management, in turn, is by definition the sector in which waste generated by the rest of the economy run together to be transformed into emissions etc, i.e. that in which these important driving forces are transformed into (reduced to minimized) actual pressures.

The depositing in dumps was not considered, in this formulation, as a true final disposal (as is incineration, for example), but instead as a stocking of waste (as long as the dump is managed) or a management operation like others (see Part II), the specific pressures of which were to be attributed to the Waste Management sector. The occupation of space, which the SIP report on Waste Management concentrated on, was considered to be an environmental pressure in itself – generated by the specific way of management represented by landfill – to be related to the specific “environmental problem areas” for which land use constitutes a crucial element⁷⁸.

1.5.5 The selection of the indicators for each sector: formulation of a unitary framework

Table I.3 summarises in a unitary framework the result of the selection process for the most significant indicators for the five sectors dealt with in the present report⁷⁹; the details of such selection process are reported in Part II.

In order to aid comparison between the choices made for the various sectors, in the table a single denomination, common to all sectors, was adopted for indicators aiming at representing the same environmental pressure but present in a variety of different forms in different papers. As can be seen in the table, many indicators are in fact common to several sectors, and this is the natural consequence of the fact that the pressures that the various sectors have on the environment are the same, or at least similar. Many indicators, moreover, are common to several “environmental problem areas” both because the same type of material exchange between economy and environment is often at the basis of more than one phenomenon of environmental deterioration, and because there are, as between the sectors, overlaps and complex relations between the various “environmental problem areas”.

In general, in the event of disagreement between the various sources, and without stronger evaluation elements, the formulation contained in the “Methodology Sheets” – where available -

⁷⁷ The part due to this sector is minimal and is given by additional waste that the specialised sector generates while managing the waste received from other sectors (e.g., sludge resulting from wastewater treatment, as well as waste from auxiliary activities of an administrative nature carried out in the same specialised sector).

⁷⁸ Depositing waste in a dump causes also environmental pressures other than occupation of space, which should be related to specific “environmental problem areas” such as “Loss of biodiversity” (for the influence that the presence of dumps has on the surrounding environment), “Water pollution and water resources” (for any possible percolation), “Climate change” (for the emissions of methane), “Air pollution” (for dust), etc.

⁷⁹ For the indicators concerning the Tourism sector, reference is made to the SIP Tourism report (Eurostat 1999b).

has been adopted, as these always contain specification for the definition and the unit of measurement to be used which are much more accurate than those in other documents.

In any case, the references to sectors have been removed – except for where they were essential for the initial definition of the indicator, i.e. the identification of the environmental pressure itself; therefore the references to the sectors remain implicit⁸⁰, and the same applies to the reference to the accounting period, that is always intended as the year. As far as the indicators selected for the Transport sector and specified identically with reference to several transport modes are concerned (road, rail, air, sea, inland waters), this reference has been suppressed in the table; more in general, all specifications such as “by economic activity” and the like have been suppressed as well.

⁸⁰ The same conventional rule is adopted in Part II, where it is obvious that one must refer the calculation of the indicator selected to the activities belonging to the specific sector examined, and not to others; for example it was considered not necessary to specify “Development along the coastlines of infrastructures for the energy sector”, “Development along the coastlines of transport”, “...of agriculture” and so on. On the other hand, as certain indicators are significant for certain sectors if the latter contain specific activities that are or may be responsible for the pressures represented by those indicators, often these activities are specifically mentioned.

Table I.3 - Synoptic table of the indicators chosen as most relevant by sector (the shaded rows are relative to driving forces)

Environmental problem area	SELECTED INDICATORS	SECTORS				
		Energy	Agriculture	Transport	Industry	Waste management
AIR POLLUTION	Emissions of nitrogen oxides (NO _x)	X	X	X	X	X
	Emissions of non-methane volatile organic compounds (NMVOCs)	X	X	X	X	X
	Emissions of particles	X	X	X	X	X
	Emissions of sulphur dioxide (SO ₂)	X		X	X	X
	Emissions of carbon monoxide (CO)	X		X	X	X
	Emissions of ammonia (NH ₃)		X		X	
	Emissions of amines (methylamines)				X	
	Coal and oil products consumption	X		X	X	
	Total electricity consumption	X				
	Gasoline and diesel oil consumption by road vehicles			X		
	Primary energy consumption	X				
CLIMATE CHANGE	Emissions of Carbon dioxide (CO ₂)	X	X	X	X	X
	Emissions of methane (CH ₄)	X	X	X	X	X
	Emissions of nitrous oxide (N ₂ O)	X	X	X	X	
	Emissions of sulphur oxides (SO _x)	X		X	X	
	Emissions of nitrogen oxides (NO _x)	X	X	X	X	
	Emissions of aerosol particles		X	X	X	
	Emissions of chlorofluorocarbons (CFCs)			X	X	X
	Emissions of non-methane volatile organic compounds (NMVOCs)			X	X	
	Emissions of Carbon monoxide (CO)		X	X		
	Emissions of hydrochlorofluorocarbons (H-CFCs)				X	
	Emissions of fluorocarbons				X	
LOSS OF BIODIVERSITY	Protected area loss, damage and fragmentation	X	X	X		
	Clearance of natural & semi-natural forested areas		X			
	Fragmentation of forests & landscapes by roads/intersections	X		X		
	Pesticide use on land		X	X		
	Wetland loss through drainage	X	X			
	Loss of forest diversity - increase in exotic monoculture		X			
	Loss of genetic resources		X			
	Increase in cultivation of hybrid cultivars		X			
	Riverbank loss through artificialisation			X	X	
	Agriculture intensity: area used for intensive arable agriculture		X			
	Change in land use	X				
	Surface disposal of minerals workings deposits;				X	X
	Surface pollution incidents			X		
	Evolution of built-up and related land				X	X
Change in traditional land-use practice		X				
Traffic intensity in protected areas			X			

(continues)

Table I.3 (continued) - Synoptic table of the indicators chosen as most relevant by sector (the shaded rows are relative to driving forces)

Environmental problem area	SELECTED INDICATORS	SECTORS				
		Energy	Agriculture	Transport	Industry	Waste management
MARINE ENVIRONMENT AND COASTAL ZONES	Discharges of heavy metals, by metal	X		X	X	X
	Oil pollution at coast & at sea	X		X		
	Wetland loss		X	X		
	Faecal pollution		X	X		X
	Fishing pressure		X			
	Emission of organic matter as biochemical oxygen demand (BOD)					X
	Emission of organic matter as chemical oxygen demand (COD)					X
	Ore extraction (from marine and coastal zones)				X	
	Eutrophication (N and P discharged into waters)		X		X	X
	Discharges of halogenated organic compounds		X		X	
	Increase in suspended solids				X	X
	Development along shore	X		X	X	
	Density of marine transport	X		X		
	Offshore oil and gas extraction	X				
	Accidents in transports in coastal zone and at sea			X		
OZONE LAYER DEPLETION	emissions of carbon dioxide (CO ₂)	X	X	X	X	X
	emissions of methane (CH ₄)	X	X	X	X	X
	emissions of nitrous oxide (N ₂ O)	X	X	X		
	Methyl bromide (CH ₃ Br) emissions	X	X	X	X	X
	Emissions of chlorofluorocarbons (CFCs)			X	X	X
	Emissions of hydrochlorofluorocarbons (H-CFCs)			X	X	
	Emissions of nitrogen oxides (NO _x)			X		
	Emissions of bromofluorocarbons (halons)			X	X	
RESOURCE DEPLETION (continues)	Increase in territory permanently occupied by urbanisation; infrastructure; waste-tipping and quarrying	X		X	X	X
	Extraction of peat	X				
	Extraction of mineral resources				X	
	Ground water abstraction for agricultural/industrial purposes		X		X	
	Surface water abstraction for agricultural/industrial purposes		X		X	
	Timber balance (new growth/harvest)		X			
	Exceedance of fish catch quota		X			
	Soil erosion		X			
	Nutrient-balance of the soil (nutrient input/nutrient output)		X			

(continues)

Table I.3 (continued) - Synoptic table of the indicators chosen as most relevant by sector (the shaded rows are relative to driving forces)

Environmental problem area	SELECTED INDICATORS	SECTORS				
		Energy	Agriculture	Transport	Industry	Waste management
RESOURCE DEPLETION (continued)	Use of mineral oil as a fuel	X		X	X	
	Use of natural gas as fuel	X		X	X	
	Use of coal as fuel	X				
	Consumption of minerals				X	
	Use of renewable raw materials				X	
	Use of fossils for non-energy purpose				X	
	Production of ferrous and non-ferrous metals from raw, non-recycled raw materials				X	
	Water consumption	X	X		X	
	Use of energy	X	X	X	X	X
	Energy dependency	X				
DISPERSION OF TOXIC SUBSTANCES	Emissions of persistent organic pollutants (POPs)	X	X	X	X	X
	Index of heavy metal emissions to water	X	X	X	X	X
	Index of heavy metal emissions to air	X		X	X	X
	Emissions of radioactive material	X				
	Consumption of pesticides by agriculture		X			
	Emissions of phthalates				X	
	Consumption of toxic chemicals (D67/548/EEC)	X			X	
	Production of chlorinated compounds				X	
	Toxic chemicals processing plant distribution by type of technology				X	
	Storage of toxic chemicals in industrial plants				X	
	Mining and metal processing				X	
	Number of accidents during transportation of toxic substances by boat			X		
	Number of accidents during transportation of toxic substances on land			X		
	Number of industrial accidents in plant covered by Seveso directive				X	
URBAN ENVIRONMENTAL PROBLEMS	Emissions of sulphur dioxide (SO ₂) and nitrogen oxides (NO _x)	X		X	X	
	People endangered by noise emissions			X	X	
	Derelict areas				X	
	Number of waste management sites					X
	Land use (change from natural to built-up area)			X	X	X
	Share of private car transport			X		
WASTE (continues)	Hazardous waste according to directive 91/689/EWC	X	X	X	X	
	Total waste from the sector	X	X			
	Municipal waste			X		
	Number of end of life vehicles			X		
	Number of scrap from all transport			X		

(continues)

Table I.3 (continued) - Synoptic table of the indicators chosen as most relevant by sector (the shaded rows are relative to driving forces)

Environmental problem area	SELECTED INDICATORS	SECTORS				
		Energy	Agriculture	Transport	Industry	Waste management
WASTE <i>(continued)</i>	Number of batteries			X		
	Number of tyres			X		
	Waste per product during a number of products entire lifetime				X	
	Average lifetime of a group of selected products				X	
	Consumption of hazardous substances				X	
	Waste of construction and demolition				X	
	Waste of mining				X	
	Waste of other industrial sectors				X	
	Sludge from sewage plants				X	X
	Trade of wastes (import)					X
WATER POLLUTION AND WATER RESOURCES	Emission of heavy metals, by metal	X	X	X	X	X
	Water use	X	X		X	
	Groundwater abstraction		X		X	
	Surface water abstraction		X		X	
	Groundwater contamination from oil spills from service station and garage			X		
	Groundwater contamination by de-icing and anti-icing of aircraft			X		
	Surface water contamination from oil spills from inland water transport activities			X		
	Emissions of organic material as BOD	X	X		X	X
	Emissions of organic material as COD					X
	Total suspended solids (TSS) of liquid effluents released in water bodies					X
	Nutrient (nitrogen and phosphorus) release	X			X	X
	Total nutrients (N+P) use (eutrophication equivalents)		X			
	Number of industrial accidents in plants covered by the Seveso directive				X	
	Pesticides used per hectare of utilised agriculture area		X			
	Losses in the sewage collection network					X

I.6 Potential future developments for the work on the sectoral environmental pressure indicators within official statistics

With the work on sectoral environmental pressure indicators presented in this report, some foundations have been laid for the calculation of the sectoral environmental pressure indicators, both in terms of general methodological approach and of actual choices for the definition of the sectors and the selection of indicators. For some of these, Istat, like other statistical offices that may want to adopt the results of this report, will, on the basis of the results achieved, already be able to proceed to an updated survey of existing data and indicators' calculation; for others, more operational recommendations must be set than those adopted, but this should be preferably done – on the basis of the criteria and restraints stated – at the same time as the survey of the sources and data characteristics.

During the work devoted to the definition of the approach, it clearly emerged as being recommendable to update the necessary survey of the existing production activities of the environmental pressures indicators themselves (or of the data bases that can be used for their calculation) once in relation to all the sectors at the same time. It would in fact be inefficient and would also risk being poorly effective, to carry out a separate research for each of the sectors, as this would cause the need to consult the potential suppliers of the information as many times as there are sectors for which their activity is significant. The indicators, as the synoptic framework above shows, are in fact in many cases the same for the various sectors, only changing the group of activities for which the source of most suitable data are to be traced. It is likely, on the other side, that the Organisations that carry out calculations of indicators or the collection of data, do so with reference to the entire economy, rather than to the individual activities, or in any case with reference to the sectors that are delimited in a different way than the one dictated by the needs of official statistics. In these cases, it will be necessary to define more appropriate methods to bring the activities to which the existing data refers to those defined with the project that is the subject of the present report, which prefigures the need for a substantial study of methodologies used by the producers of data and indicators.

For the future, then, the first step to take is that of searching for information. Alongside and following this search, the following moments of development of research activities for developing sectoral environmental pressure indicators can be:

- completion of the “module” that allows the passing of data concerning the activities to data referred to the sectors, whose “qualitative” basis – existence and totality/partiality of correspondence – is made up of the attributions shown in Tables I.1-I.2; to that end, some correspondences in quantitative terms need to be developed possibly by means of indicators;
- compilation, on the basis of the partly existing lists, of a complete list of the anthropic transformations of matter processes to which the environmental pressures are due; quantification of the connections between the processes and the environmental pressures on one hand and between processes and activities on the other⁸¹;

⁸¹ Similar connections have been created at Istat, only for the processes considered by the CORINAIR system, within NAMEA projects.

- definition of the surveying needs for the gathering of data needed for the construction of the indicators system;
- definition of the procedures of transformation of the basic information in the indicators adopted;
- definition of estimate procedures to be used in the cases in which the data at the basis of the indicators is not otherwise available or collectable.

Some of these points refer to the conceptual framework of the EPIS project⁸², i.e. to the setting up of an information system aimed at the regular production of statistics on environmental pressures and on driving forces. The creation of such an information system is without a doubt an ambitious goal, that can only be achieved in the long-term and with the involvement of various institutional players, requiring above all a substantial development of activities for producing data bases and knowledge of production and consumption processes (quantification of their input-output balances), but which is crucial for the possibility of providing complete, updated – and therefore politically relevant – information on the pressures created by human activity on the natural environment.

⁸² See e.g. the Italian contribution to this project Istat, 1997.

PART II - FURTHER INSIGHTS IN THE DEFINITION OF SECTORS AND TENTATIVE HARMONISED SELECTION OF INDICATORS BY SECTOR

II.1 Introduction

The present part of the report illustrates the results of the follow-up study carried out at Istat with reference to the individual sectors Energy, Agriculture, Transport, Industry and Waste Management – on the basis of the SIP projects⁸³ and of the other relevant Eurostat projects – in application of the general premises pointed out in Part I.

Each chapter refers to one sector and is organised in two main paragraphs:

- the first one illustrates the definition/delimitation given to the sector by the corresponding SIP report, and the possible specifications/adjustments introduced at Istat; a further subdivision of the paragraph is used to keep the descriptive parts separate from the discussion of the conceptual questions;
- the second one recalls the proposals of the SIP projects as for the indicators to be developed by “environmental problem area”, and illustrates the possible changes introduced at Istat following the reconsideration of the definition of the sectors and of some “environmental problem areas” (see Part I, chapter I.5).

As for the definition of the sectors, the question of which activities are to be included in each of them is systematically tackled, as well as the main overlappings between the sectors⁸⁴.

As for the selection of the indicators, the development of the general concept formulation reported in Part I was essential in order to achieve what appeared to be, at this stage, a suitable harmonised choice of the indicators that are most representative of the environmental pressures of the individual sectors for each “environmental problem area”; in addition to that, the following main elements, discussed in the present part of the report, were also essential:

- a) development some further methodological elements specifically concerning the individual sectors;
- b) re-examination of the main environmental pressures that can be attributed to each sector in the light of the results of the European projects reported in TEPI series of publications.

In some cases, in order to illustrate the quantitative importance of the contribution of a sector to a certain environmental pressure, the evidence provided by the TEPI publications (Eurostat 1999a and 2001), that often give sectoral breakdowns of the indicators presented, is briefly reported. This must be considered, however, as only indicative, since the definitions of the sectors to which the data refer are not explicit and therefore it is not possible to know how different the

⁸³ For an introduction to the European SIP projects, see Part I.

⁸⁴ In listing the activities, sometimes it has been useful to make reference to the Italian version of the NACE (i.e. the ATECO91 classification), as it identifies and specifies activities at a deeper level than the NACE, and allows therefore to highlight activities that are comprised in more general entries in the NACE, and include them explicitly in the delimitation of the sectors.

values given are from those that the same indicator would assume if the calculation was based on the definition of the sectors adopted here⁸⁵.

In the second main paragraph of each chapter, the indicators of environmental pressures that have been selected are presented with reference to each of the ten “environmental problem areas” that were identified on a European level. For each “environmental problem area” the main environmental pressures of the sector are briefly discussed and a summary table of the selected indicators is provided.

The expressions used in the summary tables have the following meanings:

- the first column contains the name of the indicator;
- the second column specifies the “origin” of each indicator, where the included entries have the following meanings⁸⁶:
 - SAG: the indicator comes from the list submitted to the SAG during the second survey;
 - MS: the indicator belongs to the group of indicators (selected on the basis of indications from the SAG) for which Eurostat drew up the Methodology sheets;
 - SIP: the indicator belongs to the selection proposed in the corresponding SIP report, and/or pressures/driving forces similar to the ones measured by the indicator were at the basis of some similar proposal of the same SIP report (if no other source is indicated, the indicator was introduced by the SIP report itself);
- the third column indicates for each indicator whether it is relative to an actual pressure or a driving force. Of course this is only indicative, as in many cases both meanings (or even that of state indicator) can be attributed to a single indicator.

⁸⁵ It is important to point out, at this purpose, that indicators referring to the sectors have properties and interrelations rather different from those that characterise economy-wide indicators. This is especially relevant with respect to driving force indicators, as these point out indirectly at environmental problems. There are various ways in which some activities of a sector can indirectly generate an environmental pressure as a consequence of economic cause-effect relationships: at the country level, they could be at the origin of a direct interaction with the environment by other activities of the same sector, and/or by activities of different sectors; at the international level, the effects could pass through the exchanges with other countries (see the discussion on consumption and direct intake indicators in paragraph I.5.4 of Part I, concerning the “environmental problem area” Resource Depletion). Moreover, indirect effects of direct environmental pressures also take place all the time in the natural system, so that an indicator that represents an immediate, direct pressure for a certain “environmental problem area” can be very significant as a driving force for other “environmental problem areas”. Whether one indicator expresses a direct pressure or a driving force can therefore depend on how the indicator is defined and to which “environmental problem area” it is referred. This is a very common situation, in particular, with indicators referring to Marine Environment and Coastal Zones: a substantial contribution to many important pressures on these delicate ecosystems come from polluted rivers, and are therefore related to man-induced water pollution. This is very clearly shown in the indicators reported in TEPI for this “environmental problem area”, which is partly accounted for by indicators also relevant for Water Pollution and Water Resources; indeed, many indicators which have identical or similar names have been proposed for the two “environmental problem areas”. If also their definition is identical, they must be considered as driving forces for Marine Environment and Coastal Zones; if, on the contrary, the aim is to express the immediate contribution of a specific sector to the problems at issue, it is only the direct discharge of pollutants into the sea that must be considered. The indicators proposed in the European projects are of both types. In the present study, the choice between defining each of the indicators concerned as a direct pressure or as a driving force indicator has been made sector by sector, considering the relative significance of direct and indirect contributions to the problems of the sector in question; in most cases, it seems advisable to calculate both the immediate contribution of the sectors and the potential one, which includes discharge of pollutants that could reach the sea through internal waters. Among the phenomena represented by indicators included in table I.3 of Part I, the problem concerns discharge of heavy metals, nutrients, faeces, halogenated organic compounds, suspended solids, organic matter.

⁸⁶ See Part I.

The choices made by the SIP reports have generally been maintained, so most changes concern the inclusion of additional indicators in the sets of the ones to be considered as priority for the sector/”environmental problem area”.

Most of the SIP reports present two lists of indicators, one comprising all the indicators included in the set proposed to the SAG that can in principle be considered relevant for the sector under examination, and another comprising only a selection of them, made on the basis of various reasons including the availability of data or calculation methods⁸⁷. It is the latter set which is referred to here as the list of indicators proposed by the SIP.

II.2 Energy Sector

II.2.1 Description and delimitation of the sector and main overlaps with other sectors

II.2.1.1 Description and delimitation of the sector in the SIP report

The definition of the sector that was adopted in the Joint Final Report of the SIP Energy Project⁸⁸ was developed by referring to the life cycle of the energy resource, according to a logic of “vertical integration” of activities and processes that consider both the flow of generated energy and used energy and the plants in charge of this flow⁸⁹. Extraction⁹⁰, transformation-conversion, transport, storage, consumption, management of waste generated and, with regards to the energy plants (including transmission networks), their construction, use and dismantling were considered as separate phases of the energy resource life cycle. Waste management connected with the separate phases of the energy resource life cycle and the dismantling of energy production plants were not considered to be a part of the sector as they are believed to be relevant to the Waste Management sector.

The delimitation of the resulting sector does not fully correspond with the structure of the energy balance sheets. The approach followed was in fact that of focusing attention on the two upper parts of the energy balance sheet, i.e. to consider mainly primary energy production and its transformation, and assuming that the consumption of energy by the various sectors considered in the SIP projects was considered in each of them. With reference to the main phases in the energy resource life cycle – production, transformation, distribution and consumption – the criteria actually adopted in the SIP report only correspond in part to this articulation:

- production and transformation are totally included in the sector, including autoproduction of electricity and sale of heat by units not otherwise included in the sector, in line with the guidelines from the Intergovernmental Panel on Climate Change (IPCC);
- distribution is included to the extent that it takes on characteristics that are specific to the energy sector (gas pipelines, long-distance power lines, oil tankers);

⁸⁷ As specified in Part I, the issue of the actual possibility of constructing the indicators is not considered here.

⁸⁸ See Eurostat (1999b).

⁸⁹ The lifecycle of the following types of energy is described in detail in the report: energy created by combustion processes, energy created by nuclear fission, hydroelectric, wind and solar energy; the following types of energy, however, are not analysed as they are considered to be of lesser importance: geothermal energy, energy produced by generators, batteries, “fuel cells”, energy produced by heating pumps.

⁹⁰ In addition to actual extraction of raw energy materials, the term extraction must also be interpreted as the transformation of the potential energy available in nature into electrical or thermal energy (the most relevant case is the one concerning hydroelectric energy).

- consumption is included for the part that is not included in the other five SIP sectors, which is substantiated in household consumption of energy and consumption by service production activities other than transport and tourism.

In practise, the following production or consumer activities are included in the Energy sector, in addition to the auto-production by units outside the sector:

1. Extraction of energy minerals (NACE 10, 11, 12);
2. Manufacture of coke, petroleum refining, nuclear fuel treatment (NACE 23);
3. Supply of electricity, gas, and heating (NACE 40);
4. Transport via pipelines (NACE 60.3);
5. Sea transport (NACE 61), concerning the transportation of petroleum from wells to refineries;
6. Consumption of energy by the domestic sector;
7. Consumption of energy by the Trade (NACE 50, 51, 52), Post (NACE 64), Monetary and financial brokerage (NACE 65, 66, 67), Real estate, Hire, Computer, Research, Other professional and entrepreneurial activities (NACE 70, 71, 72, 73, 74), Public administration and defence (NACE 75), Education (NACE 80), Extra-territorial organizations and bodies (NACE 85), other public social and personal services (NACE 91, 92, 93), Activities of households as employers of domestic staff (NACE 95), Extra-territorial organizations and bodies (NACE 99) sectors.

It can therefore be seen how:

- all the activities linked to the retrieval and production of energy have been included in the sector;
- with regards to the transport of energy, activities of energy transfer via long-distance power line, pipelines and the transportation of crude fuel via sea have been included, whereas the transfer of raw energy materials via the use of road, rail or other means has not been included;
- the consumption of energy has only been included in the sector for what does not concern the remaining five SIP sectors.

II.2.1.2 Clarification of the sector boundaries and of the overlaps with other sectors

The general criterion of “vertical integration” as specified in the SIP Energy report appears to be generally appropriate for the definition of the sector in view of calculating the relevant environmental pressure indicators. The environmental pressure indicators that arise from it can in fact be said to be representative of the stress on the natural environment due to all the activities that contribute to making the various forms of energy available in nature directly usable for the final users, and which are therefore in some way a subject of energy policy. Some points in the SIP report referring to the intersections with other sectors, however, did not appear to be completely convincing and suggested proceeding by developing further reflections possibly useful for the purpose of improving consistency in the delimitation of the sector in terms of activities and processes. In the paragraphs below there is an account of some close examinations concerning the intersections between the Energy sector and a number of other SIP sectors.

II.2.1.2.1 Consumption of energy

The way consumption of energy is discussed in the various SIP projects did not seem very satisfying.

The difficulties stem from the fact that the consumption of energy as such is not an activity, but something that is necessary for almost all productive and non-productive activities, so it

cannot be included or excluded from a sector as a whole without distinctions among the specific processes in which it takes place. Indeed, energy consumption, understood as the use by institutional units not belonging to the Energy sector of the products that are typical of this sector – i.e. of electrical energy or heat or transformed energy carriers, delivered to them by the Energy sector⁹¹ – may mean many different uses.

It is not very clear what are the implications for the calculation of sectoral environmental pressure indicators of attributing energy consumption as such to a sector or not. In the case of electricity use, for instance, it seems that the calculation would not make a big difference; in some other cases, such as e.g. households' use of gas or coal for cooking, emissions or ashes are generated, and the difference might be clear. Further research seems to be necessary on this point⁹².

Meanwhile, the solution adopted has been to signal the possible inclusion in the Energy sector of a part of all activities (including those included in other SIP sectors). As for energy consumption, considered in itself as a driving force, it should always be attributed to the consuming sector⁹³.

II.2.1.2.2 Energy and transport

In SIP Energy only a part of the “energy transport” activities were considered as included in the sector. More precisely, the forms of “energy transport” included were represented by gas pipelines, long-distance power lines, and sea transport of raw energy material from the extraction sites to the refineries; the connections between energy and transport, however, seem to go beyond these modes of transportation of energy. On this matter it was decided, then, to proceed by developing some further insights.

The typical activity of the Transport sector, which is the moving of objects and people, is typically carried out via transformation processes of raw energy material and electricity that are very similar to processes typical of the Energy sector, but according to the logic followed in SIP Energy the “boundary line” between the two sectors depends on the particular purposes of the transport activities under examination, and only the “energy transport” activities that answer to strategic needs of the Energy sector are to be considered as part of the same sector. In actual fact, all the transport activities of “energy material” or of “usable energy” that take on special forms in the Energy sector (gas pipelines, methane pipelines, transmission networks, oil tankers, freighters etc) – and that therefore produce typical environmental pressures of this sector – were considered by SIP Energy, while the transport activities of energy material that have standard characteristics for the Transport sector were not considered⁹⁴.

⁹¹ Thereby including auto-production of electrical energy and sale of heat.

⁹² In order to tackle systematically the issue, it would be necessary to refer to a list of energy-consuming processes, and decide case-by-case which are the environmental pressures specifically due to energy inputs and whether the attribution of these environmental pressures to the Energy sector would make sense or not. Such an analysis could reveal, among other things, to what extent the decisions taken in SIP Energy are consistent with the fundamental criterion of the “range of policy action”, adopted here for better harmonising the SIP results. With respect to this, one could verify that energy consumption processes may or may not fall under the influence of energy policy, irrespective of who is the user of energy, and this could lead to the inclusion also of some environmental pressures due to the use of energy in activities covered by SIP sectors other than Energy.

⁹³ Energy saving is also a matter of energy policy that cross-cuts all economic and institutional sectors; the driving force indicators to be defined for the Energy sectors should take this into account.

⁹⁴ In particular, all the transport of raw energy materials (coal, peat, petroleum etc) and refined fuel made by road vehicles, rail convoys, or other methods from the production sites to the usage sites – all forms of transport that characterise the energy resource's lifecycle – were included in the Transport sector and not in the Energy one. Note how one consequence of this treatment is the lack of consideration in the SIP Energy, among other things, of the environmental pressures coming from the transportation of materials used in nuclear fission, i.e. uranium and plutonium, which are probably significant for the European countries that have not abandoned nuclear power.

All the other processes that concern energy materials and electricity have instead been included, generally speaking, in the Energy sector⁹⁵ and not in the Transport sector, even when their output is destined for use in transport activity; the energy materials and electricity, in fact, have been considered in the Transport sector only with reference to the phase of their use in this latter sector.

What became apparent, in general, is that the formulation given by SIP Energy to the phenomena that are on the boundary line between Energy and Transport stems from an approach that was intended, on the one hand, to avoid as many overlaps as possible between the two sectors, on the other hand, to maintain the “vertical integration” logic of the sector’s definition. With reference to this, the reflections made concerning the intersections between the two sectors in question have brought two main aspects to light:

- the transport of energy materials is significant in terms of environmental pressures, not only for those typical of the Transport sector (mostly emissions of pollutants), but also for those specifically due to the type of materials transported and the possible dispersion or combustion of these materials as a consequence of accidents;
- the quantity and the composition for each type of energy material transported depend more on energy policy choices than on transport policy choices⁹⁶.

To conclude, therefore, as the exclusion of some forms of transport of energy materials from the Energy sector did not seem appropriate, it appeared to be recommendable, instead, to attribute – alongside with the environmental pressures coming from accidental spills and dispersions of fuels in the distribution phase – an appropriate share of the environmental pressures calculated for transport to the Energy sector – the one that corresponds to energy materials – though without removing them from the Transport sector, the main recipient of the policies aimed at reducing these environmental pressures⁹⁷.

II.2.1.2.3 Energy and waste management

The search for further insights was also focused on the fact that one of the priorities of the European Community policy concerning waste management is disposal via incinerations, with resulting recovery of energy.

Incineration of waste produces environmental pressures of a different type to those of other disposal systems (such as, for example, controlled landfilling), which are probably less significant in terms of the “environmental problem areas” linked to land use (e.g. loss of biodiversity), but much more significant for the ones concerning the air (air pollution, climate changes, dispersion of toxic substances). In fact, the priority given to incineration with energy recovery does not necessarily produce a better management of waste in itself; however, what it can improve is the environmental performance of the economic system in a broader sense, by means of the reduction in the use of energy sources available in nature (especially of raw fossil energy materials), made possible also thanks to this disposal system.

⁹⁵ As regards the consumption by other SIP sectors, see what is stated in paragraph II.2.1.1 (“Description and delimitation of the sector in the SIP report”).

⁹⁶ Which means that a significant share of the total traffic – and of its environmental pressures – depend more on energy policy choices than on transport policy choices.

⁹⁷ This approach also seems recommendable when considering the non-marginal role that road and rail transport can have on the energy sector, as for example, occurs in Italy.

Faced with the fact that final waste disposal cannot avoid all environmental costs, the European policy therefore aims at systems for the disposal of waste that also produce an easing of environmental pressure in other ways – that of reducing the demand for other energy sources – that are not part of waste management but of the Energy sector.

Due to the fact that the phenomenon of waste incineration with energy recovery involves both waste policy and energy policy⁹⁸, it therefore seemed appropriate to attribute the relative environmental pressures to both sectors.

II.2.1.3 Delimitation of the sector in terms of economic activities

The delimitation of the sector outlined in the SIP report was reviewed in light of the considerations reported above, which resulted in the identification of the appropriateness of some adjustments. With regards to this, it seemed appropriate to integrate the sector as defined in the SIP report by including some economic activities (included fully or pro-quota, depending on the case⁹⁹), as further components to be taken into consideration; also the consumption of energy by the activities that belong to the other SIP sectors was taken into consideration.

In particular, with reference to the separate phases of the energy resource lifecycle, it was decided to add the following entries:

- with regards to the distribution phase:
 - Retail sale of automotive fuel (NACE 50.50);
 - Agents involved in the sale of fuels, ores, metals and industrial chemicals (NACE 51.12) – solely with regards to energy carriers;
 - Wholesale of solid, liquid and gaseous fuels and related products (NACE 51.51) – excluding related non-combustible products and oils and lubricants;
 - Other retail sale in specialized stores (NACE 52.48) – solely with regards to “Specialized retail sale of household fuels” (ATECO 52.48.7);
- with regards to the transport phase:
 - Transport via railways (NACE 60.10) – solely with regards to transport of energy carriers;
 - Freight transport by road (NACE 60.24) – solely with regards to transport of energy carriers;
 - Scheduled air transport (NACE 62.10) – solely with regards to transport of energy carriers;
 - Non-scheduled air transport (NACE 62.20) – solely with regards to transport of energy carriers;
- with regards to the storage and warehousing phase:
 - Cargo handling (NACE 63.11) – solely with regards to handling of energy carriers;
 - Storage and warehousing (NACE 63.12) – solely with regards to the warehousing of energy carriers;
- with regards to the consumption of energy:
 - All the activities belonging to the other SIP sectors.

⁹⁸ Think of the influence that the two sectoral policies have on the relative costs of the different types of disposal, on the one hand, and on the different ways of producing energy on the other.

⁹⁹ See paragraph I.4.4.2 (“Activities carried out as principal activities and household’s activities”) in Part I.

The delimitation of the sector in terms of activities that resulted from the adjustments proposed here is shown in Table II.1. The first column contains the distinct energy lifecycle phases to which the various activities belong; these are indicated in the second and third columns, via the NACE code and name respectively (in the case that energy consumption is by households – that does not constitute an economic activity and therefore does not come under the NACE listing – these items are not applied); the fourth column indicates to which extent the activities considered must be taken into consideration for the Energy sector (i.e.: fully, partly, or for a certain share). With regards to the latter column, the meaning of the wording used is the following:

- “Fully” means that the activity is included in the sector in its entirety;
- “Pro-quota” means that the activity considered, and therefore each of the environmental pressures that it generates, are attributed to the sector only for a quota; this quota, which cannot be identified at the break-down level available in the NACE, generally corresponds to distribution and transportation of fuels;
- “In part” means that only some of the environmental pressures generated by the activity considered are attributed to the sector; in particular, this relates to the environmental pressures possibly attributable to the consumption of energy and to this consumption considered as a driving force.

The reasons of the partial inclusions have been specified above and are not shown in the table.

Table II.1 - Activities included in the Energy sector

<i>Phases of energy life cycle</i>	<i>NACE rev. 1 codes</i>	<i>Activities</i>	<i>Inclusion</i>
A) PRODUCTION ACTIVITIES			
EXTRACTION	10.10	Mining and agglomeration of hard coal	Fully
EXTRACTION	10.20	Mining and agglomeration of lignite	Fully
EXTRACTION	10.30	Extraction and agglomeration of peat	Fully
EXTRACTION	11.10	Extraction of crude petroleum and natural gas	Fully
EXTRACTION	11.20	Service activities incidental to oil and gas extraction, excluding surveying	Fully
EXTRACTION	12.00	Mining of uranium and thorium ores	Fully
TRANSFORMATION	23.10	Manufacture of coke oven products	Fully
TRANSFORMATION	23.20	Manufacture of refined petroleum products	Fully
TRANSFORMATION	23.30	Processing of nuclear fuel	Fully
PRODUCTION AND DISTRIBUTION	40.10	Production and distribution of electricity	Fully
DISTRIBUTION	40.20	Manufacture of gas; distribution of gaseous fuels through mains	Fully
PRODUCTION AND DISTRIBUTION	40.30	Steam and hot water supply	Fully
DISTRIBUTION	50.50	Retail sale of automotive fuel	Fully
DISTRIBUTION	51.12	Agents involved in the sale of fuels, ores, metals and industrial chemicals	Pro-quota
DISTRIBUTION	51.51	Wholesale of solid, liquid and gaseous fuels and related products	Pro-quota
DISTRIBUTION	52.48	Other retail sale in specialised stores	Pro-quota
TRANSPORT	60.10	Transport via railways	Pro-quota
TRANSPORT	60.24	Freight transport by road	Pro-quota
TRANSPORT	60.30	Transport via pipelines	Fully
TRANSPORT	61.10	Sea and coastal water transport	Pro-quota
TRANSPORT	61.20	Inland water transport	Pro-quota
TRANSPORT	62.10	Scheduled air transport	Pro-quota
TRANSPORT	62.20	Non-scheduled air transport	Pro-quota
TRANSPORT	63.11	Cargo handling	Pro-quota
TRANSPORT	63.12	Storage and warehousing	Pro-quota
CONSUMPTION	All codes	Intermediate consumption by enterprises	In part
B) HOUSEHOLDS' CONSUMPTION AND AUTOPRODUCTION			
CONSUMPTION	–	Final consumption by households	In part
PRODUCTION	–	Auto-production of heating and electricity	Fully

II.2.2 Selection of the indicators that are most representative of the environmental pressures of the sector

On the basis of the general concept formulation developed in Part I and the further methodological elements discussed in the previous paragraph with specific reference to the Energy sector, a close examination has been carried out of the main environmental pressures that can be attributed to the sector, starting from the most significant lists proposed in the European projects. As a result of this revision work, a selection of indicators that appeared to be, at this stage, most representative of the environmental pressures of the sector has tentatively been established.

In the paragraphs below, the indicators of environmental pressures that have been selected are presented with reference to each of the ten “environmental problem areas” that were identified on a European level. For each “environmental problem area” the main environmental pressures of the sector are briefly discussed and a summary table of the selected indicators is provided.

II.2.2.1 Air pollution

The most significant emissions in the Energy sector for this “environmental problem area” are the following: sulphur oxides (sulphur dioxide in particular), nitrogen oxides, non-methane volatile organic compounds, carbon monoxide and particles. In particular the following remarks seem to be of interest:

- sulphur oxides (SO_x) come from fossil and mineral oil combustion processes; coal is the main source¹⁰⁰, next come fuel oils and to a minimum extent natural gas and refined petrol. SO_x emissions can be reduced via technical devices that are rather expensive. In the EU, according to TEPI (Eurostat 2001), the energy industry contributed in 1998 to 65% of SO₂ emissions;
- nitrogen oxides (NO_x) also come from combustion processes, in particular from coal and fuel oils. The limitation of emissions by using technical devices is relatively less expensive for NO_x, but brings about a loss of energy efficiency. In the EU, according to TEPI (Eurostat 2001), the energy industry contributed in 1998 to 18% of these emissions in the EU;
- non-methane volatile organic compounds (NMVOC) also come from combustion, but mainly from transport and from the storage of fuels. Fugitive emissions are one of the sources dealt with in TEPI (Eurostat 2001), with 6% share in the EU, 1998; some of these are clearly due to the fuels used for energy production rather than for transport or other uses;
- particles, including heavy metal particles, are also typical products from combustion. Coal and fuel oils are once again the major culprits. The Energy sector is identified in TEPI (Eurostat 2001) as one of the main sectors responsible for these emissions (no shares are given, though).

Indicators for the first three of the environmental pressures discussed above were proposed with the SIP report: emissions of SO_x, NO_x, VOC (better transformed into NMVOC).

The group of indicators selected with the present study for this “environmental problem area” reflects, in addition to the specific aspects discussed above, the polluting potential of energy use activities, expressed by indicators (proposed in the SIP report as part of the “background indicators”) that concern driving forces and are of particular significance for the Energy sector¹⁰¹. These indicators, all present in the Methodology sheets, are:

- Total electricity consumption;
- Coal and oil products consumption:
the consumption of fossil fuels due to electricity production was 24% of the total in the EU in 1998 (Eurostat 2001);
- Primary energy consumption.

In general, no driving force indicator referring to the various forms of energy consumption has been included in sectors other than Energy for this “environmental problem area” (the only exceptions are the consumption of coal and oil products by the sectors Transport and Industry)¹⁰².

¹⁰⁰ The content of sulphur in coal is rather variable.

¹⁰¹ Energy saving is a typical objective of the policy relevant for this sector.

¹⁰² The driving forces they would express would be related to direct pressures mainly taking place into the Energy sector itself and are already accounted for in relation to the latter; on the other hand, the direct pressures taking place in sectors other than Energy are not very significant.

Table II.2 - Indicators selected for the Energy sector in relation to the “environmental problem area” Air pollution

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of sulphur dioxide (SO ₂)	MS – SIP	Pressure
Emissions of nitrogen oxides (NO _x)	MS – SIP	Pressure
Emissions of non-methane volatile organic compounds (NMVOC)	MS	Pressure
Emissions of particles	MS	Pressure
Emissions of carbon monoxide (CO)	MS	Pressure
Total electricity consumption	MS	Driving Force
Coal and oil products consumption	MS	Driving Force
Primary energy consumption	MS	Driving Force

II.2.2.2 Climate change

The Energy sector is one of the main sources of environmental pressures that are causing the ongoing changes in the global climate.

In the SIP report indicators have been selected for the emissions of:

- Carbon dioxide (CO₂);
- Methane (CH₄);
- Sulphur oxides (SO_x).

As for the shares of emissions due to the Energy sector in the EU, according to TEPI (Eurostat 2001), in 1998 32% of CO₂ came from the “energy sector” (exploration and transformation; production of electricity); for CH₄ fugitive emissions the energy share accounted for 16%. TEPI (Eurostat 1999a) also highlights that “major fuel consumers, such as power stations and large industrial plants are among the main targets for reducing SO_x emissions” (for SO₂ see the previous “environmental problem area”).

In addition to these environmental pressures, the emissions of Nitrous oxide (N₂O) – 5% of share in the EU in 1998, according to TEPI (Eurostat 2001) – and NO_x – see the previous section – were considered to be appropriate for inclusion in the selection; both indicators are present in the Methodology sheets.

Table II.3 - Indicators selected for the Energy sector in relation to the “environmental problem area” Climate change

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of carbon dioxide (CO ₂)	MS – SIP	Pressure
Emissions of methane (CH ₄)	MS – SIP	Pressure
Emissions of sulphur oxides (SO _x)	MS – SIP	Pressure
Emissions of nitrogen oxides (NO _x)	MS	Pressure
Emissions of nitrous oxide (N ₂ O)	MS	Pressure

II.2.2.3 Loss of biodiversity

The SIP report took into consideration the fact that all the activities linked to the production of energy make significant use of land, even if the overall amount of land used is judged to be an insignificant size. The report therefore proposed “Change in land use” (separately due to: coal

mines, peat fields, storage lakes, reservoirs, onshore oil and gas extraction) as an indicator of environmental pressure, expressed in terms of percentage of the whole land. It can be seen how the occupation of a portion of land can give rise to different types of environmental pressure (for example, in the case of an artificial reservoir: the destruction of river banks through artificialisation, fragmentation of natural and semi-natural forest areas, the upsetting of dry habitats, the loss of corridors elements, etc.).

More specific aspects of the alterations caused to the habitats could indeed be considered by means of another two indicators proposed in the Methodology Sheets. The first is “Wetland loss through drainage”, specified for this sector as that caused by peat extraction; the second is “Protected area loss, damage and fragmentation”, a phenomenon that can occur following the construction of energy production and distribution plants. Alongside this last indicator it was deemed appropriate to add the indicator – also proposed in the Methodology Sheets – “Fragmentation of forests and landscapes by roads/intersections”, as the structures that make up the energy distribution network can be a disturbance factor for biodiversity in areas other than protected ones.

With regards to environmental pressures other than the occupation and the fragmentation of land, a direct pressure on the forest environment (which could in principle be calculated) can only be seen in the case of the use of biomass for energy purposes; the size of this phenomenon, however, does not appear to be such as to justify the drawing up of a specific indicator.

Table II.4 - Indicators selected for the Energy sector in relation to the “environmental problem area” Loss of biodiversity

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Protected area loss, damage and fragmentation	MS – SIP	Pressure
Wetland loss through drainage caused by peat extraction	MS – SIP	Pressure
Fragmentation of forests & landscapes by roads/intersections	MS	Pressure
Change in land-use (due to: coal mines, peat fields, storage lakes, reservoirs, onshore oil and gas extraction)	SIP	Driving Force

II.2.2.4 Marine environment and coastal zones

According to what emerges from the SIP report, the greatest environmental pressure on the marine environment coming from the Energy sector is that of “operational” or accidental oil losses. Small quantities of toxic substances are released during offshore extraction and mining activities (platforms etc); the marine operations are therefore considered as the greatest source of pollution. According to OECD estimates, about 70% of marine pollution from petroleum comes from the “normal” leaks that occur during transport, while the remaining part comes from spills following accidents (International Energy Agency 1989).

The indicators selected by SIP Energy are the following:

- Oil and gas extraction (new platforms; decommissioned platforms; platforms in priority habitats area):
this is to be understood as “Offshore oil and gas extraction”;
- Oil pollution at coasts (accidents; operational activities);
- Oil pollution at sea:

this indicator and the previous one have been merged into “Oil pollution at coast & at sea” in the Methodology Sheets. In TEPI (Eurostat 2001) it is shown that the contribution of offshore extraction and refineries is significant, though decreasing;

- Heavy metal emissions from off-shore oil extraction:
this indicator corresponds to “Discharges of heavy metals”, present in the Methodology Sheets, but measures only a part of the environmental pressures directly generated within the sector. As a matter of fact, the Energy sector contributes to total emissions of heavy metals into the sea also with discharges from refineries, power plants and sea transport of energy carriers. The formulation of the Methodology Sheets, allowing both for direct and for indirect environmental pressures is therefore to be preferred.

It was deemed appropriate to add to the indicators selected in the SIP report the general indicators “Density of marine transport” – as far as petroleum transport is concerned – and “Development along shore”, in order to take into account the environmental pressure due to the construction of oil ports and refineries along the coast; this last indicator, which refers to a driving force, tends to represent a variety of specific environmental pressures that are difficult to record.

Table II.5 - Indicators selected for the Energy sector in relation to the “environmental problem area” Marine environment and coastal zones

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Oil pollution at coast & at sea	MS – SIP	Pressure
Discharges of heavy metals	MS – SIP	Pressure / Driving Force
Offshore gas and oil extraction	SAG – SIP	Driving Force
Density of marine transport (energy carrier transport by sea)	SAG	Driving Force
Development along shore	MS	Driving Force

II.2.2.5 Ozone layer depletion

The effects of the Energy sector on the depletion of the ozone layer are generally considered to be minimal, so much so that no indicator was selected in the SIP report for this “environmental problem area”.

However, the sector contributes to determining the phenomenon in question via the loss of Methane (CH₄) and the release of Nitrous oxide (N₂O) and of Methyl bromide (CH₃Br), following to the combustion of biomasses (wood, peat, composts) and fossil fuels. The Methodology Sheets also indicate one of the sources of the emission of CH₃Br from the burning of biomasses. Nitrogen oxides (NO_x), which can have a direct effect on the ozone layer, are only those released by planes at high altitude (those produced in the lower troposphere do not reach the ozone layer), and therefore are not significant for this “environmental problem area”. The effects of the emissions of Carbon dioxide (CO₂) in relation to the stratospheric ozone (emissions for which the Energy sector is the main source) are not very well known yet, but it is advisable to adopt the corresponding indicator also for this “environmental problem area”, on the basis of the precautionary principle¹⁰³.

¹⁰³ The emission of Carbon dioxide (CO₂) seems to determine a reduction in the stratosphere’s temperature, which reduces the effects of ozone attacking substances. The positive effects of CO₂ on the ozone, however, in the future could be more than offset by the formation of stratospheric clouds that in turn would considerably intensify the phenomenon of ozone layer depletion. This could occur after further reductions in stratosphere temperature, foreseen for the 21st century.

Table II.6 - Indicators selected for the Energy sector in relation to the “environmental problem area” Ozone layer depletion

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of carbon dioxide (CO ₂)	MS	Pressure
Emissions of nitrous oxide (N ₂ O)	MS	pressure
Emissions of methane (CH ₄)	MS	Pressure
Emissions of methyl bromide (CH ₃ Br)	MS	Pressure

II.2.2.6 Resource depletion

In the SIP report, in addition to the indicators selected from those on the SAG list (“Use of mineral oil as a fuel” and “Use of natural gas as fuel”), the following indicators have been proposed:

- Use of coal as fuel;
- Uptake of peat;
- Energy dependency:
(measures the domestic demand for energy’s dependence on imports).

In addition to the indicators considered in SIP Energy, the following indicators, present in the Methodology Sheets, were deemed appropriate for further inclusion in the selection:

- Use of energy:
this driving force indicator should be expressed in absolute terms, rather than per capita, as in the corresponding indicator of the Methodology Sheets, as it is to the global availability of energy resources that the current consumption should be compared to, in order to have a “standardised” indicator which is meaningful both from the environmental and the availability-of-resources points of view¹⁰⁴;
- Water consumption:
also this driving force indicator¹⁰⁵ should be expressed in absolute terms. In TEPI (Eurostat 2001), where the indicator is dealt with at the economy-wide level, water consumption coincides with “gross freshwater abstraction (from both ground and surface water resources)”. As for groundwater, the use in cooling, which is important for the energy sector (and specifically in power plants), is said to be almost null; surface water, on the contrary, is mainly used (53%) for this purpose (data refers to the EU in the mid-‘90s);
- Increase in the territory permanently occupied by urbanisation; infrastructure; waste-tipping and quarrying:
it was deemed appropriate to include in the selection this indicator as it refers to the use of the land resource by the infrastructures belonging to the Energy sector, otherwise not covered.

¹⁰⁴ See paragraph I.5.4 in Part I for a discussion of this issue. Differently from what is argued with reference to the “environmental problem area” Air pollution, as far as Resource depletion is concerned the indicator “Use of energy” has been included in the selection for all sectors as – though the direct drawing from the natural environment of the energy resource takes place in the Energy sector, which makes the resource available – in all sectors it is consumption in itself that generates the environmental pressure entailing reduction of the availability of energy for mankind.

¹⁰⁵ The use of gravitational energy from water at a height in hydroelectric power stations should not be considered.

Table II.7 - Indicators selected for the Energy sector in relation to the “environmental problem area” Resource depletion

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Use of mineral oils as fuel	MS – SIP	Pressure
Use of natural gas as fuel	SAG – SIP	Pressure
Use of coal as fuel	SIP	Pressure
Extraction of peat	SIP	Pressure
Increase in the territory permanently occupied by urbanisation; infrastructure; waste-tipping and quarrying	MS	Pressure
Water consumption (total quantity)	MS	Driving force
Use of energy (total quantity)	MS	Driving force
Energy dependency	SIP	Driving force

II.2.2.7 Dispersion of toxic substances

The most important contribution by the Energy sector to the dispersion of toxic substances is once again provided by combustion processes. In fact, the combustion of fossils causes the release of a small amount of heavy metals and radionuclides (as for the emissions to air, in TEPI 32% of the EU emissions are attributed to the energy sector for 1995); also, the combustion of oil and wood causes the emission of persistent organic pollutants (POP), including polycyclic aromatic hydrocarbons (PAH) and dioxins, that are considered to be the greatest toxic air pollutants released by the energy sector (International Energy Agency 1989). The emission of dioxins is also a risk connected to the incineration of waste, which, if carried out with recovery of energy is to be considered also for the Energy sector besides the Waste management sector. According to TEPI, on the whole, incineration of waste accounts for 41% of these emissions (referred to the EU, 1996 – Eurostat 2001), while another 18% is due to residential combustion of wood.

SIP Energy has proposed indicators for all these environmental pressures plus one referred to “Nuclear Power Plant distribution by type of technology”.

It seemed appropriate to adopt the indicators selected by SIP Energy, with the following changes:

- for the emissions of heavy metals, the synthetic indices that are present in the MS have been preferred to the indicators “by metal” proposed by the SIP report;
- the indicator “emissions of radioactive materials”, present in the Methodology Sheets, has been added to the list, in substitution of a driving force indicator proposed by the SIP report;
- also “Consumption of toxic chemicals” has been considered relevant for the Energy sector: as TEPI (Eurostat 2001) shows, refinery products contain important quantities of these substances;
- for persistent organic pollutants, the more synthetic indicator “Emissions of persistent organic pollutant (POP)”, present in the Methodology Sheets, has been selected instead of the two specific indicators that the SIP report proposed for PAH and for dioxins.

Table II.8 - Indicators selected for the Energy sector in relation to the “environmental problem area” Dispersion of toxic substances

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Index of emissions of heavy metals to water	MS – SIP	Pressure
Index of emissions of heavy metals to air	MS – SIP	Pressure
Emissions of radioactive material	MS – SIP	Pressure
Consumption of toxic chemicals	MS	Pressure
Emissions of persistent organic pollutant (POPs)	MS – SIP	Pressure

II.2.2.8 Urban environmental problems and noise

According to the SIP report, the main environmental pressure caused by the Energy sector on urban areas concerns the quality of the air, the largest sources of pollution being the electricity power plants and domestic heating¹⁰⁶.

The SIP report has proposed a rather generic indicator – “Air emissions from households and services in urban area” – but in place of this it seemed preferable to express this environmental pressure more precisely for this “environmental problem area”, through the following indicator proposed in the Methodology Sheets:

- Emissions of sulphur dioxide (SO₂) and nitrogen oxides (NO_x)
(to be specified as emissions from heating and generators in urban areas).

Table II.9 - Indicators selected for the Energy sector in relation to the “environmental problem area” Urban environmental problems and noise

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of sulphur dioxide (SO ₂) and nitrogen oxides (NO _x) (in urban areas)	MS – SIP	Pressure

II.2.2.9 Waste

The waste generated by the Energy sector was not dealt with in the SIP report for this sector, assuming that they could be better examined in the SIP dedicated to Waste Management. As explained in Part I, however, for the SIP sectors other than Waste Management, the “environmental problem area” Waste should be thought of as focused not on the management phase of waste, but on the generation one, a phase in which considerable driving forces arise.

Important waste that can be attributed to the Energy sector can be found in the energy resource production phase and mainly come from mines, nuclear power stations and combustion plants.

The indicators selected come from the Methodology Sheets.

Table II.10 - Indicators selected for the Energy sector in relation to the “environmental problem area” Waste

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Hazardous waste	MS	Driving force
Waste from energy production	MS	Driving force

¹⁰⁶ This last case can be considered as a form of self-production of thermal energy, in which generally there is correspondence with final consumption; obviously, this consideration does not apply to remote-heating. It should be noted that improvements coming from technology and territorial planning have considerably reduced the extent of the emissions in question.

II.2.2.10 Water pollution and water resources

The SIP report identified the following forms of environmental pressure on water bodies as being relevant for the sector:

- discharges from refineries and energy production plants that contain suspended or dissolved toxic substances (e.g. metals, chlorine compounds etc.);
- steam containing toxic substances (benzene, arsenic, mercury, boric acid, etc.) coming from onshore extraction wells of geothermal sources;
- waste substances or the acids used in coalmines, coke plants, or similar treatment plants;
- nutrients and solid particles coming from peat fields; the indicators proposed are “BOD¹⁰⁷ release from energy sector (peat fields)” and “Nutrient (N, P) release from energy sector (peat fields)”;
- thermal pollution coming from waters used for cooling in thermoelectric or geothermal energy production (for this form of pressure, however, the SIP report did not consider it necessary to select an indicator).

In addition to the indicators already selected by SIP Energy, which take into account the aspects considered in the first four points as above, it seemed appropriate to adopt another one referring to the use of water for cooling in the electricity production process, proposed by the SAG. Furthermore, it seemed appropriate to rename the indicator selected by SIP Energy for BOD as it is in the Methodology Sheets.

Table II.11 - Indicators selected for the Energy sector in relation to the “environmental problem area” Water pollution and water resources

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of heavy metals, by metal	SAG – SIP	Pressure
Emissions of organic matter as BOD	MS – SIP	Pressure
Nutrient (N, P) release from energy sector (peat fields)	SIP	Pressure
Waters use in cooling during electricity production	SAG	Pressure

II.3 Agriculture sector

II.3.1 Description and delimitation of the sector and main overlaps with other sectors

II.3.1.1 Description and delimitation of the sector in the SIP report

The SIP report¹⁰⁸ underlines that, unlike other sectors, the Agriculture sector is easy to identify and define in terms of economic activity, classified according to the NACE Rev.1.

With regards to the possible overlaps with the other sectors in the SIP projects, these are not considered as particularly significant, nor such as to create problems for the definition of the sector, and are therefore not discussed in the SIP report.

¹⁰⁷ Biochemical Oxygen Demand.

¹⁰⁸ See Eurostat (1999b).

II.3.1.2 Clarification of the sector boundaries and of the overlaps with other sectors

A fundamental characteristic of the products of the Agriculture sector is the fact that the output is represented by biomasses, i.e. products of an animal or vegetable nature. Among the vegetable products forestry products are also included – especially timber – and spontaneous forest products (“non cultivated”, according to the classification in the UN National Accounting System, 1993¹⁰⁹); animal products include also fishing and hunting products. These goods are destined mainly for intermediate or final consumption.

The sector does not present particularly important overlaps or complicated interactions with other SIP sectors that need to be considered in detail. For the overlaps found, it seemed appropriate to define the following treatment, consistent with the general methodological formulation developed in Part I:

- transport carried out as an auxiliary activity within units that carry out agricultural activity as their main activity is attributed to the Transport sector, unless strictly connected to agricultural operation, according to the convention established by the Transport SIP report (see chapter II.4);
- fishing (NACE 05.01) and hunting (NACE 01.50) carried out by tourists are also attributed to the Tourism sector, in addition to the Agriculture sector; rural tourism (included in NACE 55.23), is attributed only to the Tourism sector if it is an activity carried out as a main activity, whereas if it is carried out as a secondary activity in units belonging to the Agriculture sector it is also attributed to this latter sector;
- the management of waste generated by units belonging to this sector, if carried out inside agricultural units, remains as part of the Agriculture sector as an auxiliary activity, though it is also included in the Waste Management sector.

With regards to auto-consumption and household’s vegetable plots, it seemed that these should be considered in the Agriculture sector; as, in fact, the output in question is usually considered in the agricultural production statistics, it is appropriate that the environmental pressures associated with them are recorded for the sector, even if there is no production destined for the market.

II.3.1.3 Delimitation of the sector in terms of economic activities

The delimitation of the sector established in the Agriculture SIP report appeared to be fully adequate in the light of the criteria adopted for the harmonisation of the SIP results. Table II.12 shows the list of activities that – carried out as principal or secondary activities – belong to the sector.

¹⁰⁹ Commission of the European Communities et al. (1993).

Table II.12 - Activities included in the Agriculture sector

<i>NACE rev. 1 codes</i>	<i>Activities</i>
Section A - AGRICULTURE, HUNTING AND FORESTRY	
01.11	Growing of cereals and other crops n.e.c.
01.12	Growing of vegetables, horticultural specialities and nursery products
01.13	Growing of fruit, nuts, beverage and spice crops
01.21	Farming of cattle, dairy farming
01.22	Farming of sheep, goats, horses, asses, mules and hinnies
01.23	Farming of swine
01.24	Farming of poultry
01.25	Other farming of animals
01.30	Growing of crops combined with farming of animals (mixed farming)
01.41	Agricultural service activities
01.42	Animal husbandry service activities, except veterinary activities
01.50	Hunting, trapping and game propagation, including related service activities
02.01	Forestry and logging
02.02	Forestry and logging related service activities
Section B – FISHING AND PISCICULTURE	
05.01	Fishing
05.02	Operation of fish hatcheries and fish-farming
HOUSEHOLD ACTIVITIES	
-	Growing of crops and farming of animals for auto-consumption

II.3.2 Selection of the indicators that are most representative of the environmental pressures of the sector

If the delimitation of the Agriculture sector compared to the rest of the economic system does not give rise to great problems, the task of establishing a boundary compared to the natural environment is much more complex. This is in fact, a sector which involves the “extraction” of resources from nature that are essential for human life, and which is largely situated on the boundary between the natural system and the anthropic system; its interaction with the natural system emerges as a very tight-knit, immediate and bi-directional dependency. In the examination of the main environmental pressures that can be attributed to the Agriculture sector special attention has therefore been placed on identifying the boundary between the anthropic system and the natural system.

On the basis of the general concept formulation developed in Part I and the further methodological elements discussed in the previous paragraph with specific reference to the Agriculture sector, a close examination has been carried out of the main environmental pressures that can be attributed to the sector, starting from the most significant lists proposed in the European projects. As a result of this revision work, a selection of indicators that appeared to be, at this stage, most representative of the environmental pressures of the sector has tentatively been established.

In the paragraphs below, the indicators of environmental pressures that have been selected are presented with reference to each of the ten “environmental problem areas” that were identified on a European level. For each “environmental problem area” the main environmental pressures of the sector are briefly discussed and a summary table of the selected indicators is provided, similar to those already presented for the Energy sector in sections 2.2.1 to 2.2.10.

II.3.2.1 Air pollution

The SIP report has highlighted that the main agricultural activities that generate pressure on the air are the transformation of cultivation from extensive to intensive, the use of manure, of

sludge coming from wastewater purification plants, of mineral fertilisers and pesticides, the rearing of animals, the use of fossil fuels for agricultural machinery¹¹⁰.

In connection with such activities, SIP Agriculture considered the following indicators as being particularly relevant for this “environmental problem area”:

- Emissions of nitrogen oxides (NOx):
total annual emissions, expressed in tonnes, deriving mainly from the use of fossil fuels for agricultural machinery and for heating on farms;
- Emissions of volatile organic compounds (VOC):
total annual emissions, expressed in tonnes; these too derive from the use of fossil fuels;
- Emissions of particles:
total annual emissions, expressed in tonnes;
- Total energy consumption:
this aggregate represents a driving force for direct pressures on this “environmental problem area” of processes mainly taking place in another in the Energy sector;
- Emissions of ammonia (NH₃):
total annual emissions, expressed in tonnes, mainly coming from the use of nitrogen-based fertilizers and from animal farming;
- Use of pesticides for agricultural purposes:
the indicator, not present in the Methodology sheets, expresses a driving force.

The reflections made starting from the indicators selected by the SIP report highlighted the following:

- with regards to the indicator “Emissions of volatile organic compounds (VOC)”, it would be appropriate to select, in place of this, the indicator “Emissions of NMVOC”, as methane, which is a greenhouse effect gas, is not to be considered in relation to the “environmental problem area” Air pollution;
- the indicator “Total energy consumption”, does not seem to be of particular relevance for the Agriculture sector; so the corresponding indicator is not to be included in the selection;
- with regards to the indicator “Use of pesticides for agricultural purposes”, the significant emissions to air are those coming from the volatilisation of the substances contained in pesticides, which basically concern methyl bromide; this substance, however, is a greenhouse effect gas and should rather be considered with reference to the “environmental problem area” Climate change.

To conclude, in consideration of the fact that nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC), particles and ammonia (NH₃) are the gaseous pollutants to which the Agriculture sector contributes most with regards to the “environmental problem area” Air pollution¹¹¹, the emissions of these pollutants have been selected as the key indicators for this “environmental problem area”.

¹¹⁰ Some of these activities, however, are mostly relevant due to the emissions of methane, which is an environmental pressure not to be considered in relation to the “environmental problem area” Air pollution.

¹¹¹ In terms related to the other sectors, the most important contribution from the Agriculture sector to pollution is that of ammonia: about 90% of NH₃ emissions in Europe are generated by agricultural activity (see SIP Agriculture – Eurostat, 1999b).

Table II.13 - Indicators selected for the Agriculture sector in relation to the “environmental problem area” Air pollution

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of nitrogen oxides (NO _x)	MS – SIP	Pressure
Emissions of non-methane volatile organic compounds (NMVOC)	MS – SIP	Pressure
Emissions of particles	MS – SIP	Pressure
Emissions of ammonia (NH ₃)	MS – SIP	Pressure

II.3.2.2 Climate change

Agricultural activities make up the main source of emissions of some greenhouse effect gases such as methane (CH₄) and nitrous oxide (N₂O): according to the TEPI estimates for the EU in 1998, the Agriculture sector contributes 50% of the emissions of methane and 62% of nitrous oxide (Eurostat 2001).

The main agricultural sources of methane emissions are the following:

- enteric fermentation:
methane is a by-product of digestion; the amount of methane produced depends on the type, age and weight of the ruminants, the type and the amount of food eaten, the environment temperature and the digestion rate;
- animal waste:
in anaerobic conditions the same amount of methane (CH₄) can be produced as in enteric fermentation; these conditions are generally linked to the presence of a large number of animals in a limited space;
- rice-growing:
the amount of methane emitted during the anaerobic decomposition phase of organic material depends on the type of rice, the irrigation, the number and duration of the harvests, the type of soil, the temperature, and the use of fertilizers; this is a source of emissions that is not particularly significant in Europe;
- agricultural land:
it can emit as well as absorb methane;
- combustion of agricultural residues.

There are also other activities that are linked to changes in the use of agricultural land – such as some irrigation methods and drainage of wetlands – that are responsible for methane emissions; in this case, however, the flows of pollutants and their extent are not well known.

Agriculture mainly contributes to emissions of nitrous oxide (N₂O) in the following manner:

- agricultural land:
the emissions come from nitrogen mineral fertilizers, from animal residues after being spread as fertilizers on the soil, from vegetables that fix nitrogen, from the mineralization of organic material in organic soil that is rich in nitrogen, from the on-site decomposition of agricultural residue;
- farming:

the emissions derive mainly from the storage and handling of manure before it is spread on the land; these are due to the phenomena of nitrification and de-nitrification of the nitrogen content in the manure;

- incineration of agricultural waste:
the incineration of agricultural waste produces a certain number of gases including nitrous oxide as by-products of incomplete combustion.

Furthermore, indirect emissions are produced both by volatilisation and by atmospheric depositing of NH₃ and nitrogen oxides (NO_x) mainly coming from both fertilizers and the losses of nitrogen through leaching and rain-wash.

Agriculture also contributes, to a lesser extent, to emissions of carbon dioxide. The main sources are the use of fossil fuels by agricultural machinery, the variation in the quantity of organic carbon contained in the soil and the combustion of agricultural waste¹¹².

SIP Agriculture considered the following indicators as particularly relevant for this “environmental problem area”:

- Emissions of methane (CH₄);
- Emissions of carbon dioxide (CO₂);
- Emissions of nitrous oxides (N₂O);
- Emissions of nitrogen oxides (NO_x);
- Particle emissions;
- Carbon monoxide (CO) emissions due to fossil fuels used and burning of crop residues;

the unit of measurement for all is annual tons.

The selection carried out by SIP Agriculture was found to be totally appropriate in the light of the study carried out and is therefore confirmed.

¹¹² On this subject one cannot ignore the compensatory action that occurs within the Agriculture sector, deriving from the absorption of carbon dioxide by cultivated plants – especially by forests – that are a part of the sector. In fact, one of the first ten indicators selected by Eurostat on the basis of the judgements given by the SAG is the indicator “Removal of carbon dioxide”; this, however, was not considered by SIP Agriculture as one of the indicators to be calculated as it does not represent a pressure, but instead a “response” in relation to the “environmental problem area” Climate change. Moreover, the CO₂ indicator is defined in TEPI (Eurostat 1999c) as net emissions; so there is no need of a separate indicator for removals.

Table II.14 - Indicators selected for the Agriculture sector in relation to the “environmental problem area” Climate change

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of methane (CH ₄)	MS – SIP	Pressure
Emissions of carbon dioxide (CO ₂)	MS – SIP	Pressure
Emissions of nitrous oxide (N ₂ O)	MS – SIP	Pressure
Emissions of nitrogen oxides (NO _x)	MS – SIP	Pressure
Emissions of aerosol particles	MS – SIP	Pressure
Emissions of carbon monoxide (CO)	SAG – SIP	Pressure

II.3.2.3 Loss of biodiversity

Losses of biodiversity usually occur with the changes in traditional land use and in particular the conversion of non-agricultural land into agricultural land, but in this case the assessment of the impact caused on animal and vegetable species is made more complicated due to the fact that positive effects can often be found together with negative effects.

Many European lands that are considered as natural are in fact only semi-natural, as they are shaped by human activity, in particular agricultural activity, and the natural habitats are often closely associated with forms of agricultural management used for crop-growing or animal farming; as in the case of occupation of land for cultivation, the depopulation of rural areas and the abandonment of crop-growing can also bring about environmental deterioration and cause the loss of habitats and of the relative species.

The abandon of traditional agricultural practices of extensive cultivation, together with animal farming, in favour of intensive agriculture is most certainly a negative fact.

Some examples of the negative effects caused by the conversion of non-cultivated areas into agricultural land are:

- wetland loss through drainage;
- damage to land flora and fauna by nutrients and pesticides¹¹³;
- the reduction in biodiversity in water bodies that run into agricultural land due to channelling and the clearance of meadows and forests that lie alongside them;
- the disappearance of some species of trees, the reduction of funguses, insects and lichen, the reduction in the amount of light that penetrates into the underwood due to a management policy that favours more productive forest species;
- the reduction in the scenic value of the landscape due to the use of evergreen mono-culture plantations in straight lines;

¹¹³ The damage caused by pesticides, whose main task is to eliminate biological species other than the ones cultivated, is complex to determine due to the accumulation in the trophic chain.

- the deterioration of soil quality¹¹⁴;
- the increase in the risk of erosion and flooding due to the variations in the land's water-holding capacity from furrows and plantations;
- the increase in soil erosion and landslides in hill and mountain areas due to the abandon of some land use practices, such as terracing.

The indicators proposed by the SIP report are the following:

- Protected area loss, damage and fragmentation:
this represents the environmental pressure made on the integrity of the biological system and therefore on the species and their habitats present in the protected areas. The unit of measurement is expressed as a percentage or in km² of the protected area subjected to the loss, damage or fragmentation in relation to one year taken as a reference. Data in TEPI (Eurostat 1999) only refer to fragmentation by the transport network;
- Wetland loss through drainage:
measures the percentage of the wetland present in one year that has been drained to allow the practice of agricultural activities¹¹⁵. In TEPI (Eurostat 1999a) agriculture is mentioned as one of the most common causes for this pressure;
- Agriculture intensity: area used for intensive arable land:
consists of the percentage of area subject to intensive agriculture in proportion to the total area cultivated. The indicator represents a driving force and is directly connected to the matter of biodiversity due to the fact that intensive agriculture in itself is characterised by a lack of diversification in crops, and indirectly due to a series of practices on which this type of agriculture is normally based, for example the use of pesticides and fertilizers. Some data on this pressure are reported in TEPI 1999;
- Clearance of natural & semi-natural forested areas:
measures the percentage of natural and semi-natural forest area compared to the whole area classified as such that is lost each year to allow the practice of agricultural activity. There are three main causes to clearance of forests: cutting, fires and defoliation due to acid rain; the first reason is directly ascribable to agriculture, and sometimes also the second, while the third only indirectly through its contribution to air pollution. The indicator expresses an environmental pressure as the loss of a portion of forest area directly involves the loss of an ecosystem. Also for this environmental pressure data are reported in TEPI 1999;
- Changes in traditional (extensive) land-use practice:
this concerns the impact on wild species and on the diversity of cultures and animals. The indicator expresses the fact that preservation of biodiversity can also be achieved by maintaining traditional cultivation practices; the most modern techniques, characterised by

¹¹⁴ Among the possible causes of land deterioration, one can quote non-suitable forms of irrigation and agriculture practice management, deforestation, excessive use of chemical products, the use of agricultural machinery, use of purification sludge on cultivated land (with pollution from heavy metals). The impact of agriculture on the quality of land does not only depend on the management practices used but also on the vulnerability of different types of land to the various deterioration processes. The main processes of land deterioration are of a physical, chemical and biological nature. The most significant forms of physical land degradation due to agriculture concern erosion, desertification, compaction, and the presence of suspended solids in water. Chemical deterioration is instead characterised by acidification, salinization, and land contamination by micro-pollutants such as pesticides, heavy metals and nutrients. Finally, biological deterioration entails a reduction in the content of organic material and consequently a change in the biological varieties present in and on the land.

¹¹⁵ On this matter, it is necessary to take into account the difficulties of defining the boundaries of wetland and its extension.

an intensive use of the soil, give rise to the loss of habitats and species due to the homogenisation of land use¹¹⁶. TEPI (Eurostat 1999a) supplies data concerning the current situation (State) more than the changes (Pressure);

- Pesticide use on land:
the unit of measurement is in tonnes of active ingredients per hectare of cultivated area, weighted according to toxicity¹¹⁷;
- Fragmentation of natural and semi-natural forest:
measures the fragmentation of forests and landscapes due to the development of infrastructures such as roads and other separation lines. The phenomenon is already represented by another indicator: “Clearance of natural & semi-natural forested areas”;
- Loss of forest diversity - increase in exotic monoculture:
expresses the conversion of existing forests into monoculture plantations; this conversion normally results in a loss or reduction in biodiversity¹¹⁸. The indicator represents a direct environmental pressure, i.e. the immediate loss of biodiversity given the changeover to monoculture in itself, and also a driving force due to the effects that this change has on animal and vegetable species in the forest;
- Increase in cultivations of hybrid cultivars:
measures the direct pressure on biodiversity via the impoverishment of the genetic varieties within agriculture itself. There is another complementary indicator, similar in substance, in the Methodology Sheets: “Loss of genetic resources”. This last indicator, in fact, is connected to the lack of use of cultural species and the variety of animals available.

The selection of the indicators made by SIP agriculture was found appropriate and is therefore substantially confirmed, with the exclusion, due to redundancy, of the indicator “Fragmentation of forests & landscapes by roads/intersections”. It was also considered useful to add a further indicator to the group of indicators proposed by the SIP report, due to what has been said regarding the last indicator discussed above.

Table II.15 - Indicators selected for the Agriculture sector in relation to the “environmental problem area” Loss of biodiversity

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Protected area loss, damage and fragmentation	MS – SIP	Pressure
Wetland loss through drainage	MS – SIP	Pressure
Agriculture intensity: area used for intensive arable agriculture	MS – SIP	Driving force
Clearance of natural & semi-natural forested areas	MS – SIP	Pressure
Change in traditional land-use practice	MS – SIP	Driving force
Pesticide use on land	MS – SIP	Pressure
Loss of forest diversity - increase in exotic monoculture	MS – SIP	Pressure
Increase in cultivations of hybrid cultivars	SIP	Pressure
Loss of genetic resources	MS	Pressure

¹¹⁶ In the Methodology Sheets the phenomenon in question was further specified with the reference to the “variation in the number of different habitats for each rural estate compared to an appropriate base year” (this statement, in fact, was associated to the unit of measurement).

¹¹⁷ Alongside toxicity it would also be appropriate to assess bioaccumulation and persistence.

¹¹⁸ When the original forest system has deteriorated, however, the new plantations can bring about a short-term increase in biodiversity.

II.3.2.4 *Marine environment and coastal zones*

There are various environmental pressures generated by agricultural activities on the marine environment and coastal zones. The most significant are linked to the conversion of coastland to agricultural uses, water abstraction, the use of fertilizers and pesticides, and the high density of animals, wastewater and waste discharges. The main problems concern the loss of habitat and various species, eutrophication, water pollution; erosion also contributes to a constant deterioration in the coastal environment. One of the objectives of the 5EAP for conserving the biological diversity of the marine environment is a sustainable use of fish species via sustainable fishing and sustainable breeding of the species that can be farmed.

In the SIP report, the following phenomena were considered to be particularly significant for the “environmental problem area” Marine environment and coastal zones:

- eutrophication:
SIP Agriculture proposed a measurement of environmental pressures that determine this phenomenon via two indicators, respectively relative to the emissions of NO₃ and P₂O₅, linked to the use of fertilizers, expressed in annual tonnes. However, other nitrogen and phosphorus compounds are also introduced into waters and the Methodology Sheets suggested the use of aggregate measurements, while keeping the two nutrients separate. It is necessary to specify that it is the potential contribution to the phenomenon of eutrophication that can be measured, rather than the phenomenon itself. This is the way the indicator is interpreted in TEPI as well, where it is also shown that most inputs of N and P to the marine and coastal environment come from rivers, that convey also agricultural run-offs from land. It is therefore advisable to clarify the indicator by specifying “amounts of nitrogen and phosphorus introduced into waters” in its denomination. As not all of the nutrients discharged necessarily end up in the sea, this indicator expresses a driving force;
- over-fishing:
this phenomenon represents the main anthropic pressure on fish and mollusc reserves. For this matter it is necessary to identify the level of fishing that optimises production without causing the depletion of fish resources; the actual level of fishing should be compared to this “sustainable” level of fishing, in order to see whether and to what extent the “over-fishing” phenomenon is taking place. Given the existing margins of uncertainty, the Methodology Sheets suggested including the actual level of fishing among the indicators (the unit of measurement is annual tonnes per species fished in a determined area); indeed, in TEPI this is the calculated indicator, named “Fishing pressure”. This solution seems appropriate in consideration of the fact that there is a specific “environmental problem area” for considering resource depletion (with reference to this in the Methodology Sheets the level of fishing taken as reference is the one allocated by international treaties to the various countries);
- priority habitat loss:
the phenomenon to consider is the net decrease in primary habitats in a determined marine or coastal zone, expressed in hectares/year. The habitats allow the survival of many aquatic and marine species and vital functions are associated with them such as erosion control and nutrient absorption; losing them therefore means a reduction in biodiversity, pollution of the coastal and marine areas, destruction of natural equilibrium. It is difficult, however, apart from the wetlands, to specify which habitats, can be considered as priority areas;

- wetland loss:
to measure this important phenomenon is the same as to specify in operational terms an indicator which is also valid for the previous phenomenon. “Wetland loss in coastal zones” is ascribed to agriculture by TEPI (Eurostat 2001) for substantial shares in several EU countries.
- faecal pollution:
the phenomenon is represented by the discharge of faecal material into coastal and marine areas, expressed in tonnes per year. In addition to representing a direct environmental pressure on the quality of water, it also constitutes a driving force in relation to the phenomenon of eutrophication.

On the basis of the reflections made starting from the list of indicators selected by the SIP report, the list of indicators proposed by SIP Agriculture was suitably reformulated; furthermore, one indicator (“Priority habitat loss”) was dropped, and the following were included:

- Discharges of halogenated organic compounds:
as defined in the Methodology Sheets, this indicator measures “the amount of organo-halogenated compounds emitted directly or indirectly (via rivers) into the coastal zone and marine environment”. These substances are “added to compounds to fulfil a function such as to kill weeds or vermin”, and therefore much dispersed into the environment from Agriculture, and via rivers to the marine and coastal environment. It expresses a driving force.

Table II.16 - Indicators selected for the Agriculture sector in relation to the “environmental problem area” Marine environment and coastal zones

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Eutrophication (amounts of nitrogen and phosphorus introduced into waters)	MS – SIP	Driving force
Fishing pressure	MS – SIP	Pressure
Wetland loss in coastal zones	MS – SIP	Pressure
Discharges of halogenated organic compounds	MS	Driving force
Faecal pollution	MS – SIP	Pressure

II.3.2.5 Ozone layer depletion

Agricultural activities do not contribute to the emissions of the main substances responsible for the ozone layer depletion, such as bromofluorocarbons and chlorofluorocarbons, but contribute significantly to the emissions of other gases, such as methyl bromide, methane and nitrous oxide.

SIP Agriculture considered the following indicators to be particularly important for this “environmental problem area”:

- Anthropogenic emissions of carbon dioxide (CO₂) (from land use changes + fossil fuel used);
- Anthropogenic emissions of nitrogen oxides (NO_x) (from fossil fuel used):
these emissions that come from the use of fossil fuels, were considered to be significant in the SIP report; however, they do not reach the stratosphere – which is the place in which the destruction of the ozone takes place – due to the reduced lifespan of nitrogen oxides;

- Nitrous oxide (N₂O) emissions:
this is a nitrogen compound significant for stratospheric ozone destruction; it mainly comes from the soil, where it forms further to nitrification and denitrification processes and contributes to reducing the ozone layer by increasing the concentration of stratospheric nitrogen oxides;
- Emissions of methyl bromide (CH₃Br):
agricultural use of pesticides, soil fumigation and the combustion of biomasses are among the main sources of methyl bromide emissions; this substance is emitted by the agro-food sector with the use of fumigants for insect, fungus, bacteria and weed control and for the disinfection of preserved foodstuffs;
- Emissions of methane (CH₄);

for all indicators the unit of measurement is tonnes/year.

On the basis of the reflections made starting from the list of indicators selected by the SIP report, the list of indicators proposed by SIP Agriculture was suitably reformulated, omitting the indicator referring to NO_x emissions, since, as TEPI states, “due to its short lifetime, NO_x emitted in the lower troposphere, do not reach the stratosphere” (Eurostat 1999a).

Table II.17 - Indicators selected for the Agriculture sector in relation to the “environmental problem area” Ozone layer depletion

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of carbon dioxide (CO ₂)	MS – SIP	Pressure
Emissions of nitrous oxide (N ₂ O)	MS – SIP	Pressure
Emissions of methyl bromide (CH ₃ Br)	MS – SIP	Pressure
Emissions of methane (CH ₄)	MS – SIP	Pressure

II.3.2.6 Resource depletion

Most natural resources used by the Agriculture sector are renewable, such as forests, fish resources, land, water (mostly for irrigation), but agricultural activities also contribute to the depletion of non-renewable resources such as fossil fuels and metal ore.

In agriculture an exploitation of renewable resources that exceeds the same resources' capacity of regeneration often occurs, such as, for example, in the case of fish resources or, locally, of water resources. In many productions in this sector, the modern models of development have brought about a specialisation of various geographical areas so as to cause adverse environmental effects, for example with some territories that have excessive accumulations of nutrients in the soil and others that are completely depleted.

SIP Agriculture considered the following indicators as being particularly significant for this “environmental problem area”:

- Nutrient-balance of soil (nutrient input/nutrient output):
this compares the annual input and output flows of nitrogen and phosphorus on agricultural land, on the basis of the average value per hectare, thus accounting for the main quality aspects concerning soil. Data on the nitrogen balance and on phosphate input to agricultural land are included in TEPI (Eurostat 1999a and 2001 respectively);
- Timber balance (new growth/harvest):

compares on one hand the annual aggregates of timber production and imports and on the other hand that of consumption and exports, expressed in cubic metres; also this indicator is considered in TEPI 2001;

- Irrigation:
the amount of water required for irrigation mainly depends on the type of crop and the monthly rainfall. A group of indicators present in the list proposed to the SAG seems preferable to this one: “Water consumption”, “Ground water abstraction for agricultural purposes” (both present in the Methodology Sheets¹¹⁹), “Surface water abstraction for agricultural purposes”¹²⁰. TEPI (Eurostat 2001) attributes to agriculture 20% and 25% of the uses of surface and ground water abstraction respectively;
- Exceedance of fish catch quota:
this allows, from a quantitative point of view, for the environmental pressure made on fish resources from drawing, assuming that the “sustainable” level is the drawing set by international treaties; the unit of measurement is tonnes of fish per year;
- Soil erosion (caused by long standing water):
agricultural activities can cause important phenomena of erosion of the fertile surface layer; water and wind, in fact, act more easily on cultivated fields, to the point that they exceed the compensatory capacity represented by the natural renewal of the surface layer.

The reflections made starting from the list of indicators selected by the SIP report allowed most of the indicators selected by SIP Agriculture to be confirmed, proceeding with some additions: in addition to what has been pointed out above with reference to the irrigation indicator, it was deemed appropriate to select another indicator present in the Methodology Sheets, referring to energy consumption, to be defined as referring to the absolute quantity consumed¹²¹; this appeared to be particularly interesting for agriculture, as numerous studies on the energy balance of modern mechanised agriculture show that it often is negative (i.e. non-renewable energy resources used up exceed the energy content of the renewable resources created).

¹¹⁹ To be precise, the indicator proposed in the Methodology Sheets is “Water consumption per capita” (See Part I, paragraph I.5.4 for a discussion on this point) while reference for ground water abstraction is made both to agricultural and industrial purposes (this holds also for the indicator for surface water). See paragraph II.2.2.6 for the treatment of water consumption in TEPI.

¹²⁰ It is advisable that the indicators at issue be specified as to draw a clear distinction between water consumed by the sector and water directly drawn by it from the natural environment, as the former includes water purchased from specialised producers, and can therefore be quite different from the latter.

¹²¹ In the Methodology Sheets the indicator “use of energy per capita” was formulated.

Table II.18 - Indicators selected for the Agriculture sector in relation to the “environmental problem area” Resource depletion

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Nutrient-balance of the soil (nutrient input/nutrient output)	MS – SIP	Pressure
Timber balance (new growth/harvest)	MS – SIP	Pressure
Exceedance of fish catch quota	MS – SIP	Pressure
Use of energy (total quantity)	MS	Driving force
Water consumption (total quantity)	MS – SIP	Driving force
Ground water abstraction for agricultural purposes	MS – SIP	Pressure
Surface water abstraction for agricultural purposes	SAG – SIP	Pressure
Soil erosion	SIP	Pressure

II.3.2.7 Dispersion of toxic substances

The products with the highest rate of toxicity used in agriculture are pesticides used for plant defence; they have a multitude of effects on the natural environment: they can persist in the soil, contaminate water-bearing strata and/or surface waters via infiltration, surface flowing and depositing, and be dispersed in the air (where they can be transported long distances) via the volatilisation of some substances contained in them; traces can also be found in foods.

The degree of toxicity of pesticides mainly depends on the type of product use (weed killer, insecticide, fungicide) and on the concentration of active ingredients contained in them. Also the sensitivity of the biological species to toxic contamination from pesticides depends on the particular pesticide used and varies according to the species that undergoes treatment. Mobility and persistence of residues in the soil depends on various factors, including climate conditions, topography and the type of soil.

SIP Agriculture considered the following indicators as being particularly significant for this “environmental problem area”:

- Consumption of pesticides by agriculture:
this measures the total amount of pesticides used by the Agriculture sector, expressed in tonnes/year. The indicator cannot indicate the actual hazardousness of the toxic substances since, as mentioned above, the degree of toxicity and dispersion depend on many factors, not least the size of the surface treated with a given quantity and quality of pesticide; a more appropriate indicator is given by the use of pesticides per hectare of cultivated agricultural area, to which reference is also made in the 5EAP in order to determine the objectives of reducing the phenomenon in question. Data are included in TEPI (Eurostat 2001);
- Emissions of persistent organic pollutants (POPs):
this is a broad category of pollutants, known as POPs, that, in addition to the pesticides used in agriculture, also includes the hydrochlorocarbons used as solvents and other pollutants emitted by various processes; the unit of measurement adopted is tonnes/year. The data contained in TEPI refer only to dioxin, and do not suggest a very important contribution from agriculture; POPs, however, are a much larger category of substances, whose emissions, according to the Methodology Sheets “are probably associated with all economic activities”;

- Toxic chemical consumption (D67/548/EC):
this refers to the use of chemical substances that are considered to be toxic according to the EC directive 67/548, which mainly concerns chemical substances used in industry, while pesticides, fertilizers and other chemical substances used in agriculture are regulated by other directives and – at least partly – covered by other indicators;
- Emissions of heavy metals by consumption:
the SIP report also suggested specifying this phenomenon further via the reference to cadmium and mercury. In any case, indicators calculated separately for the emissions of heavy metals to air and water are more corresponding to the general criteria set for the harmonisation of the SIP projects. Moreover, “consumption” here should be understood as intermediate use of products containing heavy metals, as all environmental pressures that can be accounted for as environmental pressures of the Agriculture sector occur in the realisation of its production; the reference to this phase could then be misleading and is therefore redundant. The data included in TEPI (Eurostat 2001) suggest that in some cases the contribution of agriculture can be non-negligible for emissions to water (as in that of the Netherlands 1994), while it is not significant for emissions to air.

The reflections made starting from the list of indicators selected by SIP Agriculture brought about the reformulation of the indicator referring to the use of pesticides, the exclusion of the one connected to the directive 67/548/EC and the reconsideration of the one referring to heavy metals, as described above.

Table II.19 - Indicators selected for the Agriculture sector in relation to the “environmental problem area” Dispersion of toxic substances

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Consumption of pesticides by agriculture	MS – SIP	Pressure
Emissions of persistent organic pollutants (POPs)	MS – SIP	Pressure
Index of heavy metals emissions to water	MS – SIP	Pressure

II.3.2.8 Urban environmental problems and noise

Agriculture is a sector characterised by activities that are carried out outside urban environments and therefore it does not generate environmental pressures pertaining to this “environmental problem area”. Exceptions can occur mostly in the outskirts of cities and small urban centres, for example with regards to odours coming from intensive animal rearing, but these phenomena did not seem so significant as to recommend the formulation of ad hoc indicators.

II.3.2.9 Waste

As the SIP report underlined, most agricultural wastes are organic and biodegradable. For example, they comprise residues from harvests, animal manure, which can be reconverted into reusable products in agriculture itself, as food for animals and organic fertiliser.

SIP Agriculture considered the following indicators as particularly significant for this “environmental problem area”, representing certain specific aspects such as the production of hazardous waste, which in agriculture mostly derives from the use of chemical products:

- Hazardous waste (EC directive 91/689/EWC):
according to the directive 91/689/EWC, waste coming from the production, treatment and preparation of food in activities such as agriculture, horticulture, hunting, fishing and

aquaculture can be considered hazardous; the unit of measurement adopted is tonnes/year. Agriculture is mentioned in TEPI (Eurostat 2001) as one of the relevant sectors contributing to this (though the data presented do not suggest a large weight);

- Recycled waste/recovered material:
the indicator does not necessarily identify an environmental pressure, nor a driving force, but only the actual use of a method for managing waste;
- Consumption of hazardous materials:
in the Methodology Sheets, the indicator refers to the industrial and commercial activities and to household consumption and not to agricultural activity. It moreover refers to a driving force (the consumption which causes some waste generated to be particularly dangerous) quite far from the actual pressures on the environment, and is made superfluous by the indicator “Hazardous waste (according to the directive 91/689/EWC)”, which indicates directly the waste generated by the consumption under examination.

The reflections made starting from the list of indicators selected by SIP Agriculture brought about the exclusion of the last two indicators discussed above.

As the SIP report states, the intensification of cultivation and breeding, with the consequent growth in wastes generated, accompanied by an increase in their concentration, can be at the origin of environmental problems; on this matter, however, SIP Agriculture did not adopt an indicator that refers to the total quantity of waste produced by the sector. Such an indicator was also added to the selection made.

Table II.20 - Indicators selected for the Agriculture sector in relation to the “environmental problem area” Waste

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Hazardous waste (according to the directive 91/689/EWC)	MS – SIP	Driving force
Waste from agriculture	SAG	Driving force

II.3.2.10 Water pollution and water resources

The SIP report clarifies that the most important forms of pollution of water resources coming from agricultural activities are the introduction of nitrates, phosphates, pesticides, organic material and suspended solids into water.

The nitrates are mostly linked to the quantities and quality of fertilisers used, to the type of crop (for waterbeds, also to the degree of vegetation coverage that influences the amount of water that infiltrates with rainwater). Wastewater and, in particular, animal manure contributes to the release of phosphates to a considerable extent. The most serious effects concern eutrophication, water contamination, and the blocking of waterways due to suspended solids generated by soil erosion.

SIP Agriculture considered the following indicators to be particularly significant for this “environmental problem area”:

- Pesticides used per hectare of utilised agricultural area:
the unit of measurement is kilograms of active ingredients per hectare and per year. Data are included in TEPI;

- Total nutrient (nitrogen and phosphorous) use in eutrophication equivalent: the use in itself of nitrogen and phosphorus, i.e. the administration of these substances to soil, as well as the fixation in the soil of atmospheric nitrogen, considered regardless of the quantities that actually reach the water bodies, represents a driving force (this is related to the actual environmental pressure represented by the quantities of phosphorus and nitrogen that end up into the aquatic ecosystems);
- Nitrogen quantity used by hectare of utilised agriculture area: this refers to the total amount of nitrogen, measured in kilograms of nitrogen per hectare of utilised land, present in the chemical and biological fertilisers used. The indicator is superfluous due to the presence of the previous one (however, data are present in TEPI for this nutrient only);
- Emissions of organic matter as Biochemical Oxygen Demand: expresses the amount of organic material discharge into water, measured as BOD; the unit of measurement is tonnes of BOD per year;
- Emissions of heavy metals by metal: this is actually a series of indicators that measure the quantity of each metal introduced into aquatic systems; the unit of measurement is tonnes/year. As discussed under the “environmental problem area” Dispersion of Toxic Substances, TEPI shows that heavy metal emissions into waters from Agriculture are in some cases relevant;
- Groundwater abstraction: the unit of measurement is in millions of cubic metres per year. TEPI (Eurostat 1999a) mentions the cases of Denmark and Spain (1995), showing very important contributions from agriculture (respectively 31% and 81%). A similar indicator referring to surface waters should be placed alongside this one; also, it seems recommendable to add another more general indicator, referring to a driving force, concerning water consumed.

The reflections made starting from the list of indicators selected by SIP Agriculture gave rise to the elimination of the indicator referring exclusively to nitrogen, as far as potential contributions to eutrophication are concerned; another two indicators were selected, one concerning surface waters and one referring to consumed water, both present in the list proposed to the SAG (the latter as “per capita” consumption, but it is the absolute quantity that has to be considered relevant for the sector).

Table II.21 - Indicators selected for the Agriculture sector in relation to the “environmental problem area” Water pollution and water resources

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Pesticides used per hectare of utilised agriculture area	MS – SIP	Pressure
Nutrient (N+P) use (eutrophication equivalents)	MS – SIP	Driving force
Emissions of organic matter as BOD	MS – SIP	Pressure
Emissions of heavy metals, by metal	MS – SIP	Pressure
Ground water abstraction	MS – SIP	Pressure
Surface water abstraction	SAG	Pressure
Water used	SAG	Pressure

II.4 Transport Sector

II.4.1 Description and delimitation of the sector and main overlaps with other sectors

II.4.1.1 Description and delimitation of the sector in the SIP report

According to SIP Transport¹²², a definition of the sector that is suited to quantifying the environmental pressures it makes on the natural environment must go beyond the boundaries of categories 60-62 in the NACE, in order to be able to include all transport activities, both those carried out as commercial activities (specialised or otherwise in transport) and those carried out as non-commercial ones (i.e. for private transport)¹²³. First of all, therefore, in the SIP report, a distinction was made between these two sub-groups¹²⁴.

With regards to commercial activities in particular, a distinction was made between transportation of passengers and the transportation of goods. The latter includes activities carried out for third parties and own transport activities (self-production of transport services by economic units that are not specialised in this activity).

Transport modes included in the sector are all those that require “external power”; these have been differentiated into rail, sea, road, internal waterways, air. Also oil pipelines are covered, while mobile sources of air emissions that do not respond to transport policy such as “tractors plowing fields, forklift trucks, lawnmowers and forestry equipment” are excluded from the sector.

The SIP report also highlighted the fact that the environmental pressures generated by this sector are determined by several factors, such as the type of vehicle and fuel, the distance, the climate, the behaviour of the traveller etc; unfortunately no complete information is available on all these factors. It is to be hoped therefore, as stated in the SIP report, that future work will concentrate on these aspects and in particular on non-commercial activities, for which little data is available.

II.4.1.2 Clarification of the sector boundaries and of the overlaps with other sectors

II.4.1.2.1 Transport and energy

The transformation of energy materials or electricity into motive power for moving goods and people is a typical activity of the Transport sector. The energy transformation process that characterise the sector’s activities in this way must be kept conceptually distinct from other types of energy transformation – part of the Energy sector – that are not directly aimed at producing motive power.

As far as these other types of energy transformation are concerned, some overlaps between the Transport sector and the Energy sector were found, for which it is useful to recall here what was stated above within the discussion on the delimitation of the Energy sector:

- as regards in general energy consumption¹²⁵:
the solution adopted applies in particular to consumption of energy (within transport activities) that takes place not directly for the purpose of producing motive power;

¹²² Eurostat (1999b).

¹²³ The latter activities, unlike the former ones, are not among those included in the classification of economic activities.

¹²⁴ This distinction corresponds to the similar one made by the SIP Tourism and, as a general distinction, is dealt with in Part I.

¹²⁵ See paragraph II.2.1.2.1 - “Consumption of energy”.

- as regards the specific intersections of the Transport sector with the Energy sector¹²⁶: the transportation of energy materials, while being considered also in the Energy sector – unlike the indications given in the relative SIP report – fully belongs to the Transport sector.

II.4.1.2.2 Overlaps with other sectors

Overlaps were also found regarding the Tourism and Waste Management sectors, for which the following approach was adopted:

- Tourism: tourist transport activities are identified as significant activities. These activities fully belong to the transport sector, but are to be considered also for the Tourism sector, as foreseen by the relative SIP report¹²⁷;
- Waste Management: the transportation of waste is identified as a significant activity; this activity, which fully belongs to the Waste management sector¹²⁸, is also considered in the Transport sector, being influenced, as all other transport activities, by transport policy¹²⁹.

As for Industry and Agriculture, the “reach-of-policy” criterion applies, which excludes in-site mobile sources of air emissions; so no overlap was found. This coincides with the “mill gate” criterion established by the SIP Industry.

II.4.1.3 Delimitation of the sector in terms of economic activities and household consumption

The scheme proposed by the SIP report for the definition of the sector is consistent with the approach adopted in the present study.

Table II.22, which reflects this scheme, summarises the delimitation of the sector adopted, in terms of elementary headings (i.e. considered at the highest degree of disaggregation) of the classification of economic activities, and of the non-commercial activities not included in this classification.

In addition to the items that belong to the NACE categories 60-62, it was found appropriate to include those referring to waste transport (partial inclusion of class 90.00), as mentioned above. Furthermore, the “supporting and auxiliary transport activities” have also been added (NACE 63), with the exclusion of “Storage and warehousing” (63.12) and “Activities of travel agencies and tour operators; tourist assistance activities n.e.c.” (63.3)¹³⁰. Finally, also the activities contained in the groups 71.1 and 71.2, concerning the renting of vehicles, have been included in the sector.

¹²⁶ See paragraph II.2.1.2.2 – “Energy and Transport”.

¹²⁷ See Eurostat, 1999b.

¹²⁸ See paragraph II.6.1.

¹²⁹ In the 5EAP waste transport is expressly mentioned in the part referring to the Transport sector.

¹³⁰ These last activities, compared to the others in category 63, appeared to be less closely connected to the transport system (and therefore less subject to the relative policies), while the remaining part of NACE 63 includes activities necessary for carrying out actual transport activities, such as, for example, the handling of goods.

Table II.22 - Activities included in the Transport sector

NACE rev. 1 codes	Activities
A) PRODUCTION ACTIVITIES	
60.10	Transport via railways
60.21	Other scheduled passenger land transport
60.22	Taxi operation
60.23	Other land passenger transport
60.24	Freight transport by road
60.30	Transport via pipelines
61.10	Sea and coastal water transport
61.20	Inland water transport (including lake transport)
62.10	Scheduled air transport
62.20	Non-scheduled air transport
62.30	Space transport
63.11	Cargo handling
63.21	Other supporting land transport activities
63.22	Other supporting water transport activities
63.23	Other supporting air transport activities
63.40	Activities of other transport agencies
71.10	Renting of automobiles
71.21	Renting of other land transport equipment
71.22	Renting of water transport equipment
71.23	Renting of air transport equipment
90.00 (in part)	Sewage and refuse disposal, sanitation and similar activities (limited to the transport of waste)
B) HOUSEHOLD CONSUMPTION ACTIVITIES	
-	Private transportation of goods and passengers

II.4.2 Selection of the indicators that are most representative of the environmental pressures of the sector

On the basis of the general concept formulation developed in Part I and the further methodological elements discussed in the previous paragraph with specific reference to the Transport sector, a close examination has been carried out of the main environmental pressures that can be attributed to the sector, starting from the most significant lists proposed in the European projects. As a result of this revision work, a selection of indicators that appeared to be, at this stage, most representative of the environmental pressures of the sector has tentatively been established.

In the paragraphs below, the indicators of environmental pressures that have been selected are presented with reference to each of the ten “environmental problem areas” that were identified on a European level. For each “environmental problem area” the main environmental pressures of the sector are briefly discussed and a summary table of the selected indicators is provided, similar to those already presented for the sectors dealt with above.

II.4.2.1 Air pollution

The following environmental pressure indicators for the “environmental problem area” Air Pollution have been proposed in the SIP report:

- Emissions of CO, HC, NO_x, SO_x, particles, NMVOC – road;
- Emissions of CO, HC, NO_x, SO_x, particles, NMVOC – rail;
- Emissions of CO, HC, NO_x, SO_x, particles, NMVOC – air;
- Emissions of CO, HC, NO_x, SO_x, particles, NMVOC – sea;
- Emissions of CO, HC, NO_x, SO_x, particles, NMVOC – inland water;
- Emissions of selected persistent organic compounds;
- Emissions of heavy metals by transport mode;
- Emissions of total fugitive hydrocarbons by transport (PM10).

On this subject, the following observations seemed to be of particular importance:

- the use of catalytic exhausts has reduced, over equal distances, the main emissions from means of transport powered by petroleum-based fuel, such as, for example, nitrogen oxides (NO_x) and carbon monoxide (CO); however, transport remains a particularly important sector for these emissions, if only due to the high relative weight of the most polluting forms of transport. According to TEPI (Eurostat 2001), in 1998 transport processes were responsible for 64% of the emissions of NO_x in the EU, three quarters of which were due to road transport;
- 34% of the NMVOC emitted in the EU in 1998 were due to road transport, and the share of emissions of particles due to this means of transport (in particular to diesel engines), though differing considerably between various countries, remains significant, with absolute quantities generally increasing (Eurostat 2001);
- with regards to sulphur oxides, the indicator contained in the Methodology Sheets which refers only to sulphur dioxide (SO₂) emissions seems to be preferable; these environmental pressures are still significant, in spite of the introduction of low-sulphur content fuels that have reduced this type of emissions considerably. 5% of SO₂ emitted in the EU in 1998 can be attributed to transport processes (Eurostat 2001);
- emissions of hydrocarbons (HC) that are significant for this “environmental problem area”, and also those of other volatile organic compounds, can be considered to be substantially represented by the indicator “Emissions of NMVOC”;
- with regards to the emissions of heavy metals, these are not significant according to the understanding of this “environmental problem area” in the other European projects: the focus should mainly be on the formation of smog and on the causes of acidification;
- with regards to the driving forces, two variables are to be considered especially significant in relation to the group of environmental pressures to be taken into account for the sector: “Coal and oil products consumption” (as regards fossil fuels, TEPI 2001 calculated for transport processes 26% of consumption in the EU in 1998) and, in particular, “Gasoline and diesel oil consumption by road vehicles” (this consumption increased by 45% in the EU from 1985 to 1998, according to TEPI 2001); both indicators are present in the Methodology Sheets.

In conclusion, the selection made by SIP Transport was found quite appropriate, with the adjustments stemming from the above remarks.

Table II.23 - Indicators selected for the Transport sector in relation to the “environmental problem area” Air pollution

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of CO, NO _x , SO ₂ , particles, NMVOC from road transport activities	MS – SIP	Pressure
Emissions of CO, NO _x , SO ₂ , particles, NMVOC from rail transport activities	MS – SIP	Pressure
Emissions of CO, NO _x , SO ₂ , particles, NMVOC from air transport activities	MS – SIP	Pressure
Emissions of CO, NO _x , SO ₂ , particles, NMVOC from sea transport activities	MS – SIP	Pressure
Emissions of CO, NO _x , SO ₂ , particles, NMVOC from inland water transport activities	MS – SIP	Pressure
Gasoline and diesel oil consumption by road vehicles	MS	Driving force
Coal and oil products consumption	MS	Driving force

II.4.2.2 Climate change

For the “environmental problem area” Climate change, the SIP report proposed indicators for the emissions of CO, CH₄, N₂O, NO_x, CO₂, SO_x, particles and NMVOC, which in this case too were separated depending on the means of transport via road, rail, air, sea or inland waters.

The reflections made starting from the list of indicators selected by SIP Transport highlighted also the importance of the emissions of chlorofluorocarbons. The use of CFC-12, used in vehicle air-conditioning units seemed to be particularly significant. Although the leaks that occur during the production phases and scrapping phases of conditioning units contribute respectively to the Industry and Waste management sectors, and in spite of the fact that the most modern air-conditioning units are supplied with special devices capable of capturing the CFCs, the Transport sector’s contribution to the emission of these harmful gases may be not insignificant yet.

In conclusion, the selection made by SIP Transport was found totally appropriate, with the above integration regarding the emissions of chlorofluorocarbons.

Table II.24 - Indicators selected for the Transport sector in relation to the “environmental problem area” Climate change

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of CO, CH ₄ , N ₂ O, NO _x , CO ₂ , SO _x , particles, NMVOC from road transport activities	MS – SIP	Pressure
Emissions of CO, CH ₄ , N ₂ O, NO _x , CO ₂ , SO _x , particles, NMVOC from rail transport activities	MS – SIP	Pressure
Emissions of CO, CH ₄ , N ₂ O, NO _x , CO ₂ , SO _x , particles, NMVOC from air transport activities	MS – SIP	Pressure
Emissions of CO, CH ₄ , N ₂ O, NO _x , CO ₂ , SO _x , particles, NMVOC from sea transport activities	MS – SIP	Pressure
Emissions of CO, CH ₄ , N ₂ O, NO _x , CO ₂ , SO _x , particles, NMVOC from inland water transport activities	MS – SIP	Pressure
Emissions of chlorofluorocarbons (CFC)	MS	Pressure

II.4.2.3 Loss of biodiversity

The following indicators were proposed in the SIP report for the “environmental problem area” Loss of biodiversity:

- Protected area loss, damage and fragmentation by transport;

- Fragmentation of forests and landscapes by traffic areas distributed by roads, railroads, harbours and airports;
- Pesticide use on land used by transport;
- Riverbank loss through transport construction system;
- Loss of forest diversity - increase in exotic monoculture;
- Surface pollution incidents;
- Traffic intensity in protected areas.

The reflections made starting from the list of indicators selected by SIP Transport lead to confirm all the indicators proposed by the SIP report as being substantially suitable for representing the sector's pressures on biodiversity, with the exception of the one focused on the increase in exotic monoculture, which did not seem to be very relevant for this sector; some indicators have been reformulated according to the Methodology sheets.

Table II.25 - Indicators selected for the Transport sector in relation to the “environmental problem area” Loss of biodiversity

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Protected area loss, damage and fragmentation	MS – SIP	Pressure
Fragmentation of forests and landscapes by roads/intersections	MS – SIP	Pressure
Pesticide use on land	MS – SIP	Pressure
Riverbank loss through artificialisation	MS – SIP	Pressure
Surface pollution incidents	SAG – SIP	Driving force
Traffic intensity in protected areas	SAG – SIP	Driving force

II.4.2.4 Marine environment and coastal zones

The indicators selected by the SIP report for the “environmental problem area” Marine environment and coastal zones were as follows:

- Heavy metals discharges by transport;
- Priority habitat loss by transport;
- Wetland loss by transport;
- Faecal pollution;
- Oil pollution at coast;
- Oil pollution at sea;
- Accidents in transport in coastal zones and at sea (e.g. oil);
- Accidents in transport of hazardous waste at sea;
- Development along shore;
- Density of marine transport.

Further to some reflections made starting from the list of indicators selected by SIP Transport, the most significant indicators among those proposed on a European level for this “environmental problem area” were considered to be the following:

- Discharges of heavy metals:
mercury and organic lead are discharged directly into the sea in large quantities from ships and are present in high concentrations in the ports;
- Wetland loss:
this indicator is particularly significant as it refers to very critical habitats that are potentially damaged by the development of land transport, especially along the shores; the “share” of this environmental pressure that can be attributed to transport according to TEPI (Eurostat 2001) is relatively low but notable;
- Faecal pollution:
the contribution of sea passenger transport to this kind of degradation of the marine and coastal environment can locally be important;
- Oil pollution at coast and at sea:
this indicator, proposed in the Methodology Sheets, groups together the two corresponding indicators proposed separately in SIP Transport for coastlines and for the sea. The pollution in question involves the two environments at the same time;
- Accidents in transport along the coastal zones and at sea;
- Development along shore;
- Density of marine transport:
these are three indicators of a general value which refer to driving forces; the first of these includes the one referring to the accidents that involve hazardous waste.

Table II.26 - Indicators selected for the Transport sector in relation to the “environmental problem area” Marine environment and coastal areas

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Discharges of heavy metals, by metal	MS – SIP	Pressure
Wetland loss	MS – SIP	Pressure
Faecal pollution	MS – SIP	Pressure
Oil pollution at coast & at sea	MS – SIP	Pressure
Accidents in transport in coastal zones and at sea	SAG – SIP	Driving force
Development along shore	MS – SIP	Driving force
Density of marine transport	SAG – SIP	Driving force

II.4.2.5 Ozone layer depletion

The following indicators were selected from the SIP report for the “environmental problem area” Ozone Layer Depletion:

- Emissions of halons by transport mode;
- Emissions of chlorofluorocarbons (CFC) by transport mode;
- Emissions of CH₄, N₂O, NO_x, CO₂ – road;
- Emissions of CH₄, N₂O, NO_x, CO₂ – rail;
- Emissions of CH₄, N₂O, NO_x, CO₂ – air;
- Emissions of CH₄, N₂O, NO_x, CO₂ – sea;
- Emissions of CH₄, N₂O, NO_x, CO₂ – inland waters;
- Emissions of hydrochlorofluorocarbons HCFC by transport mode.

The reflections made starting from the list of indicators selected by SIP Transport brought to light the suitability of including an indicator that concerns the emissions of methyl bromide (CH₃Br)¹³¹ – which is considered to be significant in the Methodology Sheets – and of considering the emissions of nitrogen oxides only with regards to air transport activities (these gases have a short lifespan, and therefore only when they are emitted into the high troposphere or into the stratosphere can they damage the stratospheric ozone).

In conclusion, the selection made by SIP Transport was found to be largely appropriate with the changes stemming from the above remarks.

Table II.27 - Indicators selected for the Transport sector in relation to the “environmental problem area” Ozone layer depletion

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of chlorofluorocarbons (CFC) by transport mode	MS – SIP	Pressure
Emissions of halons for each type of transport	SIP	Pressure
Emissions of CH ₄ , N ₂ O, CO ₂ from road transport activities	MS – SIP	Pressure
Emissions of CH ₄ , N ₂ O, CO ₂ from rail transport activities	MS – SIP	Pressure
Emissions of CH ₄ , N ₂ O, , CO ₂ from air transport activities	MS – SIP	Pressure
Emissions of CH ₄ , N ₂ O, CO ₂ from sea transport activities	MS – SIP	Pressure
Emissions of CH ₄ , N ₂ O, CO ₂ from inland water transport activities	MS – SIP	Pressure
Emissions of hydrochlorofluorocarbons (HCFC) for each type of transport	MS – SIP	Pressure
Emissions of methyl bromide (CH ₃ Br)	MS	Pressure
Emissions of NO _x from air transport activities	MS	Pressure

II.4.2.6 Resource depletion

The only environmental pressure indicator that was selected by the SIP report for the “environmental problem area” Resource depletion is “Increase in territory permanently occupied by infrastructure”. The indicator appears to be important, due to the fact that, for example, in the 11 European countries for which a graph was included in the 2001 TEPI, the share of area urbanised due to transport was never less than 10%, and in some cases reached 40%.

In addition to this indicator, it seemed appropriate to consider also “Use of energy” and “Use of mineral oil as fuel” (this includes all mineral oil products destined for use in transportation), both present in the Methodology Sheets (there expressed in terms of “per-capita”); these indicators come under the general indicators in the SIP report and therefore are not included among those referring to this “environmental problem area”. Other indicators did not seem to be significant for the Transport sector, except for “Use of natural gas as a fuel”.

¹³¹ Exhaust fumes from vehicles that use leaded petrol are among the anthropogenic sources of this gas.

Table II.28 - Indicators selected for the Transport sector in relation to the “environmental problem area” Resource depletion

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Increase in territory permanently occupied by infrastructure	MS – SIP	Pressure
Use of energy (total quantity)	MS – SIP	Driving force
Use of mineral oil as a fuel	MS	Pressure
Use of natural gas as a fuel	SAG	Pressure

II.4.2.7 Dispersion of toxic substances

The main environmental pressures due to transport that are related to this “environmental problem area” are linked to accidents and the consequent dispersion of toxic substances. The SIP report, which considered the two indicators “Surface pollution incidents” and “Accidents in transport in coastal areas and at sea” in relation to the environmental problem areas “Loss of biodiversity” and “Marine environment and coastal zones” respectively, did not consider it suitable to propose the same indicators for this “environmental problem area”; for the latter, the SIP report considered only the indicators relative to heavy metals.

The indicators selected by the SIP report for the “environmental problem area” Dispersion of toxic substances are then the following ones:

- Index of heavy metal emissions to air;
- Index of heavy metal emissions to water.

These two indicators, also present in the Methodology Sheets, make up a suitable proposal for the emissions of heavy metals, which mostly take place following to accidents. TEPI (Eurostat 2001) highlighted how emissions to water can derive from several different sources; among the three cases presented, only the one concerning the Netherlands shows a significant contribution from transport (7%); emissions to air in the EU, according to the same source, besides generally decreasing overall between 1985 and 1995, witnessed also a decrease in the contribution from transport from 30% to 13%.

The reflections made starting from the list of indicators selected by SIP Transport lead to select another two indicators, in addition to the two above, in consideration of the fact that not only heavy metals need to be considered. These additional indicators are present in the list submitted to the SAG, and represent the main risk factors of dispersion of toxic substances following to accidents that occur during the transportation of chemicals; they are “Toxic chemicals transported by boat” and “Toxic chemicals transported on land” (it seemed also necessary to specify that it is the “number of accidents” that is most important in relation to these transport activities. Furthermore, the indicator “Emissions of persistent organic pollutants (POPs)”, present in the Methodology Sheets, was also selected; it represents in fact a sizeable phenomenon, especially where there is a large intensity of traffic.

Table II.29 - Indicators selected for the Transport sector in relation to the “environmental problem area” Dispersion of toxic substances

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Index of heavy metal emissions to water	MS – SIP	Pressure
Index of heavy metal emissions to air	MS – SIP	Pressure
Emissions of persistent organic pollutants (POPs)	MS	Pressure
Number of accidents during transportation of toxic substances by boat	SAG	Driving force
Number of accidents during transportation of toxic substances on land	SAG	Driving force

II.4.2.8 Urban environmental problems and noise

The indicators selected by the SIP report for this “environmental problem area” are:

- Land consumption (change from natural to built-up areas);
- Emissions of CO₂;
- People endangered by Contravention of Noise – Regulations of traffic;
- Share of private car transport;
- Noise level of vehicle fleet;
- Noise and odours from trains and railway stations;
- Noise and odours from take-offs and landings from airports;
- Traffic accidents/injured or dead distributed by traffic category.

Noise and land use can be considered as the greatest environmental pressures on the urban environment and population generated by the Transport sector (for both, TEPI 1999 showed an important contribution from traffic); it seemed therefore that priority should be given to two indicators proposed by both the SIP report and the Methodology Sheets that refer to these problems. In relation to a typically urban problem connected with respiratory illnesses, the indicator “Emissions of sulphur dioxide (SO₂) and nitrogen oxides (NO_x)” appeared to be significant as well. Finally, the “Share of private car transport” was also selected as it expresses a driving force linked to the organisational set-up of urban transport: for the countries for which specific urban traffic data is available, the share in 1995, measured as a % of passengers/km, was higher than 50% and showed signs of a growth trend (Eurostat 1999a).

Table II.30 - Indicators selected for the Transport sector in relation to the “environmental problem area” Urban environmental problems and noise

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Land use	MS – SIP	Driving force
People endangered by noise emissions	MS – SIP	Pressure
Share of private car transport	MS – SIP	Driving force
Emissions of sulphur dioxide (SO ₂) and nitrogen oxides (NO _x)	MS	Pressure

II.4.2.9 Waste

The SIP report pointed out how the European Waste Catalogue (EWC) dedicates several paragraphs to waste coming from products used in road transport. With regards to other types of

transport, however, it does not seem to be an easy task to identify the waste generated by each section separately.

The indicators selected by SIP Transport for the “environmental problem area” Waste are as follows:

- Hazardous waste from transport (according to the directive 91/689/EWC);
- Municipal waste from transport;
- Waste recycled / material recovered by transport;
- Total waste landfilled by transport;
- Total waste incinerated by transport;
- Number of end-of-life vehicles per year;
- Number of scrap from all transport per year;
- Number of batteries per year;
- Number of tyres per year;
- Change in area of old cars sites;
- Transportation of hazardous waste over land.

On the basis of the reflections made starting from the list of indicators selected by SIP Transport, the indicator “Hazardous waste (according to the directive 91/689/EWC)”, also contained in the Methodology Sheets, was found as significant for the Transport sector, due to the consumption – which is at the origin of the waste in question – of various products (e.g. oil for engines and brakes) by the activities that are part of the sector. As for the other indicators, generally speaking, it was found that those related to the management and disposal of waste are not to be considered, the focus being on those referring to the generation of waste, as they reflect the specific contribution of the sector to the driving forces to which the “environmental problem area” Waste is dedicated¹³².

Table II.31 - Indicators selected for the Transport sector in relation to the “environmental problem area” Waste

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Hazardous waste (according to the directive 91/689/EWC)	MS – SIP	Driving force
Municipal waste	MS – SIP	Driving force
Number of end-of-life vehicles	SIP	Driving force
Number of scrap from all transport	SIP	Driving force
Number of batteries	SIP	Driving force
Number of tyres	SIP	Driving force

¹³² The point here can be highlighted by considering e.g. the indicators “Change in area of old cars sites” and “Number of end-of-life vehicles per year”: the accumulation of scrap vehicles in “car cemeteries” is no doubt a source of significant environmental pressures (for the discharge of heavy metals into the soil, for instance), consequent to the way waste is managed once it is created and therefore to be considered for the Waste Management sector; on the other hand, the potential contribution of the Transport sector to the generation of these environmental pressures is well expressed by the second indicator, which is the only relevant for the “environmental problem area” Waste.

II.4.2.10 Water pollution and water resources

The indicators selected by SIP Transport for the “environmental problem area” Water pollution and water resources are as follows:

- Emission of heavy metals, by metal in the transport sector;
- Total of waste water collected/used by transport;
- Water recycling by transport sector;
- Groundwater contamination from oil spills from service stations and garages;
- Groundwater contamination from oil spills from ships;
- Groundwater contamination from oil spills from inland waters;
- Groundwater contamination from de-icing and anti-icing of aircraft.

The reflections made starting from the list of indicators selected by SIP Transport confirmed the importance for the Transport sector of the indicators that refer to the emissions of heavy metals (present as synthetic indicator in the Methodology Sheets), to the contamination of groundwater due to “oil spills from service stations and garages” and to the contamination of groundwater due to the “de-icing and anti-icing of aircraft”. Furthermore, an indicator concerning oil spills into surface water was added especially to account for fuel leaks into these water bodies¹³³. The other indicators proposed by the SIP report, as well as the ones considered in the Methodology Sheets for this “environmental problem area” were not considered to be particularly significant for the Transport sector.

Table II.32 - Indicators selected for the Transport sector in relation to the “environmental problem area” Water pollution and water resources

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of heavy metals, by metal	MS – SIP	Pressure
Groundwater contamination from oil spills from service stations and garages	SIP	Pressure
Groundwater contamination from de-icing and anti-icing of aircraft	SIP	Pressure
Surface water contamination from oil spills from inland water transport activities	SIP	Pressure

II.5 Industry Sector

II.5.1 Description and delimitation of the sector and main overlaps with other sectors

II.5.1.1 Description and delimitation of the sector in the SIP report

Compared to some other sectors, such as those of Tourism and Transport, the Industry sector is not difficult to delimit. It mainly concerns manufacturing activities for the production of

¹³³ The subsequent filtering of these leaks into groundwater is at the basis of the two indicators dealing with oil spills from ships and from inland waters proposed in the SIP report. The indicator concerning oil spills into surface water, proposed here, besides representing a phenomenon which is significant in itself, is in a sense a transformation of these two indicators.

goods¹³⁴; the activities that deal with the production of services can be considered as a part of the sector if they are carried out as auxiliary activities¹³⁵.

In the SIP report¹³⁶ only the environmental pressures of the activities that fall within the Industry sector which are generated up to the moment that the goods leave the local production unit were considered. Such a criterion (“mill gate”) can be considered to be appropriate in relation to the need to take into account the range of action of industrial policy. Not all the stages of a product’s life cycle come under the Industry sector, but only those linked to the production activities that range from the finding of ore to the completion of the production processes. For example, the phases that concern the production of energy acquired externally, distribution and market sales, consumption and disposal of waste generated during the use of industrial products outside the sector are excluded.

In line with this formulation, the SIP report included the following NACE sections and subsections in the sector:

- Subsection CB: Mining and quarrying, except of energy minerals;
- Section D: Manufacturing industry;
- Section F: Construction.

Subsection CA, concerning the extraction of energy mineral ore, was excluded from the Industry sector, as this activity is relevant to the Energy sector, consistently with the way in which this latter sector was defined in the relative SIP project. Also external waste treatment activities were excluded.

SIP Industry also expressly included some activities in the sector, due to the importance of the environmental pressures that they generate, that are carried out as secondary or auxiliary activities, which, if they were carried out as main activities would instead have only been considered in other SIP sectors. Among these are the activities of self-treatment of waste (such as incineration), self-purification of wastewater and conversion of energy (limited to pyrogenic emissions - see below).

With reference to the other SIP sectors, SIP Industry has therefore set out the following boundaries:

- a) the extraction of mineral ore, including refineries, does not belong to the Industry sector but to the Energy sector. No specification of the exclusion of refineries in terms of NACE activities is given, however;
- b) with regards to energy conversion in industrial processes, the consumption of energy has been attributed to the Energy sector, while pyrogenic emissions¹³⁷ are considered to belong to the Industry sector;
- c) self-production of transport services by manufacturing enterprises is considered as part of the Transport sector;

¹³⁴ According to standard classifications of economic activities (see e.g. the Italian ATECO 91, which provides an explicit definition of manufacturing industries – Istat 1991), an activity is considered to be a manufacturing industry when:

- it produces and transforms material goods or energy (e.g. electricity), the latter being considered as a non-material good;
- its product is susceptible to being later sold;
- the production or transformation activity is not carried out to specific order from an economic consumer unit.

¹³⁵ See Part I, paragraph I.4.5.2.

¹³⁶ Eurostat (1999b).

¹³⁷ “i.e. emissions caused by energy conversion within industrial plants” (Eurostat, 1999b, p. 187).

d) with regards to waste, environmental pressures coming from self-treatment processes within the industries remain a part of the Industry sector.

With regards to the last three points, it must be pointed out that the heterogeneity of treatment of self-production (transport is excluded, energy and waste management are included) is justified by the application of the “mill gate” criterion, with which the set conventions are consistent. This treatment, however, foresees the exclusion only of the auxiliary transport activities that are carried out outside the local industrial units, activities for which the influence of industrial policy is probably less significant.

II.5.1.2 Clarification of the sector boundaries and of the overlaps with other sectors

II.5.1.2.1 Industry and energy

With regards to energy consumption, a contradiction must be pointed out between what is reported above and what is stated by the SIP Energy report, according to which energy consumption by the activities that belong to the other five SIP sectors remain attributed to the latter (unlike the energy consumption by activities that do not belong to them).

As it is not possible to isolate and attribute to energy consumption as such any specific environmental pressure (all the more after excluding the pyrogenic emissions of energy conversions), attributing consumption as such to a sector or not does not really make a big difference for environmental pressure indicators¹³⁸. For the reasons explained in the chapter on the Energy sector, the treatment of energy consumption as a driving force is differentiated according to the “environmental problem areas”.

Another contradiction between the two SIP reports seems to apply to energy self-production in Industrial plants, which is considered by SIP Energy as belonging to the Energy sector, while SIP Industry attributes to the Industry sector the pyrogenic emissions stemming from energy conversions in the same sector. With regard to this, it must be noted, as the Council Regulation on statistical units states, that “must not be considered as ancillary activities: [...] the production of energy (integrated power station or integrated coking plant), even where this is consumed in its entirety in the principal or secondary activity of the parent unit [...]. In all these cases, if separate data are available for these activities, they should be regarded as distinct activities and subsequently recognised as KAUs”¹³⁹. It therefore seems appropriate to exclude these particular forms of energy conversion from the Industry sector (as well as from the others), while attributing their environmental pressures, including pyrogenic emissions, to Energy only.

As it has already been noted, SIP Industry excluded refineries from the sector without specifying this exclusion in terms of economic activities. As almost all activities of the subsection DF “Manufacture of coke, refined petroleum products and nuclear fuel” entail production of outputs typical of the sector Energy, it seems appropriate to exclude this class from the sector Industry, with the exception of those parts of it that have as output materials that are demanded as such, rather than (or besides for) their energy content. The activities whose products are relevant both for the material and the energy content, such as coke used in blast furnaces, should fall, therefore, under both sectors.

¹³⁸ See paragraph II.2.1.2.1 for a more general discussion of the issue.

¹³⁹ Council Regulation (EEC) no. 696/93 of 15 March 1993, OJ L 76, 30.3.93. Published with the NACE (Eurostat 1996, pp. 55-64).

II.5.1.2.2 Industry and waste management

The following two points, dealt with more thoroughly in the chapter on Waste Management sector, highlight two overlaps between the latter sector and the Industry sector:

- as seen above, the environmental pressure generated through waste management carried out within the Industry sector is considered as being attributable to this latter sector; contrary to what was set out by SIP Waste Management, this does not imply to exclude these activities from this last sector;
- activities of recycling¹⁴⁰ are the subject of specific European Community policy on waste management (directives 75/442/EEC and 91/156/EEC, Council resolution 97/C76/01); in consideration of the fact that from the point of view of output such activities are similar to extraction and treatment of raw materials, they are not excluded from the Industry sector, while being included in the Waste Management sector as well, since recycling can be assimilated to waste disposal activities, with regards to their input.

II.5.1.3 Delimitation of the sector in terms of economic activities

The delimitation of the sector outlined in the SIP report was reviewed in light of the considerations reported above. In addition to that, the appropriateness was also considered to include in the sector activities not attributed to any sector by the SIP projects and that could be considered as similar to the manufacturing activities, such as those relating to the capture, transportation, purification and distribution of water. All this resulted in the identification of some possible adjustments. With regards to this, it seemed appropriate to integrate the sector as defined in the SIP report by including some additional economic activities, as follows:

- the NACE economic activity categories 23.10 and 23.20 (“Manufacture of coke oven products” and “Manufacture of refined petroleum products”¹⁴¹), solely for the part that refers to the manufacture of coke, bitumen, tar and binding materials for road surfacing¹⁴²;
- the activities belonging to division 41 “Collection, purification and distribution of water”, belonging to section E of the NACE, in consideration of the fact that these activities make it possible to use an asset such as water, which would otherwise not be available; the collection and distribution of drinking water, in particular, can be compared to the production of mineral water and soft drinks (category 15.99, belonging to D).

The resulting delimitation of the sector is shown in Table II.33.

¹⁴⁰ These activities correspond to division 37 (subsection DN “Other manufacturing industries”) of the NACE rev.1.

¹⁴¹ In the Italian classification of economic activities, the latter activities are identified as a category of their own (23.20.4 – see Istat, 1991).

¹⁴² As said above, this inclusion was considered appropriate as it concerns the production of materials used not (or not only) for the production of energy but (also) for incorporating them into other industrial products; in particular some can be assimilated to other industrial products used in construction.

Table II.33 - Activities included in the Industry sector

<i>NACE rev. 1 codes</i>	<i>Activities</i>
Section CB - Mining and quarrying, except of energy producing materials	
13	Mining of metal ores
14	Other mining and quarrying
Section D - Manufacturing	
15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	Manufacture of pulp, paper and paper products
22	Publishing, printing and reproduction of recorded media
23.10 (in part)	Manufacture of coke oven products
23.20 (in part)	Manufacture of refined petroleum products – only for the part “manufacture of bitumen products for the manufacture of road coverings” (ATECO category 23.20.4)
24	Manufacture of chemicals and chemical products
25	Manufacture of rubber and plastic products
26	Manufacture of other non-metallic mineral products
27	Manufacture of basic metals and alloys
28	Manufacture of fabricated metal products, except machinery and equipment
29	Manufacture of machinery and equipment, including installation, assembly, repair and maintenance
30	Manufacture of office machinery and computers
31	Manufacture of electrical machinery and apparatus n.e.c.
32	Manufacture of radio, television and communication equipment and apparatus
33	Manufacture of medical, precision and optical instruments, watches and clocks
34	Manufacture of motor vehicles, trailers and semi-trailers
35	Manufacture of other transport equipment
36	Manufacture of furniture; manufacturing n.e.c.
37	Recycling
Section E - Electricity, gas and water supply	
41	Collection, purification and distribution of water
Section F - Construction	
45	Construction

II.5.1.4 Household activities

With regards to household activities, the only important element to be considered in relation to the Industry sector seemed to be the final consumption of the goods produced by this sector, intended as the final use of the goods in question, deferred or distributed over time compared to the time when they were purchased. This consumption surely causes the generation of extremely important environmental pressures (dissipation of material into the environment) or of driving forces (generation of waste).

Although distinctly separate from those created during the production phases, these environmental pressures can be considered as being under the control of the producers to the extent to which the polluting potential of the products is determined by production choices¹⁴³; the influence that industrial policy can have on the capacity of the goods produced to create pressure during the consumption phase is therefore important. Also, even the 5EAP acknowledges strong ties between production and consumption, foreseeing provisions in order to make sure that “individuals be given all the relevant information necessary to enable them to exercise informed choices as consumers”¹⁴⁴. It seemed appropriate to keep all this in mind when defining and selecting the indicators for Industry.

II.5.2 Selection of the indicators that are most representative of the environmental pressures of the sector

On the basis of the general concept formulation developed in Part I and the further methodological elements discussed in the previous paragraph with specific reference to the Industry sector, a close examination has been carried out of the main environmental pressures that can be attributed to the sector, starting from the most significant lists proposed in the European projects. As a result of this revision work, a selection of indicators that appeared to be, at this stage, most representative of the environmental pressures of the sector has tentatively been established.

In the paragraphs below, the indicators of environmental pressures that have been selected are presented with reference to each of the ten “environmental problem areas” that were identified on a European level. For each “environmental problem area” the main environmental pressures of the sector are briefly discussed and a summary table of the selected indicators is provided, similar to those already presented for the sectors dealt with above.

II.5.2.1 Air pollution

The indicators selected by the SIP Industry for the “environmental problem area” “Air pollution” are the following:

- Emissions of nitrogen oxides (NO_x):
combustion processes of both fossil fuels and biomasses which cause these emissions are most certainly present to a sizeable measure in the Industry sector; emissions of nitrogen oxides from industrial processes in the EU were about 12% of the total in 1998 (Eurostat 2001);
- Emissions of volatile organic compounds (VOC):
there is a discrepancy concerning this indicator between SIP Industry and the Methodology Sheets, which appropriately distinguish methane from the other volatile organic compounds. It seemed appropriate to replace this indicator with the one referring to non-methane volatile organic compounds only (NMVOC); the emissions of these from industrial processes in the EU were about 9% of the total in the EU (Eurostat 2001);

¹⁴³ The same can be said with regards to industrial products used by the same production activities, or which enter as intermediate input in different activities from those from which they come.

¹⁴⁴ One of “the three pillars on which the environment/industry relationship will be based” is the “use of information for promotion of better consumer choice” (Commission of the European Communities, 1993b).

- Emissions of sulphur dioxide (SO₂):
significant sources of sulphur dioxide emissions (SO₂) come from the industrial process of pyrite (FeS₂) roasting in order to obtain ferrous oxides, and from the use of coke in the production of steel; emissions from industrial processes in the EU were 22% of the total in 1998 (Eurostat 2001);
- Emissions of particles:
these stem from several industrial processes, in particular from extraction activity; emissions from industrial processes in the EU, calculated on a group of countries, amounted to 23% of the total in 1990 (Eurostat 1999a);
- Emissions of ammonia (NH₃):
these are also linked to nitrogen-based fertiliser production processes and to the production of nitrous oxides;
- Emissions of carbon monoxide (CO):
some industrial activities, such as, for example, the paper industry, contribute considerably to pollution from carbon oxides;
- Emissions of methane (CH₄):
these emissions are not important for this “environmental problem area”;
- Total amine emissions:
amines are compounds in which a group containing nitrogen atoms is linked to a hydrocarbon chain; the indicator, which was not included in those for which Eurostat developed the Methodology Sheets, represents specific potential environmental pressures of the industrial sector, within which the chemical compounds are produced and used.

In addition to what is set out above, the following driving force indicator was found to be appropriate for consideration, among those present in the methodology sheets, for the Industry sector in relation to this “environmental problem area”:

- Coal and oil products consumption.

Table II.34 - Indicators selected for the Industry sector in relation to the “environmental problem area” Air pollution

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of nitrogen oxides (NO _x)	MS – SIP	Pressure
Emissions of non-methane volatile organic compounds (NMVOC)	MS – SIP	Pressure
Emissions of sulphur dioxide (SO ₂)	MS – SIP	Pressure
Emissions of particles	MS – SIP	Pressure
Emissions of ammonia (NH ₃)	MS – SIP	Pressure
Emissions of carbon monoxide (CO)	MS – SIP	Pressure
Emissions of amines (methylamines)	SAG – SIP	Pressure
Coal and oil products consumption	MS	Driving force

II.5.2.2 Climate change

All the indicators selected by the SIP Industry for the “environmental problem area” Climate change are present in the Methodology Sheets:

- Emissions of methane (CH₄):
as it explicitly stated in the Methodology sheets, the industrial processes are being among the sources of methane emissions, even though it is likely that they contribute to these emissions to a small extent, no more than 4% according to TEPI (Eurostat 2001);
- Total emissions of carbon dioxide (CO₂):
the emissions of carbon dioxide in the EU coming from industrial processes (mainly from the chemical industry) in 1996 were 26% of the total of carbon dioxide emitted by all sectors (Eurostat 1999a);
- Emissions of nitrous oxide (N₂O):
several industrial processes make up sources of these emissions; in the EU, emissions that could be attributed to manufacturing industries in 1998 were 22% of the total (Eurostat 2001);
- Emissions of chlorofluorocarbons (CFC):
chlorofluorocarbons are mainly used in industrial production as coolants for refrigeration plants, as propellants in spray canisters, as foaming agents and detergents for electronic compounds; they are also used in foam materials;
- Emissions of nitrogen oxides (NO_x):
nitrogen oxides do not contribute to the greenhouse effect directly, but via the formation of tropospheric ozone; the main source of these emissions is the combustion of fossil fuels, also used – although not primarily – in industry;
- Emissions of particles:
suspended particles combined with high concentration of sulphur dioxide increase occurrences of “conventional” smog; emissions of particles mainly come from the combustion of fossil fuels and from several mechanical processes in extraction activities and in other industrial processes;
- Emissions of sulphur oxides (SO_x):
see what was stated in the previous section on sulphur dioxide.

On the basis of the reflections made starting from the list of indicators selected by SIP Industry it seemed appropriate to select the following extra indicators:

- Emissions of non-methane volatile organic compounds (NMVOC):
see what has been stated in the previous section;
- Emissions of fluorocarbons:
these are industrial gases that are increasingly being used; they include hydrofluorocarbons (HFC), that are currently used in some applications (especially as refrigerants and in air-conditioning equipment) to replace the harmful substances for the stratospheric ozone layer, and perfluorocarbons (PFC), emitted from the production of aluminium and used as solvents in the electronic industry;
- Emissions of hydrochlorofluorocarbons (HCFC):
these substances, used as substitutes for CFC, are significant greenhouse effect gases coming from industrial activities and from the consumption stage; in TEPI (Eurostat 2001) Industry is the only sector indicated as significant for these emissions.

Table II.35 - Indicators selected for the Industry sector in relation to the “environmental problem area” Climate change

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of carbon dioxide (CO ₂)	MS – SIP	Pressure
Emissions of methane (CH ₄)	MS – SIP	Pressure
Emissions of nitrous oxide (N ₂ O)	MS – SIP	Pressure
Emissions of chlorofluorocarbons (CFC)	MS – SIP	Pressure
Emissions of nitrogen oxides (NO _x)	MS – SIP	Pressure
Emissions of sulphur oxides (SO _x)	MS – SIP	Pressure
Emissions of aerosol particles	MS – SIP	Pressure
Emissions of non-methane volatile organic compounds (NMVOC)	MS	Pressure
Emissions of fluorocarbons	MS	Pressure
Emissions of hydrochlorofluorocarbons (HCFC)	SAG	Pressure

II.5.2.3 Loss of biodiversity

None of the indicators proposed by the SAG for this “environmental problem area” is specifically referred to the Industry sector and the SIP report did not identify direct connections between pressures on biodiversity and industrial activities, whose effects in this field are considered to be of secondary importance. Consequently, no indicator was adopted by the SIP report for this “environmental problem area”.

The Methodology Sheets, unlike the SIP report, mentions Industry while dealing with the following indicators:

- Fragmentation of forests & landscapes by roads/intersections:
this indicator, expressed in an aggregate form, includes the fragmentation of forests and landscapes by roads, railways, communication networks, urbanisation and other developments, and industry is mentioned referring to the possibility of breaking down the indicator according to sectors; the only data provided by TEPI (Eurostat 1999a) refers to the European Transport Network;
- Riverbank loss through artificialisation.
With regards to the indicator on fragmentation, it was noted that it considers exclusively linear elements of fragmentation, such as roads or power networks, as indicated by its denomination and the unit of measurement proposed (km by km² of typical landscape); given this specification, this indicator was dropped, as others are available that better represent the sector’s specific environmental pressures. The indicator referring to the loss of riverbanks was instead adopted, as well as, in addition to it, another two present in the list submitted to the SAG:
- Evolution of built-up and related land:
this indicator seems appropriate for generally expressing the potential environmental pressures of this sector on this “environmental problem area”;
- Surface disposal of mineral workings deposits:
this indicator too is believed to be significant for Industry in consideration of the activities that are pertinent to this sector.

Table II.36 - Indicators selected for the Industry sector in relation to the “environmental problem area” Loss of biodiversity

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Riverbank loss through artificialisation	MS	Pressure
Evolution of built-up and related land	SAG	Driving force
Surface disposal of mineral workings deposits	SAG	Driving force

II.5.2.4 Marine environment and coastal zones

The following indicators were selected by the SIP Industry for the “environmental problem area” Marine environment and coastal zones:

- Eutrophication¹⁴⁵:
discharges from industries that handle organic material are a source of emissions of nutrients into waters; according to TEPI, in 1995 the industrial input of nutrients in the HELCOM area (Helsinki Commission for the Baltic Sea) amounted to 2% and 5% of the total for nitrogen and phosphorus directly discharged into the sea respectively;
- Discharges of heavy metals:
heavy metals (cadmium, chrome, copper, lead, mercury, molybdenum, nickel, selenium and zinc) are a typical component of industrial productions. Like for nutrients, the direct discharge into the sea of industrial waters might give an important immediate contribution to this environmental pressure. The different metals should be kept separate;
- Discharges of halogenated organic compounds:
halogenated organic compounds (i.e. containing one or more atoms of fluorine, chlorine, bromine, iodine) are products of the chemical industry. What has been said about direct/indirect discharge for the two previous indicators holds for this one as well;
- Development (new permanent structure) along shore:
industrial activities often tend to be concentrated around transport hubs, including ports; 40% development along the shores is due to industry in Belgium and in the Netherlands (Eurostat 2001);
- Ore extraction:
abstraction of mineral ore from the sea bed and from coastal areas generates significant environmental pressures on these environments.

The SIP report highlighted how the determination of Industry’s contribution to the environmental pressures relevant for this “environmental problem area” requires that regional aspects such as location of plants and the load carried by rivers to the sea must be considered.

The reflections made starting from the list of indicators selected by SIP Industry suggested that the following further indicator should be selected from the list submitted to the SAG, and should be added to those indicated above:

¹⁴⁵ For the definition, see the chapter on the Agriculture sector.

- Increase of suspended solids coming from dredging and industry:
suspended solids, which may be ashes, dust and plastic material, obstruct the passage of light and therefore impede photosynthesis, and can damage respiratory systems; considerable quantities of suspended solids come directly and through rivers from excavations, concrete works and working of marble and similar materials. The indicator should be referred to discharge of suspended solids, and corresponds to “TSS of liquid effluents released to water bodies” proposed in the SIP Waste Management report.

Table II.37 - Indicators selected for the Industry sector in relation to the “environmental problem area” Marine environment and coastal zones

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Eutrophication (amounts of nitrogen and phosphorus introduced into waters)	MS – SIP	Pressure / Driving force
Development along shore	MS – SIP	Driving force
Discharges of heavy metals (by metal)	MS – SIP	Pressure / Driving force
Discharges of halogenated organic compounds	MS – SIP	Pressure / Driving force
Ore extraction (from seabed and coasts)	SAG – SIP	Pressure
Increase of suspended solids coming from dredging and industry	SAG	Pressure / Driving force

II.5.2.5 Ozone layer depletion

The following indicators were selected by the SIP Industry for the “environmental problem area” ozone layer depletion:

- Emissions of bromofluorocarbons (halons):
these are substances from industrial production, incorporated in industrial products such as extinguishers;
- Emissions of chlorofluorocarbons (CFCs):
see the section on Climate change ;
- Emissions of hydrochlorofluorocarbons (HCFCs):
see the section on Climate change;
- Emissions of methyl bromide (CH₃Br):
Industry does not carry great weight in the emissions of this compound (the main sources of emission are linked to its use in agriculture, to the combustion of biomasses, and to vehicles using leaded petrol), but due to its specific contribution to the destruction of the stratospheric ozone layer (bromine is about 50 times more effective than chlorine), and as it is partly an industrial product, this indicator should be considered in relation to Industry too;
- Emissions of chlorinated hydrocarbons:
these compounds are used as extinguishing agents, in pesticides and in dry cleaning, for this indicator too, TEPI (Eurostat 2001) indicates Industry as the only sector particularly relevant;
- Emissions of methyl chloroform (CH₃CCl₃):
these are included in the emissions of chlorinated hydrocarbons; the indicator therefore appears to be superfluous.

The SIP report highlighted that the largest use of these substances occurs during the final consumption stage. In these cases too, however, the contribution, though indirect, that Industry in its role as producer can make to reductions in emissions, also by product innovation, is not negligible, therefore it seems reasonable not to restrict to much the selection of indicators.

In addition to the ones listed above, the following indicators already discussed in other sections of this chapter but not considered in the SIP report were selected, which express more direct and immediate contributions to the phenomenon of ozone layer depletion:

- Emissions of carbon dioxide;
- Emissions of methane.

Table II.38 - Indicators selected for the Industry sector in relation to the “environmental problem area” Ozone layer depletion

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of bromofluorocarbons (halons)	MS – SIP	Pressure
Emissions of chlorofluorocarbons (CFCs)	MS – SIP	Pressure
Emissions of hydrochlorofluorocarbons (HCFCs)	MS – SIP	Pressure
Emissions of chlorinated hydrocarbons	MS – SIP	Pressure
Emissions of methyl bromide (CH ₃ Br)	MS – SIP	Pressure
Emissions of carbon dioxide (CO ₂)	MS	Pressure
Emissions of methane (CH ₄)	MS	Pressure

II.5.2.6 Resource depletion

The following indicators were selected by the SIP Industry for the “environmental problem area” Resource depletion:

- Increase in territory permanently occupied by urbanisation; infrastructure; waste-tipping and quarrying:
according to the Methodology Sheets the only industrial activities that cause occupation and alterations to the land that can be considered irreversible are extraction activities; the SIP Industry, more appropriately, considers the indicator as relevant for all sector activities. This should be intended as “increase in territory occupied by industrial plants”, including extraction activities. The graphs contained in TEPI confirm the importance of the sector in the uses of the territory which are difficult to reverse;
- Water consumption per capita:
considering the presence of the next two indicators, it is advisable to distinguish the consumption of water of the sector from its direct drawing of water from the natural environment. The latter also includes that carried out for distribution to other sectors for production use or for civil use (according to the definition proposed here, Industry includes NACE category 41, “Collection, purification and distribution of water”), which should not enter this indicator. It is also better to consider the absolute quantities rather than those per capita (see Part I, Paragraph I.5.4). According to TEPI (Eurostat 2001) in the mid nineties, the manufacturing industry

was responsible for 12% of the use of surface water and 14% of ground water drawn (data refers to the EU-15, excluding Greece, Italy and Portugal)¹⁴⁶;

- Surface water abstraction for agricultural/industrial purposes:
unlike the indicator concerning resource consumption, which expresses driving forces of the sector rather than total immediate pressures, the indicators referred to direct drawing express immediate pressures directly coming from the sector. This and the next indicator (to be referred in the present case to the Industry sector alone) include cooling water use by industry (on the whole cooling water accounts for 53% of surface water drawn, but this is probably due more to the energy sector than to industry); abstraction carried out by businesses specialised in collection and distribution of water for uses outside the sector, accounting for 11% of surface water use (EU-15, excluding Greece, Italy and Portugal, mid-nineties; Eurostat 2001), should also be included;
- Ground water abstraction for agricultural/industrial purposes:
this indicator should be placed alongside the previous one, which is similar but refers to surface water. According to TEPI (Eurostat 2001) in the mid-nineties, the manufacturing industry was responsible for 14% of the uses of waters drawn from underground, while another 53% went to public water supply; the contribution of cooling is irrelevant (EU-15, excluding Greece, Italy and Portugal, mid-nineties; Eurostat 2001);
- Extraction of mineral resources (sand, clay, gravel, marl, salt, sulphur, ...):
this is the total annual extraction of these resources and interests exclusively the Industry sector, which the extraction activities belong to just as much as the user activities (mainly construction) of these materials do;
- Consumption of minerals:
by assuming that the definition of minerals is the same as that of the previous indicator, it is probable that for this type of resources, which are present everywhere, the discrepancies between uses and extractions of the national industry (there are no significant intersectoral exchanges, at least for the groups of sectors and the materials considered here) are not particularly significant. For small economies, however, the pressures indirectly made on mineral resources by the Industry sector (which is the largest user) could be much different from the direct ones; this is a reason for maintain the indicator in the selection;
- Production of ferrous and non ferrous metals, from raw, non-recycled resources:
this indicator expresses a driving force on the global resources of specific scarce minerals (metal ones), that is extremely significant for Industry;
- Use of fossils for non-energetic use:
this indicator takes on greater importance with the inclusion in the sector of part of the NACE 23.20 classes referring to the production of bitumen, tar and binding materials used in road works, proposed in the herein study;

¹⁴⁶ This distinction between consumption and direct drawing is not complete in TEPI (Eurostat 2001), as the calculation of the indicators relative to drawing/use of water refers to the entire anthropic system, so that the data presented under the heading "water consumption" concerns precisely the drawing of ground and surface waters. At the aggregate level the distinction is not very relevant as water is not an asset that is important for international commerce.

- Consumption of renewable raw materials:
this is an indicator that refers to a driving force that is not contained in the list submitted to the SAG, proposed in the SIP Industry for the purpose of representing the pressures on these particular resources, that are otherwise not considered.

In addition to the indicators shown above, present in the selection from the SIP report, it seemed appropriate, for reasons of thoroughness in the description of the use of important non-renewable resources, to add the following indicators, present in the list submitted to the SAG:

- Use of natural gas as a fuel;
- Use of mineral oil as a fuel:
this indicator is also contained in the Methodology Sheets.

Furthermore, the driving force expressed by the following indicator was also considered for inclusion:

- Use of energy:
this indicator, not contained in the selection of the SIP report, is present with the specification “per-capita” in the Methodology Sheets; for this standardisation, what has already been said concerning the use of water per capita applies.

Table II.39 - Indicators selected for the Industry sector in relation to the “environmental problem area” Resource depletion

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Increase in territory permanently occupied by urbanisation; infrastructure; waste-tipping and quarrying	MS – SIP	Pressure
Water consumption (total quantity)	MS – SIP	Driving force
Ground water abstraction for industrial purposes	MS – SIP	Pressure
Surface water abstraction for industrial purposes	SAG – SIP	Pressure
Extraction of mineral resources	MS – SIP	Pressure
Consumption of minerals	SIP	Driving force
Production of ferrous metals and non-ferrous metals from non-recycled raw materials	SIP	Driving force
Use of fossils for non-energy purposes	SIP	Driving force
Use of renewable raw materials	SIP	Driving force
Use of Energy (total quantity)	MS	Driving force
Use of mineral oil as a fuel	MS	Driving force
Use of natural gas as a fuel	SAG	Driving force

II.5.2.7 Dispersion of toxic substances

The dispersion of toxic substances can be described in terms of the actual release of heavy metals and of persistent organic compounds into the physical environments air and water, or by referring to the production and/or current consumption of these substances. This consumption provides an idea of the potential future environmental pressures, which occur with a certain delay.

The list of indicators proposed by the SIP for the “environmental problem area” Dispersion of toxic substances are the following:

- Emissions of persistent organic pollutants:
according to the Methodology Sheets, these emissions are associated with all economic activities. According to TEPI (Eurostat 2001) “sinter plants” alone are responsible for 19% of the emissions that occurred in 1996 in the EU;
- Consumption of toxic chemicals (D67/548/EC):
many toxic substances produced by the chemical industry are incorporated in industrial products or products used as raw materials for the production of other chemical substances. The extent of their use is significant for the Industry sector both in relation to the risk of industrial accidents that cause dispersion of toxic substances and in relation to the possibility of alleviating, via the policies that affect this sector, the risk of dispersion or ingestion linked to the final consumption of these products;
- Index of heavy metal emissions to water:
discharges containing metals take place in the metal production and processing industries and in the processing of non-metal minerals, in chemical industries, in the production of electrical and electronic goods, in tanning, in wood working (sawing and industrial preparation), in the paper, printing and photographic industries, as well as in metal ore extraction activities. The cases presented by TEPI (Eurostat 2001), show shares for industry that range from 5% (Denmark 1993) to 48% (Sweden 1995) of total emissions;
- Index of heavy metal emissions to air:
the contribution made by industrial processes in 1995 in the EU was 40%, according to TEPI (Eurostat 2001);
- Toxic chemicals processing plant distribution by type of technology:
this and the next indicator, which are not included in the Methodology Sheets, provide interesting additional information on the risk factors;
- Storage of toxic chemicals in industrial plants:
on the risk factors expressed by this and the previous indicator “Regulatory work is ongoing at EU-level” (Eurostat 1999c);
- Production of chlorinated compounds:
these are typical products from the chemical industry; the indicator also covers products that, according to the SIP report, are not toxic, such as plastic, and which should not therefore be considered in the calculation of the indicator, which is however significant;
- Emissions of mercury:
mercury is the most volatile of all metals and its vapour is highly toxic. Large quantities of mercury vapours are freed into the natural environment as a consequence of the combustion of fossil coal and oil and the incineration of solid waste that contains mercury from, for example, batteries. Although this is obviously an important environmental pressure, this indicator – as well as the next one concerning cadmium – seem to be redundant as the two indicators of heavy metal emissions (to air and to water) already included in the selection incorporate the information that they would supply;
- Emissions of cadmium:
see the previous point. If it were not possible to construct summary indexes, all emissions of heavy metals for which data is available – not just mercury and cadmium – would have to be included;

- Emissions of phthalates.
In addition to the above indicators (with the exclusion of those concerning mercury and cadmium), it seemed appropriate to select also the following indicators, taken from the list submitted to the SAG:
- Mining and metal processing:
the level of activity in this sector is an indicator which refers to important driving forces for this “environmental problem area”; for example, environmental contamination from cadmium can be found in the areas below zinc, lead and copper smelting works;
- Number of industrial accidents in indoor plants covered by the “Seveso directive”¹⁴⁷:
this indicator, selected by the SIP report for the “environmental problem area” Water pollution and water resources, should also be considered for the “environmental problem area” Dispersion of toxic substances.

Table II.40 - Indicators selected for the Industry sector in relation to the “environmental problem area” Dispersion of toxic substances

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of persistent organic pollutants (POPs)	MS – SIP	Pressure
Consumption of toxic chemicals	MS – SIP	Driving force
Index of heavy metal emissions to water	MS – SIP	Pressure
Index of heavy metal emissions to air	MS – SIP	Pressure
Production of chlorinated compounds	MS – SIP	Driving force
Toxic chemicals processing plant distribution by type of technology	SAG – SIP	Driving force
Storage of toxic chemicals in industrial plants	SAG – SIP	Driving force
Emissions of phthalates	SIP	Pressure
Mining and metal processing	SAG	Driving force
Number of industrial accidents in indoor plants covered by the Seveso directive	SIP	Driving force

II.5.2.8 Urban environmental problems and noise

The SIP Industry selected the following indicators for the “environmental problem area” Urban environmental problems and noise:

- People endangered by noise emissions:
one of the environmental pressures coming from industrial plants situated in urban areas is most certainly noise;
- Land consumption:
according to the definition in the Methodology Sheets, this indicator measures the area that has been converted from “natural” to built-up. The construction of industrial plants can be considered to be not only a disturbance in itself of the natural

¹⁴⁷ The EEC Directive no. 82/501, known as the Seveso directive as it represents the answer that the institutions wished to give to the accident that occurred in 1976 in a plant in that town, has two main purposes: a) to reduce the incidence of technological risk via the analysis of the possible causes of accidents and the technical characteristics of the plants, b) to introduce a prevention system for accidents via the adoption of procedures and plant control instruments that could guarantee safety inside and outside the sites.

environment (due to the change in land use) but also a driving force on the surrounding area. The cases presented in TEPI (Eurostat 1999a) show how the contribution from industry is a considerable one;

- **Derelict areas:**
several urban areas are underused, abandoned and often contaminated as a result of industrial use. The indicator (as can be seen also from the formulation given in the Methodology Sheets), expresses more a state and a need for recovery rather than an existing pressure. The concept “derelict” must be specified, and it is also necessary to consider, with the SIP, the increase in derelict areas rather than their relative size in any given moment (the indicator is expressed as a percentage of the total urban area), so as not to consider the effects of past events as present environmental pressures;
- **Emissions of organic material in terms of COD/BOD through (non treated) wastewater:**
this indicator concerns environmental pressures of the urban activities on the natural environment at large, and not a problem of the urban environment in itself, as explained in Paragraph I.5.4 of Part I; the indicator therefore seems to be not appropriate for this “environmental problem area”;

In addition to the above indicators (with the exclusion of the last one), it seemed appropriate to select also the following indicator which is present in the Methodology Sheets, but not in the selection made by the SIP report:

- **Emissions of sulphur dioxide (SO₂) and nitrogen oxides (NO_x):**
the Methodology Sheets refer this indicator to the activities carried out by the urban population, but there is no conceptual problem in referring it to Industry, especially given the definition adopted here of the “environmental problem area”: the relevant emissions are those of industries situated in urban areas.

Table II.41 - Indicators selected for the Industry sector in relation to the “environmental problem area” Urban environmental problems and noise

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
People endangered by noise emissions	MS – SIP	Pressure
Land use	MS – SIP	Driving force
Derelict areas	MS – SIP	Pressure
Emissions of sulphur dioxide (SO ₂) and nitrogen oxides (NO _x)	MS	Pressure

II.5.2.9 Waste

Whilst remembering that waste in itself has been considered as a driving force and not a direct pressure on the natural environment (see Part I, Paragraph I.5.4), it can be noted how Industry has a dual position: on one hand it generates waste during production processes, and on the other most industrial products degenerate after use into waste. Only the former, i.e. waste generated directly by industrial processes, are considered for calculating the contribution made by Industry to these driving forces, while waste generated during final consumption (of industrial products, as it is the case with agricultural products and services) make up a driving force that cannot be directly attributed to any of the six SIP sectors. Due to what has been said while

discussing the definition of the sector, it seemed appropriate, however, to consider also indicators referring to products' ability to generate waste in the final consumption phase.

The indicators selected by the SIP Industry for the "environmental problem area" Waste are the following:

- Hazardous waste according to directive 91/689/EWC;
- Internal waste recycled/material recovered:
this indicator, also present in the Methodology Sheets, cannot be considered as significant in the present context as it represents the extent to which recycling possibilities are used, rather than the environmental pressures coming from the production of industrial waste; it is not, in fact an indicator of pressure, nor does it show a driving force – unless one should desire to use it to show the environmental pressures that are specifically connected to recycling activities (these, indeed, are already covered by the indicators selected for the whole of the "environmental problem areas");
- Waste per product during a number of products entire lifetime:
the use of indicators referring to the quality of products would, according to the SIP report, be desirable for state-of-the-art, eco-compatible planning within industry (even though these indicators are considered extremely difficult to calculate). The two cases presented in TEPI (Eurostat 1999a), relative to a car and a dwelling, clearly show how most waste is produced in the phase of production – for the car – (especially in the extraction of raw materials) and demolition – for the dwelling – both relevant to industrial activity;
- Average lifetime of a group of selected products:
this indicator can be considered as being complementary to the previous one; although in this case too it is not clear how these products should be selected, a measurement of the average life of products that represent Industry would express a significant driving force, informative about the implications for the production of waste of Industry's technological and production choices and is therefore appropriate for inclusion in the selection;
- Total (internal) waste incinerated:
this and the next two indicators do not refer to the production of waste, but to its internal management, in particular to that carried out in internal incineration plants. These indicators express the potential pressures on other "environmental problem areas" (air, climate, toxic substances) – considered through the indicators referring to the specific "environmental problem areas" involved each time – and it would not be appropriate to refer the environmental pressures in question to the "environmental problem area" Waste, as explained in Paragraph I.5.4 of Part I;
- (Internal) Waste incinerated with energy recovery and state-of-the art abatement:
see the comments on the previous indicator;
- (Internal) Waste burnt in facilities not equipped with state-of-the art abatement:
see the comments on the previous indicator;
- Consumption of hazardous material:
hazardous substances, in addition to being used in Industry as a raw material and as auxiliary materials, and therefore present in waste directly produced by it, are included in consumer goods, destined in turn to generate waste;
- Waste per industrial sector:
the information referring to the origin of waste and therefore to the different types can be extremely important; it is therefore necessary to specify which industrial sectors should be

distinguished. For this purpose, the following indicators from the list submitted to the SAG need to be selected:

- Waste of mining;
- Waste of construction and demolition;
- Waste from other industrial sectors.

In addition to the above indicators (with the exclusion of those referring to waste management aspects), it seemed appropriate to select also the following indicator, also present in the list submitted to the SAG, but not in the selection made by the SIP report:

- Sludge from [municipal and] industrial sewage plants:
this is material destined to be not directly discharged into the natural environment, but instead to be handed to companies specialised in its disposal, forming waste coming from the treatment of other waste (wastewater). The indicator included in the list submitted to the SAG refers to municipal plants and also to industrial plants; its denomination is to be modified, to consider solely the amount of sludge produced by purification plants in Industry.

Table II.42 - Indicators selected for the Industry sector in relation to the “environmental problem area” Waste

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Hazardous waste (according to directive 91/689/EWC)	MS – SIP	Driving force
Waste from other industrial sectors	SAG – SIP	Driving force
Waste of mining	SAG – SIP	Driving force
Waste of construction and demolition	SAG – SIP	Driving force
Sludge from industrial sewage plants	SAG	Driving force
Consumption of hazardous substances	MS – SIP	Driving force
Waste per product during a number of products entire lifetime	MS – SIP	Driving force
Average lifetime of a group of selected products	SAG – SIP	Driving force

II.5.2.10 Water pollution and water resources

The following indicators were selected by the SIP Industry for the “environmental problem area” Water pollution and water resources:

- Ground water abstraction:
the data reported from TEPI under the “Resource depletion” section seems more than enough to confirm the indicator’s inclusion in the selection;
- Surface water abstraction:
this indicator makes up a useful addition of information supplied by the previous one; also refer to the “Resource depletion” section;
- Total (internal) water treated/water collected:
this and the next two indicators do not appear to be extremely significant for Industry as they do not supply sufficient information either from a quantitative (drawing of water) or qualitative (environmental pressures created by wastewater treatment carried out within the sector) point of view;

- Total of waste water treated by industry/total quantity of water used:
see the comments on the previous indicator;
- Total waste water collected/water use:
see the comments on the previous indicator;
- Water recycling by industry:
this indicator, which is interesting as a measure of the progress towards sustainability (recycling water is however an operation that has become widespread in the last few years, with percentages close to 100% in some cases), indicates neither a pressure nor a driving force;
- Number of industrial accidents in plants covered by the Seveso directive:
this indicator represents a driving force;
- Water use per capita:
this indicator is made superfluous by the presence of the next one;
- Industrial water use:
this indicator, present in the M.S., expresses a significant driving force for this “environmental problem area”: the indicator provides information about the potential pollution of water due exclusively to this sector; see the “Resource depletion” section and Paragraph I.5.4 of Part I;
- Emissions of organic matter as BOD:
industrial discharges are among the main sources of emissions of organic materials.

The reflections made starting from the list of indicators selected by the SIP Industry brought about a review of the selection, in light of the comments reported above and the selection of the further indicators below, not proposed in the SIP report for this “environmental problem area”:

- Emissions of heavy metals, by metal:
this indicator is present in the Methodology Sheets as an aggregate index; see the Introduction to Part I (§ I.1) for a discussion about the choice of a disaggregate measure.
- Nutrient (nitrogen and phosphorus) release:
this indicator is similar to that concerning eutrophication selected for the “environmental problem area” Marine Environment and Coastal Zones; however in this case it only comprises discharges in inland waters and represents a direct pressure on them. Also in the M.S. there is an indicator referring to nutrients, though to their use. The denomination used here corresponds to the one selected for Water Pollution and Water Resources for the Energy sector.

Table II.43 - Indicators selected for the Industry sector in relation to the “environmental problem area” Water pollution and water resources

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Nutrient (nitrogen and phosphorus) release	SIP	Pressure
Ground water abstraction	MS – SIP	Pressure
Surface water abstraction	SAG – SIP	Pressure
Industrial water use	MS – SIP	Driving force
Emissions of heavy metals, by metal	MS	Pressure
Number of industrial accidents in plants covered by the Seveso directive	SAG – SIP	Driving force
Emissions of organic material as BOD	MS – SIP	Pressure

II.6 Waste Management Sector

II.6.1 Description and delimitation of the sector and main overlaps with other sectors

II.6.1.1 Description and delimitation of the sector in the SIP report

The SIP report¹⁴⁸ defined the Waste Management system as “the collection of economic activities that receives solid or liquid waste inputs from other economic sectors and either recycles or disposes of them”.

Typical activities in this sector are collection, transport, recovery, treatment, temporary storage and final disposal of waste, including the control of the afore-mentioned operations and of the disposal plants after their closure.

As the SIP report has highlighted, waste management could “be regarded as an industrial operation or a functional unit occurring in all economic activities. This would also be in accordance with the concept of statistical unit (698/91/EC). Functional units such as waste treatment facilities in an establishment or an enterprise can be considered as a Unit of Homogeneous Production. Indeed, the functional role rather than the sectoral one may be the most important for the overall Waste Management sector in a Member State”.

The existence of auxiliary activities in waste management was considered as especially important by SIP Waste Management, in particular with regards to waste management activities in the Industry sector: a large number of manufacturing industries in fact, arrange on site treatment of waste that they produce, before transferring the residue coming from this treatment for final disposal to specialised units. The environmental pressures that result from this on-site treatment could be allocated to the Waste Management sector if this were conceived as a group of processes and functions that are present in several manufacturing activities; the same environmental pressures should, instead, remain attributed to the Industry sector if the Waste Management sector were defined as a collection of enterprises that carry out this activity for third parties.

On this subject, SIP Waste Management has followed an approach that was determined by the concern over minimizing the problem of gathering data, considered to be especially relevant in the event that intermediate phases in the production cycle carried out within a production unit were taken into consideration¹⁴⁹. They therefore decided that it was more appropriate to adopt the “mill gate” as the boundary between the Industry sector and the Waste Management sector and to attribute the environmental pressures generated by an activity that treats its own waste on site to the activity itself; in this hypothesis, the Waste Management sector will only be attributed with the environmental pressures generated by the treatment and final disposal of waste that leaves the site where it was produced to be handed over to local specialised units. In other words, all the public and private figures whose main or secondary activity is providing third parties with collection, treatment and disposal services for waste generated by other economic or consumer activities will be included in the

¹⁴⁸ Eurostat, 1999b.

¹⁴⁹ On this matter, the SIP states “firms usually keep detailed accountings of the overall amount of goods, raw materials, products and wastes (when they are managed by external companies) which enter or leave the mill, but they may not be able or they may not want to spread information about intermediate processes”.

Waste Management sector. Consequently, with regards to the manufacturing sector, this will be held responsible:

- for the environmental pressures generated by onsite treatments of primary wastes (in principle contributing to all the policy fields except “Waste”);
- for the environmental pressures related to the generation of wastes which leave the mill gate (both treated and untreated);

it is only the latter environmental pressures that contribute to the policy field “Waste”.

On the other hand, the Waste Management sector will be held responsible:

- for the environmental pressures due to off-site treatments (again contributing to all the policy fields except “Waste”);
- for the environmental pressures of final wastes to be disposed of (only contributing to the policy field “Waste”).

With regards to the activities to be included – whether carried out as main or secondary activities – in the Waste Management sector, the SIP report includes (Eurostat 1999b, pages 309 and 321¹⁵⁰), not only the sections 37 (Recycling) and 90 (Sewage and refuse disposal, sanitation and similar activities), but also section 51 (Wholesale trade and commission trade, except of motor vehicles and motorcycles) and 75 (Public administration and defence; compulsory social security).

II.6.1.2 Clarification of the sector boundaries and overlaps with other sectors

As shown above, the SIP report, faced with the two possible ways of defining the Waste Management sector – as a collection of processes or as a collection of economic activities, depending on whether management operation carried out by economic units as auxiliary activities are included or not – chose the latter, based on reasoning of a practical nature, having recognised the possibility of obtaining the necessary data more easily.

On this matter, it can be said that the greater difficulty in obtaining data from enterprises, shown in the SIP report, does not necessarily imply that the calculation of environmental pressures is more difficult for a sector defined as a collection of processes rather than for one defined as a collection of main or secondary activities¹⁵¹. The same handling contained in the SIP report of the methods that can be used for the calculation of the environmental pressures, in fact suggests the superiority of an approach by process rather than by activity. Application of the material balances method shows, according to the report, how the amount of waste actually generated is much higher than that which crosses the “mill gate”, contained in traditional statistical data available¹⁵².

¹⁵⁰ Both references can be found in the part of the SIP report that is dedicated to the availability and quality of data; in the parts that are explicitly dedicated to the definition and delimitation of the sector, however, there is no listing of activities in terms of NACE entries.

¹⁵¹ Difficulties can be found also with regards to the need of distinguishing inputs and outputs of secondary activities from those of main activities within a local unit.

¹⁵² The SIP report states: “A comparative analysis of some common industrial processes shows large discrepancies between statistical data concerning process inputs and outputs and the results of the law of conservation of matter” (Eurostat 1999b); as can be noted, the application of the material balances method is explicitly referred to processes. It must be remembered that the building – though in part – of a Technology Database of industrial processes has already been carried out during the EPIS project.

As a matter of fact, this method, applied to industrial production, provides information on the overall demand for disposal services, regardless of who actually carries them out. The comparison with data that can be directly calculated, referring to the amounts that leave industrial site, can be useful in understanding what the actual importance of self-disposal is, whose environmental pressures must be added to those coming from manufacturing processes in order to obtain the overall amount of environmental pressures caused by the Industry sector. What's more, the use of technical coefficients (such as, for example the emission factors which the SIP report speaks of), is generally referred to processes and not to economic activities (see the consolidated case of CORINAIR): in these cases, in order to calculate the indicators referring to given sets of economic activities (e.g., for the construction of a NAMEA), the environmental pressures must be attributed to the latter; in the cases in which this attribution is not univocal, reference to economic activities may complicate, rather than simplify, the statistician's or the environmental accountant's job. Finally, with regards to the possibility of the direct gathering of data, the SIP pointed out the limits of self-reporting procedures.

In any case, it should also be noted that, though the concept of "mill gate" is valid for outlining the boundaries of the Industry sector (see Paragraph II.5.1), the same may not necessarily be said for the Waste Management sector, in light of the European Community formulation of the relative policy. The European Community directives on the matter, in fact express a concept of such a policy that corresponds more to the concept of "waste management" as a collection of processes than a collection of specialised companies. The fact that waste is, for example, incinerated inside rather than outside the production site where it was generated, does not change the substance of the problem that must be faced, i.e. of the load placed on the natural environment from the co-production of scrap, waste, slag, rubble and other things, involving any activity, both production – of goods and of services – and consumption ones. If the "onsite" activities of waste disposal were not included in the calculation of the environmental pressures, the indicators would be distorted and not very significant with regards to the environmental problem at issue: the values taken on by them would vary depending on the institutional set-ups and the economic climate (i.e. depending on the solution adopted each time by businesses faced with the dilemma of internalisation vs. externalisation of functions).

All this does not mean that the fact that there might be added difficulties in including auxiliary activities in the sector does not exist, but the potential gaining of significance of the indicators appears to be such that it makes it appropriate that a sound definition of the sector from a conceptual and methodological point of view should be tested in pilot applications.

The reflections made starting from the SIP report therefore gave rise to the conclusion that, at this stage of the analysis, it is more appropriate to consider the waste disposal processes carried by the industries themselves, of any class of activity, as a part of the sector. With regards to activities that produce services, it can reasonably be assumed that internal disposal is not statistically significant; for the producers of goods (agricultural or industrial), however, there are commonly activities that are carried out in support of the main activity. As they are auxiliary activities, they should also remain pertinent to the sectors to which the main activities belong.

For reasons of thoroughness, the overlaps with the Energy sector (with regards to the recovery of energy during incineration – see chapter on Energy) and those with the Transport

sector (with regards to the transportation of waste – see chapter on Transport) should also be remembered here.

II.6.1.3 Delimitation of the sector in terms of economic activities

In Table II.44, all the economic activities in NACE rev.1 are listed, singled out as far as the maximum level of detail, that it was found appropriate to consider for the Waste Management sector.

With regards to the sections 51 and 75, the activities to be taken into consideration are especially those belonging to category 51.57 (Wholesale of waste and scrap) and some activities belonging to category 75.12 (Regulation of activities of agencies that provide health care, education, cultural services and other social services, excluding social security) and concerning the public administration of programmes, specifically those that focus on the subject of sewage and refuse disposal and sanitation activities.

Table II.44 - Activities included in the Waste Management sector

NACE CODE	Activity
37.10	Recycling of metal waste and scrap
37.20	Recycling of non-metal waste and scrap
90.00	Sewage and refuse disposal, sanitation and similar activities
51.57	Wholesale of waste and scrap
75.12	Regulation of activities of agencies that provide health care, education, cultural services and other social services, excluding social security (only for the part concerning the activities typical of the sector)
	All the activities of waste management and final disposal carried out alone by units that do not belong to sections 37 or 90

II.6.2 Selection of the indicators that are most representative of the environmental pressures of the sector

Once the sector's boundaries compared to the rest of the economy have been defined, it was seen that there is at least one case, that of tips, for which it is appropriate to ask oneself the problem of how to define the boundary between the sector (and therefore the anthropic system) and the natural system. The main environmental pressures linked to this type of disposal, have been investigated therefore as shown below.

The tip, as a solution to the problem of waste disposal, contains numerous advantages, such as, for example, the simplicity in building them and the speed with which they are created and the low initial investment needed, compared to other systems. On the other hand, in addition to the loss of materials and energy, this form of disposal generates several environmental pressures, on:

- the soil and the subsoil, in particular on ground-water;
- the land and its uses;
- the atmosphere, due to fermentation gases, smells, dust and other light materials that can be carried by the wind; there is also a risk of fires, which may not be easy to control if deep down in the mass.

The most important risks of environmental impact from a tip are those of the production of leachate and biogases. These polluting liquid and gaseous fluids that are generated through the accumulation of waste, can in fact, spread dangerously into the natural environment: the liquid may, percolating into the ground, pollute ground water streams, damaging the drinking water requirements or water for more general use, while the gas may directly threaten plant life, and leaks could aid the formation of explosive mixtures, causing damage to people and things.

The leachate contains biological and chemical contaminants, the first coming from microorganisms that develop in the tip at the expense of the organic substances present, and the second coming from the deterioration of the materials present. The biological species tend to migrate slowly from the tip to water while the spreading of chemical pollution is usually rapid.

Biogas is a mix of gases produced by the fermentation of the organic substances present. This fermentation normally occurs in the surface layers where the exchange of air between atmosphere and waste layer is possible: it begins with the production of organic acids (which are also strongly nauseating) and continues with the production of carbon dioxide and methane with a percentage of methane that varies from 50 to 70% and carbon dioxide that goes from 30 to 50%.

The gases emitted by the tips can cause: explosions and fires, the formation of unpleasant odours and damage to the vegetation.

Methane, which is lighter than air, tends to migrate, but if the land around the tip is more permeable than the top layer of the tip itself, the compacting can make this journey more difficult so that the gas will travel along horizontal paths, spreading over considerable distances to far-off constructions, to the lower floors of buildings and into pipelines.

The principles of protecting the natural environment, which is at the root of the current laws in force on the matter of waste management, contain strong implications on the attitude to adopt for defining the boundary between anthropic system and nature, with regards to tips. In order to protect the environment, waste must in fact be managed far beyond any depositing in the tips, and beyond the closure of the tip where they are deposited. In order to limit the production of leachate the design of tips is set out so as to limit infiltration into the heap of waste from direct rainwater, by means of covering the waste with waterproof material; rain wash water is also limited via the building of a draining system. However, this is not sufficient: the leachate must be drained so as to guarantee that it is removed without stagnating and it must be prevented from coming into contact with surface water and ground water. Capturing biogases is an important element of environmental protection (also, in the specifically equipped tips, it is also a production factor).

Finally, waste policy, taking on the safeguarding of the natural environment as the principle guide, orders that waste deposited in a tip, far from being considered “disposed of” in the natural environment, must be “managed”, which suggests placing the boundary between Waste Management and the natural system where deposited waste is transformed into leachate and biogas, at least until they are not transformed into inert residues that no longer need to be “managed” in any way. Waste deposited in a tip, in this perspective, is an important driving force, limiting its immediate environmental pressure, like all the physical components in the anthropic system, to the mere occupation of space.

In light of what has been specified with regards to the definition of the sector and the environmental pressures to be considered as being significant, a review of the indicators used in the SIP report was then carried out. On the basis of a comparison between the indicators chosen by the SIP report and those contained in the list submitted to the SAG during the second survey (and in particular those for which Eurostat drew up the Methodology Sheets), this analysis has brought about a selection of a group of significant indicators for the Waste Management sector, which are shown for each “environmental problem area” in the paragraphs below and which are proposed in a summary form in the tables contained here below.

II.6.2.1 Air pollution

The Waste Management sector’s contribution to air pollution concerns both disposal operations and collection and transportation of waste.

With regards to the contribution from disposal operations, the only significant process for air pollution is incineration. The amount of emissions generated depends closely on the type of waste incinerated.

Emissions consisting of carbon monoxide (CO), nitrogen oxides (NO_x) and sulphur oxides (SO_x) can instead be attributed to the Waste Management Sector due to the contribution given by the collection and road transportation of waste from collection centres to treatment centres and final disposal units.

The amount of particle emissions is in direct relation to the activity of fossil or waste combustion. The regulations for tips that enforce daily covering of the sites and the construction of specific fire-prevention installations limit the emissions of particles to the emissions linked to the vehicles used for collection and transportation of waste.

The Waste Management sector's contribution to volatile organic compound emissions is linked to the presence of tips and to the production of surface biogases.

All the indicators proposed in the SIP report show environmental pressures coming from combustion processes:

- Emissions of carbon monoxide (CO);
- Emissions of nitrogen oxides (NO_x);
- Emissions of sulphur oxides (SO_x);
- Emissions of particles;
- Emissions of non-methane volatile organic compounds (NMVOC).

The five environmental pressure indicators proposed are all present in the list of indicators contained in the Methodology Sheets for this "environmental problem area", except for the one referring to sulphur oxides (SO_x) to be replaced with a more specific one referring to sulphur dioxide only (SO₂). In TEPI (Eurostat 2001), the emissions of NO_x, SO₂, particles and NMVOC are reported without express reference to Waste Management, which does therefore not appear as a major contributor to Air pollution. However, as combustion processes are present in the sector, it is advisable that these indicators be calculated for Waste Management too.

Table II.45 - Indicators selected for the Waste Management sector in relation to the "environmental problem area" Air pollution

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of nitrogen oxides (NO _x)	MS – SIP	Pressure
Emissions of sulphur dioxide (SO ₂)	MS – SIP	Pressure
Emissions of carbon monoxide (CO)	MS – SIP	Pressure
Emissions of non-methane volatile organic compounds (NMVOC)	MS – SIP	Pressure
Emissions of particles	MS – SIP	Pressure

II.6.2.2 Climate change

As the Waste Management sector's contribution is relatively low or almost negligible with regards to the emissions of compounds that are significant for climate change, SIP Waste Management limited the analysis to a small number of substances:

- Carbon dioxide (CO₂);

- Methane (CH₄);
- Chlorofluorocarbons (CFC-11 e CFC-12).

Carbon dioxide is mainly emitted from incinerators, old type tips and from the transportation of waste from sites where it is collected to treatment plants.

Methane is produced in tips via the anaerobic digestion of organic material and is emitted directly into the atmosphere (some tips are equipped with special systems for the extraction and reuse of the gas). According to TEPI, the contribution of Waste Management amounted to 30% of EU emissions in 1998.

Although the use of CFC as coolants and as propellants is now forbidden in Europe, emissions can still come from aerosol sprays produced in the past and disposed of in open-air tips.

The indicators referring to the emissions of nitrogen oxides (NO_x) and sulphur oxides (SO_x) were not selected by SIP Waste Management, due to the low contribution made by this sector to these emissions. This reason alone would not be sufficient to exclude these two indicators from selection (in relation to other “environmental problem areas”, in fact, they were adopted), but exclusion is equally justified by the fact that these emissions are not significant as environmental pressures in relation to this “environmental problem area”.

For this “environmental problem area” too, the environmental pressures that the indicators proposed by the SIP report refer to are among those considered to be significant for the “environmental problem area”, to which the indicators selected by Eurostat for the Methodology Sheets refer to. With regards to CFC emissions, the formulation of the indicator contained in the Methodology Sheets, “Emissions of CFC”, an amount considered according to the radiative forcer of the various chlorofluorocarbons emitted to the air, appeared to be preferable.

Table II.46 - Indicators selected for the Waste Management sector in relation to the “environmental problem area” Climate change

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of carbon dioxide (CO ₂)	MS – SIP	Pressure
Emissions of methane (CH ₄)	MS - SIP	Pressure
Emissions of chlorofluorocarbons (CFC)	MS	Pressure

II.6.2.3 Loss of biodiversity

The SIP report did not find any specific contribution from the Waste Management sector regarding the problem of loss of biodiversity, and therefore did not propose any environmental pressure indicators for this “environmental problem area”. The present study instead pointed out how pressures on land biodiversity are also carried out by this sector, specifically by the accumulation of waste. Waste occupies a vast area of land, and this corresponds to an often-permanent fragmentation of the landscape. The effects that tips have on biological diversity are complex: they themselves are a habitat for some species and, generally speaking, their presence brings about a disturbance of the balance between the species (for example, of the food resources present in them); therefore they must be kept “under observation” for this “environmental problem area” too.

The following from among those proposed to the SAG, were considered as particularly significant indicators that could be applied to this sector for this “environmental problem area”: “Evolution of built-up and related land” with regards to tips and “Surface disposal of mineral

workings deposits”, in consideration of the inclusion of all the waste management activities in the sector, even if carried out by units that are specialised in other productions.

Table II.47 - Indicators selected for the Waste Management sector in relation to the “environmental problem area” Loss of biodiversity

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Evolution of built-up and related land	SAG	Driving force
Surface disposal of mineral workings deposits	SAG	Driving force

II.6.2.4 Marine environment and coastal zones

According to the SIP report, the specific environmental pressures generated by the Waste Management sector on the marine environment and on coastal zones come entirely from water pollution; the indicators proposed are therefore the same foreseen for this last “environmental problem area” (see Paragraph II.6.2.10):

- Emission of organic matter as BOD;
- COD of liquid effluents released to water bodies;
- TSS of liquid effluents released to water bodies.

The first two indicators are directly correlated to an excessive introduction of organic material to waters, while the third is a direct cause of the increase in the turbidity of sea water (the environmental pressure is the same as that already shown for Industry, a sector for which the indicator “Increase in suspended solids” was selected, which is present in the list submitted to the SAG).

It seemed advisable to select also the following indicators from the Methodology Sheets:

- Faecal pollution:
as faeces is solid and liquid waste matter coming from households and zootechnical industries, their disposal, by definition, comes under the Waste Management sector, even when this should occur without being preceded by any type of treatment. In addition to the amount of faeces produced, faecal pollution is in fact directly dependent on the disposal system that is used for this waste (the better the treatment applied, the less the pressure on the marine environment would be). Given the definition adopted for the sector, the management of wastewater from boats is also significant.
- Eutrophication (nitrogen and phosphorus discharged into waters):
as TEPI (Eurostat 2001) highlights, point sources of sewage, as well as industrial wastewater discharge, contain the nutrients that cause eutrophication. In addition, the management of waste from farming of animals activities is relevant for the sector, as defined here.
- Discharges of heavy metals (by metal):
as TEPI (Eurostat 2001) states: “sources of direct inputs to coastal waters include effluents [...] from waste treatment plants”.

Table II.48 - Indicators selected for the Waste Management sector in relation to the “environmental problem area” Marine environment and coastal zones

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emission of organic matter as BOD	SIP	Pressure / Driving force
COD of liquid effluents released to water bodies	SIP	Pressure / Driving force
TSS of liquid effluents released to water bodies	SAG – SIP	Pressure / Driving force
Eutrophication (nitrogen and phosphorus discharged into waters)	MS	Pressure / Driving force
Discharges of heavy metals, by metal	MS	Pressure / Driving force
Faecal pollution	MS	Pressure / Driving force

II.6.2.5 Ozone layer depletion

The SIP report identified devices containing CFC disposed of in open-air tips – especially for the emissions of CFC-11 and CFC-12 – as the source causing the greatest contribution of the Waste Management to this “environmental problem area”. These emissions, considered separately in the SIP report, are summarised in the indicator “Emissions of CFC” from the Methodology Sheets.

After a more thorough examination, quantification of these emissions does not seem sufficient to adequately describe the sector’s contribution to the problem. It was therefore decided to also select the indicators referring to “Emissions of methane” (CH₄) (contained in the Methodology Sheets), which represent extremely significant environmental pressures for the “environmental problem area” in question, which the Waste Management sector contributes to significantly (see “Climate Change”). Also, “Emissions of carbon dioxide” (CO₂) coming from waste combustion in general and “Emissions of Methyl Bromide” (CH₃Br) from organic waste in particular, may be significant.

Table II.49 - Indicators selected for the Waste Management sector in relation to the “environmental problem area” Ozone layer depletion

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of chlorofluorocarbons (CFC)	MS – SIP	Pressure
Emissions of methane (CH ₄)	MS	Pressure
Emissions of methyl bromide (CH ₃ Br)	MS	Pressure
Emissions of carbon dioxide (CO ₂)	MS	Pressure

II.6.2.6 Resource depletion

According to the SIP report, it would be useful to be able to use a simple indicator in which the various flows of materials and energy could be accounted using the same physical unit of measurement that could reflect the actual usefulness of the resources consumed. For this purpose, the SIP report proposed the use of the “exergy” concept, as a measurement of all the material and energy flows¹⁵³.

¹⁵³ Exergy quantifies the maximum potential work that can be extracted from a given substance or system in relation to the real conditions in which the process takes place; as it is linked to the amount of energy that nature must spend to reproduce the given substance, it supplies a measurement of its “value” in environmental terms; it is particularly useful from an accounting point of view: it allows analysts to supply a single representation, with the same unit of measurement, for the various flows of energy or materials involved in the process analysed; its unit of measurement is the Joule, like energy, and can be calculated for each type of material, compound or energy flow (Eurostat 1999b, p.303).

The “exergy” concept is potentially an excellent instrument for resource accounting. However, the possibility of quantitatively applying this concept was only recently acknowledged (in the life cycle analysis context) and many efforts are still needed to standardise the methodology and arrive at an indicator that can be adopted for official statistics. The SIP report, however, did not specify the resources for which the “exergy” should be calculated, i.e. for which use of materials and energy should the Waste Management sector be held responsible. The statement that said “these measures have to be used to assess both for consumption and eventual production or recycling” (Eurostat 1999b, p. 303), allows one to think that it is not the wish to limit the matter to the current inputs needed to carry out waste operations, but to extend the evaluation to those that are the subject of such operations, waste. As a matter of fact, energy and material resources, in addition to being destroyed, are also generated in some cases by waste management¹⁵⁴, and therefore opposite flows of creation and destruction of resources exist that should be measured in order to be able to build a complete balance of “exergy” that passes through the sector. However, this would correspond to a need that is much different than the one to measure the sector’s contribution to the use of resources: the use due to waste treated within the sector, in fact, is not attributable to the latter.

It appeared therefore that currently, the methodology proposed in the SIP report could not be considered as a valid replacement of the environmental pressure indicators proposed in the Methodology Sheets, which can be considered as significant for the sector. Among these, the following two were selected for the Waste Management sector:

- Increase in territory permanently occupied by urbanization, infrastructures, waste-tipping and quarrying:
waste-tipping is the most significant here, and its presence is an irreversible use of the “land” resource;
- Use of energy:
for this indicator, the reference is to the quantities used for the carrying out of the management activity and not to those contained in the materials managed (energy materials are sometimes used in incineration, and transport and treatment of waste requires energy input).

Table II.50 - Indicators selected for the Waste Management sector in relation to the “environmental problem area” Resource depletion

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Increase in territory permanently occupied by waste-tipping or by waste treatment plants	MS	Pressure
Use of energy (absolute quantity)	MS	Driving force

II.6.2.7 Dispersion of toxic substances

According to the SIP report, the sector’s contribution to this “environmental problem area” comes from a wide number of toxic chemical compounds, mostly produced by the chemical industry, that are contained in various types of waste. However, what is interesting, as shown in the report, is not so much the fact in itself that there are toxic substances in waste, but the

¹⁵⁴ For example, in incineration, waste is often used as a fuel for the production of heat or electrical energy. In addition, many materials such as paper, aluminium, glass etc., are recovered.

possibility that the management method for the former is such as to imply the spreading of the latter into the environment. Modern waste treatment systems are able to almost completely neutralise the hazard of these substances, to the extent that the risk of dispersion is no longer a real problem for most types of toxic waste. On the contrary, risks may derive from those types of waste that, as they are not classified as hazardous, are not treated as special waste, even though they contain toxic residue that can be significant in the long-term after action from atmospheric agents in normal tips.

The emissions of many substances could be used as an indicator for this problem. Direct measurement seems to be extremely difficult as the estimates may not be reliable due to the great diversities among the various sites. The SIP report suggests that some heavy metals could be used to test the size of the problem: a first evaluation could be provided by the amount of mercury and chrome emitted from tips, as indicators of a general value for this “environmental problem area”. As heavy metals are all present in waste, it is however appropriate to not limit attention to only these two metals, and to adopt aggregate indices as measurements for this “environmental problem area”. It is therefore appropriate to consider the possibility of calculating the “Indices of emissions of heavy metals” (to water and to air) proposed in the Methodology Sheets, which summarise the emissions of lead, cadmium, copper, arsenic, nickel and zinc according to the relative toxicity of the emissions of mercury. According to TEPI, the emissions from Municipal Waste Treatment Plants into waters were 86% of the total in Denmark in 1993 and 52% in Sweden in 1995, while the whole of waste treatment accounted for 8% in the Netherlands in 1994 (Eurostat 2001); as for emissions into air, the same source attributes 1% of the total in the EU in 1995 to waste incineration.

A significant phenomenon not considered by the SIP report is the one referring to the emissions of persistent organic pollutants (POP). Emissions containing POP occur during the treatment of organic waste. TEPI reports that incineration of hospital and municipal waste was responsible in the EU in 1998 for 41% of dioxins emissions (Eurostat 2001).

Table II.51 - Indicators selected for the Waste Management sector in relation to the “environmental problem area” Dispersion of toxic substances”

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of persistent organic pollutants (POPs)	MS	Pressure
Index of heavy metal emissions to air	MS – SIP	Pressure
Index of heavy metal emissions to water	MS – SIP	Pressure

II.6.2.8 Urban environmental problems and noise

According to the formulation adopted by the SIP report in relation to this “environmental problem area”, many environmental pressure phenomena that occur in urban areas should not be taken into consideration any further, as they have already been considered in relation to other “environmental problem areas” (e.g. Air pollution). The SIP report therefore proposed to consider the problems of traffic, noise and bad odours and land use in general. The approach is therefore totally compatible with the one adopted here, and discussed in Part I (Paragraph I.5.4), according to which this “environmental problem area” identifies a set of territorial environments for which it is intended to supply information on the pressures that it undergoes, using the indicators.

As the SIP report pointed out, a good number of environmental pressures referring to urban problems can be attributed to the Waste Management sector, as a consequence of the widespread collection of waste and the presence of waste treatment sites, or tips, or incinerators in or nearby urban areas.

Given the correlation between specific urban problems and the waste management sites and the importance of land use for waste disposal, the SIP proposed the use of simple general indicators for all the problems identified. The environmental pressure from the Waste Management sector on this “environmental problem area” was therefore considered to be measurable via the following driving forces:

- Number of waste management sites;
- Area occupied by landfills.

This last indicator was proposed as the application of the most general indicator present in the Methodology Sheet list to the sector, entitled “Land consumption (change from natural to built-up area)”.

Table II.52 - Indicators selected for the Waste Management sector in relation to the “environmental problem area” Urban environmental problems and noise

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Land consumption (change from natural to built-up area)	MS – SIP	Driving force
Number of waste management sites	SIP	Driving force

II.6.2.9 Waste

According to the SIP report, the Waste Management sector’s contribution to this “environmental problem area” is to be measured in terms of amounts of non-hazardous material deposited in the natural environment (for the unit of measurement, a volumetric index is considered more appropriate than a mass index). Consistently with the concept of waste adopted, the SIP report also contained a proposal for a single indicator expressed as follows:

- Volume of solid non-hazardous waste.

According to the formulation adopted here, however, no environmental pressure should be considered for this “environmental problem area”; instead the specific role of the various sectors should be pointed out as far as the driving force “production of waste” is concerned. The sector in question carries out the specific role of manager of this driving force, and the final results that it determines, in terms of environmental pressures, are in fact documented by the indicators selected for the other themes.

As for the production of waste by the Waste Management sector itself, it seemed appropriate to select, from among those proposed in the European projects, the following indicators:

- Sludge from municipal and industrial sewage plants;
- Trade of wastes (export and import):
as it is only the contribution to the creation of the problem “waste” that we want to describe, this measure should be limited to import only.

Table II.53 - Indicators selected for the Waste Management sector in relation to the “environmental problem area” Waste

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Sludge from municipal and industrial sewage plants	SAG	Driving force
Trade of wastes (export and import)	SAG	Driving force

In dealing with this particular combination between a sector and an “environmental problem area”, it is interesting to highlight that many indicators have been proposed in the SAG list which are suited to supplying useful general information about the way waste is dealt with in the waste management system, i.e. a description of the composition and functioning of the sector itself; these indicators can be seen as a collection of general driving force indicators for the sector at issue. The consideration of these indicators complements the picture of the waste cycle given in the rest of the present study, as the indicators chosen for the “environmental problem area” Waste (for all sectors) describe the starting point of the cycle and the indicators chosen for the sector Waste Management in relation to “environmental problem areas” other than Waste describe the final point of the cycle (outputs towards the natural environment).

In the selection of the Methodology Sheets, the following indicators are present:

- Total waste land-filled;
- Total waste incinerated;
- Hazardous waste having special and controlled treatment;
- Waste recycled / material recovered:
this indicator has been operationalised in TEPI first as “Recycling amount divided by Apparent consumption” (Eurostat 1999a), then as “Material recycled as a percentage of Apparent consumption” (Eurostat 2001). Both formulations express the relative efficiency of the sector, while, in order to complement the former three indicators, a measure of the absolute quantity of waste recycled would be more appropriate.

In the rest of the list of the SAG, the following ones further complement the indicators already mentioned:

- Waste burnt in facilities equipped with state-of-the-art abatement technology, without energy recovery;
- Waste burnt in facilities not equipped with state-of-the-art abatement technology, without energy recovery;
- Waste burnt in facilities not equipped with state-of-the-art abatement technology, with energy recovery;
- Waste disposed to sea;
- Trade of wastes (export and import):
- as this is meant to describe the way in which the problem “waste” is dealt with, this should be limited to export;
- Waste treated by biological treatment with utilisation of compost/fertilizer products;
- Waste land-filled not adapted to minimum standards concerning soil and groundwater protection;
- Illegal discharge;
- Total area covered by landfills;

- Average transport distance for waste;
- Organic waste from separate collection.

II.6.2.10 Water pollution and water resources

The sector's contribution to water pollution is mostly in relation to liquid effluent treatment, such as sewage water, wastewater coming from industrial chemical and metallurgical processes and liquid residues of various types coming from manufacturing industries (the problem is particularly important with regards to the paper industry: the large quantities of organic substances treated in this sector give rise to a high level of organic pollution and suspended solids).

The three indicators suggested by the SIP report as being most representative of the sector's pressures on water pollution at a local level are:

- Emission of organic matter as BOD;
- data referring to the discharge of organic matter in terms of BOD coming from households and industry can be found in TEPI (Eurostat 2001);
- COD of liquid effluents released to water bodies;
- TSS of liquid effluents released to water bodies.

High values of COD, BOD and TSS can be found in the liquid effluents that are released to water bodies, both directly and after specific treatment. In fact, even if treatment systems are adopted, these cannot completely remove the entire quantity of pollutants contained in the discharges.

Instead, the SIP report does not take into consideration the pollution of water caused by the percolation of toxic substances from tips, as these substances have already been included in the "environmental problem area" Dispersion of toxic substances. This does not correspond to the interpretation of environmental problem areas adopted here (see Part I, Paragraph I.5.4), therefore it is hereby proposed to adopt the indicator "Emissions of heavy metals, by metal".

The following are also most surely of interest for the sector:

- Nutrient (nitrogen and phosphorus) release¹⁵⁵:
an indicator referring to the discharge of nutrients to waters. The most suitable unit of measurement among those proposed in the Methodology Sheets for this indicator is tons of nitrogen and phosphorus/year. Data relating to the discharge of nutrients coming from households and industry can be found in TEPI (Eurostat 2001);
- Losses in the sewage collection network:
an indicator contained in the SAG list that expresses the risk that environmental pressures occur following accidents or breakdowns.

¹⁵⁵ For the denomination see the section on Water pollution and water resource concerning the Industry sector.

Table II.54 - Indicators selected for the Waste Management sector in relation to the “environmental problem area” Water pollution and water resources

<i>Indicator</i>	<i>Source</i>	<i>Pressure / driving force</i>
Emissions of heavy metals, by metal	MS	Pressure
COD of liquid effluents released to water bodies	SIP	Pressure
Emission of organic matter as BOD	MS – SIP	Pressure
TSS of liquid effluents released to water bodies	SAG – SIP	Pressure
Nutrient (nitrogen and phosphorus) release	MS	Pressure
Losses in the sewage collection network	SAG	Driving force

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B

CONTABILITÀ DEI FLUSSI DI MATERIA A LIVELLO DI INTERO
SISTEMA ECONOMICO (EW-MFA)

Abbreviazioni e parole chiave

NA	– National Accounts
GDP	– Gross Domestic Product
SNA	– System of National Accounts
ESA	– European System of Accounts
SEEA	– System of Environmental and Economic Accounting
NAMEA	– National Accounts Matrix with Environmental Accounts
EW-MFA	– Economy Wide Material Flow Accounting
EW-MFB	– Economy Wide Material Flow Balance
MIOT	– Monetary Input-Output Table
PIOT	– Physical Input-Output Table
DE	– Domestic Extraction (of used materials), measured in weight units
DMI	– Direct Material Input (= DE + Imports, measured in weight units)
DMC	– Direct Material Consumption (= DMI - Exports, measured in weight units)
PTB	– Physical Trade Balance (= Imports - Exports, measured in weight units)
TMR	– Total Material Requirement (= DMI + Domestic Unused Eextraction + Indirect Flows of Imports)
TMC	– Total Material Consumption (= TMR - Exports - Indirect Flows of Exports)
PTBIF	– Physical Trade Balance including Indirect Flows (= Imports + Indirect Flows of Imports - Exports - Indirect Flows of Exports)
APAT	– (Italian) National Agency for Environmental Protection and Technical Services
CNx	– Combined Nomenclature (EU classification of internationally traded goods) considered at the x th digit
PRODCOMx	– The classification used in the homonymous Survey on industrial production carried out in EU countries, considered at the x th digit
NACE Rev.1	– The European classification of economic activities in use in the ‘90ies, now updated to NACE Rev.1.1
ATECO91	– The Italian version of NACE Rev.1 in use in the ‘90ies, now updated to ATECO 2002.

Capitolo 2

Rapporto ad Eurostat

Economy-wide Material Flow Accounts and Balance for Italy, 1997

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1 INTRODUCTION

1.1 Material Flow Accounting: materials matter

Material Flow Accounting (MFA) is a family of decision-support tools, providing information on human-induced flows of materials and allowing the overview and analysis of trends in resource and waste management and sustainability policy. Economy-Wide Material Flow Accounting (EW-MFA), in particular, is a methodology for the construction of synthetic information on the physical exchanges of the economy, based on a holistic approach.

The informative value of MFA is closely related to the importance of material flows themselves, which we will briefly recall here.

The world is a single living material entity, whose life principally consists in the flowing of matter from one component to the other. The basic condition for life to continue to prosper on this planet is the existence of some equilibrium in the material flows that interconnect the different components of this immensely complex system.

In order to discuss and understand the role of man with respect to these flows, it is necessary to divide the world system into two components: the realm of human beings and artefacts, which we will call the anthroposphere (see Baccini and Brunner 1991), on the one hand, and the realm of the matter that man has not (yet) moved, which we will call Nature, on the other hand. In Nature, the solar-energy-powered self-organised flows of matter tend to be in substantial (and dynamic) equilibrium with one another. Human intervention tends to disrupt these equilibria.

Il testo riportato è una rielaborazione del rapporto originale consegnato all'Eurostat nel 2003, per quanto riguarda la parte relativa ai conti per il 1997.

Il progetto e la stesura del rapporto originale sono stati coordinati da Aldo Femia (Istat), che ha curato anche la presente rielaborazione.

Il § 3.5.3 è stato redatto da Giulia Barbiero (IRSA); il § 3.2.4.2 da Stefano Camponeschi (stagista Istat); i §§ 3.1.2.3, 3.2.1 e 3.2.2 da Gianna Greca (Istat); il § 3.2.3 da Antonio Macrì (Istat); i §§ 3.5.1, 3.6 e 3.7 da Angelica Tudini (Istat); il § 3.1 eccetto 3.1.2.3 da Miriam Vannozzi (Istat); Aldo Femia ha redatto tutte le rimanenti parti.

Humans, thanks mainly to the exploitation of non-solar energy (mainly fossil energy), are currently one of the main determinants of the material flows that take place on our planet: the quantity of earth moved yearly by man is much bigger than that naturally moved by wind, glaciers and mountains formation, and comparable to that coming out from oceanic volcanoes as well as to that carried by all the rivers in the world.

Man is not only a very effective geomorphic agent, but also a major determinant of change in the biosphere, changing the coverage of the earth's surface and the quantities of living creatures according to its needs. On a global scale, it is estimated that at least 20% of the total biological production of the earth is now appropriated by man (RIVM-UNEP 1997; Vitousek et al. 1986, 1997; Imhoff et al. 2004).

The physical processes that take place in the anthroposphere can be seen as a "societal or industrial metabolism" (see e.g. Fischer-Kowalski and Hüttler 1998). Society is viewed as a living organism, ingesting, digesting and discarding materials.

This organism, as it is today, is the result of the historic process of production and accumulation of artefacts whose role is basically to enhance man's ability to manipulate matter (and ideas). The part of the human system that has the role to take, manipulate, transform, mix, use and discard the matter taken from the natural environment almost coincides with the economic system, so that it is common, with regard to this topic, to use the words "anthroposphere" and "conomy" as if they were synonyms.

Due to the fact that materials do not disappear (law of conservation of matter), nor do most of them leave the earth, every material that humans manipulate must either be accumulated in the anthroposphere or remain in the natural environment in a transformed way, or go back to the natural environment after becoming a product and eventually being disposed of.

From the material point of view, the emission of air pollutants is (mainly) the other side of the coin of the use of fossil fuels for energy production and for transportation. Similarly, the impoverishment of soils (and/or the spreading of water and soil pollutants) is the consequence of agricultural biomass production. The occupation and sealing of land is the effect of buildings and roads construction and the dangerous heaps of mining retails are what is left after ores extraction, besides the useful minerals that eventually end up in landfills.

The sheer volume of the flows of materials due to human activity induces changes in the natural environment, which can immediately be perceived as changes in the landscapes. Nature often puts again in circulation the materials discarded by man after transformation. Some materials are the same as those already circulating in Nature, and could therefore be metabolised by it without problems, if their quantity was not such as to disrupt the overall balance. For example, CO₂ emissions are a consequence of many natural processes, and one function of forests is to absorb them; anthropogenic CO₂ emissions would not be a problem if not for their size.

Most materials, moreover, are given back by man to Nature in forms, locations, times and natural media radically different from those they originally belonged to. For instance, matter embodied in plants in South America may be given back to the environment as sludge after being eaten by cattle imported to Europe, and oil extracted in Asia may end up partly as plastics in an African dumping site (some years later, maybe after being transformed in the body of an home appliance in Japan), and partly in the atmosphere as air emissions produced during transformation and transportation processes.

This difference of forms, location, etc. of the materials given back to Nature represents one main cause of imbalance of material flows into Nature, (i.e. of environmental disruption), and ultimately of the threats to human health and quality of life deriving from environmental pollution. Human induced material flows are often such that the natural bio-geo-chemical material cycles are distorted and the equilibrium of natural material cycles threatened. To name a few, macroscopic examples: the alteration of carbon cycles produces climate changes; the imbalance of nutrient cycles leads to eutrophication and acidification; the impediment to water absorption by land causes devastating flooding; the massive use of construction minerals results in landscape destruction and loss of biodiversity; the accumulation in Nature of metals – which naturally flow only in geological time dimensions – creates long-term risks for the health of humans and ecosystems (due to their toxic properties); the extraction of ores generates huge amounts of waste and landscape destruction, threatening biodiversity; waste and emissions from plastics and other synthetic substances, for which no natural cycle exists, accumulate in Nature, with toxic effects on all living creatures...

These basic facts are the reason why materials matter, and explain why the knowledge of the size (to be complemented with the quality) of the flows of materials activated by the economic system is of crucial importance. The knowledge of the causes and determinants of these flows is indispensable for any policy that wants to preserve or restore the quality of the natural environment and to ensure the ecological sustainability of economic activities while not just posing a halt on them.

1.2 Economy-wide MFA: basic concepts

In EW-MFA, the anthropic system is seen as a single living organism – composed by buildings, streets, railways, human bodies, machinery etc. – whose activities and growth need flows of materials that are extracted or harvested from the natural environment (inputs) and then refined, mixed, burned etc. through manufacture, use, reuse and recycling. These materials are either accumulated inside the organism (additions to stocks) or returned back to the natural environment in an altered form (outputs). Since matter is neither created nor destroyed by any (non nuclear) process, a material balance must hold between the physical mass of all inputs and outputs of the processes: this equivalence is at the very basis of the accounts which will be shown in detail in the next paragraphs, and is crucial for the significance of the indicators which are the object of the next chapter.

The two kinds of products supplied by EW-MFA – the accounts and the indicators derived thereof – serve different purposes. The accounts lead step-by-step to the construction of the economy's complete material balance, showing how the material resources that a country acquires from Nature and from abroad are used and where they end up. They also provide a framework for a coherent and comprehensive description of the particular flows that sustain the economy's metabolism, i.e. of the whole set of physical interactions between man and nature that affect the equilibrium of the latter. The indicators describe in a synthetic way the overall size of the material flows due to a country's activities, and provide information on how much the country at issue is contributing to changing the earth's surface as well as – if time series are available – on how this contribution is evolving.

The measurement of the overall dimension of the material throughput of an economy requires a common measurement unit for all the flows that are caused by man. This unit must be a physical

one, because it has to be comparable to the quantities expressing the size of the environment, which are necessarily of a physical nature: it must express energy, space or, as in our case, matter. The unit chosen is the earthly weight, which is in fixed proportion with the physical mass.

The system boundaries are defined in EW-MFA as follows: Inputs are all previously unmoved materials that are intentionally moved by the application of labour; Outputs to Nature are materials on whose location and composition man loses control; other Outputs are directed to the economic system itself and go into the Additions to Stocks; intermediate and non-durable products, including recycled materials, are not accounted for, as they are not entering nor leaving the anthropic system. Water and air are included into the accounts and indicators only to the extent that they are embodied in products; in the overall balance some air and water flows also appear as memorandum items (ancillary inputs or outputs of material transformation processes). Flows are classified as used or unused and as direct or indirect. Unused materials are the ones moved but not embodied in products (e.g. soil excavation); indirect has the same meaning as in I-O analysis and is referred to the material flows associated to Imports and Exports.

All inputs are transformed into outputs that eventually will be returned to nature, so that the size of the inputs of materials to the economic system, as can be derived from EW-MF accounts, also give indications concerning the future possible outputs, and therefore represent the overall potential pressures to the natural environment.

EW-MFA and the indicators derived thereof are the only items of official statistics that meet the call for general information on the evolution of man-Nature interactions, i.e. for easy-to-understand all-encompassing indicators that help to understand in a holistic perspective whether the situation is getting, in general, better or worse. They also have the exclusive feature of including an evaluation of indirect, life-cycle-wide effects of a country's production and/or consumption, that allows to connect the pursuit of ecological sustainability to the quest for a more equitable international distribution of the burdens and advantages of international exchange, which is also called for by important sectors of society.

As compared to other holistic approaches, EW-MFA has three specific valuable features: i) it is meant to describe actual phenomena, without recurring in principle to "what if" evaluations; ii) being a satellite account, it is based on the main national accounting concepts (SNA93 and SEC95), so that its physical aggregates can be put in relation to aggregates of the core set of national accounts; iii) the aggregation basis is unambiguous, i.e. only physical quantities that can be intrinsically measured in weight units are aggregated without the need of doubtful transformations.

All this, of course, coexists with the evident flaws of aggregate indices, whose real meaning is always made fuzzy by the possible infinite combinations of internal composition that can give rise to any single value. This is a common phenomenon with aggregate indicators; the antidote is the knowledge of the limits given by the indicators' definition and the attitude not to use them in isolation, but together with other indicators and details on composition that provide complementary information.

1.3 EW-MFA development and sustainability policy

There is a growing awareness among policy-makers about the importance for sustainability of containing the use of natural resources. The available information tells us that modern economic growth is characterised by a strong positive correlation between income and resource use. Keywords in policy documents are "decoupling economic growth from the use of resources"

“efficiency in the use of resources”, “resource productivity”, “closing the cycles” – i.e. the emphasis is on pursuing continued economic growth without a corresponding increase, or even with a decrease, of the burden imposed on the natural environment. Whether this is possible or not, is an open question. The issue of the size of human systems of material transformation, next to those of their quality and spatial distribution, is nevertheless a crucial one for long-term environmental concerns, i.e. for the quality of human life on this planet and its very sustainability.

G8 Environment Ministers (2003) recognised that “it is essential to improve resource productivity”, and in 2004, the Heads of State and Government of G8 countries endorsed a “Reduce, Reuse, Recycle” (3Rs) initiative proposed by Japan, which promotes a closed material cycle society.

Also the OECD environmental strategy for the first decade of the 21st century, adopted in 2001 by OECD Environment Ministers and the OECD council at ministerial level, includes the decoupling objective, to be pursued by addressing consumption and production patterns and more efficient resource use. In 1997 the High Level Advisory Group on the Environment to the Secretary General of the OECD had already stated that it was “time for the OECD to concentrate on increasing resource productivity with the same effectiveness it applied to labour productivity” (OECD, 1997).

In Europe, the issue of materials use management is strictly connected to waste generation. The European Commission and the European Parliament have given priority to the issue of resource productivity in the 6th Environmental Action Programme (EAP – CEC 2001a), by entitling one of the four priority areas “sustainable use of resources and management of waste”. At the Gothenburg Summit in June 2001 the European Council endorsed the Commission’s proposal for a Sustainable Development Strategy (CEC 2001b) which includes, as one of the long-term objectives, the decoupling of economic growth from the use of resources and the generation of waste.

In Italy, targets on material flows were included in the national strategy for sustainable development (Ministero dell’Ambiente e della Tutela del Territorio, 2002).

1.4 The current state of EW-MFA implementation

The knowledge of the quantities of materials directly moved and of the flows indirectly caused by a country’s activities represents a basic pre-requisite of every policy aimed at influencing the evolution of a complex society towards more sustainable ways of satisfying the needs of its population.

Work on the measurement of material flows has been promoted at the international level in connection to the need to “measure progress across all three dimensions of sustainable development, including decoupling of economic growth from environmental degradation” (OECD, 2001). EW-MFA is increasingly applied and used as a policy-support tool.

Activities in the field of EW-MFA and related indicators have been implemented in 23 out of the 41 countries that answered to a recent OECD survey, and are planned in a number of other countries. In Europe EW-MFA is promoted by Eurostat with the support of an ad hoc task force (including Italy, with Istat), that in 2000 prepared a Methodological Guide to harmonize concepts and definitions, including a set of accounts and tables (Eurostat, 2001); this Guide is the main reference for compilers, along with the United Nations handbook of national accounting Integrated Environmental and Economic Accounting 2003. In the last years the OECD has started a program for the promotion of MFA applications world-wide and the production of coherent and

comparable accounts and indicators. Italy is one of the countries that most actively support this initiative.

In this framework, Istat regularly produces EW-MFA aggregates that are consistent with Eurostat's Guide. Some of these aggregates are included in the "Report on the State of the Environment", published by the Ministry of the Environment.

The complete sequence of accounts proposed in Eurostat's Methodological Guide has the advantage of allowing to highlight the relationships between all the different flows and to check whether the data comply with the material balance principle. However, the compilation of a complete sequence is a quite demanding task, and all the data necessary are available only for recent years. Therefore, it has been decided to calculate a complete sequence every fifth year starting with 1997. Nevertheless, for some accounts – namely those for which data were more readily available or at least estimation was feasible – a time series has been calculated, in order to allow a diachronic analysis. Currently, Istat's realisations consist in a complete sequence of material flow accounts for 1997 (the accounts for 2002 are under construction), and a time series of material input and material consumption indicators for the years 1980-2001. These realisations are illustrated in the present (the sequence of accounts for 1997) and the next chapter (the indicators' time series).

2 MAIN RESULTS

2.1 Inputs and outputs - detailed classifications

The following tables show the results of the elaborations concerning the input and output sides of the Economy-wide Material Flow Account for 1997, making reference to the detailed classifications of inputs and outputs of Eurostat's methodological guide (Eurostat, 2001). This classification however has not been fully respected for the lack of the data or of their disaggregation, and has been in some cases suitably integrated with additional items¹⁵⁶.

These tables provide most of the data that have to be placed into the accounts, including those needed in order to derive, for the year 1997, the Economy-wide material-flow-based indicators dealt with in chapter 3 of the present volume. The tables, furthermore, provide some details which are not included in the accounts, e.g. breakdown of Imports and Exports by kind of material.

Table 1 - 1997 Material Inputs Italy (tons)

<i>Domestic extraction (used)</i>	615.454.615
<i>Fossil Fuels</i>	19.941.704
<i>Minerals</i>	408.461.764
Metal ores	39.397
Industrial Minerals	10.161.709
Construction Minerals	398.260.658
<i>Biomass</i>	187.051.147
from Agriculture	179.601.020
from Forestry	7.005.650
from Fishing	315.892
from Hunting	....
from other activities (Honey gathering, Mushrooms etc.)	128.585
<i>Imports</i>	289.397.845
<i>Raw Materials and Semi-manufactured products (intermediate uses)</i>	276.609.972
Biomasses	41.193.187
Fossil fuels	168.149.636
Minerals	64.783.075
Composite products	2.484.074
<i>Finished Products (final uses)</i>	12.787.873
Biomasses	7.825.649
Fossil fuels	440.634
Minerals	3.680.439
Composite products	841.151
<i>Packaging materials imported with products</i>	....
<i>Waste imported for final treatment and disposal</i>	....

(continues)

¹⁵⁶ In these tables, the use of "...." means that the quantity has not been determined. It should be noted that this case occurs only in relation to flows which are likely to be very small or which would be disaggregations of more general items that have been quantified.

Table 1 (continued) - 1997 Material Inputs Italy (tons)

Memorandum items for balancing	676.665.879
Oxygen for combustion	541.260.306
Oxygen for respiration	31.685.802
Nitrogen for emissions from combustion	661.531
Air for other industrial processes	....
Air for manure decomposition	106.554
Drinking water for livestock	102.951.686
Unused domestic Extraction	80.605.572
from mining and quarrying	16.715.068
from harvest	18.961.230
soil excavation and dredging	44.929.274
Indirect flows associated to imports	1.034.351.668
Raw material equivalents	....
Unused extraction associated	....

Table 2 - 1997 Material outputs Italy (tons)

Emissions and wastes	536.093.940
Emissions to air from combustion and industrial processes	468.856.115
CO2	456.789.725
SO2	1.073.904
NOx as NO2	1.725.749
VOC (NMVOC excl. solvents and CH4 excl. CH4 from landfills)	2.284.477
CO	6.384.638
PM - Particulate matter (incl. dust)	187.250
N2O excl. use of products and N from agriculture and wastes	68.807
NH3 excl. N from fertilisers	332.645
CFCs and Halons	8.920
Waste landfilled	55.919.592
from private households (and household-type waste from industry and commerce)	21.257.555
from industry and commerce (production waste and construction/demolition waste)	26.523.143
from waste and waste water management activities	8.138.894
Emissions to water	11.318.233
Nitrogen (N)	116.908
Phosphorus (P)	12.140
Other substances and (organic) materials	11.189.185
Dumping of materials at sea	....
Dissipative use of products and dissipative losses	144.125.446
Dissipative use of products	142.561.714
Dissipative use on agricultural land	140.690.299
Mineral fertilisers	4.473.570
Farmyard manure	133.903.306
Sewage sludge	270.760
Compost	259.423
Other fertilisers	648.300
Pesticides	167.090
Seeds	967.850
Dissipative use on roads (thawing and grit materials)	....
Dissipative use of other kind (incl. solvents)	1.871.415
Dissipative losses	1.563.732
Abrasion (tyres, etc.)	....
Accidents with chemicals	....
Leakages (natural gas, etc.)	1.563.732
Erosion and corrosion of infrastructures (roads, etc.)	....
Exports	111.037.449
Biomasses	27.570.174
Fossil fuels	31.018.475
Minerals	46.316.062
Composite products	6.132.739
Memorandum items for balancing	330.711.430
Water vapour from combustion (H2O)	249.425.342
From water (H2O) contents of fuels	3.162.518
From hydrogen (H) contents of fuels	246.262.824
Water evaporation from products	....
Water content of biomass	....
Water content of other materials	....
Respiration of humans and livestock	81.286.088
CO2	40.091.406
Water vapour (H2O)	41.194.682
Disposal of unused domestic extraction	80.605.572
from mining/quarrying	16.715.068
from biomass harvest (in dry weight)	18.961.230
soil excavation	44.929.274
Indirect flows associated to exports	344.407.274
Raw material equivalents	....
Unused extraction associated	....

2.2 The sequence of accounts

The first three accounts refer to direct flows:

1) DMI ACCOUNT	Resources	Uses
Domestic Extraction	615.454.615	
<i>Fossil Fuels</i>	<i>19.941.704</i>	
<i>Minerals</i>	<i>408.461.764</i>	
<i>Biomass</i>	<i>187.051.147</i>	
Imports	289.397.845	
DMI - direct material input		904.852.460
2) DMC ACCOUNT	Resources	Uses
Direct material input	904.852.460	
Exports		111.037.449
DMC - domestic material consumption		793.815.011
3) PTB ACCOUNT	Resources	Uses
Imports	289.397.845	
Exports		111.037.449
PTB - physical trade balance		178.360.396

The DMI account shows the total quantity of matter used in the Italian economic system, and the contributions of the various sources to this quantity. The main source is the domestic environment, but also the rest of the world plays a very important role, providing almost one third of the total. Domestic extraction is dominated by minerals, and in particular, as table 1 shows, by construction minerals.

The DMC account shows that in 1997 almost 794 million tons of materials remained in Italy, in one form or another, while around 12,3% of all materials introduced in the Italian economy ended up in the rest of the world as exported products.

The PTB account shows the imbalance between the material Imports and Exports of the Italian economy, confirming – together with the distinction of Imports between intermediate and final products (see table 1) – the characterisation of the Italian economy as one importing raw materials and fossil fuels and transforming them into final products for the domestic and the foreign market.

The fourth account is devoted to Domestic Processed Output. It introduces the output side, considering the outputs of production and consumption processes to nature only, and not those directed to the technosphere itself.

4) DPO ACCOUNT	Resources	Uses
Emissions and Wastes	536.093.940	
<i>Emissions to air</i>	<i>468.856.115</i>	
<i>Waste Landfilled</i>	<i>55.919.592</i>	
<i>Emissions to water</i>	<i>11.318.233</i>	
Dissipative use of products and losses	144.125.446	
DPO - domestic processed output		680.219.386

As Eurostat's methodological guide points out (§§ 3.17 and 3.18), it is doubtful whether all wastes landfilled can really be considered as outputs to nature, as landfills are often controlled, so that the processes that take place in them are to a certain extent under human control. Controlled landfills can be assimilated to a stock of the technosphere, like buildings: it is when they release pollutants into the environment – i.e. when a material flow to the surrounding nature takes place – that they exert environmental pressures different from that of the occupation of space, which is a pressure common to all built-up stocks of the economy. However, we included all landfilled waste in the DPO for the following reasons: a) it would have been difficult to assess how much of the waste is disposed of in controlled landfills and how much in non-controlled ones; b) not all flows from landfills to the surrounding environment are known (emissions are, but percolate isn't); c) comparability to the existing calculations carried out for other countries (see Matthews *et al.* 2000), is thus maximised.

As we have pointed out, outputs of production to the technosphere are not considered in the previous accounts. Actually, they constitute a special kind of outputs, which represent additions to produced stocks. Net Additions to Stocks is a very important indicator, as it shows how much the economic organism physically grows year by year. The physical growth of an artificial organism like the technosphere in a limited environment like a country's territory, inevitably causes environmental problems: water cycles are changed by construction materials' excavation and by the sealing of surfaces; biodiversity is endangered by the presence of roads and other linear structures; the wearing out of structures releases pollutants into the various environmental media. Moreover, Stock Accumulation means that natural resources are permanently transformed into a potential for future growth of current flows: *ceteris paribus*, the larger the organism, the larger the current flows necessary to sustain it.

In the present study we have computed Net Accumulation of Stocks directly; it is however interesting to consider an estimate which is by definition consistent with that of the other flows, given by the calculation of NAS as balancing item.

5a) NAS as balancing item ACCOUNT	Resources	Uses
DMC - domestic material consumption	793.815.011	
Emissions and Wastes		536.093.940
<i>Emissions to air</i>		<i>468.856.115</i>
<i>Waste Landfilled</i>		<i>55.919.592</i>
<i>Emissions to water</i>		<i>11.318.233</i>
Dissipative use of products and losses		144.125.446
Memorandum items for balancing	676.665.879	330.711.430
NAS - net addition to stocks		459.550.074

Account 5a also gives us the possibility to introduce the memorandum items, whose consideration is necessary in order to have a conceptually consistent accounting framework and a potentially exact balance: the matter embodied in the processed outputs comes not only from materials embodied in inputs directly consumed, but also from additional ancillary air and water inputs that have to be taken into account on the resources side; on the use side, water vapour coming from oxidation of hydrogen contained in fuels has also to be accounted for. As it can be seen, they are all but irrelevant.

As said above NAS has also been computed directly evaluating its components:

5b) NAS directly compiled

Transport infrastructure and Buildings	289.490.966
<i>Gross additions</i>	308.400.522
<i>Demolition</i>	18.909.556
Machinery	12.711.297
<i>Gross additions</i>	15.011.297
<i>Discard</i>	2.300.000
Other durables	8.090.256
<i>Gross additions</i>	8.636.564
<i>Discard</i>	546.308
Inventory changes	157.133.355
Live animals	-818.875
Total NAS - net addition to stocks	466.606.999

The results are not very far from the ones to be expected on the basis of account 5a. The quantity of materials accumulated in the Italian economy in 1997 is a huge one, and the lower of the two estimates amounts to 57,8% of DMC, i.e. of all processed inputs that remain in the Italian territory. Account 5b also shows, however, that in 1997 an important part of the outputs have been accumulated in inventories, that is materials that remained available for production and consumption uses of subsequent years.

The Direct Material Flow Balance account summarises all previous accounts, and the fact that its items are estimated almost all independently from one another (in particular, no item is determined residually), gives rise to a “Statistical discrepancy” that is necessarily equal to the difference between NAS directly compiled and NAS derived as balancing item. This discrepancy provides the balance of all errors and omissions, which is around 7 million tons. In absolute terms this may not be a small quantity, but it definitely is in relation to the quantities involved in the accounts (around 1,5% of NAS directly compiled). Of course, this discrepancy might be a sum of errors that partially compensate each other; nevertheless, as far as what an economy-wide MFA can highlight, the result obtained for Italy can be considered quite satisfactory, as the coverage of flows is almost complete and their overall consistency verified.

7) Direct material flow balance	Resources	Uses
Domestic Extraction	615.454.615	
<i>Fossil Fuels</i>	<i>19.941.704</i>	
<i>Minerals</i>	<i>408.461.764</i>	
<i>Biomass</i>	<i>187.051.147</i>	
Imports	289.397.845	
Emissions and Wastes		536.093.940
<i>Emissions to air</i>		<i>468.856.115</i>
<i>Waste Landfilled</i>		<i>55.919.592</i>
<i>Emissions to water</i>		<i>11.318.233</i>
Dissipative use of products and losses		144.125.446
Exports		111.037.449
Net addition to stocks		466.606.999
Memorandum items for balancing	676.665.879	330.711.430
<i>Statistical discrepancy</i>		<i>-7.056.925</i>
TOTAL	1.581.518.339	1.581.518.339

Surprisingly enough the discrepancy is due to an excess of the uses on the resources, while a-priori considerations on the quality of the data would probably suggest that those on outputs to the environment are less complete than those on inputs. However, it must also be pointed out that the direct estimate of NAS is incomplete (it was not possible to estimate the quantity of dismissed machines), and its “Inventory changes” item seems a bit too high. On the whole, the estimate of total NAS as balancing item appears to be the more reliable of the two (see § 3.8 below), while account 5b provides important insights on its composition.

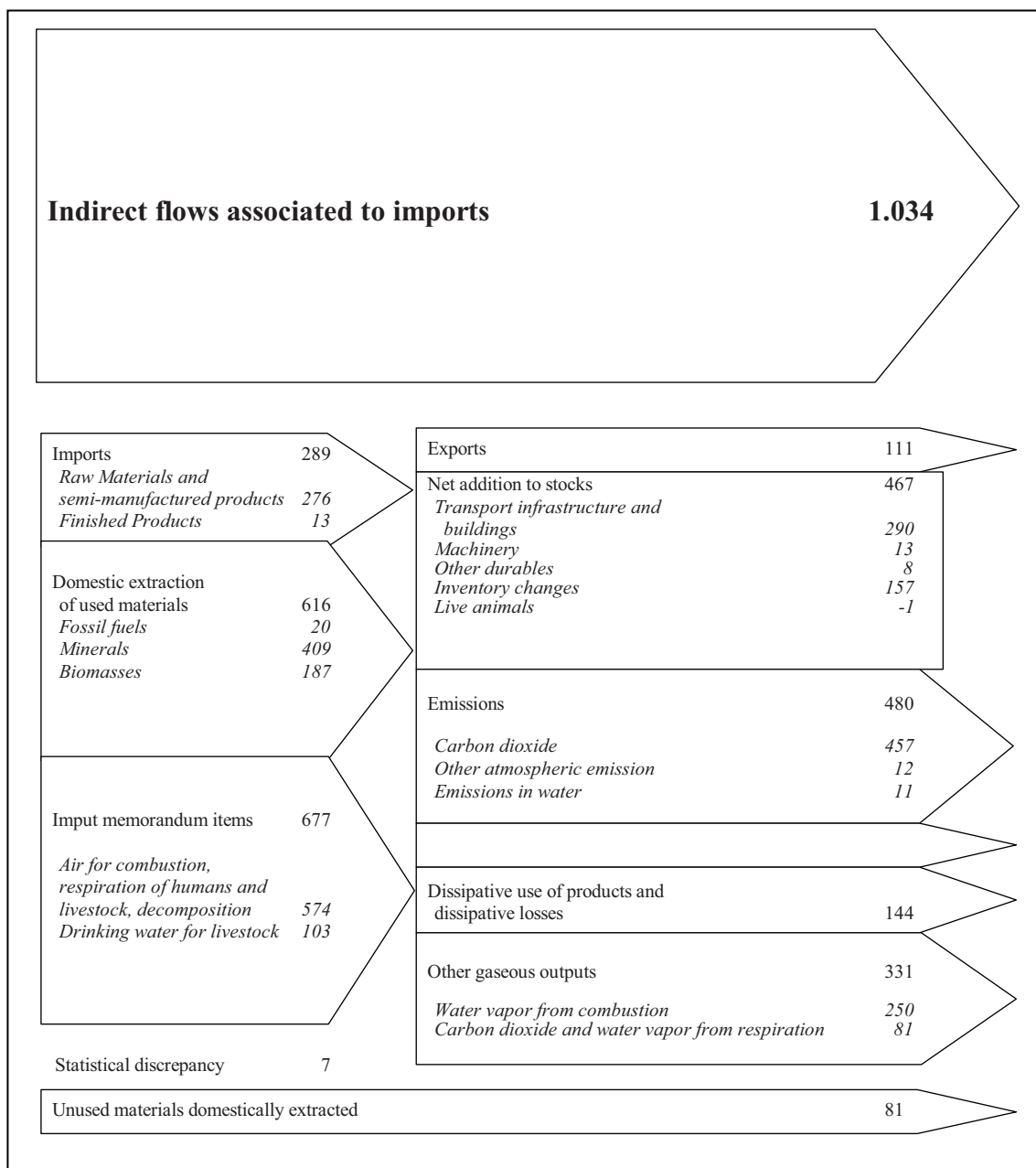
The last four accounts give the most comprehensive EW-MFA indicators (account 9 of the Methodological Guide has been modified in order to obtain the Physical Trade Balance including Indirect Flows rather than the Indirect Flows Trade Balance). These include estimates of two kinds of items that allow to consider the contribution of the Italian economy to material flows in a wider sense and in a global dimension. These items are “unused domestic extraction” and “indirect flows associated to imports/exports”. Both comprise flows that are usually neglected though environmentally relevant: in the first case because they are economically not valuable, in the second because they are not immediately due to the activities to which they are associated, but only caused by them, i.e. are required for the production of imports/exports though not embodied in them. The inclusion of these measures strongly characterises EW-MFA and allows to calculate a virtual consumption indicator – Total Material Consumption – telling of much matter has been moved, altogether, in the world, in order to satisfy all and only the Italian final demand for products.

	Resources	Uses
8) Unused extraction account		
Unused domestic extraction	80.605.572	80.605.572
<i>from mining/quarrying</i>	<i>16.715.068</i>	<i>16.715.068</i>
<i>from biomass harvest</i>	<i>18.961.230</i>	<i>18.961.230</i>
<i>soil excavation</i>	<i>44.929.274</i>	<i>44.929.274</i>
9) Physical Trade Balance including Indirect Flows	Resources	Uses
Imports	289.397.845	
Indirect flows associated to imports	1.034.351.668	
Exports		111.037.449
Indirect flows associated to exports		344.407.274
<i>Physical Trade Balance including Indirect Flows</i>		<i>868.304.790</i>
10) TMR ACCOUNT	Resources	Uses
Domestic Extraction	615.454.615	
Imports	289.397.845	
Unused domestic extraction	80.605.572	
<i>from mining/quarrying</i>	<i>16.715.068</i>	
<i>from biomass harvest</i>	<i>18.961.230</i>	
<i>soil excavation</i>	<i>44.929.274</i>	
Indirect flows associated to imports	1.034.351.668	
<i>TMR - Total Material Requirement</i>		<i>2.019.809.700</i>
11) TMC ACCOUNT	Resources	Uses
TMR - Total Material Requirement	2.019.809.700	
Exports		111.037.449
Indirect flows associated to exports		344.407.274
<i>TMC - Total Material Consumption</i>		<i>1.564.364.977</i>

2.3 A summary picture

The following picture provides an image of the material flows activated by the Italian economy in 1997, highlighting the relative importance of the different items.

Figura 1 - Material Balance, Italy 1997 (million tons)



3 DATA SOURCES AND METHODS

An important specific feature of the construction of a balance of the materials that flow through the whole economy is that it requires the integration of several different sources, which often do not fully respond to the needs of economy-wide MFA, as the flows are measured at boundaries different from the one between the whole economy and nature as defined in the Methodological Guide. In these cases, some processing of the information provided by basic statistics usually leads to better approximations to the concepts of MFA, though not always ensuring complete consistency.

This is the case especially on the side of outputs. In some instances, it was necessary, in order to keep the conceptual consistency of the balance, to review the data on inputs, for instance in order to add to the used materials the quantities of some waste arising from ancillary flows – initially considered as unused materials – that has been discovered to be actually recovered and used.

Another important fact, strictly connected to the previous one, is that, in order to construct the balance, it is often necessary to single out all of the outputs to nature and/or the products that derive from a specific input flow and connect the former to the latter; or, vice-versa, starting from some specific output, it is sometimes necessary to determine the set of inputs from which it stems. This is useful for instance in order to decide which part of a specific item of the processed output is actually a final destination of used inputs and which part corresponds instead to ancillary flows (unused ones, or ones that must be accounted for as balancing items). This is the case, for instance, of wastes, which are reported in waste statistics without explicit distinctions between used and unused materials, and of air emissions, which contain the ancillary flows of atmospheric elements necessary to combustion and decomposition processes. This has in several cases led to the formulation of specialised sub-balances, by macro-sectors and/or kind of material (biomass, fuels, minerals). These sub-balances can be seen as a first working approximation to an aggregate input-output table, as obviously some items serve as inputs for a specific sub-balance and as outputs for another one at the same time. Though these sector and type-of-material sub-balances are not discussed in detail in the present chapter, their tentative formulation is an important part of the results of the work presented here, as they constitute a promising starting point for the continuation of research on the flowing of materials through the economy.

3.1 Used Domestic Extraction

3.1.1 Fossil Fuels

Data on fossil fuel extraction are published yearly in the “Annuario Statistico Italiano”; these data have been integrated with Ministry of Industry data for Coal and GPL.

Methane is reported in official statistics in terms of cubic meters. This has been transformed into weight units using a factor of 0,705 kg per cubic meter, supplied by the Italian Environment and Territory Protection Agency (APAT, formerly ANPA).

As for peat, the data are incomplete as they come from the results of a joint Istat-Ministry of Industry survey on the production of quarries and peat fields, which covered in 1997 not more than half of the Italian provinces. The extracted quantities reported for this material are very small, and it is clear that even with complete data, the total of domestic fossil fuel extraction would not change much.

3.1.2 Minerals

3.1.2.1 Metal ores

Also for Metal ores, the sources are Istat's surveys' results and the Ministry of Industry. The former source has been privileged in case of discrepancy between the data supplied by the two.

3.1.2.2 Industrial minerals

The sources are the same as for metal ores, but for marine salt, for which data have been provided by the Ministry of Finance, State Monopoles.

3.1.2.3 Construction minerals¹⁵⁷

The most complete source of information on quarries' production is the PRODCOM survey. However, this does not cover extraction sites with less than three employees, and therefore its results have been adapted on the basis of the ratio between the total value of sales given by the PRODCOM and the corresponding value estimated in the National Accounts, by 5-digit ATECO code.

As far as reused soil from excavation is concerned, we used information supplied by the waste statistics published by the Italian Environment Protection Agency (ANPA, now APAT). According to our calculations, based on the data provided by this source, the percentage of reused waste soil resulted to be 28,4%. The total quantity of excavated soil, on which the estimate of the reused quantity is based, was in turn derived by a procedure which is described in the "unused flows" part of this chapter (see § 3.2.4).

3.1.3 Biomass

3.1.3.1 from Agriculture

The data concerning this item come from Istat's surveys on agricultural production; these data can be found in publications such as the "Annuario delle statistiche dell'agricoltura", which supply data that are complete and available with a great richness of detail.

Among the used materials from agriculture are included the leaves of sugar root and the straw from cereals cultivations (namely wheat, rye, barley, oat, rice), which are used mainly in animal production, as fodder or as bed for the animals. Like most other sub-product biomasses, these flows have been calculated by the application of technical coefficients to harvested plant production. These coefficients are discussed in § 3.2.3, along with the others, concerning biomasses that remain unused.

3.1.3.2 from Forestry

The source for forestry production data are Istat surveys' results, published yearly in the volumes "Annuario delle statistiche forestali", "Coltivazioni agricole e forestali" and "Annuario delle statistiche dell'agricoltura". Data comprise the main non-wood products gathered in the forests as well as the timber felled. The latter is expressed in volume units, and has been transformed in weight using a coefficient of 0.7 and 0.8 tons per cubic meter for resinous and broad-leaved species respectively.

¹⁵⁷ All products of NACE groups 14.1 and 14.2 are included under the present heading, irrespective of their actual final destination, which might in some cases be different from "constructions" in a strict sense.

3.1.3.3 *from Fishing*

Also for fishing the source is Istat's surveys, whose results are published in the "Annuario Statistico Italiano".

3.1.3.4 *from Hunting*

No data are available on this component of domestic extraction, which however is quantitatively irrelevant in Italy, nor it seems possible to produce an estimate that be something more of a pure guess.

3.1.3.5 *from other activities (Honey gathering, Mushrooms etc.)*

Mushrooms and other forest non-wood products to be reported under this heading are included in forestry statistics. Also honey production has been included here.

3.2 Unused Domestic Extraction

3.2.1 *General remarks*

The items included in the Unused Extraction account are among the most uncertain and difficult to calculate. It has been possible, however, to carry out estimates which give a clear idea of the order of magnitude of some environmentally relevant flows, usually neglected by statistics.

While plenty of statistical surveys, as well as reports by companies and studies in the economic literature are readily available that allow to determine with a certain precision the useful production realised in the different fields of economic activity, it is very difficult to find information about the «materials extracted or otherwise moved on a nation's territory on purpose and by means of technology which are not fit or intended for use»¹⁵⁸. The reason is probably that these materials are wastes, and due to the lack of economic importance, knowing their amount has not been until recently of great interest. Nevertheless in recent years the environmental relevance of these flows, as well as their impact on the economic system, i.e. the costs connected to their movement and disposal, have become more and more clear; as a consequence, new sources of information have been made available.

The work on the flows included in the Domestic Unused Extraction item has been carried out in two phases. In the first one, a base estimate has been produced by using default technical coefficients which can be found in the literature, and in particular, the minimum values among those present in the technical report "Total Material Requirement of European Union" published by European Environment Agency¹⁵⁹; in the second one, in order to replace these "default" estimates by more accurate evaluations, studies have been carried out on the most important flows of unused materials, which have been recalculated on the basis of the specific knowledge thus acquired about the Italian case.

3.2.2 *Unused materials from mining and quarrying*

The present paragraph describes how we determined the coefficients used to express the amount of unused materials in relation to the domestic material extractions from mining and quarrying activities, and applied to available production data.

In general, whenever such coefficients could be constructed on the basis of evidence from the Italian case, they have been calculated as the ratio between the quantities of wastes arising from

¹⁵⁸ Definition from Eurostat's methodological guide (Eurostat, 2001), § 3.36.

¹⁵⁹ Bringezu and Schetz (2001a).

specific productions, reported in surveys or company reports, and the total physical quantity of used production from the corresponding set of economic activities.

When this was not possible, figures found in the literature have been adopted. Coefficients are indeed available from other case studies at the European or world level, but it is clear that the results obtained by applying the same coefficient to different countries could be misleading as in each country there are different geological conditions which affect the ease or the difficulty in carrying out minerals' extraction. The use of common coefficients therefore could bias the results of the analysis.

In determining specific coefficients for the Italian case, the use of the classifications of economic activities, of products and of wastes, has been determinant. In fact it is only by making constant reference to these classifications that it has been possible to establish correct relationships between the available data and thus to get to the coefficients' estimates.

In particular, in order to get to the estimate of the coefficients regarding the unused materials from mining and quarrying, the following classifications have been taken into account:

- NACE Rev. 1, the statistical classification of economic activities in the European Community¹⁶⁰;
- 1997 PRODCOM list, the European classification of industrial products¹⁶¹;
- EWC, the European Waste Catalogue¹⁶².

As the objective of this part of the study relates to unused materials from mining and quarrying, it is necessary to get deeper into the analysis of these categories. In this sense the NACE classification helps with the detail it provides for each activity included in it.

Two main categories of activity that interest here are included in the NACE Rev. 1:

- Energetic materials extraction, which correspond to the subsection "CA - Mining and quarrying of energy producing materials" of the NACE Rev. 1;
- Non-energetic materials extraction, which correspond to the subsection "CB - Mining and quarrying, except of energy producing materials".

For each of these subsections, unused flows have partly been estimated by using specific national coefficients, calculated ad-hoc, partly using the default coefficients found in the literature.

As far as the extraction of energetic minerals is concerned, specific coefficients based on data concerning the domestic Italian territory have been calculated for oil and natural gas. The economic activities for which it has been possible to calculate new coefficients are therefore those included in the division "11 - Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying" of the NACE Rev.

¹⁶⁰ NACE Rev. 1 is a 4-digit activity classification which was drawn up in 1990. Cfr. Eurostat (1996) and Council Regulation (EEC) No 3037/90 of 9 October 1990 (OJ No L 293, 24.10.1990, p. 1) on the statistical classification of economic activities in the European Community and Council Regulation (EEC) No 761/93 of 24 March 1993 (OJ No L 83, 3.4.1993, p. 1), amending Council Regulation (EEC) No 3037/90.

¹⁶¹ The title comes from the French "PRODUCTION COMMUNAUTAIRE". PRODCOM is the title of the European Community production statistics for Mining and Quarrying, Manufacturing, and Electricity, Gas and Water Supply. These sectors of production correspond to the specific sections of the NACE Rev. 1 (Section C, D and E). The PRODCOM list does not, however, include the product of coal and lignite mining, peat extraction of crude petroleum and natural gas, manufacture of coke and refined petroleum products, processing nuclear fuel, and electricity, gas and water supply (Divisions 10, 11, 23, 40 and 41 of NACE Rev. 1; it does not also include the products of Division 37 of NACE Rev. 1 (Recycling). The basis of survey is Council Regulation (EEC) No 3924/91 on the establishment of a Community survey of industrial production (PRODCOM Regulation, OJ No L 374, 31.12.1991, p.1). Cfr. Eurostat (1997).

¹⁶² European Union Commission Decision 2001/573/EC 23 July 2001.

1. The data used, concerning the absolute quantities of wastes arising from drilling for oil and natural gas extraction, have been published by ENI – Exploration & Production Division¹⁶³. These data have been used as basic data for the determination of the coefficients for the assessment of unused materials arising from these activities. The ratio between the absolute quantities of wastes and the extracted quantities of oil and natural gas have been computed.

For the other energetic materials that have been extracted from the domestic environment, such as coal, lignite and peat, i.e. for the activities included in the division of the NACE Rev. 1 “10 - Mining of coal and lignite; extraction of peat”, no data were readily available to estimate a specific coefficient and therefore the coefficients available in the literature have been provisionally adopted. Finally, no extraction of the materials included in the division “Mining of uranium and thorium ores” takes place in Italy, and therefore no correlated wastes had to be accounted for.

As far as the extraction of non-energetic materials is concerned, the analysis for the construction of specific coefficients has started from the data about wastes from Italian companies as declared in the MUD (“Modello Unico di Dichiarazione in materia ambientale”), a form that has to be compiled by all the companies which produce special wastes in their activity, in order to declare the amount of those wastes¹⁶⁴. Data reported in the MUD are classified according to the European Waste Catalogue (EWC).

In the present work, the data that have been taken into account from the MUD are those which are identified by the six digit codes “01xxxx”, corresponding to “Waste resulting from exploration, mining, dressing and further treatment of minerals and quarrying” with a specific focus on the categories “010102 - Wastes from non-metalliferous excavation”, “010408 - Waste gravel and crushed rocks” (other than containing dangerous substances from chemical processing) and “010409 - Waste sand and clays”. The basic data referring to the generation of these kinds of wastes by individual companies have been provided by the Italian Environment and Territory Protection Agency (APAT).

After the relevant data about wastes have been identified, another selection has been carried out in order to identify the activities of interest. Indeed, waste of the “01” kind are generated by several activities (in particular, by the working of minerals, i.e. divisions “26 - Manufacture of other non-metallic mineral products” and “27 - Manufacture of basic metals” of the NACE Rev. 1). However, only extraction activities, i.e. divisions “13 - Mining of metal ores” and “14 - Other mining and quarrying” of the NACE Rev. 1, had to be taken into account. Data about production of non-energetic materials by individual Italian companies belonging to the divisions 13 and 14 of the NACE Rev. 1 have been provided by the “PRODCOM” survey carried out by Istat.

The data from PRODCOM and MUD have then been linked by using the fiscal code, which was an information required in both surveys (though not always present in the records), thus selecting the companies that were present in both data sets. Wastes’ quantities and corresponding production quantities from these companies have finally been compared, in order to get the searched coefficients.

The available data unfortunately did not allow to make an exact calculation for all the activities included in the NACE Rev. 1 subsection “CB - Mining and quarrying, except of energy producing materials”. Actually it has been possible to determine the coefficients for two groups of activities only:

¹⁶³ Cfr. Eni - Exploration & Production Division (2001).

¹⁶⁴ Cfr. UNIONCAMERE (1999).

- 14.1 - Quarrying of stone;
- 14.2 - Quarrying of sand and clay.

Moreover, for each of these two groups of activities, whose products consist in a variety of materials, a single coefficient has been estimated, that covers all the activities comprised in them. One reason for this was the fact that even if the production reported by the PRODCOM survey is classified referring to single categories of products for each company included in the survey, in the MUD wastes are aggregated by (company and) type of waste, and not by product that generates it. It is impossible therefore to establish a direct link between the production of a single good and the wastes arising exactly from that production, since a single company often produces several different minerals. The result is that the coefficients which could be obtained with this method refer to groups of activities and products, not to single products. For each group of economic activity the coefficients calculated can be therefore considered as weighted averages of the waste intensities of several different mineral extraction activities.

For other materials such as metal minerals, i.e. for the activities included in the division “13 - Mining of metal ores” of the NACE Rev. 1, the available data on wastes that could be linked to PRODCOM data were not enough to enable a similar estimation procedure, so that coefficients developed for other countries have been provisionally adopted.

3.2.3 *Unused materials from biomass harvest*

The flows included in this item originate from agricultural, forestry and fishing activities, and have been accounted for in dry weight (with the exception of fishing residues, for which the only available source of information was the estimate reported in Bringezu and Schuetz, 2001a and b). As far as agriculture is concerned, the unused materials extracted consist in the parts of plants which are not harvested, but remain on the ground and are ploughed back into the soil, in order to restore its organic material endowment, which is directly correlated to agronomic productivity. Forestry unused flows consist in minor branches and leaves remaining on the ground after the trees have been felled.

No data on actual weight of unused biomass by-product flows are directly available. It was therefore necessary to devise an estimation procedure. This is the case also for the by-products of agricultural production which are used, on which no data are available, included in the items dealt with in § 3.1.3.1.

For both agriculture and forestry activities, the estimate has followed a two-steps procedure, with the use of two groups of coefficients, reported in two columns of table 3. The coefficients of the first group transform in dry weight the used materials removed (the quantities included in DMI) which are reported in harvest statistics in terms of total weight at the time of harvest; the ones in second group allow to calculate, starting from harvested products' dry matter thus calculated, the connected flows of by-product materials, again in terms of dry matter. The choice of accounting these flows in terms of dry matter was imposed by the fact that the data available in literature usually concern dry matter contents of used parts of the plants and by-products when they are ready to be harvested. In many cases it was possible to derive from these data the ratios which have been applied to account for by-product materials starting from used ones. Transforming dry weight of by-product materials into actual weight was not considered a viable option mostly for the lack of appropriate parameters and because of the degree of uncertainty that this operation would have introduced in the procedure. Also, a direct estimation of actual values (weight) of by-product material flows resulted not feasible, again for the lack of an adequate number of statistics on pertinent parameters. For the first group a specific coefficient has been

determined for each product/crop; the estimation of these coefficients has been relatively easy; indeed, data on water content of agricultural products at the time of harvest are calculated on the basis of repeated laboratory tests and released by various institutions (universities, research centres etc.). The coefficients of the first group are specified in terms of dry matter percentage and each one represents a “reasonable” average resulting from series of different data issued by different sources (publications, technical, agronomic or nutritional handbooks). Despite of the high number of data sources (around 25 different ones were used), it hasn't been difficult to manage a synthesis since values from different sources resulted not very different from each other: in this case the values adopted mostly represent a mode of dry matter content in agricultural products. As for dry matter content of fruits, the coefficients adopted have been designed to account for the dry matter content of the sole edible part of the fruits when matured and distributed. For wood felled and removed from forests and outside forests we adopted the coefficients used by UN and FAO to account for forests' bio-masses, as reported in the Global Forest Resources Assessment 2000. These coefficients express wood bio-mass in terms of dry matter per cubic meter; when applied to wood removals statistics they allow to take into account wood bio-mass contained in the trunk and in the major branches of the tree. Distinct coefficients have been adopted for coniferous and non-coniferous species.

The second group of coefficients, which give dry matter ratios between agronomic residue and agricultural product (e.g. straw/grain), has been designed in a way that allows to apply them (product by product) to the detailed results of the calculations based on the first group of coefficients. The estimation of this second group of coefficients relies on values from technical manuals: in some cases these values, taken as basic reference, have been weighted with data released by various institutions (universities, research centres etc.) and relating to agronomic productivity in the major national agricultural areas: in this way the coefficients can take into account also the existing differences between the major cultivars adopted in the different climatic regions of Italy (e.g. for high/low size cereal cultivars). It was thus possible in these cases to quantify the residues to be accounted for each unit of useful product, so these values mostly represent a weighted average value of the discarded by-products generated by all crops included in the same product category. The coefficients relating to fruit trees' residues take into account only the residues resulting from harvesting operation, since in this case the part of the plant which has not been harvested is not physically separated from the soil and therefore does not represent a crop residue but a productive capacity for the year to come. The coefficients relating to the ratio “residues/wood removals” have been estimated on the basis of losses' modal value of the years between 1991 and 2000 and have been issued distinctly for coniferous and non-coniferous species. They result from the time series of residues provided by Istat's survey on wood removals. These coefficients allow, when applied to dry weights of removed wood, to account for processing losses resulting from felling and removing operations. As far as non-wood products of forests are concerned, the coefficients estimated reflect the differences in the biological characteristics of each product gathered (i.e. fruit, as for strawberries, or whole plant, as for mushrooms) and in the type of plant, ligneous or herbaceous: also in this case the sources used are technical books and manuals.

Finally (last column of the table), it has been specified the destination assigned in the present study to each flow of agronomic and forestry by-products. Cereals by-products destinations have been assigned according to information used in monetary national accounting.

Table 3 - Coefficients for the estimation of agriculture and forestry by-products and by-products classification in Italian EW-MFA

	% dry matter in agricultural products	By-product /product ratio	Classification of the material flow as used/unused
1 - AGRICULTURE			
<i>Crops (excl. Flowers and ornamental plants)</i>			
a) Cereals			
Wheat	0,89	1,50	Used
rye	0,89	1,86	Used
barley	0,84	1,50	Used
oat	0,89	1,22	Used
rice	0,75	1,63	Used
Grain maize	0,78	1,86	unused
Grain sorgum	0,78	2,13	unused
Triticale	0,88	2,23	unused
b) Legumes			
broad bean	0,77	1,22	unused
bean	0,78	1,50	unused
green pea	0,78	1,86	unused
cick pea	0,86	1,86	unused
lentil	0,80	2,33	unused
lupins	0,80	2,33	unused
vetches	0,80	2,33	unused
others dried pulses	0,80	1,86	unused
c) Tuberous plants			
potato	0,25	1,22	unused
batata	0,25	1,22	unused
d) Vegetables			
<i>d.1) in field</i>			
fresh broad bean	0,33	0,67	unused
fresh bean	0,38	1,00	unused
fresh green pea	0,22	1,00	unused
onion	0,19	0,05	unused
garlic	0,25	-	-
beet root	0,24	1,00	unused
carrot	0,16	0,11	unused
onion	0,16	0,11	unused
leeks	0,18	0,11	unused
turnip	0,20	0,25	unused
radish	0,22	0,05	unused
asparagus	0,10	0,11	unused
chard	0,23	-	-
little turnip	0,20	0,25	unused
artichoke	0,16	-	-
fennel	0,18	0,11	unused
cardoan	0,18	0,11	unused
cabbage	0,09	0,11	unused
savoy	0,09	0,11	unused
Brussels sprouts	0,09	0,11	unused
other brassica	0,09	0,11	unused
cauliflower	0,09	0,11	unused
endive	0,07	-	unused
lettuce	0,06	-	unused
chicory	0,05	-	unused

(continues)

Table 3 (continued) - Coefficients for the estimation of agriculture and forestry by-products and by-products classification in Italian EW-MFA

	% dry matter in agricultural products	By-product /product ratio	Classification of the material flow as used/unused
parsley	0,09	-	unused
celeriac and celery	0,12	-	unused
spinach	0,10	-	unused
cucumber	0,12	0,30	unused
gherkins	0,11	0,25	unused
melon	0,11	0,15	unused
watermelon	0,06	0,11	unused
strawberry	0,07	0,49	unused
egg-plants	0,09	0,49	unused
red pepper	0,08	0,49	unused
tomato	0,06	0,43	unused
courgettes	0,09	0,30	unused
mushrooms	0,22	-	unused
<i>d.2) vegetables in green house</i>			
fresh bean	0,38	1,00	unused
fresh green pea	0,22	1,00	unused
beet root	0,20	1,00	unused
carrot	0,16	0,11	unused
radish	0,22	0,05	unused
asparagus	0,10	-	-
basil	0,09	-	-
chard	0,23	-	-
fennel	0,11	0,11	unused
endive	0,07	-	-
lettuce	0,06	-	-
chicory	0,05	-	-
parsley	0,09	-	-
celeriac and celery	0,12	-	-
spinach	0,10	-	-
valerian	0,09	-	-
gherkins	0,18	0,30	unused
watermelon	0,09	0,13	unused
strawberry	0,06	0,11	unused
egg-plants	0,09	0,49	unused
red pepper	0,08	0,49	unused
tomato	0,06	0,49	unused
melon	0,11	0,15	unused
courgettes	0,09	0,30	unused
<i>h) industrial crops</i>			
sugar beet	0,24	0,30	used
tobacco	0,20	0,18	unused
oil flax	0,85	-	-
flax	0,25	-	-
cotton	0,80	4,00	unused
hemp	0,30	-	-
oil hemp	0,85	-	-
peanut (oil)	0,80	1,86	unused
rape (oil)	0,84	1,63	unused
sunflower seed	0,89	1,86	unused
mustard seed	0,90	1,63	unused

(continues)

Table 3 (continued) - Coefficients for the estimation of agriculture and forestry by-products and by-products classification in Italian EW-MFA

	% dry matter in agricultural products	By-product /product ratio	Classification of the material flow as used/unused
Sesame seed	0,92	2,57	unused
Soy beans	0,87	1,63	unused
<i>Grassland</i>			
temporary	0,40	-	-
permanent (meadow and pastures)	0,35	-	-
<i>Fodder plants for seeds production</i>			
Medicago sativa	0,60	1,50	unused
Medicago lupulina	0,60	1,50	unused
Hedysarum coronarium	0,60	1,50	unused
Trifolium pratense	0,60	1,50	unused
Trifolium repens	0,60	1,50	unused
Trifolium hybridum	0,60	1,50	unused
Trifolium alexandrinum	0,60	1,50	unused
Trifolium incarnatum	0,60	1,50	unused
Others	0,60	1,50	unused
<i>Permanent crops (fruits)</i>			
a) Vine			
fresh grape	0,18	0,05	unused
wine grape	0,16	0,05	unused
b) Olive			
olive	0,50	0,05	unused
c) Citrus fruits			
oranges	0,13	0,05	unused
mandarins	0,14	0,05	unused
clementines	0,12	0,05	unused
mandar. & clement.	0,13	0,05	unused
lemons	0,11	0,05	unused
bergamot	0,16	0,05	unused
citron	0,18	0,05	unused
grapefruit	0,11	0,05	unused
e) Fresh fruits			
apricots	0,14	0,05	unused
cherries	0,14	0,05	unused
peaches	0,10	0,05	unused
nectarines	0,10	0,05	unused
plums	0,14	0,05	unused
apples	0,15	0,05	unused
pears	0,12	0,05	unused
kiwi	0,15	-	-
quinces	0,16	0,05	unused
pomegranates	0,20	0,05	unused
kaki, persimmons	0,18	0,05	unused
figs	0,18	0,05	unused
almonds	0,88	0,05	unused
hazelnuts	0,90	0,05	unused

(continues)

Table 3 (continued) - Coefficients for the estimation of agriculture and forestry by-products and by-products classification in Italian EW-MFA

	% dry matter in agricultural products	By-product /product ratio	Classification of the material flow as used/unused
walnuts	0,78	0,05	unused
medlars	0,18	0,05	unused
prickly pear	0,16	-	-
pistachio nuts	0,70	-	-
banana	0,15	-	-
raspberries	0,18	-	-
f) Others fruits			
carobs	0,70	0,05	unused
2 - FORESTS			
a) non-wood products			
chestnuts	0,50	0,10	unused
pinos	0,70	0,11	unused
acorns	0,70	0,05	unused
cork	0,82	-	-
hard cork	0,87	-	-
mushrooms	0,20	-	-
truffles	0,30	-	-
hazelnuts	0,90	-	-
blueberries	0,20	-	-
strawberries	0,07	-	-
raspberries	0,20	-	-
b) forest wood removals			
coniferous	0,42	0,09	unused
non coniferous	0,56	0,04	unused
c) out of forest wood removals			
coniferous	0,42	0,09	unused
non coniferous	0,56	0,04	unused

3.2.4 Unused materials from soil excavation and dredging

This item results from three distinct estimations, relative respectively to buildings, railways and roads. No estimate has been made for dredging. All quantities were first estimated as volumes, and then transformed into weight units using a specific weight parameter of 1,75 tons per cubic meter. Moreover, a fixed proportion equal to 28,4% of the estimated quantity of materials moved for construction purposes has been subtracted from this item and added to the used one referring to construction materials, in order to account for quantities reused in and outside construction sites. This proportion has been calculated on the basis of 1997 data on waste disposal from ANPA (1999b).

3.2.4.1 Soil excavation for the construction of buildings

As far as buildings are concerned, the estimate is based on information about surfaces newly built and coefficients expressing excavation depths varying according to the seismic risk of the municipality in which the building is situated and, where available, to the number of floors. Since the latter information is available only for residential buildings, we performed two slightly different calculations, for residential and non-residential buildings respectively. The data provided by Istat's survey on building activities, moreover, were complemented by the use of data supplied

by CRESME (a research centre specialised on construction markets), in order to cover non-reported buildings, included illegal ones.

For residential buildings, the base estimate has been determined for each year by a matrix multiplication of a “covered surfaces” matrix by a “depths” matrix. The data used are detailed at the communal level and by number of floors of the buildings. The variable provided by the survey is in this case the total surface of the buildings, so that it has been possible to calculate the surface covered, i.e. the one mostly interested by the excavation, by dividing this variable by the number of floors. The depth of the excavation has been determined according to a “minimum certain” criterion, as varying between 1,2 and 1,5 meters: the higher the seismic risk and the number of floors, the deeper the excavation. The depth is clearly underestimated, if anything for the presence of underground floors. However, in complete absence of information about this phenomenon, we preferred to behave as if there was none, to stay on the safe side. The same applies to the area surrounding the covered surface, which is often also interested by excavation, but has not been accounted for.

For non-residential buildings, the variable number of floors was not available (not included in the survey), but fortunately the one on the surface covered was. The depths therefore only varied slightly according to seismic risk.

3.2.4.2 *Soil excavation for the construction of transport infrastructure*

The estimate for this item is the result of two different calculations, referring respectively to roads and railways.

As far as roads are concerned, ANAS, the national company for roads maintenance and development, supplied data referring to roads of national importance except motorways. These data allowed to calculate only the quantity of earth removed for the construction of galleries for these roads, on the basis of the assumption that the holes dug had a circular section with a 10 meters diameter.

As far as railways are concerned, data were provided by the railway company on three different kinds of tracks, only two of which imply excavations: in gallery and in trench. Also two different “standard” coefficients per meter of track were provided, so that the computation of the total quantity of earth removed was easily done.

3.2.4.3 *The estimate of excavated soil as a certain minimum quantity*

It should be noted that, for various reasons, these calculations give an underestimate of soil excavation flows in Italy. Dredging is not comprised; the depth coefficients adopted for buildings are quite low and the surface considered is only a part of that actually excavated; communal, provincial roads and motorways have been fully neglected, as well as excavation other than for galleries. Thus, the estimate provides not just an idea of the magnitude of these flows where there was none, but a minimum certain value that can be considered as a benchmark for possible future additions on the basis of new knowledge. Useful information could be provided for instance by the census of dwellings of 2001 and by deeper enquiries on road construction.

3.3 Imports and exports

Data on foreign trade are available in physical units, and published by Istat in the “Statistica del commercio con l'estero”. It must be pointed out, however, that these data do not comprise all packaging crossing borders along with goods. The hypothesis has been considered, of an *ad hoc* study for the calculation, via extrapolation of the evidence provided by the available data, of

packaging associated to imports, but the existing evidence has been considered too scant for such an exercise to have enough hopes of being successful, in the face of its relatively high costs.

3.4 Input memorandum items for balancing

3.4.1 *Oxygen for combustion and Nitrogen for emissions from combustion*

The method followed for the determination of this item is that suggested by the methodological guide, i.e. that of a stoichiometric determination of atmospheric gases contained in air emissions, thereby comprising the oxygen included in water vapour output not coming from water content of biomasses¹⁶⁵. This estimate has been checked by inserting it in a specialised sub-balance of combustion processes, i.e. the ones listed under “combustion” in § 3.5.1 below, that includes fuels and air on the input side, and air emissions, water vapour and ashes on the output side. This sub-balance shows that there is a good degree of consistency of the various data and estimates, but no exact balance. Indeed, total inputs exceed total outputs by 4,2%, notwithstanding the fact that air inputs are not estimated independently from air emissions. This discrepancy could be due to various reasons, and suggests that a more careful consideration of the aggregated balance of combustion, including an independent assessment of air inputs, could lead to improvement of the estimate of some item included in this sub balance.

3.4.2 *Oxygen for respiration*

This item includes the oxygen consumed in their metabolism by both animals and humans. The estimate for animals is based on the data present in Pizzoli Mazzacane *et al.* (2002), from which an average coefficient of around 5 tons air per ton of live weight of livestock has been derived. As for humans, it has been possible, with the help of the experts of the Italian National Research Institute for Food and Nutrition (INRAN), to establish a much more detailed calculation, with coefficients differentiated by sex and age classes.

3.4.3 *Air for manure decomposition and drinking water for livestock*

In addition to the items considered in the methodological guide, we decided to include in the memorandum items of the accounts the following two:

- a “stoichiometric” estimate of the quantity of atmospheric gases that combine themselves with carbon and nitrogen present in manure giving rise to the air emissions of the SNAP processes 1005 - Manure management regarding organic compounds and 1009 - Manure management regarding nitrogen compounds;
- an estimate of the quantity of water drunk by animals, which is present in various outputs – mainly, in those deriving from farmyard manure (see below, § 3.6.1), but also in meat and other animal products. This choice descends from the consideration that the water present in these outputs comes both from drinking and from inputs included in the DMC aggregate, and it would have been quite difficult – if at all sensible – to tell apart the water already present in the inputs from the total water present in the outputs of animal production.

¹⁶⁵ More precisely this “stoichiometric” exercise consists in using the ratio, which can be determined at the level of an individual molecule, between the weight of the elements which are supposed to come from the atmosphere and the total weight of the emitted compounds.

Indeed, the estimates of these two additional memorandum items for balancing are part of a specialised flows and stocks balance of the animal production system, that shows how all the estimated quantities for this part of the economy are on the whole compatible with each other. Each item in this sub-balance has been accounted for in actual weight (i.e. comprising its water content) and the list of inputs has been completed with these memorandum items, so that the account can be consistent without the need of changing the definition of the material input indicators. It must be pointed out, nevertheless, that the water actually entering or leaving products at some stage of production – a case present not only in animal production but also some industrial processes – poses also problems that cannot be solved by applying accounting *escamotages*, but that require additional information¹⁶⁶.

3.5 Emissions and wastes

3.5.1 Emissions to air

Emissions to air included in the Italian material balance are consistent with Eurostat's methodological guide (see Table 8 "Detailed classification of material outputs" in Eurostat 2001); however, besides those from combustion and industrial processes, we included the emissions from some other processes that produce atmospheric pollutants. They cover the following pollutants:

- CO₂
- SO₂
- NO_x as NO₂
- VOC (NMVOC excl. solvents and CH₄ excl. CH₄ from landfills)
- CO
- PM - Particulate matter (incl. dust)
- N₂O excl. use of products and N from agriculture and wastes
- NH₃ excl. N from fertilisers
- CFCs and halons

The Italian CORINAIR air emission data classified according to SNAP 97 were used as input to calculate emissions to air for the Italian material balance flows for all pollutants listed above except CFCs.

For each pollutant, emissions from combustion and industrial processes are included as well as emissions from other waste treatment and enteric fermentation. For the set of combustion processes listed below, a separate mass balance has been drawn as a working tool, in order to calculate the balancing items of combustion and check the overall consistency of the estimate of emissions with total fuel input of these processes.

The specific SNAP 97 processes included in the calculations are:

- **combustion processes**¹⁶⁷:

- 01 *Combustion in energy and transformation industries*
 - 0101 Public power
 - 0102 District heating plants
 - 0103 Petroleum refining plants

¹⁶⁶ The alternative to including this balancing would be compiling the accounts always using dry weights for biomasses. However, this would pose a lot of additional difficulties of practical nature, especially for the accounting of foreign trade flows.

¹⁶⁷ The set of processes listed in the text coincides with the IPCC 1996 source category 1A Fuel combustion activities. See "correspondence between 1996 IPCC source categories and SNAP 97" in EEA (1999). Processes for which no estimate is available for Italy are not listed.

0104 Solid fuel transformation plants
 0105 Coal mining, oil / gas extraction, pipeline compressors

02 Non-industrial combustion plants

0201 Commercial and institutional plants
 0202 Residential plants
 0203 Plants in agriculture, forestry and aquaculture

03 Combustion in manufacturing industry

0301 Combustion in boilers, gas turbines and stationary engines
 0302 Process furnaces without contact
 0303 Processes with contact

07 Road transport

0701 Passenger cars
 0702 Light duty vehicles < 3.5 t
 0703 Heavy duty vehicles > 3.5 t and buses (r)
 0704 Mopeds and Motorcycles < 50 cm³
 0705 Motorcycles > 50 cm³
 0706 Gasoline evaporation from vehicles

08 Other mobile sources and machinery

0801 Military
 0802 Railways
 0803 Inland waterways
 0804 Maritime activities
 0805 Air traffic
 0806 Agriculture
 0807 Forestry
 0808 Industry
 0809 Household and gardening

09 Waste treatment and disposal (part of)

0902 *except* 090203 Waste Incineration except flaring in oil refinery

All the other processes belonging to the last source group (09) have not been included for the following reasons:

- they concern the treatment of wastes that are unused materials (0907 - open burning of agricultural wastes), or
- no estimate is available for Italy (minor processes like e.g. 0909 - Cremation), or
- the flow takes place outside the conventional boundary of Material Flow Accounting (e.g. the emissions from landfills of 0904 - Solid waste disposal on land), or
- the flow belongs to another category of outputs of Material Flow Accounting (0910 - Other waste treatment).

- **industrial processes**¹⁶⁸:

04 *Production processes*

- 0402 Processes in iron and steel industries and collieries except coke oven (door leakage and extinction)
- 0403 Processes in non-ferrous metal industries
- 0404 Processes in inorganic chemical industries
- 0405 Processes in organic chemical industries (bulk production)
- 0406 Processes in wood, paper pulp, food, drink and other industries

- **other processes**

- 0910 Other waste treatment
- 1004 Agriculture - enteric fermentation
- 1005 Manure management regarding organic compounds
- 1009 Manure management regarding nitrogen compounds

The data source for producing estimates of CFCs and halons is APAT¹⁶⁹.

Consumption data were used as proxy for emissions. Total national consumption of ozone depleting substances for 1996 was used as this was the latest available year. All the ozone depleting substances for which consumption data are available are included in our calculations, specifically¹⁷⁰: CFCs, halons, carbon tetrachloride, HCFCs, methyl chloroform, methyl bromide. Since APAT data are given in ODP (Ozone Depleting Potential) tonnes, the UNEP coefficients for ODP were used – to the extent possible – to obtain data in tonnes.

3.5.2 *Waste landfilled*

Data about landfilled quantities of waste are provided by APAT, whose estimates are based both on an administrative survey on production, transport, handling and disposal of waste, that collects data according to the EWC and on activity-specific estimates of special wastes produced by some industries and of the uses of these wastes. These sector studies by APAT are based on the reconstruction of the mass balances of the industries, and therefore are particularly suited for the inclusion in material flow accounts. Not all activities, however, are covered by this kind of studies.

The data on the total quantity of household waste produced in Italy in 1997 and on its share (79,9%) disposed of in landfills are published in ANPA (1999a).

The data on special waste are published in ANPA (1999b). Some calculations and additional assumptions were necessary in order to adapt the data to the detailed classification of outputs of MFA. From the total quantity of special waste landfilled reported, it has been necessary first of all to subtract the waste deriving from waste treatment, which have to be reported separately; for this purpose it has been assumed that all non-hazardous waste of the category 19 of the EWC are disposed of in landfills. Then we subtracted from the remaining quantities the part that corresponds to unused materials, in particular excavated soil and residues from extraction activities, identified by EWC code 01. Finally we added the quantity of demolition waste not

¹⁶⁸ The set of processes listed in the text coincides with the IPCC 1996 source category 2 Industrial processes. See “correspondence between 1996 IPCC source categories and SNAP 97” in EEA (1999). Processes for which no estimate is available for Italy are not listed.

¹⁶⁹ See ANPA (2002); the ANPA data are, in turn, based on UNEP (2002).

¹⁷⁰ Substances for which consumption is zero are listed as well.

already comprised in the starting figure, which is derived from the administrative survey mentioned above, and is incomplete with respect to EWC category 17, being non-compulsory the declaration of waste of this type.

3.5.3 *Emissions to water*

Emissions to water are estimated in Italy by IRSA-CNR – the Water Research Institute, of the Italian National Research Council – with the methodology of “potential pollutant load assessment”. The IRSA methodology is based on the identification of potential pollution sources of water emissions and the conversion into load units or load indexes using suitable numeric transformation coefficients. Estimates are carried out separately for emissions of organic matter and eutrophication elements (phosphorus and nitrogen).

The potential sources of water pollution for Italy, covered by IRSA estimates, are:

- for eutrophication load (nitrogen and phosphorus): Resident Population, Industry, Animal farming, Actual Agricultural Area (A.A.A.) and Other Land
- for organic load (other substances and organic materials): Resident Population, Industry and Animal farming.

Not all these potential sources are relevant as far as the accounting needs of economy-wide MFA are concerned. This is a consequence of the way the border between economy and nature is set in economy-wide MFA. Indeed, for the purposes of the evaluation of the “emissions to water” item of these accounts, the substances (especially nitrogen) that reach the natural water bodies from agricultural and other land as a consequence of the dispersion on the soil of used or unused materials, which are comprised in IRSA estimates of eutrophication load, do not have to be accounted for as outputs in MFA. This matter is contained in materials that are already accounted for in other output items of the general balance, namely “disposal of unused materials” or “dissipative uses”. The most important example is that of farmyard manure spread on the soil, which is included in “dissipative uses”; in other words, manure spreading is considered as a restitution of matter to nature and the consequent flows from soil to water are considered as internal to the natural system and must therefore not be accounted for in MFA’s “emissions to water”. Including them would mean having a double count in the accounts.

Another “borderline” question relevant for the estimation of the “emissions to water” as intended in MFA –in this case one that implies complications rather than simplifications in the calculation – is given by the fact that the treatment of discharged water is considered in MFA part of the human system. As a consequence, what has to be accounted for is not what flows in the water before treatment (potential load), but all what flows out of treatment plants: sludge, air emissions, and “emissions to water” (in MFA sense, or “actual load”). In case of no treatment, the two flows coincide, but in the presence of treatment one needs to know (besides the substances contained in the discharged waters): a) the percentage of water treated; b) the abatement ratio of the substances contained in the waters treated.

Emission of nutrients

Anthropogenic nutrient loads (emissions of phosphorus and nitrogen) represent one of the principal factors determining the concentration of these substances in aquatic environments and thus the trophic state of the latter.

As already explained, used agricultural land and other land do not contribute to “emissions to water” in MFA sense. The loads for the other anthropogenic pressure sources have been assessed as follows, directly using specific unit coefficients [Beccari et al., 1993]:

Resident population	
Phosphorus	0.92 g per person/day
Nitrogen	6.16 g per person/day
Industry	
Phosphorus	10 % phosphorus of resident population
Nitrogen	27.40 g per industrial employee/day
Animal production	
Bovines	7.51 g N and 1.01 g P per head/day
Swine	1.56 g N and 0.52 g P per head/day
Equines	8.49 g N and 1.19 g P per head/day
Sheep and goats	0.68 g N and 0.11 g P per head/day
Poultry	0.07 g N and 0.02 g P per head/day

The assumptions regarding the abatement due to treatment or stockage for the other released loads are, for nutrients, as follows (the figures derive from experts' knowledge and estimates available in the literature):

	Nitrogen	Phosphorus
Population	50%	50%
Industry	0%	0%
Animal farming	95%	95%

Emission of other (organic) materials

As far as organic loads are concerned, the usual measurement units are BOD5 and TOC, which are not suited to express emissions in a material balance: the first is a measure of the additional oxygen input demanded to the water in the natural process of decomposition of the organic matter emitted, and therefore expresses a flow internal to the natural system; the second only accounts for carbon, and therefore provides an incomplete measure of the flow of substances other than nitrogen and phosphorus in water bodies. A different estimation procedure has therefore been implemented as far as possible (i.e. for households and animal farming).

The contribution of households to these emissions has been calculated starting from an estimate of total human excrements, carried out at Istat on the basis of values differentiated by age and sex, supplied by INRAN experts. To this estimate, a 75,6% abatement coefficient has been applied, equal to the ratio between the population connected to wastewater treatment plants and the total population (1993 survey on water treatment plants)¹⁷¹.

The organic contribution of animal farming has been computed on the basis of Istat's estimate of produced manure, considering that only 5% of the total is not stocked but released into water bodies.

¹⁷¹ The abatement of organic loads due to treatment has substantially increased only after a new law (D. Lgs. 152/99) was passed in 1999; it is therefore appropriate to use for 1997 data referring to some years before.

It must be pointed out that in both cases the quantities thus estimated are inclusive of the water contained in the excrements, and that from both values, the nitrogen and phosphorus quantities, separately accounted for (see above), have been subtracted.

As far as emissions from industrial water discharge are concerned, a rough estimate of organic matter released into waters has been made on the basis of: a) the potential load corresponding to equivalent inhabitants and b) a 54,6% abatement due to treatment, calculated starting from a study by PROACQUA referred to 1991.

3.6 Dissipative use of products and dissipative losses

3.6.1 Dissipative use of products

In Eurostat's methodological guide the item "dissipative use on agricultural land" includes:

1. mineral fertilisers
2. farmyard manure
3. sewage sludge
4. compost
5. pesticides
6. seeds.

To these items we have added "other fertilisers", in order to complete the scheme in a way consistent with the available data.

Under **Mineral fertilisers** we have included all distributed chemical fertilisers; the source of data are Istat's Agriculture Statistics¹⁷².

Sewage Sludge is given by an elaboration on 1993 data referring to the destination of the mud produced by depuration plants. It has been estimated that 12% of it is used in agriculture.

For **Compost**, 1998 data from Istat's Agriculture Statistics have been used, since this item was not yet included in the surveys for 1997.

Farmyard manure has been calculated by applying to the existing stocks of live animals suitable coefficients of excrement production per unit of weight and by kind of animal. The latter were classified in 20 different groups, in order to exploit as much as possible the detail present in the available information, concerning: a) the number of live animals per species, and in some cases per age class or function (reproduction, milk or egg production...), supplied by Istat's Agriculture Statistics; b) the average weight of the different types of animals; c) the daily or yearly production of excrements in dry and/or total weight by kind of animal and weight unit. The latter two pieces of information were taken from a specialised study by ANPA¹⁷³. The estimate inserted in the outputs list is the one in total weight, diminished in order to take into account¹⁷⁴:

¹⁷² See Istat (1999).

¹⁷³ See Valenzano, F. et al. (2000).

¹⁷⁴ Percentages are based on IRSA expert's advice.

1. that not all manure is stocked and used as fertiliser: it has been assumed that a 5% exits the economic system as emission into water. The same hypothesis is at the basis of the estimate of water emissions from animal production;
2. that after being stocked, manure loses some of its weight in air emissions (nitrogen compounds, methane and NMVOC, partly by combination with atmospheric gases these items are also accounted for as outputs and included in the appropriate items).

Of course, stocked manure also loses water; this loss however has not been accounted for separately. The actual dissipative use of farmyard manure might therefore be sensibly lower than that reported in the accounts. This clearly affects the DPO, but does not change the overall balance, since the water loss possibly subtracted from manure should have been recorded as “water evaporation from products”, a “memorandum item for balancing” of the output side.

Under **Pesticides** we have included all phytosanitary products distributed for agricultural use; the source of data are Istat’s Agriculture Statistics.

Data on **Seeds** have been taken from FAO food balance sheets.

Other fertilisers are the ones based on microelements, organic ones other than manure, organomineral ones and the ones used to correct soil composition.

It was not possible to provide an estimate for the item “Dissipative use on roads (thawing and grit materials)”.

As far as the “**Dissipative use of other kind (incl. solvents)**” are concerned, the only data included in this item are on solvents’ use. Since these use translate entirely into air emissions, their use was estimated by selecting from the Italian CORINAIR database the emissions due to the following SNAP 97 processes:

- 0601 Paint application
- 0602 Degreasing, dry cleaning and electronics
- 0603 Chemical products manufacturing or processing
- 0604 Other use of solvents and related activities

3.6.2 Dissipative losses

In the Eurostat’s methodological guide the item “dissipative losses” includes:

- Abrasion (tyres, etc.)
- Accidents with chemicals
- Leakages (natural gas, etc.)
- Erosion and corrosion of infrastructures (roads, etc.)

Of these, only leakages have been included in the accounts.

Leakages were estimated by selecting from the Italian CORINAIR database the emissions of the SNAP 97 processes corresponding to the IPCC 1996 source category *1B Fugitive emissions from fuels*, specifically:

- 0401 Processes in petroleum industries
- 040201 Processes in iron and steel industries and collieries: cook oven (door leakage and extinction)
- 0501 Extraction and first treatment of solid fossil fuels
- 0502 Extraction, first treatment and loading of liquid fossil fuels
- 0503 Extraction, first treatment and loading of gaseous fossil fuels

0504	Liquid fuel distribution (except gasoline distribution)
0505	Gasoline distribution
0506	Gas distribution networks
090203	Waste incineration – flaring in oil refinery

3.7 Output memorandum items for balancing

3.7.1 *Water vapour from combustion*

Eurostat's methodological guide points out that water vapour from combustion can come from:

- water (H₂O) contents of fuels
- hydrogen (H) contents of fuels

Water vapour from water contents of fuels has been isolated only in the case of burnt biomasses, while for all other fuels, results were obtained through the following steps:

1. identification, together with the APAT CORINAIR experts, of the input of energy products – in tonnes – that are the counterpart of air emissions from combustion; the datasource is BEN, the Italian National Energy Balance;
2. identification, together with APAT experts, of coefficients that provide the tonnes of water vapour generated by the combustion of one ton of energy input, for all the energy products used in the estimates of emissions from combustion (see point 1 above);
3. calculation of total water vapour from combustion obtained by multiplying – for each energy product – the quantity used as input in combustion processes (see point 1) by the product-specific coefficient identified at point 2.

3.7.2 *Respiration of humans and livestock*

Consistently with the Eurostat's methodological guide, the objective was to evaluate CO₂ and water vapour (H₂O) deriving from humans' and livestock's respiration.

As far as humans are concerned, we obtained from INRAN experts coefficients of tonnes/year of CO₂ and H₂O produced per person, broken down by age class and sex. These coefficients were multiplied by the total number of people (male and female) in each age class in the year 1997.

As far as animals are concerned, the estimate is based on the data present in Pizzoli Mazzacane *et al.* (2002), from which an average coefficient of around 7 tons CO₂ and 8 tons H₂O per ton of live weight of livestock has been derived.

3.8 Material stock changes

This item has been estimated mainly on the basis of the integration of data from the PRODCOM survey and foreign trade statistics.

In order to be able to use PRODCOM data for material flow accounting, it is first of all necessary to have all the data in weight. The quantities reported, as a matter of fact, are often expressed (besides of course in monetary value terms) in different units, such as number of pieces,

square or cubic meters etc. For their transformation into homogeneous weight units we have applied the following procedure:

1. The data already in weight units have been set apart and expressed all in tons (some were in kilograms or even in grams). About 40% of the number of the products belonged to this group, representing almost 90% of the total final weight of production;
2. a connection between the PRODCOM classification of products and the Combined Nomenclature (CN), developed by Istat experts¹⁷⁵, has been adopted. The links are only in a minority of cases of the one-to-one type, but this does not pose particular problems, as long as the CN products corresponding – even if not univocally – to any given 8-digit PRODCOM code can be identified;
3. for the set of PRODCOM products remaining from step 1, the corresponding ones of the CN, having as supplementary unit the same unit as the one in which the PRODCOM data are expressed, average unitary weights of goods exported (e.g. tons per piece, or tons per square meter) have been computed¹⁷⁶. These values have been used for the transformation of the PRODCOM data whenever possible (around 30% of cases, accounting for 7% ca. of total final weight);
4. for the cases where there was no correspondence with foreign trade supplementary units, the weight per unit of value of corresponding exports has been used for the transformation (around 25% of cases and virtually all the remaining weight);
5. a handful of cases could not be solved in this way, and were settled by using the average weights of the group of goods to which they belong.

Once all PRODCOM data are available in weights, they have to be made compatible with national accounting aggregates: indeed, the PRODCOM survey does not give the whole of national productions, mainly because it does not include firms smaller than three workers. The data have therefore been reported to a quantity coherent with national accounting basic estimates simply by using as rescaling coefficient the ratio between the value of sales at the 5-digit level of the ATECO (the Italian specification of the NACE), that are at the basis of monetary national accounts, and the corresponding value calculated from the PRODCOM survey. This requires aggregating all 3575 PRODCOM products with non null data into something more than 300 ATECO activities, which is done by using a simple correspondence key.

The next step consists in the calculation of total resources by type of commodity, i.e. imports have to be summed up to national productions, and exports subtracted. This cannot be done at the commodity level, because of the complexity of the connections between the products of the two nomenclatures, with several many-to-many correspondences. Therefore, also foreign trade data have been aggregated at the 5-digit ATECO level, again using a simple key telling what activity is the one producing any particular good. It is clear that in both the PRODCOM and foreign trade cases, the activities thus defined are homogeneous ones from the point of view of the products they give.

Once the total resources available for domestic use have been thus determined by ATECO category, it was necessary to split them again in order to go back to PRODCOM products, as it is for

¹⁷⁵ Namely, it is a working databank of product nomenclature developed by Giuseppe Puglisi, of the Economic Statistics Department. Correspondences between the two nomenclatures are also present in the PRODCOM volume.

¹⁷⁶ A very important characteristic of foreign trade data, is that they are always reported in two, and in many case three, different units of measure. The two always present are weight and value, the third one, which is present in a majority of cases, is a "supplementary unit" which often corresponds to the PRODCOM unit. The choice of operating on exported goods' unitary weight is due to the idea that Italian exports are clearly more homogeneous to Italian production than Italian imports.

these that the use destinations are known¹⁷⁷. This has been done by using the relative weights of the individual PRODCOM products in the total weight of each ATECO's national production.

Possible destinations of the resources available for domestic use are intermediate or final consumption and investments. Goods going to final consumption have been further split, for the specific purposes of the present work, into durables and non-durables, by considering as durables all the goods that also have a quota going to investments, and using the results of a former study by Istat for the cases that could not be settled in this way¹⁷⁸. The same destinations have been specified for imported goods not coming from activities covered by the PRODCOM survey, which also have to be allocated to the various uses.

Thus, the data and tools necessary for a direct estimation of the main categories of material accumulation in the technosphere are ready.

3.8.1 *Infrastructures and Buildings*

This item has been calculated on the basis of the results of the elaborations of PRODCOM and foreign trade data described above. Construction activities are not covered by the PRODCOM survey, but all materials embedded in constructions come from some activity included in it. Therefore, it is among intermediate uses of the products of PRODCOM industries that the relevant data have to be searched. No attempt has been made to include the use of metals for construction purposes in the estimate. For other building materials, a simple flow model has been developed, showing that these either go directly from the activities of NACE groups 14.1, 14.2 and 14.5 to construction activities (e.g. sand and gravel, marble), or flow through the activities of division 26 (e.g. clay is transformed in bricks, limestone in cement...). In this passage, part of the materials are transformed in waste, and this has been accounted for by subtracting the waste produced by these industries. Moreover, part is delivered directly from division 26 to final uses, and also these have been subtracted, and allocated to the corresponding accumulation categories (other investments and consumer durables) when suited. The remaining part is assumed to be accumulated in the products of construction works.

Data on removals for this item have been drawn from the sector study on demolition waste in ANPA (1999a), based in turn on a study by CRESME (1998). Reused quantities of demolition waste have been excluded from the removals, as they go back into new constructions and are probably not among the materials accounted for under gross additions.

3.8.2 *Machinery*

The gross additions to this item are given by the sum of all investments and durable consumer goods produced by the NACE divisions 28-35, as resulting from the elaboration of PROCOM and foreign trade data described above.

The removals computed only cover demolished vehicles; data by ANPA (1999b).

3.8.3 *Other durables*

This item has been set equal to the products of all NACE divisions except 28-35 destined to investments or characterised as durable consumer goods, according to the elaborations of PRODCOM and foreign trade data described above.

Removals have been accounted only as far as separate collection of bulky wastes in Urban wastes is concerned (ANPA, 1999a).

¹⁷⁷ These destinations have been determined on the basis of their individual characteristics and of the results of Istat surveys by an ad hoc Working Group, for the use of this kind of information in national accounting (see Istat, 2000, pag. 16).

¹⁷⁸ The study is the same quoted in note 175.

3.8.4 Inventory changes

The PRODCOM survey reports both produced and sold quantities. Inventory changes have been estimated as difference between these two quantities. No estimate concerning intermediate inputs bought in 1997 but not used in that year has been attempted.

3.9 Indirect flows associated to imports and exports

This item has been calculated by using the technical coefficients that have been kindly supplied, together with their connection to the codes of the Combined Nomenclature (the classification of internationally traded commodities currently in use – CN), by the Wuppertal Institute¹⁷⁹. These coefficients, gathered and calculated on the basis of accurate, and in some cases Country-specific, Life Cycle Analyses, have been so far used in several country studies carried out by the Wuppertal Institute itself and by some NSIs and research institutes such as the World Resources Institute¹⁸⁰, and therefore guarantee, to a certain extent, a comparability of data that would not be ensured by any other method.

Of course, these coefficients also have weaknesses. In the vast majority of cases they do conceal the variability of production techniques across countries, as they are attached to goods irrespective to their provenience. However, this is not the case for metal minerals, metals and fuels, the goods for which the variability of the waste produced per unit of product is maximum, as a consequence of the different metal concentrations in ores and characteristics of extraction sites. These goods alone give around 40% of indirect flows connected to Italian imports. It is clear that in many cases the coefficients have been calculated considering only some part of the production cycle: this can be seen by the fact that for many raw materials and for the goods thereof the same coefficient is given, when the latter should of course have higher values; however, the stages considered are clearly the most important ones from the point of view of indirect flows generation (again, that of extraction and refinement of the raw materials). The most important “hole” in these coefficients is perhaps the fact that they do not cover in any way services, which are not produced “free of charge” for the environment and play an increasingly important role in international trade. Finally, they do not allow to calculate separately Raw Material Equivalents and unused materials connected to imports, as ideally required by the Methodological Guide. Nevertheless, no method is yet available that allows this distinction, and having an estimate of the total is the most important thing from the point of view of the environmental meaning of the indicators.

The collection, updating and use of information on production practises and on the streams of outputs to the environment they imply, both in EU countries and in their commercial partners that supply material goods, should be seen as a priority for European environmental statistics, as Indirect Flows connected to imports and exports are the one and only item in official statistics that allows to assess the stress put on world resources by a country’s way of life. The direction should be that of improving detail (coefficients relating to a more detailed classification of goods, distinction of indirect flows between used and unused and by type of material...).

¹⁷⁹ As these coefficients are defined at variable levels of aggregation, they have been reorganised as to have a coefficient for each individual (8-digit) item of the Combined Nomenclature, in order to include and use the information in Istat’s database, which for the years after 1990 elaborates data at the maximum level of detail available from current surveys.

¹⁸⁰ Adriansee et al. (1997).

Harmonisation/integration of Wuppertal data with the results of the PRODCOM module of the Environmental Pressure Information System (EPIS) on the one hand and with the parameters used for the inclusion in food balances of raw material equivalents of refined and elaborated edible goods on the other, are a research direction that could only be tentatively explored in the present study, but whose implementation at the European level can be recommended as a first step towards a consistent set of indirect flow parameters for use in MFA and other applications.

From the point of view of the practical use of the coefficients provided by the Wuppertal Institute, data for 1997 are detailed by 8-digit code of the CN and by country of provenience (this detail on imports has been required only for the goods with country-specific coefficients).

For the computation of indirect flows associated to exports, the values provided for Italy by the Wuppertal Institute have been adopted for the goods with country-specific coefficients. It must be pointed out however that the values present for Italy are default ones, but also that these goods are definitely not important items in Italy's export.

4 CONCLUDING REMARKS

The compilation of economy-wide material flow accounts is important not only because it allows to know where the materials, once used, end up (the atmosphere, the soil...) but also because it provides an idea of the overall state of the art in our statistical knowledge of environmental pressures, even if at an aggregated level, that no other tool of statistics gives. This is important for identifying the gaps that have to be filled, not only in terms of quantity, but also of quality. It is clear enough that there is much room for improvement there.

Moreover, in the compilation of a complete balance, the first steps have been made towards the compilation of a Physical Input-Output Table (PIOT). Specialised balances for some groups of activities and types of material have been set up, and the combined treatment of PRODCOM and foreign trade data has allowed to derive some basic quantitative information on total resources available by producing activity, at least for the activities covered by the PRODOM survey, as well as on the intermediate or final nature of the uses of these resources. The next step towards a PIOT will be to organise this information on the basis of qualitative information from commodity science and of further quantitative knowledge, in order to develop the intermediate exchanges frame of the PIOT; similar elaborations of the lists of inputs and outputs should give the frames of primary inputs and final outputs towards the environment, which are already partly available and under development as environmental modules of the NAMEA.

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Capitolo 3

Rapporto ad Eurostat

Economy-wide Material Flow Indicators for Italy, 1980-2001

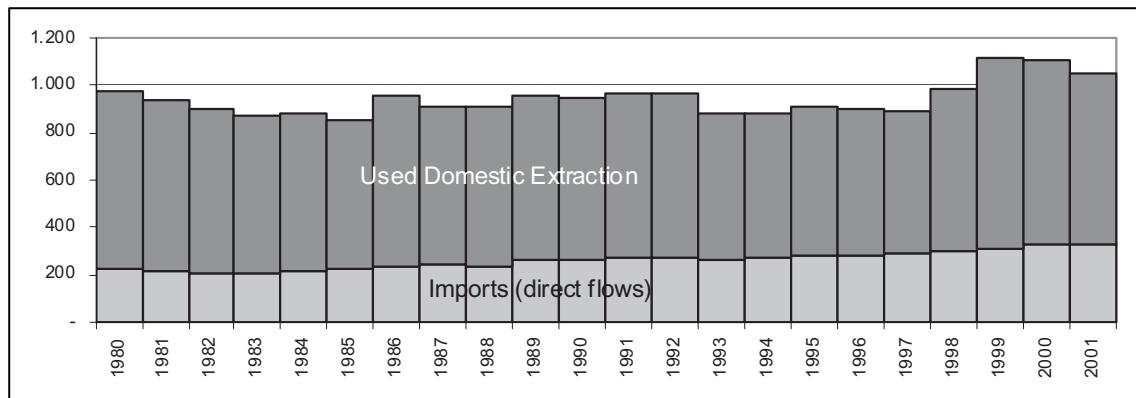
Aldo Femia, Gianna Greca, Donatella Vignani

1 MAIN RESULTS AND INTERPRETATION OF THE EMPIRICAL EVIDENCE

1.1 DMI - Direct Material Input

Figure 1 shows the evolution of the indicator referring to the Direct Input of Materials of the Italian economy, considered as a unitary system, from 1980 to 2001. Observing the whole period the overall level of DMI seems not to have changed very much, fluctuating around an average of about 957 million tons. But looking at the closing five years, a rising dynamic begun in 1998 can be underlined: DMI has reached a peak in the year 1999, with 1.142 million tons, and it has remained over one billion tons in the following two years, notwithstanding a little decrease.

Figure 1 - Direct Material Input (DMI) Italy 1980-2001 (tons)



Il testo riportato è una rielaborazione dei rapporti originali consegnati all'Eurostat nel 2003 e 2004 rispettivamente, per quanto riguarda le parti relative agli indicatori.

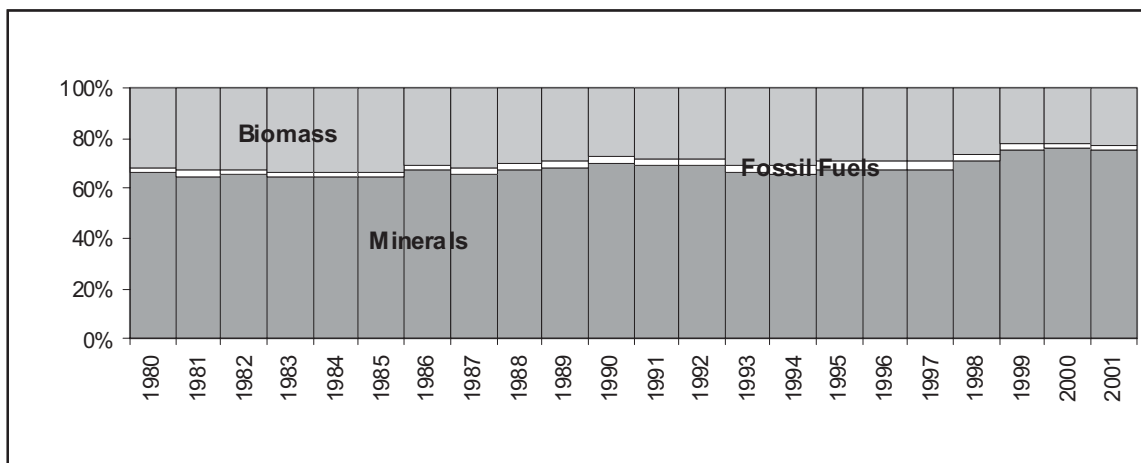
I progetti e la stesura dei rapporti originali sono stati coordinati da Aldo Femia, che ha curato anche la presente rielaborazione.

Il § 1 è stato redatto da Donatella Vignani (Istat); il § 2 da Gianna Greca (Istat); il § 3 da Aldo Femia (Istat).

In order to understand better the importance of the domestic environment in supplying resources to the national production system, it is useful to refer to the first level disaggregation of DMI so defined: Domestic Extraction of materials (DE, all that is taken from Nature directly, i.e. from the national environment) and Imports (raw materials and finished products taken from abroad). DE parallels GDP as it also does not include Imports. The figures point out that this aggregate (DE) increases in absolute terms of around 21,5% in the closing five years: it passes from 615 million tons, in 1997, to 748 million tons in 2001, though having a floating profile with a peak in 1999 around 834 million tons and a decrease in the last two years. This tells us that in these years more value has been produced in Italy with more resource extraction from the national environment.

At a second level of disaggregation, DE, in turn, is decomposed in the following categories: Biomass, Minerals and Fossil Fuels. This allows to see, in particular, the kinds and quantities of used resources domestically extracted¹⁸¹. As shown in figure 2, in the 1997-2001 period the relative increase of Used Domestic Extraction as a whole has been mainly due to Minerals production, which increases of 35,4%, reaching more than 50% of overall Direct Material Inputs.

Figure 2 - Percentage composition of Domestic Extraction - Italy 1980-2001



The highest level is that of the year 1999 with 619 million tons. Only a little share of these materials is sold abroad; the rest is mainly used in construction activities (buildings, roads, railways) and remains in the national territory, so that each year a substantial accumulation of materials into the antroposphere takes place. On the contrary, in the same period we note a decrease (-24,5%) of Fossil Fuels production, which has always constituted a small share of Domestic Extraction anyway, that reaches a minimum value in the year 2001 with around 15 million tons. This confirms the historical and strong dependence of Italy on the rest of the world for the supply of Fossil Fuels necessary to the national economic activities. Finally, looking at Biomass production in the last five years, it remains on the same levels around an average of 189 million tons. Nevertheless it has to be underlined how the relative weight of this kind of resources

¹⁸¹ Each of these can be further decomposed in sub-categories: for example the item Minerals is divided in Metals, Industrial Minerals and Construction Minerals.

on the Domestic Extraction has decreased in the 1997-2001 period in comparison with the average level it had before (219 million tons in 1980-1996); this, together with grown imports, reveals that Italy is suffering a progressive loss of its leadership in Biomass production (mainly agricultural products) in the EU countries, maintained for a long period due to a high competitiveness.

As usual in the specialised literature, in order to assess whether there is or not a relative *decoupling* of resource use from economic growth by comparing the long-term dynamics of DMI to those of Gross Domestic Product (GDP), the ratio of the former to the latter has been calculated. Indeed in the 1980-2001 period Italy's GDP at constant 1995 prices has grown around 49%. Looking at this ratio in the whole period, we can observe a clear trend of relative decoupling¹⁸² of growth from Direct Material Inputs. However it must be pointed out how the growth of DMI accompanies GDP growth in the last five years, showing an increasing use of resources by economic activities in Italy: this dynamic highlights a slowdown of relative decoupling.

It must be recalled that since DMI includes the weight of Imports, it does not correspond to GDP, which does not include the value of Imports; so the comparison between DMI and GDP does not have a great explanatory value.

Let us therefore refer to a more correct comparison i.e. that between DMI and GDP *plus* the value of Imports, as DMI is given by Domestic Extraction *plus* the weight of Imports. It is clear that the overall positive dynamic of DMI (9,5%) in the whole 1980-2001 period is not sufficient to balance the parallel growth of GDP *plus* the value of Imports (around 65%) so that again a relative decoupling is confirmed.

Also this comparison, however, is not entirely satisfactory, as Imports have a very different meaning from that of Domestic Extraction as far as resource use (and environmental burden) are concerned. Indeed, one unit of Domestic Extraction represents, by definition, just one unit of matter that is taken from the (national) environment. One unit of Import, on the contrary, represents more than one unit of material taken from Nature. Therefore much importance must be given to the composition of DMI, in the assessment of decoupling.

Following this, we can highlight that the composition of the Italian DMI has indeed been slowly shifting through time in favour of Imports: they have grown from 23,4% (year 1980) to 30,6% (year 2001) of DMI. This is coherent with an economy based on transformation and poor of Natural Resources like the Italian one, in presence of economic growth. This suggests that the relative decoupling highlighted above is at least in part the consequence of a shift to foreign countries of the growth of environmental burden connected to the growth of Italian production, rather than of a genuine change towards greater resource efficiency in the Italian production structure.

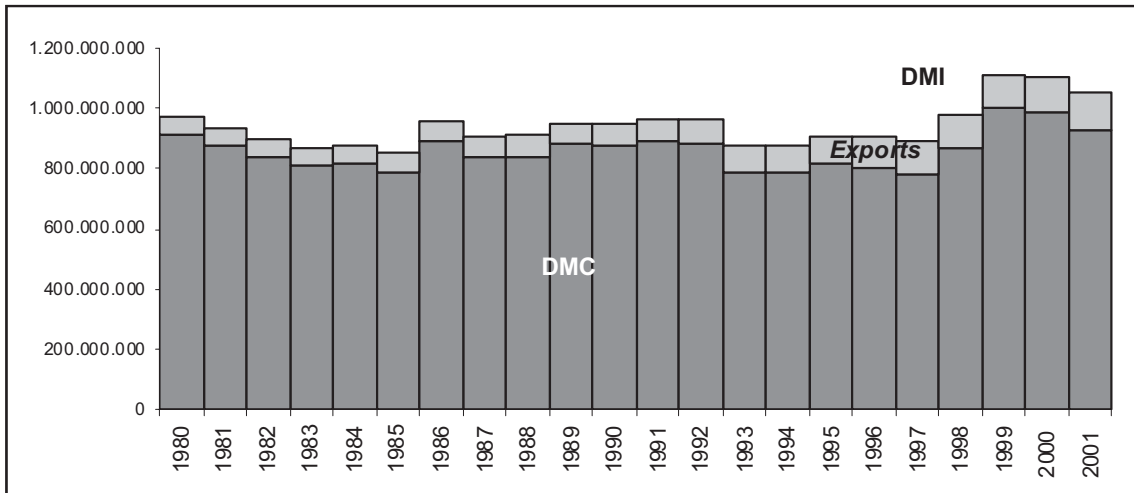
1.2 DMC - Domestic Material Consumption

Figure 3 shows the evolution of Domestic Material Consumption, which is obtained by subtracting from DMI the quantities exported. Due to the law of matter conservation, DMC is equal to the sum of all the materials, extracted domestically or imported, that remain in the country and that are either accumulated in stocks or transformed into wastes, emissions,

¹⁸² *Relative decoupling* is defined, in relation to used materials, as decreasing DMI/GDP share; the decoupling is said to be *absolute* when the decrease of the ratio is achieved with decreasing DMI and non-decreasing GDP.

dissipative uses, and so forth. Therefore DMC gives a clearer measure of the material resources directly used by national activities, relevant for the direct generation of pressures on the natural environment.

Figure 3 - Domestic Material Consumption Italy 1980-2001 (tons)



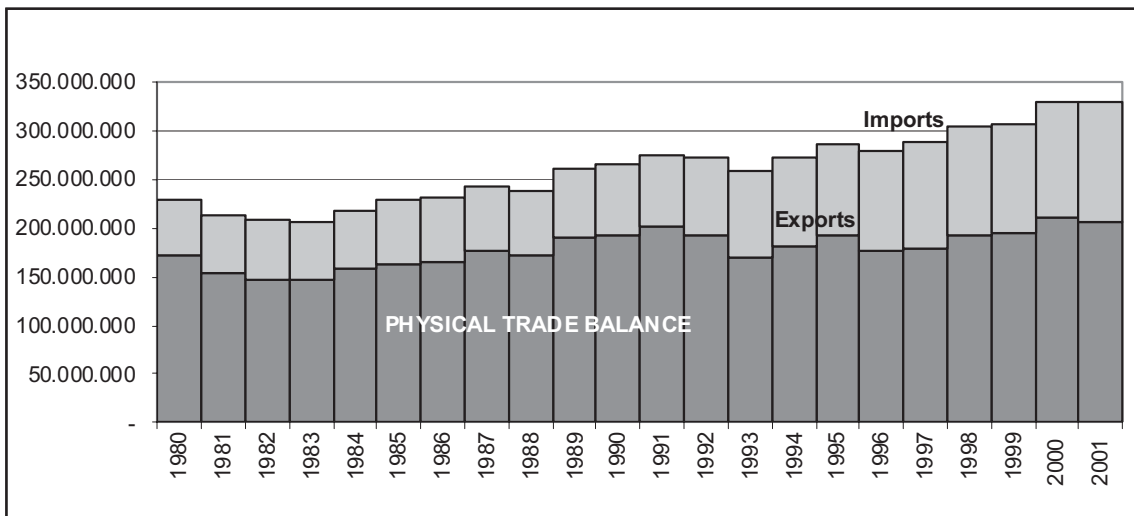
As far as the issue of disaggregation of DMC is concerned, three alternative ways are in principle available: two are connected to the way DMC is calculated, i.e. highlight the components DMI and (minus) Exports as figure 3 does, or the components DE and PTB; the third is given by the analysis of the indicator in an output-side perspective. The latter disaggregation presents practical difficulties as it expresses DMC as the sum of flows according to their destination (i.e. net addition to stocks, emissions and wastes, dissipative use of Products, dissipative losses). Splitting up DMC into these categories would require a complete balance to be drawn up for each year of the series including also the balancing items (see the previous chapter in the present volume). DE has already been discussed and PTB will be in the next paragraph, therefore let us refer to the first disaggregation, which emphasises the role of Exports, as the latter makes the difference from DMI.

In the whole 1980-2001 period Exports have almost doubled in physical terms (+112%); also in the period 1997-2001 they increased constantly and more rapidly than DMI reaching 11.4% of DMI in the last year. However this growth has not been sufficient to offset the positive contribution to DMC given, especially in the closing years, by DMI's growth.

The monetary aggregate that parallels DMC is total resources for domestic use, given by GDP plus Imports minus Exports: in a long term analysis comparing 2001 values with 1980 ones, we observe that DMC results more or less constant (+3%) while the resources for domestic use grow by 47,4%. This means that there is a tendency to a relative decoupling of the weight of the materials that physically remain in the country from the value of the goods in which they are embodied and of the services for which they are used.

1.3 PTB - Physical Trade Balance

The Physical Trade Balance of an economy is given by the difference between the matter that flows into the country as Imports and the matter that flows outside the country as Exports.

Figure 4 - Physical Trade Balance (PTB) Italy 1980-2001 (tons)

As can be seen from figure 4, both Italy's historical dependency from foreign material resources and that from foreign demand of transformed products have increased in the whole period analysed. In fact in the period 1980-2001 the Imports' growth is around 44% and the Exports' around 112% reaching respectively 330 million tons and 123 million tons in the year 2001. Looking at the last five years, it can be noted that the growth of Imports (around 14%) has remained higher than that of Exports (around 11%), and that the PTB has grown by 16% in these five years, being equal to 207 million tons in 2001.

Also the comparison of PTB to the Monetary Trade Balance confirms the importance of material transformation in the Italian economy, whose function is mainly of adding value to imported materials. Indeed, there has been a surplus of Exports on Imports in the last five years, which has been on average of around 20.800 million euro-lire.

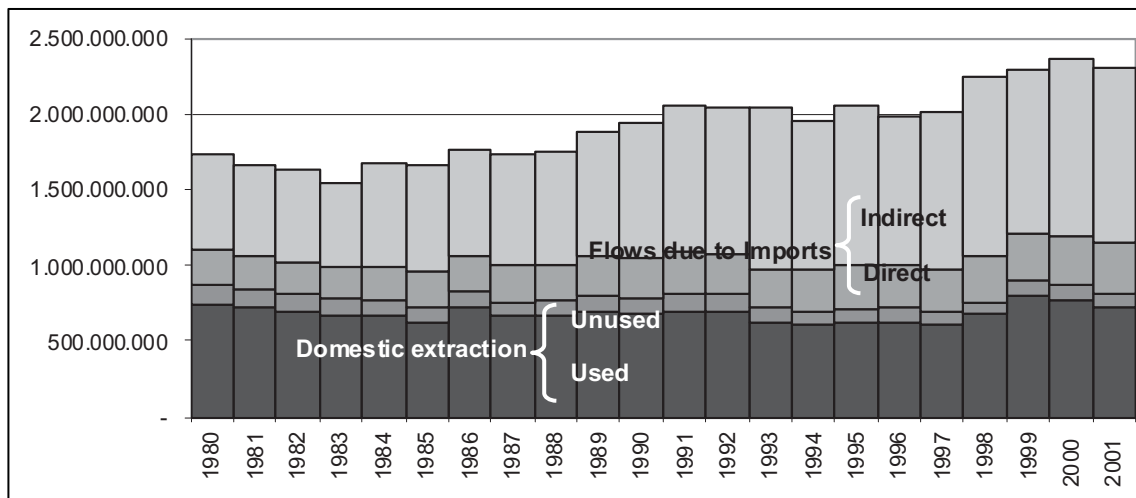
1.4 TMR - Total Material Requirement

Figure 5 shows the evolution of the Total Material Requirement of the Italian economy in the 1980-2001 period. We recall that this indicator is equal to all the quantities of materials (excluding water and air) that have directly or indirectly been moved in the country or abroad, in order to allow the realisation of the domestic production and consumption even though they have not actually been incorporated into products, at any stage of domestic production. Indirect Flows associated to Imports are included in this indicator so that it gives an overall measure of all the potential pressures exerted on the natural environment, in order to guarantee the metabolism of the national economic system not just at local but at global level.

In the whole period analysed, the TMR of the Italian economy has grown by 33,6%. Growing resources demand is therefore an important feature of the Italian economic growth

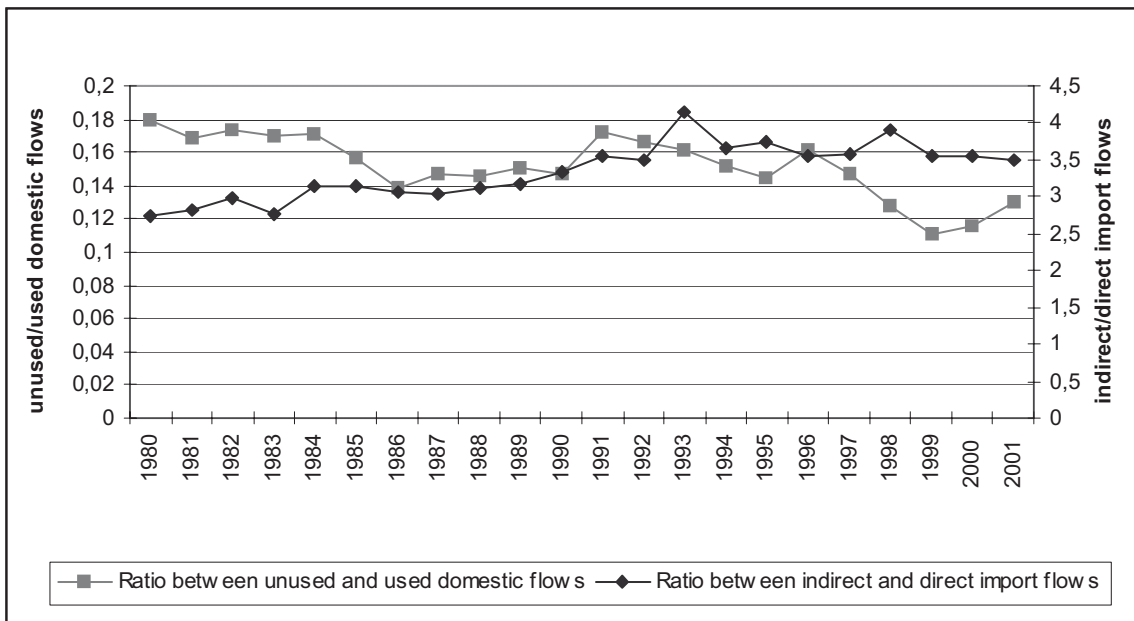
of the last decades. It is confirmed that this growth is primarily due to the Indirect Flows associated to Imports, risen around 84% going from around 36% of TMR in 1980 to 50% in 2001, and secondarily to the growth of Imports risen around 44% but varying only from 13% of TMR in 1980 to 14% in 2001. The greater increase of the former with respect to the latter means that the Italian Imports have indirectly required the abstraction from Nature in foreign countries of a growing quantity of materials per unit of matter directly embodied in the Imports. This is due to the change in the composition of Imports, as the coefficients used for the calculation vary from good to good, but do not vary across the period.

Figure 5 - Total Material Requirement Italy 1980-2001 (tons)



As far as the 1997-2001 period is concerned, the positive dynamic of TMR is confirmed with a growth of 14,9%, notwithstanding a little decrease in the last year: the peak of 2.385 million tons has been reached in 2000. It can be underlined that in these last five years the growth of the indicator has to be linked primarily to Domestic Extraction and only secondarily to Indirect Flows associated to Imports: in fact, the former has grown in absolute terms 21,5%, changing from 615 million tons in 1997 to 748 million tons in 2001 and the latter has grown around 12% from 1.034 millions tons in 1997 to 1.156 million tons in 2001.

Figure 6 shows that the ratio between Unused Domestic Materials and Used ones has decreased through time: it passed from 0,16 in 1980 to 0,12 in 2001. We recall that up to 1997, when the ratio reached 0,14, the reduction of the ratio was mainly due to the decrease of its “soil excavation” component (linked in turn to the slowdown of construction activities in Italy). In the last five years the ratio has continued its decreasing trend, but this is due to the fact that domestic extraction of Used Materials (DE) has grown more than that of Unused Domestic Extraction (respectively around 21,5% and 7,3%). In other words to the rise of the Domestic Extraction does not correspond an equivalent increase of the Unused Materials, and there is a shift towards extraction of resources requiring smaller quantities of Unused Materials per unit produced.

Figure 6 - Ratios between Unused and Used Domestic Extraction and between Indirect and Direct Flows of Imports Italy 1980-2001

Also TMR is usually compared to GDP: in the whole period analysed the comparison emphasizes a relative decoupling, as GDP (+49%) has grown more than TMR (+33,6%). However, physical indicators that comprise import flows (whether actual or indirect) are more sensibly compared to monetary indicators comprising their value. Thus considered the relationship between monetary and physical measures, the relative decoupling is even more evident since, as already seen, GDP plus the value of Imports has grown by 65% in the 1980-2001 period.

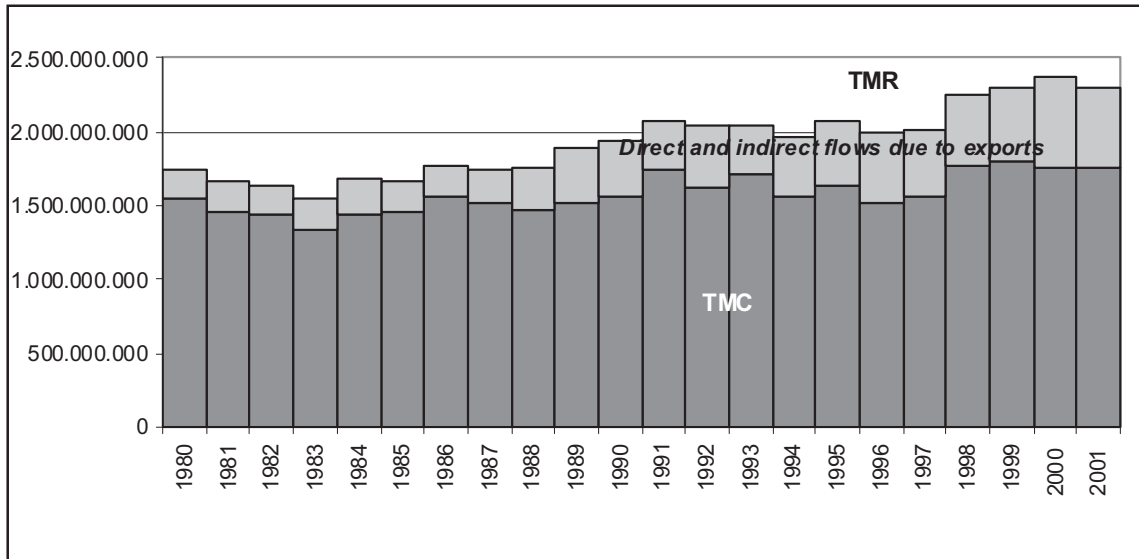
1.5 TMC - Total Material Consumption

Total Material Consumption is obtained by subtracting from TMR both the Exports and the Indirect Flows associated to them. In the 1980-2001 period the figures reveal that, notwithstanding the growth of the latter two items¹⁸³, the TMC time series has an upward trend, with an overall growth of 15.2%, due to the growth of TMR (+33,6%) seen before. Moreover it can be noticed that while in Italy production and consumption activities grew without directly increasing the pressure on the national natural environment – as DMC remains more or less stable in the period – TMC raises, proving that trough time these pressures have increased at global level to satisfy the Italian domestic demand. Indeed, TMC as the other indicators including the Indirect Flows, is independent from the localization of the activities, as it refers to the whole production chain and not just to the domestic part of it. Thus when the Indirect Flows are included in the

¹⁸³ In the whole period analysed Exports grow around 112,5%, passing from 58 million tons in 1980 to 123 million tons in 2001, and Indirect Flows connected to them grew by almost 207%, passing from 137 million tons to 421 million tons in the last year.

analysis, no absolute de-materialisation is highlighted but rather we can observe a growth of the overall stress imposed on natural resources at the global level and also relative de-materialisation proves to be slower than otherwise would seem.

Figure 7 - Total Material Consumption, Italy 1980-1998 (tons)



In the usual comparison with monetary aggregates it is clear that a relative decoupling has taken place, as the growth of GDP plus Imports minus Exports has been of 47,4%. This means that the Italians have consumed and invested more (in value units), directly using about the same quantity of materials for that, but requiring more materials to be moved from foreign countries for the same purpose, though not as much more as if there had been growth in fixed proportions.

Examining the closing five years, figures shows an increase of TMC by 13,6% as it has gone from 1.564 million tons in 1997 to 1.776 million tons in 2001; it can be pointed out that the peak of 1.814 million tons, reached in 1999, also represents the highest value of the overall period. The growth of TMC is due to the growth of TMR, around 14,9% in the same period, that exceeded the positive dynamic both of Indirect Flows associated to Exports (+22,2%) and of Exports (+10,9%) that have reached respectively 421 million tons and 123 million tons in 2001.

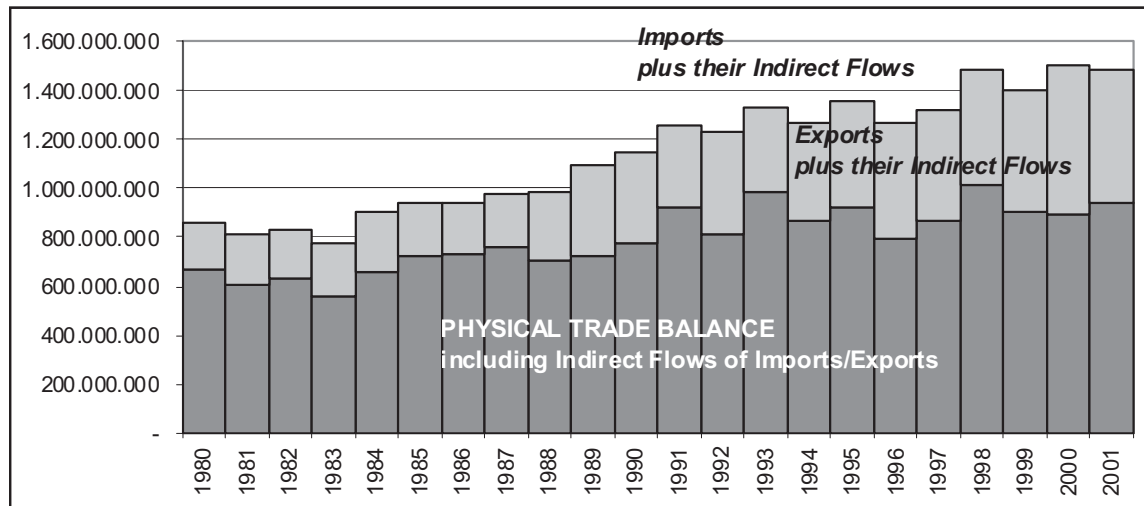
1.6 PTBIF - Physical Trade Balance including Indirect Flows

This indicator highlights the position of the country in international trade with respect to its effects on the worldwide movements of materials that support modern economies¹⁸⁴. It is given by the “virtual” Physical Balance of foreign trade that can be calculated considering, besides the

¹⁸⁴ As pointed out above, the Methodological Guide does not include this indicator among the ones proposed. We consider it very interesting as a modified version of the balance of the Indirect Flows Trade Balance Account (see page 60 of the Methodological Guide), from which it is derived by including Direct Flows, or in other words summing the PTB to it.

direct flows comprised in the PTB, also the flows indirectly due to international trade. This is a “total flows” kind of measure, parallel to PTB. Figure 8 presents the time series of this indicator, particularly meaningful for describing transformation economies like the Italian one.

Figure 8 - Physical Trade Balance including Indirect Flows of Imports/Exports Italy 1980 (tons)



Considering the 1980-2001 period, the PTBIF has remained largely positive and moreover it has grown around the 42% showing in physical terms the dimension of the “ecological deficit” of the Italian economy; figures emphasise that there is a growing gap between the Natural Resources demanded by Italy to the rest of the world in order to satisfy domestic demand and those necessary to produce the goods supplied to the rest of the world. Observing the closing five years, the indicator keeps its positive dynamic with an overall increase of 8,5%, though fluctuating in the period between a minimum value of 868 million tons and a maximum one of 1.012 million tons.

In the whole period, Imports plus Indirect Flows associated to them have grown by 73.2% while Exports plus Indirect Flows associated to them have grown by 179%; though through time total flows related to Exports grew faster in relative terms than those related to Imports, they have been always sensibly lower in absolute terms. The same considerations are valid when the medium term tendency is examined: from 1997 up to 2001 both Imports plus Indirect Flows associated to them (+12,3%) and Exports plus Indirect Flows associated to them (+19,5%) have grown, reaching respectively 1.486 million tons and 544 million tons in the last year.

2 ADDITIONAL DATA SOURCES AND METHODS WITH RESPECT TO THOSE USED FOR THE ACCOUNTS FOR THE YEAR 1997

On the whole, the construction of the time series has been inspired to a caution criterion: doubtful cases where more than one solution was admissible have been treated in a way that underestimation is a very likely outcome for some individual items included in the indicators, and an almost certain one for certain aggregates. This however does not influence the order of magnitude of the indicators nor their evolution through time, but only their level, and to a limited extent.

The sources and methods used in the construction of the indicators' time series are mostly the same as those described in the previous chapter of the present volume, to which reference should be made. However, in some cases it has been necessary to fill gaps in the available data and/or make them consistent through time. In the following paragraphs we will describe only the solutions adopted in such cases.

2.1 Used Domestic Extraction

As far as used domestic extraction is concerned, only for construction minerals is it necessary to complement the information supplied in the previous chapter.

The figures calculated in the present study for construction minerals result from two different estimation procedures that exploit information from various sources, trying to integrate them as to have a complete coverage of extraction activities concerning these materials. These estimates concern respectively reused soil from excavation and construction minerals extracted from quarries.

A share around 5% of the construction materials accounted for in the time series is given by soil from excavation activities which is reused in construction.

As far as this reused soil is concerned, we extrapolated to the whole period the 28,4% share of reuse, estimated on the basis of information given for 1997 by the waste statistics published by the Italian Environment Protection Agency (see the previous chapter in the present volume, § 3.1.2.3).

Materials extracted from quarries gives on average 95% of total construction minerals' input.

The estimation procedure adopted for the construction of the time series builds on the results of a regression model that has already been used in past applications (in particular, for the resource intake modules of the Italian NAMEAs), integrating these results with the better knowledge of the phenomenon provided by the PRODCOM survey, whose results are available for the latest years of the period.

The regression model describes the data on quantities extracted, aggregated at the province level, that have been reported through the years by the producers in a survey on the production of quarries and peat fields. These data were reported until 1986 in a publication of the Ministry of Industry ("Relazione sul servizio minerario e statistica delle industrie estrattive in Italia"), that was no more compiled after the regulatory powers on these activities were handed over to the Regions. Thereafter, the questionnaires that fed the "Relazione" continued flowing in at the Ministry and at Istat from a slowly dwindling number of provinces, and were thus available for the "download" of the basic data. This survey, serving mainly administrative purposes, is no

longer the main source of information on the phenomenon, as nowadays more complete information on quarries' production is supplied by the PRODCOM survey. It is indeed the availability of both these questionnaires and of PRODCOM results for the last years of the period that makes an integration of the two sources possible.

The "regression" step of the estimation procedure adopted has consisted in the reconstruction of the missing data (concerning the province/year couples for which no data were reported), made by extending the statistical regularities that could be observed in the available data, with reference to the relationship between the quantities of extracted materials that had been declared and relevant supply and demand variables (number of employees of the quarries, value of public works realised, buildings' growth in cubic meters).

The following step of the estimation procedure has consisted in the comparison of the results with those of the PRODCOM survey, which were available for 1997 and 1998, and had in turn been adapted in order to cover extraction sites with less than three employees, not covered by the PRODCOM survey. This comparison resulted in the discovery of a substantial "hole" in the estimate based on administrative data, which however were the only available source for the years before 1997. The corrected PRODCOM data have therefore been adopted for the last two years of the time series, and a further correction has been made to the results of the regression model for the previous years, rescaling everything to make it consistent with 1997 and 1998. Therefore, the level of the series is dictated by the PRODCOM results, while its profile is determined by the results of the regression model.

2.2 Unused Domestic Extraction

As far as unused domestic extraction is concerned, only for materials from drilling for oil and natural gas extraction and soil excavation for the construction of roads is it necessary to complement the information supplied in the previous chapter.

In order to determine the quantities of wastes arising from drilling for oil and natural gas extraction, data published by ENI, concerning the years from 1997 to 2001, have been used for the calculation of the coefficients. A slightly different coefficient has been obtained and applied for each of these years. For the other years of the time series (1980-1996) the coefficient applied has been obtained by calculating a weighted average of these coefficients, with weights given by the quantities of materials extracted in the corresponding years.

As far as roads are concerned, detailed data have been obtained from ANAS, the national company for roads maintenance and development, only for the years 1997-2002 and only for roads of national importance except motorways. On the basis of these data we calculated the quantity of earth removed for the construction of galleries for these roads, on the basis of the assumption that the holes dug had a circular section with a 10 meters diameter. For the years before 1997, only the aggregate data on the overall length of these roads was available, showing in some years a decrease, probably due to improvement and change of classification of the roads. On the basis of these data, an extrapolation to the whole period of interest has been made of the 1997-2002 data and estimate, under the assumption that the proportion of gallery tracks to the total of this kind of roads was constant at the 9,12% average of 1997-2002. No flow has been attributed to years with negative variation.

2.3 Indirect flows associated to imports and exports

From the point of view of the practical use of the coefficients provided by the Wuppertal Institute (see previous chapter, § 3.9), some adjustments were necessary due to the different levels of aggregation and to the use of two different classifications in foreign trade detailed data. Data for the 1991-1998 period are detailed by 8-digit code of the CN and by country of provenience (this detail on imports has been required only for the goods with country-specific coefficients). Data for 1988-1990 were only available by 4-digit CN code and without the country-of-origin detail, so it has been necessary to compute weighted averages of the coefficients used for the more recent period¹⁸⁵; in many cases this has only meant going back to the aggregation level with which indirect flow coefficients are supplied, so that no distortion has been introduced in these cases. However, for imported goods with country-specific coefficients, which are also better specified (in some cases, up to the 8-digit level of the CN), the result is actually the synthesis of different values. Data for 1980-1987 were available at the maximum level of disaggregation of the NIMEXE classification, though without country of origin, so that the weighted average used for 1988-1990 imports' has been transferred to the corresponding NIMEXE codes.

For the computation of indirect flows associated to exports, the values provided for Italy by the Wuppertal Institute have been adopted for the goods with country-specific coefficients. It must be pointed out however that the values present for Italy are default ones, but also that these goods are definitely not important items in Italy's export.

¹⁸⁵ We have used data of the three-year subsequent period (1991-1993) for calculating this average.

3 CONCLUDING REMARKS

Two kinds of conclusions can be drawn from the study presented in this chapter: conclusions of a substantial nature (what do the figures tell us about the Italian way of producing and consuming, and in particular on their environmental consequences?) and conclusions of a technical nature (are the indicators and the accounts feasible and reliable? What are the next steps to make in order improve and enlarge their significance?). We will briefly discuss here only the latter aspect, having already said something about the interpretation of the results in the text.

Given the methods and data sources, the production of the EW-MFA-based indicators dealt with here can be considered routine work, as data acquisition and elaboration has been arranged in a semi-automatic way. However, the update work has revealed that some calculations will need some reconsideration, mainly as a consequence of changes in the availability of data. A thorough revision of the EW-MFA-based indicators time series is therefore foreseen, in order to make sure that the regular production of these aggregates will actually follow the best procedures and use the most trustworthy data. This revision will benefit from the studies currently being carried out for the construction of a Physical Input Output Table (PIOT) prototype, referred to the year 1997, which is expected to bring substantial improvements in our knowledge on how materials flow to, through and from the economy (see the next chapter in the present volume).

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ANNEX - ITALIAN ECONOMY-WIDE MATERIAL FLOW INDICATORS 1980-2001

Table 1 reports the figures resulting from our calculations of the MFA-based indicators derived from some of the accounts described in the previous chapter, namely from the DMI, DMC, PTB, TMR, TMC and PTBIF.

It can be noted that we did not include in the table the indicator “Indirect Flows Trade Balance”, but substituted it with the PTBIF variant (Physical Trade Balance including Indirect Flows) which we consider more interesting even if not included in Eurostat’s Methodological Guide¹⁸⁶.

The time series have first been calculated in 2003 for 1980-1998; in this first phase, the methodology has been also developed which has been subsequently applied for the update to 2001.

¹⁸⁶ Eurostat, 2001.

Table 1 - 1980-2001 Material Flow Based Indicators Italy - Tons

	1980	1981	1982	1983	1984	1985
DMI ACCOUNT						
Domestic Extraction	754.783.954	737.567.272	705.249.741	677.806.981	675.050.937	639.491.961
Fossil Fuels	12.607.926	13.382.273	13.980.922	13.233.878	13.864.483	14.366.161
Minerals	492.752.313	473.149.310	453.316.162	432.718.485	427.413.892	405.065.665
Biomass	249.423.715	251.035.689	237.952.657	231.854.618	233.772.562	220.040.135
Imports	229.959.493	212.908.824	207.500.469	205.590.974	218.309.637	228.215.568
DMI - direct material input	984.743.447	950.476.096	912.750.210	883.397.955	893.360.574	867.707.529
DMC ACCOUNT						
Direct material input	984.743.447	950.476.096	912.750.210	883.397.955	893.360.574	867.707.529
Exports	57.945.200	59.843.610	59.760.796	59.033.886	60.028.098	64.340.773
DMC - domestic material consumption	926.798.247	890.632.486	852.989.414	824.364.069	833.332.476	803.366.756
PTB ACCOUNT						
Imports	229.959.493	212.908.824	207.500.469	205.590.974	218.309.637	228.215.568
Exports	57.945.200	59.843.610	59.760.796	59.033.886	60.028.098	64.340.773
PTB - physical trade balance	172.014.293	153.065.214	147.739.673	146.557.088	158.281.539	163.874.795
PHYSICAL TRADE BALANCE including INDIRECT FLOWS						
Imports and their associated indirect flows	858.206.401	815.395.826	828.034.930	773.814.917	906.924.674	942.883.748
Exports and their associated indirect flows	194.989.521	208.976.338	196.143.622	214.061.141	244.264.352	217.458.591
PHYSICAL TRADE BALANCE including INDIRECT FLOWS	663.216.880	606.419.488	631.891.308	559.753.776	662.660.322	725.425.157
TMR ACCOUNT						
Domestic Extraction	754.783.954	737.567.272	705.249.741	677.806.981	675.050.937	639.491.961
Imports	229.959.493	212.908.824	207.500.469	205.590.974	218.309.637	228.215.568
Unused domestic extraction	124.301.961	113.407.748	111.586.785	104.311.132	102.995.968	89.488.931
from mining/quarrying	34.903.612	34.339.326	33.231.857	31.383.705	31.247.072	31.580.707
from biomass harvest	11.897.087	12.903.947	12.351.789	12.403.936	12.403.414	11.992.607
soil excavation	77.501.262	66.164.475	66.003.139	60.523.491	59.345.482	45.915.617
Indirect flows associated to imports	628.246.908	602.487.002	620.534.461	588.223.943	688.615.037	714.668.180
TMR - Total Material Requirement	1.737.292.316	1.666.370.846	1.644.871.456	1.555.933.030	1.684.971.579	1.671.864.640
TMC ACCOUNT						
TMR - Total Material Requirement	1.737.292.316	1.666.370.846	1.644.871.456	1.555.933.030	1.684.971.579	1.671.864.640
Exports	57.945.200	59.843.610	59.760.796	59.033.886	60.028.098	64.340.773
Indirect flows associated to exports	137.044.321	149.132.728	136.382.826	155.027.255	184.236.254	153.117.818
TMC - Total Material Consumption	1.542.302.795	1.457.394.508	1.448.727.834	1.341.871.889	1.440.707.227	1.454.406.049

(continues)

Table 1 (continued) - 1980-2001 Material Flow Based Indicators Italy - Tons

	1986	1987	1988	1989	1990	1991
DMI ACCOUNT						
Domestic Extraction	737.992.409	675.907.658	683.348.226	702.572.125	695.677.988	706.391.525
Fossil Fuels	15.413.133	17.202.415	18.263.360	18.271.286	18.441.748	18.199.163
Minerals	489.770.031	435.419.811	454.779.706	469.982.250	476.286.944	477.260.376
Biomass	232.809.245	223.285.432	210.305.160	214.318.589	200.949.296	210.931.986
Imports	231.432.394	241.805.934	238.734.578	261.637.068	266.458.830	275.585.478
DMI - direct material input	969.424.803	917.713.592	922.082.804	964.209.193	962.136.818	981.977.003
DMC ACCOUNT						
Direct material input	969.424.803	917.713.592	922.082.804	964.209.193	962.136.818	981.977.003
Exports	65.419.488	65.458.268	66.952.754	71.094.410	73.358.432	74.491.710
DMC - domestic material consumption	904.005.315	852.255.324	855.130.050	893.114.783	888.778.386	907.485.293
PTB ACCOUNT						
Imports	231.432.394	241.805.934	238.734.578	261.637.068	266.458.830	275.585.478
Exports	65.419.488	65.458.268	66.952.754	71.094.410	73.358.432	74.491.710
PTB - physical trade balance	166.012.906	176.347.666	171.781.824	190.542.658	193.100.398	201.093.768
PHYSICAL TRADE BALANCE including INDIRECT FLOWS						
Imports and their associated indirect flows	940.436.888	974.742.511	982.107.195	1.089.422.522	1.152.025.877	1.253.160.715
Exports and their associated indirect flows	210.859.085	220.351.087	277.818.791	365.225.672	373.636.682	331.075.461
PHYSICAL TRADE BALANCE including INDIRECT FLOWS	729.577.803	754.391.424	704.288.404	724.196.850	778.389.195	922.085.254
TMR ACCOUNT						
Domestic Extraction	737.992.409	675.907.658	683.348.226	702.572.125	695.677.988	706.391.525
Imports	231.432.394	241.805.934	238.734.578	261.637.068	266.458.830	275.585.478
Unused domestic extraction from mining/quarrying	90.890.600	87.204.779	89.448.920	95.339.543	91.390.398	109.402.201
from biomass harvest	32.711.300	30.378.130	31.764.240	32.890.746	28.596.535	27.726.418
from soil excavation	13.167.055	13.274.379	13.713.570	14.275.548	13.649.444	13.548.744
Indirect flows associated to imports	45.012.245	43.552.270	43.971.110	48.173.249	49.144.419	68.127.039
TMR - Total Material Requirement	709.004.494	732.936.577	743.372.617	827.785.454	885.567.047	977.575.237
TMC ACCOUNT						
TMR - Total Material Requirement	1.769.319.897	1.737.854.948	1.754.904.341	1.887.334.190	1.939.094.263	2.068.954.441
Exports	1.769.319.897	1.737.854.948	1.754.904.341	1.887.334.190	1.939.094.263	2.068.954.441
Indirect flows associated to exports	65.419.488	65.458.268	66.952.754	71.094.410	73.358.432	74.491.710
TMC - Total Material Consumption	1.558.460.812	1.517.503.861	1.477.085.550	1.522.108.518	1.565.457.581	1.737.878.980

(continues)

Table 1 (continued) - 1980-2001 Material Flow Based Indicators Italy - Tons

	1992	1993	1994	1995	1996	1997
DMI ACCOUNT						
Domestic Extraction	707.458.108	631.901.311	618.366.137	634.624.026	637.472.418	615.454.615
Fossil Fuels	18.556.557	19.511.539	19.954.024	19.959.258	19.898.626	19.941.704
Minerals	478.721.591	410.842.496	398.173.578	421.779.399	423.158.136	408.461.764
Biomass	210.179.960	201.547.276	200.238.535	192.885.369	194.415.656	187.051.147
Imports	272.736.581	257.853.849	271.510.473	285.731.830	278.599.295	289.397.845
DMI - direct material input	980.194.689	889.755.160	889.876.610	920.355.856	916.071.713	904.852.460
DMC ACCOUNT						
Direct material input	980.194.689	889.755.160	889.876.610	920.355.856	916.071.713	904.852.460
Exports	80.337.918	88.273.404	91.164.624	94.021.401	101.239.198	111.037.449
DMC - domestic material consumption	899.856.771	801.481.756	798.711.986	826.334.455	814.832.515	793.815.011
PTB ACCOUNT						
Imports	272.736.581	257.853.849	271.510.473	285.731.830	278.599.295	289.397.845
Exports	80.337.918	88.273.404	91.164.624	94.021.401	101.239.198	111.037.449
PTB - physical trade balance	192.398.663	169.580.445	180.345.849	191.710.429	177.360.097	178.360.396
PHYSICAL TRADE BALANCE including INDIRECT FLOWS						
Imports and their associated indirect flows	1.229.985.312	1.328.683.912	1.266.100.844	1.352.998.970	1.268.084.684	1.323.749.513
Exports and their associated indirect flows	417.348.599	339.446.222	397.468.646	427.737.592	475.915.780	455.444.723
PHYSICAL TRADE BALANCE including INDIRECT FLOWS	812.636.713	989.237.690	868.632.198	925.261.378	792.178.904	868.304.790
TMR ACCOUNT						
Domestic Extraction	707.458.108	631.901.311	618.366.137	634.624.026	637.472.418	615.454.615
Imports	272.736.581	257.853.849	271.510.473	285.731.830	278.599.295	289.397.845
Unused domestic extraction	105.843.062	91.211.785	82.643.083	81.318.747	91.475.900	80.605.572
from mining/querying	29.937.099	26.175.579	17.591.358	17.384.225	16.686.508	16.715.068
from biomass harvest	15.028.736	15.219.341	15.062.662	16.509.848	18.064.605	18.961.230
soil excavation	60.877.227	49.816.865	49.989.063	47.424.674	56.724.787	44.929.274
Indirect flows associated to imports	957.248.731	1.070.830.063	994.590.371	1.067.267.140	989.495.389	1.034.351.668
TMR - Total Material Requirement	2.043.286.482	2.051.797.008	1.967.110.064	2.068.941.743	1.997.043.002	2.019.809.700
TMC ACCOUNT						
TMR - Total Material Requirement	2.043.286.482	2.051.797.008	1.967.110.064	2.068.941.743	1.997.043.002	2.019.809.700
Exports	80.337.918	88.273.404	91.164.624	94.021.401	101.239.198	111.037.449
Indirect flows associated to exports	337.010.681	251.172.818	306.304.022	333.716.191	374.676.582	344.407.274
TMC - Total Material Consumption	1.625.937.883	1.712.350.786	1.569.641.418	1.641.204.151	1.521.127.222	1.564.364.977

(continues)

Table 1 (continued) - 1980-2001 Material Flow Based Indicators Italy - Tons

	1998	1999	2000	2001
DMI ACCOUNT				
Domestic Extraction	689.278.973	834.009.582	802.909.552	747.810.442
<i>Fossil Fuels</i>	19.270.309	17.458.920	17.125.030	15.057.170
<i>Minerals</i>	477.279.833	619.059.870	599.087.134	553.067.997
<i>Biomass</i>	192.728.831	197.490.792	186.697.388	179.685.275
Imports	304.265.097	307.843.454	329.027.983	330.035.125
DMI - direct material input	993.544.070	1.141.853.036	1.131.937.535	1.077.845.567
DMC ACCOUNT				
Direct material input	993.544.070	1.141.853.036	1.131.937.535	1.077.845.567
Exports	112.520.167	113.485.286	119.299.456	123.117.502
DMC - domestic material consumption	881.023.903	1.028.367.750	1.012.638.079	954.728.065
PTB ACCOUNT				
Imports	304.265.097	307.843.454	329.027.983	330.035.125
Exports	112.520.167	113.485.286	119.299.456	123.117.502
PTB - physical trade balance	191.744.930	194.358.168	209.728.527	206.917.623
PHYSICAL TRADE BALANCE including INDIRECT FLOWS				
Imports and their associated indirect flows	1.489.172.487	1.399.532.382	1.500.840.428	1.486.084.142
Exports and their associated indirect flows	476.999.266	499.910.762	609.202.793	544.034.611
PHYSICAL TRADE BALANCE including INDIRECT FLOWS	1.012.173.221	899.621.620	891.637.635	942.049.531
TMR ACCOUNT				
Domestic Extraction	689.278.973	834.009.582	802.909.552	747.810.442
Imports	304.265.097	307.843.454	329.027.983	330.035.125
Unused domestic extraction	76.950.962	80.009.784	81.559.371	86.445.648
<i>from mining/quarrying</i>	17.950.420	23.738.638	22.828.241	19.682.377
<i>from biomass harvest</i>	17.677.111	18.741.871	18.856.566	19.271.971
<i>soil excavation</i>	41.323.431	37.529.275	39.874.564	47.491.300
Indirect flows associated to imports	1.184.907.390	1.091.688.928	1.171.812.445	1.156.049.017
TMR - Total Material Requirement	2.255.402.422	2.313.551.748	2.385.309.351	2.320.340.232
TMC ACCOUNT				
TMR - Total Material Requirement	2.255.402.422	2.313.551.748	2.385.309.351	2.320.340.232
Exports	112.520.167	113.485.286	119.299.456	123.117.502
Indirect flows associated to exports	364.479.099	386.425.476	489.903.337	420.917.109
TMC - Total Material Consumption	1.778.403.156	1.813.640.986	1.776.106.558	1.776.305.621



TAVOLE INPUT-OUTPUT IN TERMINI FISICI (PIOT)

Rapporto ad Eurostat

Physical Input-Output Table of the Italian economy: feasibility study and aggregate prototype

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1 INTRODUCTION

The work presented here builds on the results of a previous work, in whose framework an economy-wide Material Flow Balance for Italy, 1997 has been constructed (see chapter 2 in the present volume). The realisation of that work showed, besides the general feasibility of the account – i.e. the availability of data for almost all items of the balance or at least the possibility of calculating sufficiently reliable estimates – that:

- a) drawing sub-balances for particular kinds of materials and/or parts of the economy is useful and in some cases even necessary in order to draw and verify an economy-wide balance;
- b) in some cases it is also necessary to trace the flow of a particular material from one part of the economy to the others up- or downstream;
- c) a statistical discrepancy of 2% of Direct Material Input (DMI) remained after considering all items which could be accounted for. This discrepancy surely cannot be explained by the impossibility of including some items in the account and should be therefore regarded more as a measure of our ignorance of the real dimensions of material flows than as a measure of the balance of missing items.

Il testo riportato è una rielaborazione dei rapporti originali consegnati all'Eurostat nel 2004 e 2007 rispettivamente, per quanto riguarda le parti relative alle tavole Input-output in termini fisici.

I progetti e la stesura dei rapporti originali sono stati coordinati da Aldo Femia (Istat), che ha curato anche la presente rielaborazione.

I §§ 4.3.1 and 5.3.1 sono stati redatti da Stefania Balzamo (APAT); il § 5.2.8.1 da Ludovico Bracci (Istat); il § 5.2.5.1 da Livia Calabrese (Istat); il § 4 eccetto 4.3.1 da Gianna Greca (Istat); il § 5.2.2.2 da Antonio Macrì (Istat); il § 5.2.5.2 da Paolo Panfili (Istat); il § 5.2.8.2 da Carmela Pascucci (Istat); il § 5.2.2.1 da Edoardo Pizzoli (Istat); Aldo Femia ha redatto tutte le rimanenti parti.

Si ringrazia il Prof. Giorgio Nebbia.

In the light of the above, a deeper analysis of the circulation of matter through the economy was the natural continuation of the work started. Besides allowing amelioration of the economy-wide balance (in a disaggregated description, for instance, the discrepancy can be dealt with by using balancing procedures based on the principle of matter conservation and on mathematical statistical techniques) such an analysis has a value added in itself, as knowledge of how the matter circulates in the economy is crucial for understanding and managing the driving forces of the environmental pressures: matter is taken from the environment and transformed – a good part of it into substances which are harmful to the environment in which they are released – for someone to use or accumulate the products. It is exactly this that a Physical Input-Output table would tell us: who transforms the materials and who uses them.

A good deal of information exists that can be used for the construction of an Italian PIOT. It is not yet certain, however, whether these data are complete enough for the construction of a full-fledged and well disaggregated PIOT. Nor can this be assessed a-priori, i.e. before the attempt of putting together all useful information is actually made.

On the one hand, if for some variables data are not available at the start, this is not sufficient for declaring the unfeasibility of the table: the unknown quantities might turn up to be derivable from the known ones, just as a consequence of the principle of matter conservation and of the technical relationships that exist between the various types of inputs and outputs; the uncertainty attached to the derived data would then depend on the precision of the known ones in case of application of the principle of matter conservation, and also on the stability of technical relationships in case these are used.

On the other hand, even when information is available on all quantities to be included in the table, this information might nevertheless turn up to be so contradictory, and the input totals so far from the output totals, that no estimation of missing items and balancing procedure would hide the flaws of primary data.

Therefore, the results of the feasibility study described here cannot be final ones, while they enable us to design a project for actually trying its realisation, in addition to providing some “intermediate” results. Indeed, the main result of the feasibility study is that, on the basis of the information collected and the analyse carried out so far, “it is worthwhile going on” – which is what Istat is currently doing, with the institution of an *ad hoc* working group. In operational terms this means that it has been possible to formulate a fairly detailed project that, given what’s known, has good chances of success. This chapter discusses the project, as it appears at its current state of realisation.

The structure of this project, summarised in very broad terms and skipping the steps of going through the construction of Supply and Use tables, is summarised in figure 1, where the most important sources of information that have been considered and identified as useful are related to the parts of the table to which they should contribute. This figure anticipates the topics that are discussed in the paragraphs below.

As can be seen from the picture, an analysis parallel to that on physical data consists in considering the existing Supply, Use and symmetric monetary Input-Output tables of the Italian economy. After all, the phenomena studied are the basically same, as far as part of the table that describes the interrelationships between the economic activities are concerned: only the units of measure change from Euro to tons. In the construction of this part of the table – that involves the use of classifications and the attribution of specific flows to the different kinds of units involved – coherence must be granted with the principles and the current methods of realisation of National Accounts (NA), in order to grant comparability. Though a satellite module, moreover, the

construction of the PIOT might turn out useful for improving NA, and this is another good reason to keep under control the relationship between the two.

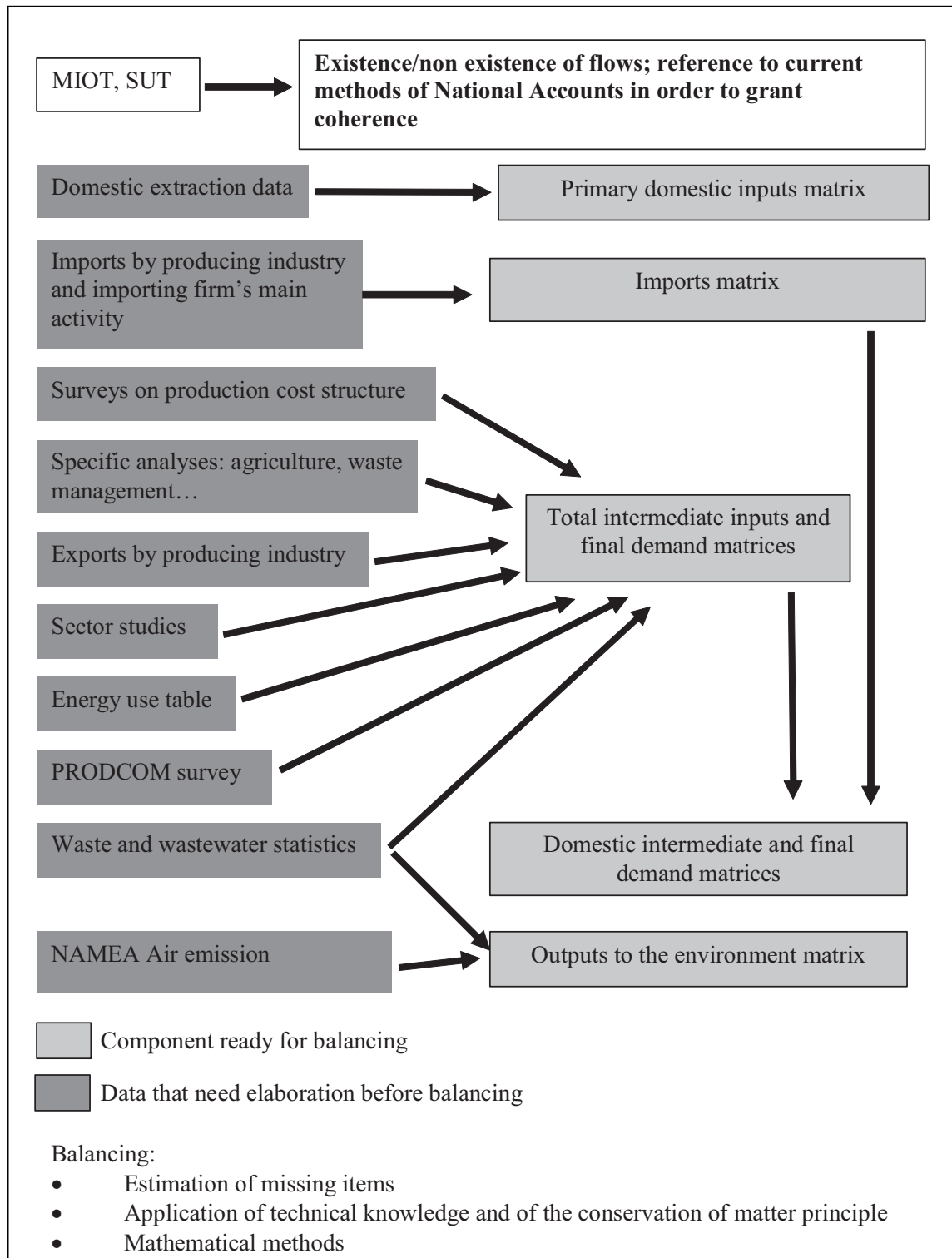
The other parts of the picture show how the different sources do contribute to the overall design of the PIOT, i.e. which module they feed or contribute to. Only the main sources and modules can be dealt with in such a picture, nor did we show in it how the data will be used: the details and the elaborations needed are partly described in the next paragraphs, partly need further work to be determined.

As far as data sources are concerned, though the pilot study refers to 1997, this should be partly understood as a “pivot” year, around which, in case of missing information for this target year, we have been looking for data that provide information on the structure of the material flows connected to the Italian economic life of the nineties. It is important to underline the word “structure” in the previous sentence, by which we mean information that concerns ratios, percentage allocations, technical coefficients and the like; all information of this kind from years other than 1997 must be used for the elaboration of level data specifically referred to that year (e.g. for the allocation through using industries of some known total quantity of a certain good produced in 1997). After balancing, 1997 will be a benchmark year for Italy’s MFA, to be considered as a reference point in the revision of the time series of economy-wide MFA-based indicators, which will have to be coherent with the 1997 PIOT.

The construction of the 1997 PIOT will show that PIOTs are in general feasible for Italy. Such an indication, however, should be accompanied by some warning. Indeed, even though new sources of data appear through time and some existing tools and sources are improving (e.g. enterprises’ registers, sector studies), some other sources which are suitable for contributing to the determination of 1997 material flows tables will not be such for later years, because of their occasional nature and distance in time from more recent years (e.g. Physical data in Istat’s surveys on production costs of 1992 and 1996).

In the following paragraph (§ 2) we discuss the reference models for the product we strive for; in the subsequent paragraph (§ 3) we deal with some general issues about classification and system boundaries; in §§ 4 and 5 we describe the sources of data which can be used in order to fill in the Supply and Use tables respectively and the elaborations that will be necessary to do so; then (in § 6) we discuss the issue of estimation of missing items, which shall be done in strict connection with the derivation and balancing of the Material Integration table (the symmetric PIOT properly said), discussed in § 7). The elaborations that have already been performed are described in connection with the items they are relevant for.

Figure 1 - An image of the project



2 REFERENCE MODELS

2.1 The SEEA

Chapter 3 of the System of Economic and Environmental Accounting (SEEA; see UN et al. 2003) deals with physical flow accounts and their linkage to the national accounts. This is the basic reference for the theoretical aspects concerning the Physical Input Output framework and for granting the maximum coherence with NA principles and comparability with NA aggregates.

In the following we will focus on the practical aspects of implementing an IO framework for material flows, nevertheless reference to the principles of SEEA will be implicit in the whole discussion.

2.2 Foreign experiences

PIOTs have been published by Germany (Stahmer et al. 1997; Statistisches Bundesamt, 2001) and Denmark (Gravgard, 1999). We will focus here mostly on the German example, as it is a PIOT model nearer to the one we strive for.

The German PIOT has been first elaborated at the Statistisches Bundesamt by C. Stahmer and others for 1990 and has recently been replicated for 1995. These tables offer a description of the circulation of materials from the environment to the economy, inside the economy and from the economy to Nature, disaggregating the productive activities in the same branches as in the country's monetary input-output tables.

One important aspect for which our project is inspired to the German PIOT is the logic of the MEFIS (Material and Energy Flow Information System) cube. The "faces" of this cube are matrices reporting the marginal distribution of flows that give the total Supply, Use and Material Integration (the PIOT properly said) tables. The classification of the materials that flow and of the concerned systems and sub-systems also allows to generate matrices for the partial distributions of flows (i.e. partial Supply, Use and Material Integration tables), namely those giving the breakdown into energy, water and other materials of the SUTs and those giving the breakdown into domestic and imported flows, as well as that highlighting energy flows in calorific power, for the PIOT properly said. Moreover, as the data in the cube are disaggregated at a much higher level than the published tables, more detailed analyses of flows of particular importance are possible, such as that of air emissions by branch.

The formulation of Supply-Use tables prior to integration of material flows into a Table where Input and Output flows of industries are interconnected is also corresponding to the use of physical commodity balances made at Statistics Denmark for the construction of the Danish PIOT, which also presents a disaggregation of the PIOT into detailed tables referred to the flows of the various different kinds of materials, as well as to the results of the analyses carried out on the data for air emissions with help of an input-output model.

The separate consideration of the supply and use aspects of the material flows occurring in economic transactions is indeed a highly useful step, for it allows gaining a deep understanding of the flows of Natural resources, Products, and Residuals, before going into the quantification of the physical interconnections between the activities. Indeed, the compilation of Supply and Use tables

amounts to the formulation of two kinds of material balances that can be made explicit by jointly reading the Supply and Use tables:

- A balance by material, i.e. by market as far as the Products parts of the tables are concerned, whose resources and uses sides are given respectively by a row of the Supply table and the corresponding row of the Use table, detailed respectively by producing and using activities, irrespective of the inputs of the former and of the outputs of the latter. The set of these balances parallels the usual goods and services account of National Accounts;
- A balance for each activity, i.e. by group of production, or consumption, or accumulation processes, whose resources and uses sides are given respectively by a column of the use table and the corresponding column of the supply table, which are detailed respectively by input and output materials, irrespective of the provenience of the inputs and of the destination of the outputs. The set of these balances parallels the usual production account of National Accounts (ESA 1995, § 9.05; see Eurostat 1996a, p. 207).

One respect in which the Italian PIOT will very likely differ from the German example is the treatment of water, which – due to the lack of data – will be included in our accounts only to the extent that it is embodied in some material product¹⁸⁷.

2.3 Academic work

In the academia substantial work on an Italian PIOT has been carried out in the last decade by Prof. G. Nebbia, who has pioneered Material Flow studies in Italy, who proposing his prototypes in several occasions. In his most recent publication on the topic (Nebbia, 2003) prof. Nebbia presents a 26 x 26 symmetric table describing, with reference to the year 2000, the web of physical exchanges that interconnect natural bodies (air, water, soil and natural stocks), domestic economic activities (classified into 19 different branches), Households, Stocks (of produced assets) and the Rest of the world.

The table, reported below, is a balanced one (i.e. its row totals are equal to the corresponding column totals) and results from the combination of the skilful use of published statistical data with the application of the knowledge of matter transformation processes provided by the natural sciences in general and by commodity science in particular as far as production processes are concerned. Indeed, technical coefficients tying the different inputs with one another and with the outputs (both desired and undesired), constants and necessary relationships from physics and chemistry (given by the law of conservation of matter in the first place) can play an important role not just in checking the correctness of the existing data and balancing the table but also in estimating the missing ones. This is an important feature of the approach, that the project presented here aims at transferring in the toolbox of physical flow accounting from prof. Nebbia's experience, carrying it through to physical environmental accounting in general¹⁸⁸. It can be noted that the application of technical coefficients is a method already in use in important areas of environmental statistics such as for instance the estimation of emissions of pollutants to air or water.

One specific application of these “non-statistical” tools is connected to the way agricultural production is included in the table. Its treatment, in fact, is different from that of EW-MFA. In the latter the harvested quantities are considered as inputs from Nature, whilst in prof. Nebbia's PIOT – as well as in the German one – the boundary between Nature and the economy is established at

¹⁸⁷ However, studies are currently going on at Istat, for the reconstruction of the circulation of water from and to the natural environment and within the economy, which could supply useful input, for the PIOT.

¹⁸⁸ Prof. Nebbia is member of the working group mentioned above.

the level of plants' nutrition, so that the primary inputs are (mainly) CO₂ and water, rather than already formed biomass. In order to find how much CO₂ and water have to be accounted for as agriculture's primary inputs, coefficients expressing average composition and humidity of the different kinds of biomass have to be used.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Air					186	51	208	6	10	51	15	10	12	18	3	10	10	14	10	32	13	146	10	135			950
Waters						180	7	5		21	7			16	8	15				4			8	51			354
Soil					104																						104
Natural Stocks							59	8	457	31	10			12						7							589
Agriculture					3	91	1							93	2					5							319
Livestock														41						61							1 361
Energy, Water					3		179	3	7	24	4	6	5	1	1	1	2	3	2	3	2	7	41	2	30		627
Metallic ores and metals								2	2		20									8							38
Non metallic minerals and products							5		6	15	6			3					5	403	20						5 486
Chemical products					11	5	1	1	1	45	1	1	2	8	2	2	15	10	2	12	8				3	12	199
Metal products											50	10	5						20	1	1					7	158
Machinery																										10	3 28
Transport equipments							4															5	2		17	5	39
Food, Beverages														103		1	4					32	74				5 340
Textiles, Leather products													1	8													6 33
Paper, Wood products														2		10									10	6	53
Rubber and plastics														3	2		8								4	1	50
Other manufactured products														2	5	1	1	2	15						10	15	72
Building and construction																				5	9				413	12	492
Waste treatment							5							2	4	3	5			10				69	20		308
Trade services														2	10	1	2	5		5	5		11	86			155
Transport services																											187
Services																				3							31
Households																				55					5		302
Stocks																				26					5		31
Imports						2	162	16	7	20	10	1	6	22	7	6	10	10	9	2	13				35		340
Total inputs	1.22	136	297	319	361	627	38	486	199	158	28	39	340	33	53	50	72	492	308	155	187	31	302	601	110	6.64	

Gross Domestic Material Product (GDMP) 2000 = X(n,22) + X(n,23) + X(n,24) + [X(n,25) - X(25,n)] + [X(n,26) - X(26,n)] = 860 Mt

Through time, prof. Nebbia's elaborations have become more and more compliant with the requirements of an accounting scheme in physical terms which parallels National Accounts in monetary terms, and have also become more disaggregated. Nevertheless, there still is much room for improving the detail of the description of physical flows, by using the existing information, available in the Italian statistical system in a much more disaggregated way than published, or unpublished and unexploited at all. Also, some conventions of National Accounts have to be applied. For instance, in the table reported below, two of the economic activities, namely *Transports* and *Services*, are classified as final users, along with Household consumption. Moreover, the latter category of final users appears to receive goods only from two branches (*Energy, water* and *Trade services*), which is certainly correct in the chosen prospective, but does not correspond to the treatment of these transactions in National Accounts.

As shown at the bottom of the table, Prof. Nebbia derives from it an aggregate, the Gross Material Domestic Product, whose construction parallels that of GPD seen as final consumption plus Investments minus Imports plus Exports, which was equal to 860 million tons in 2000.

2.4 The Italian MIOT

Coherence with the Italian Monetary Input-Output Tables (MIOT) has to be considered a fundamental requisite for the Italian PIOT. In particular, the classification of industries will tend to be the same as that of the Italian MIOT, in order to grant comparability with it. It is likely, however, that the Italian PIOT will have to be more aggregated than the Italian MIOT, for reasons of availability of disaggregated data and/or lack significance of disaggregation (e.g. in the service sector not all activities featuring in the MIOT need be singled out when dealing with material flows, as these are often negligible in service branches).

The MIOT can be considered also a source of information for the construction of the PIOT as a consequence of the methodological coherence of the latter with it. In that it gives qualitative information that can be used in order to identify the cases where no relevant flow of Products is expected to occur. Indeed, for Products only (Natural Resources are supplied freely and Residuals are usually not paid for), a sufficient condition for a physical flow to be null is that the corresponding monetary flow be null.

3 SOME GENERAL POINTS ON THE CLASSIFICATION OF MATERIALS AND SYSTEM BOUNDARIES

In the following paragraphs we will often use the word “material” as a noun. By this we mean anything that has a physical mass. Our attention however is limited to the materials that are intentionally moved by man for no matter what human activity, with the exception of most of water and air.

Publishable aggregated Physical Supply (output) and Use (input) tables (PSOTs) will be the result of aggregation of much more detailed material-by-activity matrices, whose construction we discuss in the next two paragraphs. The Material Integration table (i.e. the PIOT properly said) will be based on the elaboration of these material-by-activity tables.

In order to construct these matrices, it is first of all necessary to enumerate the materials of interest. A complete list of these materials shall include:

- all useful material Products deriving from economic activities, domestically produced or imported, both of primary nature (i.e. directly extracted from Nature) and resulting from transformation processes;
- all materials that are classified as “unused” in EW-MFA, as well as ancillary materials like oxygen for combustion and the like;
- all materials that derive from useful Products but are not embodied in other Products or stocks, being an undesired joint result of production or consumption activities, such as waste, emissions, water vapour etc.

In order to obtain a detailed classification of all relevant materials, it is sufficient to take the union set of the relevant classifications in use for the different kinds of materials, i.e. of the usual classifications of Products used in NA and of the classification of materials listed in the EW-MFA methodological guide (Eurostat 2001). In the following, we refer by default to the most disaggregated classification level at which data are available. Most of the necessary analyses, indeed, are best carried out at the most disaggregated level; the aggregation into materials groups – necessary for making all data fit into a common framework, as to allow balancing and publication – can be done subsequently.

For purposes of exposition and organisation of data, it is useful to refer to the SEEA grouping of materials, i.e.:

1. Natural Resources
2. Ecosystems Inputs
3. Products
4. Residuals

As in the German SUTs, we will consider Ecosystems Inputs under the same heading as natural Resources, as they have in common the characteristics that are most relevant for our purposes. We will use the term Natural Resources rather than Raw Materials as in the German case, for the reasons stated below.

Some material supply and use data have been collected or estimated in the framework of the Economy-Wide Material Flow Balance (EW-MFB) for Italy, 1997, mostly referred to the use of Natural Resources (harvest and extraction of primary resources, unused domestic flows connected to them, imports, input ancillary flows included as balancing items) and to Residuals released into the natural environment (waste, emissions to air and to water, farmyard manure, output ancillary

flows). These however are only the flows that cross the economy-Nature boundary, while the PIOT describes the flows of many more materials, as it includes all Products, though some of these are also included in EW-MFB (imports and exports, dissipative uses and losses of solvents, seeds, and the like).

Moreover, in the PIOT slightly different borders from those of the EW-MFB are assumed between the two systems:

- cultivated plants are classified as Products and not as Natural Resources;
- controlled landfills are included in the economy, so that waste, though a Residual, is not released into the environment.

As a consequence, some materials which are not products and nevertheless were not included in the accounts have to be added to the list, such as plant nutrients on the Natural Resources side and emissions from controlled landfills on the Residuals side. Another consequence is that, next to the accumulation of the usual stocks of useful products considered in NA (Buildings, Infrastructure, Machinery...), also the accumulation of some Residuals must be considered. Indeed, as long as a landfill is managed, it constitutes the working object of an economic activity (namely, of the waste management activity), and therefore it must be considered internal to the economy. In our view, these boundary choices correspond to a characterisation of the interested systems (agricultural landscapes and controlled landfills) as semi-natural ones, i.e. systems where neither man nor Nature rule entirely, but tightly interact¹⁸⁹.

In our view, it is important for the purpose of the PSUTs and the PIOT, Natural Resources to carefully keep distinct from Raw materials. Natural Resources are all the materials as they are found in Nature. These are freely supplied on human demand, be they useful for human activities or not. Raw materials are, in this prospective, the same materials once they have been transformed into a product, i.e. separated from the rest of Nature and from the Natural Resources that are not suitable for use but have to be moved anyway in order gain access to the useful ones. In EW-MFA Raw materials are accounted for as used inputs from Nature, while the other Natural Resources moved in order gain access to the useful ones are named “unused”. In Supply and Use tables, this distinction between used and unused materials is reflected – *mutatis mutandis* according to the different boundaries – into that between Natural Resources and Products. Thus, a quantity that is accounted for only once, as input from Nature in an EW-MFB, appears twice in a Supply table, as it is once supplied by Nature as Natural Resource, once by the sector that extracts it as a Product (Raw material). This is not the case for most of biomasses however, which only appear as output of agriculture (i.e. Products), while Nature only supplies their nutrients and water and air.

Finally, it must be highlighted that the activities of households cannot be characterised as final ones from a material transformation point of view, so that in a PIOT (as well as in EW-MFB, actually) households play a quite different role than that played in a MIOT (and in NA in general). Indeed, in consumption activities the matter embodied in products is either accumulated (durable goods) or transformed into Residuals. This has the consequence that two columns are included for households in a PIOT, in order to describe how they purchase respectively non-durable and durable goods from the various activities; two rows are also included to show, respectively, how households generate Residuals by using the former, and how accumulate and dismiss the latter kinds of goods.

¹⁸⁹ See Calafati, 2000, where the concept is referred to the agricultural landscape; we find it appropriate to extend it to controlled landfills.

4 SUPPLY TABLE: SOURCES OF INFORMATION AND ELABORATIONS NEEDED

4.1 Natural Resources

Material resources of various nature are supplied by the domestic natural environment¹⁹⁰ directly to the activities that carry out extraction processes. These resources are transformed in the extraction process into Products (raw materials) and Residuals. The subsequent transformations and uses of the products deriving from these resources, lead to the accumulation of stocks in the economy and to the emission of further Residuals into the natural environment. Indeed, the intake of these resources, along with imports, is the other side of the coin of emissions and stocks accumulation.

Data on all but a few minor items of Natural Resources intentionally moved by man have been produced and included in the 1997 EW-MFB for Italy (Femia (ed.), 2001). Making reference to EW-MFB definitions and classifications these comprise:

- minerals and fossil fuels extracted from the domestic territory;
- unused by-flows of mineral extraction and construction activities (soil excavation);
- ancillary flows accounted for as input balancing items (oxygen and nitrogen for combustion and respiration processes, drinking water for animals¹⁹¹).

As a consequence of the different boundaries between the economy and Nature assumed in the PIOT framework, the minerals, water and air (CO₂) supplied by Nature for the production of biomass, both used and unused, will have to be calculated. These will include the quantities that are embodied in cultivated work in progress items¹⁹². In practice, it will be necessary to reduce the quantities of biomass produced to their constituent components, with a quite straightforward application of scientific knowledge on plants and fruits.

All these materials are supplied, by definition, by the natural environment (i.e. by the “non-produced natural assets” of NA), which can be partitioned in various ways, e.g. as in prof. Nebbia’s table (see also § 2.3).

4.2 Products

Many materials, namely the ones that are useful products, are produced exclusively by one branch of activity, due to the fact that the branches we want to describe in the SUTs and in the PIOT are homogeneous ones. In its “Products” part, the matrix resulting after aggregation both of the rows (Products) and of the columns (activities) of the Supply table will be – like the monetary one – an almost perfectly diagonal one: each family of products is the result of a single family of activities, identified precisely on the basis of their products.

¹⁹⁰ It should be noted that there is a coincidence between the expressions “domestic extraction of Natural Resources” and “extraction of natural resource by the domestic economy”, as all imported materials are by definition Products and not Natural Resources.

¹⁹¹ This drinking water is in reality not always directly supplied by the environment, but for simplicity we will deal with it as if this was the case, as this allows to balance the accounts without going into the complex problems of the circulation of water into the economic system.

¹⁹² A project for estimation of biomass work in progress based on dendrometrics is currently ongoing at Istat.

4.2.1 *Domestic output of agriculture, forestry, animal and fishery products*

These data are regularly produced and published in the great detail by Istat. Excepting the ones on animal production, all of them are included into the DE aggregate. The allocation to production activities is trivial.

4.2.2 *Domestic output of industrial products*

The main source of information on useful industrial production is the PRODCOM survey. This survey supplies data on primary products (Raw materials) such as extracted minerals, as well as on other industrial products.

The products covered are those stemming from the activities of NACE divisions 13-36 (with the exclusion of division 23 which deals with energy transformation), and cover production of all firms with more than 2 job holders.

The data on production and sales are reported both in monetary and physical units. The latter however are not always weights, but can be linear, square or cubic meters, number of pieces or pairs, etc.

The data supplied by the PRODCOM survey on the physical quantities of industrial goods produced and sold therefore need two different kinds of elaboration before they can be included in a supply table:

- a) they must be supplemented in order to include production of small firms, which are quite important in Italy for many activities;
- b) for the products expressed in physical units other than weight, the data must be transformed into tons.

In the EW-MFB for Italy, 1997, the integration of the data has been done at the 5-digit ATECO level of aggregation, by using as a leading variable the ratio between the total value of output, as determined in the framework of National Accounts, and the value of PRODCOM output. The transformation into weights of products expressed in different units has been done by using the correspondence with the commodity classification used in foreign trade statistics (the Combined Nomenclature - CN)¹⁹³. The latter always include weights, besides values; moreover, the same quantities are often expressed also in an alternative unit, which is in most cases the same as the one used in the PRODCOM survey. It is thus possible to use the ratio between these two measures of the same quantity as a leading variable for the transformation into data in tons of the PRODCOM data that are expressed in units other than weight. The latter elaboration has been carried out at the product level, using export data (i.e. data on commodities domestically produced, as the ones in PRODCOM) so that this transformation can be considered quite reliable. In cases where the correspondence between PRODCOM and CN commodities is missing, other methods such as donation of unitary weight from similar products have been used¹⁹⁴.

¹⁹³ A very similar transformation method has been used both by the Statistisches Bundesamt and by Statistics Denmark. A comparison of results, especially with those of the German application for 1995, which is the nearest as for reference period, will possibly provide a better understanding of its reliability.

¹⁹⁴ The method used is described in greater detail in Femia (ed.), 2003.

4.2.3 *Domestic output of energy products*

Data on physical quantities of domestic production of energy products are supplied by the National Energy Balance. The products can be easily attributed to the producing branches, as also in this case the product identifies the activity.

4.2.4 *Material products of domestic service activities*

Some service activities, such as for instance preparation of meals, do provide something that is a service in economic terms, but also a material product in physical terms. This product is a material input to mostly households.

Unfortunately no direct source of data on these flows seems to be available; it will be therefore necessary to carry out ad hoc estimates.

4.2.5 *Imports*

These data are available at the 8-digit level of the Combined Nomenclature (CN8). Though in general it could be difficult to place the imported products in a Supply matrix whose rows follow the classifications used for domestic products, due to correspondences that are not one-to-one, when products are aggregated into groups according to the 5-digits ATECO of the producing activity which generate them, the correspondence does not pose any problem. Nevertheless, the possibility of using the more detailed correspondences between groups of goods present in the PRODCOM classification and established in other Istat works, will be studied.

For the purpose of the Italian 1997 EW-MFB, the imports have also been classified according to the prevailing kind of material they derive from (Biomass, Fossil fuels and Minerals plus the Composite products category for the goods that mix the three kinds of materials so that none prevails by far). This classification has also been donated to the PRODCOM, and is at the basis of the possibility of drawing sub-balances (and hopefully sub-tables, see 0) by kind of material.

4.3 Residuals

Residuals are usually not the product of a specific activity; on the contrary, the generation of some Residuals – such as for instance air pollutants – is an inevitable result of most activities. Therefore, further analyses of the available data sources might be necessary for the attribution of some Residuals flows to the activities that produce them, such as that carried out on air emissions in the framework of the NAMEA.

4.3.1 *Domestic waste production*

Data on waste produced by activity are supplied by the Italian National Agency for Environmental Protection and Technical Services (APAT). A preliminary analysis of the data shows that they are sufficiently complete and detailed for the elaboration of a waste Supply table, where activities (in the columns) are classified at the 3-digit NACE level. All wastes (in the rows) are classified by type according to CER, but for a residual part which is classified according to the Italian classification in use before CER was adopted.

As data on waste derive from an administrative source set up in order to monitor the waste management system, it is useful to briefly recall how the institutional mechanism that produces the data works.

The national framework law on waste, issued in 1997, is Legislative Decree 22/97 (commonly known as the “Ronchi decree”), which implements the packaging directive (94/62/EC), the EU Framework Directive on Waste (91/156 EC) and the EU Hazardous Waste Directive (91/689 EC).

This law implements the integrated waste management policy set up by the European Waste Strategy and has changed completely the waste management system in Italy. In fact it promotes clean technologies, the Ecolabel, the EMAS certification system and voluntary agreements between public administrations and economic operators, in order to create real opportunities for waste recycling. As for waste disposal, in accordance with Article 4 of the Council Directive 91/156/EEC, it must be done without endangering human health and without the use of processes or methods likely to harm the environment.

Waste producers are obliged to handle waste on their own or to use an authorized waste management enterprise. Transporters are obliged to be registered with the National Register of Waste Management Enterprises and need a waste identification document for each waste transport. For waste recovery or waste disposal operations, waste management enterprises need a permit of the regional authority (some regions have delegated the provinces to provide the permits). The Italian system for recovery and re-use of packaging materials is based on the principle of producer responsibility; a specialised organisation (CONAI) co-ordinates the collection and recycling system. The CONAI system is based on the activities of six material consortia representing steel, aluminium, paper, wood, plastic and glass. The consortia, whose associates are the producers, include all the main companies and cover the entire life cycle of each material. CONAI directs and co-ordinates the activities of the six material consortia. The collection of packaging waste is carried out by the municipalities, on the basis of contracts with CONAI.

The framework law on waste also enforces the European Waste List as waste classification that shall be used in every permit and waste identification document by all authorities involved in waste management. Waste Act 22/97 has adopted Annexes IIA and IIB of Council Directive 91/156/EEC, and intends to list disposal and recovery operations as they occur in practice. These are very important innovations in terms of availability of statistical information, because they allow checking the consistency of the information referred to the different stages of the waste cycles, and therefore to reconstruct a coherent picture of the flows to, between and from the various waste management activities.

Indeed, every year, all Italian municipalities and local units producing and/or managing waste have to fill an Environmental Compulsory Declaration called MUD; waste management enterprises have to register all information on nature, quantity, destination and transport of waste handled, and report yearly all this information to the National Waste Inventory by means of this questionnaire. Only some minor categories of local units are not required to fill in the questionnaire. This is the case, for example of agricultural farmers with a turnover lower than 7.800 Euro (15 million of old liras) and, as far as non hazardous waste is concerned, craftsmen with less than 3 employees.

The MUD must be sent to the Chamber of Commerce competent by area. The questionnaires must arrive not later than the 30th of April of each year, filled in with the data referring to the previous calendar year. The Union of Chambers of Commerce has to put the data in digital form and to transmit them to the competent administrations (i.e. the National Waste Inventory, the Regions, the Provinces).

This administrative source produces a great quantity of statistical information concerning the collection, treatment and disposal of waste, referred to municipalities and other waste producers and coded by economic activity. For economic activities, statistical units are Local Unit and data are available for sections, divisions, groups and classes of NACE Rev. 1.

Moreover, the Decree n. 372/1998 reorganizes the National Waste Inventory, which now is fully operational and is localized in the Italian Agency for Environmental Protection and Technical Services (APAT) at national level and in the Regional Environment Agencies (ARPA) at the regional one.

The MUD data set on waste has been extracted from about 400.000/450.000 declarations. The data coming from MUD need to be validated and in the last years IT tools that help to correct the systematic and random mistakes by using a bottom-up methodology have been established. In order to correct and validate the data coming from the MUD declarations, a standard common procedure has been developed, which has been followed by everyone involved in the correction of the data. This procedure has been drawn up together with the responsible of the Regional Waste Inventory of each Regional Environment Agencies (ARPA) at regional level. As a consequence the data on waste are validated in the same way at the different administrative levels.

The procedure is made by several steps. The first three steps are:

1. evidencing double declarations;
2. checking for possible wrong measurement units;
3. checking for possible wrong EWC and NACE Rev.1 code.

Subsequently the declared quantities of the single declarations made by managers of waste disposal, treatment plants and final disposal plants under permit are merged and compared with those derived from the permits issued by the Institutional Authority (pursuant to artt. 27 e 28 of law n. 22/1997), in order to improve the quality of the data referred to these units.

Thanks to this double check, often performed at regional level, the final quality of the data set is quite high. A further improvement of the data set is expected from the realization of a local network and an appropriate telematic tool.

The available time series range from 1996 to 2001 for Municipal waste (whose Italian definition is very similar to that of the OECD). Data of waste generation on industrial waste are available from 1997 to 2001 coded by EWC or HWL (non-hazardous and hazardous waste) and by economic activity (NACE).

The following table shows some summary figures on waste supply in Italy in the period 1995-2001.

YEARS	Municipal waste		Other waste ¹ (1.000 t)	Hazardous waste (1.000 t)	C&D (1.000 t)	Total (1.000 t)
	Total (1.000 t)	Per capita (kg/inh)				
1995	25.780	449	31.136 ²	1.632 ²	18.106	75.022
1996	25.960	451	n.a.	n.a.	18.414	n.a.
1997	26.605	462	40.488	3.401	20.397	87.490
1998	26.846	466	47.977	4.058	21.286	96.109
1999	28.364	492	48.656	3.811	23.880	100.900
2000	28.959	501	55.809	3.911	27.291	112.059
2001	29.409	516	59.359	4.279	30.954	119.721

Source: APAT

C&D: construction and demolition

¹ Without C&D waste; ² Source: ISTAT

In 2001 more than 110 million of tons of waste have been generated, with an increase rate of 100% in the last 10 years. Municipal waste amounts to about 30 million of tons (1/4 of the total waste generation) while about 60 million of tons are mainly industrial and commercial waste (representing 2/4 of the Italian total waste generation) and about 30 million of tons construction and demolition waste (C&D), i.e. 1/4 of the total waste generation.

4.3.2 *Polluting air emissions from domestic activities*

Data on air emission of the most important 10 pollutants (CO₂, SO₂, NO_x as NO₂, NMVOC, CH₄, CO, PM - Particulate matter (incl. dust), N₂O, NH₃, CFCs and halons) by branch of activity are produced by APAT. These are included – after attribution to production and consumption activities – in the Italian NAMEA, which gives the detail of the emissions by supplying activity. The 1997 NAMEA air emission matrix will be available by June 2004, when the 1990-2000 time series of these matrices will be completed.

Differently from EW-MFB, as a consequence of the different system boundaries, gases and other Residuals that leave controlled landfills have to be accounted for as Residuals (going to the natural environment), to which a negative accumulation in the controlled landfills entry under the man-made assets shall correspond.

4.3.3 *Material residues contained in domestic wastewater*

Data on this kind of flows at the economy-wide level have been calculated with some sectoral disaggregation in the framework of the construction of the 1997 material flow balance for Italy, both before and after depuration (though this has been possible only thanks to some simplifying assumption). The determination of the discharge of materials into wastewater by branch of activity can be done on the basis of the data on emissions by branch in terms of inhabitant equivalent figures.

4.3.4 *Water vapour*

Water vapour is one result of processes such as combustion and respiration (including by humans). Water vapour output has been calculated in drawing the 1997 material flow balance for Italy, keeping the different processes separated. The attribution to the various activities can be done following the same procedure, based on stoichiometric calculation, used for the Italian total.

5 USE TABLE: SOURCES OF INFORMATION AND ELABORATIONS NEEDED

5.1 Natural Resources

Natural Resources are used by the activities that extract them from the natural environment and transform the useful part of them in Raw materials, i.e. in products, and the remaining part in Residuals such as extraction waste and unused biomass. As far as the materials classified as used in EW-MFA are concerned, these are extracted only by a few activities, which transform Natural Resources into raw materials for the rest of the economy to use them. The attribution of the use is in these cases straightforward, as the activities are identified precisely on the basis of the materials they extract. A special case is that of agriculture and forestry, which use minerals and water from the soil and air from the atmosphere in order to create the plants and fruits which constitute their material output, both of Products (including work in progress) and of Residuals.

The allocation to using activities is straightforward also for the materials that are classified as unused domestic extraction in EW-MFA, as these are by-flows of mineral extraction and construction activities (soil excavation).

As far as the ancillary flows of air and water that are accounted for as input balancing items in EW-MFA are concerned:

- oxygen and nitrogen inputs for combustion processes have been calculated in drawing the 1997 material flow balance for Italy, keeping the different processes separated. The attribution to the activities that use them can be done following the same procedure, based on stoichiometric calculation, used for the Italian total;
- oxygen consumed by animals and humans, also present in the 1997 economy-wide MFA for Italy, is straightforwardly attributed to animal farming and household consumption activities;
- drinking water for animals will be considered as directly abstracted by the animal farming activities, even though this is probably not always the case.

5.2 Products

As far as the Use matrix is concerned, the part where most data sources and analyses converge is that concerning products. Indeed, many different products flow into each domestic activity and final use, and no unique and complete data source exists on the cost structures of industries and compositions of final uses. Nevertheless, several potential sources exist, that can be used in order to determine the destination of the products. In the following we will not take a univocal approach, but rather we will deal with the problem of constructing the Physical Use Table “by column” (i.e. we will discuss about cost structures or compositions of final uses) or “by row” (i.e. we will discuss about destination of products) as suggested by the characteristics of the available data, also with the purpose of highlighting some cases of special interest or particularly challenging.

5.2.1 *Istat's surveys on the 1992 production cost structure*

Surveys on the production costs structure of Italian firms have been carried out by Istat expressly for the construction of the (monetary) 1992 Input-Output Table, covering all categories of economic activity but agriculture. This survey includes data both in monetary and in physical quantities. The latter were included for checking purposes, and have been used to correct incoherent monetary data. The 1992 Input-Output Table, based on this survey, is at the basis of the balancing of the Italian National Accounts of the 1990ies, as it provided the benchmark structure of the economy for those years.

This survey is the most complete source of information on the structure of the Italian economy of the '90ies also as far as physical flows are concerned. However, since our focus year is 1997, we will consider this survey's results as a last resort, to be used only in case no information is available for 1997 or years less distant from that. Moreover, they will provide a control benchmark for doubtful results.

5.2.2 *Destination of agricultural, animal, forestry and fishery products*

5.2.2.1 *Istat's annual agriculture business survey*

The Italian annual business survey in agriculture (RICA-REA) by Istat, Inea and Regions started in 1999 with 1998 as reference year. The sample population of the survey includes all farms involved in vegetable and animal production (fishing and forestry excluded) and allows estimations for NACE Section A.01 "Agriculture, hunting and related service activities".

In its short-form questionnaire, designed to satisfy National Accounts requirements (SEC95), this survey includes a section on the structure of costs of farms. The data thus collected, however, cannot be used as such in the construction of the agriculture column of the use table, as the quantities of products used are expressed in monetary units only. Nevertheless, the survey is useful in order to identify the inputs used in agricultural activities, though not to quantify them directly in physical units. In case of lack of more direct methods, prices could be used in order to estimate quantities starting from surveyed values.

As far as the destination of the farms' Products is concerned (agricultural Products' rows of the use table), the questionnaire includes information in physical terms that is potentially useful. In fact, in order to get proper information and reliable estimates of money values of some economic flows of the farms, the data collectors have to fill up an auxiliary part of the questionnaire that includes information expressed in physical units. A page of the questionnaire (reported below) is devoted to reporting the quantities, while in the subsequent, equal in structure, the corresponding values have to be reported. For each kind of products and animals included, a balance for the reference year is drawn up in the corresponding row, including:

- on the resource side: opening stock, farm's production (for animals: births), and purchases;
- on the use side: reuse and transformation, own consumption (for animals: deaths and slaughtering), sales and closing stock.

Scheda ausiliaria per il riepilogo delle quantità dei prodotti e degli animali nell'anno 2002

I. PRODOTTI	Risorse dell'anno 2002						Totale Risorse=Impieghi		Impieghi delle risorse dell'anno 2002							
	Giacenze iniziali (all' 1/1/2002)		Produzione dell'azienda		Acquisti				Impieghi e Trasformati		Autoconsumo		Vendite		Giacenze finali (al 31/12/2002)	
	1		2		3		4=1+2+3=5+6+7+8		5		6		7		8	
	Q.li	Kg	Q.li	Kg	Q.li	Kg	Q.li	Kg	Q.li	Kg	Q.li	Kg	Q.li	Kg	Q.li	Kg
1. Prodotti vegetali																
1.1 Primari																
1.2 Sottoprodotti																
1.3 In corso di trasformazione																
1.4 Trasformati																

2. Prodotti zootecnici																
2.1 Non trasformati																
2.2 Sottoprodotti																
2.3 In corso di trasformazione																
2.4 Trasformati																

II. ANIMALI (esclusi quelli da riproduzione, da latte, da lana e da lavoro)	Giacenze iniziali (all' 1/1/2002)	Nati	Acquisti	Totale Risorse=Impieghi	Morti	Macellati	Venduti	Giacenze finali (al 31/12/2002)
	1	2	3	4=1+2+3=5+6+7+8	5	6	7	8
	Numero	Numero	Numero	Numero	Numero	Numero	Numero	Numero

This information can be used in order to determine a broad allocation of agricultural output between use of own products for transformation, own final consumption, sales and changes of

stocks. Such a broad allocation would be preliminary to a more detailed one between the users of the sold production (see the next section).

Since the auxiliary pages of the questionnaire are currently not registered, a preliminary analysis will be carried out in order to decide whether making this information available on electronic support is worth the cost. This analysis will consist first of all in counting the questionnaires with a filled auxiliary part, and analysing the coverage in terms of Products; the registration of a sample of these auxiliary pages might also be useful before going into the registration of the whole set, in order to carry out a preliminary analysis of the contents and to determine the reliability of the information.

After registration, it will be possible to check all the individual data, make the necessary corrections and integrations for wrong or missing values, and finally estimate the aggregate variables via population expansion coefficients.

5.2.2.2 *Destination of agricultural, animal, forestry and fishery products: other sources*

An *ad hoc* analysis has been carried out in order to identify possible sources of data on physical flows of Products from Agriculture, Forestry, Fishery and Animal farming (from now on only “agricultural Products”, unless necessary) to the production branches of the Italian economy and to final uses. The sources considered here are only the ones that are specific to the uses of agricultural Products and do not comprise other possible and more general sources such as surveys on industry cost structures or the sector studies dealt with elsewhere in the present chapter.

The first step in reconstructing the material flows of agricultural Products to other sectors and branches of economy consists in identifying the industrial branches which use agricultural Products as inputs for production. Since many of these inputs may have substitutes – depending on the kind of use to which they are assigned – and many Products may have several competing destinations, it has been necessary to track directly the flows of agricultural products to the industrial branches of the economy. For this purpose a specific analysis of the destination of these products has been carried out. This has been realised mainly on the basis of the 1995 monetary input-output table of the Italian agribusiness sector elaborated by ISMEA¹⁹⁵. In this table ISMEA subdivided the agribusiness system into 51 branches, of which 24 belonging to the agricultural sector (including forestry and fishery) and 13 belonging to the food industry.

ISMEA’s agricultural sector breakdown identifies agricultural branches on the basis of groups of agricultural products (i.e. cereals, oilseed, fruits etc.). This structure relies on the results of a sample survey realised by ISMEA, targeted on Italian farms included in 1990 census. ISMEA utilised a similar survey also to determine the relevant breakdown of the food industry; the groups of economic activities identified by this industry breakdown correspond to NACE industrial divisions or groups or classes, as a result of ISMEA’s survey design.

This table cannot be taken as direct source of material use data, because the flows are expressed in monetary terms. Nevertheless it provides an essential contribution to the knowledge of the Italian agribusiness sector, defining a structure for the breakdown of the flows of agricultural products to the Italian economy. It is as such, indeed, that it has been used in order to identify the most important agricultural products’ flows to other branches (mainly manufacturing industries) and final consumption.

¹⁹⁵ See ISMEA 1997. ISMEA is a member of the Italian Statistical System (SISTAN).

The analysis of the 1995 ISMEA table and the use of technical manuals allowed to track the uses of different agricultural products in the Italian economy of the 1990s, by singling out the economic activity that processes exactly that group of raw materials; subsequently the correspondent NACE code has been assigned to the activity.

This NACE labelling procedure of all identified uses has been necessary in order to assign each flow to one of the 92 branches of the economy, according to the architecture of the 1992 Italian input-output table, taken as reference structure in the present study.

5.2.2.2.1 The breakdown framework of the agricultural products' rows of the Physical Use Table

The following table reproduces the breakdown framework adopted for the agricultural products' rows of the physical use table, to be used in the pilot construction of the 1997 PIOT.

Breakdown framework for the agricultural products' rows of the physical use table

Production\Import	Uses/ n° I-O Branch/Ateco codes													Final consumption		
	1	2	7	8	9	10	11	12	13	14	19	20	23		25	94
	Agricul- ture	Animal farming	Meat proces.	Other food Industries	Vegetab. fruit proces.	Milk processing	Cereals processing	Fodders processing	Beverages processing & tobac.	Textile fiber & tissues	Wood products	Paper	Basic Chemicals	Pharmac. products		
Wheat & Rice	01.1	1.2					15.6									
- prod.	x	x				xxx										x
- import	.					xxx										x
Total	x	x				xxxxxx										xx
Maize & other c.	01.1	1.2		15.4		15.6	15.7	15.96-97								
- prod.	.	x		.		.	xxxx	x								x
- import	x	.		x		x	x	x								x
Total	x	x		x		x	xxxxx	xx								xx
Sugar beet.	01.1			15.83												
- prod.	x			xxxx												x
- import	.			xxxx												x
Total	x			xxxx												xx
Oilseeds crops	01.1			15.4			15.7									
- prod.	.			xx			xx									x
- import	x			x			x									x
Total	x			xxx			xxx									xx
Other ind. crops incl. Textile crops	01.1			15.4						17						
- prod.	.			xx						x						x
- import	x			xxx						x						x
Total	x			xxxxx						xx						xx
Tobacco	01.1								16							
- prod.	xx								xxxx							x
- import	.								.							x
Total	xx								xxxx							xx

(continues)

Breakdown framework for the agricultural products' rows of the physical use table (continued)

Uses/ n° I-O Branch/Ateco codes		1	2	7	8	9	10	11	12	13	14	19	20	23	25	94				
Production/Import		01.1	1.2	Agricul- ture farming proc.	Animal Industries	Meat fruit proces.	Other food fruit proces.	Vegetab. processing	& milk processing	Milk processing	Cereals processing	Fodders processing	Beverages processing & tobac.	Textile fiber & tissues	Wood products	Paper	Basic Chemicals	Pharmac. products	Final consumption	
Potatoes		01.1	1.2			15.3		15.6												
- prod.			x			x														x
- import		xx				x														x
Total		xx	x			xx														xx
Tomatoes		01.1	1.2			15.3														
- prod.		x	.			xxx														x
- import		x				xxx														x
Total		xx	.			xxx														xx
Other vegetables		01.1	1.2			15.8														
- prod.		x	x			xxx														x
- import		x				x														x
Total		x	x			xxxx														xx
Flowers & others		01.1				15.8							15.9							
- prod.		xx				xx							xx							x
- import		xx				xx							xx							x
Total		xxxx				xxxx							xxxx							xx
Citruses p. crops		01.1				15.3							15.9							
- prod.		x				xxx							xx							x
- import		x				xxx							xx							x
Total		x				xxx							xx							xx
Fruit p. crops		01.1	1.2			15.8				15.5			15.9							
- prod.		x	x			xxx				x			x							x
- import		x				.				.			x							x
Total		xx	x			xxx				x			xx							xx

(continues)

Breakdown framework for the agricultural products' rows of the physical use table (continued)

Uses/ n° I-O Branch/Ateco codes

	1	2	7	8	9	10	11	12	13	14	19	20	23	25	94
	Agricul- ture	Animal farming	Meat proces. Industries	Other food & fruit proces.	Vegetab. & fruit proces.	Milk processing	Cereals processing	Fodders processing	Beverages processing & tobac.	Textile fiber & tissues	Wood products	Paper	Basic Chemicals	Pharmac. products	Final consumption
Production/Import															
Vineyards	01.1								15.9						
- prod.	x								xxxx						x
- import	x								.						x
Total	xx								xxxx						xx
Olive growing				15.4/15.8	15.3										
- prod.				xxxx	x										x
- import				.	.										x
Total				xxxx	x										xx
Permanent grassland								15.7							
- prod.	01.1	1.2						xx							x
- import	x	xxxxx													x
Total	x	xxxxxx						xx							xx
Forest wood prod.															
- prod.											20	21	24.1		x
- import											x	xx	x		x
Total											xxxx	xxxx	.		x
Forest non-wood products															
- prod.		1.2													
- import		xx													x
Total		xx													xx

(continues)

Breakdown framework for the agricultural products' rows of the physical use table (continued)

Production/Import		Uses/ n° I-O Branch/Ateco codes													Final consumption	
		1	2	7	8	9	10	11	12	13	14	19	20	23		25
		Agricul- ture	Animal farming	Meat proces. Industries	Other food Industries	Vegetab. & fruit proces.	Milk processing	Cereals processing	Fodders processing	Beverages processing & tobac.	Textile fiber & tissues	Wood products	Paper	Basic Chemicals	Pharmac. products	Final consumption
Animal farming		1.2	15.1	15.4/15.8	15.5	17	24.5									94
- prod.		XX	X	XXXX	X	X	XXXX				X				X	X
- import			•	X	X	X					X				•	X
Total		XX	X	XXXXX	XX	XX	XXXX				XX				X	XX
Fishery				15.2										24.1		
- prod.				•										X		X
- import				X										•		X
Total				X										X		XX

Notes

- negligible
- x not very small
- xx small
- xxx medium
- xxxx large
- xxxxx very large

shades of grey

- official data / Istat - Sistan
- administrative data / Government, Mipaf - Ismea
- Estimates / Producers assoc - others

The columns of this framework are the same of those of the 1992 IO table and in particular they represent all branches of the economy and final consumption which receive and process physical inputs of products from Agriculture, Forestry, Fishery and Animal farming. The rows represent the different sets into which it is convenient to group these products in order to study their destination.

This framework has been designed for the 1997 PIOT pilot construction; should the same framework be applied to the construction of a PIOT of another (distant) year, it would be necessary to carry out a preliminary analysis, in order to verify whether the relationships between sectors and branches had structurally changed in the meantime. For instance, new uses of agricultural products, in branches of the economy not comprised in the framework could intervene, or some current uses could disappear.

The number at each crossing point (cell) between the rows and the columns is the NACE code that identifies the activity processing the products in the row. This NACE activity is included in the 1992 I-O branch named on top of the column. For each use of agricultural products, the flows are distinguished between domestic and foreign (import) origin, in order to assess separately their relevance.

A preliminary evaluation of each flow's importance is represented by the number of "x"s in the corresponding cell; a dot "." means that the flow's amount should be negligible. The different shades of grey in the cells indicate the kind of data source that can supply data on the corresponding flow for the 1997 use table.

5.2.2.2.2 Specific data sources for the agricultural products' rows of the Physical Use Table

This section describes the data sources represented by the different shades of grey in the table, read by column. As the uses of agricultural products in Italy are not always registered by official data sources, especially for what concerns physical quantities, the use of administrative data is foreseen. A role is also assigned to experts' knowledge of the using sectors; however this should be seen as a last resort, should the other sources not suffice for covering all flows.

Uses in the Agriculture branch

Data about flows of agricultural and forestry products to Agriculture are supplied by official sources of the Italian Statistical System (Istat surveys on products of forests and cultivation). These sources can provide data on flows of domestic production whereas trade statistics can supply data on imports. Only to account for flows of Animal farming by-products (manure) to Agriculture data must be supplied by expert estimates or computed by applying technical coefficients to cattle's stock figures, as has been done in computing the economy-wide material flow balance for 1997.

Uses in the Animal farming branch

Data about flows of agricultural products to the Animal farming branch can be retrieved from product balance sheets. These balances are endorsed by Government approval (Ministry of Agriculture and Forestry Policy) with ISMEA technical support and supplied yearly to Eurostat and European Commission. Data on the uses of forage (from permanent grassland) in the Animal farming branch are supplied by official statistical data (Istat's survey on permanent grassland and forages), whereas as far as Forest non-wood products' uses in Animal farming are concerned, we have to rely mostly on expert estimates or farmers/breeders associations.

Uses in the Meat processing branch

Data on flows of animal products to the Meat processing branch may be retrieved from Istat survey on slaughtering and/or estimated from the production of the using branch surveyed by the PRODCOM.

Uses in the Other food industries branch

Flows from many agricultural cultivations to the Other food industries branch may be retrieved from the specific product balance sheets (i.e. those on oilseeds, cereals, sugar beet, olive oil etc.). Data about some minor flows such as fruit, vegetables and flowers can be supplied mostly by expert estimates or industrial producers' associations. Data about flows of fishery products to the Other food industries branch can be retrieved from ISMEA yearly sector report, estimated from PRODCOM surveyed production or provided by Industrial Associations.

Uses in the Vegetables and fruit processing branch

Flows of agricultural products to the Vegetables and fruit processing branch may be retrieved from the specific product balance sheets (i.e. those on fruits, citrus, tomato, etc.).

Uses in the Milk processing branch

Data on flows from Animal farming to the Milk processing branch can be retrieved from Istat survey on milk and milk derivatives and/or estimated from PRODCOM surveyed production. Data about some minor fruit flows can be supplied mostly by expert estimates or sector's associations.

Uses in the Cereal processing branch

Flows of agricultural product to the Cereal processing branch can be retrieved from cereals balance sheets.

Uses in the Fodder branch

Data on flows from Agriculture to the Fodder branch can be retrieved from cereals balance sheets.

Uses in the Beverages and tobacco branch

Data on material flows from Vineyards to the Beverages and tobacco branch can be supplied by official sources of the Italian statistical system. Data on flows from tobaccos to Beverages and tobacco branch can be retrieved from product balance sheets or administrative archives (those of AGEA, the national agency that controls the application of the Common Agricultural Policy), as tobacco is a product subject to Common Agricultural Policy regulation. For data about other flows of agricultural products to this branch, we will have to rely on expert estimates or sector's associations.

Uses in the Textile fibres and tissues branch

Data on material flows from Agriculture and Animal farming to the Textile and tissue branch can be estimated by applying technical coefficients to the statistics supplied by the survey on the area of textile crops, assuming that all sold domestic production not exported is used in this branch. On the basis of the same assumption, another potential source of data is the survey on cattle stocks and other variables (wool), whereas for other minor flows we will have to rely on estimates.

Uses in the Wood product branch

Data on flows from Forestry to the Wood product branch will be provided by official forestry statistics (survey on wood removals), which specifies the use to which the wood is destined.

Uses in the Paper branch

Data on flows from Forestry to the Paper branch will be provided by official forestry statistics (survey on wood removals).

Uses in the Basic chemical branch

Data on flows from Forestry and Fishery to the Basic chemical branch will be supplied by estimates provided by expert and sector's associations, coupled with statistics from the PRODCOM survey.

Uses in the Pharmaceutical products branch

Data on flows from Animal farming to the Pharmaceutical products branch will be supplied by estimates provided by expert and sector's associations, coupled with statistics from the PRODCOM survey.

Uses by Final consumption

For data about all flows from Agriculture, Forestry, Fishery and Animal farming to Final consumption we will have to rely on the available product balance sheets and/or statistical estimates based on the commodity flow approach.

5.2.3 *Use of industrial products by economic destination and useful material stocks accumulation*

Some important intermediate results for the Physical Use Table, and especially for its rows concerning industrial products, have been obtained in the framework of the Italian 1997 EW-MFB. These results consist in:

- a) the allocation to economic destinations of the total resources available for domestic uses of each industrial product, i.e. the determination of this total and its split into the components intermediate consumption, household consumption and gross investments; this allocation has been obtained by applying the method and tools in use in National Accounts;
- b) the calculation, also on the basis of the allocation under a), of the "Additions to stocks" aggregate of the EW-MFB. For this, we had to further split the household consumption component into the non-durable goods part, which is an intermediate input for the "household material transformation" activity, and the durable goods part, which contributes to the build-up of stocks. Also, the additions and subtractions to the components Inventories, Buildings and infrastructures and Machinery have been separately assessed.

The premises for these operations are in the transformation of all PRODCOM data into weight units and integration for incomplete coverage, described in § 4.2.2.

Though a revision of this work is foreseen for its use in the realisation of the PIOT, it is worth recalling the procedures followed, which provide a starting point for further work.

The first step consisted in the calculation of total resources by type of commodity, i.e. imports had to be summed up to national productions, and exports subtracted. As this cannot be done at the commodity level, due to the existence of several many-to-many correspondences

between the PRODCOM and the CN classification, both the data on domestic industrial production and on foreign trade have been aggregated at the 5-digit ATECO level, using simple correspondence keys telling what ATECO activity is the one producing any particular good. It is clear that in both the industrial production and foreign trade cases, the activities thus defined are homogeneous ones from the point of view of the products they give. One aim of the foreseen revision is the use of correspondences between groups of products smaller than those defined by ATECO categories, as to allow calculation and allocation of resources available for domestic use at a more detailed level.

Once the total resources available for domestic use have been thus determined by ATECO category, we did split them again by PRODCOM8 products, as it is for these that the use destinations are known. This has been done by using the relative weights of the individual PRODCOM products in the total weight of each ATECO's national production.

Finally, the uses by kind of economic destination have been determined by using the percentage allocations that had been determined for the use in NA (see Istat, 2000, pag. 16) by an *ad hoc* Working Group on the basis of their individual characteristics and of the results of Istat surveys.

Possible destinations of the resources available for domestic use, according to these allocation quotas, are intermediate or final consumption and investments. As hinted above, we further split goods going to final consumption into durables and non-durables; this has been done by considering as durables all the goods that also have a quota going to investments, and on the basis of the results of a former study by Istat for the cases that could not be settled in this way¹⁹⁶.

On the basis of this allocation, we produced estimates for the main categories of material accumulation in the technosphere. The description of the procedures used for obtaining the subsequent estimation of Gross and Net Additions to Stocks are reported in chapter 2 of the present volume¹⁹⁷.

5.2.4 Istat's survey on the 1996 industrial production cost structure

A survey has been carried out by Istat in order to collect information to be used in the construction of an updated MIOT. This survey deals with the industrial sector only, its scope being limited to the activities inherent the PRODCOM classification, i.e. sections C and D of NACE Rev. 1 (Mining, Quarrying and Manufacturing Industries, except subsection DF - Manufacture of coke, refined petroleum products and nuclear fuel and of division 37 - Recycling), plus the section F - Construction.

The degree of coverage varies from branch to branch. It is therefore not possible to draw a general conclusion on the possibility of using the results of this survey; rather, it will be necessary to assess it case by case, also taking into account that the distribution of the average unit value of a same commodity used in the various production activities often shows a wide variability.

The branches with a better coverage in terms of job holders are the following:

¹⁹⁶ This distinction between durable and non durable goods is mostly based on an economic concept of durability, and therefore needs to be revised for our purposes, as a classification based on the physical concept of durability does not necessarily coincide with that based on the economic concept (e.g. a needle is not durable as such, and therefore is classified as non-durable in economic terms; however it still is an addition to useful physical stocks when driven into a wall, and must be classified as such in MFA applications).

¹⁹⁷ The items that have been subtracted in order to go from Gross to Net Additions to stocks are actually Residuals that are supplied by the individual stocks; in the Use table they appear in the columns of the activities that use them, e.g. external environmental protection services and recycling.

DENOMINATION OF THE BRANCH	% Coverage
Tobacco products	67.7
Basic chemicals	37.9
Pharmaceuticals	23.2
Home appliances	19.8
Man-made fibres	18.8
Rubber	18.7
Metals	18.0
Beverages	15.7
Ceramic products	15.4
Electric transformers	12.8
Electronic products	12.1

Many categories, however, have a number of surveyed firms that is insufficient both for a revision of average unitary values of raw materials and of per-capita values of their uses classified by 3-digit ATECO groups, and for an adequate coverage of the economic activities surveyed.

As can be seen from the following frequency table:

No. of surveyed firms	No. of ATECO91 categories
0	29
1	32
2	33
3	26
4	24
5	21

165 ATECO91 categories on 388, i.e. 42.5% of the total, are represented by a number of firms lower than 6.

It can be noted that the sample is not representative for the oils and fats industry (ATECO 15.41.3: Manufacture of crude animal oils and fats and ATECO 15421: Manufacture of refined olive oil have frequency 0, while ATECO 15.41.1: Manufacture of crude olive oil is present with only 1 firm), and for Construction (NACE 45.21: General construction of buildings and civil engineering work has frequency 0, while the number of firms surveyed covers 0.58% of the job holders).

Among ATECO categories with frequency 0, the following deserve highlighting:

24.20.0 Manufacture of pesticides and other agro-chemical products

29.11.2 Manufacture and putting in place of hydro- and thermoengines and turbines, and other machines producing mechanical energy, comprised parts thereof, reparation etc.

33.20.3 Manufacture of instruments and appliances for navigating, hydrology, geophysics and meteorology

36.22.2 Working of precious and semi-precious stones for jewellery for industrial use

Also the industry of transport vehicles (motor vehicles, ships, railway and tramway rolling stock, airplanes) is not adequately represented as firms of particular relevance as FIAT and FINCANTIERI have not answered.

As for the data, these in principle include both quantities (opening stocks, closing stocks and current uses) and values (current uses). The commodities included in the questionnaires (concerning raw materials, semi-finished goods, detached parts, ancillary materials and packaging) have been registered in three distinct files:

- a file of 31.931 records, containing data both in value and in quantity, with their respective measurement units;
- a file of 2.389 records, without measurement units;
- a file of 8.048 records with quantities but without values.

Assuming that a measurement unit can be properly attached to the quantities reported in the second kind of records, and that those of the third kind are checked (e.g. against the firm's output) there is a total of 42.368 potentially useful records to be further analysed.

5.2.5 *Ministry of Finance sector studies*

5.2.5.1 *General features*

Since 1998 the Ministry of Finance carries out a survey on small and medium enterprises and professions for taxation purposes. To each respondent a specific presumed taxable income is assigned, that depends on the results of the relevant sector study to and on the information collected on the unit through the survey.

The procedure used for constructing the sector study has three phases. Firstly, for the reference year the data are collected and the reference data set is created. Then the data are reduced through a principal component analysis and a cluster analysis is carried out on the principal components to define groups of homogeneous enterprises. Lastly, for each cluster the function for the determination of the presumed taxable income is calculated with a multivariate regression; enterprises having extreme values for the relevant variables are excluded from this stage. Some elements of correction are introduced in the income functions depending on the geographical location of the enterprise. The data set is annually updated and via a discriminatory analysis the enterprises are assigned to the appropriate cluster and, as a consequence, to the appropriate income function and corrections.

While considering the calculation of the presumed taxable income is useful to correctly understand the meaning of the available variables' set, we are basically interested in the annually updated data set. Let us therefore consider the Ministry of Finance sector study just as

an administrative source on small and medium enterprises and professions¹⁹⁸.

The scope of the survey is defined by a turnover ceiling, equal to € 5.164.569, and a filter on the economic activity code. The economic activity nomenclature used is more detailed than ATECO91, and perfectly fits into the structural and hierarchical framework of the latter¹⁹⁹. By appropriately grouping the activity codes, industry segments are defined (the sectors), that fit in four general areas of activity labelled as Services, Manufacturing, Trade and Professions. For each sector a questionnaire is provided.

The unit of observation is a sort of local kind of activity unit, i.e. the part of the enterprise carrying out a single activity and having a specific location. At a micro level it may be difficult to identify the enterprise as a unit. However, the majority of the enterprises involved are simple organizations with a sole (main) activity and a unique location. Some 'clauses of exclusions' are also foreseen, i.e. conditions by which an enterprise belonging to the theoretical scope is exempted from responding. The scope of the survey is in progress, as each year new studies are added: the studies were 45 in 1998 and went up to 168 in 2001. In the same period the collected observations grew from 1.058.899 up to 2.718.306. According to the Tax Authority, in 2003 almost 4 millions taxpayers have been concerned by the studies. The following table shows the development of the scope in terms of number of concerned 5-digit ATECO91 activities by division of economic activity.

¹⁹⁸ The method used to check the tax declaration is interesting for our purposes to the extent that they contain coefficients which tie variables known at the sector level (such as revenues, or labour force employed) to the material inputs used (or outputs produced, for the material supply table), as to find the latter from the former. However, these results might not be applicable for our purpose, because the focus variables – the dependent ones – of our study are different from taxable income; moreover, our analysis can profit from linking the sector studies' data set with other archives. It is therefore advisable to formulate our own analysis strategy in the first place, and decide thereafter whether further considering sector studies' results and methodologies.

¹⁹⁹ Due to the higher degree of detail of the Ministry of Finance nomenclature, it is possible that some activities in the survey scope cover only partially the corresponding 5-digit ATECO91 activities.

NACE DIVISION	Sector Studies			
	1998	1999	2000	2001
14	8	9	9	9
15	8	8	8	8
17	4	20	20	20
18		8	10	10
19	3	3	5	5
20		7	7	7
21				3
22				7
26	3	6	9	13
27			1	11
28			28	28
29	1	1	36	36
31			1	1
33		2	2	3
35				1
36	6	6	8	9
45	3	12	12	17
50	5	9	9	9
51	5	9	42	71
52	30	35	40	64
55	4	13	13	13
60	1	1	5	5
63				4
64				1
70	1	1	2	2
72				7
74	2	2	11	13
80				1
85			3	9
92			1	1
93	3	5	5	5
Total	87	157	287	393

The survey proves to be a precious source also when its coverage vis-à-vis ASIA is considered. We evaluated the coverage by considering the ratio between the number of enterprises present in the sector study and the number of enterprises present in ASIA and belonging to the 5-digit codes that each year define the scope of the Ministry of Finance survey. No condition has been set on ASIA enterprises' size. Moreover, due to the difficulty of identifying the enterprise as a whole when it has more than one activity or more than one location, only mono-activity mono-location enterprises data sets are considered among the enterprises present in the sector study. The small average dimension of the Italian enterprises nevertheless implies that the coverage thus calculated is only slightly an underestimate. The following table shows that it is very good.

C - TAVOLE INPUT-OUTPUT IN TERMINI FISICI (PIOT)

NACE DIVISION	Sector Studies			
	1998	1999	2000	2001
14	68,7	69,3	72,7	69,7
15	64,6	69,3	78,0	71,6
17	65,9	72,4	75,1	77,2
18		72,0	75,1	74,3
19	73,8	74,8	71,6	71,5
20		70,4	74,8	73,6
21				68,8
22				72,9
26	73,8	71,8	71,7	73,0
27			(*)	89,8
28			74,3	75,9
29	76,5	74,3	67,9	69,2
31			61,2	61,9
33		63,7	70,1	90,7
35				63,0
36	65,0	68,9	71,1	73,2
45	79,6	76,2	78,9	78,2
50	77,9	74,2	78,3	76,7
51	75,1	73,8	74,3	72,8
52	77,8	74,0	78,5	72,0
55	72,7	71,4	76,4	70,2
60	78,1	77,5	80,1	80,9
63				54,2
64				64,7
70	66,3	69,1	74,9	78,5
72				51,9
74	(**)	(**)	73,7	72,7
80				82,4
85			(***)	(***)
92			86,0	87,1
93	84,4	82,8	84,4	84,1
	72,6	72,8	77,3	74,7

(*) The data are omitted because they refers to very few units active in a sole 5-digit code

(**) The data are omitted because the Sector Studies scope covers only partially the corresponding 5-digit codes

(***) The data are omitted because the scope of ASIA covers only partially the units active in this division

The data collected in any given year refer to the taxation period, which coincides with the previous year²⁰⁰. By now Istat has acquired the data sets referring to four years, namely from 1998 to 2001.

The questionnaires tend to be strictly tailored to the activities they refer to²⁰¹. The source is rich in information because it tries to fully describe the activity of the enterprise and the economic context in which it takes place. The high specificity of the studies entails that each sector's questionnaire has to be considered individually and that it is not always possible to reduce specific pieces of information into an overall comprehensive item. In general it can be said that for each sector plenty of information is collected, including very important pieces referring to:

- employment
- features of the local unit
- machinery
- inputs and/or outputs and/or process of manufacturing
- organization
- main accounting variables.

5.2.5.2 *Analysis of the questionnaires*

The analysis has interested all the sector studies carried out so far, including also the year 2002. With reference to this year, 202 questionnaires have been examined. Some of these questionnaires have been used to collect information already from 1998, as shown above, and all of them will probably be used in the future.

A thorough analysis of these questionnaires has been made, in order to find the possible physical input (or output) variables that can be used in the elaboration of the Italian PIOT.

The questionnaires are different depending on the category of productive activity they refer to. Their analysis has allowed to highlight number and type of the potentially useful variables. In particular the attention has been concentrated on the frequency and structure of information on raw or semi-finished materials (input variables) but also information on the finished products obtained (output variables) has been considered. Moreover, special attention has been paid to the indications on the measurement units.

The results of the analysis have been fixed in a comprehensive table that examines all the Manufacturing macro-sector and is based on the ATECO91 classification. The following is a translated example of the table, that evidences the scheme used for our collection of meta-information.

²⁰⁰ In what follows the word 'year' is used for 'taxation period of reference'.

²⁰¹ The questionnaires were drawn up by the trade associations representatives, who are deemed to have an in depth knowledge of the sectors they are delegated for.

C - TAVOLE INPUT-OUTPUT IN TERMINI FISICI (PIOT)

ATECO91 activity	Description	Covered by the sector studies	Sector studies code	Input Materials	Unit of measure	Output Materials	Unit of measure	Beginning year
15.13.1	PRODUCTION OF MEAT AND SLAUGHTERING PRODUCTS (EXC. FOWL)	YES	SD05U	D01 Bovines and bovine meats	100 kgs	D33 Half cuts	% revenues	98
						D34 Quarters	% revenues	
				D02 Ovines and ovine meats	100 kgs	D35 Other cuts	% revenues	
				D03 Pigs and pig meats	100 kgs	D36 Precooked or ready to cook food of meat products	% revenues	
				D04 Equines and equine meats	100 kgs	D37 Deep frozen food	% revenues	
				D05 Ostriches and ostrich meats	100 kgs	D38 Meats in gelatine	% revenues	
				D06 Birds, rabbits and the like; game meats	100 kgs	D39 Gourmet meat products	% revenues	
						D40 Birds, rabbits and the like; game	% revenues	
				D07 Game	100 kgs	D41 Ostriches	% revenues	
						D42 Others	% revenues	
15.20.1	FISH, CRUSTACEANS AND CLAMS CONSERVATION	NO						

The following table summarizes the results, grouping the activities in the same macro-sectors as the sector studies (professions are included in the Services macro-sector), with some reference to the coverage of activities by the sector studies in 2002.

MACRO-SECTOR	No. of ATECO91 activities	No. of ATECO91 activities comprised in the sector study	No. of activities for which data on physical inputs are present
MANUFACTURING	379	194	148
COMMERCE	204	141	0
SERVICES	295	145	0
Totale	878	480	148

As can be seen from the table, Services and Commerce prevail, as a consequence of the specific purpose of the sector studies. Unfortunately, for none of these two macro-sectors the surveyed units are requested to report data on physical inputs or outputs.

Indeed, only for the Manufacturing macro-sector are the questionnaires used for collecting information that is useful in relation to material flows accounting. Let us therefore focus our attention on this macro-sector.

The following table summarizes the results for the manufacturing sector.

ATECO Sub-sections	No. of ATECO91 activities	No. of ATECO91 activities comprised in the sector study	No. of activities for which data on physical inputs are present
CA Mining and quarrying of energy producing materials	8	0	0
CB Mining and quarrying, except of energy producing materials	16	9	9
DA Manufacture of food products, beverages and tobacco	48	19	17
DB Manufacture of textiles and textile products	43	30	8
DC Manufacture of textiles and textile products	5	5	1
DD Manufacture of wood and wood products	9	8	1
DE Manufacture of pulp, paper and paper products; publishing and printing	20	10	10
DF Manufacture of coke, refined petroleum products and nuclear fuel	6	0	0
DG Manufacture of chemicals, chemical products and man-made fibres	26	4	4
DH Manufacture of rubber and plastic products	7	5	5
DI Manufacture of other non-metallic mineral products	29	13	13
DJ Manufacture of basic metals and fabricated metal products	46	39	39
DK Manufacture of machinery and equipment n.e.c.	36	35	35
DL Manufacture of electrical and optical equipment	34	4	2
DM Manufacture of transport equipment	20	1	1
DN Manufacturing n.e.c.	26	12	3
Total	379	194	148

On the whole it can be said that the information present in the sector studies has a sufficient level of completeness, so that this source can be seen as a valid input for the construction of a Use table for the Italian economy. In fact, the sector study covers approximately 50% of the activities of the Manufacturing macro-sector and for 148 of the 194 activities considered, there is information at least for the input variables. Nevertheless, it must be underlined that for some activities of the Manufacturing sector the survey does not provide information on the raw material inputs, so that its results will not suffice to cover the macro-sector, but need be integrated with other sources. Moreover, while for the inputs a quantitative expression of numerical type is nearly always present (kg, tons, etc.), for the output variables there is nearly always only an indication of presence (yes/no) or the percentage on the total of the revenues. When information on the volume of products obtained as output is present the measurement is in monetary units. This implies that it will not always be possible to derive unitary input coefficients from the sector studies alone, but linkage with other archives will be required. This can be done, for instance, by using the fiscal codes that identify the units.

5.2.6 *Destination of energy products*

An energy Use table is already being constructed in the framework of National Accounts. It describes the use of energy products by 101 activities, including household consumption. Disaggregated by function (transport, heating, other uses) it contributes to the attribution of air emissions to the activities, done in the framework of the NAMEA.

5.2.7 *Data on exports by commodity*

Foreign trade statistics supply all data necessary on exports by commodity – which are straightforwardly assigned to the producing activities.

5.2.8 *Imports' Use Matrix*

This matrix can be seen as composed by two pieces, reflecting the two-step approach that will be followed in its construction:

- the matrix of imported products going to accumulation, comprising a column for durable goods going to households;
- the matrix of products imported for intermediate use, comprising non-durable goods used in households consumption activities.

The first of these two matrices describes the imports which are directly built in the stocks, the second describes the imports that are further transformed before going either to accumulation or to Nature as Residuals.

The two-steps procedure foreseen, consisting in first splitting total imports by commodity as to determine contextually the columns of the first matrix (stock accumulation) and the totals by commodity for the second (intermediate uses), and then determining the destination by economic activity of intermediate imports, corresponds to the methodology used in the construction of the Italian 1992 MIOT and of subsequent years' NAs, with the variant described in § 5.2.3 concerning the split of household's demand into durables and non-durables, which can be easily extended to the whole of products from industrial ones.

As far as the first step is concerned, we briefly describe in the next section the premises and ideas that guide the foreseen revision of the tool currently in use at NA.

The subsequent section describes method and results of an elaboration specifically carried out for the purpose of the PIOT on the micro data on import flows, which leads to a matrix of imports by commodity (8-digit NC codes) and by main activity of the importing firm, which is an important input for both the steps described above.

The problems to be solved in this transformation can be thus summarised:

- Identifying the real destination of the goods when these are imported by traders;
- Identifying the real use of the intermediate imported input when this is imported for purposes other than the main production activity of the firm.

The realisation of these operations might require going back to the micro data and linking them with the information present other archives, in order to deal correctly with the data concerning firms that operate in more than one ATECO category.

The second problem is certainly less important when the IO classification is considered rather than the 5-digit ATECO categories, as many firms operate in activities that are similar to one another and therefore end up in the same IO industry.

5.2.8.1 Developing a new method for the allocation of imports between intermediate and final uses

A working group has been set up at Istat on the Rest of the World account; one of the aims of the group is the development of a new methodology for the estimation of the matrix of Imports of goods. One of the innovations introduced in the compilation of the 1992 Italian MIOT has been the direct construction of an Import matrix, from which it has been possible to derive, by difference, the matrix of domestic production flows. As already seen, from the methodological point of view two phases can be distinguished in the current way of compiling the Import matrix. In the first phase for each imported good (imports are collected at a detail level of about 10.000 goods) the destination between intermediate and final (consumption, investment and valuables) use has been determined. The allocation by economic destination has been done on the basis of the content of the product, according to knowledge from commodity science. In the second phase the imports destined to intermediate use have been detailed by branch on the basis of the economic activity to which the importing firm belongs according to the “Documento amministrativo unico del Ministero delle Finanze”. The shares by economic destination fixed for the compilation of the 1992 Import matrix have subsequently been used to split imports between final and intermediate uses for the years following this benchmark year.

Since an important part of domestic demand is estimated by using the commodity flow method, i.e. by adding to the net resources made available by domestic production (final production minus exports) the imports for final uses, the allocation between final and intermediate uses of imported products plays a crucial role. The relevance of this is even larger in the light of the intensification of production internationalisation and delocalisation processes which has taken place in the last decade.

The objective in the estimation of the new Imports matrix is therefore to determine, as far as possible, the allocation among final and intermediate uses on the basis of the actual use of the products in the economic circuit, rather than on the basis of the characteristics of the commodity. In particular the aim is to analyse whether the purchase from abroad of a good x done by a manufacturing firm whose principal activity is the production of goods of the same kind, should be considered as an input of its production process or rather as a purchase for re-selling the good without further transformation (in this case, this would be a secondary activity of the firm). In the first case, if the good is classified, by the shares of economic destination, as a good not going to intermediate uses, we would have a duplication in final demand calculated by the commodity flow method.

For the analysis of these processes it will be necessary to link and cross-check foreign trade data by commodity and by firm with data from surveys on firms (surveys on Structural Business Statistics and on small firms).

5.2.8.2 The construction of the matrix imports' by product (CN8) and by economic activity of the importing enterprise

This section describes the sources of information used and the procedure followed in order to obtain the matrix of the quantities of imported products by kind of product and main economic activity of the importing enterprise (from now on “imports by main activity”), as well as the results obtained.

The sources of information used

To get the “imports by main activity” matrix it is necessary to combine information present in two different registers: the Enterprises Business Register and the Foreign Trade Operators Business Register.

The main problem to be taken into account with reference to the linking of these two registers is the different definition of the statistical unit and of the field of interest of the two registers.

The enterprise is the basic statistical unit of the Enterprises Business Register, in which it is identified on the basis of its fiscal code. The field of interest of the Enterprise Business Register is given by the enterprises belonging to a subset of economic activities, which does not include agriculture and fishing activities and the Public Administration.

The field of interest of the Trade Register is given by commodity trade. The Trade register refers to the foreign trade operator as basic statistical unit, which is identified by the VAT code. A single economic operator can have different VAT codes within the fiscal year according to changes of location of its business headquarter. It is clear that this may cause both an overestimation of the number of foreign trade operators and problems in linking the two Registers.

The Trade Register derives indirectly from the micro data of the foreign trade survey. From a technical point of view this procedure is very easy to carry out. Indeed it is sufficient to sort all the records by the variable “VAT code” and to aggregate information on micro data in order to obtain a single record for each VAT code. Nevertheless this presents some statistic problems. In fact, for some records the VAT code information can be incomplete, so the value and the quantity of the import flows of the operators included in the Trade Register is often lower, for a given NC8 code, than the total imports flow of that code. It is necessary, also, to consider that the origin of the data is a statistical survey whose reference unit is the commodity flow and therefore, all variables are referred to the imported commodities. Any commodity-related variable must be used carefully, according to the new statistical unit used in the Trade Register (the foreign trade operator). In particular, the code of the product-related economic activity (CPA) refers to the imported good (i.e. says which product is take into account) and not necessarily reflects the main economic activity of the importing enterprise, that can be found in the Enterprises Business Register.

The linking key adopted and the information extracted

The fiscal code has been chosen as key to link the two different business register, because this information is more reliable than the VAT code. In general, a one to one relationship occurs between the VAT and the fiscal code, except for the case of a change of location of the business headquarter of enterprises, as said above. Before linking the information of the two registers, the information of different VAT codes within the Trade Register that correspond to a single fiscal code in the Business Register must be added up.

A register’s Tributary file joining together the code fiscal and the VAT code has been used to link the two registers.

The information of the two registers has therefore been linked using the fiscal code and merged to obtain a matrix of the quantities of imported products by main economic activities of the importing enterprises.

The information taken from the Foreign Trade Operator Business Register is:

- products imported by every economic operator according to the more disaggregated classification available, the Combined Nomenclature (CN8), in 1997;
- imports value of every operator for each item of CN8 in 1997;
- imports quantity of every operator for each item of CN8 in 1997.

The information taken from the Enterprises Business Register is only the enterprise main economic activity according to the Level 5 of the General Industrial Classification of Economic Activities (NACE Rev.1).

Coverage analysis

It is important to analyse the coverage of the final results in terms of trade values and quantities, as there are reasons to expect that a consistent number of records in both of the two registers do not match. Indeed, the two following different causes of loss of coverage can be highlighted:

1. the incomplete VAT codes present in the Trade register;
2. the different fields of interest of the two registers.

The coverage ratio of the results of the linkage in terms of values and quantities on national imports is high. In fact, in terms of values the coverage ratio of the data processing is 98,2 per cent on national imports values, in terms of quantity the rate is 98,1 per cent.

5.3 Residuals

5.3.1 Destination of wastes

A Use table for waste can be drawn – with some elaboration – from information on the treatment and recovery operations undergone by the various types of wastes. Indeed, knowledge of the way the waste is dealt with (landfill, incineration, recycling, etc.) is in general sufficient to determine the activity to which the waste is destined.

This kind of information is in general available in the APAT database deriving from MUD questionnaires (see § 4.3.1). Some waste flows, like for example Municipal waste, are very well known and it is possible to calculate how they are disposed of and where. Another example is given by packaging and packaging waste. The data set also provides overall knowledge on the operative treatment plants in Italy. Nevertheless, the analysis of this data set also shows that some further studies are also necessary, as difficulties are encountered on the attribution of some disposal and recovery operations codes, since the definitions of the various management operations are not always clear and unique.

5.3.2 Destination of other residuals

By definition, all air emissions flow to Nature, including those coming from landfills (unless recovered). Materials contained in wastewaters are in part held into the economic system by depuration systems, and destined to agricultural uses or landfilled. Estimates on these flows that can be considered as preliminary inputs for the Use table have been made in the framework of the Italian EW-MFB for 1997.

6 ESTIMATION OF MISSING ITEMS AND “PRE-BALANCING”

6.1 The importance of feedbacks and interaction between the various steps

The process foreseen for the final phases of the implementation of the PIOT framework can be stylised into the following two moments:

- utilisation of additional information from logic, scientific knowledge, commodity science, industry material balances and the like for the estimation of possible missing items and the preliminary reconciliation of resources and uses by commodity and of inputs and outputs by industry (“pre-balancing”); the purpose of this step is to obtain matrices ready for the mathematical balancing, in the sense that inputs and outputs are reconciled as far as possible by the application of the above mentioned *a priori* information pieces, which provide useful constraints on the dimensions of the flows relative to each other. A possible secondary output of this step will be an inventory of technical coefficients and physical constants, drawing from and integrating existing technological coefficients’ databases, to be used in future MFA applications.
- Final derivation of the Material Integration tables and adaptation/application of the mathematical balancing procedures in use in NA, for the final balancing of the matrices.

It is not possible at this stage of the work to tell how well the data available on the Supply and the Uses of the different materials will match. It is likely, however, that a positive supply will be reported for some materials for which no uses are known, and also that for some other materials total Supply will exceed total known uses. In some other – less frequent – cases, the situation will be the opposite. The estimation of missing data will therefore be an important step. Since this estimation will partly be based on the material balance principle, applied by material or by activity, this estimation can be seen also as a pre-balancing of the tables, to be done before going to mathematical balancing. This pre-balancing should not be independent from the derivation of the Material Integration tables, as it should not be forgotten that

“trying to derive symmetric input-output tables from supply and use table may reveal inconsistencies and weaknesses in the supply and use tables. In this respect there is therefore also a feedback from the symmetric input-output tables to the supply and use tables” (ESA 1995, § 9.08, see, Eurostat, 1996a, p. 209).

Indeed, the aggregation of flows by activity provides additional constraints that can help completing or ameliorating the picture. Therefore it is important to stress that the estimation of missing items and the derivation of the Material Integration table should not be looked at as self-contained and separate steps, but rather as interacting ones, with continuous feedbacks. Not even the final mathematical balancing can be considered as a completely separate step: the setting the admissible variation of each flow’s estimate from the initial one, will require that the knowledge acquired from the previous steps be used; the way the starting values have been obtained must therefore be kept in mind until the end of the construction process of the tables.

6.2 Additional information from logic, scientific knowledge, commodity science, industry material balances and use of technical coefficients and physical constants for estimation of missing items and pre-balancing

Given the incomplete coverage of the economic activities provided by the information sources described in the previous paragraphs, it will be necessary to integrate in our study of material flows inside the economy the a-priori quali-quantitative information provided by the natural sciences and by the knowledge of production technologies. Indeed, there are many exact and necessary relationships between different inputs, between inputs and outputs, and between different outputs, whose knowledge can be exploited to determine aggregates that would otherwise remain unknown. One important condition for using this knowledge is that the total quantity of products available for domestic use is known, so that the problem is in most case reduced to that of determining its destination. For this, the use of qualitative information is often sufficient, as the use of certain products is exclusive of some activity. One example in this line is that of building materials, which are used, by definition, in construction works.

The first tool that science makes available is the same that is at the basis of the very possibility of balancing the tables: the law of matter conservation, or 1st law of thermodynamics. Materials are never destroyed or created, but always transformed, and this gives the mass balance principle: the total outputs of a well-defined system are equal to the total inputs minus the change in stocks. This means that whatever comes into a system is either accumulated into the system itself or given back to the surrounding environment, and if no input flow exists, outputs can derive only from the reduction of stocks accumulated in the past. In a formula: $I=O+\Delta S$. This formula can be applied to whatever subsystem or process whose material balance is incomplete, in order to find an unknown quantity, provided the other two are known with reasonable certainty.

Moreover, this is also valid for the individual chemical elements entering the processes and reactions. Knowledge on chemical composition of materials and elements' weights can therefore also be used in connection with it, e.g. to calculate the weight of the oxygen demanded for burning a given quantity of methane.

Of course, if there is uncertainty attached to the known quantities, this is transferred to the one derived this way, which must be made smaller if a subtracted quantity is made bigger and vice versa.

An example of the use of technical coefficients for the calculation of otherwise unknown quantities of flowing materials is that of the CORINAIR system of air emission estimation, which provides official figures on countries' emissions for use in the international arena. The following two sub-paragraphs provide two further examples of possible knowledge inputs to pre-balancing.

6.2.1 *The Technology Database of EPIS*

The European Environmental Pressure Information System (EPIS)²⁰² is an attempt to put into practice the idea that knowledge on the technologies used in the economy should systematically be exploited in order to calculate the pressures on the natural environment generated in the production and use of goods and services.

The Technology Database (TD) has been developed at the Institute for Technology Assessment and Systems Analysis of the Research Centre Karlsruhe as part of the so-called

²⁰² See, among others, Bombana et al. (1997).

PRODCOM module of EPIS; it provides a complete technical description of a number of industrial production processes, identified by their main products, to which the appropriate PRODCOM codes are attached. Unitary factors quantified in physical units are given for the inputs (including energy) and outputs (including Residuals) involved in these processes, expressing the quantities that is necessary to use or co-produce in order to obtain one unit of main product; in other words, the TD gives the whole material/energy balance of the production process from which the product considered arises, expressed in terms of units (of energy input, of wastewater, and so on) per product unit²⁰³.

One important feature is that these coefficients derive directly from knowledge of the production techniques. The coverage of products and activities provided, however, is quite limited.

A warning that should be kept in mind when considering the possibilities of application of the TD and similar coefficients' databases for our purposes is the fact that in some cases the production process described for a given product is not the one in use in Italy. The TD factors are indeed often explicitly related to the technologies in use in a specific country and calculated on the basis of that country's data. Even if the resulting product as such is exactly the same, however, technologies of production might be country-specific. This is the case, for instance, in glass production and primary non ferrous metal production. Another example is that of pulp paper production, for which the only process described in the TD is the Kraft process, which is not relevant for Italy; the use of PRODCOM data on paper production along with the factors given by the TD for this product could then be misleading²⁰⁴.

One interesting thing we learn from the TD thanks to the completeness of its material balances, is that joint production is quite a frequent phenomenon. Indeed, there often are, next to the main output of a production process and to its unwanted residues, useful by-products which are also marketed. Also this should be considered when applying coefficients for calculating inputs from known outputs, since a duplication of inputs could follow from a product being at the same time the main output of a process and the by-product of another process.

6.2.2 APAT Sector Studies

The Italian National Agency for Environmental Protection and Technical Services (APAT, formerly ANPA) has produced several sector studies in order to validate and integrate the estimates it produces of the waste generated in Italy by the various economic activities, starting from specific analyses of the main processes. Let consider here to some of the publications containing these studies.

The following activities are covered in ANPA, 1999b:

- Manufacture of food products and beverages (NACE division 15)
- Manufacture of textiles (NACE division 17)
- Tanning and dressing of leather (NACE group 19.1)
- Manufacture of refined petroleum (NACE group 23.2)
- Manufacture of other inorganic basic chemicals (NACE class 24.13)
- Manufacture of other organic basic chemicals (NACE class 24.14)
- Manufacture of plastics in primary forms (NACE class 24.16)
- Manufacture of basic metals (NACE division 27)

²⁰³ In at least one case, however, the factors are expressed per unit of an important input, from which many co-products stem at once.

²⁰⁴ See also Tudini (ed.), 2001, p. 49.

- Production and distribution of electricity (NACE group 40.1).

Most of these studies are based on the reconstruction of the material balance of the activities, and may immediately supply information inputs for the integration of the Use table. Even when this is not the case, flow charts and descriptions of the production processes, as well as lists of their inputs and outputs – though without a quantification of the respective proportions – are provided, so that the studies can be at least be used as a starting point for the reconstruction of the material balance.

Another publication specifically deals with the chain of production activities that serve the motor vehicles industry, providing information (though not material balances), in addition to some already present in the list above, on the following activities (ANPA, 2002a):

- Manufacture of dyes and pigments (NACE class 24.12)
- Manufacture of synthetic rubber in primary forms (NACE class 24.17)
- Manufacture of paints, varnishes and similar coatings, printing ink and mastics (NACE group 24.3)
- Manufacture of rubber tyres and tubes (NACE class 25.11)
- Manufacture of other rubber products (NACE class 25.13)
- Manufacture of plastic plates, sheets, tubes and profiles (NACE class 25.21)
- Manufacture of flat glass (NACE class 26.11)
- Shaping and processing of flat glass (NACE class 26.12)
- Manufacture of hollow glass (NACE class 26.13)
- Pressing and stamping of steel (ATECO categories 28.40.2 and 28.40.3)
- Manufacture of bearings, gears, gearing and driving elements (NACE class 29.14)
- Manufacture of motor vehicles, trailers and semi-trailers (NACE division 34)

For a minority of these activities, however, the information is said to be insufficient, and as far as the step of production of components is concerned “it is not clearly foreseeable with mass balances or estimates, due to the multiplicity of technologies involved” (p. 79).

The results for waste generation of some other studies are contained in ANPA, 2002b, referring to the following additional activities:

- Manufacture of pulp, paper and paperboard (NACE group 21.1)
- Treatment and coating of metals (NACE class 28.51)
- Manufacture of ceramic tiles and flags (NACE group 26.3)

An important feature that the studies considered here share with the Technology Database is that, besides products and activities, they introduce a further dimension in the analysis, that of processes, whose relation with the former two needs clarification case by case (on this, see also Bombana et al., 1997).

7 DERIVATION OF THE MATERIAL INTEGRATION TABLES AND FINAL BALANCING

7.1 Total flows

After compiling detailed and as far as possible complete Supply and Use Tables, also with the help of the estimation of missing items and pre-balancing, it will be possible to derive the Material Integration tables. This will require combining the information contained in those tables, as well as additional data elaborations.

7.1.1 A summary picture

The following table represents in broad terms the structure of the table – the same as that of the German PIOT – and the expected relationship between the PSUTs and the PIOT:

	Production activities	Households non-durable	Useful Stocks	Landfills	Nature	Rest of the World
Production activities	USE TABLE Products (plus <i>ad hoc</i> elaborations for Residuals flowing into production activities)	USE TABLE Products		Ad hoc elaborations on the waste database and on the SUPPLY and USE TABLES Residuals	SUPPLY TABLE Residuals	USE TABLE (Exports)
Households non-durable	<i>ad hoc</i> elaborations for Residuals flowing into production activities					
Useful Stocks	<i>ad hoc</i> elaborations for Residuals from Stocks flowing into production activities					
Landfills					SUPPLY TABLE Residuals	
Nature	USE TABLE Natural Resources					
Rest of the World	SUPPLY TABLE (Imports of similar products)					

As can be seen, the relationship is not a very complex one. The most complicated case is that of Residuals used for production or otherwise dealt with by economic activities, which will require the *ad hoc* elaborations discussed in § 7.1.4.

The explicit inclusion in this figure of a row and column entitled to Households has the purpose of highlighting a specific feature of the PIOT, i.e. that of allowing to see how Households, after receiving Products (which is all that is shown in a MIOT), transform them into Residuals – precisely, the non-durables part of their purchases has to come out of the economic system as waste, wastewater or air emissions.

7.1.2 *Flows of Natural Resources*

By definition all flows of Natural Resources have Natural stocks as source and economic activities as users. The data on these flow to be included in the Material Integration table can be found in the corresponding part of the Use table.

7.1.3 *Flows of Products*

Products flow within the domestic economy (intermediate and final uses), between this and the Rest of the World (imports and exports) and from the domestic economy to the natural environment (dissipative uses and losses, according to EW-MFB terminology; even though in the SEEA these flows are considered as of Residuals, we consider it necessary to classify them as Products even when they leave the economy, as otherwise the identity total supply = total uses would not hold for them).

To the extent that Products are the output of a single activity each, the Supply table is important only as key for the aggregation of the Products in the homogeneous branches, and the description of the use of Products (by production activities, households and useful stocks) can be derived from the Use matrix alone. The intermediate flows block coincides with the matrix of flows of Products to production activities but for the flows of Residuals used in production activities, especially waste, discussed in the following.

7.1.4 *Flows of Residuals*

7.1.4.1 *Managed waste flows*

As far as the data are concerned, a deeper analysis of waste flows is necessary to tell at the same time where they come from and where they flow to, since some kinds of waste can be generated by several activities and/or used by several others. In particular, a specific study has to be carried out for the economic activities of NACE divisions 37 (recovery and treatment for recycling), 27 (production of metals and their alloys) and 90 (disposal of solid waste, and wastewater). Indeed, a great part of the raw materials used in these activities or otherwise flowing into them is waste. From the MUD dataset (see § 4.3.1) it is possible to calculate the quantity of waste reintroduced in the economic cycle. From the dataset both the amount of waste coming from other activities and the waste generated by these activities can be calculated.

As far as the representation of managed waste (and managed Residual in general) flows in a PIOT is concerned, the fact that they are not Products in SNA's sense, yet they are used by economic activities, requires that the representation issue be specifically dealt with.

Attention must be paid first of all to the fact that two different kinds of material flows going into waste management activities can be distinguished:

- flows of materials that are the “working object” of the activity (the waste collected);

- additional flows of materials that are necessary for carrying out the activity's operations (e.g. the fuel consumed by the lorries).

Flows of the first kind are not paid for, and do not constitute a cost of production as intermediate inputs in SNA's sense. Therefore, coherence with the MIOT would require that only the second kind of flows be included in the intermediate flows part of the Material Integration Table. Nevertheless, these Residuals, especially waste, physically flow from one activity to the other and need therefore be recorded somewhere in the PIOT in order to keep the balance between inputs and outputs.

A reference for solving the problem is provided by the fact that the above distinction between two different kinds of flows is in practice applied in NA to many activities which produce services. This is the case of transport, trade and repair activities. For instance a car repair activity does not have the cars coming in and out of the business premises as inputs nor as outputs. Almost all goods sold to final and intermediate users go through trade and transport, but this notwithstanding the same goods are recorded as if directly delivered to the users by the producing activity, even if the traders pay for them and the transporters move them around, as the output of these activities is given by their margins only, and not by the whole value of the good to the purchaser²⁰⁵. If we were to apply rigidly this rule, then we should attribute to the activity generating the waste all the outputs to the environment and/or the increases of landfill stock generated by their disposal, while the waste management activity would only have the second kind of materials as inputs.

This kind of treatment would have the merit of showing the structure of the material inputs to waste management in a way fully comparable to that of the MIOT, as only items to which a production cost corresponds would be included in this activity's column. However, it would hide the specific role of waste management in material cycles, and in particular the fact that some wastes are heavily transformed in waste management activities. Showing this is of primary importance for an accounting in physical terms that aims at being meaningful from an environmental perspective. For example, it would not be very informative if we attributed the air emissions that correspond to the incineration of some waste to the activity that generates the waste, because we would thus mix these air emissions with the ones directly generated by the activity itself. The generation of the air emissions due to incineration would in fact appear as a direct consequence of a productive process who in reality directly generates waste, while only a decision taken in the waste management activity makes a waste that can a priori be treated in several different ways end up in the atmosphere. Therefore we deem it important to distinguish the waste that is not transformed – even if it is brought to a landfill by an economic unit different from the one that generates it – from the waste that is actually transformed in the waste management activities, i.e. transformed to a sufficient extent for the output of its management to be considered a physically different material from the initial waste. Therefore, we will aim at further distinguishing the first kind of flow in two parts, the one transformed by the “waste management services” which will be shown as going through this activity, and the non-transformed one, which will be recorded directly in the “controlled landfills” column, consistently with the general treatment of transport and trade in the IO framework of NA.

²⁰⁵ If this was not the case, we would not have a IOT, but rather two input columns and two output rows, with several duplications in each of them.

Moreover, it can be observed that the taking in charge of waste is the very service that waste management activities sell to the other activities, as the unusual relationship between the flow of money and that of matter proves: contrary to what happens in all other cases, matter flows in the same direction as money²⁰⁶. This suggests that the treatment which most guarantees comparability with the MIOT is one where the transformed waste is recorded as negative material output in the row of waste management, rather than as a positive input in its column, where it would bias the representation of the structure of the current material inputs of the activity. This solution therefore allows not only to see that the waste goes through the waste management sector but also to maintain the meaning of the intermediate flows matrix as the material counterpart of current production costs²⁰⁷.

Waste going to non-controlled landfills, even if dealt by waste management activities, is an output to the Natural environment.

7.1.4.2 Other Residuals

Most of the Residuals flow to Nature. The supply table tells which activities are directly responsible for air emissions. Emissions to water are like managed waste when going to depuration. The materials contained into waters that are not collected but discharged directly into the environment, as well as other non-managed waste will have to be calculated as difference between total and managed quantities.

Residuals other than waste that flow within the domestic economy are of minor importance, except for the case of farmyard manure, which goes from animal farming to agriculture and is spread to the soil. Manure is not always delivered free of charge, however, but often paid for, as it is a valuable input for agriculture. It is therefore correct to deal with it as with a product. This flow thus will appear as intermediate input from animal farming to agriculture and then from agriculture to the soil.

The same kind of reasoning as for waste should be applied to the other possible cases of use by some activity of the Residuals generated by some other, when no positive price is paid for the material by the activity that uses it.

7.2 Nature in the PIOT

The German PIOT deals with Nature using the categories of National Accounts that apply to it. As NA has not been developed to deal with Nature, however, there just seems to be one category for it: "Non produced natural assets". This implies compressing all information on flows from and to Nature into a row and a column. Of course more detailed information is contained in the Supply and Use tables. However, it might be difficult for the non-specialist, to perceive from this table the importance of the environmental pressures connected to the use of Nature as Resource provider and as sink for emissions, and to figure the new analyses on the interaction of the economic and natural systems that the PIOT makes possible. The Danish PIOT does not have

²⁰⁶ Custody services could seem to be another exception, but it can be said that no material flow takes place in that case, as the goods usually go back to the unit that pays for the service.

²⁰⁷ The *j*-th cell of the waste management row thus contains the balance between the waste absorbed for transformation by activity *j* and waste given by the same activity to waste management for transformation; by adding to the absolute value of this balance the quantity sent to landfills, it will be possible to see how much more waste activity *j* generates than uses.

SUTs, but includes in the PIOT more detailed information on the type of Residuals which flow into the environment.

We deem it interesting to include some information on which are the natural “activities” that supply resources and receive residuals in the PIOT properly said. In particular, both the flows of Resources from Nature and the flows of Residuals to Nature can be aggregated according to the natural body they come from or go to. This is the way prof. Nebbia deals with Nature in his table, by dividing it into Soil, Water, Air, and Natural Stocks. We will adopt this approach, making sure to apply it consistently with the concept of “Non produced natural assets” - i.e. that the natural bodies define a complete and exhaustive partition of these assets - for the reason that it allows to show in the same table how the flows regarding the individual natural bodies are not in a balance, partly because of the accumulation of materials in the economy, partly because something taken from a body is returned to another, reducing the availability of the Resources of the former and changing the composition of the latter (the most immediate example is that of fossil fuels transformed into air pollutants).

7.3 Sub-tables

The Material Integration tables are potentially as many as the ways in which the materials can be classified. The most relevant classifications referred to so far are by origin of the material (domestic or foreign) and by type of material (Natural Resources, Products, Residuals). These are the classifications used e.g. in the German PIOT system, and by using them it is possible to provide interesting details that are hidden in the most aggregate Materials Integration table, the one that refers to total flows, including all flows irrespective of the origin and type of materials.

As far as the origin is concerned, this total flows matrix can be split – as usual in NA – into the matrices of domestic and import flows. This split concerns only Products, but for some minor import/export flows of Residuals. It is clearly sufficient to determine one of these two component, since, given the totals, the other component must be equal to the difference. The component we aim at constructing is that of import flows. Nevertheless, to the extent that information total and domestic flows can be estimated independently, the additional information that their estimates incorporate should also be exploited for better balancing. E.g., surveys on the use of products give the total quantities used, while statistics on sales of domestic production and imports give figures independently obtained for domestic and imported quantities. The constraint given by the fact that the sum of the latter two items must be equal to the former total should be implemented in the balancing procedures, so that an adjustment of the less reliable figure can follow.

Among the tables by type of material, those referring to Residuals allow to see how these are used by the recycling or waste management industries, and finally disposed of into the natural environment. However, it is not possible to see from these tables e.g. how much of the Residual matter used by recycling is actually transformed into Products.

Indeed, a feature of these two types of partial tables is that, taken individually, they are not balanced (i.e. the row-totals do not equal the corresponding column-totals also for activities and not just for stocks), as the outputs of one of them are often inputs of another. E.g. something that comes in as a product in an activity does not appear in the Residuals table that contains the waste derived from it, so that the column of that activity has a lower total than the corresponding row.

One distinguishing feature of PIOTs, however, should be exactly that of showing how the materials are transformed into one another. One possible exercise that would add further value to the data in the derivation of Material Integration tables, is that of applying not just a “direct”

classification of materials but also an “indirect” one, i.e. of constructing tables whose scope is defined by an homogeneous physical nature of the materials at a certain stage of the economic cycle (say, at the entry in the economic system), and which track the fate of those materials (say, all biomasses) through the subsequent stages of their usage and transformation, until they become Residuals. Thus, we would not just be able to tell separately, e.g., how biomasses are formed in agriculture from Natural Resources, and how Residuals are given back to Nature or recycled, but also how biomasses are transformed into Residuals after becoming Products of the food industry and non-durable consumption goods used by households. The embryo of one such exercise can be seen in the construction of material balances by kind of raw material, tried in the EW-MFB of Italy, 1997.

7.4 Mathematical balancing

The last step in the implementation of the PIOT framework will be the mathematical balancing of the tables, integrated and organised as described in the previous paragraphs.

The mathematical procedure to be used is the Stone-Champernowne-Meade one, based on least squares, which will be adapted for the specific needs of the PIOT.

As far as the Material Integration Table is concerned, it is mainly production activities and households’ non-durables consumption that are interested by the procedure, as the other “activities” featuring in the table represent the Rest of the World and man-made and natural stocks, whose accumulation/depletion reported in the table is typically not null. However, it must be kept in mind that the overall unbalance of natural stocks (not present in monetary tables) must be equal in absolute terms, and have different sign, to the overall unbalance of manmade stocks and foreign trade. This unbalance expresses the net direct result on Nature, in terms of changes in material stocks, of all economic activities carried out by the domestic activities. The analysis of its composition between air, waters and soil, will also provide interesting information.

8 AN AGGREGATE PROTOTYPE

As a follow-up to the feasibility study, the following Tables, consistent with it though highly aggregated, were produced at Istat, with 1997 as reference year:

- The Physical Use Table
- The Physical Supply Table
- One Physical Input-output Tables for Natural Resources and Ecosystem Inputs (this is sufficient to provide the additional information on their destination, not present in the Supply and Use Tables, which provide further breakdown by type of material)
- Five Physical Input-output Tables for Products: Biomass Products, Fossil Fuels, Minerals, Composite Products and All Products (the latter is the sum of the other four)
- Three Physical Input-output Tables for Residuals: Residuals to air and water, Residual that circulate also inside the socio-economic system and the Table for Total Residuals (sum of the other two)
- The Physical Input-output Table for All materials, given by the sum of the Table for All products and the Table for Total residuals, combined with the Natural Resource and Ecosystem Input rows of the Physical Use Table

These tables are reported in the following pages. Flows are expressed in thousand tons.

The partition of the system used in the tables has been obtained by joining the physical distinction between Transformation activities and Accumulation of stocks and the usual economic categories of Production, Consumption and Investments. Transformation activities have by definition their material balance in perfect equilibrium, i.e. do not imply any accumulation of materials, and consist in Production and Consumption of non-durables; the Stock, by definition, only accept or supply materials without transforming them. The joint use of this purely physical distinction with the economic categories has given the following categories, whose individual material balances (materials' use and supply), as well the exchanges between one another, are described by the tables constructed: Production; Final Household's Consumption of Durables; Final Household's Consumption of Non-durables; Capital Formation in Inventories; Capital Formation in Other Capital; Landfills; Rest of the World Socio-economic System; Rest of the World Natural Environment; Domestic Natural Environment. Moreover, the residence principle is respected in the tables as far as the most important flows relevant in this respect are considered, i.e. by including among national activities transport activities carried out abroad by Italian residents (belonging partly to Production and partly to Consumption) and by excluding from national activities transport activities carried out on the Italian territory by non-residents. This implies that not only the relative air emissions, but also the corresponding Product and Ecosystem Inputs have been allocated according to the residence principle, so that the balance between inputs and outputs of the individual transformation activities remains in equilibrium.

		Socio-economic system										Natural environment - NE			TOTAL MATERIAL SUPPLY BY MATERIAL
		National socio-economic system					Rest of the world					National environment - NE1	Rest of the world environment - NE2	Total Natural Environment - NE=NE1+NE2	
		Material transformation - T	Accumulation of products-S1		Landfills		Total national socio-economic system	Imports, including purchase of fuel for transport by resident units abroad	Supply of residuals by transport activities of non residents on	Rest of the world environment - NE2	NE1					NE2
Production of non durable goods	Consumer durables	Inventories net increase	Other capital	S1.1	S1.2	S1.3	S2	N=F+S1+S2	RW	H=H+RW	NE1	NE2	NE=NE1+NE2		
Natural resources		T1	T2									19.942		19.942	19.942
	N1 - Fossil fuels	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N2 - Ferrous metal ores	-	-	-	-	-	-	-	-	-	-	-	-	-	39
	N3 - Non-ferrous metal ores	-	-	-	-	-	-	-	-	-	-	-	-	-	9.444
	N4 - Industrial minerals	-	-	-	-	-	-	-	-	-	-	-	-	-	398.261
	N5 - Construction minerals	-	-	-	-	-	-	-	-	-	-	-	-	-	436
	N6 - Non-cultivated biomass	-	-	-	-	-	-	-	-	-	-	-	-	-	19.598
	N7 - Water	-	-	-	-	-	-	-	-	-	-	-	-	-	447.720
	N - All natural resources	-	-	-	-	-	-	-	-	-	-	-	-	-	195.141
Ecosystems	E1 - Water absorbed by cultivated plants and animals	-	-	-	-	-	-	-	-	-	-	-	-	-	683.044
	E2 - Air for combustion, respiration and decomposition	-	-	-	-	-	-	-	-	-	-	-	-	-	238.920
	E3 - CO2 and nutrients absorbed by cultivated plants	-	-	-	-	-	-	-	-	-	-	-	-	-	1.114.382
	E - All ecosystem inputs	-	-	-	-	-	-	-	-	-	-	-	-	-	1.127.105
Products	P1 - Biomass products	566.788	-	-	-	-	-	-	-	-	-	-	-	-	615.806
	P2 - Fossil fuels products	64.124	-	-	-	-	-	-	-	-	-	-	-	-	236.732
	P3 - Non-energy mineral products	1.085.906	-	-	-	-	-	-	-	-	-	-	-	-	1.154.369
	P4 - Composite products	18.023	-	-	-	-	-	-	-	-	-	-	-	-	21.348
	P - All products	1.734.841	-	-	-	-	-	-	-	-	-	-	-	-	2.028.255
Residuals	W1 - GHGs, acidifying substances, ozone layer depleters, heavy metals to air	393.374	112.042	-	-	-	533	-	-	-	-	-	-	-	519.432
	W2 - Other pollutants and toxic substances to air (POPs, PCBs, etc.)	1.060	1.022	-	-	-	7	-	-	-	-	-	-	-	2.132
	W3 - Other gaseous residuals (vapour, oxygen, etc.)	400.963	88.819	-	-	-	-	-	-	-	-	-	-	-	497.352
	W4 - Nutrients and other residuals to water	10.074	1.244	-	-	-	-	-	-	-	-	-	-	-	11.318
	W5 - Demolition waste	18.385	-	-	-	-	-	-	-	-	-	-	-	-	37.495
	W6 - Manure, sewage, residuals from dissipative use of products	146.553	4.792	-	-	-	-	-	-	-	-	-	-	-	151.345
	W7 - Other hazardous and non-hazardous waste	121.433	8.139	-	-	-	-	-	-	-	-	-	-	-	132.418
	W - All residuals	1.092.042	216.058	546	-	21.210	540	1.330.396	-	21.096	-	-	-	-	1.351.492
	TOTAL MATERIAL SUPPLY BY ACTIVITY	2.826.883	216.058	546	-	21.210	540	3.065.237	293.414	21.096	1.562.102	42.723	1.574.825	4.994.172	
	ACCUMULATION IN THE ACTIVITY	-	-	8.311	190.511	304.502	55.380	568.704	-182.013	376.691	-380.281	3.560	-376.691	-	
Unused materials	U1 - Wild biota	107	-	-	-	-	-	107	-	-	-	-	-	107	-
	U2 - Mining overburden	16.715	-	-	-	-	-	16.715	-	-	-	-	-	16.715	-
	U3 - Soil removal	44.929	-	-	-	-	-	44.929	-	-	-	-	-	44.929	-
	U - All unused	61.751	-	-	-	-	-	61.751	-	-	-	-	-	61.751	-

Physical Input-output table for ALL MATERIALS Italy 1997 Thousand tons		Socio-economic system										Natural environment - NE			TOTAL MATERIAL SUPPLY ACTIVITY H+NE
		National socio-economic system					Rest of the world					National environment - NE1	Rest of the world environment - NE2	Total Natural Environment NE=NE1+NE2	
		Material transformation - T		Accumulation of products - S1			Total national socio-economic system		Exports including uses of fuels and ecosystem inputs for transport by non residents on national territory							Total socio-economic system H+H+RW
		Production T1	Consumption of non durable goods T2	Consumer durables S1.1	Inventories' net increase S1.2	Other capital S1.3	Landfills S2	N=F+S1+S2	RW	H+RW	ME1	NE2	ME=NE1+NE2		
Production	1,104,655	56,177	6,965	190,511	323,335	55,920	1,737,463	116,049	1,853,512	958,663	14,708	973,371	2,826,883		
Consumption of non durable goods	12,931	-	-	-	-	-	12,931	-	12,931	201,522	1,605	203,127	216,058		
Consumer durables	546	-	-	-	-	-	546	-	546	-	-	-	546		
Other capital	21,210	-	-	-	-	-	21,210	-	21,210	-	-	-	21,210		
Landfills	-	-	-	-	-	-	-	-	-	540	-	540	540		
Total national socio-economic system	1,139,242	56,177	6,965	190,511	323,335	55,920	1,772,150	116,049	1,888,199	1,160,725	16,313	1,177,038	3,065,237		
Imports, including uses of fuel for transport by resident units abroad	280,315	8,830	1,892	-	2,377	-	293,414	-	293,414	-	-	-	293,414		
Supply of residuals by transport activities of non residents on national territory	-	-	-	-	-	-	-	-	-	21,096	-	21,096	21,096		
Total socio-economic system - H	1,419,557	65,007	8,857	190,511	325,712	55,920	2,065,564	116,049	2,181,613	1,181,821	16,313	1,198,134	3,379,747		
supply of natural resources	447,720	-	-	-	-	-	447,720	-	447,720	-	-	-	447,720		
supply of ecosystem inputs	948,128	149,806	-	-	-	-	1,097,934	16,448	1,114,382	-	-	-	1,114,382		
supply of ecosystem inputs	11,478	1,245	-	-	-	-	12,723	-	12,723	-	-	-	12,723		
Total Natural Environment - NE	1,407,326	151,051	-	-	-	-	1,558,377	16,448	1,574,825	-	-	-	1,574,825		
TOTAL MATERIAL USE BY ACTIVITY - H+NE	2,826,883	216,058	8,857	190,511	325,712	55,920	3,623,941	132,497	3,756,438	1,181,821	16,313	1,198,134	4,954,572		
Balance (material accumulation by the activity)	-	-	8,311	190,511	304,502	55,380	558,704	-182,013	376,691	-380,281	3,590	-376,691	-		

Physical input-output table for ALL PRODUCTS Italy 1997 Thousand tons		Socio-economic system										Natural environment - NE			TOTAL MATERIAL SUPPLY BY ACTIVITY	
		Socio-economic system										National environment - NE1	Rest of the world environment - NE2	Total Natural Environment	H+NE	
		National socio-economic system					Rest of the world									Total socio-economic system
		Material transformation - T	Consumption	Consumer durables	Inventories' change	Accumulation of products S1	Landfills	Other capital	S2	S13	S2	Exports including uses of fuels by non residents on national territory	R	H+R	NE1		NE2	NE+NE1+NE2
T1	T2	S11	S12	S13	S2	S2	S2	S13	S2			H+R	NE1	NE2	H+NE	
Production	1.041.804	56.177	6.965	190.511	323.335	-	1.618.792	116.049	1.734.841	-	-	-	-	-	-	1.734.841
Consumption of non durable goods	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Consumer durables	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Landfills	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total national socio-economic system	1.041.804	56.177	6.965	190.511	323.335	-	1.618.792	116.049	1.734.841	-	-	-	-	-	-	1.734.841
Imports, including uses of fuel for transport by resident units abroad	280.315	8.830	1.892	-	2.377	-	293.414	-	293.414	-	-	-	-	-	-	293.414
Supply of residuals by transport activities of non residents on national territory	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total socio-economic system - H	1.322.119	65.007	8.857	190.511	325.712	-	1.912.206	116.049	2.028.255	-	-	-	-	-	-	2.028.255
supply of natural resources	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
supply of ecosystem inputs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
supply of ecosystem inputs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Natural Environment - NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL MATERIAL USE BY ACTIVITY - H+NE	1.322.119	65.007	8.857	190.511	325.712	-	1.912.206	116.049	2.028.255	-	-	-	-	-	-	2.028.255

Physical Input-output table for ALL RESIDUALS Italy 1997 Thousand tons		Socio-economic system										Natural environment - NE			TOTAL MATERIAL SUPPLY BY ACTIVITY	
		Socioeconomic system										National environment - NE1			Rest of the world environment - NE2	NE=NE1+NE2
		National socio-economic system				Rest of the world Exports including uses of fuels by non residents on national territory		Total national socio-economic system				Total socio-economic system			H=NE	
Material transformation - T		Consumer durables		Accumulation of products-S1		Landfills		Total national socio-economic system		R		H=NR				
Production	T1	S11	S12	S13	S2	S1	S2	NE+ST+S2			NE1	NE2	NE=NE1+NE2			
Production	62,751	-	-	-	55,920	-	-	118,671	-	-	958,663	14,708	973,371	1,092,042		
Consumption of non durable goods	12,931	-	-	-	-	-	-	12,931	-	-	201,522	1,605	203,127	216,058		
Consumer durables	546	-	-	-	-	-	-	546	-	-	-	-	-	546		
Other capital	21,210	-	-	-	-	-	-	21,210	-	-	-	-	-	21,210		
Landfills	-	-	-	-	-	-	-	-	-	-	540	-	540	540		
Total national socio-economic system	97,438	-	-	-	55,920	-	-	153,358	-	-	1,160,725	16,313	1,177,038	1,330,396		
Imports, including uses of fuel for transport by resident units abroad	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Supply of residuals by transport activities of non residents on national territory	-	-	-	-	-	-	-	-	-	-	21,096	-	21,096	21,096		
Total socio-economic system - H	97,438	-	-	-	55,920	-	-	153,358	-	-	1,181,821	16,313	1,198,134	1,351,492		
supply of natural resources	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
supply of ecosystem inputs	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
supply of ecosystem inputs	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Total Natural Environment - NE	-	-	-	-	-	-	-	-	-	-	1,181,821	16,313	1,198,134	1,351,492		
TOTAL MATERIAL USE BY ACTIVITY - H+NE	97,438	-	-	-	55,920	-	-	153,358	-	-	1,181,821	16,313	1,198,134	1,351,492		

Socio-economic system		Socio-economic system										Natural environment - NE			TOTAL MATERIAL SUPPLY BY ACTIVITY
		National socio-economic system					Rest of the world Exports including uses of fuels by non-residents on national territory	Total socio-economic system	National environment - NE1	Rest of the world environment - NE2	Total Natural Environment				
		Material transformation - T	Accumulation of products-ST			Landfills						Total national socio-economic system	H=NR	NE1		NE2	NE=NE1+NE2
Production	Consumption	Consumer durables	Inventories change	Other capital	S11	S12	S13	S2	N=F+S+S2	R	H=NR	NE1	NE2	NE=NE1+NE2	
T1	T2	S11	S12	S13	S2	N=F+S+S2	R	H=NR	NE1	NE2	NE=NE1+NE2				
Production															
Consumption of non-durable goods															
Consumer durables															
Other capital															
Landfills															
Total national socio-economic system															
Imports including uses of fuel for transport by resident units abroad															
Supply of residuals by transport activities of non-residents on national territory															
Total socio-economic system - H															
supply of natural resources	447.720					447.720			447.720						447.720
supply of ecosystem inputs	948.128	149.806				1.097.934	16.448		1.114.382						1.114.382
supply of ecosystem inputs	11.478	1.245				12.723			12.723						12.723
Total Natural Environment - NE	1.407.326	151.051				1.558.377	16.448		1.574.825						1.574.825
TOTAL MATERIAL USE BY ACTIVITY - H+NE	1.407.326	151.051				1.558.377	16.448		1.574.825						1.574.825

Socio-economic system		Socioeconomic system										Natural environment - NE			TOTAL MATERIAL SUPPLY BY ACTIVITY		
		National socio-economic system				Rest of the world		Total socio-economic system				National environment - NE1	Rest of the world environment - NE2	Total Natural Environment			
Socio-economic system	World	Material transformation - T		Consumption of non-durable goods		Production		National socio-economic system		Rest of the world Exports including uses of fuels and Ecosystem inputs for transport by non residents on national		Total socio-economic system		National environment - NE1	Rest of the world environment - NE2	Total Natural Environment	H/NE
		T1	T2	S1.1	S1.2	S1.3	S2	S1	S2	RW	H+N+RW	NE1	NE2	NE=NE1+NE2			
Production		437.012	49.504	394	49.651	2.657	-	539.218	27.570	566.788	-	-	-	-	-	566.788	
Consumption of non-durable goods		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Consumer durables		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other capital		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Landfills		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total national socio-economic system		437.012	49.504	394	49.651	2.657	-	539.218	27.570	566.788	-	-	-	-	-	566.788	
Imports, including uses of fuel for transport by resident units, abroad		4.1.193	7.234	139	-	452	-	49.018	-	49.018	-	-	-	-	-	-	49.018
Supply of residuals by transport activities of non residents on national territory		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total socio-economic system - H		478.205	56.738	533	49.651	3.109	-	588.236	27.570	615.806	-	-	-	-	-	615.806	
supply of natural resources	National environment - NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
supply of ecosystem inputs	National environment - NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
supply of ecosystem inputs	Rest of the environment - NE2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Natural Environment - NE		478.205	56.738	533	49.651	3.109	-	588.236	27.570	615.806	-	-	-	-	-	615.806	

Physical Input-output table for P2 - FOSSIL FUEL PRODUCTS Italy 1997 Thousand tons		Socio-economic system										Natural environment - NE			TOTAL MATERIAL SUPPLY BY ACTIVITY H+NE				
		National socio-economic system				Landfills		Total national socio-economic system		Rest of the world Exports including uses of fuels and Ecosystem inputs for transport by non residents on national		National environment - NE1	Rest of the world environment - NE2	Total Natural Environment					
Socio-economic system	World of the National environment - NE1	Material transformation - T		Consumer durables		Inventories' net increase		Other capital		Landfills		Total national socio-economic system		Rest of the world Exports including uses of fuels and Ecosystem inputs for transport by non residents on national		National environment - NE1	Rest of the world environment - NE2	Total Natural Environment	TOTAL MATERIAL SUPPLY BY ACTIVITY H+NE
		T1	T2	S1.1	S1.2	S1.3	S2	N=F+S+SZ	RW	NE1	NE2	NE=NE1+NE2							
Production		23,442	1,324	103	3,202	23	-	28,094	36,030	-	64,124	-	-	-	-	-	-	64,124	-
Consumption of non durable goods		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Consumer durables		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other capital		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Landfills		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total national socio-economic system		23,442	1,324	103	3,202	23	-	28,094	36,030	-	64,124	-	-	-	-	-	-	64,124	-
Imports, including uses of fuel for transport by resident units abroad		171,855	752	-	-	1	-	172,608	-	-	172,608	-	-	-	-	-	-	172,608	-
Supply of residuals by transport activities of non residents on national territory		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total socio-economic system - H		195,297	2,076	103	3,202	24	-	200,702	36,030	-	236,732	-	-	-	-	-	-	236,732	-
supply of natural resources	Natural environment - NE1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
supply of ecosystem inputs	Natural environment - NE2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
supply of ecosystem inputs	Rest of the world environment - NE2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Natural Environment - NE		195,297	2,076	103	3,202	24	-	200,702	36,030	-	236,732	-	-	-	-	-	-	236,732	-

Physical Input-output table for P3 - MINERAL PRODUCTS Italy 1997 Thousand tons		Socio-economic system										Natural environment - NE			TOTAL MATERIAL SUPPLY BY ACTIVITY H+NE	
		Socio-economic system										Total socio-economic system H+H+RW	Rest of the world environment - NE2 NE2	Total Natural Environment NE+NE1+NE2		
		National socio-economic system					Landfills S2	Rest of the world Exports including uses of fields and Ecosystem inputs for transport by non residents on national territory RW								National environment - NE1 NE1
		Material transformation - T Production	Consumption of non-durable goods T2	Consumer durables S1.1	Inventories net increase S1.2	Other capital S1.3		Accumulation of products - S1	Total national socio-economic system H+T+S1+S2							
Production	573,965	1,384	3,895	142,602	317,744	-	1,039,590	46,316	1,085,906	-	-	-	1,085,906			
Consumption of non-durable goods	-	-	-	-	-	-	-	-	-	-	-	-	-			
Consumer durables	-	-	-	-	-	-	-	-	-	-	-	-	-			
Other capital	-	-	-	-	-	-	-	-	-	-	-	-	-			
Landfills	-	-	-	-	-	-	-	-	-	-	-	-	-			
Total national socio-economic system	573,965	1,384	3,895	142,602	317,744	-	1,039,590	46,316	1,085,906	-	-	-	1,085,906			
Imports, including uses of fuel for transport by residents, abroad	64,783	230	1,617	-	1,833	-	68,463	-	68,463	-	-	-	68,463			
Supply of residuals by transport activities of non residents on national territory	-	-	-	-	-	-	-	-	-	-	-	-	-			
Total socio-economic system - H	638,748	1,614	5,512	142,602	319,577	-	1,108,053	46,316	1,154,369	-	-	-	1,154,369			
Supply of natural resources	-	-	-	-	-	-	-	-	-	-	-	-	-			
Supply of ecosystem inputs	-	-	-	-	-	-	-	-	-	-	-	-	-			
Supply of ecosystem inputs	-	-	-	-	-	-	-	-	-	-	-	-	-			
Total Natural Environment - NE	-	-	-	-	-	-	-	-	-	-	-	-	-			
TOTAL MATERIAL USE BY ACTIVITY - H+NE	638,748	1,614	5,512	142,602	319,577	-	1,108,053	46,316	1,154,369	-	-	-	1,154,369			

Physical Input-output table for P4 - COMPOSITE PRODUCTS Italy 1997 Thousand tons		Socioeconomic system										Natural environment - NE			TOTAL MATERIAL SUPPLY BY ACTIVITY
		National socio-economic system					Landfills S2	Total national socio-economic system N=F+S1+S2	Rest of the world Exports including use of fuels and Ecosystem inputs for transport by non residents on national	Total socio-economic system H=N+RW	National environment - NE1 NE1	Rest of the world environment - NE2 NE2	Total Natural Environment NE=NE1+NE2		
		Material transformation - T consumption of non-durable products	Production T1	Consumer durables S11	Inventories' net increase S12	Other capital S13								Accumulation of products S1 increase	
Production	7.385	3.965	2.573	4.944	2.911	11.890	6.133	18.023	18.023	-	-	-	18.023		
Consumption of non-durable goods	-	-	-	-	-	-	-	-	-	-	-	-	-		
Consumer durables	-	-	-	-	-	-	-	-	-	-	-	-	-		
Other capital	-	-	-	-	-	-	-	-	-	-	-	-	-		
Landfills	-	-	-	-	-	-	-	-	-	-	-	-	-		
Total national socio-economic system	7.385	3.965	2.573	4.944	2.911	11.890	6.133	18.023	18.023	-	-	-	18.023		
Imports, including uses of fuel for transport by residents units abroad	2.484	614	136	-	91	3.325	-	3.325	3.325	-	-	-	3.325		
Supply of residuals by transport activities of non residents on national territory	-	-	-	-	-	-	-	-	-	-	-	-	-		
Total socio-economic system - H	9.869	4.579	2.709	4.944	3.002	15.215	6.133	21.348	21.348	-	-	-	21.348		
supply of natural resources	-	-	-	-	-	-	-	-	-	-	-	-	-		
supply of ecosystem inputs	-	-	-	-	-	-	-	-	-	-	-	-	-		
supply of ecosystem inputs	-	-	-	-	-	-	-	-	-	-	-	-	-		
Total Natural Environment - NE	9.869	4.579	2.709	4.944	3.002	15.215	6.133	21.348	21.348	-	-	-	21.348		
TOTAL MATERIAL USE BY ACTIVITY - H+NE	9.869	4.579	2.709	4.944	3.002	15.215	6.133	21.348	21.348	-	-	-	21.348		

Physical Input-output table for W1 to W4 - RESIDUALS that are emitted directly to air and water Italy 1997 Thousand tons		Socio-economic system										Natural environment - NE			TOTAL MATERIAL SUPPLY BY ACTIVITY H+NE
		National socio-economic system					Total socio-economic system					National environment - NE1	Rest of the world environment - NE2	Total Natural Environment NE=NE1+NE2	
		Material transformation - T		Accumulation of products-ST			Landfills S2	Total national socio-economic system N=TS+S2	Rest of the world Exports including uses of fuels and Ecosystem inputs for transport by non residents on national		Total socio-economic system H+N+RW				
		Production T1	Consumption of non-durable goods T2	Consumer durables S1.1	Inventories net increase S1.2	Other capital S1.3			Landfills S2	Exports including uses of fuels and Ecosystem inputs for transport by non residents on national RW		Rest of the world H+N+RW			
	Production										790.763	14.708	805.471	805.471	
	Consumption of non-durable goods										201.522	1.605	203.127	203.127	
	Consumer durables														
	Other capital														
	Landfills										540		540	540	
	Total national socio-economic system										992.825	16.313	1.009.138	1.009.138	
	Imports including uses of fuel for transport by resident units abroad														
	Supply of residuals by transport activities of non residents on national territory										21.096		21.096	21.096	
	Total socio-economic system - H										1.013.921	16.313	1.030.234	1.030.234	
	supply of natural resources														
	supply of ecosystem inputs														
	supply of ecosystem inputs														
	Total Natural Environment - NE										1.013.921	16.313	1.030.234	1.030.234	

Physical input-output table for W5 to W7 - RESIDUALS that also circulate inside the socioeconomic system Italy 1997 Thousand tons		Socio-economic system										Natural environment - NE			TOTAL MATERIAL SUPPLY BY ACTIVITY H+NE
		Socio-economic system										Natural environment - NE			
		National socio-economic system					Rest of the world exports (including uses of fuels and Ecosystem inputs for transport by non residents on national territory)					Total socio-economic system	National environment - NE1	Rest of the world environment - NE2		Total Natural Environment
Material transformation - T	Production	T1	T2	S1.1	S1.2	S1.3	S2	N-F-T-S1+S2	RW	H+NRW	NE1	NE2	NE+NE1+NE2		
Production		62.751	-	-	-	-	55.920	118.671	-	118.671	167.900	-	167.900	286.571	
Consumption of non durable goods		12.931	-	-	-	-	-	12.931	-	12.931	-	-	-	12.931	
Consumer durables		546	-	-	-	-	-	546	-	546	-	-	-	546	
Other capital		21.210	-	-	-	-	-	21.210	-	21.210	-	-	-	21.210	
Landfills		-	-	-	-	-	-	-	-	-	-	-	-	-	
Total national socio-economic system		97.438	-	-	-	-	55.920	153.358	-	153.358	167.900	-	167.900	321.258	
Imports, including uses of fuel for transport by resident units abroad		-	-	-	-	-	-	-	-	-	-	-	-	-	
Supply of residuals by transport activities of non residents on national territory		-	-	-	-	-	-	-	-	-	-	-	-	-	
Total socio-economic system - H		97.438	-	-	-	-	55.920	153.358	-	153.358	167.900	-	167.900	321.258	
supply of natural resources		-	-	-	-	-	-	-	-	-	-	-	-	-	
supply of ecosystem inputs		-	-	-	-	-	-	-	-	-	-	-	-	-	
supply of ecosystem inputs		-	-	-	-	-	-	-	-	-	-	-	-	-	
Total Natural Environment - NE		-	-	-	-	-	55.920	153.358	-	153.358	167.900	-	167.900	321.258	

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MATRICE DI CONTI ECONOMICI INTEGRATA CON CONTI
AMBIENTALI (NAMEA)

Capitolo 5

Rapporto ad Eurostat

The 1990 Italian NAMEA

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1 INTRODUCTION AND OUTLINE

The National Accounting Matrix including Environmental Accounts (NAMEA) is a statistical tool that combines national accounts (economic module) and environmental accounts (environmental module). The economic module records monetary flows, including the main aggregates of national accounts; the environmental module aims at recording the environmental pressures caused by economic activities. The system was originally developed by Statistics Netherlands²⁰⁹. The same Institute hosted in 1995 a Workshop organised by Eurostat to introduce national accountants, environmental accountants and environmental statisticians of other EU member states to the accounting logic of the matrix so that they could start to build their own NAMEAs. Since then, almost all EU countries have compiled a national NAMEA reproducing the Dutch model to the extent possible, given the availability of data in each country. Specifically, the development of the environmental module within the matrix stemmed from air emission accounts, characterised by better data availability than for other environmental pressures. In a second Eurostat Workshop, held in 1997, participants discussed the possibility of expanding the scope of the environmental module to water and waste accounts as well. The following year, at the third NAMEA Workshop, some countries proved that the exercise was indeed feasible for them. The third meeting also marked the start of efforts to harmonise the methodologies used by different countries in building their national NAMEAs, with the aim of improving the comparability of the

Il testo riportato è una rielaborazione del rapporto originale consegnato all'Eurostat nel 1999, rispetto al quale risulta sintetizzata la descrizione dei processi CORINAIR utilizzati e non vengono riportati i dati NAMEA in percentuale; è stato inoltre aggiunto l'Annex C. La realizzazione del progetto e la stesura del rapporto originale sono state coordinate da Angelica Tudini (Istat).

I §§ 2, 3.1 sono stati redatti da Federica Battellini (Istat); il § 3.2.2 da Riccardo De Lauretis (ANPA - Agenzia Nazionale per la Protezione dell'Ambiente); i §§ 3.3, 4.3 da Aldo Femia (Istat); l'Annex C da Filippo Moauro (Istat); il § 3.2.3 da Stefano Spagnolo (stagista Istat); il §§ 1, 3.2.1, 4.1, 4.2, l'Annex A e l'Annex B da Angelica Tudini.

Gli autori ringraziano Luisa Picozzi, Roberto Bruno, Manlio Calzaroni, Paolo Dolfi, Carmine Fimiani, Laura Loriga, Livia Mastrantonio e Massimo Ricci (Istat); John Allen e Maila Puolamaa (Eurostat); Raffaella Ceccacci (stagista Istat).

²⁰⁹ See De Haan, Keuning (1994).

results²¹⁰. This effort led to the agreement, reached at the fourth workshop (June 2000), on a set of tables for standardised reporting of NAMEA air emission and economic data.

As far as Italy is concerned, the first step towards an Italian NAMEA was the feasibility study conducted by Battellini and Tudini (1996) in order to explore data availability. On the basis of the results of that study Istat put down a work project aimed at producing the first Italian NAMEA for the year 1990, including:

1. the flows of the Input Output (I-O) Table and national accounts;
2. environmental accounts for six air pollutants: carbon dioxide (CO₂), sulphur oxides (SO_x), nitrogen oxides (NO_x), nitrous oxide (N₂O), ammonia (NH₃), methane (CH₄);
3. the direct intake of resources from nature by economic activity.

The remainder of this chapter describes the work carried out to produce the 1990 Italian NAMEA and illustrates the main results. Specifically, Paragraph 2 shows the aggregated NAMEA matrix for Italy; Paragraph 3 describes the methodology used for building the economic module (§ 3.1) and the environmental module (§§ 3.2 and 3.3); Paragraph 4 presents economic and environmental data for significant groupings of NACE divisions.

²¹⁰ As a matter of fact, up to now, the national NAMEAs are hardly comparable as they differ with respect to, for example, the reference years, the classification of activities, the methodology used for building the environmental accounts as well as the pollutants included.

2 THE 1990 ITALIAN NAMEA: AN OVERVIEW

The structure of the 1990 Italian NAMEA mirrors the Dutch NAMEA²¹¹: it includes a matrix presentation of national accounts – the NAM section or economic module²¹² - extended to environmental accounts - the EA section or environmental module. Data availability both in the economic and in the environmental module have determined the actual design of the Italian NAMEA²¹³, which does not reproduce the complete design of the NAMEA as proposed by the Dutch Statistical Office. In particular, in the absence of a whole set of accounts, dummy rows and columns are included in the NAM, making it a non-square matrix; this mainly presents the Supply and Use flows and does not include the income distribution and financial flows²¹⁴. Moreover, in the EA section the Italian NAMEA presents flows on air emissions caused by production and consumption activities as well as the direct intake of resources from nature.

The following “Overview Table” provides a summary of the flows recorded along the rows and columns of the Italian matrix, including the nomenclatures and the breakdown and valuation criteria adopted. The NAM section includes rows 1 to 4 and columns 1 to 5; with the addition of row 5 and column 6 the EA section is provided.

As the table shows, the Italian NAMEA includes the accounts describing operations relating to industries: the Goods and Services account and the Production account. The design of this very first part of the matrix reproduces that of the Dutch NAMEA.

The uses of the Goods and Services account (entering the first row of the table) equal the resources of the same account (recorded in the first column, where the intake of natural resources is recorded as well - row 5), thus showing the total resources of the economy. The same applies to the Production account (third row, excluding air emissions - column 6, and third column) which records the domestic output of the economy; the emissions recorded in the last column of the third row are those directly linked to production activities.

The second and fourth columns record respectively the separate imputation of products that are different from those typically produced by each industry and the quota of trade and transport margins related to the intermediate consumption of industries: the first of these flows makes the aggregates recorded in the Goods and Services account consistent with those in the production account; the second allows to value the intermediate consumption of each industry at purchaser’s prices.

The fifth column records the final uses of total resources. Households’ expenditure for final consumption is broken down by industry in the first row; specific amounts of this aggregate are separately shown in the second row in order to measure the part of consumption expenditure of households which finances the consumption activities causing the emissions recorded in the last column.

Finally, the fifth row indicates the amount of resources directly taken from nature by the industries indicated in the first column.

²¹¹ See footnote 209.

²¹² The National Accounts Matrix is described in the United Nations System of National Accounts (SNA93) and in the European System of Accounts (ESA95) handbooks.

²¹³ As mentioned in § 3.1, data availability is analysed in detail in Battellini – Tudini (1996).

²¹⁴ A traditional NAM, instead, as described by the United Nations System of National Accounts (SNA93), is a square matrix where the whole sequence of National Accounts is shown both in the rows and in the columns, thus allowing to record the whole circular flow of income (its generation, distribution, redistribution and use).

Overview Table. The 1990 Italian NAMEA

	Goods & Services account (NACE Rev.1 groupings)	Transfer of products	Production account (NACE Rev.1 groupings)	Margins on Intermediate Consumption	Final Uses		Emissions (pollutants)
	1	2	3	4	5		6
Goods & Services account (NACE Rev.1 groupings)	1 Trade and transport margins on total supply-totals by industry of destination		Intermediate consumption by industry of origin and industry of destination (depart-usine)	Trade and transport margins on intermediate consumption-totals by industry of origin	Consumption of Households by industry (purchaser's prices)	Other Final Uses by industry: Government & NPISHs ²¹⁵ final Consumption, Investments, Exports (purchaser's prices)	
Households Consumption (consumption purpose)	2				Consumption of Households by purpose (purchaser's prices)		Air emissions caused by households consumption activities (physical units)
Production account (NACE Rev.1 groupings)	3 Output by industry (depart-usine)	Products different from those typically produced by each industry					Air emissions caused by production activities (physical units)
Value Added and rest of the world flows	4 Imports by industry (depart-douane)		Value added (factor cost); net indirect taxes & VAT on production by industry				
Intake of materials from nature (kind of material)	5 Intake of natural resources by industry (physical units)						

The aggregated 1990 Italian NAMEA is presented in Figure 1. Industries have been grouped into eight main macro-industries (identified by the codes shown in the headings). The same grouping of industries has been adopted in the design of the environmental profiles (Paragraph 4).

The economic data, emissions data and the intake of resources underlying the aggregated flows shown in the NAMEA are presented in more detail in Annex A.

²¹⁵ Non Profit Institutions Serving Households (see SNA93).

Figure 1 - 1990 Italian NAMEA: aggregated matrix (a)

	Goods & Services NACE groupings (b)										Transfer of products	Production NACE groupings (b)										Margins on intermediate consumption			Final Uses			Air Emissions (c)						
	01-05		10-14		15-37		40-41		45			50-55		60-63		64-95		84-95		Fism		Total		Households Consumption	Other	SO ₂	NO _x	CH ₄	CO ₂	N ₂ O	NH ₃			
	01-05	10-14	15-37	40-41	45	50-55	60-63	64-95	84-95	Fism		Total	Households Consumption	Other	SO ₂	NO _x	CH ₄	CO ₂	N ₂ O	NH ₃														
(b) Goods & Services	9,990	1,429	119,598	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18,880	2,605											
Households Consumption																						18,880	2,605											
(a) Heating																																		
Other																																		
Total	33,131	4,980	493,646																			383,920	393,265											
(b) Production																																		
01-05																																		
10-14																																		
15-37																																		
40-41																																		
45																																		
50-55																																		
60-63																																		
64-95																																		
Total	22,979	3,352	153,943	13,748	39,669	109,039	33,861	276,663	-32,630	620,623																								
Value Added																																		
Net Indirect Taxes & VAT	6,285	11,137	100,088	865	46	3,682	1,802	10,386	134,371																									
Imports																																		
Energy																																		
Endogenous																																		
Exogenous																																		
Wood and fossil fuels																																		
Non-energy																																		
Minerals																																		
Bioc materials																																		

(a) Economic module (bold frame). Unit: billion lire. Valuation: intermediate consumption; depart-usage prices; consumption and other final uses; purchaser's prices; production; depart-usage prices (VAT included); value added; factor cost; imports; depart-douane prices (VAT included).
 Environmental module (double frame). Unit: air emissions except CO₂; tons; CO₂ emissions: 1000 tons; intake of materials from nature: 1000 tons.
 (b) NACE groupings: 01-05: agriculture, forestry and fishing; 10-14: mining and quarrying; 15-37: manufacturing; 40-41: electricity, gas and water supply; 45: construction; 50-55: trade, hotels and restaurants; 60-63: transport; 64-95: other services. Fism: financial intermediation services indirectly measured.
 (c) Pollutants: SO₂: sulphur oxides; NO_x: nitrogen oxides; CH₄: methane; CO₂: carbon dioxide; N₂O: nitrous oxide; NH₃: ammonia.
 (d) Households consumption by purpose: Transport: household consumption for "transport" purposes corresponds to expenditure on "operation of personal transport equipment" (COICOP item 07.2). Heating: household consumption for "heating" purposes corresponds to expenditure on "electricity, gas and other fuels" (COICOP item 04.5). Other: among the activities included in this category, only gardening generates the emissions considered here.
 Note that differences in the totals of rows and columns may depend on rounding of decimals.

3 METHODOLOGY AND DATA SOURCES

3.1 Economic module

The content of each cell of the NAM section has been defined with reference to a consistent set of macro-aggregates and accounts. The main data source are the 1990 national accounts and the 1992 Input-Output Table, both compiled according to ESA95 definitions and nomenclatures: therefore the 1990 NAMEA is consistent with ESA95. Due to the schedule of ESA95 implementation, sector accounts were not available at the moment of compiling the NAM module. This is the reason why the 1990 NAMEA only describes supply and use flows, i.e. the flows recorded in the Goods and Services and in the Production accounts.

Among the main issues concerning the implementation of the economic module of a NAMEA there are the definition of break-down criteria and the evaluation of aggregates and flows in a way that enables these flows to be linked to data on environmental pressures.

With respect to the dis-aggregation of flows, Eurostat suggests to break down production activities by industry (in particular by Nace rev.1 categories adequately grouped) and consumption activities by purpose. As far as production activities are concerned, in the Italian NAMEA both the Goods and Services account and the Production account data have been reported as traditionally presented in the national accounts series: they are broken down by industry according to the NACE Rev.1 nomenclature. To that end, industries have been defined by grouping units based on the ESA95 concept of Local Kind-of-Activity Unit (LKAU), which represents a proxy of the homogeneous unit of production. This means that an industry results from the grouping of production units according to the output produced and not according to the main activity of the enterprise to which these units belong. The approach followed is more suitable to enable a proper linkage with the environmental module, since the latter is based on the CORINAIR data base, which is compiled according to production processes (see § 3.2).

As far as consumption activities are concerned, a break-down of final consumption of households (by purpose) is adopted which aims at isolating the amount of households' expenditure for products that are considered responsible for almost the whole generation of air emissions, i.e. products related to transport and heating purposes, corresponding to COICOP categories 07.2 (operation of personal transport equipment) and 04.5 (electricity, gas and other fuels)²¹⁶.

Both the breakdown of flows by macro-industries and by purpose of final consumption are shown in the aggregated NAMEA (Figure 1). The data on production, value added and employment (full-time equivalent units) broken-down by macro-industries are also presented in the environmental profiles (see § 4.1). Annex A presents output and value added broken down according to the detailed NAMEA classification together with data on environmental pressures (air emissions and resource intakes).

Turning to evaluation criteria, the Italian Input-Output Table data and related flows are available for the year 1990 not only at purchaser's prices, but also at depart-usine values. Thanks to this, production and intermediate consumption flows have been recorded in the NAMEA at depart-usine values (including VAT on production), in order to enable the identification of each industry actually producing a given output and generating the related environmental pressures

²¹⁶ No statistically appreciable direct intake of resources from households takes place. Therefore, the classification of final consumption by purpose is relevant here only in relation to air emissions.

(emissions and direct intake of resources), even in the case of transport activities: as a matter of fact, when aggregates are valued at purchaser's prices, the quota of the market price due to transportation of the output from the production site to the selling site (transport margins) is attributed to the industry which has produced the good; when aggregates are at depart-usine values, this quota is attributed to the transport industry. Since in the Italian NAMEA, emissions due to these transport activities are attributed to the transport industry, in the economic module output has been valued at depart-usine values. On the contrary, final uses have been valued at purchaser's prices. The balancing of the items valued according to different evaluation criteria is obtained in the economic module by reporting trade and transport margins of each industry separately.

Since both production and consumption activities are responsible for the emissions considered in the NAMEA, in the following paragraphs we will simply use "(human) activities" to summarise both types, specifying respectively "economic" or "consumption" when we intend to refer exclusively to one type.

3.2 Air emissions accounts

In Italy the emissions of air pollutants are calculated for the Community CORINAIR inventory. Therefore, the 1990 CORINAIR emissions data, classified according to SNAP94 (Simplified Nomenclature for Air Pollution)²¹⁷, are the basis for the air emissions accounts of the 1990 Italian NAMEA matrix.

For a proper interpretation of the figures and in order to facilitate the comparison with other countries' data, the following paragraph (§ 3.2.1) lists the SNAP94 processes that are not included in the Italian NAMEA because of their irrelevance in the present exercise or because of lack of data.

Paragraphs 3.2.2 and 3.2.3 describe how the air emissions accounts were developed starting from the CORINAIR data.

In the CORINAIR inventory, emission data are classified according to the process causing them. The NAMEA environmental module, instead, requires to record the amount of emissions generated by each activity of the NAMEA NACE-based classification. Thus, the main problem, when compiling air emissions accounts based on CORINAIR data, is to shift from a process-based classification to an economic one²¹⁸. In the Italian NAMEA the problem was solved in two stages. The first stage addressed the question: in which production and final consumption activities does a process take place? To answer this question the qualitative link between SNAP94 processes and activities was studied (see § 3.2.2). The second stage addressed the question: given a process, what is the share of its air emissions to be attributed to each of the activities? To answer this question the process-based emissions were distributed to the corresponding NACE branches and final consumption categories by using indicators suited for the purpose and other ad hoc methods (see § 3.2.3).

²¹⁷ 1990 CORINAIR data classified according to SNAP94 are available in Italy in addition to the 1990 air emissions classified according to the SNAP90 nomenclature.

²¹⁸ The problem of linking SNAP and NACE classifications in general, without specific reference to the Italian case, is discussed in Femia - Segatori (1998).

3.2.1 CORINAIR processes not included in the Italian NAMEA

Some processes need not, or may not, be considered for the allocation of their emissions to the activities in which they are carried out, and are therefore excluded from the elaboration described in the following paragraphs. These are:

- processes belonging to the category “Nature” (code 11) of the SNAP classification; these processes are, by definition, not due to human activities, and therefore irrelevant for the determination of the pressures generated by the economic and consumption activities recorded in the NAMEA
- processes not taking place in Italy;
- processes not emitting any of the six substances considered in the Italian 1990 NAMEA;
- processes potentially emitting at least one of the six substances considered, but for which emission estimates are not available for Italy.

3.2.2 Qualitative links between SNAP94 processes and NAMEA activities

The exercise of imputing emissions to the originating activities, produces different results depending on whether a “producer” or “user” approach is adopted. Consistently with the outcome of the discussion at the 3rd NAMEA Workshop²¹⁹, the Italian NAMEA adopts a “producer” approach, i.e. – as far as production activities are concerned - emissions are assigned to those economic activities that derive their value added from the production of goods/services that originates the emissions. More generally, the emissions are always assigned to the activity that directly generates them.

Tables 1-8 below show the results of the analysis of the qualitative link between processes and activities. Each table refers to a specific SNAP source category. Only 8 out of the 11 SNAP source categories are subject to a detailed analysis since:

- “solvent and other product use” (processes belonging to SNAP cat. 6), only emit NMVOCs and are therefore outside the scope of the work;
- “agriculture and forestry, land use and wood stock change” (processes belonging to SNAP cat. 10), can be univocally linked to NACE Rev.1 division 01 without further processes’ split; the estimates for emissions by the only process that, in principle²²⁰, can be linked to both agriculture and forestry - 1006 “use of pesticides” - are not available in Italy;
- “Nature” processes (SNAP cat. 11), are outside of the NAMEA boundary since they are not related to human activities.

In the tables, some rows report two processes together, since the data on the emission are calculated with reference to the two jointly considered.

In each table, the first 3 columns, under the heading “Process based air emissions”, relate to the SNAP processes that are the starting point of the work; column 1 specifies the process name, column 2 the SNAP94 process code, and the third column lists all air pollutants for which estimates are available in the Italian 1990 CORINAIR inventory for the year 1990 based on SNAP94. CO and NMVOCs are excluded. The second group of columns, under the heading “Corresponding activities (NACE Rev.1 code + households)” reports the activities to which process emissions can be imputed. Households consumption is identified by codes 101, 102,

²¹⁹ Luxembourg, 23-24 November 1998.

²²⁰ See Eurostat (1998), chapter 4 “The treatment of NOSE-P headings with multiple NACE associations”.

103, (respectively “transport”, “heating” and “other”). The columns report the results of different studies. The first one (column 4, heading: “Italy”) reports the activities identified by our analysis for the NAMEA project. The match between CORINAIR processes and NAMEA activities for Italy was obtained by applying the knowledge of the Italian CORINAIR to the NAMEA context.

In the tables the economic activities linked to each process are shown at the highest possible level of breakdown. However, for the next step of the work (the quantitative allocation of emissions to activities, see § 3.2.3) the economic activities linked to each process can be identified at the second and, only in some cases, third digit of the NACE rev.1, consistently with the breakdown of the NAMEA classification (see Annex A). Therefore, if a process is linked to a group of economic activities belonging to the same NACE rev.1 division (as in the case, for example, of process 040302 linked to NACE rev.1 27.1 and 27.35), the process is regarded as being linked to a single economic activity at the division level (in this case division 27); the same holds at the third digit breakdown, for the economic activities appearing at the group level in the NAMEA classification.

Columns 5 and 6 present the results of other two SNAP-NACE exercises: the Eurostat working document “Main SNAP94 headings corresponding to NACE branches” presented at the 1997 NAMEA workshop²²¹, (column 5, heading: “Eurostat 97”), and the PRODCOM-SNAP linkage created as part of the CORINAIR Conversion System (column 6 heading: “CCS”)²²². Some tables also contain a 7th column based on the NOSE manual²²³.

The symbol “----” means that information is not available.

The shaded cells highlight some cases in which the SNAP-NACE linkages proposed for the Italian case are different from those proposed by other sources (columns 5-6 or 5-7 where applicable). Three are the main causes of differences identified in this study:

1. the approach of the study;
2. the methodology applied in estimating the emissions;
3. the specific national process-activity association. For each case, a few examples are given below.

Process 010101 provides one example of how the approach adopted in the association can determine a different outcome: the emissions can be associated to NACE 40.10 - production of electricity - when a “producer” approach is adopted (as in the Italian case), whereas they are associated with all of the economic activities consuming electricity in the CORINAIR Conversion System (CCS) that adopts a “user” approach.

Processes 020103, 020105, 020106 and 091001 show how differences in the associations may be due to the way the CORINAIR emissions are produced (case 2). As regards the first two processes, in the Italian case, they are responsible for all emissions from heating - with the exception of residential emissions - whereas according to the CORINAIR methodology heating should be part of 03 processes as well. In the case of process “Waste water treatment in industry” (091001) emissions were estimated for CORINAIR90 by an ad hoc study that included only the economic activities “Manufacture of food products and beverages” (15), “Manufacture of textiles and textile products (not incl. wearing apparel)” (17), and “Manufacture of pulp, paper and paper products” (21).

²²¹ See Eurostat (1997). The associations under column 5 should be interpreted with caution as the document is a provisional working tool. For a more comprehensive analysis of the associations set in Eurostat (1997) see Femia-Segatori (1998).

²²² See Stahl (1998), Annex 2.

²²³ See footnote 220.

Finally, one example of differences, in the SNAP-NACE linkages identified by various sources, due to the specific national process-activity association is process 030313 “Combustion in manufacturing Industry - asphalt concrete plant”, that in the Italian version of NACE Rev.1 matches category 23.20.4.

Table 1 - Qualitative link between SNAP cat. 1 “Combustion in Energy and Transformation Industries” and NACE Rev.1

Process based air emissions			Corresponding activities (NACE Rev.1 code + households) identified by:		
Type of process	SNAP94 code	Pollutants	Italy	Eurostat 97	CCS
Public power			0101		
Combustion Plants >=300MW (Boilers)	010101	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	40.1	40.1	(1)
Combustion Plants >=50 and <300 MW	010102	SO _x NO _x CH ₄ CO ₂ N ₂ O	40.1	40.1	40.1
Combustion Plants <50 MW	010103	NO _x CO ₂	40.1	40.1	40.1
Gas Turbines	010104	SO _x NO _x CH ₄ CO ₂ N ₂ O	40.1	40.1	40.1
Stationary Engines	010105	SO _x NO _x CH ₄ CO ₂ N ₂ O	40.1	40.1	40.1
District heating plants			0102		
Combustion Plants >=300MW (Boilers)	010201	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	40.3	40.1, 40.3	40.30.1
Combustion Plants <50 MW (Boilers)	010203	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	40.3	40.1, 40.3	40.30.1
Gas Turbines	010204	NO _x CH ₄ CO ₂ N ₂ O	40.3	40.1, 40.3	40.30.1
Stationary Engines	010205	SO _x NO _x CH ₄ CO ₂ N ₂ O	40.3	40.1, 40.3	40.30.1
Petroleum refining plants			0103		
Combustion Plants >=300MW (Boilers)	010301	SO _x NO _x CH ₄ CO ₂ N ₂ O	23.2	23.2, 40.1	23.2
Combustion Plants >=50 <300 MW (Boilers)	010302	SO _x NO _x CH ₄ CO ₂ N ₂ O	23.2	23.2, 40.1	23.2
Combustion Plants <50 MW (Boilers)	010303	SO _x NO _x CH ₄ CO ₂ N ₂ O	23.2	23.2, 40.1	23.2
Gas Turbines	010304	SO _x NO _x CH ₄ CO ₂ N ₂ O	23.2	23.2, 40.1	23.2
Process furnaces	010306	SO _x NO _x CH ₄ CO ₂ N ₂ O	23.20.1	23.2, 40.1	23.2
Solid fuel transformation plants			0104		
Combustion Plants >=300MW (Boilers)	010401	SO _x NO _x CH ₄ CO ₂ N ₂ O	23.1, 27.1	10, 23, 24, 27, 40	----
Combustion Plants >=50 and <300 MW (Boilers)	010402	SO _x NO _x CH ₄ CO ₂ N ₂ O	23.1, 27.1	10, 23, 24, 27, 40	----
Combustion Plants <50 MW (Boilers)	010403	SO _x NO _x CH ₄ CO ₂ N ₂ O	23.1, 27.1	10, 23, 24, 27, 40	----
Gas Turbines	010404	SO _x NO _x CH ₄ CO ₂ N ₂ O	23.1, 27.1	10, 23, 24, 27, 40	----
Coke oven furnaces	010406	SO _x NO _x CH ₄ CO ₂ N ₂ O	23.1	10, 23.1, 24, 27.1, 40.2	23
Coal mining, oil/gas extraction, pipeline compressors			0105		
Combustion Plants >=50 <300 MW (Boilers)	010502	SO _x NO _x CH ₄ CO ₂ N ₂ O	10.1, 10.2, 11.11, 11.12	10, 11, 40	10.2
Gas Turbines	010504	SO _x NO _x CH ₄ CO ₂ N ₂ O	10.1, 10.2, 11.11, 11.12	10, 11, 40	11.1
Pipeline engines	010506	NO _x CH ₄	60.30.2	10, 11.2, 40.2, 60.3	11.1, 40.2, 60.3

(1) 10.1, 10.2, 13.1, 15.4, 15.8, 15.9, 17.3, 19.1, 20.1, 20.2, 21.1, 21.2, 23.1, 24.1, 25.1, 26.1, 26.2, 26.3, 26.4, 26.5, 26.8, 27.1, 27.2, 27.4, 34.1, 40.1, 95.

Table 2 - Qualitative link between SNAP cat. 2 “Non-Industrial Combustion Plants” and NACE Rev.1

Process based air emissions			Corresponding activities (NACE Rev.1 code + households) identified by:			
Type of process	SNAP94 code	Pollutants	Italy	Eurostat 97	NOSE (Ch. 4)	CCS
Commercial and Institutional plants	0201					
Combustion Plants <50 MW (Boilers) and other stationary equipments”	020103 and 020106	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	10-95	(2)	45-93	40.30.10
Stationary Engines	020105	SO _x NO _x CH ₄ CO ₂ N ₂ O	10-95	(2)	45-93	40.30.10
Residential plants	0202					
Combustion Plants <50 MW (Boilers) and other equipments (stoves, fireplaces, cooking...)	020202 and 020205	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	102	----	102	95
Stationary Engines	020204	SO _x NO _x CH ₄ CO ₂ N ₂ O	102	----	102	----
Plants in agriculture, forestry and aquaculture	0203					
Combustion Plants <50 MW (Boilers)	020302	SO _x NO _x CH ₄ CO ₂ N ₂ O	01, 02, 05	01, 02, 05	01, 02, 05	----
(2) 50, 51, 52, 55, 63, 64, 65, 66, 67, 70, 71, 72, 73, 74, 75, 80, 85, 91, 92, 93						

Table 3 - Qualitative link between SNAP cat. 3 "Combustion in Manufacturing Industry" and NACE Rev.1

Process Based Air Emissions			Corresponding activities (NACE Rev.1 code + households) identified by:		
Type of process	SNAP94 code	Pollutants	Italy	Eurostat 97	CCS
Comb. In Boilers, Gas Turbines And Stat. Engines	0301				
Combustion Plants >=300mw	030101	SO _x NO _x CH ₄ CO ₂ N ₂ O	24, 34	12-41, 90	34.1
Comb.Pl.>=50 And <300 MW	030102	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	12-22, 24, 25, 28- 37	12-41, 90	24.14, 27.42, 34.1
Combustion Plants <50 Mw	030103	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	12-22, 24, 25, 28- 37	12-41, 90	(3)
Gas Turbines	030104	SO _x NO _x CH ₄ CO ₂ N ₂ O	12-22, 24, 25, 28- 37	12-41, 90	34.1
Stationary Engines	030105	SO _x NO _x CH ₄ CO ₂ N ₂ O	12-22, 24, 25, 28- 37	12-41, 90	----
Proc. Furnaces W/O Contact	0302				
Blast Furnace Cowpers	030203	SO ₂ NO _x CO ₂	27.1	27.1, 40	27.1
Plaster Furnaces	030204	SO _x NO _x CH ₄ CO ₂ N ₂ O	26.53	26.53	----
Processes With Contact	0303				
Sinter Plants	030301	SO _x NO _x CH ₄ CO ₂	27.1	13.1, 20, 27.1, 43, 44, 45	13.1, 27.43, 34.1
Reheating Furn. Steel and Iron	030302	SO _x NO _x CH ₄ CO ₂ N ₂ O	27.1, 27.5	27.1	27.1, 34.1
Gray Iron Foundries	030303	NO _x	27.1, 27.51, 27.52, 27.21	27.1	27.21
Primary Lead Production	030304	SO _x NO _x	27.43	27.43	27.43, 34.1
Primary Zinc Production	030305	SO _x NH ₃ CO ₂	27.43	27.43	27.43
Secondary Lead Production	030307	SO _x NO _x	27.43	27.43	27.43
Secondary Zinc Production	030308	NO _x	27.43	27.43	27.43
Secondary Copper Production	030309	NO _x	27.44	27.44	27.44
Secondary Aluminium Production	030310	SO _x NO _x	27.42	27.42	27.42
Cement	030311	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	26.51	26.51	26.51
Lime	030312	SO _x NO _x CH ₄ CO ₂ N ₂ O	26.52, 27.1	21.11, 26.51, 26.52, 27.1	26.52
Asphalt concrete Plant	030313	NO _x	23.20.4	26.1, 26.82, 45.23	26.82
Flat Glass	030314	SO _x NO _x CH ₄ CO ₂ N ₂ O	26.11	26.11	26.11
Container Glass	030315	SO _x NO _x CH ₄ CO ₂ N ₂ O	26.13	26.13	26.13
Glass Wool	030316	SO _x NO _x CH ₄ CO ₂ N ₂ O	26.14	26.14	26.14
Other Glass	030317	NO _x CH ₄ CO ₂ N ₂ O	26.12, 26.15	26.15	26.11, 26.15
Bricks And Tiles	030319	SO _x NO _x CH ₄ CO ₂ N ₂ O	26.4	26.3, 26.4	26.4
Fine Ceramics Materials	030320	SO _x NO _x CH ₄ CO ₂ N ₂ O	26.2	26.2	26.2, 26.3
Alumina Production	030322	SO _x NO _x	27.42	27.42	27.42
(3) 15.4, 15.8, 15.9, 17.3, 19.1, 20.1, 20.2, 21.1, 21.2, 22, 24.1, 25.11, 26.11, 26.82, 27.4					

Table 4 - Qualitative link between SNAP cat. 4 "Production Processes" and NACE Rev.1

Process based air emissions			Corresponding activities (NACE Rev.1 + households) identified by:		
Type of process	SNAP94 code	Pollutants	Italy	Eurostat 97	CCS
Processes in Petroleum Industries			0401		
Petroleum products processing	040101	CH ₄	23.2	23.2, 40.2	23.2
Petrol. prod. process. - Fluid catalytic cracking - co boiler	040102	SO _x NO _x	23.2	23.2	23.2
Petrol. prod. process. - Sulphur recovery plants	040103	SO _x NO _x	23.2	23.2	14.3
Processes in Iron and Steel Industries and Collieries			0402		
Iron/steel & colliery - coke oven (door leakage & extinction)	040201	CH ₄	23.1	23.1, 27.1, 40.2	23.1
Blast furnace charging	040202	CH ₄	27.1	27.1	27.1
Pig iron tapping	040203	SO _x	27.1	27.1	27.1
Basic oxygen furnace steel plant	040206	SO _x NO _x CH ₄ CO ₂	27.1	27.1	27.1
Electric furnace steel plant	040207	NO _x CH ₄ CO ₂	27.1	27.1	27.1
Rolling mills	040208	CH ₄	27.1, 27.22, 27.32	27.1, 27.22, 27.32	27.1
Processes in non-ferrous metal Industries			0403		
Aluminium production (electrolysis)	040301	SO _x CO ₂	27.42	27.42	27.42
Ferro alloys	040302	CO ₂	27.1, 27.35	27.1	----
Silicium productions	040303	CO ₂	27.45	27.45	24.13
Processes in Inorganic Chemical Industries			0404		
Sulfuric acid	040401	SO _x	24.13	(4)	24.13
Nitric acid	040402	NO _x N ₂ O NH ₃	24.15	24.15	24.15
Ammonia	040403	CO ₂ NH ₃	24.15	24.15	24.15
Ammonium sulphate	040404	NH ₃	24.15	24.15	24.15
Ammonium nitrate	040405	NH ₃	24.15	24.15	24.15
NPK fertilisers	040407	NH ₃	24.15	24.15	24.15
Urea	040408	NH ₃	24.15	24.15	24.15
Carbon black	040409	CH ₄	24.13	24.13	24.13
Titanium dioxide	040410	SO _x	24.12	24.12	24.12
Calcium carbide production	040412	SO _x CO ₂	24.13	24.13	24.13
Processes in Organic Chemical Industries (bulk production)			0405		
Ethylene oxide	040516	CH ₄	24.14	24.14	24.14
Phtalic anhydride	040519	SO _x	24.14	24.14	24.14
Acrylonitrile	040520	NH ₃	24.14	24.14	24.14
Adipic acid	040521	NO _x N ₂ O CO ₂	24.7	24.14	24.14
Processes in Wood, Paper pulp, Food, Drink and other Industries			0406		
Paper pulp (acid sulfite process)	040603	SO _x NO _x	21.11	21.11	21.11, 21.12
Paper pulp (Neutral Sulphite Semi-Chemical process)	040604	SO _x NO _x	21.11	21.11	21.11, 21.12
Bread-making & other food manufacturing	040605	CO ₂	15.81	15.81	15.1, 15.2, 15.4, 15.7, 15.8
Wine	040606	CO ₂	15.93	15.93	15.93
Beer	040607	CO ₂	15.96	15.96	15.96
Cement (decarbonizing)	040612	SO _x CO ₂	26.51	26.51	26.51
Glass (decarbonizing)	040613	CO ₂	26.1	26.1	26.11, 26.15
Lime (decarbonizing)	040614	CO ₂	26.52, 27.1	21.11, 26.11, 26.52, 27.1	26.52

(4) 24.13, 27.1, 27.43, 27.44, 27.45

Table 5 - Qualitative link between SNAP cat. 5 “Extraction and distribution of fossil fuels and geothermal energy” and NACE Rev.1

Process based air emissions			Corresponding activities (NACE Rev.1 code + households) identified by:			
Type of process	SNAP94 code	Pollutants	Italy	Eurostat 97	CCS	NOSE (Ch. 4)
Extraction and 1st treatment of solid fuels	0501					
Open cast mining	050101	CH ₄	10.2	10	10.1, 20	10
Extraction 1st treatment and loading of gaseous fuels	0503					
Other land based activities	050302	CH ₄	11.12	11.1	11.1	11.12
Off shore activities.	050303	CH ₄	11.12	11.1	11.1	11.12
Gas distribution networks	0506					
Pipelines	050601	CH ₄	40.2	60.3	60.3	40.2
Distribution networks	050603	CH ₄	40.2	60, 51	40	40.2
Geothermal energy extraction	0507					
Geothermal energy extraction	0507	CO ₂	40.1	40.3	----	40

Table 6 - Qualitative link between SNAP cat. 7 “Road Transport” - and NACE Rev.1

Process based air emissions			Corresponding activities (NACE Rev.1 code + households) identified by:			
Type of process	SNAP94 code	Pollutants	Italy	Eurostat 97	CCS	NOSE (Ch. 4)
Passenger cars	0701	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	all	45, 60	60-63, 95	all
Light duty vehicles	0702	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	all	45, 60	60-63	all
Heavy duty vehicles	0703	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	all	45, 60	60-63	all
Mopeds <50 cm ³	0704	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	all	----	60-63	all
Motorcycles >50 cm ³	0705	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	all	----	60-63	all

Table 7 - Qualitative link between SNAP cat. 8 "Other Mobile Sources and Machinery" and NACE Rev.1

Process based air emissions			Corresponding activities (NACE Rev.1 code + households) identified by:			
Type of process	SNAP94 code	Pollutants	Italy	Eurostat 97	CCS	NOSE (Ch. 4)
Military	0801	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	75.22	75	60-63	75.22
Railways	0802	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	60.1	60	60-63	60.1
Inland Waterways	0803	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	61.2, 71.22, 75.22, 92.72, 101	05, 61	60-63	05, 61.11, 63, 75
Maritime Activities	0804					
National Sea Traffic	080402	SO _x NO _x CH ₄ CO ₂ N ₂ O	61.1, 71.22	61	60-63	05, 61.11, 63, 75
National Fishing	080403	SO _x NO _x CH ₄ CO ₂ N ₂ O	05	05	60-63	05, 61.11, 63, 75
International sea traffic	080404	SO _x NO _x CH ₄ CO ₂ N ₂ O	61.11, 61.12	05, 61	60-63	05, 61.11, 63, 75
Airports	0805	SO _x NO _x CH ₄ CO ₂ N ₂ O	mainly 62 and potentially others	61, 62	60-63	62, 63.11, 75
Agriculture	0806	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	01, 71.31	01	01, 60-63	01
Forestry	0807	SO _x NO _x CH ₄ CO ₂ N ₂ O	02, 71.31	02	60-63	02
Industry	0808	SO _x NO _x CH ₄ CO ₂ N ₂ O NH ₃	10-36, 45	10-45	60-63	several
Household/Gardening	0809	SO _x NO _x CH ₄ CO ₂ N ₂ O	92.53, 92.61, 95, 103	----	60-63	01, 90

Table 8 - Qualitative link between SNAP cat. 9 “Waste Treatment and Disposal” and NACE Rev.1

Process based air emissions			Corresponding activities (NACE Rev.1 code + households) identified by:		
Type of process	SNAP94 code	Pollutants	Italy	Eurostat 97	CCS
Waste incineration			0902		
Incineration of domestic or municipal wastes	090201	SO _x NO _x CO ₂ N ₂ O	90	40, 90	90
Incineration of industrial Wastes	090202	SO _x NO _x CO ₂	23.2	23.2, 24.13, 90	90
Flaring in oil refinery	090203	SO _x NO _x	23.2	23.2	23.2
Incineration of sludges from waste water treatment	090205	SO _x NO _x N ₂ O	23.2, 90	90	90
Incineration of hospital wastes	090207	SO _x NO _x CO ₂ N ₂ O	90	85.11, 90	90
Incineration of waste oil	090208	SO _x NO _x CO ₂ N ₂ O	90	23.2, 90	----
Open burning of agricultural wastes	0907	NO _x CH ₄ N ₂ O	01.1	01	01, 90
Other waste treatment			0910		
Waste water treatment in industry	091001	CH ₄ CO ₂	15, 17, 21	10-45	90
Sludge spreading	091003	CO ₂ NH ₃	90	90	90
Land filling	091004	CH ₄ CO ₂ NH ₃	90	90	90
Compost production from waste	091005	CH ₄ CO ₂	90	----	90

Having completed the assessment of the qualitative link between SNAP processes and activities, the next step was the allocation of the *amount* of emissions caused by a process to the activities associated with the process itself.

The following paragraph describes the methodology followed at this stage of the work.

3.2.3 Quantitative allocation of process-based emissions to NAMEA activities

For each of the six air pollutants included in the Italian NAMEA, SNAP processes can be split into two groups:

- processes with only one - link to the activities of the NAMEA classification;
- processes with multiple links to the activities of the NAMEA classification.

The first group includes two sub-groups of processes:

- a) all the processes that are matched to only one activity in Tables 1-8 (column “Italy”);
- b) some processes that – although matched to more than one activity in Tables 1-8 (column “Italy”) – were allocated to only one activity by assumption, to simplify the quantitative allocation stage. These are: processes 0806, 0807 and 0809, assumed to be matched only with – respectively – 01, 02 and 103.

For processes a) and b) the CORINAIR emissions can be directly allocated to the corresponding NAMEA activity without further calculations.

For all the other processes additional steps are necessary to split the emissions among the corresponding NAMEA activities.

Two main methods proved to be suitable for distributing all processes but a few ones for which specific methods were found.

The following paragraph describes the rationale behind each method and the detailed steps undertaken. In all cases one primary condition was the consistency with the way the CORINAIR estimates used had been produced.

3.2.3.1 Emissions distributed through point source data

Among SNAP processes a distinction relevant to the aim of distributing the emissions, is the following one:

1. processes whose emissions were estimated for the CORINAIR through POINT sources only;
2. processes whose emissions were estimated for the CORINAIR through POINT SOURCES AND AREA SOURCES, the latter deriving from one NAMEA activity;
3. processes whose emissions were estimated for the CORINAIR through POINT SOURCES AND AREA SOURCES, the latter deriving from more than one NAMEA activity;
4. processes whose emissions were estimated for the CORINAIR exclusively through AREA sources.

The emissions of processes belonging to categories 1 and 2 were distributed on the basis of the information available in the CORINAIR on point source data. Specifically:

- for processes belonging to category 1, emissions were distributed on the basis of the Italian CORINAIR list of establishments. The economic activity – according to the NAMEA classification – of each establishment was identified in most cases by the CORINAIR expert direct knowledge of the activity of the establishment. In some cases, the activity was checked in the Istat “new enterprise register” (NAI), by looking at the economic activity reported for local units;
- for processes belonging to category 2, emissions were distributed similarly to category 1 for the part of emissions derived from point source estimates and – for the part of emissions derived from area source estimates – through direct allocation to the corresponding activity.

All processes belonging to categories 1 and 2 distributed on the basis of point source data are listed below.

Table 9 - Processes whose emissions were distributed through point source data

Type of process	SNAP94 code	corresponding activity [NACE Rev.1 code + households]
Combustion Plants >=300mw (1)	030101	24, 34
Lime (combustion processes) (2)	030312	26 for area emissions; 27 for point source emissions
Lime (production processes) (2)	040614	26 for area emissions; 27 for point source emissions
Incineration of sludges from waste water treatment (2)	090205	90 for area emissions; 23 for point source emissions

(1) Point source data only.

(2) Point source data and area sources, corresponding to only one economic activity.

For all processes belonging to categories 3 and 4 the CORINAIR information does not allow, by itself, to distribute the emissions among the various economic activities responsible for

them. Hence, suitable criteria – described in the following paragraphs – had to be found to complete the quantitative allocation.

3.2.3.2 Emissions distributed on the basis of the consumption of energy products

For most processes the emission of polluting substances is related to the consumption of energy products. Therefore, in order to distribute the emissions between the corresponding activities, data on energy consumption by activities are necessary.

In Italy a regular and comprehensive source of data on energy consumption is the National Energy Balance (BEN), published annually by the Ministry of Industry. Data from the BEN are used for the CORINAIR estimates, either as a direct source of data (e.g. in the case of the off-road industrial transport), or as a check for estimates obtained from other sources (e.g. in the case of road transport). For the NAMEA air emission accounts, however, the BEN has the following limits:

- a) the consumption of energy products for heating – necessary in our case to distribute the emissions of some processes of the group 02 – is not broken down by activity;
- b) similarly, the consumption of energy products for transport – necessary in our case to distribute the emissions of all processes of the category 7 and of some processes of the category 8 – is broken down by type of transport (road, rail, maritime, air) and not by activity;
- c) the consumption of energy products for combustion other than heating and transport – necessary in our case to distribute the emissions of some processes of the categories 1 and 3 – are broken down by industrial economic activity, but the classification is not NACE.

Given the existing limitations, the BEN could not be used to distribute the emissions due to the use of energy products. The alternative source considered was the Istat “energy use Table”; the Table is occasionally produced by Istat, generally in connection with the publication of the Input/Output Table. The closest Table to the year 1990 – the NAMEA reference year – is the 1988 one. The Table provides data on the use of 25 energy products by 92 economic activities plus private consumption; the classification of the economic activities is ATECO 81, the Italian version of NACE70. Moreover, for each product the total amount used is broken down by “function” or type of use (transport, heating, other energy use, non-energy use) and by origin of supply (domestic production, imports).

Data are available in four units: metric units; tonnes of oil equivalent (toe); market price; depart-usine price.

For our purposes, the Table can be seen as a three-entry “matrix”, where energy consumption is available by “fuel” (energy product), by function and by activity.

In order to use the Table to distribute the emissions of some SNAP processes, it was first of all necessary to check the degree of consistency between the “functions” of the Table and the CORINAIR processes to be distributed.²²⁴ The existence of a certain degree of correspondence between a given function and a subset of processes is in fact a minimum pre-requisite for considering the information on the energy consumed by each activity for that function, as an information about the level at which some processes (namely, the ones corresponding to that function) are carried out in the activities – and therefore about the share of those processes’

²²⁴ For details on the methodology of the Istat energy use Table see Istat (1991).

emissions that has to be attributed to the activities. The tighter the correspondence, the better the approximation.

The analysis showed the following main results:

- A. the methodology used for the function “heating” of the Table is consistent with the SNAP processes related to heating²²⁵;
- B. the function “transport” of the Table includes the use of energy products for purposes that are consistent with the SNAP processes related to road transport (07), railways (0802), inland waterways (0803), maritime activities (0804), airports (0805)²²⁶. The consumption of energy products related to other off-road transport, i.e. military (0801), agriculture (0806), forestry (0807), industry (0808) and household/gardening (0809) is excluded from the Table. Out of the processes listed as non consistent with the Table, only one, the process “off-road industry” (0808) needs to be distributed among several economic activities since all the others correspond to only one activity. For this process a different allocation method was used (see Paragraph 3.2.3.3 below);
- C. the methodology used for the function “other energy use” of the Table is consistent with the SNAP processes related to combustion for purposes other than heating and transport (categories 1 and 3);
- D. the function “non-energy use” of the Table does not relate to the CORINAIR processes whose emissions needs to be distributed.

Summing up, the results of the check allowed to conclude that the Table could be used as a tool for distributing the emissions, on the basis of the correspondence found between the functions of the Table and the sets of processes specified above.

In order to improve the approximation given by the function-processes correspondence, also the information on the specific energy products consumed by the activities was used (this information is provided by the Istat energy use Table), in connection with that on the process-specific mix of energy products (this information is provided by Italian CORINAIR experts). By using this information, a tighter correspondence has been established, involving not just the function but the combination of energy products and function on the one hand and the processes on the other hand. To find the correspondence between energy products, the ones included in the Table were compared to those used for the CORINAIR estimates with the following outcome:

- a) 14 out of the 18 energy products used for the CORINAIR estimates find an exact match with the energy products of the Istat energy use Table²²⁷;
- b) 4 out of the 18 energy products used for the CORINAIR estimates (municipal waste, waste gas, wood and similar, industrial solid waste) are not included in the Istat energy use Table; for these products the following ad hoc hypothesis were introduced:
 - b.1. “waste gas” and “industrial solid waste” were included together with “work gas”;
 - b.2. the emissions arising from the use of “municipal waste” and “wood and similar” were distributed with weights obtained as average of the weights calculated on the

²²⁵ Only processes of the category 2 in the Italian CORINAIR - see above.

²²⁶ See Annex B for a specific discussion of the consistency between the CORINAIR estimates of emissions from international transport and the NAMEA approach.

²²⁷ CORINAIR energy products follow the NAPFUE classification whereas the Istat energy products are consistent with the Eurostat energy product classification.

basis of the other energy products used in the specific process (see below for details on the weights structure);

- c) two energy products used for the CORINAIR estimates, although matching one product of the Istat energy use Table - case a) – for the total use, found no match for specific functions. Specifically, this is the case for “brown coal” and “motor gasoline” used for the CORINAIR estimates of emissions from heating processes. In this case the emissions resulting from the use of these products were distributed with weights obtained as the average of the weights calculated on the basis of the other energy products used in the specific process (see below for details on the weights structure);
- d) 10 energy products included in the Istat energy use Table have not been used for the CORINAIR estimates and were therefore not included in the group of products used for calculating the weights.

Finally, before the Table could actually be used, some *inconsistencies* between the Table and the requirements of the NAMEA had to be solved.

The first difference concerns the classification used; the Table uses the ATECO 81 – the Italian version of NACE70 – instead of the ATECO 91 – the Italian version of NACE Rev.1 – required by the NAMEA. In order to solve this problem (occurring in many cases other than the NAMEA), Istat developed a conversion matrix that allows to turn data classified according to ATECO 81 into data consistent with the new classification²²⁸. For the conversion exercise, the 101 homogeneous branches of national accounts were used as a basis²²⁹. The conversion matrix allowed to obtain a Table of energy use by activity with the breakdown of the NAMEA classification. Considering as separate entries, for what concerns households, the functions “heating”, “transport” and “other” (these are in fact the purposes of households’ consumption that is useful to keep as distinct when considering air emissions), this classification consists of 55 items.

A second difference between the Istat energy use Table and the emission data concerns the reference year, which is 1988 for the Table and 1990 for the CORINAIR data. This difference has not been solved since no data are available to update the functional breakdown or the activity breakdown. 1990 data are available for the total use of each energy product but the indicators built for the NAMEA on the basis of the Table would not be affected by this updating (see below).

The weights based on energy use are calculated as follows.

The CORINAIR data base, for the general process “p”, gives the total emissions $EMI(p)$ as the sum of the emissions of each energy product used in the estimates:

$$(1) \quad EMI(p) = EMI_1(p) + EMI_2(p) + \dots + EMI_j(p) \dots + EMI_n(p)$$

where the generic $EMI_j(p)$ is the quantity of emissions arising from the use of the energy product j and the group of n_p energy products used for estimating the emissions of process p is a subset of the 18 total energy products used for the CORINAIR estimates.

For the j -th energy product used in process p (or group of processes), the following weights are calculated:

²²⁸ The conversion matrix is based on employment data. For details in the matrix structure see Annex C as well as Agresti - Moauro (1997). Annex C also includes an assessment of the effects of the ATECO 81 – ATECO 91 conversion matrix for the NAMEA exercise.

²²⁹ This level of breakdown is not available in the published Table that supplies data for 44 economic branches.

$$(2) \quad W_j^i(p) = \frac{use_j^i(l)}{\sum_i use_j^i(l)}$$

where:

$i = 1, \dots, h_p$ is the generic element of the subset of h_p out of 55 NAMEA activities in which process p is carried out;

$j = 1, \dots, n_p$ is the generic element of the subset of n_p energy products used to estimate emissions of process p ;

$l = \text{transport, heating, other}$ indicates the specific function of the energy use, associated to process p (for details on the function associated to each process to be distributed see below).

By construction the following holds:

$$(3) \quad 0 \leq W_j^i(p) \leq 1$$

The quantity of emissions from use of energy product j in process p , allocated to the activity i , is given by:

$$(4) \quad EMI_j^i(p) = W_j^i(p) * EMI_j(p)$$

i.e., by the product of the weight $W_j^i(p)$ calculated above and the CORINAIR emission quantity for the product j used in process p .

Finally, the total emissions of a specific process p by each activity i are obtained as:

$$(5) \quad EMI^i(p) = \sum_j EMI_j^i(p)$$

Details on the link between processes and specific functions of the Istat energy use Table are given below.

Emissions from heating processes

In the Italian CORINAIR emissions from heating are included in the SNAP category 2 only. Within this group, the processes to be distributed are 020103, 020105 and 020106 (which are jointly estimated in CORINAIR), 020302.

The emissions related to these processes were allocated to the corresponding activities, with weights given by the procedure described above, on the basis of data of the Istat energy use Table for the function "heating".

Emissions from combustion processes

In the CORINAIR emissions from combustion are included in the SNAP categories 1 and 3. Within these groups, the processes to be distributed are 010502, 010504, 030102, 030103, 030104, 030105.

The emissions related to these processes were summed together and allocated to the corresponding activities, with weights given by the procedure described above, on the basis of data of the Istat energy use Table for the function “other energy use”.

Emissions from transport processes

In the CORINAIR emissions from transport are included in the SNAP categories 7 and 8. Within these, the processes to be distributed are 0701, 0702, 0703, 0704, 0705, 080402, 0805; 0808. The last process, as stated above, could not be distributed on the basis of energy use data and a specific method was found.

The emissions of process 0805 were separately allocated on the basis of the use of “Jet Fuels”.

The emissions related to the remaining processes and those related to processes 0802, 0803, 080403, 080404²³⁰, were summed up and distributed together with weights given by the procedure described above, on the basis of data of the Istat energy use Table for the function “transport”.

The case of international transport emissions is discussed further in Annex B.

The CORINAIR estimates are obtained by considering – in addition to data on energy consumption – also data on numerous technical parameters that, for a given consumption of energy, influence the amount of emissions from a certain process. For example, in the case of transport, the type of engine and the speed are critical factors determining the emissions in addition to the fuel consumption. For the NAMEA estimates, technical characteristics were not taken into account in distributing the emissions; this is equivalent to assuming the same average technical standard for all the economic activities and households.

3.2.3.3 Emissions distributed through other methods

For some processes the two methods described above were not suitable and ad hoc distribution methods, described in this paragraph, were developed.

Indicators based on BEN

For processes 010401, 010402, 010403 and 010404, emissions are related to the production of electricity for own use. The CORINAIR knowledge regarding these processes in the Italian economic framework allowed to associate them to the production of coke (NACE 23) and steel (NACE 27)²³¹. The emissions were distributed in proportion to the 1990 BEN data on electricity consumption from own production in the two activities.

²³⁰ Let's take the example of process 0802, that is linked – in principle – only to the activity “Transport via railways” (60.1): if the emissions due to railway transport had been allocated to the activity 60.1, it would have been very difficult to use the Istat energy use Table data to distribute the remaining transport uses of the same activity, since this table reports the whole of the consumption of energy products of 60.1, i.e. the energy used to make trains go is not distinct from that used e.g. in company cars of the railway company; therefore, the emissions of process 0802 were added to those of the group of processes above and allocated to the corresponding activities. The same explanation applies to processes 080403 and 080404.

²³¹ The two productions belong to enterprises of the NACE division 27 but, consistently with the concept of homogeneous production unit adopted in the Italian NAMEA, the emissions were separately allocated.

Indicators based on employment

For the process 0808 - off-road transport in industry - it was not possible to use the Istat energy use Table (see above). The CORINAIR estimates are consistent with the BEN data on gasoline use in the industry sectors. The NACE activities included in the BEN sectors have been identified with the help of the Ministry of Industry. For the economic activities identified, the share of emissions was assessed as a proportion of total employment.

Other indicators

The emissions of the process “Waste water treatment in industry” (091001) were estimated for CORINAIR90 through an ad hoc study that included only the economic activities “Manufacture of food products and beverages” (15), “Manufacture of textiles and textile products (not including wearing apparel)” (17), and “Manufacture of pulp, paper and paper products” (21). The total methane emissions are calculated in the study as a sum of the emissions from the three economic activities, and therefore, on the basis of the original data, it was possible to exactly distribute the methane emissions.

For the other pollutant emitted by the process, CO₂, the emissions were distributed on the basis of the assumption that the share of the three activities is the same as that calculated for methane emissions²³².

3.2.3.4 Overview of methods used to distribute the emissions

Table 10 lists all SNAP processes, relevant for the emissions considered and for which data are available, with multiple NACE associations. In order to give a general overview of the methods used to distribute the emissions, the rows of the table are shaded according to the method chosen:

- processes whose emissions were distributed on the basis of point source data (see § 3.2.3.1) are shown with a light shade in the table;
- processes whose emissions were distributed on the basis of data from the Istat energy use Table (see § 3.2.3.2) are shown without shade in the table;
- processes whose emissions were distributed on the basis of methods other than the two above (see § 3.2.3.3) are shown with a dark shade in the table.

²³² The assumption can be made without further calculations as the process accounts for only 0,3% of total CO₂ emissions.

Table 10 - Overview Table of methods used to distribute the emissions of SNAP processes with multiple NACE associations

Type of process	SNAP94 code	corresponding economic activity NACE Rev.1 code + households (1)
Combustion Plants >=300MW	010401	23.10, 27.10
Combustion Plants >=50 and <300 MW	010402	23.10, 27.10
Combustion Plants <50 MW	010403	23.10, 27.10
Gas Turbines	010404	23.10, 27.10
Combustion Plants >=300MW	010502	10.10, 10.20, 11.11, 11.12
Gas Turbines	010504	10.10, 10.20, 11.11, 11.12
Combustion Plants <50 MW	020103	10-95
Stationary Engines	020105	10-95
Combustion Plants <50 MW	020302	01, 02, 05
Combustion Plants >=300mw	030101	24, 34
Comb.Pl.>=50 And <300 MW	030102	12-22, 24, 25, 28-37
Combustion Plants <50 MW	030103	12-22, 24, 25, 28-37
Gas Turbines	030104	12-22, 24, 25, 28-37
Stationary Engines	030105	12-22, 24, 25, 28-37
Lime (combustion processes)	030312	26 – area emissions; 27 - point source emissions
Lime (production processes)	040614	26 – area emissions; 27 - point source emissions
Passenger cars	0701	all
Light duty vehicles	0702	all
Heavy duty vehicles	0703	all
Mopeds & Motorcycles <50 cm3	0704	all
Mopeds & Motorcycles <50 cm3	0705	all
Railways	0802	all
Inland Waterways	0803	all
National Sea Traffic	080402	all
National Fishing	080403	all
International Sea Traffic	080404	all
Airports	0805	all
Industry	0808	10-45
Incineration of sludges from waste water treatment	090205	90 – area emissions 23 - point source emissions
Waste water treatment in industry	091001	15, 17, 21

(1) For processes 0802, 0803, 080402, 080403, the activities listed in the table are different from those listed in Table 7 for the same processes. The reasons are explained in § 3.2.3.2 above (see also note 230).

3.3 The intake of resources from nature

The methodology followed for the calculation of the intake of material resources from the Italian territory to the economy is basically the same used for a similar calculation, carried out for the year 1988²³³. Therefore, this section does not provide a detailed description of the methodology; we will however recall the main features of the application:

- all the materials are accounted for in terms of weight (expressed in metric tons);
- with the only exception of steam, the materials accounted for are all physically *embodied* in primary products: no attempt has been made to take into consideration “hidden” flows such as erosion in agriculture, overburden removal in mining and excavation in construction; therefore, there is a coincidence between the material intake from nature and the production, expressed in physical terms, of some primary goods;

²³³ See Femia (2000).

- the flows accounted for are, by definition, only those crossing an hypothetical and conventional border between nature and the economic system, and do not comprise any flow that can be considered internal to either of the two systems. As an example, refined metals are not considered, since they are obtained by material inputs that are produced by other activities, and therefore accounted for under the appropriate heading;
- as a consequence of the two previous points, the use of air and water is covered by the figures of the material intake only to the extent that they enter in the physical composition of the goods accounted for (basically agricultural and forestry products); as an example, it can be noted that only a tiny share of all the water used for irrigation is incorporated into items that enter our calculations;
- materials taken from nature are classified into 4 categories: endogenous steam, wood and fossil fuels, minerals, biotic resources;
- for biotic intakes, fresh weight is used whenever an alternative with dry weight is available (if we had separately accounted the use of water, we should have used dry weight);
- in our approach, the aggregation of the weights of different materials belonging to the same category is seen as legitimate, while it is not allowed among different categories.

The following differences with the application for 1988 must be highlighted:

- the matrix of material intakes constructed for 1988 was connected to an input-output table based on NACE 70, while the one for 1990 is based on NACE Rev. 1;
- as a consequence, the aggregation of the materials, which partly follows that of the activities undertaking withdrawal from nature is slightly different. This does imply only one noticeable difference, concerning peat, which is no longer a product of the division 23 of NACE 70, the same of marble and salt production, but one of division 10 of NACE Rev. 1, like coal and lignite; as a consequence, the corresponding intake of the resource “wood and fossil fuels” is now assigned to this latter NACE division;
- the materials physically embodied in imported goods, that were considered (separately) for 1988, are not covered for 1990: only direct intake from nature is considered in the input-module of the 1990 Italian NAMEA;
- fodder, coming from temporary or permanent cultivation, that was absent from 1988 accounts, is now present in the accounts as a non-fuel biotic product of agriculture;
- a distinction not present for 1988 has been introduced between:
 - wood used as a fuel (directly or after transformation into charcoal), which has been accounted for under the heading “Energy sources – wood and fossil fuels”; and
 - wood used for other purposes, which remains under the heading “biotic materials”, now specified as “non-fuel”.

Though the pressures due to the withdrawal of wood from nature *per se* are the same whatever use is made of the wood, those generated by its *use* as a fuel are much more similar to those coming from fossil fuels than to those of most other biotic materials²³⁴;

- asphaltic and bituminous rock is no longer considered a non-energy mineral, since its main use consists in distillation for oil production.

²³⁴ It is worth underlining that there is yet no official agreement on the way materials should be classified and added together; the distinction of wood according to its use (energy or non-energy) seems suited not just for the NAMEA, but also for other kinds of environmental accounting schemes where different kinds of material intakes must be kept distinct, as well as for the definition of pressure indicators for the energy sector.

4 MAIN RESULTS

This section presents the NAMEA data in more detail.

Paragraph 4.1 shows economic and environmental data side by side for significant groupings of NACE divisions.

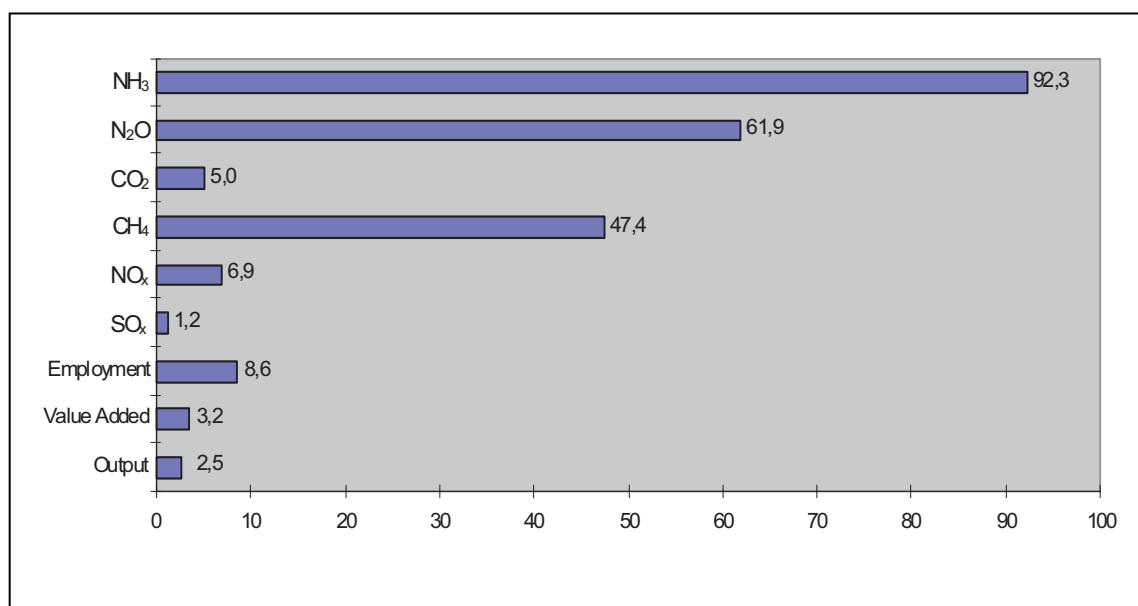
Paragraph 4.2 analyses in detail the emissions of air pollutants by activity and by process.

Finally Paragraph 4.3 presents detailed data on material intakes.

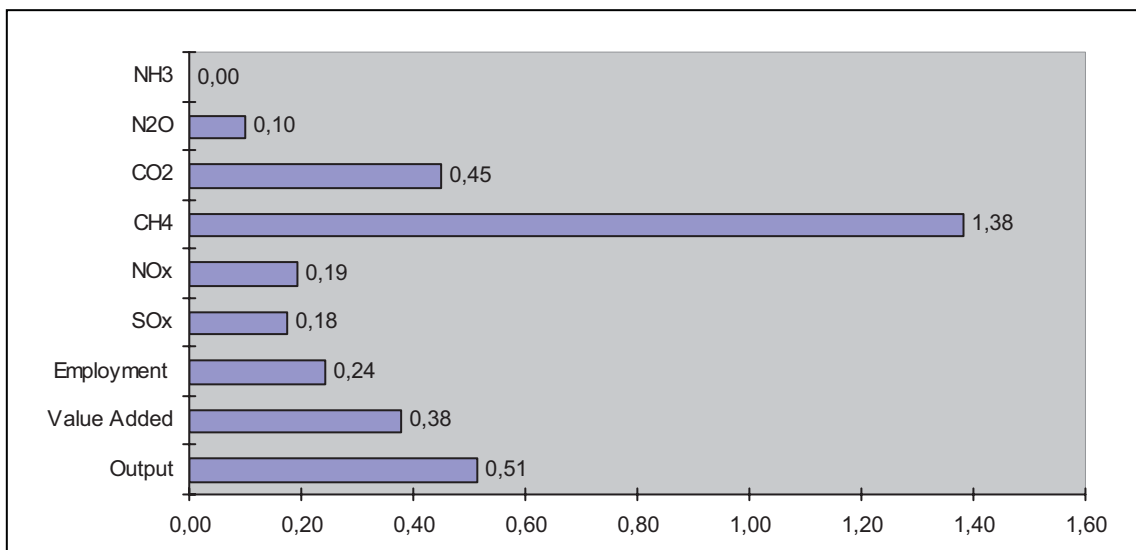
4.1 Environmental profiles

The following figures show “environmental profiles” for the six air pollutants included in the Italian NAMEA and three economic variables: output, value added and employment. Employment figures are calculated as full time equivalent units. Material intakes data, when not zero, are reported in the text for each NACE grouping. All data are expressed as percentage of all economic activities, excluding the emissions attributed to household consumption activities.

Figure 2 - Environmental profile for NACE 01, 02 and 05 – Agriculture, forestry and fishing
(percentage of all economic activities)



This NACE grouping also accounts for 100% of the intake of non-fuel biotic materials and for 13% of wood and fossil fuels intake.

Figure 3 - Environmental profile for NACE 10-14 – Mining and quarrying (percentage of all economic activities)

This NACE grouping also accounts for about 100% of non-energy minerals intake and for 87% of the intake of wood and fossil fuels.

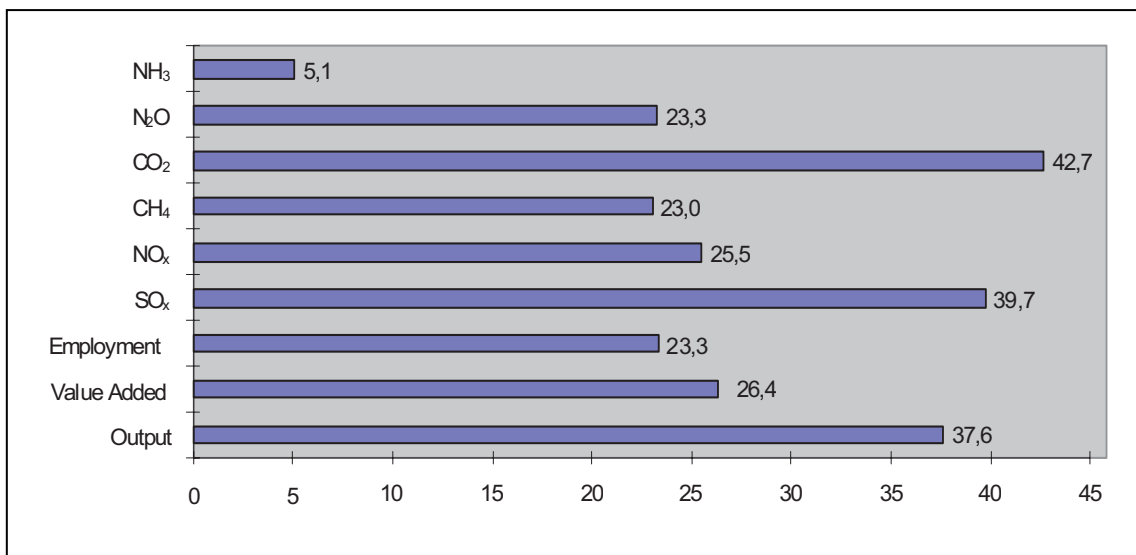
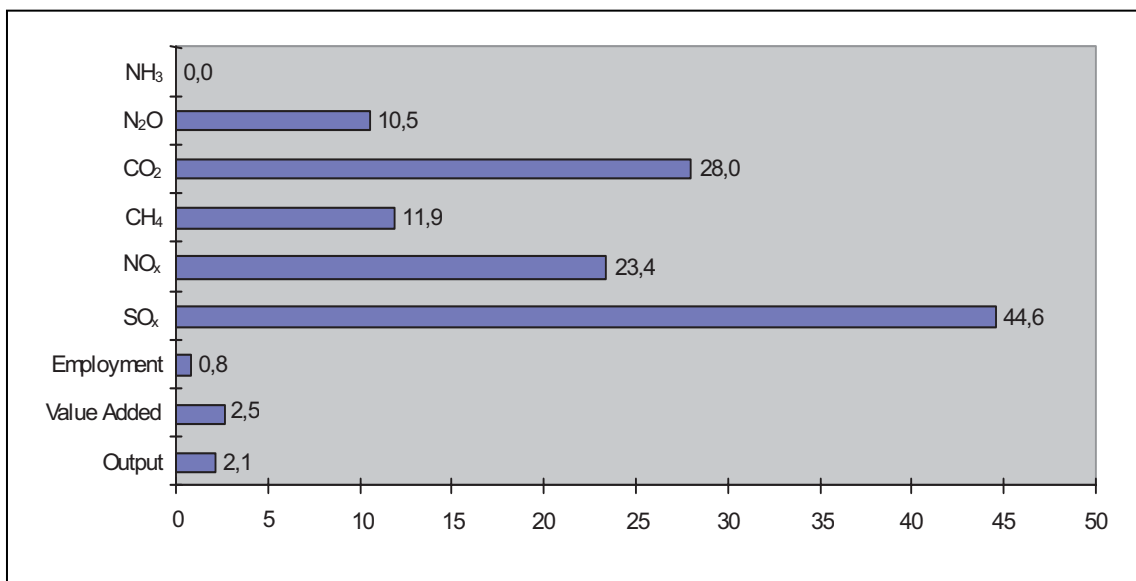
Figure 4 - Environmental profile for NACE 15-37 – Manufacturing (percentage of all economic activities)

Figure 5 - Environmental profile for NACE 40 and 41 – Electricity, gas and water supply (percentage of all economic activities)



This NACE grouping also accounts for 100% of the intake of endogenous steam.

Figure 6 - Environmental profile for NACE 45 – Construction (percentage of all economic activities)

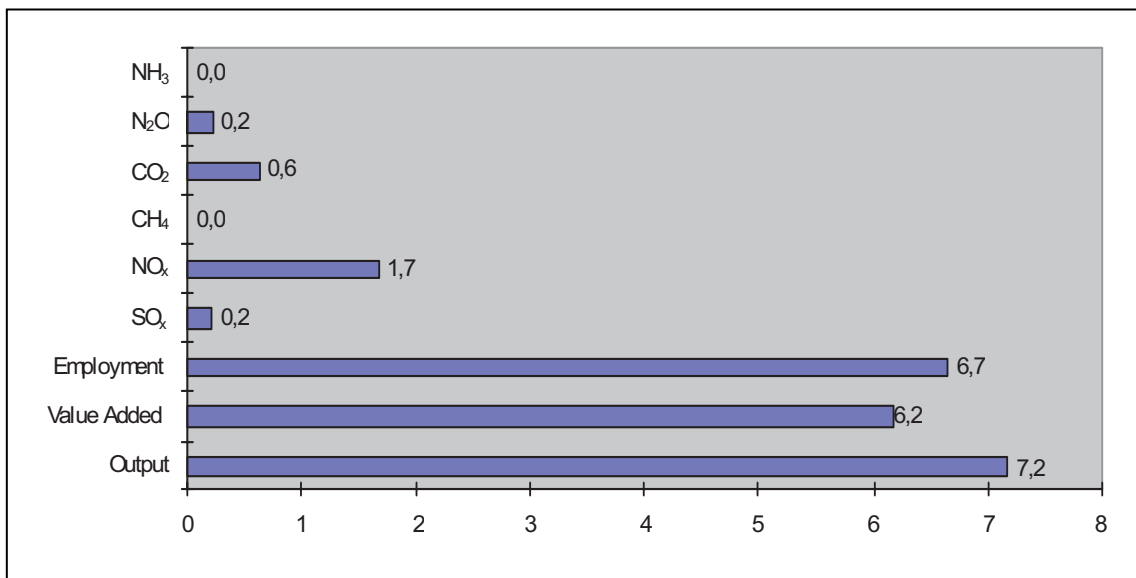


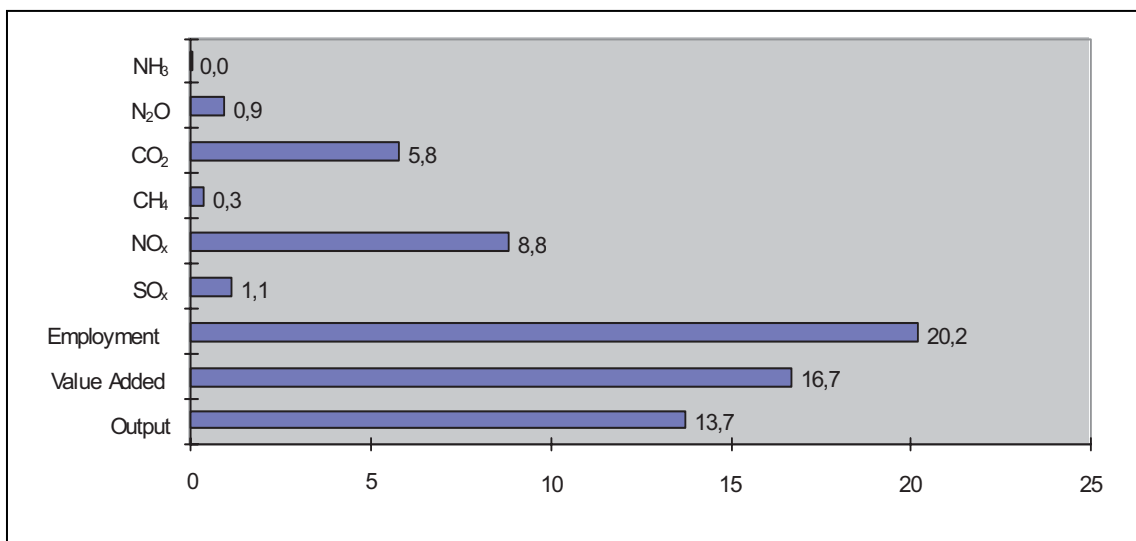
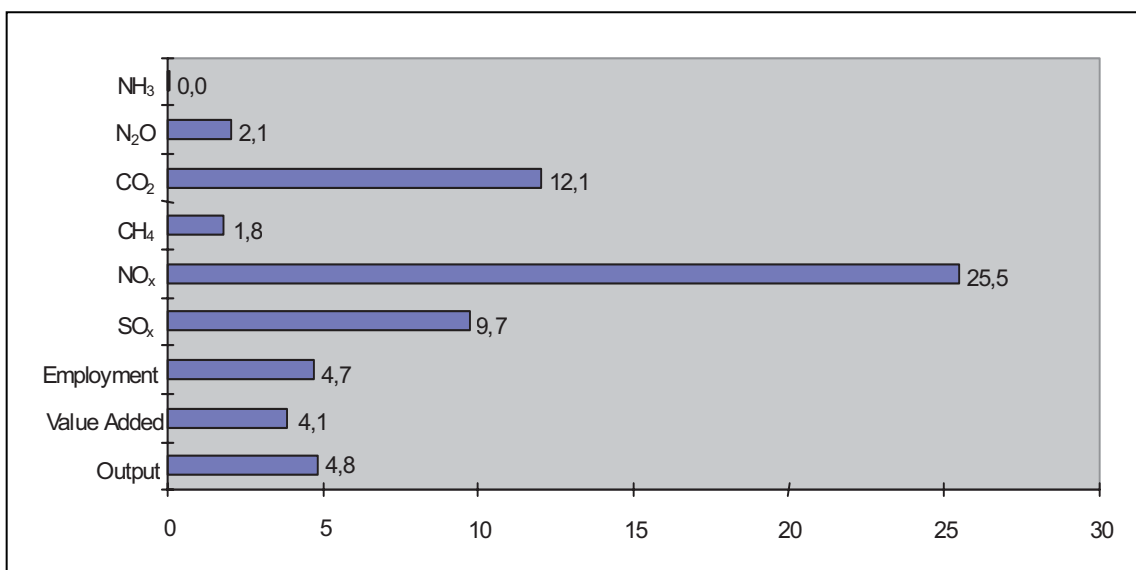
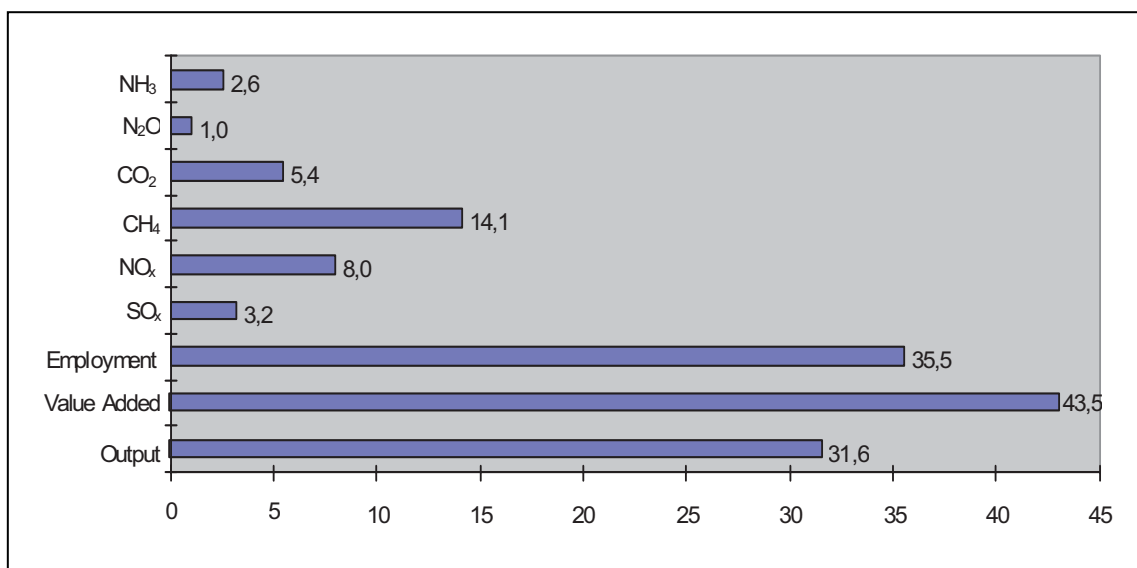
Figure 7 - Environmental profile for NACE 50-55 – Trade, hotels and restaurants (percentage of all economic activities)**Figure 8 - Environmental profile for NACE 60-63 – Transport** (percentage of all economic activities)

Figure 9 - Environmental profile for NACE 64-95 – Other services (percentage of all economic activities)



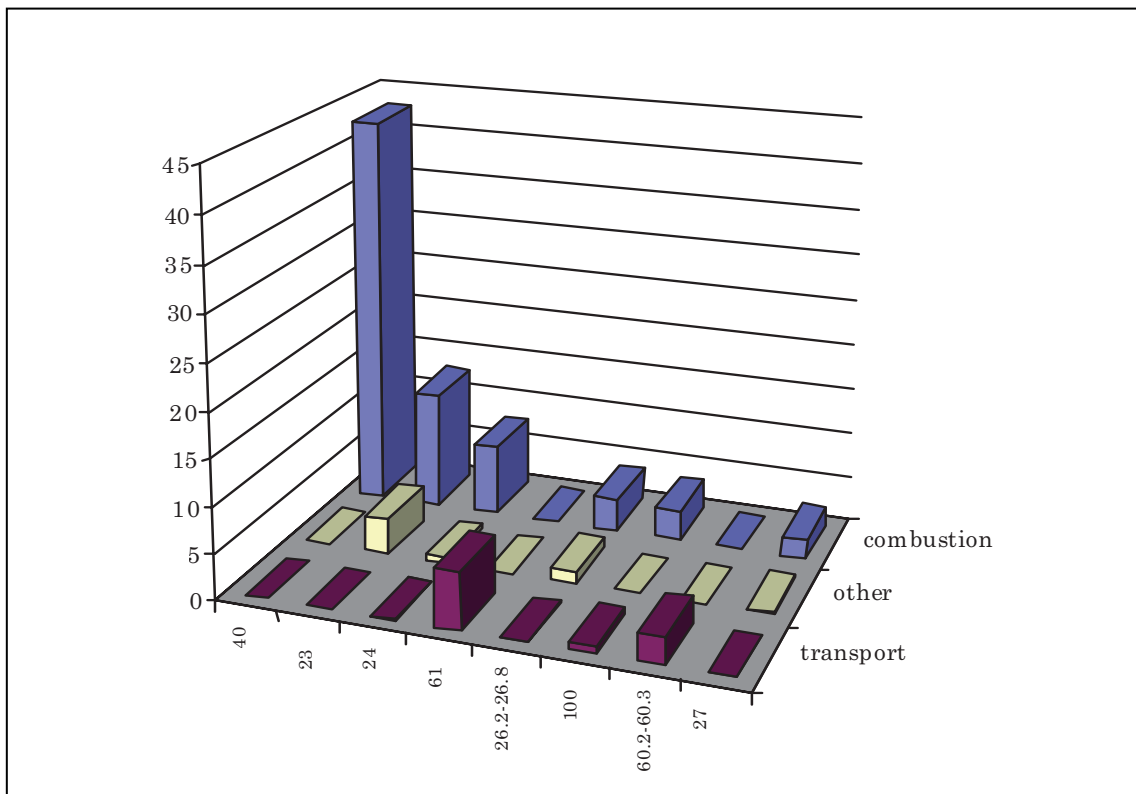
4.2 Emissions of air pollutants by activity and by process

In the following paragraph the emissions of the six air pollutants included in the Italian NAMEA are presented in detail. For each pollutant percentage emissions by activity in decreasing order are shown in Tables 11 - 16. For the activities accounting for most of the emissions Figures 10 - 14 show the emissions broken down by the SNAP processes causing them.

4.2.1 SO_x emissions

As shown in Table 11, the production of “Electricity, gas, steam and hot water supply” (40) accounts for about 43% of SO_x emissions and (see Figure 10) most of these emissions are due to combustion processes. Other activities that rank high in terms of share of emissions due to combustion of fuels are: “Manufacture of coke, refined petroleum products and nuclear fuel” (23) and “Manufacture of chemicals and chemical products”. For a second grouping of activities represented in Figure 10, the contribution to SO_x emissions is due to the transport process; these are: “Water transport” (61) and “Other land transport/Transport via pipelines” (60.2-60.3). The 8 activities included in the figure account together for more than 87% of the emissions while the remaining 13% is distributed among about 40 different activities.

Figure 10 - SO_x emissions by activity (first 8) and by process (percentage)



NAMEA activities

40	Electricity, gas, steam and hot water supply
23	Manufacture of coke, refined petroleum products and nuclear fuel
24	Manufacture of chemicals and chemical products
61	Water transport
26.2-26.8	Manufacture of other non-metallic mineral products
100	Total household consumption
60.2-60.3	Other land transport/Transport via pipelines
27	Manufacture of basic metals

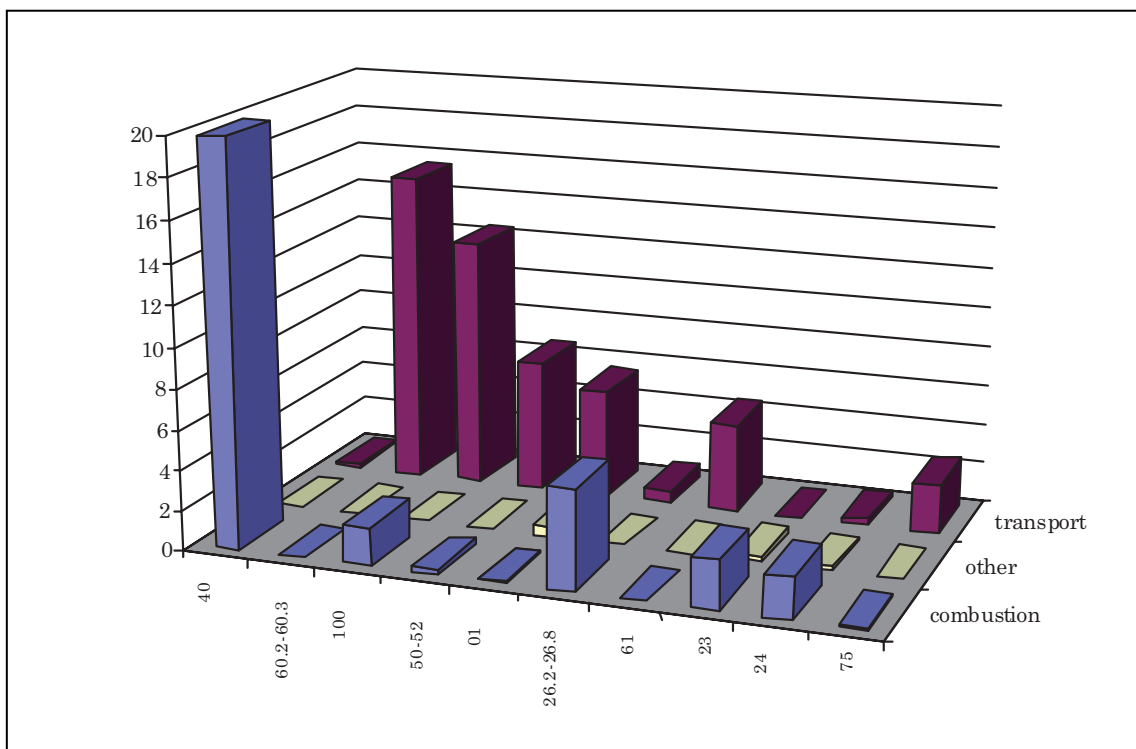
Table 11 - SO_x emissions by activity

NAMEA ACTIVITIES CLASSIFICATION		%	<i>cumulative</i>
40	Electricity, gas, steam and hot water supply	42,85	42,85
23	Manufacture of coke, refined petroleum products and nuclear fuel	16,47	59,32
24	Manufacture of chemicals and chemical products	8,25	67,57
61	Water transport	6,12	73,69
26.2-26.8	Manufacture of other non-metallic mineral products	4,87	78,55
100	TOTAL HOUSEHOLD CONSUMPTION	3,94	82,49
60.2-60.3	Other land transport/Transport via pipelines	2,89	85,38
27	Manufacture of basic metals	2,28	87,66
75	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	1,81	89,47
15&16	Manufacture of food products, beverages and tobacco	1,56	91,03
01	Agriculture, hunting	1,15	92,18
G 50-52	WHOLESALE AND RETAIL TRADE; REPAIR	0,88	93,07
17	Manufacture of textiles and textile products (not incl. wearing apparel)	0,86	93,93
21	Manufacture of pulp, paper and paper products	0,76	94,69
N 85	HEALTH AND SOCIAL WORK	0,68	95,36
20	Manufacture of wood and wood products (not incl. manufacture of furniture)	0,45	95,81
26.1	Manufacture of glass and glass products	0,38	96,19
25	Manufacture of rubber and plastic products	0,36	96,55
28	Manufacture of fabricated metal products, except machinery and equipment	0,33	96,88
19	Manufacture of leather and leather products	0,28	97,16
18	Manufacture of wearing apparel	0,23	97,40
36	Manufacturing of furniture, manufacturing n.e.c.	0,23	97,63
H 55	HOTELS AND RESTAURANTS	0,22	97,84
34	Manufacture of motor vehicles, trailers and semi-trailers	0,20	98,04
F 45	CONSTRUCTION	0,19	98,24
29	Manufacture of machinery and equipment n.e.c.	0,19	98,43
K 70-74	REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	0,17	98,60
22	Publishing, printing and reproduction of recorded media	0,14	98,74
M 80	EDUCATION	0,14	98,87
31	Manufacture of electrical machinery and apparatus n.e.c.	0,13	99,00
35	Manufacture of other transport equipment	0,12	99,12
62	Air transport	0,12	99,24
60.1	Transport via railways	0,10	99,34
14	Other mining and quarrying	0,09	99,44
63	Supporting and auxiliary transport activities; activities of travel agencies	0,09	99,53
13	Mining of metal ores	0,07	99,60
32	Manufacture of radio, television and communication equipment and apparatus	0,07	99,67
J 65-67	FINANCIAL INTERMEDIATION	0,06	99,73
92	Recreational, cultural and sporting activities	0,06	99,79
64	Post and telecommunications	0,05	99,84
91	Activities of membership organisations n.e.c.	0,05	99,89
93	Other service activities	0,03	99,92
90	Sewage and refuse disposal, sanitation and similar activities	0,03	99,95
33	Manufacture of medical, precision and optical instruments, watches and clocks	0,02	99,97
P 95	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	0,01	99,98
30	Manufacture of office machinery and computers	0,01	99,99
37	Recycling	0,00	99,99
41	Collection, purification and distribution of water	0,00	100,00

4.2.2 NO_x emissions

The figure shows the 10 activities accounting for about 80% of total NO_x emissions. For six of them transport is by far the main cause of pollution generation. This is the case not only for activities in which transport is the main output (60.2, 60.3 and 61) but also for households and for activities in which road or off-road transport is an ancillary activity (50-52, 01, 75). For other activities shown in Figure 11 including the one that has the largest relative share of emissions (40), emissions are mainly related to combustion.

Figure 11 - NO_x emissions by activity (first 10) and by process (percentage)



NAMEA activities

40	Electricity, gas, steam and hot water supply
60.2-60.3	Other land transport/transport via pipelines
100	Total household consumption
50-52	Wholesale and retail trade; repair
01	Agriculture, hunting
26.2-26.8	Manufacture of other non-metallic mineral products
61	Water transport
23	Manufacture of coke, refined petroleum products and nuclear fuel
24	Manufacture of chemicals and chemical products
75	Public administration and defence; compulsory social security

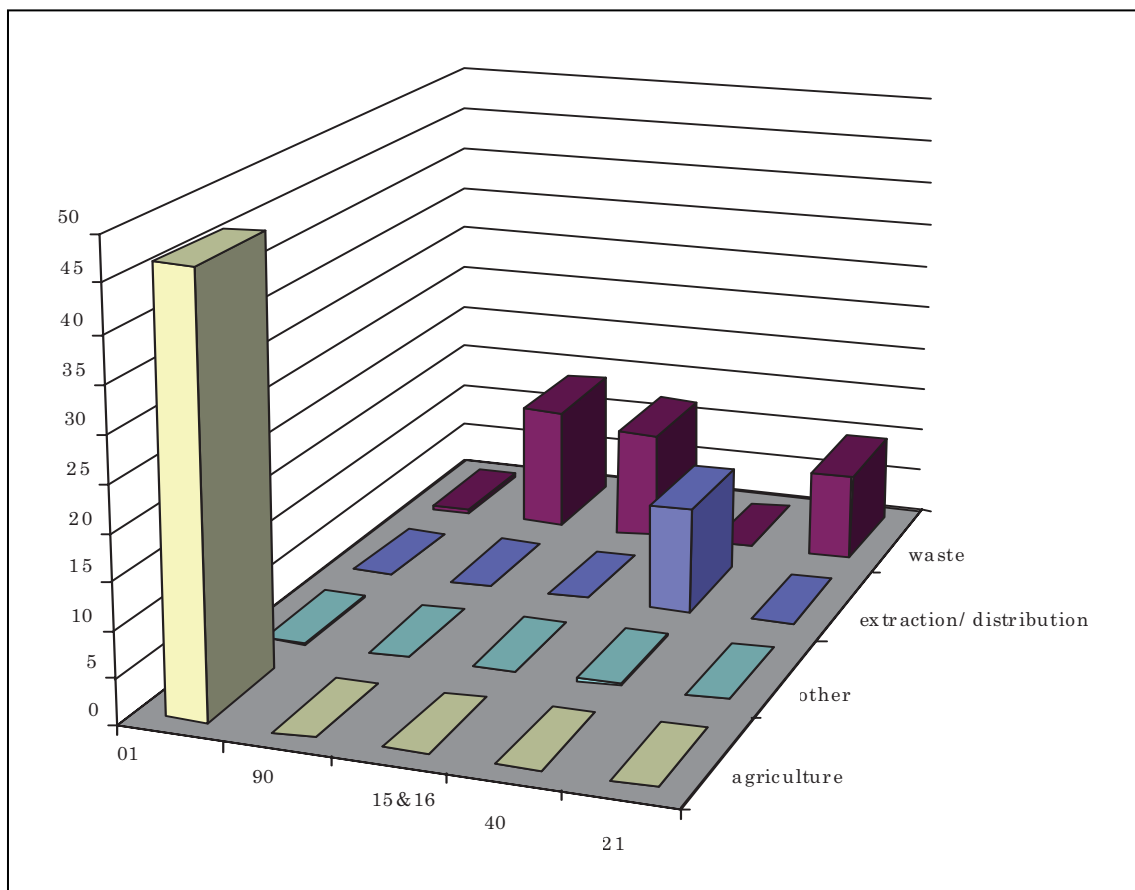
Table 12 - NO_x emissions by activity

NAMEA ACTIVITIES CLASSIFICATION		%	<i>cumulative</i>
40	Electricity, gas, steam and hot water supply	20,00	20,00
60.2-60.3	Other land transport/Transport via pipelines	15,50	35,50
100	TOTAL HOUSEHOLD CONSUMPTION	14,30	49,80
G 50-52	WHOLESALE AND RETAIL TRADE; REPAIR	6,76	56,55
01	Agriculture, hunting	5,93	62,48
26.2-26.8	Manufacture of other non-metallic mineral products	5,56	68,04
61	Water transport	4,36	72,40
23	Manufacture of coke, refined petroleum products and nuclear fuel	2,68	75,08
24	Manufacture of chemicals and chemical products	2,51	77,59
L 75	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	2,49	80,08
15&16	Manufacture of food products, beverages and tobacco	2,18	82,26
N 85	HEALTH AND SOCIAL WORK	1,75	84,02
27	Manufacture of basic metals	1,50	85,52
F 45	CONSTRUCTION	1,44	86,96
62	Air transport	1,36	88,32
26.1	Manufacture of glass and glass products	1,24	89,56
K 70-74	REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	1,13	90,69
28	Manufacture of fabricated metal products, except machinery and equipment	0,90	91,59
H 55	HOTELS AND RESTAURANTS	0,79	92,38
17	Manufacture of textiles and textile products (not incl. wearing apparel)	0,70	93,08
29	Manufacture of machinery and equipment n.e.c.	0,59	93,67
21	Manufacture of pulp, paper and paper products	0,52	94,19
36	Manufacturing of furniture, manufacturing n.e.c.	0,48	94,66
34	Manufacture of motor vehicles, trailers and semi-trailers	0,45	95,11
18	Manufacture of wearing apparel	0,42	95,53
20	Manufacture of wood and wood products (not incl. manufacture of furniture)	0,41	95,95
M 80	EDUCATION	0,41	96,35
25	Manufacture of rubber and plastic products	0,35	96,70
19	Manufacture of leather and leather products	0,33	97,03
60.1	Transport via railways	0,31	97,34
35	Manufacture of other transport equipment	0,31	97,65
63	Supporting and auxiliary transport activities; activities of travel agencies	0,30	97,95
93	Other service activities	0,26	98,20
31	Manufacture of electrical machinery and apparatus n.e.c.	0,24	98,44
22	Publishing, printing and reproduction of recorded media	0,21	98,65
92	Recreational, cultural and sporting activities	0,20	98,85
64	Post and telecommunications	0,19	99,03
J 65-67	FINANCIAL INTERMEDIATION	0,17	99,20
32	Manufacture of radio, television and communication equipment and apparatus	0,12	99,32
90	Sewage and refuse disposal, sanitation and similar activities	0,11	99,43
11&12	Extraction of crude petroleum and natural gas and incidental services	0,11	99,53
91	Activities of membership organisations n.e.c.	0,11	99,64
33	Manufacture of medical, precision and optical instruments, watches and clocks	0,10	99,73
14	Other mining and quarrying	0,09	99,82
P 95	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	0,06	99,88
30	Manufacture of office machinery and computers	0,03	99,92
41	Collection, purification and distribution of water	0,02	99,94
37	Recycling	0,02	99,96
13	Mining of metal ores	0,02	99,98
02	Forestry	0,01	99,99
05	Fishing and fish farms	0,00	100,00

4.2.3 CH₄ emissions

Figure 12 shows the breakdown by activity and process for almost 95% of methane emissions. As shown in Figure 12, almost half of methane emissions are due to agriculture and, specifically, to the typical processes associated to this activity. An additional 35% of emissions is due to activities 90, 15, and 21, that are involved in waste treatment and disposal processes. Finally, more than 10% comes from a non-combustion process taking place in activity 40: the extraction and distribution of fossil fuels.

Figure 12 - CH₄ emissions by activity (first 5) and by process (percentage)



NAMEA activities

01	Agriculture, hunting
90	Sewage and refuse disposal, sanitation and similar activities
15&16	Manufacture of food products, beverages and tobacco
40	Electricity, gas, steam and hot water supply
21	Manufacture of pulp, paper and paper products

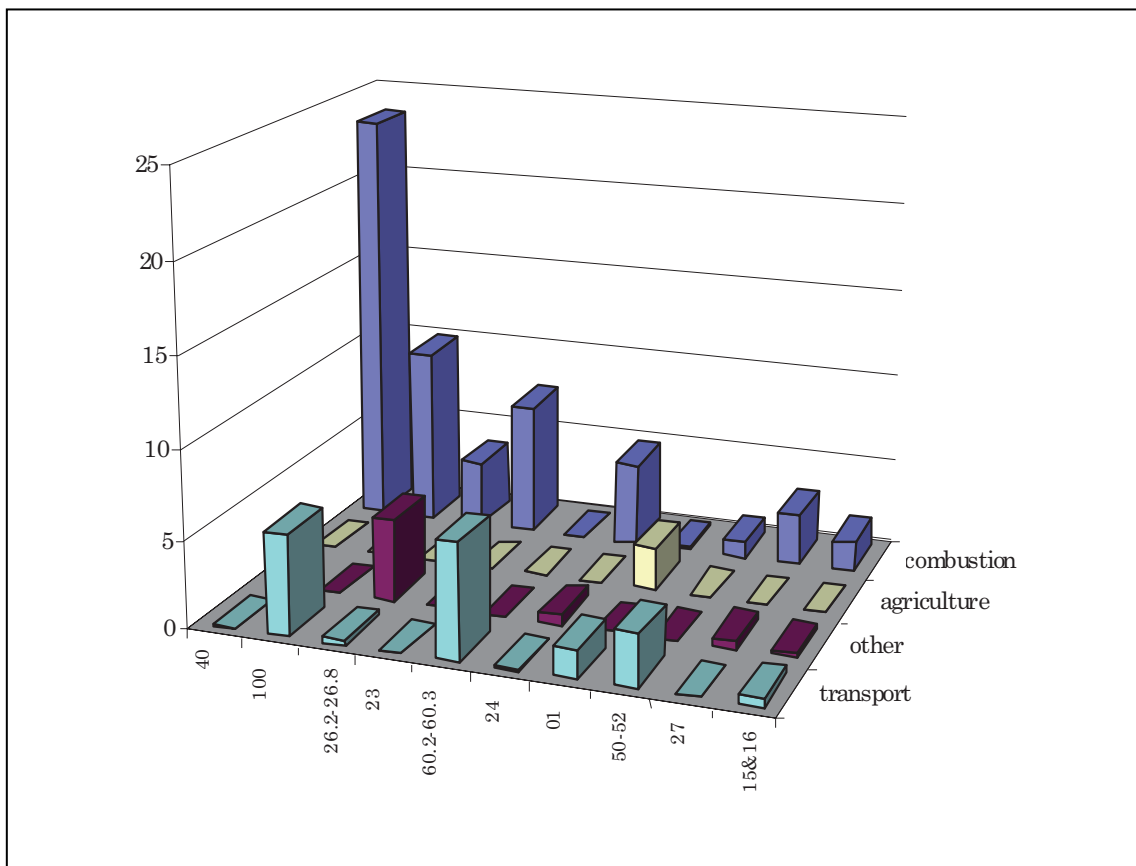
Table 13 - CH₄ emissions by activity

NAMEA ACTIVITIES CLASSIFICATION		%	<i>cumulative</i>
01	Agriculture, hunting	46,95	46,95
90	Sewage and refuse disposal, sanitation and similar activities	13,73	60,68
15&16	Manufacture of food products, beverages and tobacco	12,01	72,68
40	Electricity, gas, steam and hot water supply	11,76	84,44
21	Manufacture of pulp, paper and paper products	9,72	94,16
60.2-60.3	Other land transport/Transport via pipelines	1,65	95,81
11&12	Extraction of crude petroleum and natural gas and incidental services	1,28	97,09
100	TOTAL HOUSEHOLD CONSUMPTION	0,98	98,07
27	Manufacture of basic metals	0,28	98,35
23	Manufacture of coke, refined petroleum products and nuclear fuel	0,27	98,62
G 50-52	WHOLESALE AND RETAIL TRADE; REPAIR	0,25	98,87
17	Manufacture of textiles and textile products (not incl. wearing apparel)	0,16	99,04
24	Manufacture of chemicals and chemical products	0,15	99,19
61	Water transport	0,13	99,32
10	Mining of coal and lignite, extraction of peat	0,08	99,40
L 75	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	0,08	99,48
N 85	HEALTH AND SOCIAL WORK	0,07	99,55
26.2-26.8	Manufacture of other non-metallic mineral products	0,06	99,62
H 55	HOTELS AND RESTAURANTS	0,06	99,68
K 70-74	REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	0,05	99,73
34	Manufacture of motor vehicles, trailers and semi-trailers	0,03	99,76
28	Manufacture of fabricated metal products, except machinery and equipment	0,02	99,78
M 80	EDUCATION	0,02	99,80
35	Manufacture of other transport equipment	0,02	99,82
29	Manufacture of machinery and equipment n.e.c.	0,02	99,83
F 45	CONSTRUCTION	0,02	99,85
63	Supporting and auxiliary transport activities; activities of travel agencies	0,01	99,86
J 65-67	FINANCIAL INTERMEDIATION	0,01	99,87
36	Manufacturing of furniture, manufacturing n.e.c.	0,01	99,88
25	Manufacture of rubber and plastic products	0,01	99,89
93	Other service activities	0,01	99,90
62	Air transport	0,01	99,91
64	Post and telecommunications	0,01	99,92
26.1	Manufacture of glass and glass products	0,01	99,93
20	Manufacture of wood and wood products (not incl. manufacture of furniture)	0,01	99,94
92	Recreational, cultural and sporting activities	0,01	99,95
18	Manufacture of wearing apparel	0,01	99,95
22	Publishing, printing and reproduction of recorded media	0,01	99,96
19	Manufacture of leather and leather products	0,01	99,97
31	Manufacture of electrical machinery and apparatus n.e.c.	0,01	99,97
60.1	Transport via railways	0,00	99,98
91	Activities of membership organisations n.e.c.	0,00	99,98
02	Forestry	0,00	99,99
32	Manufacture of radio, television and communication equipment and apparatus	0,00	99,99
P 95	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	0,00	99,99
33	Manufacture of medical, precision and optical instruments, watches and clocks	0,00	99,99
14	Other mining and quarrying	0,00	100,00

4.2.4 CO₂ emissions

“Electricity, gas, steam and hot water supply” accounts for about 24% of CO₂ emissions and other 6 activities represented in the following figure (NAMEA codes 100, 26.2-26.8, 23, 60.2-60.3, 24, 01) account together for about 50%. For most of the activities shown in the figure, transport and/or combustion processes are significant sources of CO₂.

Figure 13 - CO₂ emissions by activity (first 10) and by process (percentage)



NAMEA activities

40	Electricity, gas, steam and hot water supply
100	Total household consumption
26.2-26.8	Manufacture of other non-metallic mineral products
23	Manufacture of coke, refined petroleum products and nuclear fuel
60.2-60.3	Other land transport/Transport via pipelines
24	Manufacture of chemicals and chemical products
01	Agriculture, hunting
50-52	Wholesale and retail trade; repair
27	Manufacture of basic metals
15&16	Manufacture of food products, beverages and tobacco

Table 14 - CO₂ emissions by activity

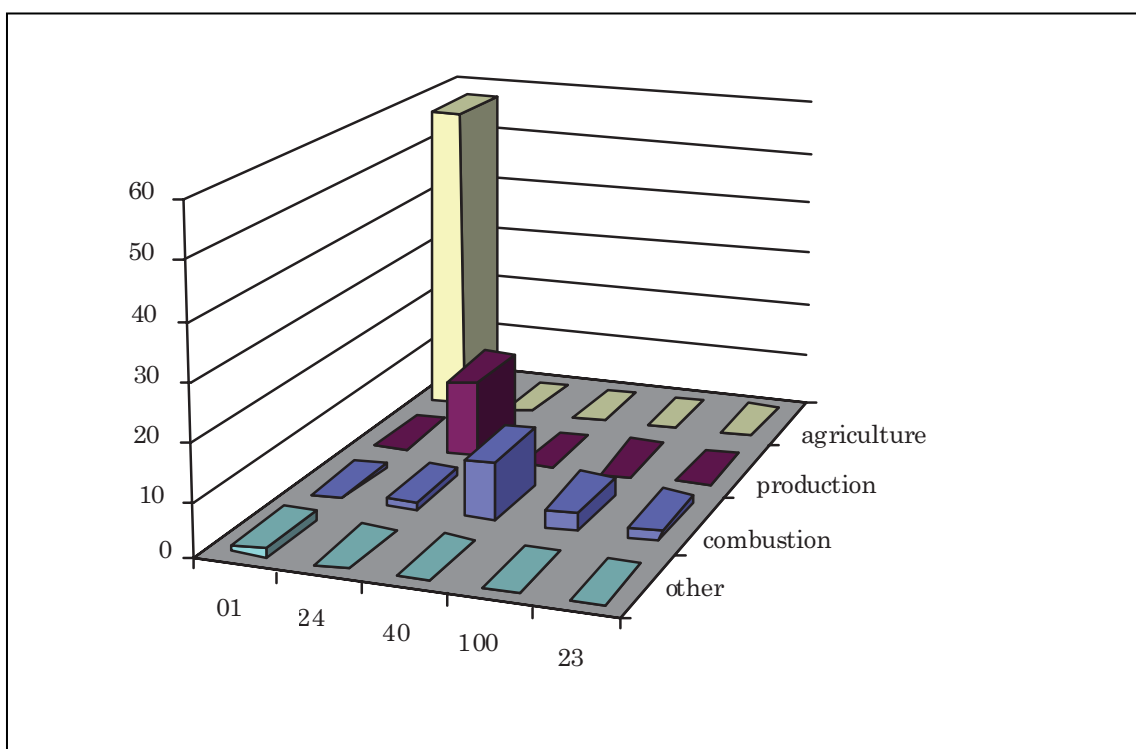
NAMEA ACTIVITIES CLASSIFICATION		%	<i>cumulative</i>
40	Electricity, gas, steam and hot water supply	23,67	23,67
100	TOTAL HOUSEHOLD CONSUMPTION	15,54	39,21
26.2-26.8	Manufacture of other non-metallic mineral products	8,51	47,71
23	Manufacture of coke, refined petroleum products and nuclear fuel	8,17	55,88
60.2-60.3	Other land transport/Transport via pipelines	6,41	62,29
24	Manufacture of chemicals and chemical products	5,31	67,60
01	Agriculture, hunting	4,17	71,77
50-52	WHOLESALE AND RETAIL TRADE; REPAIR	3,82	75,59
27	Manufacture of basic metals	3,76	79,34
15&16	Manufacture of food products, beverages and tobacco	2,45	81,79
61	Water transport	1,85	83,65
62	Air transport	1,54	85,19
75	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	1,43	86,62
N 85	HEALTH AND SOCIAL WORK	1,16	87,78
21	Manufacture of pulp, paper and paper products	1,07	88,85
H 55	HOTELS AND RESTAURANTS	1,06	89,92
28	Manufacture of fabricated metal products, except machinery and equipment	1,00	90,91
17	Manufacture of textiles and textile products (not incl. wearing apparel)	0,88	91,80
26.1	Manufacture of glass and glass products	0,80	92,59
35	Manufacture of other transport equipment	0,78	93,37
K 70-74	REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	0,66	94,03
34	Manufacture of motor vehicles, trailers and semi-trailers	0,62	94,65
F 45	CONSTRUCTION	0,54	95,19
29	Manufacture of machinery and equipment n.e.c.	0,46	95,65
36	Manufacturing of furniture, manufacturing n.e.c.	0,45	96,09
90	Sewage and refuse disposal, sanitation and similar activities	0,42	96,51
25	Manufacture of rubber and plastic products	0,34	96,85
20	Manufacture of wood and wood products (not incl. manufacture of furniture)	0,33	97,18
M 80	EDUCATION	0,29	97,48
19	Manufacture of leather and leather products	0,27	97,74
18	Manufacture of wearing apparel	0,25	98,00
11&12	Extraction of crude petroleum and natural gas and incidental services	0,24	98,24
63	Supporting and auxiliary transport activities; activities of travel agencies	0,22	98,46
22	Publishing, printing and reproduction of recorded media	0,21	98,67
31	Manufacture of electrical machinery and apparatus n.e.c.	0,18	98,85
60.1	Transport via railways	0,15	99,00
93	Other service activities	0,14	99,14
64	Post and telecommunications	0,13	99,27
92	Recreational, cultural and sporting activities	0,12	99,39
J 65-67	FINANCIAL INTERMEDIATION	0,11	99,50
32	Manufacture of radio, television and communication equipment and apparatus	0,10	99,60
14	Other mining and quarrying	0,08	99,69
91	Activities of membership organisations n.e.c.	0,07	99,76
33	Manufacture of medical, precision and optical instruments, watches and clocks	0,06	99,82
13	Mining of metal ores	0,06	99,88
P 95	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	0,05	99,93
30	Manufacture of office machinery and computers	0,03	99,96
37	Recycling	0,01	99,97
02	Forestry	0,01	99,99
41	Collection, purification and distribution of water	0,01	100,00
05	Fishing and fish farms	0,00	100,00

4.2.5 N_2O emissions

Almost 60% of total N_2O emissions arise from agriculture (01); the two other relatively significant activities causing the emissions of this pollutants are:

- “Manufacture of chemicals and chemical products” (24) in which emissions are caused by the specific production process of the activity;
- “Electricity, gas, steam and hot water supply” in which emissions are caused by combustion.

Figure 14 - N_2O emissions by activity (first 5) and by process (percentage)



NAMEA activities

01	Agriculture, hunting
24	Manufacture of chemicals and chemical products
40	Electricity, gas, steam and hot water supply
100	Total household consumption
23	Manufacture of coke, refined petroleum products and nuclear fuel

Table 15 - N₂O emissions by activity

NAMEA ACTIVITIES CLASSIFICATION		%	<i>cumulative</i>
01	Agriculture, hunting	59,58	59,58
24	Manufacture of chemicals and chemical products	15,72	75,30
40	Electricity, gas, steam and hot water supply	10,14	85,44
100	TOTAL HOUSEHOLD CONSUMPTION	3,69	89,13
23	Manufacture of coke, refined petroleum products and nuclear fuel	1,81	90,94
26.2-26.8	Manufacture of other non-metallic mineral products	1,54	92,48
60.2-60.3	Other land transport/Transport via pipelines	1,15	93,64
61	Water transport	0,71	94,34
G 50-52	WHOLESALE AND RETAIL TRADE; REPAIR	0,63	94,97
15&16	Manufacture of food products, beverages and tobacco	0,62	95,59
35	Manufacture of other transport equipment	0,39	95,98
L 75	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	0,36	96,34
28	Manufacture of fabricated metal products, except machinery and equipment	0,33	96,68
17	Manufacture of textiles and textile products (not incl. wearing apparel)	0,30	96,97
N 85	HEALTH AND SOCIAL WORK	0,26	97,23
H 55	HOTELS AND RESTAURANTS	0,25	97,49
27	Manufacture of basic metals	0,23	97,71
F 45	CONSTRUCTION	0,22	97,93
21	Manufacture of pulp, paper and paper products	0,22	98,15
29	Manufacture of machinery and equipment n.e.c.	0,17	98,32
34	Manufacture of motor vehicles, trailers and semi-trailers	0,15	98,47
36	Manufacturing of furniture, manufacturing n.e.c.	0,14	98,61
20	Manufacture of wood and wood products (not incl. manufacture of furniture)	0,13	98,74
K 70-74	REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	0,12	98,86
18	Manufacture of wearing apparel	0,12	98,99
25	Manufacture of rubber and plastic products	0,12	99,10
26.1	Manufacture of glass and glass products	0,11	99,21
19	Manufacture of leather and leather products	0,11	99,32
22	Publishing, printing and reproduction of recorded media	0,08	99,39
M 80	EDUCATION	0,07	99,47
31	Manufacture of electrical machinery and apparatus n.e.c.	0,07	99,54
63	Supporting and auxiliary transport activities; activities of travel agencies	0,07	99,60
32	Manufacture of radio, television and communication equipment and apparatus	0,04	99,64
90	Sewage and refuse disposal, sanitation and similar activities	0,04	99,68
11&12	Extraction of crude petroleum and natural gas and incidental services	0,04	99,72
14	Other mining and quarrying	0,04	99,76
60.1	Transport via railways	0,04	99,79
64	Post and telecommunications	0,03	99,82
J 65-67	FINANCIAL INTERMEDIATION	0,03	99,85
33	Manufacture of medical, precision and optical instruments, watches and clocks	0,03	99,87
92	Recreational, cultural and sporting activities	0,02	99,90
93	Other service activities	0,02	99,92
13	Mining of metal ores	0,02	99,94
91	Activities of membership organisations n.e.c.	0,02	99,96
62	Air transport	0,02	99,97
P 95	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	0,01	99,98
30	Manufacture of office machinery and computers	0,01	99,99
37	Recycling	0,00	100,00

4.2.6 NH₃ emissions

Table 16 shows that the almost exclusive source of ammonia is agriculture with more than 90% of total NH₃ emissions. Almost all of them are due to the typical agricultural processes. The analysis by activity and process is therefore not relevant in this case.

Table 16 - NH₃ emissions by activity

NAMEA ACTIVITIES CLASSIFICATION		%	cumulative
01	Agriculture, hunting	92,26	92,26
24	Manufacture of chemicals and chemical products	5,03	97,29
90	Sewage and refuse disposal, sanitation and similar activities	2,54	99,83
100	TOTAL HOUSEHOLD CONSUMPTION	0,05	99,87
40	Electricity, gas, steam and hot water supply	0,03	99,90
60.2-60.3	Other land transport/Transport via pipelines	0,03	99,93
G 50-52	WHOLESALE AND RETAIL TRADE; REPAIR	0,02	99,95
26.2-26.8	Manufacture of other non-metallic mineral products	0,01	99,96
27	Manufacture of basic metals	0,01	99,97
N 85	HEALTH AND SOCIAL WORK	0,00	99,97
K 70-74	REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	0,00	99,98
L 75	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	0,00	99,98
61	Water transport	0,00	99,98
15&16	Manufacture of food products, beverages and tobacco	0,00	99,98
F 45	CONSTRUCTION	0,00	99,99
H 55	HOTELS AND RESTAURANTS	0,00	99,99
M 80	EDUCATION	0,00	99,99
28	Manufacture of fabricated metal products, except machinery and equipment	0,00	99,99
63	Supporting and auxiliary transport activities; activities of travel agencies	0,00	99,99
93	Other service activities	0,00	99,99
29	Manufacture of machinery and equipment n.e.c.	0,00	99,99
J 65-67	FINANCIAL INTERMEDIATION	0,00	99,99
64	Post and telecommunications	0,00	99,99
20	Manufacture of wood and wood products (not incl. Manufacture of furniture)	0,00	99,99
36	Manufacturing of furniture, manufacturing n.e.c.	0,00	99,99
92	Recreational, cultural and sporting activities	0,00	100,00

Summing up, the number of activities accounting for the largest share of emissions varies among the 6 pollutants: on the one hand NH₃ emissions are almost exclusively due to one activity (Agriculture); on the other, for NO_x and CO₂ the emissions are more evenly spread among several economic activities and also households consumption plays a significant role in generating them.

4.3 The intake of resources

The following table summarises the results concerning the material intakes from the Italian territory (direct inputs from nature) to the economic system in 1990.

Table 17 - Direct intake of materials from nature of the Italian economy, 1990

Materials extracted/gathered					NACE Rev. 1 Economic Activities by which the materials are extracted/gathered	NACE Rev. 1 code of the activities
Description	Quantity (tonnes)					
	Energy		Non-energy			
	Endogenous steam	Wood and fossil fuels	Minerals	Biotic materials		
Products of herbaceous cultivation, excluding floricultural cultivation (grains, seed legumes, tuberous, horticultural and industrial plants); fodder (temporary and permanent); ligneous cultivation (vines, olives, citrus fruits, fruit trees and others)	0	0	0	173.872.486	Growing of crops, market gardening, horticulture, mixed farming	01.1 01.3
Forestry products: non-ligneous and ligneous uses in and outside forests	0	2.882.715	0	3.415.259	Forestry and logging	02.01
Fish, crustaceans, molluscs	0	0	0	345.075	Fishing, operation of fish hatcheries and fish farms	05
Coal, crude brown coal, peat	0	1.520.068	0	0	Mining of coal and lignite, extraction of peat	10
Petrol, crude oil, GPL, methane, bituminous shale and sand	0	17.849.642	0	0	Extraction of crude petroleum and natural gas	11.1
Metal ores: antimony, magnesium, manganese, lead and zinc minerals	0	0	178.351	0	Mining of non-ferrous metal ores	13.2
Halite, pyrite, cement marl, feldspar, barite, aluminium silicates, talc and steatite, fluorite, asbestos, carbon dioxide, bauxite for refractory uses, celestite, potassium salts, mineral sulphur, sea salt, alabaster, slate, sandstone, limestone, schistose limestone, white and coloured marbles, porphyry, quartz and quartzite, travertine, tuff, clay, pumice, pozzolan, sand and gravel, volcanic and siliceous sands, whetstones, etc.	0	0	366.038.847	0	Quarrying of stone, sand and clay, chemical and fertiliser minerals, production of salt, other mining and quarrying	14.1 14.2 14.3 14.4 14.5
Steam	32.180.589	0	0	0	Electricity generation	40
TOTAL	32.180.589	22.252.425	366.217.198	177.632.820		

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ANNEX A DETAILED RESULTS

Table A shows economic data (output, value added and households final consumption expenditure), air emissions and intake of materials broken down by all NAMEA activities (economic activities + households). The classification is based on the Eurostat proposed NAMEA classification of activities.

Table A - The 1990 Italian NAMEA - Economic data, air emissions and material intakes by economic activity and purpose of household consumption

ECONOMIC DATA (billion lire)		ECONOMIC ACTIVITIES AND HOUSEHOLD CONSUMPTION	AIR EMISSIONS - TONS (a)						MATERIAL INTAKES FROM NATURE - TONS			
Output (depart- tisine VAT included)	Value added (market prices)		SO _x	NO _x	CH ₄	CO ₂ (a)	N ₂ O	NH ₃	Energy		Non-energy	
		Classification of economic activities						Endogenous steam	Wood and fossil fuels	Minerals	Biotic materials	
		AGRICULTURE, HUNTING AND FORESTRY										
60.957,3	39.604,0	01 Agriculture, hunting	20.659,1	121.965,4	1.100.995,6	19.238,2	99.044,8	430.004,1	-	-	-	173.872.486,2
744,8	635,7	02 Forestry	27,8	212,9	95,4	54,6	1,1	0,1	2.882.715,3	-	-	3.415.258,7
		FISHING										
2.448,7	1.727,3	05 Fishing and fish farms	12,4	98,6	2,3	9,5	0,5	0,1	-	-	-	345.075,0
		MINING AND QUARRYING										
87,5	66,2	10 Mining of coal and lignite, extraction of peat	4,5	17,1	1.987,1	2,4	0,5	-	1.520.068,0	-	-	-
4.200,4	3.872,7	11&12 Extraction of crude petroleum and natural gas and incidental services	34,8	2.182,9	30.044,6	1.099,3	60,9	0,1	17.849.642,1	-	-	-
100,1	33,6	13 Mining of metal ores	1.334,2	427,5	28,2	272,2	37,4	0,5	-	178.551,0	-	-
5.216,9	2.477,3	14 Other mining and quarrying	1.649,8	1.879,2	42,3	380,6	59,2	0,4	-	366.038.846,8	-	-
		MANUFACTURING										
128.015,8	34.254,6	15&16 Manufacture of food products, beverages and tobacco	27.888,0	44.867,0	281.464,6	11.291,7	1.035,4	10,9	-	-	-	-
57.173,2	20.112,0	17 Manufacture of textiles and textile products (not incl. wearing apparel)	15.430,4	14.477,0	3.783,8	4.065,4	495,4	2,4	-	-	-	-
40.620,7	15.209,0	18 Manufacture of wearing apparel	4.137,3	8.713,9	150,6	1.172,3	203,1	2,2	-	-	-	-
31.926,2	9.900,1	19 Manufacture of leather and leather products	5.035,0	6.785,6	148,5	1.222,2	177,6	1,9	-	-	-	-
19.634,7	7.772,5	20 Manufacture of wood and wood products (not incl. manufacture of furniture)	8.061,5	8.530,3	204,7	1.531,8	212,1	2,6	-	-	-	-
20.605,3	5.963,1	21 Manufacture of pulp, paper and paper products	13.567,9	10.642,9	227.805,8	4.928,0	363,5	0,9	-	-	-	-
31.048,7	12.341,0	22 Publishing, printing and reproduction of recorded media	2.525,3	4.296,5	133,8	969,8	127,1	1,0	-	-	-	-
65.689,8	35.467,0	23 Manufacture of coke, refined petroleum products and nuclear fuel	294.966,1	55.225,2	6.395,5	37.674,9	3.004,7	0,2	-	-	-	-
80.171,5	23.116,0	24 Manufacture of chemicals and chemical products	147.724,7	51.666,6	3.707,9	24.457,7	26.135,3	23.439,1	-	-	-	-
31.338,4	10.913,0	25 Manufacture of rubber and plastic products	6.366,2	7.139,5	174,2	1.567,9	195,3	1,6	-	-	-	-
7.390,0	3.030,2	26.1 Manufacture of glass and glass products	6.818,7	25.532,5	200,6	3.674,7	175,3	0,9	-	-	-	-
40.035,1	15.976,0	26.2-26.8 Manufacture of other non-metallic mineral products	87.192,0	114.467,8	1.483,9	39.211,6	2.566,8	45,1	-	-	-	-

(continues)

Table A (continued) - The 1990 Italian NAMEA - Economic data, air emissions and material intakes by economic activity and purpose of household consumption

ECONOMIC DATA (billion lire)		ECONOMIC ACTIVITIES AND HOUSEHOLD CONSUMPTION	AIR EMISSIONS - TONS (a)							MATERIAL INTAKES FROM NATURE - TONS			
Output (depart- using VAT included)	Value added (market prices)		SO _x	NO _x	CH ₄	CO ₂ (a)	N ₂ O	NH ₃	Endogenous steam	Energy	Non-energy	Minerals	Biotic materials
42.322,1	10.270,0	27 Manufacture of basic metals	40.873,5	30.870,0	6.564,3	17.310,3	374,8	28,6	-	-	-	-	
77.029,8	31.376,0	28 Manufacture of fabricated metal products, except machinery and equipment	5.988,8	18.443,6	466,0	4.600,5	556,4	4,5	-	-	-	-	
98.141,1	34.000,0	29 Manufacture of machinery and equipment n.e.c.	3.363,0	12.130,2	337,2	2.109,1	279,3	3,0	-	-	-	-	
6.227,0	1.552,4	30 Manufacture of office machinery and computers	92,7	708,2	22,8	160,1	17,3	0,2	-	-	-	-	
31.094,7	12.020,0	31 Manufacture of electrical machinery and apparatus n.e.c.	2.244,4	4.888,9	108,4	832,5	121,6	0,9	-	-	-	-	
24.042,6	9.993,5	32 Manufacture of radio, television and communication equipment and apparatus	1.287,8	2.477,9	67,1	463,7	66,1	0,5	-	-	-	-	
13.581,5	6.271,1	33 Manufacture of medical, precision and optical instruments, watches and clocks	327,1	1.955,8	49,8	296,3	41,7	0,5	-	-	-	-	
43.994,7	12.408,0	34 Manufacture of motor vehicles, trailers and semi-trailers	3.558,2	9.161,4	504,8	2.855,5	255,3	1,7	-	-	-	-	
21.203,6	7.374,5	35 Manufacture of other transport equipment	2.235,1	6.304,0	396,5	3.586,9	640,5	0,9	-	-	-	-	
41.600,9	13.531,0	36 Manufacturing of furniture, manufacturing n.e.c.	4.119,8	9.811,3	223,5	2.061,3	230,5	2,5	-	-	-	-	
2.945,1	687,9	37 Recycling	89,0	488,7	8,1	60,4	4,5	0,2	-	-	-	-	
		ELECTRICITY, GAS AND WATER SUPPLY											
50.310,1	29.758,0	40 Electricity, gas, steam and hot water supply	767.504,6	411.656,6	275.716,6	109.118,7	16.852,7	144,3	32.180.589	-	-	-	
4.310,4	1.537,2	41 Collection, purification and distribution of water	56,0	502,8	15,5	51,5	2,7	0,3	-	-	-	-	
182.424,7	78.889,0	F 45 CONSTRUCTION	3.488,6	29.642,9	353,1	2.480,0	367,3	10,2	-	-	-	-	
274.414,7	171.117,0	G 50-52 WHOLESALE AND RETAIL TRADE; REPAIR	15.818,2	139.048,2	5.841,2	17.597,3	1.041,8	98,1	-	-	-	-	
73.620,6	39.776,0	H 55 HOTELS AND RESTAURANTS	3.945,0	16.179,8	2.114,5	4.909,1	432,3	7,3	-	-	-	-	
		I TRANSPORT, STORAGE AND COMMUNICATION											
4.749,1	1.957,8	60.1 Transport via railways	1.802,4	6.457,8	137,4	684,1	59,0	2,4	-	-	-	-	
62.015,2	29.971,0	60.2-60.3 Other land transport/Transport via pipelines	51.769,3	319.026,8	38.649,2	29.543,1	1.919,9	125,7	-	-	-	-	

(continues)

Table A (continued) - The 1990 Italian NAMEA - Economic data, air emissions and material intakes by economic activity and purpose of household consumption

ECONOMIC DATA (billion lire)		ECONOMIC ACTIVITIES AND HOUSEHOLD CONSUMPTION	AIR EMISSIONS - TONS (a)							MATERIAL INTAKES FROM NATURE - TONS			
Output (depart- using VAT included)	Value added (market prices)		SO _x	NO _x	CH ₄	CO ₂ (b)	N ₂ O	NH ₃	Energy		Non-energy		
		Classification of economic activities	Endogenous steam	Wood and fossil fuels	Minerals	Biotic materials							
099.1	3.819,7	61 Water transport	109.601,6	89.687,3	2.996,4	8.548,6	1.175,3	14,5	-	-	-	-	
8.993,6	3.673,8	62 Air transport	2.148,6	28.068,9	211,6	7.112,3	25,4	0,7	-	-	-	-	
34.106,0	12.976,0	63 Supporting and auxiliary transport activities; activities of travel agencies	1.594,6	6.083,8	261,7	1.031,7	108,8	3,8	-	-	-	-	
3.1179,3	21.217,0	64 Post and telecommunications	889,5	3.831,1	188,0	568,0	49,1	2,6	-	-	-	-	
113.072,2	82.438,0	J 65-67 FINANCIAL INTERMEDIATION	3.081,2	3.439,1	236,4	522,5	42,3	2,6	-	-	-	-	
275.460,8	194.760,0	K 70-74 REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	1.067,1	23.328,1	1.127,3	3.034,4	206,4	18,6	-	-	-	-	
106.451,5	74.880,0	L 75 PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	32.440,3	51.271,4	1.948,7	6.587,3	603,1	15,7	-	-	-	-	
78.165,1	69.353,0	M 80 EDUCATION	2.439,0	8.402,2	417,4	1.353,3	123,2	4,5	-	-	-	-	
116.917,4	55.239,0	N 85 HEALTH AND SOCIAL WORK	12.095,9	36.112,4	1.729,8	5.365,7	421,4	21,1	-	-	-	-	
		O OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICE ACTIVITIES											
12.451,6	5.278,3	90 Sewage and refuse disposal, sanitation and similar activities	533,0	2.186,4	321.913,5	1.934,3	64,4	11.840,1	-	-	-	-	
6.454,2	4.447,2	91 Activities of membership organisations n.e.c.	879,1	2.173,0	105,9	324,1	27,1	1,2	-	-	-	-	
35.206,9	20.930,0	92 Recreational, cultural and sporting activities	1.029,8	4.065,1	203,5	577,3	41,5	2,4	-	-	-	-	
20.754,7	13.966,0	93 Other service activities	563,9	5.330,1	228,2	657,9	38,1	3,7	-	-	-	-	
8.334,0	8.334,0	P 95 PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	249,4	1.156,9	75,4	213,4	18,2	0,9	-	-	-	-	
2.542.079,4	1.264.872,9	TOTAL - ECONOMIC ACTIVITIES	1.720.612,1	1.763.983,8	2.322.073,0	389.375,7	1.601.103,9	465.878,2	32.180.589	22.252.425	366.217.198	177.632.820	
		Classification of household consumption by purpose											
47.720,0		Transport*	12.072,2	255.670,9	11.945,3	25.985,2	715,6	216,7	-	-	-	-	
28.463,0		Heating**	58.429,2	38.629,9	10.895,2	45.597,8	5.426,6	1,2	-	-	-	-	
685.284,4		Other***	9,3	18,6	93,6	32,6	0,2	-	-	-	-	-	
761.467,4		TOTAL - HOUSEHOLD CONSUMPTION	70.510,7	294.319,3	22.934,2	71.615,6	6.142,5	217,8	-	-	-	-	
		TOTAL - ECONOMIC ACTIVITIES AND HOUSEHOLDS	1.791.122,8	2.058.303,1	2.345.007,2	460.991,3	166.246,4	466.096,0	32.180.589,0	22.252.425,4	366.217.197,8	177.632.819,9	

(a) The unit of measurement for CO₂ is 1000 tons

* Household consumption for "transport" purposes corresponds to expenditure on "operation of personal transport equipment" (COICOP item 07.2)

** Household consumption for "heating" purposes corresponds to expenditure on "electricity, gas and other fuels" (COICOP item 04.5)

*** Of all household activities comprised in this category, only gardening generates the emissions considered here

ANNEX B CONSISTENCY BETWEEN THE ITALIAN CORINAIR EMISSIONS DATA AND THE NAMEA FRAMEWORK IN THE CASE OF TRANSPORT

The case of transport processes deserves a specific discussion; what makes transport different from other processes is its “mobile” nature that implies that emissions can occur inside or outside a national territory and the difference between resident and non resident units is more relevant and more difficult to quantify with respect to other SNAP processes. This implies that when “country” emissions are calculated, the exact boundary of the concept needs to be specified, since country emissions can alternatively refer to emissions on the national territory or to emissions by resident people anywhere they are, or to other definitions²³⁵. It is therefore important to check whether the definition of Italian transport emissions in the CORINAIR are consistent with the NAMEA framework. This issue is relevant in the case of road, maritime and air transport.

CORINAIR estimates are considered in this context as they are available in the country, and not necessarily as they are reported for the purpose of International inventories (for example the UN-ECE convention on long range transboundary air pollution or the International Panel on Climate Change), that impose specific requirements on the way emissions should be reported.

Road transport

The Italian CORINAIR data for road transport emissions are obtained through the COPERT methodology (that uses information such as km. driven, speed, car fleet, average consumption, etc.). The estimates, consistently with the SNAP classification, do not distinguish between national and international transport. The difference with respect to the NAMEA framework is the following: in the CORINAIR data the emissions from road transport include emissions on the Italian territory by non resident units (that should be excluded from the NAMEA) and do not include the road emissions by Italians abroad (that should be included in the NAMEA). In this work we assumed that emissions on the Italian territory by non-resident units equal the road emissions by Italians abroad.

Maritime transport

The Italian CORINAIR data for maritime transport emissions are based mainly on the BEN data on bunkering. Similarly to the case of road transport, the data include emissions on the Italian territory by non-resident ships (that should be excluded from the NAMEA) and do not include the emissions by Italian ships abroad (that should be included in the NAMEA). In this work we introduced the same assumption of the road transport case: emissions on the Italian territory by non-resident ships equal the emissions by Italian ships abroad.

Air transport

The Italian CORINAIR data for air emissions due to international air transport are obtained through a complex procedure that includes – inter alia – the total number of international flights leaving the country (and excludes the number of flights entering the country) regardless of the air company. In the NAMEA all flights from resident companies whether or not they occur in the national territory should be included. Also here, we assumed that the number of flights by resident companies not leaving from Italy (and hence not accounted for in CORINAIR) equals the number of flights by non-resident companies leaving Italy (and hence accounted for in CORINAIR).

²³⁵ See Gravgard, O. Problems in combining National Accounts and Environmental Statistics, 5th annual meeting of the London Group on Environmental Accounting, France, May 1998.

ANNEX C THE ATECO 81 – ATECO 91 CONVERSION MATRIX

As described in § 3.2.3.2, the Istat 1988 “energy use Table” played an important role for splitting some SNAP based emissions among NAMEA activities. One of the preliminary steps undertaken in order to use the Table was to turn the data referred to the economic activities, originally broken down by 92 ATECO 81 (the Italian version of NACE70) national accounting economic branches, into the 52 ATECO 91 (the Italian version of NACE Rev.1) NAMEA groupings. The shift was made possible by an ATECO 81-ATECO 91 conversion matrix developed by Istat. This Annex describes in detail the methodology used to compute the conversion matrix in the specific case of the NAMEA exercise.

Let x_t denote a vector measuring an economic variable for m economic activity units at time t . Aggregation of x_t into n ($n < m$) sectors is obtained defining a binary 0/1 ($n \times m$) aggregation matrix A such that

$$(A.1) \quad y_t = Ax_t$$

y_t represents a n -vector of aggregated data in n sectors. A is a full row rank matrix where every column sums to unity and it is unique for each classification standard. A scalar sum Y_t of the elements of y_t is also defined. In these terms, a different classification standard means a new ($p \times m$) aggregation matrix B ($p < m$), such that

$$(A.2) \quad z_t = Bx_t \quad ,$$

where z_t represents the new p -vector of aggregated data in p sectors. Moreover a scalar Z_t as sum of the elements of z_t can be defined with the same meaning of Y_t .

Suppose now that new standards modify only the composition, without any changes for the total aggregate, so that $Y_t = Z_t$. Then, a ($p \times n$) conversion matrix C_t is univocally defined, such that

$$(A.3) \quad z_t = C_t y_t$$

where

$$(A.4) \quad C_t = Bx_t^d A' (Ax_t^d A')^{-1}$$

and x_t^d is a m -diagonal matrix with $x_{1t}, x_{2t}, \dots, x_{mt}$ as diagonal terms.

C_t is a full column rank matrix and, as for A and B , every column sums to 1. Each element of C_t , c_{ij} ($i=1,2,\dots,p$ and $j=1,2,\dots,n$) is bounded between zero and one.

In other terms, each element c_{ij} of C_t gives a transition weight from a sector of the old classification to a sector of the new one. If the definition of the i -th new sector (in terms of joined economic activities) is exactly the same as the j -th sector of the old classification, then $c_{ij}=1$; if there is a split from the j -th old sector into more than one new sector, then $0 < c_{ij} < 1$; finally, if there are no linkages $c_{ij}=0$.

Such an analytical framework is extremely useful when full information in terms of x_t and the aggregation matrices A and B is available. To this respect a very detailed data set is available from the National Accounts benchmark estimates of employees, compiled for the

implementation of ESA95. The data set includes the 1992 distribution of employees by both the 4 digit ATECO 81 and 5 digit ATECO 91 economic activity classification.

These data allowed to work with a 1344-vector x_i , representing the distribution of employees among all the possible cross-classifications of ATECO 81 and ATECO 91 economic activities. For the NAMEA exercise, matrices A and B of order 1344×92 and 1344×52 , respectively, were used.

The implications of using the matrix in the NAMEA exercise were assessed by separately evaluating the effects on energy use data, weights and emissions²³⁶; the results of the analysis are summarised below:

1. as regards energy use data, the implications of the matrix conversion were evaluated by comparing ATECO 81 and ATECO 91 energy use data grouped into five macro-industries²³⁷. The calculation shows that there are differences for some macro-industries, the amount and the sign of which vary depending on the specific energy product. Such differences are in some cases large (more than 100%) when compared against the use of the specific macro sector; however, they are always small (in most cases less than 1% and always less than 3%) when evaluated against the total use of an energy product;
2. as far as the weights are concerned, the implications of the use of the conversion matrix are greatly reduced. This is due to the fact that weights for a generic process p and activity i are calculated as the share of the energy use of activity i out of the total energy use of the subset of 55 NAMEA activities (52 economic activities + households heating, transport and other), that are associated to process p :

$$(A.5) \quad W_j^i(p) = \frac{use_j^i(l)}{\sum_i use_j^i(l)} .$$

Obviously, as in the case of energy use data, the sign of the variation and its amount vary depending on the specific energy product and type of use;

3. finally, the implications on the emissions are further reduced. The explanation is twofold. First, the emissions by NAMEA activity i of a single process p are obtained by summing up the emissions from each energy product:

$$(A.6) \quad EMI_i(p) = \sum_j EMI_j^i(p), \text{ where } EMI_j^i(p) = W_j^i(p) * EMI_j(p) .$$

As seen above, the variation in the weights by energy product, and hence in the emissions by product, may have different signs (see point 2 above); in our case, they (partly) offset each other when summed up.

Second, the processes that were distributed among different NACE through energy use data are only a subset of CORINAIR processes. Therefore, the effects on the final NAMEA output, the emissions by pollutant and by activity are reduced even further.

²³⁶ See § 3.3.2.3.2 for details on the methodology used to distribute emissions using weights derived from the consumption of energy products.

²³⁷ The five macro-industries are: agriculture, energy, industry, construction and services.

Summing up, the overall effects of the use of the ATECO 81 – ATECO 91 conversion matrix on the calculation of emissions by activity and by pollutant in the NAMEA exercise are small. More specifically, the impact is inversely related to the share of each particular activity on the total emissions of a given pollutant:

- smaller (in percentage terms) for activities that account for the largest share of the total emissions;
- larger (in percentage terms) for activities that account for the smallest share of the total emissions.

Capitolo 6

Rapporto ad Eurostat

Italian NAMEAs: 1991, 1992; enlarged and revised 1990 data

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1 OUTLINE OF THE REPORT

A first Italian NAMEA was completed in 1999 with reference year 1990. It included an Input-Output (I/O) based economic module and an environmental module comprising emission accounts for six air pollutants – carbon dioxide (CO₂), sulphur oxides (SO_x), nitrogen oxides (NO_x), nitrous oxide (N₂O), ammonia (NH₃), methane (CH₄) – as well as the intake from nature of virgin materials – endogenous steam, wood and fossil fuels, minerals, biotic materials – by economic activity.

This report contains the output of a second project aiming at building up NAMEA-type matrices for Italy, namely:

- extension of 1990 environmental accounts to emissions of CO (carbon monoxide) and non-methane volatile organic compounds (NMVOC);
- compilation of 1991 and 1992 NAMEA matrices. These include an extended economic module and, in the environmental module, air emission accounts for eight pollutants – CH₄, CO, CO₂, N₂O, NH₃, NMVOC, NO_x, SO_x – and the estimation of the direct intake of resources by economic activity.

Il testo riportato è una rielaborazione del rapporto originale consegnato all'Eurostat nel 2001, soprattutto per quanto riguarda il testo del § 5. La realizzazione del progetto e la stesura del rapporto originale (Istat, 2001) sono state coordinate da Angelica Tudini (Istat). Aldo Femia (Istat) ha curato la presente rielaborazione.

I §§ 2, 4.1 sono stati redatti da Alessandra Coli (Istat); il § 4.2.1.3 da Riccardo De Lauretis (ANPA - Agenzia Nazionale per la Protezione dell'Ambiente); i §§ 3 e 5 da Aldo Femia; il testo del § 4.2.2 da Gianna Greca (Istat); il § 5.6 da Daniela Romano (ANPA); i §§ 1, 4.2.1.1, 4.2.1.4.1 e il testo del § 7 da Angelica Tudini; le tavole del § 4.2.2 da Miriam Vannozzi (Istat); i §§ 4.2.1.2, 4.2.1.4.2, 4.2.1.4.3 da Giusy Vetrella (Istat); le tavole del § 7 da Alessandra Coli per quanto riguarda la NAMEA completa e da Aldo Femia per quanto riguarda MSec, MSem, Hem, Hec, EA e la NAMEA aggregata.

Gli autori ringraziano Luisa Picozzi, Raffaele Malizia, Federica Battellini, Roberto Bruno, Cesare Costantino, Claudia Giansante, Deborah Guerrucci, Filippo Moauro, Giuliano Rallo, Francesca Tartamella (Istat); Hartmut Stahl (Oeko Institute); il Prof. Giorgio Nebbia.

Besides the increase in the number of air pollutants included in the matrices, the new project comprises, as new elements, a significant enlargement of the NAM, a partial revision of the methodology used to calculate air emission accounts, the evaluation of a possible alternative methodology for air emission accounts themselves and data on resources' intake revised according to the European guidelines on Material Flows Accounting (MFA).

In addition, for the economic module, revised 1990 data consistent with the methodology applied for the years 1991 and 1992 are provided.

Paragraph 2 presents the aggregated NAMEA framework, Paragraph 3 provides an overview of the various activities carried out in the context of the second Italian NAMEA project while §§ 4 and 5 describe in detail individual components of the work itself, specifically: Paragraph 4 provides the description of sources, estimation methods and problems encountered in the actual construction of the matrices and Paragraph 5 is devoted to the discussion of the possibility to use the EPIS PRODCOM module as an alternative method to build air emission accounts.

The attached tables include economic as well as environmental data broken down conforming – to the extent possible – to the European standards set in the NAMEA 2000 manual.

2 FULL NAMEA FRAMEWORK

The conceptual framework underlying the Italian NAMEA is the Dutch NAMEA, i.e. the matrix presentation of national accounts – the NAM – described in the 1993 UN SNA and in the ESA95, extended to environmental flows.

The Overview Table shows the flows recorded in each significant cell of the NAMEA.

The NAM offers a synthetic view on the main macro-economic variables and on their inter-relations. Rows record receipts by origins and columns present payments by destination. Each row/column pair contains the information of a T-account and therefore the row total is equal to the corresponding column total.

The Italian NAM reproduces almost completely the one described in the UN SNA and ESA manuals.

The first row/column pair presents the “Goods and Services account”. The row shows the uses of goods and services measured in purchasers' prices. The column presents the supply of goods and services, with the distinction between domestic industry products and imports. It also records trade and transport margins charged on products and indirect taxes minus subsidies on products. Starting from the “Production” account, we can easily follow the circuit of income. Industries produce the output (cell 2,1) by using intermediate goods (cell 1,2) and primary factors (cell 3,2). Through the “Generation of Primary Income” account the institutional units receive the compensation for the services provided by the primary factors, the generated income particularly showing the part paid by industries to resident units. The “Distribution of Income” account shows the other entries and outlays recorded by institutional sectors (cells 5,4 5,5 5,8 8,5) during the primary and secondary distribution of income. The result is the disposable income (cell 6,5). The next two accounts describe the final uses in which available resources are spent: the “Use of income” account records final expenditure (cells 1,6 b,6) and the “Capital” account presents gross capital formation (1,7). In both cases, disposable income turns into a request of goods and services on the market and therefore in entries for industries which can compensate their costs. Finally, in order to invest, resident sectors borrow money from the Rest of the world or, on the contrary, lend money to Rest of the world (cells c,7 c,8). This leads to the balancing item net borrowing or net lending from or to the Rest of the world.

The framework respects as far as possible the rules of the matrix presentations, i.e. the recording of data through balanced column/row pairs. Nevertheless, the lack of properly detailed data has compelled us to introduce four isolated rows whose total is zero:

- row *a* records the “transfers of products”. This is necessary in order to make the “Goods and Services” totals match. On the supply front, in fact, output is analysed according to the industries which produce it, whereas on the demand front it is analysed according to the industries which sell it on the market.
- row *b* presents the “purchases abroad by residents less purchases in domestic market by non resident”. This row allows us to proceed from domestic to national final consumption (which is equal to the sum of cells 1,6 b,6);
- row *c* points out net borrowing or net lending from or to the Rest of the world.

With respect to the UN SNA and ESA frameworks, the Italian NAMEA includes also the “Net Indirect Taxes” account and the “Households’ Consumption” accounts. The “Net indirect Taxes” account records the amount of net indirect taxes charged on goods and services both domestically produced and imported. The row presents taxes by industries (as a proxy of goods and services groups) and the column by receiving institution (the Government and the Rest of the World). The introduction of the Households’ consumption account allows to meet one of the

of the main purposes of the NAMEA that is to show which Households' consumption activities are associated to air emission.

In a complete NAM all the accounts are broken down according to the criteria and nomenclatures followed by national accounts. For the NAMEA we have broken down only the accounts directly linked to environmental data. The "Goods and Services" account as well as the "Production account" are broken down by industries (according to the NACE.rev.1 classification), while the Households' consumption account is broken down by purpose (according to selected items of the COICOP classification, see Paragraph 4.1). This allows to know the amount of Households' expenditure for transport and heating i.e. for the products which are considered responsible for the emissions attributed to household consumption activities: fuels for heating and transport.

The NAM is directly linked to environmental accounts represented in row and column 10. The row account indicates the amount of resources directly taken from nature by the industries indicated in the first column; thus, by reading the "Goods and Services" account by column we can point out all the resources actually available in the economic system. The "Emission" column presents the air pollutants associated to production and to households' consumption activities.

Overview table										
Economic module										
	1	2	3	4	5	6	7	8	9	
	Goods & Services (NACE groupings)	Production (NACE groupings)	Generation of primary income	Net Indirect Taxes	Distribution of income	Use of income	Households' consumption (purposes)	Capital	Rest of the world	Total
Goods & Services	Trade and transport margins	Intermediate consumption				Final domestic expenditure	6.1	Gross capital formation	Exports (FOB prices)	Uses (market prices)
<i>Transfer of products</i>	Transfer of products									
<i>Purchases abroad by residents less purchases in domestic market by non residents</i>						Purchases abroad by residents less purchases in domestic market by non residents (+)			Purchases abroad by residents less purchases in domestic market by non residents (-)	
Production	Output (basic prices)									Output (basic prices)
Generation of primary income		GROSS VALUE ADDED (basic prices)							Compensation of employees	
Net Indirect Taxes	Net indirect taxes on products and imports, VAT included									
Distribution of income			GROSS GENERATED INCOME	Indirect taxes on products and imports, VAT included	Property income and current transfers				Property income and current transfers	
Use of income					GROSS DISPOSABLE INCOME	Adjustment for the change in net equity of households on pension funds				
Households' consumption							Final domestic expenditure of Households by purpose			Final expenditure of Households by purpose
Capital						GROSS SAVING		Capital transfers	Capital transfers	
Rest of the world	Imports (CIF prices)		Compensation of employees	Indirect taxes on production and imports VAT included	Property income and current transfers			Capital transfers		
<i>Borrowing from / Lending to the Rest of the World</i>								Borrowing from (-) Lending to (+) the Rest of the World	BORROWING (+) LENDING (-) OF THE R.O.W	
Total	Resources (market prices)	Output (basic prices)								
Environmental module										
Material inputs from nature (kind of input)	10	Intake of materials from nature								
Emissions (pollutants)	10									

3 OVERVIEW OF THE WORK

The aim of this paragraph is to provide a general outlook of the activities implemented for building the Italian NAMEAs.

The flow chart of Figure 1 shows that the work is split into four main groups of activities:

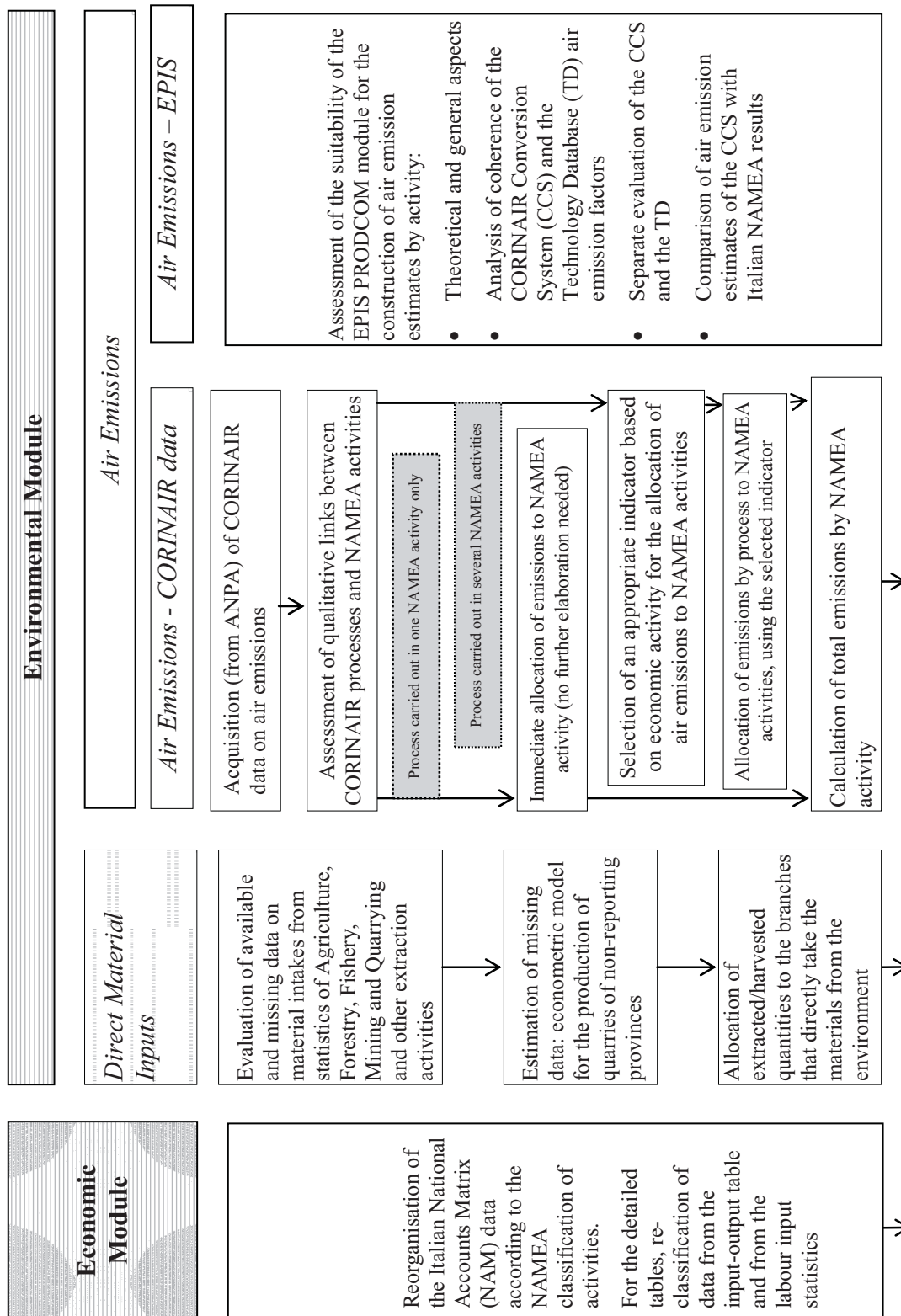
1. construction of the economic module according to the requirements of the NAM;
2. calculation of direct material inputs by economic activities;
3. construction of air emission accounts using CORINAIR data;
4. evaluation of the possibility of building air emission accounts using as a tool the EPIS - PRODCOM module.

As regards the relationship **among the groups**, provided that the theoretical consistency with the NAMEA framework is met at all stages of the work, the groups are substantially independent as concerns the practical data production processes. The activities can therefore proceed all at the same time, in parallel streams, as illustrated by Figure 1, until when (with the exception of group number 4) they are eventually integrated in the final NAMEA tables.

As regards the specific activities **within the groups**, they follow the main sequence illustrated in Figure 1.

Methodological details on the individual steps are described in the following Paragraphs: §§ 4.1 and 4.2 contain a description of the elements that led to produce actual numbers in the matrices, i.e. the economic module (§ 4.1) and, within the environmental module, the part on “direct material inputs” (§ 4.2.2) and the part on air emissions based on CORINAIR data (§ 4.2.1); Paragraph 5 deals with the remaining element of the environmental module, i.e. the “EPIS” component, that consists in the evaluation of a possible alternative method to the one used up to now for air emission accounts.

Figure 1 - Groups of activities leading to the Italian NAMEAs



4 METHODOLOGY

4.1 Economic module

The economic module is the Italian National Accounts Matrix (NAM) adapted to the requirements of the NAMEA framework.

According to the NAMEA requirements, output and value added are valued at basic prices, whereas final demand is valued at purchaser prices. The “Goods and services” account and the “Production” account have been broken down into eight main macro-industries which are relevant in order to single out the effects of highly pollutant economic activities on environment. The Households consumption account is broken down by purpose with the aim of isolating the amount of households’ expenditure that corresponds to the generation of air emissions, specifically: households’ consumption for “transport” purposes corresponds to expenditure on “operation of personal transport equipment” (COICOP item 07.2); households’ consumption for “heating” purposes corresponds to expenditure on “electricity, gas and other fuels” (COICOP item 04.5). Finally, households’ consumption for “other” purposes corresponds to expenditure on items not included in the transport and heating categories whereas the emissions included in the category “other” are generated by gardening, paint application and solvent use (other than paint application)²³⁸.

The other accounts are not broken down.

The main data sources used to compile the NAM are the Input-Output Tables and the Institutional sectors economic accounts. The Financial accounts have not been yet estimated for the years 1991 and 1992 according to ESA95 definitions and nomenclatures. This is the reason why we do not have a complete NAM which should include a Financial account as well. As far as Input Output Tables are concerned, only départ usine and market price tables are available. For this reason we had to estimate basic price Input-Output Table for 1990 1992 and to build an “ad hoc” Input-Output Table for 1991.

Changes from the first Italian 1990 NAMEA

With respect to the first 1990 Italian NAMEA, the economic module shows the following main changes:

- the number of accounts has considerably increased; it is now possible to point out clearly each step of the economic process from the production to savings;
- the evaluation of some monetary aggregates has changed. Particularly, the output is valued at basic prices, intermediate consumption at market prices and imports at CIF prices. As a consequence the “Net indirect taxes” account records net indirect taxes (VAT included) on products and imports whereas in the first NAMEA the account recorded net indirect taxes (VAT included) on production;
- in accordance with the last Eurostat requirements²³⁹ output and intermediate consumption do not include the other social security benefits in kind (D.6312 according to ESA95), which were part of General Government’s output and intermediate consumption in the first 1990 Italian NAMEA. As a consequence, the output and the intermediate consumption of the Health and social work industry (N85 according to the NACE Rev. 1) decreases of an amount equal to the other social security benefits in kind.

²³⁸ No statistically appreciable direct intake of resources from households takes place. Therefore, the classification of final consumption by purpose is relevant here only in relation to air emissions.

²³⁹ See EU regulation 1500/2000 of 10-07-00.

4.2 Environmental module

The environmental module of the Italian NAMEAs covers air emission accounts and the intake of resources from nature.

The construction of air emission accounts is obtained by linking CORINAIR data to economic activities and household consumption on the basis of a methodology very similar to that applied to the first 1990 Italian NAMEA: details of the method and differences from the first Italian 1990 NAMEA are described in § 4.2.1.

The direct intake of material resources by economic activity was calculated consistently with the European guidelines on MFA, as illustrated in Paragraph 4.2.2.

4.2.1 Air emission accounts - allocation of process-based CORINAIR data to economic activities

4.2.1.1 Outline of the methodology

The Italian NAMEAs cover the following eight air pollutants: CH₄, CO, CO₂, N₂O, NH₃, NMVOC, NO_x, SO_x.

As regards *internationally agreed upon aspects*, the air emission accounts are consistent with the guidelines laid out in the Eurostat NAMEA 2000 manual²⁴⁰, specifically:

- emissions are classified according to the NAMEA 2000 industry classification based on NACE rev.1 and on the classification of household consumption²⁴¹ (see Annex 1 in Eurostat, 2000);
- emissions are always attributed to the activity that directly produces them;
- emissions covered are those stemming from the national economic activities and those from non-economic agents are excluded (see § 4.2.1.2 for details);
- since the Italian NAM adopts homogeneous industries, emissions from secondary activities are allocated to the relevant industry according to the nature of the activity and emissions from ancillary activities are allocated to the industry where they are carried out; the exception to this general rule is described in § 4.2.1.3.

As far as *national specific aspects* are concerned, the methodology to build air emission accounts is largely based on the one adopted for the first Italian NAMEA pilot project, completed in 1999 with reference year 1990. The method, that uses the CORINAIR air emission data as input, comprises two main stages: the first one investigates the qualitative link between each CORINAIR process and NAMEA activities and the second one allocates the emissions of each CORINAIR process to the related NAMEA activities either directly (for processes linked to one activity only) or through specific indicators (for processes linked to more than one activity). In the methodology behind the 1991, 1992 and revised 1990 NAMEAs, the following main changes to the previous method apply:

- the CORINAIR data are classified according to SNAP97 instead of SNAP94: for the new processes of SNAP97 the process-activity link was investigated;

²⁴⁰ See Eurostat (2000).

²⁴¹ In the Italian NAMEA the following NAMEA economic activities are grouped together while they are split as reported in brackets in the Eurostat NAMEA classification: 11-12 (11, 12); 15-16 (15, 16); 27 (27.1-3, 27.4-5) 40 (40.1, 40.2, 40.3), 60.2-60.3 (60.2, 60.3), 61 (61.1, 61.2). Households' consumption by purpose is coded as follows: transport = 101, heating = 102, other = 103. See § 7 for further details.

- the availability of emission estimates for processes (other than the new SNAP97 ones) that were not included in the Italian CORINAIR inventory before, implied the need to study additional process-activity links;
- new information available both on the I/O Table side and on the CORINAIR data themselves suggested to revise the existing qualitative process-activity links (based on SNAP94 processes and used for the construction of the first Italian 1990 NAMEA) and to make some changes;
- some of the methods devised in the first pilot project for the quantitative allocation of emissions to the related NAMEA activities were revised as a consequence of the change in the indicators used in the method (for example changes in the Istat data on energy use by economic activity), or due to the availability of new indicators;
- the changes introduced in the qualitative links – see above – affected the quantitative stage as well, particularly with regard to the set of CORINAIR processes to which a specific allocation method was applied.

More details on the differences from the first NAMEA project are given below.

As in the first 1990 NAMEA the *consistency between CORINAIR transport emission* related to the “Italian territory” and the *NAMEA framework* based on “resident units” is met partly by construction and partly by introducing some assumptions²⁴²:

Road transport

1. CORINAIR road transport emissions = road transport emissions on the Italian territory by resident units (1a) + road transport emissions on the Italian territory by non resident units (1b);
2. NAMEA road transport emissions = road transport emissions on the Italian territory by resident units (2a) + road transport emissions by Italians outside the Italian territory (2b);

since $1a = 2a$, and we can assume that $1b = 2b$, 1 and 2 can be regarded as being largely consistent.

Maritime transport

3. CORINAIR maritime transport emissions = transport emissions on the Italian territory by resident ships (3a) + transport emissions on the Italian territory by non resident ships (3b);
4. NAMEA maritime transport emission = transport emissions on the Italian territory by resident ships (4a) + transport emissions by resident ships abroad (4b);

since $3a = 4a$, and we can assume that $3b = 4b$, 3 and 4 can be regarded as being largely consistent.

Air transport

5. CORINAIR air transport emissions = air transport emissions on the Italian territory from national flights (5a) + air transport emissions from all international flights leaving the country (5b),
where:

²⁴² The possibility to use national accounts data on sea and air bunkering to estimate additional emissions will be taken into account for future NAMEA exercises.

5b = air transport emissions from international flights leaving the country and run by resident companies (5b.1) + air transport emissions from international flights leaving the country and run by non resident companies (5b.2);

6. NAMEA air transport emission = air transport emissions on the Italian territory by resident air companies (6a) + air transport emissions outside the Italian territory by resident air companies (6b),

where:

6a = air transport emissions on the Italian territory from national flights run by resident companies (6a.1) + air transport emissions on the Italian territory from international flights leaving the country and run by resident companies (6a.2) + air transport emissions on the Italian territory from international flights coming from abroad and run by resident companies (6a.3)

and

6b = air transport emissions outside the Italian territory from international flights leaving the country and run by resident companies (6b.1) + air transport emissions outside the Italian territory from international flights coming from abroad and run by resident companies (6b.2);

since $5a = 6a.1$ and $5b.1 = 6a.2 + 6b.1$ and since we can assume that $5b.2 = 6a.3 + 6b.2$, i.e. that air transport emissions from international flights leaving the country and run by non resident companies (5b.2) is equal to air transport emissions from international flights coming from abroad and run by resident companies ($6a.3 + 6b.2$), 5 and 6 can be regarded as being largely consistent.

All principles, methods and data described in this paragraph are translated into *tables*, *queries* or *modules* of an ACCESS database that – by means of a single *macro* – allows the practical calculation of air emissions by NAMEA activity.

4.2.1.2 Features of the CORINAIR data used as input for the NAMEA

The Italian CORINAIR inventory classified according to SNAP97 provides the input data to build the air emission accounts.

As in the case of the first Italian 1990 NAMEA, some CORINAIR processes are not relevant for the NAMEA.

They are first, as stated above, emissions from non-economic agents and also processes related to the absorption of emissions; in terms of the SNAP97 classification, all processes belonging to the source category “Other sources and sinks” – code 11 – are excluded with the exception of processes classified in SNAP97 source sub-categories “Managed broadleaf forests” and “Managed coniferous forests” – respectively codes 1111 and 1112 – since these processes relate to economically used forests²⁴³.

In addition, the emissions of the following three types of processes are not included in the NAMEA:

1. processes not taking place in Italy;
2. processes emitting air pollutants other than the eight included in the Italian NAMEAs;
3. processes for which emission estimates are not available for Italy.

²⁴³ The SNAP97 processes 111117 and 111216 belonging to the sub-categories 1111 e 1112 are not included in the Italian NAMEAs, because the related emission estimates are not available for Italy. SNAP97 codes 1111 and 1112 were formerly SNAP94 codes 1007 and 1008 and thus included in the first Italian 1990 NAMEA as well.

As far as the data breakdown is concerned, CORINAIR data at the 4th SNAP97 digit (source sub-categories) can be used for the NAMEA when all the SNAP97 processes at the 6th digit included in the Italian NAMEA and belonging to the same source sub-category, are linked to the same NAMEA activities; data at the 6th SNAP97 digit are needed instead when at least two processes included in the Italian NAMEA and belonging to a same source sub-category are not linked to the same NAMEA activities.

Changes from the first Italian 1990 NAMEA

The input data differ with respect to the classification and the data breakdown.

As regards the classification, all data are now classified according to SNAP97 whereas SNAP94 was used in the first project. The implications are twofold. First, the following SNAP94 processes have a different code: 091004 (now 090401, 090402 and 090403), 1007 (now 1111) and 1008 (now 1112). Second, emissions due to land use change, coded as 101201, 101202, 101203, 101303 101402 and 101702 in SNAP94, are part of category 11 in SNAP97 and therefore excluded from the NAMEA²⁴⁴.

Moreover, the revision of CORINAIR data by ANPA, due both to the application of new international guidelines on emission inventories and to improvements in the national methodologies caused two main changes. The first one concerns the list of SNAP processes for which emissions are available in the Italian inventory, specifically: on the one hand the following processes, not included in the CORINAIR database used for the first Italian 1990 NAMEA are covered in the 1991, 1992 and revised 1990 NAMEAs: 020304, 040304, 040527, 060312, 060313, 060314; on the other hand, the following processes, included in the CORINAIR database used for the first Italian 1990 NAMEA are not covered any longer in the input data: 010502, 010504, 040522, 040524, 060311. The second change concerns the pollutants for which the estimates of a given process are available; also in this case there are examples of processes that in the first 1990 Italian NAMEA emitted more pollutants than in the current estimates and examples of processes that in the first 1990 Italian NAMEA emitted less pollutants than in the current estimates.

4.2.1.3 Qualitative links between SNAP97 processes and NAMEA activities

The activities responsible for carrying out each SNAP process were identified through cooperation with the Italian CORINAIR experts.

They coincide with those of the first Italian NAMEA pilot project in all but a few cases specified below.

Most of the changes relate to the treatment of the production of electricity for own consumption. In the Italian 1992 I/O Table electricity produced as ancillary activity is allocated to NACE 40 as well as electricity produced as secondary activity. Hence, all emissions from electricity produced as ancillary activity are allocated to NACE 40 accordingly. In the first Italian 1990 NAMEA the air emissions were allocated to the principal activity on the basis of the assumption that the production of electricity as an ancillary activity was treated in a way similar to all other ancillary activities, i.e. not separated from the principal activity. The change affects SNAP processes 010301, 010302, 010303, 010304, 010401, 010402, 010403, 010404.

²⁴⁴ All processes with codes from 10.11 to 10.19 in SNAP94 were moved to the SNAP97 category 11; the processes listed in the text are the ones affected by this shift among those included in the first 1990 Italian NAMEA.

Another change concerns SNAP processes 090202, 090205, for which more detailed information is now available on the industrial establishments carrying out the incineration of - respectively - industrial wastes and sludges from waste water treatment.

4.2.1.4 Quantitative allocation of process-based emissions to NAMEA activities

4.2.1.4.1 Overview

Emissions from all processes linked to one activity only are directly allocated to the related NAMEA activity without further calculation. For all other processes, the emissions are split between the corresponding activities on the basis of some specific methods; the following paragraphs provide a description of each allocation method, specifying the list of processes for which it applies in the Italian NAMEAs.

In some cases activity-related CORINAIR data allow to split the emissions by NAMEA activities (see § 4.2.1.4.2 below). In all other cases the indicator “use of energy products by activity” is applied in order to split the emissions (see § 4.2.1.4.3 below).

The following table lists all SNAP97 processes, among those included in the 1991, 1992 and revised 1990 Italian NAMEAs, with multiple NACE associations. In order to give a general overview of the methods used to distribute the emissions, the 4th column specifies the method applied to each process, namely method “A” for processes whose emissions were distributed on the basis of CORINAIR activity-related data and method “E” for processes whose emissions were distributed on the basis of energy use data by activity.

Table 1 - Overview of methods used to distribute the emissions of SNAP97 processes with multiple NACE associations

TYPE OF PROCESS	SNAP97 code	Corresponding NAMEA activity	Method (*)
Coke oven furnaces	010406	23 for area emissions; 27 for point source emissions	A
Combustion in commercial and institutional plants	0201	10-95	E
Combustion plants in agriculture, forestry and aquaculture	0203	01, 02, 05	E
Lime (combustion processes)	030312	26.2-26.8 for area emissions; 27 for point source emissions	A
Coke oven (door leakage and extinction)	040201	23 for area emissions; 27 for point source emissions	A
Other industrial paint application	060108	28, 29	A
Application of glues and adhesives	060405	19, 20, 35, 36, 50-52	A
Passenger cars	0701	01-95, 101	E
Light duty vehicles < 3.5 t	0702	01-95, 101	E
Heavy duty vehicles > 3.5 t and buses	0703	01-95, 101	E
Mopeds and Motorcycles <50 cm ³	0704	01-95, 101	E
Mopeds >50 cm ³	0705	01-95, 101	E
Gasoline evaporation from vehicles	0706	01-95, 101	E
Industry (off-road transport)	0808	10-37, 45	E
Incineration of industrial wastes (except flaring)	090202	1/3 of emissions to NACE 24 and 2/3 to NACE 90	A
Incineration of sludges from waste water treatment	090205	1/3 of emissions to NACE 24 and 2/3 to NACE 90	A
Waste water treatment in industry	091001	15-16, 17, 21	A

(*) A: process whose emissions were distributed on the basis of CORINAIR activity-related data.

E: process whose emissions were distributed on the basis of energy use data by activity.

In many cases the methods used for distributing the emissions in the first Italian 1990 NAMEA apply here as well, even though they may be grouped differently for presentation purposes. However, as explained below, differences exist in relation both to the processes for which a specific method is used and to the details of the method itself.

4.2.4.4.2 Emissions distributed on the basis of CORINAIR activity-related data

The method based on CORINAIR activity-related data includes two cases:

- the use of CORINAIR emission data broken down between point source and area source – see “Point source and area source data” below;
- the use of background data (different from point source) applied to the calculation of CORINAIR emissions that allow direct identification of economic activities originating the emissions – see “Other economic activity-related data” below.

Point source and area source data

For some CORINAIR processes, point source emission data, i.e. data collected at specific establishments, are available; sometimes all the emissions of a process are estimated as point sources and in other cases there is another component estimated as area source. In this case the CORINAIR experts’ direct knowledge of the activity of the establishment allows to identify the share of each NAMEA economic activity responsible for producing the emissions.

In the 1991, 1992 and revised 1990 NAMEAs, this method is used for processes: 010406 “Coke oven furnaces”, 030312 “Lime (combustion processes)” and 040201 “Coke oven (door leakage and extinction)”. The emissions of these processes are partly estimated through point source data and partly through area sources. For processes 010406 and 040201 the establishments responsible for the point source emissions all belong to NAMEA activity 27 while the emissions estimated through area sources are attributed to NAMEA activity 23. For process 030312 the establishments responsible for the point source emissions all belong to NAMEA activity 27 while the emissions estimated through area sources are attributed to NAMEA activity 26.2-26.8.

Other economic activity-related CORINAIR data

- i. SNAP97 process 060108.
The process 060108 “Other industrial paint application” emits NMVOC and CO₂ and takes place in NACE activities 28 and 29. Detailed background data based on production and on the percentage content of solvent per unit of production are available as inputs of the 1999 CORINAIR estimates and show that 21% of emissions come from NACE 28 and 79% from NACE 29. The same percentages are used to split the 1990, 1991 and 1992 emissions.
- ii. SNAP97 process 060405.
The Italian CORINAIR experts estimate that 90% of the emissions of process 060405 “Application of glues and adhesives” come from the shoes industry (manufacture and repair) and that the remaining 10% of emissions come from the wood industry. Emissions were first divided, accordingly, in two groups accounting - respectively - for the 90% and 10% of the total and then, within the two groups, further allocated to specifically identified NACE divisions (19 and 52 for shoes and 20, 35 and 36 for wood) on the basis of employment data. The source of data on employment is the 1991 census on industry and services – local unit data.

iii. SNAP97 processes 090202 and 090205.

The Italian CORINAIR experts estimate that the 2/3 of emissions coming from incineration processes classified as 090202 “Incineration of industrial wastes (except flaring)” and 090205 “Incineration of sludges from waste water treatment” are due to NACE 90 and that the remaining 1/3 belong to NACE 24 enterprises²⁴⁵.

iv. SNAP97 process 091001.

As in the first Italian 1990 NAMEA, the methane emissions of process 091001 “Waste water treatment in industry” are estimated through an ad hoc study that includes only the economic activities “Manufacture of food products and beverages” (NACE 15), “Manufacture of textiles and textile products (not including wearing apparel)” (NACE 17) and “Manufacture of pulp, paper and paper products” (NACE 21). The total methane emissions of process 091001 are calculated in the study as a sum of the emissions from the three economic activities, and therefore, on the basis of the basic data, it is possible to exactly distribute the total methane emissions among the NAMEA activities 15, 17 and 21.

4.2.1.4.3 Emissions distributed on the basis of energy use data by activity

The emissions of processes coded as 0201, 0203, 0701, 0702, 0703, 0704, 0705 and 0706 and 0808, all related to the consumption of energy products, are distributed through the data on energy use by economic activity derived from two Istat energy use Tables: the 1988 energy use Table for the revised 1990 NAMEA and the 1992 energy use Table for the 1991 and 1992 NAMEAs. These Tables were produced for the compilation of the energy sector of the I/O Tables (respectively the 1988 and the 1992 ones) and differ both in the structure and in the methodology applied to build them. As concerns the structure:

- the 1988 energy use Table provides data on the use of 25 energy products broken down by 92 economic activities classified according to ATECO81 (the Italian version of NACE 70), and also broken down by four functions or types of use – transport, heating, other energy use, non-energy use – and by origin of supply²⁴⁶;
- the 1992 energy use Table provides data on the use 29 energy products used by 101 economic activities classified according to ATECO91 (the Italian version of NACE Rev. 1)²⁴⁷.

Among the various methodological differences behind the two Tables, the most relevant ones in the NAMEA context are the following two:

- i. different components of “transport” are included in the two Tables – see the following sub-paragraph;
- ii. in the 1992 energy use Table, due to ESA95 rules, all values of energy uses for NACE 95 “private households with employed persons” are null whereas positive values exist in the 1988 Table for some economic activities; to make the revised 1990 NAMEA figures

²⁴⁵ Other NACE divisions such as 15, 17, 19, 20, 23, 25 and 26 are likely to incinerate their waste at least occasionally but they were not included among those responsible for the emissions due to the lack of specific indicators.

²⁴⁶ The 1988 energy use Table was also used for the first 1990 Italian NAMEA, see Battellini et al. (1999).

²⁴⁷ Although the total use by product was estimated as a sum of four types of uses, see Giansante (2000), the functional breakdown is not available in the final estimates. In addition to the data by economic activity, Istat data on the consumption of the principal energy products by households are also available; in this case the data are already split by the main functions: transport and heating.

consistent with those of the 1991 and 1992 matrices the consumption of energy products of NACE 95 in the 1988 Table is entirely attributed to households' consumption.

The correspondence between SNAP97 processes (0201, 0203, 0701, 0702, 0703, 0704, 0705, 0706 and 0808) and functions of the Istat energy use Tables

As stated above, unlike the data of the 1998 Istat energy use Table, used for the first Italian 1990 NAMEA project and for the revised 1990 NAMEA, those at hand for the 1991 and 1992 NAMEAs, derived from the 1992 Istat energy use Table, lack the breakdown by function.

Since the split by function plays indeed an important role in the allocation of emissions in the NAMEA²⁴⁸, alternative solutions were sought in order to compensate for the lack of data by function.

The first option was to work with the total use for each product regardless of the function breakdown; to evaluate the feasibility of this option, the "similarity" between the distribution by function and the total one was analysed for each energy product of the 1988 Istat energy use Table. In addition, the 1990 NAMEA emissions were estimated by using the total use instead of the specific uses. Both exercises confirmed the importance of the distinction by function and therefore the option was rejected.

The solution adopted was to apply the split by function of each branch of the 1988 data to the total use by branch of the 1992 data.

Hence it is possible to specify a link between SNAP97 processes and specific functions of the Istat energy use Tables as described below.

A. Emissions from heating processes.

In the CORINAIR, emissions from heating are included in the SNAP97 category 02 only. Within this group, the processes to be distributed are 0201 and 0203. The emissions related to these processes are allocated to the corresponding activities, with weights given by the formulas (2)-(4) below on the basis of data of the Istat energy use Tables for the function "heating".

B. Emissions from transport processes.

In the CORINAIR, emissions from transport are included in the SNAP97 categories 07 "road transport" and 08 "other mobile sources and machinery" here referred to as "off-road transport"; as regards category 08, all processes but 0808 "Industry" (see Table 1) are linked to one activity only and their emissions are then directly allocated to that activity. Hence, the problem in this case is twofold: to find a suitable indicator to split the off-road industry emissions of process 0808 and to find a suitable indicator to split the emissions of road transport processes (category 07).

As regards process 0808, no suitable CORINAIR basic data exist since the estimates are based on the number of vehicles combined with the consumption of gas oil with no detailed information on the breakdown by industry. The data needed to split the emissions are derived from BEN (National Energy Balance) that provides data on gas oil consumption by industrial

²⁴⁸ In the first Italian 1990 NAMEA project the functions of the 1988 Istat energy use Table were linked to groups of CORINAIR processes: the function "heating" of the Table with the SNAP94 processes related to heating (category 02), the function "transport" of the Table with SNAP94 processes related to road transport (category 07) and some processes related to off-road transport (category 08), the function "other energy use" of the Table with the SNAP94 processes related to combustion for purposes other than heating and transport (categories 01 and 03).

economic activity; although the BEN classification is different from NACE, a link between BEN and NACE is available.

As regards the road transport processes (category 07), the function “transport” of the Istat energy use Tables could not be used as such since it covers consumption for road as well as off-road transport purposes, with the exception of those specified below:

- in the 1988 Istat energy use Table, the function “transport” does not include consumption for off-road military transport (classified as SNAP97 process 0801 “Military”), the international sea and air bunkering (classified respectively as SNAP97 processes 080404 “International sea traffic - international bunkers” and 080504 “International cruise traffic - >1000 m”), agriculture, forestry and industry off-road transport (classified respectively as SNAP97 processes 0806 “Agriculture”, 0807 “Forestry” and 0808 “Industry”) and “Household and gardening” (classified as SNAP97 process 0809);
- in the 1992 Istat energy use Table, the function “transport” does not include consumption for off-road military transport (classified as SNAP97 process 0801 “Military”), the international sea and air bunkering (classified respectively as SNAP97 processes 080404 “International sea traffic - international bunkers” and 080504 “International cruise traffic - >1000 m”) and “Household and gardening” (classified as SNAP97 0809).

In order to derive data on energy use specific for “road transport”, the fuel consumed for off-road purposes is subtracted from the function “transport” of the Istat energy use Tables. Since the off-road purposes included in the function “transport” of the 1988 and 1992 Istat energy use Tables differ as specified above, distinct components of off-road consumption are subtracted from the data for the use “transport” in the two cases:

- (1) for the 1988 Istat energy use Table the data subtracted from the use “transport” include the quantity of fuel used by CORINAIR as background data to estimate the emissions of processes 0802, 0803, 080402, 080403 and 0805 (for the economic activities corresponding to the processes) as well as the data on the consumption of jet fuel and kerosene since these two fuels are not used for road transport purposes;
- (2) for the 1992 Istat energy use Table the data subtracted from the use “transport” include the quantity of fuel used by CORINAIR as background data to estimate the emissions of processes 0802, 0803, 080402, 080403, 0805, 0806, 0807 (the economic activities are identified as those corresponding to the processes), the data on the consumption of jet fuel and kerosene and the consumption of gas oil related to the emissions of process 0808 (estimated with data derived from BEN as described above).

Hence, the emissions related to processes 07 are allocated to the corresponding activities, with weights given by the formulas (2)-(4) below, on the basis of data of the “Istat energy use Tables” for the function “road transport” created as described above.

The correspondence between Istat and CORINAIR energy products

As in the first Italian 1990 NAMEA project, the information on the specific energy products consumed by the activities is used in connection with that on the process-specific mix of energy products (provided by Italian CORINAIR experts). The correspondence between the 1988 Istat energy products and the energy products used for the previous 1990 CORINAIR estimates - already determined for the first Italian 1990 NAMEA - is the starting point of the new project²⁴⁹.

In order to find the new correspondence between the 1992 Istat energy products and the energy products used for the revised CORINAIR estimates, it was necessary first to check

²⁴⁹ CORINAIR energy products follow the NAPFUE classification whereas the Istat energy products are consistent with the Eurostat energy product classification.

whether any new products was used for the CORINAIR estimates (and, if so, to find out its relationship with the 1992 Istat energy products); second, to understand the relationship between the 1988 Istat energy products and the 1992 ones. As regards the first point, in addition to the energy products used for the previous 1990 CORINAIR estimates, the revised CORINAIR estimates are also based on “biogas”, corresponding to the 1992 Istat energy product “natural gas”. As regards the correspondence between the 1992 29 Istat energy products and the 1988 25 Istat products, it can be assessed on the basis of the description of Giansante (2000).

By combining all of the information above, the updated correspondence between the new Istat energy products and those used for the 1991, 1992 and revised 1990 CORINAIR estimates is obtained.

The weights based on energy use

The emissions of all processes listed above were allocated to the corresponding activities, with weights given by the formulas below. These weights are calculated identically to weights based on energy use of the first Italian 1990 NAMEA project²⁵⁰, as follows: the CORINAIR data base, for the general process “p”, gives the total emissions EMI(p) as the sum of the emissions of each energy product used in the estimates:

$$(1) \quad EMI(p) = EMI_1(p) + EMI_2(p) + \dots + EMI_j(p) \dots + EMI_n(p)$$

where the generic $EMI_j(p)$ is the quantity of emissions arising from the use of the energy product j and the group of n_p energy products used for estimating the emissions of process p is a subset of the 19 energy products used for the CORINAIR estimates.

For the j -th energy product used in process p (or group of processes), the following weights are calculated:

$$(2) \quad W_j^i(p) = \frac{use_j^i(l)}{\sum_i use_j^i(l)},$$

where:

$i = 1, \dots, h_p$ is the generic element of the subset of h_p out of 54 NAMEA activities in which process p is carried out;

$j = 1, \dots, n_p$ is the generic element of the subset of n_p energy products used to estimate emissions of process p ;

$l = \text{“road transport”}, \text{“heating”}$ indicates the specific function of the energy use, associated to process p (for details on the function associated to each process to be distributed see above).

By construction the following holds:

$$(3) \quad 0 \leq W_j^i(p) \leq 1 \quad .$$

The quantity of emissions from use of energy product j in process p , allocated to the activity i , is given by:

²⁵⁰ This paragraph is a slightly revised version of the description of weights based on energy use provided in the report of the first Italian 1990 NAMEA project.

$$(4) \quad EMI_j^i(p) = W_j^i(p) * EMI_j(p)$$

i.e., by the product of the weight $W_j^i(p)$ calculated above and the CORINAIR emission quantity for the product j used in process p .

Changes from the first Italian 1990 NAMEA

In many cases the methods used for the 1991 and 1992 NAMEAs and for the revised 1990 NAMEA are the same used for distributing the emissions in the first Italian 1990 NAMEA; however, differences exist in relation sometimes to the processes for which a specific method is used and sometimes to the working of the method itself.

Specifically, changes occur for the following cases:

- the method described as “indicators based on BEN (National Energy Balance)” in the first Italian 1990 NAMEA report is no longer used since the related processes are now linked to one activity only (processes 010401, 010403 and 010404) or no longer included in the NAMEA (process 010402);
- the emissions of processes 010406 and 040201, now distributed on the basis of the point source method (see “Point source and area source data” in § 4.2.1.4.2), were formerly not distributed as the process belonged to those linked to one activity only;
- the emissions of processes 010502, 010504, no longer included in the Italian CORINAIR database (see § 4.2.1.2), were formerly distributed on the basis of data of the Istat energy use Table for the function “other energy use”;
- the emissions of process 030101, now belonging to processes with only one link with economic activities (the whole source sub-category 0301 is linked to one activity only), were previously distributed with the “point source method”;
- the emissions of processes 030102, 030103, 030104, 030105 now linked to one activity only (the whole source sub-category 0301 is linked to one activity only), were formerly distributed on the basis of the data of the Istat energy use Table for the function “other energy use”;
- the emissions of process 040614, now belonging to processes with only one link with economic activities, were previously distributed with the “point source method”;
- the emissions of processes 07, now distributed on the basis of data of the “Istat energy use Table” for the purpose built function “road transport”, were formerly distributed on the basis of data of the “Istat energy use Table” for the function “transport”;
- the emissions related to processes 0802, 0803, 080402, 080403, 080404 and 0805, now linked to one activity only, were formerly distributed on the basis of data of the “Istat energy use Table” for the function “transport”;
- emissions from process 0808, now distributed on the basis of BEN data, were formerly distributed on the basis of the number of employees;
- the emissions from processes 090202, now distributed through “other economic activity-related CORINAIR data”, were formerly linked to one activity only;
- the emissions of process 090205, now distributed through “other economic activity-related CORINAIR data”, were previously distributed with the “point source method”.

4.2.2 *The intake of resources from nature*

This section provides the data on the material inputs from the Italian territory to the economic system in 1990, 1991 and 1992.

The methodology adopted is essentially the same used for similar calculations, carried out for the years 1988²⁵¹ and 1990²⁵². Data for 1990 had been included already in the first Italian 1990 NAMEA; these have been revised implementing some minor changes that were necessary in order to fully respect the definitions and classifications of material flows adopted at the European level²⁵³. The data for 1991 and 1992 have been extracted for the NAMEAs from a larger database, whose ongoing construction at Istat is aimed at the production of regular material flows accounts and time series of aggregate Material Flow indicators, according to the principles of Material Flows Accounting (MFA). The figures from this database have been organised into the resources intake module of the NAMEA by attributing the flows to the branches of activity directly “responsible” for the intake.

For each year we therefore have a “material intake by activity” matrix, of which we report in Table 2, Table 3 and Table 4 only the parts concerning the activities with non-zero data. The activities (in the rows) are those of the NAMEA and the materials (in the columns) are aggregated as recommended by the guidelines issued by Eurostat. As additional information, in the tables, the specific materials taken from nature by the individual activities are reported in the third column.

Referring to the European guidelines, what we account for are (with the exception of endogenous steam) all and only the components of the “Domestic Extraction” aggregate of the Direct Material Input account. The materials extracted or gathered fall into three main material groups:

- *fossil fuels*;
- *minerals*;
- *biomass*.

For each of these groups there is a column heading in the tables. To these we added a fourth column, for the above-mentioned exception: endogenous steam, employed in electricity production, is not part of the Direct Material Input – it is rather a component of the “unused domestic extraction” aggregate – and must therefore be considered separately.

The only noticeable difference with the first Italian 1990 NAMEA, is that the column *fossil fuels* does no longer include wood used as fuel (directly or after transformation into charcoal). In fact all wood has been aggregated into the column containing biotic materials (*biomass*), without distinction (as it was in the 1988 application) between wood used as a fuel and wood used for other purposes.

In one case only, that of “asphalt shale and sand”, the classification of the European guidelines on MFA has not been strictly followed: in that classification asphalt is included in the “*minerals*” group (precisely in the category of construction minerals) while here it is classified as *fossil fuel*, since its main use in Italy consists in distillation for oil production.

As for the changes in the basic data, the only relevant change concerns minerals extracted from quarries. Total quantities extracted in Italy are not reported by any official source since 1986, due to the shift of responsibility for the regulation and control of this kind of activities

²⁵¹ Femia (2000).

²⁵² In particular the methodology adopted for year 1990 is based upon the one adopted for year 1988 with slight differences. Cfr. Battellini et al. (1999).

²⁵³ Eurostat (2001).

from the State to the Regions. As a consequence of these changes the basic data regarding quarry materials are not available or are not continuous over time for some Italian Provinces. The data provided here therefore incorporate (into the *minerals* column of the tables) the results of an improved estimation of the quantity of minerals extracted from quarries; the new estimates are based on the same econometric model used for the applications quoted above (years 1988 and 1990), which has however been extended to the period 1988-1998 and thus adapted to the need of constructing a coherent time-series of these quantities. Consequently, the previous estimates for the years 1988 and 1990²⁵⁴ have been revised too.

The model used assumes that the total quantity of materials extracted depends on buildings construction, public works and direct indicators of quarrying activities.

More precisely by “buildings construction” we mean the total volume of buildings constructed in the year (new buildings and extensions of buildings, both residential and non-residential), expressed in volumes (cubic metres empty for full)²⁵⁵. With the expression “public works” we mean the expenditures sustained by the Public Administrations for infrastructures (completed works) such as roads, airports, etc.²⁵⁶. All these phenomena clearly correlate (being the causes for it) with the intake from nature of the materials concerned. We also used more direct information on the quarrying activities, using indicators such as “number of local units in the relevant activities”; these activities are those falling into the following NACE Rev.1 categories: “quarrying of stone” (14.1), “quarrying of sand and clay” (14.2) and “other mining and quarrying n.e.c.” (14.5)²⁵⁷.

The model used for the estimation is based on the following relationship²⁵⁸:

$$(5) \quad Y = \alpha X_1 + \beta X_2 + \gamma X_3 + e$$

where Y , the dependent variable, represents the quantities of quarry minerals extracted; X_1 , X_2 and X_3 are the independent variables representing respectively the constructed buildings volume, the expenditure for public works and the number of local units carrying out quarrying activities; α , β and γ represent the unknown parameters to be estimated respectively for variables X_1 , X_2 and X_3 and, finally, e is the error or noise.

On the basis of the standard statistical tests the model has been judged to be suitable to represent this phenomenon and the parameters' estimates to be an adequate basis for the extrapolation of the missing data. The estimate of the total quantities of quarry materials has been obtained by multiplying the coefficients, calculated with the regression, with the value of the independent variables, known for the provinces whose data are missing for the dependent variable.

The estimated amounts for each Province have been then added to those already available for other Provinces, used in the model.

²⁵⁴ As Table 1 shows this is the only change for 1990: the quantities of minerals are now estimated to be 358.088.183 tonnes while in the previous estimate they were 366.038.847 tonnes.

²⁵⁵ Istat, Statistiche dell'attività edilizia, years 1988-1998.

²⁵⁶ Istat, Statistiche delle opere pubbliche, years 1988-1998; in the quoted data source data are provided at current prices while for the NAMEA exercise data at constant 1995 prices were calculated.

²⁵⁷ Istat (1991) Census of Industry and Services and (1996) Intermediate Census of Industry and Services.

²⁵⁸ The theoretical model on which we base the equation is a “supply-use” balance model applied to quarry minerals on a provincial basis. It is based on the assumption that the materials market is balanced at a provincial level, and that prices and quantities are determined simultaneously. The equation that we estimate here, is the reduced form, for quantities, obtainable from the structural form of such a model.

Table 2 - Material inputs of domestic origin by type of material and activity undertaking removal - Italy, 1990

NACE Rev. 1 Economic Activities by which the materials are extracted/gathered	NAMEA codes of the activities	Description of the specific materials extracted/gathered	Quantity (tonnes)			
			Endogenous steam	Fossil fuels	Minerals	Biomass
Growing of crops, market gardening, horticulture, mixed farming	01	Products of herbaceous cultivation, excluding floricultural cultivation (grains, seed legumes, tuberous, horticultural and industrial plants); fodder (temporary and permanent); ligneous cultivation (vines, olives, citrus fruits, fruit trees and others)	-	-	-	173.872.486
Forestry and logging	02	Forestry products: non-ligneous and ligneous uses in and outside forests	-	-	-	6.297.974 (a)
Fishing, operation of fish hatcheries and fish farms	05	Fish, crustaceans, molluscs	-	-	-	345.075
Mining of coal and lignite, extraction of peat	10	Coal, crude brown coal, peat	-	1.580.068	-	-
Extraction of crude petroleum and natural gas; mining of uranium and thorium ores	11-12	Petrol, crude oil, GPL, methane, bituminous shale and sand	-	17.849.642	-	-
Mining of non-ferrous metal ores	13	Metal ores: antimony, magnesium, manganese, lead and zinc minerals	-	-	178.351	-
Quarrying of stone, sand and clay, chemical and fertiliser minerals, production of salt, other mining and quarrying	14	Halite, pyrite, cement marl, feldspar, barite, aluminium silicates, talc and steatite, fluorite, asbestos, carbon dioxide, bauxite for refractory uses, celestite, potassium salts, mineral sulphur, sea salt, alabaster, slate, sandstone, limestone, schistose limestone, white and coloured marbles, porphyry, quartz and quartzite, travertine, tuff, clay, pumice, pozzolan, sand and gravel, volcanic and siliceous sands, whetstones, etc.	-	-	358.088.183	-
Electricity generation	40	Steam	32.180.589	-	-	-
		TOTAL	32.180.589	19.429.710	358.266.534	180.515.535

(a) Including 2.882.715 tonnes of wood used as fuel.

Table 3 - Material inputs of domestic origin by type of material and activity undertaking removal - Italy, 1991

NACE Rev. 1 Economic Activities by which the materials are extracted/gathered	NAMEA codes of the activities	Description of the specific materials extracted/gathered	Quantity (tonnes)			
			Endogenous steam	Fossil fuels	Minerals	Biomass
Growing of crops, market gardening, horticulture, mixed farming	01	Products of herbaceous cultivation, excluding floricultural cultivation (grains, seed legumes, tuberous, horticultural and industrial plants); fodder (temporary and permanent); ligneous cultivation (vines, olives, citrus fruits, fruit trees and others)	-	-	-	181.460.160
Forestry and logging	02	Forestry products: non-ligneous and ligneous uses in and outside forests	-	-	-	6.570.673 (a)
Fishing, operation of fish hatcheries and fish farms	05	Fish, crustaceans, molluscs	-	-	-	376.448
Mining of coal and lignite, extraction of peat	10	Coal, crude brown coal, peat	-	1.580.581	-	-
Extraction of crude petroleum and natural gas; mining of uranium and thorium ores	11-12	Petrol, crude oil, GPL, methane, bituminous shale and sand	-	17.708.094	-	-
Mining of non-ferrous metal ores	13	Metal ores: antimony, magnesium, manganese, lead and zinc minerals	-	-	134.196	-
Quarrying of stone, sand and clay, chemical and fertiliser minerals, production of salt, other mining and quarrying	14	Halite, pyrite, cement marl, feldspar, barite, aluminium silicates, talc and steatite, fluorite, asbestos, carbon dioxide, bauxite for refractory uses, celestite, potassium salts, mineral sulphur, sea salt, alabaster, slate, sandstone, limestone, schistose limestone, white and coloured marbles, porphyry, quartz and quartzite, travertine, tuff, clay, pumice, pozzolan, sand and gravel, volcanic and siliceous sands, whetstones, etc.	-	-	342.983.978	-
Electricity generation	40	Steam	31.012.223	-	-	-
		TOTAL	31.012.223	19.288.675	343.118.174	188.407.282

(a) Including 3.334.962 tonnes of wood used as fuel.

Table 4 - Material inputs of domestic origin by type of material and activity undertaking removal - Italy, 1992

NACE Rev. 1 Economic Activities by which the materials are extracted/gathered	NAMEA codes of the activities	Description of the specific materials extracted/gathered	Quantity (tonnes)			
			Endogenous steam	Fossil fuels	Minerals	Biomass
Growing of crops, market gardening, horticulture, mixed farming	01	Products of herbaceous cultivation, excluding floricultural cultivation (grains, seed legumes, tuberous, horticultural and industrial plants); fodder (temporary and permanent); ligneous cultivation (vines, olives, citrus fruits, fruit trees and others)	-	-	-	180.484.353
Forestry and logging	02	Forestry products: non-ligneous and ligneous uses in and outside forests	-	-	-	7.252.200 (a)
Fishing, operation of fish hatcheries and fish farms	05	Fish, crustaceans, molluscs	-	-	-	363.510
Mining of coal and lignite, extraction of peat	10	Coal, crude brown coal, peat	-	1.244.486	-	-
Extraction of crude petroleum and natural gas; mining of uranium and thorium ores	11-12	Petrol, crude oil, GPL, methane, bituminous shale and sand	-	18.543.724	-	-
Mining of non-ferrous metal ores	13	Metal ores: antimony, magnesium, manganese, lead and zinc minerals	-	-	98.231	-
Quarrying of stone, sand and clay, chemical and fertiliser minerals, production of salt, other mining and quarrying	14	Halite, pyrite, cement marl, feldspar, barite, aluminium silicates, talc and steatite, fluorite, asbestos, carbon dioxide, bauxite for refractory uses, celestite, potassium salts, mineral sulphur, sea salt, alabaster, slate, sandstone, limestone, schistose limestone, white and coloured marbles, porphyry, quartz and quartzite, travertine, tuff, clay, pumice, pozzolan, sand and gravel, volcanic and siliceous sands, whetstones, etc.	-	-	348.999.596	-
Electricity generation	40	Steam	33.178.276	-	-	-
		TOTAL	33.178.276	19.788.210	349.097.827	188.100.062

(a) Including 4.021.954 tonnes of wood used as fuel.

5 THE EPIS PRODCOM MODULE AS A TOOL FOR AIR EMISSION ACCOUNTS

5.1 Potential utility of EPIS and methodological problems in the way its PRODCOM module is being conceived

The ongoing effort for the construction of a European Environmental Pressure Information System (EPIS)²⁵⁹ is an attempt to put into practice the idea that knowledge on the technologies used in the economy should systematically be exploited in order to calculate the pressures on the natural environment generated in the production and use of goods and services. This idea is not new – indeed it is at the basis of most calculations of specific environmental pressures carried out on a regular basis, such as the CORINAIR estimates of air pollutants' emissions. However, EPIS - for the kinds of man-made transformations of matter and energy to be considered and for the material and energy flows involved in each of them – is characterised by a quest for completeness that makes its construction particularly complex. As a matter of fact, EPIS has been conceived as having at its core a database of complete standardised material balances. Unitary input and output factors describing the technologies adopted in Europe are key variables and will be applicable, in principle, to different years and countries, the different situations being characterised by different mixes of technologies adopted and levels and compositions of economic output. This completeness makes of EPIS an ideal tool for the provision of data on environmental pressures by kind of activity, i.e. of data readily comparable to economic aggregates and therefore of particular interest for an ecological economic policy²⁶⁰.

The elementary unit of this database, i.e. the entity for which the material balance is defined, is, in general terms, a “technology”, which we can loosely define as a specific type of human-governed operation of transformation of matter and energy. A complete material balance for all such analytical units would enable to calculate virtually all pressures on the natural environment by applying the unitary factors contained in the database to the corresponding scale indicators (the latter are usually already part of the currently available statistical information). Therefore, completeness (or at least, good coverage) should be achieved not only in the individual material balances, but also in the set of technological transformations of matter/energy included in the list, which should at least comprise the technologies that *directly* produce pressures on the environment.

In the early stages of development of EPIS, the concept of technologies was translated into practice by choosing the “process” as the analytical unit of the database, and reference was made to the SNAP classification of air-polluting processes as a basis for the construction of the complete list of records to be included in it; in order to achieve completeness in this list, the SNAP had to be opportunely supplemented, and this would have allowed, if completed, to have a comprehensive picture not just of air emissions but also of the other material flows, from and to the environment (waste, sludge, ...). Later on, the units have been identified as “products”, and reference is now made, as a basis for the list of units of the EPIS database, mainly to the PRODCOM, which also has to be adequately supplemented, since it only covers products of manufacturing industries. The research activity concerned with the development of the core

²⁵⁹ See, among others, Bombana et al. (1997).

²⁶⁰ For instance, such a tool would enable to forecast the ecological implications (in terms of pressures) of different scenarios, corresponding to different policies, implying a change in the level and composition of output.

database has therefore taken the name of “EPIS PRODCOM module”. One claimed advantage of the organisation of the core EPIS database by products is that it would enable to provide “quick” estimates²⁶¹: figures for the pressures, by NACE or NAMEA activity, would be available very soon once production levels are known, thanks to the fact that no data are required other than the results of the PRODCOM and similar surveys. This claim requires some clarification.

As far as air emissions as such are concerned, it must be first of all pointed out that in the case of Italy there would be no point in looking for estimates alternative to those of existing inventories, such as CORINAIR, since the latter are in fact not only well-established and based on internationally agreed-upon methodologies, but also produced well *before* the results of the PRODCOM survey are made available, i.e. before an essential input of the EPIS method is at hand²⁶². The alternative option provided by the EPIS method rather concerns the possibility of obtaining estimates of air emissions that are broken down *by activity*. The method currently in use at Istat for this breakdown, indeed, starts from the CORINAIR estimates themselves, while under the EPIS method the unitary emission factors given by the PRODCOM module would be used. The main reason for considering an alternative to the existing method is that the CORINAIR inventory itself does not produce the emissions with the breakdown by activity needed for the NAMEA (it provides instead emissions by process), and that the additional information – such as consumption of energy products by activity – which is necessary in order to allocate CORINAIR air emissions to the activities is currently known only with a delay²⁶³ far greater than that of production statistics. It is clear then that the EPIS method might provide the way to have a NAMEA air emission module for recent years in a more reasonable time than starting from “traditional” estimates.

In very general terms, therefore, the potential utility of EPIS for the NAMEA is clear. Indeed, once completed, EPIS would allow to calculate not only air emissions, but virtually all kinds of environmental pressures, in a very detailed way *with reference to “technologies”*, which indeed are its elementary units of analysis. The main problem will then be to establish a correct quali-quantitative connection between these units and NAMEA activities. How easy or difficult it will be to establish a link between “technologies” and NAMEA activities crucially depends on how the core database is organised.

From this point of view the chosen organisation “by product” of the core database of EPIS seems to have a great advantage: the existence of an immediate correspondence between products coded according to the PRODCOM and NACE activities, and therefore with the branches of the NAMEA. The latter are indeed broken down by a NACE-based classification and are defined, in Italy, precisely on the basis of the homogeneity of their outputs. Given this correspondence, if pressure factors were available for all products, a simple method for the estimation of environmental pressures by branch would be available, consisting of two very simple operations: first, the unitary pressure factors would be multiplied by the scale indicators, i.e. by the quantities of the corresponding goods and services that have been produced in a given year; and second, the pressures thus calculated would be summed up according to the NAMEA classification of activities, thus obtaining the pressures by branch. The matching between

²⁶¹ See Puolamaa, M. (2000), p. 3.

²⁶² Production data are also used in the Italian CORINAIR estimation procedure, but they are supplied directly by the organisations representing the firms or taken from their technical reports and from the UN publication “Industrial Commodity Statistics Yearbook”.

²⁶³ At the moment, as far as Italy is concerned, about 8 years. Data on energy products with the desired economic activity breakdown have in fact so far been produced as inputs for the construction of the I/O Table.

homogeneous branches' output and "products", however, is not perfect, and things are more complex than it would seem at first.

In fact, analysing the consequences for the NAMEA of the database organisation in terms of "products", the following considerations emerge²⁶⁴:

1. if unitary pressure factors are applied to production levels, either the pressures caused by households' consumption activities remain out of the picture, or there is the risk of erroneously attributing them to productive activities. Let us consider, as an example, the case of the "car transport" technology keeping in mind the distinction between transport as a business activity on the one hand and households' transport activities on the other. Whatever indicator for the level of this activity is chosen (say for instance Km/person), the following two situations are possible: a) the notion of transport service of national accounting is adopted for the chosen level indicator given by production statistics, so that households' use of private cars is not included in it; in this case, the quantity of emissions attributed to productive activities is correct, but one still has to estimate households' emissions from car transport somehow; b) a looser notion of "transport service" is embodied, instead, in the chosen level indicator, so that households' use of private cars is included in it; in this case the estimated level of emissions due to car transport will include indistinctly the emissions due to both the productive and the final use of cars, and there is still the need to provide correct estimates of emissions separately for the different components of transportation. In practice, it is better to deal with car transport as a technology (a process) which occurs both in production and in consumption, and whose total emissions have to be split between them, by using additional information on the relative levels at which the activity is carried out²⁶⁵. The latter operation is best done using indicators of the level of the process, rather than of the "product" obtained by it – that is exactly what Istat currently does;
2. For the making of products usually several ancillary activities are carried out. According to the SNA/ESA these activities, by definition, do not give an output themselves but only serve the main productive activities of the institutional unit that carry them out. Consequently, in national accounting, the inputs of these activities are accounted for as inputs for the making of finished products of that unit. In a NAMEA, therefore, the pressures generated by ancillary activities have to be considered, coherently, as pressures of the principal or secondary activities for which they are carried out. In terms of an EPIS organised by products, this means that pressure factors attached to the individual products should include the pressures of the ancillary activities carried out specifically for their production. However, it is clearly impossible to define, for the inputs and emissions of the ancillary activities, product-specific factors that can be regarded as technical coefficients.

Considering the result of the ancillary activities "products" in themselves, as it is done in the EPIS database, and hence attributing the emissions they cause to the branches

²⁶⁴ The present paragraph focuses on the conceptual aspects of the matter; by contrast the next paragraphs look at how the PRODCOM module of EPIS is actually developing.

²⁶⁵ More in general, even though many polluting processes take place and are exactly the same both in production and in consumption (i.e. have the same unitary physical inputs and outputs), so that they generate the same pressures, when these activities are undertaken by households, their "useful" results are not products in the sense of national accounting, and do not appear in production statistics since they are outside the production boundary. The pressures directly generated by households can indeed be connected only to the sheer use of some products, differently from the productive sector, where the (intermediate) use of products causing emissions contributes to the production of other products (usually services), to which therefore the emissions can be connected.

specialised in their production, instead of those served by the ancillary activities at issue, would contradict the fundamental criterion of the environmental modules of the NAMEA, according to which the pressures should be attributed to the activities in a way that is fully coherent with the way the activities are defined in the NAM.

Ancillary transport and room heating are very important activities of this kind, as far as air emissions are concerned²⁶⁶: both have well-defined, autonomous material balances, but it is not possible to assess *a priori* “how much” transport and room heating are needed for a given individual product, because this does not depend upon fixed relationships between inputs and outputs of a material transformation process, i.e. is not a result of technology only, but crucially depend upon logistic and organisational arrangements, and therefore greatly vary according to the place and time of production, and not only according to the product.

As a consequence, in a NAMEA derived just by aggregation from an EPIS whose database of pressure factors is organised “by product”, the pressures associated to some branches will be systematically underestimated, since the pressures due to ancillary activities will not be included; the latter will end up to be considered as giving products in themselves and their pressures will be aggregated to those of the branches producing the same things as finished goods or services. Adjustments like the re-distribution of the emissions of some “products” to branches different from those specialised in its production would then be necessary, which is equivalent in practice to adopting processes rather than products as basic units of the database. Therefore, the basic problem of the construction of the environmental module of the NAMEA – the allocation to the activities of the pressures of the “technologies” that are common to many activities – remains to be solved also if the database is organised with products as units of analysis, despite the PRODCOM-NACE correspondence;

3. in the existing classifications of products, to be used in EPIS, identical or similar products are classified as being the same – e.g. are identified by the same 8-digit PRODCOM code – regardless of the technology of production. Products which are *per se* identical, however, can be produced with quite different technologies; the kind of product-specific technologies used can vary sensibly both in space and in time (e.g. production of crops with or without fertilisers; aluminium from primary mineral or scrap...). Therefore, using production figures referred to products irrespective of production technologies, along with product-specific (but technology-unaware) pressure factors, while allowing to capture the effects on the pressures of changes in the mix of products, would not account for the effects of the choice of techniques.

All of these problems suggest that the product is a good analytical unit for the purpose of the NAMEA only when there is a complete correspondence between technological processes and products, i.e. in the cases where a database with processes as analytical units would have the processes identified by their resulting products²⁶⁷. It is not by chance that the problems highlighted at points 1 and 2 above concern activities that are ancillary and/or common to both production and consumption, i.e. the ones for which the process/activities connections are of the “one-to-many” kind: the problem of distributing pressures from “non-activity-specific” processes remains unsolved, since these activities are – all the more – also not product-specific.

²⁶⁶ If one thinks of pressures other than air emissions, other examples come to mind, such as for instance the contribution of ancillary administration activities to the generation of waste.

²⁶⁷ As we will see, this is the case of the industrial products, dealt with in the Technology Database (TD).

The problems pointed out under 2 and 3 gain particular relevance if one thinks of the database of EPIS as one that should be non-country- or site-specific, nor time-specific as much as possible²⁶⁸. Indeed, if its coefficients are fixed, differences between countries and years will explicitly emerge only as a result of different compositions of production/consumption (expressed by the “levels” vectors to which the coefficients are applied); otherwise there will be, for different countries/years different pressure factors associated to the same products (either because the pressures of ancillary activities, varying according to the situation, are included in the factors, or because the same product can be obtained by using different technologies), and this does not facilitate the analysis. The problem of going from “technologies” to activities must be solved somewhere into EPIS – inside or outside its database. If it is done outside, as it was in the initial idea of EPIS, the time and country dependency of the solution of this problem is explicit and it is not necessary to recalculate every time the core component of EPIS, its database of unitary coefficients describing technologies.

5.2 Assessment of the EPIS PRODCOM module at its present stage of development of its current suitability

At its present stage of development, the PRODCOM module of EPIS consists of two distinct pieces, resulting from two pilot studies commissioned by the EU to specialised research institutes: the “CORINAIR Conversion System” (CCS)²⁶⁹ and the “Technology Database” (TD)²⁷⁰. In the present report we will consider, of these two ponderous and complex studies, only the aspects relevant for our ultimate purpose, i.e. the estimation of air emissions by branch of activity to be included in a NAMEA: though it will be unavoidable to develop some general points, and therefore parts of our analysis might prove relevant for other purposes, the reader should bear in mind that it is the utility of EPIS for the environmental pressures modules of the NAMEA, and the air emissions one in particular, that is the object of what follows.

Both pieces that presently form the EPIS PRODCOM module are relevant for the NAMEA-air; each of them has its own coefficients database, having products (or groups of products) as analytical units and providing air emission factors (by pollutant, per product unit) for these units. As for the products included, in both cases they cover only a subset of the existing products, as it immediately emerges from a simple comparison with a classification of products, e.g. the PRODCOM itself; one important incompleteness of these subsets, for instance, is that they almost exclusively include goods: as for services, only transport and waste management are included in the CCS. The two subsets of products, included respectively in the TD and the CCS, are partially overlapping, i.e. many – but not all – of the products contained in the former are also covered, as far as air emissions are concerned, by the latter, which however contains also other products. In both cases the products are identified by an 8-digit “PRODCOM code”²⁷¹.

In the CCS, all the products included generate air emissions. Indeed, the only output coefficients given are air emission factors for SO₂, NO_x, NMVOC, CH₄, CO, CO₂, N₂O and

²⁶⁸ It will be in every case necessary to add new units to the database as time passes and technologies change, while other units will become irrelevant.

²⁶⁹ Stahl (1998).

²⁷⁰ Research Centre Karlsruhe.

²⁷¹ The quotation marks are intended to highlight that in many cases the code is not really a code belonging to the PRODCOM classification but a similar code (8 digits, corresponding to the NACE up to the fourth and to the CPA up to the sixth digit), and that the products dealt with are not covered by the PRODCOM survey.

NH₃; input factors are not included at all. This is due to the simple fact that the emission factors of the CCS are derived, as the name itself tells, from a conversion of the factors expressing “emissions per unit of process” of the CORINAIR system into factors expressing “emissions per unit of product”. One very important feature is that the system has been applied to the 1994 CORINAIR data of three European countries (Austria, Denmark and Italy), for each of which a different set of factors is given.

In the TD, for a number of products (included among others which, according to the TD itself, do not cause any relevant air emissions), factors for air emissions are given, as well as for the other material outputs of the production process, all expressed in physical units. This is done besides a complete description of the inputs (including energy) necessary to obtain one unit of product; in other words, the TD gives the whole material/energy balance of the production process from which the product considered arises, expressed in terms of units (of energy input, of wastewater, and so on) per product unit²⁷². The TD clearly is, in this respect, more adherent to the logic of EPIS than the CCS.

Whilst in the TD only the unitary material flow balance by product is given, in the CCS study the coefficients have also been multiplied by the quantities produced, so that emission levels by product are given for the three test countries, for the year 1994.

It is interesting to consider the “integrated” list of the products already included in the EPIS PRODCOM module (given by the set of products resulting from the union of the two sets) and in particular of the ones for which air emission factors exist (i.e. all products of the CCS plus a subset of those of the TD).

Considering such a list, the overlap between the TD and the CCS, in terms of products dealt with, appears to be substantial and concerning the output of many different branches. This overlap will be analysed in depth in § 5.2.1.

In general, the TD tends to be more precise in the specification of products, whilst the CCS often groups together various products with similar codes. This is likely to stem from the fact that products which are similar are obtained by the same kind of process, so that the transformed CORINAIR coefficients are valid for a bunch of products rather than just one. However, the choices made in this respect are sometimes surprising: for example, the last item in the CCS (Waste management), groups a whole division of the NACE classification of activities as a single record, as if it was a single product.

Before going into the analysis of the possibility of using EPIS, as it is at present, for the NAMEA-air, it is necessary to clarify the rationale of the analysis itself, anticipating the main points covered and highlighting some problems of data availability and results interpretation. For this purpose let us refer to an ideal testing procedure and explain why we won't be able to follow it.

In principle, in order to assess the suitability of the EPIS method for the purpose of the construction of the air module of the NAMEA, one would go through the following steps:

1. calculation of the emission estimates provided by the EPIS method, by:
 - 1.1. multiplication of the “emission factors” provided by the PRODCOM module by the production levels, recorded in the test year, of the products for which such emission factors are provided;
 - 1.2. aggregation by branch of the product-specific emissions calculated at step 1.1, with the branches defined according to the NACE-based NAMEA classification of activities;

²⁷² In at least one case, however, the factors are expressed per unit of an important input, from which many co-products stem at once.

2. application, to the same year, of another method, which is already well-established and certain enough in its results to be considered as a benchmark against which the results of the application of the EPIS method can be assessed;
3. comparison of the results obtained under 1. and under 2. and evaluation of their differences.

In an ideal situation, the differences possibly highlighted by the comparison of point 3 would have a simple meaning: the larger the differences between the results of the EPIS method and the benchmark estimates, the larger the doubts which can be cast on the new method (unless, of course, there are *a-priori* reasons to believe that the latter is better than the benchmark method itself). In our case, however, a simple application-and-comparison procedure is not possible, since some requirements are not satisfied.

A preliminary desirable condition for this kind of testing procedure would be the existence, in the PRODCOM module, of a *single* set of air emission factors to be applied to level indicators, or at least the possibility to create a unitary list. In the absence of a single set, and since the possibility of merging the CCS and the TD cannot be taken for granted, one must first of all decide whether the two pieces of the PRODCOM module are coherent enough to draw from them a single list of emission factors²⁷³. We tackle this problem §5.2.1, on the basis of the overlap between the two pieces.

Since the conclusion we draw on the previous point is that the two pieces are not compatible and cannot be merged, we will analyse them separately in Paragraphs 5.2.2 and 5.2.3.

As far as the TD is concerned, our analysis is only qualitative. analysis (§ 5.2.2). Indeed, while highlighting TD's coherence with the original design of EPIS and other interesting features, this analysis also reveals its very limited coverage of activities, which implies that a comparison with the estimates of an alternative method would not be significant enough.

As far as the CCS is concerned, we perform both an analysis of the methodology (§ 5.2,3,1) and a comparison of quantitative results with the established method (§ 5. 23.2). The first kind of analysis leads us to conclude that the method to be tested is not very different, as for its conceptual basis, from the one used for the Italian NAMEA, which also serves as a benchmark for the quantitative comparison.

As for the quantitative results, a requirement for the comparison of two different estimates to reflect only methodological differences has been mentioned under point 2. of the ideal testing procedure outlined above: the two calculations should refer to the same year. This condition, unfortunately, cannot be met in the Italian case, at least to the extent that the products, for which EPIS gives air emission factors, are industrial products that should be covered by the PRODCOM survey. As a matter of fact:

- no “benchmark” calculation of air emissions by branch of the Italian economy is available for 1994, which is the reference year of the existing EPIS factors, and it is therefore not possible to carry out the comparison for the year 1994; indeed, the most recent available data are the ones supplied with this report, deriving from the indicator-based distribution of CORINAIR emissions-by-process estimates;
- the data on industrial production available for years previous to 1994 are not consistent with the PRODCOM regulation; moreover, no grossing up of the answers gathered has

²⁷³ In § 5.3 we gave an integrated list of products, but refrained from giving the factors attached to them, because for the products in common this would have implied an arbitrary choice.

ever been tried²⁷⁴. As a consequence, the available statistics on industrial production in Italy report the respondents' total, i.e. only give a minimum of production that has been certainly generated, with a very variable coverage of the survey among products. Moreover, for some industrial products included in the CCS and the TD there might be no simple match in the classification of the products used in Italian surveys on industrial production carried out before 1994, since this classification is not the PRODCOM and no "transcoding" system is available. Therefore, it is also not possible to apply the EPIS method to the most recent year for which the benchmark is available (1992) and to carry out the comparison for the same year.

Summing up, a comparison can only be tried between the results of the CCS method with reference year 1994 and those of the "Istat method" with reference year 1992.

Of course, in such a comparison, the effects of all other reasons for the existence of discrepancies will add to those of the changes through time in the determinants of the emissions and it will not be possible to disentangle the effects of the different causes. However some conclusions can be drawn anyway provided that certain sufficient conditions are met: very big discrepancies can only be due to the differences between the methodologies, and their origin can be at least partially understood with the help of qualitative analysis. Notwithstanding all the shortcomings encountered in comparing the results of the CCS with the Italian NAMEA data, this is an interesting exercise, if anything because it tells us a lot on the distance between the objective (complete estimates of air emissions by branch, consistent with national accounting conventions) and the reach of the tool presently available.

5.2.1 Is it possible to merge the air emission factors of the TD and the CCS in a single list? An analysis of coherence

The basic difference existing between the two current components of EPIS, in terms of approach followed, has already been pointed out: complete material balances of products are given in the case of the TD, whilst only air emission factors, resulting from transformation of the CORINAIR ones, are given by the CCS. This difference is relevant for our purpose to the extent that the different methodologies behind the respective emission factors might imply different results. A certain degree of divergence should probably be expected and accepted, but it is important to know exactly "how big" the difference is. The existence of overlaps in the lists of products of the CCS and the TD gives us the opportunity to check, for the products in common, the magnitude of the discrepancies between their emission factors²⁷⁵.

The assessment of the magnitude of the discrepancies between the factors given by the two studies for the products that are present in both of them (individually or as part of a group of products to which a single set of emission factors is attached) is based on the comparison between the absolute difference of the emission factors of the CCS and those of the TD. Indeed, the extent to which there are differences – between figures that should, in principle, be very similar (if not exactly the same) can be taken as an indication in favour or against the possibility of integrating the two sets of emission factors into a single set to be used for the estimation of the emissions by branch.

In some cases (unfortunately only in a minor number) the TD itself provides a range for the factors it supplies. This range, expressed as percentage of the factor, constitutes an important benchmark for the discrepancies. In some cases it is nil, while in others reaches as much as

²⁷⁴ These data stem from the Istat survey: "Rilevazione annuale della produzione industriale".

²⁷⁵ According to the CCS report (page 1) "The coefficients of air emissions are part of the Technology Database of EPIS". However, the emission factors are actually not the same in both components of EPIS, at least as far as Italy is concerned.

100%. Where this range is available, we interpreted it as the value of the “maximum acceptable discrepancy”²⁷⁶; with this in mind, the discrepancy is compared to the range. In all other cases, where no range is given by the TD, the percentage ratio between the difference between the two factors and the TD factor is taken as basis for the assessment.

The results of our comparison show that the differences between the two sets of air emission coefficients are very significant. As a matter of fact, in 19 out of the 27 cases where the range is available, the difference between the TD and the CCS coefficients is bigger in absolute terms, whilst in the other cases, the discrepancies are very often greater than 100% in the cases where the CCS factor is greater than the TD, and greater than 50% in absolute terms for the cases where the CCS factor is smaller (since we are dealing with positive numbers, there is a –100% lower bound to the relative discrepancy).

It must be noted that, besides the different methodologies, the discrepancies observed arise as a consequence of the utilisation of data referring to different countries. The CCS uses data from the Italian CORINAIR, whilst the TD in some cases specifies that the calculation is carried out for a different country, as for instance in the cases of secondary lead (code 27.43.11.30), where data are given for Austria and Sweden, and in the case of electricity (40.10.10.51/52), dealt with using Swedish data. Where such differences exist, the application of the coefficients, given by either of the two studies, to situations different from those with reference to which the coefficients have been calculated, would imply the risk of obtaining biased estimates. Clearly, this problem does not only concern the cases for which a comparison between different studies is possible, though made evident by this comparison, but all cases where the technologies are country-specific and the EPIS database does not comprise all different situations.

Given the differences between the CCS and TD factors, a single database of unitary air emissions factors by product cannot be created; as a consequence, the potential user of the air emission factors would have to choose the factors to use for the calculations, and the choice would either be arbitrary, or need a big technical expertise. This is a serious limit to considering EPIS as it is now a ready-to-use instrument for the calculation of pressures with a NAMEA-type breakdown.

²⁷⁶ We preferred this interpretation to that – perhaps more straightforward – of the range as the width of a symmetrical interval around the point value, in which acceptable values of the emission factor have to fall, because there was no reason to assume this symmetry; the criterion we have chosen is less restrictive, in the sense that there are more cases where the discrepancy can be considered “not relevant” according to this criterion than there would be according to that of confronting the discrepancy with half the range. Our conclusions (see below) would therefore only be strengthened if we had interpreted the range as the double of the acceptable discrepancy.

5.2.2 *Some remarks on the Technology Database*

The TD provides technical knowledge about a number of industrial production processes, identified by their main products. As already mentioned, the TD is characterised by completeness in the material balances that describe the technologies included. This completeness fully responds to the logic of EPIS, potentially allowing to extend the variety of the pressures that can be calculated beyond air emissions, for instance to waste and wastewater flows. Innovative elements are also the presence of a flow chart for each production process and the indication of a range for the emission factors of some of its records; moreover, all information given in the TD is duly referenced. All this makes this information system potentially useful also for Life Cycle Assessments, integrated emission inventories and the assessments of the uncertainty of the estimates.

As a consequence of the fact that the TD has not been designed for the specific purpose of calculating air emissions, but virtually all pressures on the environment, many of the products dealt with are not very interesting for the present analysis, since they do not cause the emission of pollutants into the atmosphere. For those which do, the study provides, in the context of its complete material balances, a set of air emission factors, usually expressed in tons per physical unit of the main product. One important feature is that these coefficients derive directly from the knowledge acquired on the production techniques, rather than from an elaboration of other “tools” already existing and in use for emission inventories. In this sense, the TD is as “basic” as the methodological documents at the background of CORINAIR itself (whilst the CCS can be considered a “derived” tool, like the Italian method for constructing the NAMEA-air) and therefore provides an additional tool, an original piece of literature that enriches the corpus of information already available on production processes. As such, the TD can be considered as a background document to which the experts can make reference for the calculation of the air emissions to be included in the CORINAIR inventory. One important thing to be noted in this respect is that the products dealt with in the TD are such that there often is a full correspondence between processes and products (i.e. only one process, and a product-specific one, is included in the material balance of the product). A check of the air emissions accounted for in the individual records of the TD has shown that these are complete at least as far as the “variety” of pollutants described is concerned.

However, also the TD has its weak points. The main one is the limited coverage of products and activities, or equivalently, given the correspondence noted above, of processes, and therefore of emissions. Indeed, a quick evaluation can be based on the analysis of the SNAP processes that are involved in the making of the products dealt with in the study. These can be mainly attributed to the SNAP sectors 03 and 04, that is “Processes with contact” and “Production Processes”, which are fairly well covered, while little information is provided regarding SNAP sectors 01 and 02, Production of electricity and heating plants. The TD does not provide useful information for the other SNAP sectors – 05, 06, 07, 08, 09 and 10 – that account, according to the 1999 Italian CORINAIR inventory, for more than 75% of NMVOC, CO, CH₄, N₂O, NH₃ emissions, 50% of NO_x and 25% of CO₂ and SO_x.

As far as the relevance for Italy is concerned, emission estimates of the Italian CORINAIR derive from 117 SNAP different activities. It can be noted that only 40% of these activities are represented in the production processes of the TD. For these, the technical knowledge provided by the TD is potentially of help in the estimation process. As far as the various “sectors” of the SNAP classification of processes are concerned, the one better represented in the TD seems to be sector 0405, “Processes in organic chemical industry (bulk production)”, but only 11 products resulting from its processes are described, while the emissions currently estimated in Italy for this sector derive from the production of 27 goods.

Another limit of the TD for our purpose is that the specific kind of production process described for a given product does reflect a national specificity other than Italy. As noted above, TD factors are indeed often explicitly related to the technologies in use in a specific country and calculated on the basis of that country's data. It could be misleading, however, to assume that what applies to a given product for a given country applies to another country as well, even if the product as such is exactly the same. For instance, it is in general true that for basic materials the production technologies in Europe do not deviate much from country to country, but in some important cases they do, like in glass production and primary non ferrous metal production. Another example is that of pulp paper production, for which the only process described in the TD is the Kraft process. Such a process is not present in Italy, where pulp paper is produced by other processes; the use of Italian PRODCOM data on paper production along with the emission factors given by the TD for this product could then be misleading²⁷⁷.

In some cases, it is the production data that create a limit to the application of the information contained in the TD, since in production statistics products are usually not broken down by process of production; so, even if a description of the different processes is available, the method can not be properly applied. This is the case for primary and secondary non ferrous metals, where the related emissions are substantially different. However, for each product only one technology of production is generally reported in the TD, even if different abatement technologies are sometimes taken into account.

As concerns the need of determining, for the specific purpose of the NAMEA, a correct relationship between emissions, products and activities, it can be noted that all products dealt with in the TD are very specific of the branches they belong to according to the PRODCOM-NACE correspondence; they are never the result of e.g. ancillary or households' activities, in which case part of the emissions caused by their production should be attributed to other activities. This implies that it is correct to allocate all the pressures that can currently be estimated using the TD coefficients simply to the NAMEA branches of which the products included are typical, on the basis of the immediate NACE-PRODCOM correspondence. Unfortunately, such a fortunate case will not occur when products of a different kind are taken into account. The estimations will then suffer all of the general drawbacks coming from the organisation of the EPIS database by product, highlighted in § 5.1. As regards the branches covered by the TD, even abstracting from the lack of some of their products from the database, the estimates feasible are in no way exhaustive of the emissions to be attributed to these branches, because of the absence of the pressures due to ancillary activities.

One interesting thing we learn from the TD thanks to the completeness of its material balances, also concerning the issue of the relationship between emissions and production levels, is that joint production is quite a frequent phenomenon. Indeed, there often are, next to the main output of a production process and to its unwanted residues, useful by-products which are also marketed. These are, in a sense, obtained "free of emissions", since the emissions arising when they are produced are attributed to the main product (it would be too complicated and arbitrary, to split the emissions among main and by-products). Many outputs that are by-products in a given production process, are at the same time the main output of some other production process. If the emissions attributed to this product were calculated by multiplying the factors of the latter process by the total amount produced in the economy of the same product, there would be an

²⁷⁷ The usual way to look at the problem is in terms "country-specificity of technologies". However, we prefer to think simply in terms of technologies missing from the database, which happen to be used in a specific country (but in principle could be used also elsewhere) for the production of the same goods or services that somewhere else are produced by means of different technologies – which happen to be present in the database.

overaccounting of emissions, since the calculation would include also that part of production which had already been treated as “free of emissions”, due to that fact that some other main product had been identified as responsible of the relevant emissions.

5.2.3 Analysis of the CORINAIR Conversion System

5.2.3.1 Methodology

As its name itself tells, the CCS provides a conversion of the factors used in the calculations of the CORINAIR emissions inventory – which express “emissions per process unit” – into factors expressing “emissions per product unit”. A basic difference between the CCS and the TD is therefore that the former does not provide “new” emission factors, derived from the analysis of individual technical processes, but “only” a reorganisation, according to new criteria, of the knowledge embodied in the CORINAIR inventory methodology.

The emission factors per product unit are calculated in the CCS “with the help of additional information on the energy demand per PRODCOM product of the TEMIS database and on branch-specific fuel mixes of the SIRENE database”²⁷⁸.

Thus, it can be immediately noted, the CCS basically solves the same reorganisation problem solved at Istat for the construction of the NAMEA as described in the present and – in greater detail – in a previous report on the matter²⁷⁹. The major difference, as for the problem tackled, is that the CCS – as required by its being a part of EPIS – sets out to solve it in terms of *products* and *emission factors*, whilst at Istat a more aggregate approach, dealing directly with productive and households' *activities* and *emission levels*, has been adopted, given the specific purpose of the construction of the NAMEA-air²⁸⁰.

As we will show in the present paragraph, not only the problem tackled, but also the method used in the CCS for this conversion, is very similar to that used at Istat. Indeed, as far as the information used is concerned, the only substantial innovation of the CCS is the introduction of coefficients of product-specific energy demand. However, the CCS method leads to substantially different results, as we will see in the next section, because of the use of different data sources and of the general problems for the NAMEA, discussed in § 5.1, of the EPIS approach “by product”.

As for the methodological similarities, we can start noticing that both methods go through a first phase of determining qualitative associations between the elementary processes of the SNAP classification and the entities which are the objective of the transformation (NAMEA activities in one case, products in the other), and perform in a second step the quantitative allocation of emissions needed (expressed in levels in one case, in unitary factors in the other).

²⁷⁸ CCS report, quoted, p. 11.

²⁷⁹ See Battellini et al. (1999).

²⁸⁰ The steps necessary to go from the CCS to NAMEA-air type estimates are the ones indicated in § 5.2, point 1 of the “ideal testing strategy”.

The first step is almost exactly the same for both methods: technical knowledge (mainly derived from the CORINAIR itself) is used in order to establish a qualitative link between processes and economic activities. Actually, the CCS only makes explicit, in this respect, something that lies behind the Istat method but remains implicit in it: a qualitative link between a process and a branch is established, in the Istat method, exactly because it is known that the branch in question produces some well-identified good or service whose production requires that specific process to be performed in the plant where the good takes its finished shape. In other words, the CCS provides additional information, concerning which is/are the exact product/s for whom that processes is carried out. This precision, however, has no value added for the NAMEA air-emission module.

The second step, that of quantitative allocation, has also some very similar features. For any of the products dealt with, the CCS includes:

- emission coefficients for product-specific process(es), i.e. for the process(es) that serves only for the production of that specific product (the plurals in brackets are meant to remind that there often is more than one such process; however, we can ignore that for the moment);
- emission coefficients for electricity inputs, which imply “indirect emissions” attributable to products, and are therefore treated separately from the other “process energy”;
- emission coefficients for energy inputs other than electricity, i.e. for the energy processes carried out contextually to the product-specific process and supplying all or part of the energy necessary for carrying it out.

The following can be noted:

- a) product-specific (non energy) processes of the CCS correspond to the branch-specific processes of the Istat method: indeed, product-specific processes are automatically branch-specific ones, since every single product stems from a single branch (namely, the one identified by the first 4 digits of the PRODCOM code). In the Istat method, the whole amount of emissions due to a branch-specific process is simply allocated to the branch where it takes place. In the CCS, the CORINAIR “emissions per process unit” factor is first converted (where necessary) into an “emissions per product unit” factor (the conversion coefficient therefore expresses “process units per product unit”), which can subsequently be multiplied by the output level of that product; when this operation is done for the year for which the factor has been converted, the result is that the total emission estimated by CORINAIR for that process are calculated again. The new information, the value added, in all this, is clearly not this result, but rather the set of factors themselves, that express “emissions per product unit”, and were not known before the conversion. Indeed, these coefficients can be used – assuming they are stable through time – for the construction of preliminary emission estimates from the product-specific processes in years for which no CORINAIR emission estimates exist yet, if production figures do already exist. But such a case is not relevant for Italy: Italian CORINAIR estimates of emissions by process are far more timely than production statistics, and their allocation to the branches of product-specific processes is straightforward (actually, all the qualitative links are already established). Moreover, the CCS report itself clearly states that “Generally, the output of a non-combustion SNAP process refers to a product and for the majority of processes a corresponding PRODCOM product exists. Therefore,

the CORINAIR process emission factor is already product-related and no transformation of the coefficient is necessary”²⁸¹; the report also argues that in other cases only a conversion of units of measurement is necessary;

- b) in the NAMEA, the emissions caused “upstream” by the production of electricity inputs are not to be included among the pressures of the branches that use the electricity, at least as long as a representation of the pressures according to the producer (“direct responsibility” approach) is preferred²⁸². Moreover, input-output techniques applied to a NAMEA with direct emissions data would allow to calculate indirect contributions to the emissions (“final responsibility” approach), not only for electricity inputs, but also for other material and energy flows activated upstream by all production activities;
- c) for energy processes other than those supplying electricity, the fundamental elements determining emissions are the quantity of energy necessary per product unit (called “specific energy demand per product” in the CCS, with symbol *eprod*) and the mix of fuels used in order to obtain this energy, since each fuel has its own unitary emission factor; the mix of fuels is represented by the shares of the individual fuels on the *eprod* of the product. Once again we have a distinction between “specific” and “non-specific” (energy) processes, i.e. processes that serve only for one product (which implies that the product fuel mix and the process fuel mix coincide) and processes that are carried out for several products (which implies that some approximation to product-specific fuel mixes has to be found). For the first ones, the arguments discussed under a) for product-specific non-energy processes apply here as well; the only difference is that the conversion is in these cases always necessary, with the use of the *eprod* coefficient for going from “emissions per process unit” to “emissions per product unit”. For non-specific energy processes, “branch-specific fuel mixes” have been used as approximation for product-specific fuel mixes²⁸³. The kind of information used in this step is the same as that of the Italian energy use Table, used by Istat in order to distribute CORINAIR emissions to the branches. However, there is a difference in the way the information is used by the CCS and Istat: if we think of a matrix of inputs with fuels in the rows and branches in the columns, the information used by the CCS is given by the column profiles (shares of the various fuels in the total energy used by a given branch), whilst that used by Istat is given by the row profile (shares of the branches in the total consumption of a given fuel). Another important difference is in the sources of information: the SIRENE database in the case of the CCS, a table compiled by Istat itself in the case of the Italian NAMEA. Summing up, it seems that the important innovation contained in the CCS, from the point of view of the methodology, is the introduction of the *eprod* coefficient, derived from the TEMIS model, in the calculations. This is surely an important and necessary addition in order to be able to produce emission estimates from energy transformations at the level of individual products, but it is not clear that this would improve NAMEA aggregates²⁸⁴.

²⁸¹ CCS report, quoted, p. 12.

²⁸² I.e. if no attribution of the emissions caused in production of intermediate inputs to their users is done in its “pressure” modules.

²⁸³ The reason why the CCS chooses this approximation rather than using the process-specific fuel mixes themselves is not discussed in the study commissioned by the EU.

²⁸⁴ It can be noted that the distribution of CORINAIR emissions in proportion to the branches’ fuel consumption guarantees that, for each pollutant, NAMEA emissions are coherent with the relevant parts of CORINAIR estimates. Such a condition of invariance of total emissions does not seem to be necessarily satisfied by the CCS for the energy processes, due to the introduction of the new piece of information, which is external and independent from the rest.

A last remark concerns the fact that the emission factors referring to some products are obtained as weighted average of two or more different combinations of product-specific processes. This is an obvious consequence of having the database organised with products as units: when the same product can be obtained in more than one way, the emission-per-product-unit coefficient loses its meaning of technological output factor: its value changes through time and countries according to the changing mix of techniques used to obtain the total amount of that product. Together with the branch-specific fuel mixes, this is another reason why the system produces a different set of factors for each country.

5.2.3.2 Coverage of activities and comparison of results with the Italian NAMEA data

Let us now take a look at how representative of the whole set of products and emissions currently present in the CCS are. Given the results of the analysis of § 5.2.1, it would not be justified to add together or even juxtapose the emissions covered by the TD and the CCS and to compare them to other data. We therefore will try a quantitative analysis only for the CORINAIR Conversion System, which covers a large number of products, belonging to many branches.

In Table 5 we report the emissions²⁸⁵ calculated by the CCS next to the data of the Italian 1992 NAMEA, using, as far as possible, the NAMEA industry classification proposed in the NAMEA Q2000²⁸⁶, reported in the first column. The activities that at present are not covered at all in the CCS, making up 32,3% of the 1992 Italian NAMEA emissions, are highlighted by a grey background. The frequency of shaded rows gives a first impression of the coverage of the CCS in terms of activities; however, it is also necessary to assess “how much” the activities for which products are present (i.e. those with a white background) are actually covered. This kind of analysis is done in terms of the share of air emissions covered, as the main aim of our analysis is to understand how suitable the “EPIS method” is for the calculation of air emissions by branch, so it is the emissions themselves that have to serve as a metric for assessing the coverage²⁸⁷.

The estimates of the emissions of CO₂ reported in the second column of the table are those given specifically for Italy by the CCS study itself²⁸⁸. In some cases the figure is zero despite the fact that there are products of that branch in the CCS (and therefore the background of the row is not grey), because the products, according to the CCS, do not emit CO₂. In the third column we calculated the share of emissions of the branch covered by the CCS, as compared to the figure reported in the 1992 Italian NAMEA; the latter can be read in the fourth column; the last column contains the share of total CO₂ emissions due to that branch, particularly interesting in the case of the grey-shaded rows.

As already pointed out, unfortunately we are not in the position to compare the CCS estimates with data referring to the same year, but can only use the 1992 NAMEA as a benchmark. Nevertheless, the comparison is meaningful as long as conditions that are sufficient in order to reach some conclusions are met. Specifically, in case the evidence is strong enough that it cannot be attributed only to the difference in the reference years, it is legitimate to

²⁸⁵ Of course, the situation changes from pollutant to pollutant, because the products considered are likely to be more complete with respect to some emissions and less with respect to others. Since it would be very difficult to read a table with eight different pollutants, we chose to present here just one (CO₂) as an example, leaving to the reader the possibility to check data about the other pollutants in the appendix.

²⁸⁶ Eurostat (2000).

²⁸⁷ Alternatively, one could have considered the number of products or the share of their value on the branches' output, but these are less significant for our purpose.

²⁸⁸ See table 6.3 in the EU study.

consider it due to the methodological differences²⁸⁹. Indeed, conclusions can be drawn on the basis of the *a-priori* knowledge that no big change in industrial structure nor environmental policy occurred between the two years at issue, so that neither very large increases nor very large reductions of the emissions can be related to the time difference²⁹⁰.

On the one hand, since very large emission reductions between 1992 and 1994 for any given branch are extremely unlikely, big negative differences between the 1992 NAMEA data and the 1994 CCS ones can be safely attributed to the combined effects of:

- possible inadequacies of the conversion process with respect to the Italian situation; errors in this process can derive from imperfect knowledge of the specific situation, like e.g. allocation to the products dealt with of processes different from the ones actually relevant in the Italian case, inappropriate specific coefficients of energy demand per product coefficients, access to data less accurate than the ones used at Istat, etc.;
- incomplete coverage of the products of that branch by the CCS. This implies differences not only for the branch but also for total emissions. However, comparing the already mentioned 32,3% share of the activities not covered at all, with the 28% of emissions missing from the whole economy total of the CCS, it is evident that other effects prevail, at least in the case of CO₂;
- lack of allocation to the products of that branch of the emissions of the ancillary activities. This in principle only implies a shift of emissions between activities – the corresponding emissions should in fact be attributed to some other branch (namely, the one of which the product is characteristic); however, the ancillary emissions missing could be due to “products” not dealt with at all.

Assessing which of these reasons actually applies and are relevant for any given activity, is a matter of case-by-case analysis, not performed in detail here. Let us discuss the example, for instance, the case of the activity “Other mining and quarrying” (NAMEA activity 14), credited in the CCS with 6,2% only of its NAMEA 1992 emissions: no matter whether the emission factors are right, the lack of products is clear (only sulphur extraction is considered in the CCS, see Table 7) as well as that of ancillary activities.

On the other hand, in some cases we are confronted with much higher levels of emissions in the CCS than in the NAMEA. When this is the case, out of the explanations given above, the first one (inadequacies of the conversion process) needs not be reformulated and the third one just needs to be seen the other way round (the products typical of the branch are self-produced in the other branches by ancillary activities or are really households’ consumption activities),

²⁸⁹ As any other test, our comparison would in any case only be conclusive in case of diverging results: since the effects of different sources of error could compensate each other, results that appear to be correct might by chance be obtained from a wrong method. The impossibility of eliminating an “external” cause of variability only makes larger the region where the null hypothesis (in our case, that of substantial suitability of the CCS for the NAMEA) cannot be ruled out, but does not change the fundamental characteristic of the test; the important thing is that we are able to know – albeit approximately – how much larger it becomes, and determine the boundaries between acceptance and refusal “by excess”, to be on the safe side in considering conclusive the evidence collected.

²⁹⁰ To further clarify this point, let us consider what are the differences between years that increase the uncertainty of the test. Changes can occur “within” the individual branches and “between” branches, and can be due to technology or to composition and level of output. The ones “within” are changes of the production technologies of the individual products and of their mix in composing the output of the branch, the ones “between” are changes in the level and composition by branch of the output. Assuming that the coverage of CCS is complete, and that the emission factors provided by the CCS are perfectly suited to the Italian situation, the differences between the emissions recorded for a particular branch would be the result of the following mix of causes: a) changes in the level of activity of the branch; b) changes in the product mix of the branch; c) changes in the technologies used for the making of the individual products of the branch. None of these changes appear to have been dramatic in Italy between 1992 and 1994.

whilst the second one (incomplete coverage of the products of the branch) can be dropped altogether (in the sense that it surely is not the prevailing one). Dramatic positive differences are therefore easier to explain, and can be reasonably attributed to:

- emission factors not quite fitting the Italian case; this is very likely to be the case of activities 13 (Mining of metal ores) and 26.1 (Manufacture of glass and glass products), since none of the other explanations would fit;
- emissions due to ancillary and households' activities that should be distributed among the branches, as in the paradigmatic case of transport (NAMEA activities 60-63) and in that of NAMEA activity 90 (Sewage and refuse disposal, etc.).

In all other cases, i.e. when the two values are similar, the comparison does not provide strong reasons to believe that the coverage of the branch by the CCS system is insufficient, nor that the CCS coefficients for the products of that branch are not suited to the Italian situation, nor that the problem of “auxiliary emissions” is relevant. However, it does not give strong reasons to think the contrary either, given the mix of possible explanations for discrepancies between the two estimates, which could just compensate one another.

Table 5 - Coverage of CCS air emission estimates in terms of NAMEA industry classification. The example of CO₂

NAMEA ACTIVITY CLASSIFICATION	CCS		1992 NAMEA	
	tons	% of NAMEA 1992 estimate	tons	% of total
01	7364483,7 (a)	99,5%	7401527,9	1,67%
02	-	-	63094,4	0,01%
05	-	-	653834,4	0,15%
10	-	-	301,0	..
11-12	-	-	15713,4	..
13	910000,0	7332,5%	12410,6	..
14	27739,9	6,2%	446326,4	0,10%
15-16	200394,1	19,9%	1008212,6	0,23%
17	-	-	999550,3	0,23%
18	-	-	334643,6	0,08%
19	-	-	418281,8	0,09%
20	-	-	568172,5	0,13%
21	-	-	4268517,6	0,96%
22	-	-	512098,7	0,12%
23	668748,4	4,9%	13624854,1	3,07%
24	7506524,9	289,3%	2594486,4	0,58%
25	-	-	896620,4	0,20%
26.1	4630498,8	209,5%	2210554,2	0,50%
26.2-26.8	33271829,8	84,1%	39552411,3	8,91%
27	15130540,0	73,6%	20561942,5	4,63%
28	-	-	1455003,1	0,33%
29	-	-	1537580,0	0,35%
30	-	-	13909,4	0,00%
31	-	-	380836,0	0,09%
32	-	-	184528,5	0,04%
33	-	-	125831,9	0,03%
34	-	-	2068629,0	0,47%
35	-	-	230194,6	0,05%
36	-	-	368744,1	0,08%
37	-	-	84798,1	0,02%
40	115911344,6	70,1%	165289577,4	37,24%
41	-	-	67104,6	0,02%
45	-	-	2458927,1	0,55%
50-52	-	-	26071138,9	5,87%
55	-	-	2117573,1	0,48%
60.1	-	-	646379,0	0,15%
60.2-60.3	-	-	25275834,3	5,69%
61	129860833	304,5%	9078238,0	2,05%
62	-	-	6696577,0	1,51%
63	-	-	950568,9	0,21%
64	-	-	1442943,4	0,33%
65-67	-	-	1223771,9	0,28%
70-74	-	-	6295724,7	1,42%
75	-	-	2582967,0	0,58%
80	-	-	797501,2	0,18%
85	-	-	2562783,5	0,58%
90	4096302,9 (a)	379,2%	1080240,6	0,24%
91	-	-	119842,3	0,03%
92	-	-	626494,4	0,14%
93	-	-	953696,3	0,21%
95	-	not applicable	-	-
101 (households – transport)	-	-	31796448,4	7,16%
102 (households – heating)	-	-	52616271,3	11,85%
103 (households – other)	-	-	535365,0	0,12%
Total	319579240,4	72,0%	443879577,5	100%

(a) Indicates that the figure includes the emissions of some SNAP processes allocated by the CCS to the branch as a whole, but not connected to any particular product – whose emissions would therefore not be captured using converted coefficients.

5.3 Conclusions

In the present part of the report we assessed the suitability of EPIS as a tool for obtaining quick estimates of air emissions by economic and household activity, as required by the NAMEA. We did this first considering the recent evolution of EPIS towards a system having at its core a database of material and energy balances referred to products and then analysing the current contents of the EPIS toolbox.

Our analysis revealed various reasons why EPIS is at the moment not an option for the calculation of air emissions by NAMEA activity.

The most important reason is that the two studies that currently go together under the title of EPIS, are in fact two very different objects, whose contents show, where the comparison is feasible, differences that do not allow to rely on a single set of air emission coefficients (by product) to be used for calculating reliable emissions by NAMEA activities.

Another reason – not independent from the first one, since the heterogeneity makes it impossible to merge the two parts – is the substantial incompleteness of EPIS²⁹¹. Of the two pieces that presently compose it, only in one, the CCS, a certain degree of completeness is reached, but this is done at the level of products defined in a way different from “output” in national accounting. The inclusion of estimates based on the CCS in a NAMEA would be at the expenses of accuracy of the allocation of the emissions to the branches, which is the most important thing in a NAMEA. We have shown that this problem is given by the impossibility of allocating *ex-ante* the emissions of ancillary activities to the products (or even the activities, for that matter)²⁹², and that the organisation of the database of EPIS by product conceals the problem rather than solving it. In the other piece, the TD, the problem does not arise only because its products are not the result of ancillary and consumption activities; given that a one-to-one correspondence between processes and products holds, the entry of the database would be the same if identified in either terms²⁹³.

Yet another reason is that the coefficients attached to products so far are often quite country-specific, and cannot safely be extended to countries other than the ones for which the calculations have been carried out. Country specificity, however, is on the one hand the cause, in some cases, of the first problem mentioned above (heterogeneity of results), and could on the other hand be seen merely as a form of incompleteness of the database, that could be solved by extending it to as many technologies as possible.

²⁹¹ The still rather incomplete state of EPIS was the main factor behind the choice to tackle our particular problem by adopting a more “analytical” approach, based mainly on qualitative reasoning on the two pieces of EPIS held as separate, than a more “statistical” one, based mainly on the comparison of results between a benchmark and the EPIS method itself.

²⁹² In other words, of defining unitary coefficients that are the expression of necessary technical relationships.

²⁹³ The coefficients would not necessarily be the same, though, since the TD calculates for each product the emissions due to both to the product-specific transformation process and to the energy processes, which are kept distinct in the SNAP classification.

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7 TABLES

The following tables present the Italian NAMEAs data for 1992 according to the European standards, set in the NAMEA 2000 manual²⁹⁴. In the original report to Eurostat data for 1990 and 1991 were reported as well.

For each year the following tables are available²⁹⁵:

- *Hec* (Table 2a) – final consumption of households – and *Hem* (Table 2b)- households' air emissions - broken down into *transport*, *heating* and *other*;
- *MSec* (Table MS-1a) – output, value added and intermediate consumption at current and constant prices, employment – and *MSem* (Table MS-1b) - air emissions - reported according to a national specific grouping of NACE rev.1;
- *EA* (Table 3): tables filled in partly with the aggregated environmental figures recorded in the previous tables and partly with the environmental themes (greenhouse gas only) evaluation;
- *Aggregated NAMEA* (Table 4): very aggregated summary table;
- *Full NAMEA*: matrix based on a revised Italian format; the new format, applied to the three years 1990, 1991 and 1992 is more comprehensive than the one adopted for the first Italian NAMEA (see § 2). In the full NAMEAs, the “Goods and services” account, and the “Production” account are broken down into eight main macro-industries which are relevant for the description of the relations between economic activities and environmental consequences.

7.1 Notes for filling in the tables²⁹⁶

For each table a set of notes explain how to fill it in or what to include (or not include) under each heading or industry. The general rule is that emission data should be allocated in a way that mirrors the economic data. The economic data should be allocated as specified in the system of national accounts, and thus only a few detailed notes are given on the economic data. A few specific notes are given on the allocation of emission data to industries and households.

Notes for Table 1a (sheet NACEec) - Detailed economic data from the national accounts, industries

- 1a.1 Industry classification: The proposed industry classification is NACE 2-digit plus extra selective breakdowns (for the following NACE categories: 23, 24, 26, 27, 40, 60, 61, and 75) as it is shown in the sheet NACE-NAMEA. The tables should be filled in by Member States using this classification as far as possible. If it is not possible to fill in all the details of this proposed classification, extra selective aggregations of industries have been 'nested' in the proposed classification. This is the first alternative (alternative extra aggregated industries of the NACE 2-

²⁹⁴ Economic data are reported in Italian lira as in the original Report to Eurostat.

²⁹⁵ In the original Report to Eurostat the following additional tables are available: NACEec (Table 1a) - output, value added and intermediate consumption at current prices – and NACEem (Table 2b) - air emissions - reported according to the NAMEA 2000 industry classification.

²⁹⁶ Source: Eurostat “NAMEA set of standard tables – Notes.”

digit are underlined and extra aggregated NACE divisions are in bold font. Aggregations of the NACE 2-digit that are not underlined are part of the ideal industry classification proposed for NAMEA-Air). Some of the extra aggregations are based on the “Tables with comparable data” in the Eurostat publication *Pilot Studies on NAMEAs for air emissions*, representing the aggregations most suitable for most Member States. The others (and some of the extra selective breakdowns) come from discussions with Member States at the 4th NAMEA Workshop (20-21 June 2000).

Please note that each part of the table should be filled in according to the most disaggregated level as far as economic and emissions data are available according to the same level. Member States whose national accounting industry classification is not consistent with the NACE Rev. 1 are welcome to fill in the Table MS-1a (sheet MSec).

- 1a.2 Current prices: Output of industries at basic prices. Unit: Appropriate level of national currency.
- 1a.3 Current prices: Gross Value Added of industries at basic prices. Unit: Appropriate level of national currency.
- 1a.4 Current prices: Intermediate Consumption of industries at purchasers' prices. Unit: Appropriate level of national currency.
- 1a.5 As far as possible, employment of industries in hours worked. Unit: 1000 hours.
- 1a.6 Or, as far as possible, as well, employment in full time equivalent - Unit: number of jobs.
- 1a.7 If not possible in hours worked, employment of industries in number of persons (employees and self-employed). Unit: 1000 persons.
- 1a.8 Constant prices: Output of industries at basic prices. Base year 1995. If this data is not available, please report annual changes instead.
- 1a.9 Constant prices: Gross Value Added of industries at basic prices. Base year 1995. If this data is not available, report annual changes.
- 1a.10 Constant prices: Intermediate consumption of industries at purchasers' prices. Base year 1995. If this data is not available, please report annual changes instead.
- 1a.11 This column is to be filled in by Member States with the references of the notes they would provide at the bottom of this sheet (Notes).
- 1a.12 “Not allocated” under industries: this concerns FISIM not allocated to the industries (for VA and intermediate consumption only).
If FISIM has been allocated, please make a clear note about this in your comments regarding this at the bottom of this page.
Note that not allocated only appears under Industries.
Not allocated in Table 1a does not necessary have to cover the same items as Not allocated in Table 1b.

Notes for Table 1b (sheet NACEem) - Detailed emission data according to NAMEA definitions, industries

- 1b.1 Industry classification: please consult note 1a.1.
Please note that each part of the table should be filled in according to the most disaggregated level as far as economic and emissions data are available according to the same level. Member States whose national accounting industry classification is not consistent with the NACE Rev. 1 are welcome to fill in the Table MS-1b (sheet MSem).

- 1b.2 The post not allocated under industries concerns the emissions that it has not been possible to allocate. In all cases it is preferable to include non-allocated emissions here than in any other industry. Please make clear comments on the non-allocated emissions at the end of the sheet "Notes". If the non-allocated item concerns several issues, please specify this in specific notes too.
Note that "Not allocated" only appears under Industries aggregated level. Not allocated in Table 1b does not necessary have to be covering the same items as Not allocated in Table 1a.
- 1b.3 This column is to be filled in by Member States with the references of the notes they would provide at the end of this sheet, "Notes".
- 1b.4 Please be aware of the definition of the transport industries in NAMEA. Only emissions that are connected to the activities of commercial transport services are to be included. Further emissions connected to activities by national entities abroad are to be included.

Please do:

Emissions due to "own account" transport should be allocated individual industries. This means that the sectors for transport only include emissions due to activities connected to market transport services and the own account transport of the transport industries themselves. If it is not possible to allocate all own account transport emissions to industries, please do not allocate these to the transport sector but include these under non-allocated.

Please include emissions from international bunkering (tanking up) by land transport in NACE 60 (60.2 Other land transport). If this is not possible at present please specify this in your notes. Further the emissions from international bunkering in the specified cells in the Table 3 (EA) (see note 3.4 below).

Please include emissions from international bunkering by ships in NACE 61 (61.1 Sea and coastal water transport). If this is not possible at present please specify this in your notes. Emissions from international bunkering are covered in the specified cells in the Table 3 (EA) (see note 3.4 below).

Please include emissions from international bunkering by international flights in NACE 62. If this is not possible at present please specify this in your notes. Emissions from international bunkering in the specified cells are covered in the Table 3 (EA) (see note 3.4 below).

Please be aware of:

Emissions due to marketed transport services should be placed in the transport sectors (NACE 60-64). Allocation of these emissions to the users of the transport services is a further analysis of the NAMEA data, but lies beyond the definitions of the basic NAMEA framework.

- 1b.5 Please note that emissions from burning of bio-fuel, renewable resources, etc. should be allocated to and included in the emissions for all industries concerned.
- 1b.6 On the one hand, for the time being, the carbon sequestration in forests are not subtracted from the total emissions to air in forestry. On the other hand, emissions from forests are to be included only when they come from managed forests.
- 1b.7 The emissions from fishing etc. must include emissions in foreign or international waters.

- 1b.8 Emissions related to the extraction of natural resources must be included. Emissions connected to e.g. flaring must be included on top of the emissions from the energy used in the extraction process.
- 1b.9 Evaporation of substances from stored fuel in connection with refineries have to be included in the total emissions from refineries.
- 1b.10 Emissions due to the production of electricity sold on the market should be placed in the NACE 40, when it is either carried out as primary production or if it is a secondary production while industries are homogeneous. Allocation of these emissions to the final users of the electricity is a further analysis of the NAMEA data, but lies beyond the definitions of the basic NAMEA framework. Emissions due to the production of electricity for own consumption should be allocated to the industries, even if economic data is of an homogeneous nature.
Emissions related to losses due to distribution of natural gas are to be allocated to NACE 40, since they are stemming from distributors' mains.
- 1b.11 Emissions from waste dumping sites: these emissions are to be allocated to the economic activity that are economically responsible for the management of the waste dumping site. If an industry has 'their own' waste dumping site, the emissions are put there. The same is the case where the management of the waste dumping sites is a community service.

Notes for Table 2a (sheet Hec) - Detailed economic data from national accounts, households

- 2a.1 Current prices: Final Consumption of households at purchasers' prices. Unit: Appropriate level of national currency.
- 2a.2 Constant price: Final Consumption of households at purchasers' prices. Base year 1995. If this data is not available, please report annual changes.
- 2a.3 To be filled by Members States with the references of the notes they would provide at the bottom of this sheet, Notes.
- 2a.4 Please note that the "Non allocated" row is not similar to "Other". "Non allocated" has to be filled in only when "Transport" and "Heating" breakdowns cannot be filled in. When it is possible, "Other" must be filled in with the part of household consumption that is neither transport nor heating.

Notes for Table 2b (sheet Hem) - Detailed emission data according to NAMEA, households

- 2b.1 To be filled in by Member States references of the notes they would provide at the bottom of this sheet, Notes.
- 2b.2 Please note that "Not allocated" row is not similar to Other. It has to be filled in only when emissions cannot be broken down into Transport and Heating. Then, when they could be, Other has to be filled in with the part of the households' emissions that neither come from transport nor from heating. Please make a clear note about this in your comment (see above note 2b.1).

NB! Please consult the notes 1b.4, 1b.5, 1b.6 and 1b.10 for Table 1b.

Notes for Table MS-1a (sheet Msec) - Detailed economic data from the national accounts according to Member States industry classification

Only Member States whose national accounting industry classification is not consistent with the NACE Rev. 1 are welcome to fill in this table (see the Table 1a, note 1a.2 on the sheet NACEec). Please note that economic data should be provided according to the same industry breakdown that is used for emissions data.

MS-1a.1 **Please see notes 1a.3 to 1a.11 in the Table 1a (sheet NACEec).**

MS-1a.2 To be filled by Member States with references of the notes they would provide at the bottom of this sheet, Notes.

Notes for Table MS-1b (sheet MSem) - Detailed emission data according to Member States national accounts industry classification

Only Member States whose national accounting industry classification is not consistent with the NACE Rev. 1 are welcome to fill in this table (see the Table 1b, note 1b.2 on the NACEem sheet). They are also encouraged to break down emissions to the air according to the level of aggregation the most closely to the NACE 2 digits. Please note that emissions data and economic data should be provided according to the same industry breakdown.

MS-1b.1 **Please see notes 1b.2 and 1b.4 to 1b.11 in the Table 1b (sheet NACEem).**

MS-1b.2 To be filled by Members States with the references of the notes they would provide at the bottom of this sheet, Notes.

Notes for Table 3 (sheet EA) - Environmental accounts overview, origin and destination of substance flows in the NAMEA for air emissions

3,1 To be filled by Member States with references of the notes they would provide at the bottom of this sheet, Notes.

3,2 Sum of the household emissions.

3,3 Total national producers' emissions including waste dumping sites, bunkering (shipping and flying) and road transport (trucking and tourism) abroad, and excluding foreign entities' emissions inside (flying, trucking and tourists). If producers' emissions reported in detailed Tables 1b (NACEem) or MS-1b (MSem) already include national emissions abroad and exclude foreigners' emissions inside, totals from the relevant detailed table have to be reported here.

3,4 In the NAMEA, environmental accounts have to be in concordance with national economic activity. Air emissions from national entities abroad have to be included and air emissions from foreign entities inside have to be excluded.

3,5 If neither bunkering and road transport abroad are included nor emissions from foreign entities inside are excluded in detailed Tables 1b (NACEem) or MS-1b (MS-1b), totals from the relevant detailed table have to be reported here, either in the first row when emissions from waste dumping sites are excluded or in the second row when they are included.

3,6 Only transboundary outflows/inflows through movements of atmospheric masses.

3,7 Carbon sequestration according to the Kyoto agreement (growth in forestry bio-mass for forests established since 1990).

3,8 In tonnes ('000s tonnes for CO₂) for the relevant emissions.

3,9 When global warming potential is calculated, the measures in tonnes of CO₂ equivalents used should be those defined by the International Panel on Climate Change in 1995, Global Warming Potential over 100 years (GWP100 per tonne of gas emitted

now, weighting factors are shown in the manual). The first index proposed – based on CO₂, N₂O and CH₄ emissions – is used by most of the Member States in their NAMEA-Air pilot studies. As mentioned in the manual, it is also possible to include other gases in a more comprehensive greenhouse gas theme in the row “greenhouse theme as you like”.

- 3,10 Acid rain precursors are expressed in number of H⁺ moles per unit of gas emitted. The coefficients used for the calculation of acid rain precursors differs according to circumstances, and thus in between countries. Nevertheless, in NAMEA-Air pilot studies most of the Member States use a simple Potential Acid Equivalent index (weighting factors are shown in the manual) that does not take into account the location of the emissions or their transport through the atmosphere. As mentioned in the manual, the row “acidification theme as you like” offers the possibility to evaluate the acidification effect through another way of calculation.

Notes for Table 4 (sheet NAMEA) - NAMEA summary table based on a simplified supply and use table including emissions to air

In all white areas, cells with question marks (???) are supposed to be filled.

White areas with a dashed outline represent data from the detailed tables. Figures reported in cells with question marks are a grand total of each matching table.

In the **NAM**, identity between total supply and total use has to be reached by including additional information from national accounts that is not reported in other parts of the detailed standard tables. Those extra figures correspond with grand total of each national accounting item (imports, exports, other final consumption, gross fixed capital formation) quoted there.

In the **EA**, emissions to air are allocated to greenhouse effect and acidification themes. Heavy metal emission types are not included because there is no standard toxicity theme indicator yet. Not all the emission types are included in this aggregated overview table, heavy metals are suppressed as hidden rows/columns.

Please note that employment data reported in detailed economic table (1a or MS-1a) is placed as an extension at the bottom of the aggregated NAMEA.

7.2 1992 data

Table 2a - Detailed households' expenditures data from the national accounts

1992 I Italy	Final consumption		Category specific notes
	Current prices	Constant prices	
	billion lira		
Notes	2a.1	2a.2	2a.3
Households, total	897.639	1.046.852	
Transport	56.788	66.704	Household consumption for "transport" purposes corresponds to expenditure on "operation of personal transport equipment" (COICOP item 07.2)
Heating	36.361	41.651	Household consumption for "heating" purposes corresponds to expenditure on "electricity, gas and other fuels" (COICOP item 04.5)
Other	804.490	938.497	Of all household activities comprised in this category, only gardening, paint application and solvent use (other than paint application) generate the emissions considered here
Not allocated	2a.4		

Table 2b - Detailed households' emissions data according to NAMEA definitions

1992 I Italy	1 st Priority							Category specific notes
	CO ₂	of which CO ₂ from biomass	N ₂ O	CH ₄	HFCs	PFCs	SF ₆	
	tonnes							
Notes								
Households, total	99.194.722	14.246.638	7.724	34.867				
Transport	31.796.448	-	1.181	20.079				
Heating	66.862.909	14.246.638	6.542	14.681				
Other	535.365	-	0	107				
Not allocated	2b.2							

1992 I Italy	2 nd Priority								Category specific notes
	NO _x	SO _x	NH ₃	NM VOC	CO	Particulate matter	CFCs	HCFCs	
	tonnes								
Notes									2b.1
Households, total	389.705	63.794	346	702.390	3.416.801				
Transport	342.727	15.083	345	506.985	3.092.040				
Heating	46.954	48.701	1	25.320	304.053				
Other	23	10	0	170.085	20.708				
Not allocated	2b.2								

Table MS-1a - Detailed data from national accounts according to Member States industry classification

	1992		Notes		Employment		Constant prices		Industry specific notes	
	I Italy				full-time jobs	number/persons	Output	Value added 1995 billion lira		Intermediate consumption
	Output	Value added	Intermediate consumption	Output							Value added
		billion lira	'000 manhours	MS-1a.1				1995 billion lira		
	2.700.262	1.368.054	1.332.208	23.457.200	22.920	3.080.852	1.534.761	1.546.092	MS-1a.2	
Industries, total (including FISIM)										
01-02	72.368	46.534	25.834	1.854.800	1.538	80.794	51.771	29.023		
05	2.633	1.966	667	82.700	45	2.444	1.732	712		
10-12	4.351	3.990	361	10.700	11	5.187	4.756	431		
13-14	5.632	2.652	2.980	38.600	39	6.089	2.855	3.234		
15-16	130.560	34.862	95.698	494.500	502	149.055	36.774	112.281		
17	59.591	21.315	38.276	410.200	428	69.227	24.084	45.143		
18	40.907	16.122	24.785	437.900	452	44.109	16.136	27.973		
19	31.004	10.391	20.613	254.300	262	36.038	10.881	25.157		
20	21.268	8.585	12.683	199.000	203	24.786	9.398	15.388		
21	21.535	6.899	14.636	87.700	95	27.966	8.221	19.745		
22	31.781	13.799	17.982	194.700	202	37.608	14.933	22.675		
23	30.261	6.910	23.351	25.300	28	37.107	8.830	28.277		
24	76.511	23.349	53.162	236.200	246	94.644	28.781	65.862		
25	32.029	12.018	20.011	176.400	184	40.794	14.605	26.190		
26	50.300	20.134	30.166	292.100	298	55.598	21.162	34.436		
27	42.669	10.503	32.166	148.200	162	56.928	14.279	42.649		
28	75.567	31.907	43.660	600.200	609	87.832	34.995	52.837		
29	100.782	35.958	64.824	532.800	553	115.198	38.226	76.972		
30	6.660	1.623	5.036	18.800	21	7.592	1.435	6.157		
31-32	57.101	23.007	34.093	330.500	345	63.021	22.756	40.265		
33	14.096	6.567	7.528	108.100	108	15.772	6.904	8.868		
34	41.616	10.741	30.875	181.300	209	50.425	12.451	37.974		
35	20.061	6.397	13.664	125.500	133	24.367	7.667	16.700		
36-37	43.468	15.156	28.312	321.900	329	48.861	15.168	33.693		
40-41	54.730	31.334	23.396	179.200	180	63.708	35.673	28.035		
45	198.131	88.875	109.256	1.640.200	1.584	215.600	94.913	120.687		
50-52	313.938	198.637	115.301	3.632.000	3.590	348.487	216.633	131.854		
55	84.049	46.347	37.702	1.124.200	881	97.722	54.239	43.483		
60	88.099	49.289	38.810	861.100	585	99.648	55.402	44.246		
61-63	65.354	24.855	40.500	252.600	255	79.049	30.588	48.461		
64	36.648	28.136	8.513	308.500	312	38.462	28.761	9.701		
65-67	133.360	89.658	43.702	634.000	635	136.866	89.695	47.171		
70-74	314.176	228.045	86.131	1.787.200	1.697	381.879	279.575	102.505		
75	120.645	35.786	33.786	1.483.400	1.494	131.027	91.659	39.368		
80	89.414	79.190	10.224	1.624.100	1.661	98.344	86.607	11.737		
85	98.987	66.298	32.689	1.225.100	1.229	106.624	73.052	33.572		
90-93	79.321	47.214	32.107	875.800	863	89.539	52.213	37.326		
95	10.660	10.660	-	667.400	954	12.456	12.456	-		
Not allocated (FISIM)	-76.728	-76.728	76.728				-75.505	75.505		

Table MS-1b - Detailed emission data according to Member States national accounts industry classification

1992 I Italy	1 st Priority										2 nd Priority						Industry specific notes
	CO ₂	of which CO ₂ from biomass	N ₂ O	CH ₄	HFCs	PFCs	SF ₆	NO _x	SO _x	NH ₃	NMVOC	CO	Particulate matter	CFCs	HCFCs		
	tonnes																
	Notes															MS-1b.2	
Industries, total		363.177.001	4.245.508	118.135	1.812.395											MS-1b.1	
		1.719.063	1.505.444	438.506	1.606.463	4.342.802											
01-02		7.464.950	328	78.939	902.935												
05		653.834	-	2	87												
10-12		16.014	0	3	19.502												
13-14		459.003	266	92	35												
15-16		1.018.920	10.708	182	65.552												
17-18		1.372.776	38.582	148	3.923												
19		419.516	1.234	44	56												
20		569.294	1.121	69	47												
21-22		4.791.245	10.628	90	45.284												
23		13.635.546	10.692	938	5.548												
24		2.618.312	23.826	21.420	3.134												
25		906.101	9.481	94	143												
26		41.781.203	18.237	2.858	1.499												
27-28		22.041.383	24.437	537	10.469												
29		1.552.322	14.742	207	208												
30-33		711.357	6.251	103	125												
34-35		2.325.322	26.499	194	323												
36-37		456.104	2.562	108	57												
40-41		169.059.184	3.702.502	6.234	309.070												
45		2.462.273	3.346	353	475												
50-52		26.165.104	93.965	1.698	8.587												
55		2.175.217	57.644	153	851												
60-64		44.156.315	65.774	2.594	6.906												
65-67		1.234.845	11.073	81	532												
70-74		6.328.251	32.526	423	2.753												
75		2.608.611	25.644	161	668												
80		803.884	6.383	50	230												
85		2.590.199	27.416	147	986												
90-93		2.799.915	19.642	215	422.412												
95		-	-	-	-												

Table 3 - Environmental Accounts Overview, origin and destination of substance flows in the NAMEA for air emissions

Italy I 1992	Unit	Notes	CO2	N2O	CH4	HFCs	PFCs	SF6	NOx	SOx	NH3	NMVOC	CO	Particulate matter	CFCs	HCFCs	Specific notes
ORIGINS OF EMISSIONS																	
Emissions by households		3,2	99.194.722	7.724	34.867				389.705	63.794	346	702.390	3.416.801				
Total emissions from national producers		3,3															
<u>Emissions to include</u>		3,4															
Emissions from waste dumping sites																	
Emissions from bunkering abroad																	
- shipping abroad																	
- flying abroad																	
Emissions from road transport abroad																	
- trucking abroad																	
- tourism abroad																	
<u>Emissions to exclude</u>		3,4															
Emissions from foreigners inside																	
- international flying inside																	
- international trucking inside																	
- foreign tourists																	
National territory producers' emissions excluding waste dumping sites		3,5															
National territory producers' emissions including waste dumping sites			363.177.001	118.135	1.812.395				1.719.063	1.505.444	438.506	1.606.463	4.342.802				
Transborder emissions from the rest of the world		3,6															
Total origin of emissions																	
DESTINATION OF SUBSTANCES																	
Carbon sequestration		3,7															
Transborder emissions to the rest of the world		3,6															
Contribution to environmental themes																	
Greenhouse effect		3,8	462.371.723	125.859	1.847.262												
Acidification																	
Photochemical pollution																	
Total destination emissions																	
Environmental themes																	
GWP100 (CO2, N2O, CH4)		3,9	540.180.405														
GWP100 (CO2, N2O, CH4, HFCs, PFCs, SF6)																	
PAE (SO2, NOx, NH3)		3,10	120.696														
			In theme equivalents														

Rapporto ad Eurostat

Italian NAMEA: air emission accounts for the year 1999

Angelica Tudini, Giusy Vetrella

1 INTRODUCTION

Istat produced in 1999 a first pilot Italian NAMEA with reference year 1990. It included an Input-Output (I/O) based economic module and an environmental module comprising emission accounts for six air pollutants - carbon dioxide (CO₂), sulphur oxides (SO_x), nitrogen oxides (NO_x), nitrous oxide (N₂O), ammonia (NH₃), methane (CH₄) - as well as the direct intake from nature of virgin materials – endogenous steam, wood and fossil fuels, minerals, biotic materials - by economic activity²⁹⁷.

A second pilot project, completed in 2001, generated the 1991 and 1992 NAMEA matrices and the revised 1990 NAMEA²⁹⁸. The three matrices include:

- in the economic module, a NAM that reproduces almost completely the one described in the UN SNA²⁹⁹ and ESA³⁰⁰ manuals;

Il testo riportato riproduce integralmente il rapporto originale consegnato all'Eurostat nel 2003. In esso è riportato quanto segue:

The project was coordinated by Angelica Tudini (Istat – Environmental accounting).

The paragraphs were authored as follows: §§ 1, 2.2 and 3 (including the compilation of the Tables) by Angelica Tudini; §§ 2.1 and 2.3 by Giusy Vetrella (Istat – Environmental accounting).

Giusy Vetrella also built the ACCESS database that allows to calculate air emissions by activity.

The authors wish to thank Riccardo De Lauretis (APAT), Alessandra Milani and Filippo Moauro (Istat) for their substantial contribution to the project. Riccardo De Lauretis provided the CORINAIR emissions data and contributed to the identification the related NAMEA activities as well as to the definition of some of the methods to distribute the process emissions to the related NAMEA activities. Alessandra Milani and Filippo Moauro calculated energy use data for 1999 broken down by branch, energy product and function.

We are also grateful to Federica Battellini (Istat), Francesca Tartamella (Istat), Andrea Mercanti (Ministry of productive activities).

²⁹⁷ See Battellini et al., 1999.

²⁹⁸ See Coli et al., 2001.

²⁹⁹ See United Nations, 1993.

³⁰⁰ See Eurostat, 1996.

- in the environmental module, air emission accounts for eight pollutants - CH₄, CO, CO₂, N₂O, NH₃, NMVOC, NO_x, SO_x and the estimation of the direct intake of virgin materials by economic activity³⁰¹.

This report concerns the third Istat NAMEA-related project co-financed by the Commission of the European Communities³⁰². The main purpose of the work is the implementation of NAMEA air emission accounts for ten air pollutants CH₄, CO, CO₂, N₂O, NH₃, NMVOC, NO_x, SO_x, Pb and PM10 with reference to 1999.

Furthermore, Istat is currently engaged in another Eurostat co-financed project – to be completed in 2004 – with the aim of producing a NAMEA air emission time series for the years 1990-2000.

Paragraph 2 describes in detail the data sources used and the methodology applied to build the air emission accounts. The methodology is basically the same as for the 1990-1992 NAMEAs³⁰³. There are, however, some important changes that were introduced as a follow up to the conclusions of a Working Group set up and co-ordinated by Istat with the aim of improving some aspects of the Italian NAMEA methodology and to make it consistent over the years covered by the NAMEA air emissions time series to be produced for next year³⁰⁴. Participants included experts from Istat, APAT (the Italian National Agency for Environmental Protection and Technical Services)³⁰⁵ as well as the Ministry of Productive Activities.

Paragraph 3 presents the main output of the work: the 1999 NAMEA air emissions data broken down by economic branches and households consumption purposes according to the format set in the Eurostat 2002 NAMEA air standard tables.

³⁰¹ Air emissions data consistent with the NAMEA 1990-1992 methodology are available on the Istat web site (see Coli Femia Tudini - Vetrella, 2003). See Battellini et al., 1999. See Coli et al., 2001. See United Nations, 1993. See Eurostat, 1996. Air emissions data consistent with the NAMEA 1990-1992 methodology are available on the Istat web site (see Coli - Femia - Tudini - Vetrella, 2003).

³⁰² Reference: sub 200241200008

³⁰³ See footnote 298 above. For a general description of the Istat methodology to build NAMEA air emission accounts see also De Lauretis - Tudini - Vetrella, 2002.

³⁰⁴ More detailed references to the output of the Working Group will be included in the Istat 2004 final report to Eurostat for the NAMEA air time series.

³⁰⁵ Formerly known as ANPA.

2 METHODS AND DATA SOURCES

NAMEA air emission accounts produced by Istat use as main input the Italian CORINAIR air emission data classified according to the process-based SNAP 97 classification. Data are supplied by APAT. Paragraph 2.1 describes some relevant features of the CORINAIR data used for the NAMEA as well as the changes made to the CORINAIR emissions database to make it consistent with the NAMEA principles.

Paragraphs 2.2 and 2.3 describe in detail the activities carried out in order to shift from the CORINAIR process-based classification to the NAMEA economic activity-based classification, namely:

- i. the analysis of the qualitative link between each SNAP 97 process and NAMEA activities, i.e. the identification of the NAMEA activities in which a process takes place (§ 2.2);
- ii. the allocation of the emissions of each SNAP 97 process to the related NAMEA activities (§ 2.3).

Differences from the method adopted for the 1990-1992 Italian NAMEAs will be highlighted.

2.1 From CORINAIR to NAMEA emissions

2.1.1 *The SNAP 97 processes excluded from the NAMEA*

Out of all the SNAP97 processes³⁰⁶ those belonging to SNAP 97 category 110000 are excluded in principle from the NAMEA framework because they refer to emissions from non economic agents and processes related to the absorption of emissions.

In this respect, the main change from the 1990-1992 Italian NAMEAs concerns the two processes coded 1111 and 1112, respectively referring to “Managed broadleaf forests” and to “Managed coniferous forests”. While they were included in the Italian 1990-1992 NAMEAs consistently with the guidelines laid out in the Eurostat NAMEA 2000 manual, they are now excluded in agreement with the notes of the Eurostat 2002 standard tables.

In addition, some processes are not available in the Italian CORINAIR database used as input for at least one of the following reasons:

- the process does not take place in Italy
- the emission estimates are not available for Italy
- the process emits pollutants other than the ten included in the Italian NAMEA

2.1.2 *Changes to CORINAIR transport emissions*

Istat is currently finalising a method to shift from the national territory related CORINAIR transport emissions to the NAMEA framework based on “resident units”³⁰⁷. At present the consistency between CORINAIR and NAMEA transport emissions is met partly by construction and partly by introducing some assumptions as in the 1990-1992 Italian NAMEAs³⁰⁸. Thus, total CORINAIR transport emissions and total NAMEA transport emissions are currently the same.

³⁰⁶ The structure of the SNAP 97 classification includes: 11 source categories, 76 source sub categories and 414 source activities.

³⁰⁷ This is one of the issues studied within the NAMEA Working Group mentioned above. The method devised by the Working Group will be applied to calculate NAMEA-consistent transport emissions in the 1990-2000 NAMEA air time series to be produced in 2004.

³⁰⁸ See Coli et al., 2001.

2.2 Qualitative link between each SNAP 97 process and NAMEA activities

Table 1 below provides the full list of qualitative links between SNAP 97 processes included in the 1999 Italian NAMEA and NAMEA activities. Since the key to ensure a correct match between SNAP 97 process and NAMEA activities is, on the one hand, the knowledge of how the emissions are estimated in practice in the Italian CORINAIR and, on the other, the understanding of the actual structure of the Italian NAM, the identification of the NAMEA activities responsible for the emissions of each SNAP 97 process is achieved through a process-by-process analysis carried out jointly by the CORINAIR and NAMEA experts³⁰⁹.

The first column of the Table 1 shows that some processes are included in the NAMEA at the 6th digit of the SNAP 97 (source activities) while in other cases the 4th SNAP 97 (source sub-category) digit is used. The actual level of breakdown, depends, for each process, on the qualitative link with the NAMEA activities; specifically:

- when all the SNAP 97 processes at the 6th digit included in the Italian NAMEAs and belonging to the same source sub-category, are linked to the same NAMEA activities, then emission data at the 4th SNAP 97 digit can be used for the NAMEA³¹⁰;
- when at least two SNAP 97 processes at the 6th digit included in the Italian NAMEAs and belonging to a same source sub-category are not linked to the same NAMEA activities, emission data at the 6th SNAP 97 digit are needed instead³¹¹.

The second column reports the NAMEA classification activity codes for which air emission estimates exist in the Italian NAMEA. Some of them are grouped together while they are split - as reported in brackets - in the Eurostat NAMEA classification: 11-12 (11, 12); 27 (27.1-3, 27.4-5); 40 (40.1, 40.2, 40.3); 60.2-60.3 (60.2, 60.3); 61 (61.1, 61.2).

Economic activities 15 and 16 are no longer grouped together.

Households' consumption by purpose is coded as follows: transport = 101; heating = 102; other = 103.

³⁰⁹ As stated in De Lauretis – Tudini – Vetrella, 2002, § 2: “For each process the CORINAIR experts are asked to provide details on:

- the general features of the process (as described in the CORINAIR methodology);
- the way the emission estimates are actually produced for Italy.
- The NAMEA experts can identify the NAMEA activities in which the specific process takes place by matching the information obtained on the emission estimates with their knowledge on:
 - the internationally agreed upon NAMEA features;
 - the specific features of the Italian NAM, particularly the fact that homogeneous industries are used.”

³¹⁰ For example, since all SNAP 97 processes of the source sub-category 010100 (010101, 010102, 010103, 010104 and 010105) are linked to the NAMEA activity 40, emissions of process 0101 are used for the data input.

³¹¹ This is the case for example of the source sub-category 010300, since processes 010301, 010302, 010303 are linked to the NAMEA activity 40 and process 010306 is linked to the NAMEA activity 23.

Table 1 - Link between SNAP 97 processes included in the Italian NAMEAs and NAMEA activities

Processes included in the Italian NAMEAs (SNAP 97 code)	Related NAMEA activities	Processes included in the Italian NAMEAs (SNAP 97 code)	Related NAMEA activities
010100	40	040614	26.2-26.8
010200	40	040615	31
010301	40	050101	10
010302	40	050102	10
010303	40	050103	23, 24, 26.2-26.8, 27, 40
010306	23	050200	11-12
010401	40	050300	11-12
010403	40	050401	23
010406	27 (a)	050402	60.2-60.3
010500	60.2-60.3	050501	23
020100	10-95	050502	23
020200	102	050503	50-52
020300	01, 02, 05	050600	40
030100	40	050700	40
030203	27	060101	34
030204	26.2-26.8	060102	50-52
030301	27	060103	45
030302	27	060104	103
030303	27	060105	28
030304	27	060106	35
030305	27	060107	20, 36 (c)
030307	27	060108	28, 29
030308	27	060201	28
030309	27	060202	93
030310	27	060301	25
030311	26.2-26.8	060302	25
030312	26.2-26.8, 27	060303	25
030313	23	060304	25
030314	26.1	060305	25
030315	26.1	060306	24
030317	26.1	060307	24
030319	26.2-26.8	060308	24
030320	26.2-26.8	060309	24
030321	21	060312	17
030322	27	060313	19
040100	23	060314	19
040200	27 (b)	060401	26.1
040300	27	060403	22
040400	24	060404	15
040500	24	060405	19, 20, 35, 36, 50-52
040601	20	060408	103
040603	21	060409	50-52
040604	21	070100	01-95, 101
040605	15	070200	01-95, 101
040606	15	070300	01-95, 101
040607	15	070400	01-95, 101
040608	15	070500	01-95, 101
040610	45		
040611	45		
040612	26.2-26.8		
040613	26.1		

(continues)

Table 1 (continued) - **Link between SNAP 97 processes included in the Italian NAMEAs and NAMEA activities**

Processes included in the Italian NAMEAs (SNAP 97 code)	Related NAMEA activities	Processes included in the Italian NAMEAs (SNAP 97 code)	Related NAMEA activities
070600	01-95, 101	090205	24, 90
070700	01-95, 101	090207	90
080100	75	090208	90
080200	60.1	090400	90
080300	61	090700	01
080402	61	091001	15, 17, 21, 23, 24, 27 (e)
080403	05	091002	90
080404	61	091003	90
080500	62	091005	90
080600	01	100100	01
080700	02	100200	01
080800	10-37, 45	100300	01
080900	101 (d)	100400	01
090201	90	100500	01
090202	24, 90	100900	01
090203	23		

- (a) The previous link with NACE divisions 23 and 27 is correct for years up to 1993. After 1993, changes in the Italian industrial structure imply the need to link this process to NACE 27 only.
- (b) In the 1990-1992 NAMEAs processes belonging to sub-category 040200 were previously included in the database at the 6th digit since one of them, 040201 was associated with NACE 23 and 27 while all others were linked to NACE 27 only. This still applies to years up to 1993. After 1993, changes in the Italian industrial structure imply the need to link process 040201 as well to NACE 27 only; therefore in 1999 all processes belonging to SNAP 97 040200 are linked to one NACE only and can be included at the 4th digit in the NAMEA database.
- (c) The previous link, with NACE 20 only, did not take into account furniture making.
- (d) Process 080900 "Household and gardening" was previously linked with NAMEA code 103, i.e. households – other. The new link with NAMEA code 101, i.e. households – transport is consistent with the 2002 standard tables, in which the definition of household consumption for transport includes gardening equipment such as lawnmowers.
- (e) With respect to the previous link the activities 23, 24 and 27 were added.

Based on Table 1 links, the SNAP 97 processes can be split into two groups:

- processes with only one link to the activities of the NAMEA classification;
- processes with multiple links to the activities of the NAMEA classification.

The following paragraphs provide details on how the calculation of air emissions by NAMEA activity is carried out in each case.

2.3 Allocation of the emissions of each SNAP 97 process to the related NAMEA activities³¹²

Emissions from all processes linked to one activity only can be directly allocated to the related NAMEA activity without further calculation.

Emissions from all processes linked to more than one activity have to be distributed among the corresponding NAMEA activities.

The methods used to distribute the emissions with multiple NACE associations are dealt with in detail in the following paragraphs and summarised in the table below. The choice of a specific method depends on the characteristics of the processes themselves as well as on the kind of background information available for them.

In any case, the starting point for the quantitative allocation of emissions with multiple NACE associations is to look at the basic data used to produce the CORINAIR emission estimates as a possible source of information. In practice, three main kinds of data can be used:

- data on emissions by fuel (see § 2.3.1 below);
- activity-related CORINAIR background data (see § 2.3.2 below);
- data on full time employees (see § 2.3.3 below).

³¹² This paragraph is based on De Lauretis – Tudini – Vetrella (2002), § 4.

Table 2 - Overview of methods used to distribute the emissions of SNAP 97 processes with multiple NACE associations

Type of process	SNAP 97 code	Corresponding NAMEA activities	Method (*)
Combustion in commercial and institutional plants	020100	10-95	E
Combustion plants in agriculture, forestry and aquaculture	020300	01, 02, 05	E
Lime (combustion processes)	030312	26.2-26.8 for area emissions; 27 for point source emissions	CB
Storage of solid fuel	050103	23, 24, 26.2-26.8, 27, 40	E
Paint application : wood	060107	20, 36	FTE
Other industrial paint application	060108	28, 29	CB
Application of glues and adhesives	060405	19, 20, 35, 36, 50-52	FTE
Passenger cars	070100	01-95, 101	E
Light duty vehicles < 3.5 t	070200	01-95, 101	E
Heavy duty vehicles > 3.5 t and buses	070300	01-95, 101	E
Mopeds and Motorcycles <50 cm3	070400	01-95, 101	E
Mopeds >50 cm3	070500	01-95, 101	E
Gasoline evaporation from vehicles	070600	01-95, 101	E
Automobile tyre and brake wear	070700	01-95, 101	E
Industry (off-road transport)	080800	10-37, 45	E
Incineration of industrial wastes (except flaring)	090202	1/3 of emissions to NACE 24 and 2/3 to NACE 90	CB
Incineration of sludges from waste water treatment	090205	1/3 of emissions to NACE 24 and 2/3 to NACE 90	CB
Waste water treatment in industry	091001	15, 17, 21, 23, 24, 27	CB

(*) CB: process whose emissions were distributed on the basis of CORINAIR background data.

E: process whose emissions were distributed on the basis of energy use data by activity.

FTE: process whose emissions were distributed on the basis of the number of full time employees by economic activity.

2.3.1 Emissions distributed on the basis of energy use data by activity

For some SNAP 97 processes with multiple NACE associations (specifically SNAP 97 codes 020100, 020300, 070100, 070200, 070300, 070400, 070500), the emissions for the general process “ p ” are obtained as the sum of the emissions of each energy product used in the estimates:

$$(1) \quad EMI(p) = EMI_1(p) + EMI_2(p) + \dots + EMI_j(p) + \dots + EMI_{n_p}(p)$$

where:

$EMI(p)$ are the total emissions from SNAP 97 process p ;

$EMI_j(p)$ is the quantity of emissions arising from the use of the energy product j in the SNAP 97 process p ;

$j=1, 2, \dots, n_p$ is the generic element of the group of n_p energy products used for estimating the emissions of SNAP 97 process p .

For the j -th energy product used in process p , it is necessary to find a weight $W_j^i(p)$ that represents the part of emissions to be attributed to each NAMEA activity i in which process p is carried out.

$$(2) \ EMI_j^i(p) = W_j^i(p) * EMI_j(p)$$

where:

- $EMI_j^i(p)$ is the quantity of emissions arising from the use of the energy product j in SNAP 97 process p allocated to the NAMEA activity i ;
- $i = 1, \dots, h_p$ is the generic element of the group of h_p NAMEA activities in which the SNAP 97 process p is carried out.

The CORINAIR background data used to estimate the emissions cannot be used to build the weights $W_j^i(p)$ as they are not available with a breakdown consistent with the NAMEA economic activities³¹³.

As in the case of the Italian NAMEAs 1990-1992, the data source to split the emissions of the processes listed above was found in the 1999 Istat national accounts data on energy use by economic activity and households. The data have a number of features that make them suitable for the purpose of splitting the heating and transport related emissions: they relate to the use of a set of energy products - that can be linked to the energy products used for the CORINAIR estimates³¹⁴ - and are broken down by economic activities consistently with the NAMEA classification. However, for an optimal use of energy consumption data for NAMEA purposes, the breakdown by function or type of use is needed as well. Specifically, the breakdown into “road transport”, “off road transport”, “heating”, “other energy use”, “non-energy use” appears to suit well the NAMEA needs as long as:

- the function “heating” is consistent with the SNAP 97 processes related to heating, (SNAP 97 category 02);
- the function “road transport” is consistent with the SNAP 97 processes related to road transport (processes belonging to the SNAP 97 category 07).

Since the split by function was originally not available in the 1999 national accounts data, a specific method was devised based on the following main steps³¹⁵:

1. identification of the five different uses - road transport, off road transport, heating, other energy use, non-energy use - within the National Energy Balance (NEB) data; basic inputs to this calculation included information from APAT on which NEB sections are used to estimate specific CORINAIR emissions as well as information on the contents of the uses in previous Istat energy use Tables³¹⁶.
2. assessment of the link between Istat energy products and NEB energy products;

³¹³ For the SNAP 97 processes at issue (see list in the text) the emission estimates are based on data on energy consumption derived mainly from the National Energy Balance (not fully consistent with the NAMEA activity classification), as well as, in the case of transport, on numerous technical parameters that allow to take into account factors such as the type of engine and the speed in the calculation of emissions.

³¹⁴ CORINAIR energy products follow the NAPFUE classification whereas the Istat energy products are consistent with the Eurostat energy product classification.

³¹⁵ This is one of the achievements of the NAMEA Working Group.

³¹⁶ In the 1988 Istat energy use Table data were split by function as well.

3. calculation, for each Istat energy product, of the share of the five different uses based on National Energy Balance data.

The availability of energy consumption data by branch, by product and by function allows the calculation of the following weights for the j -th energy product used in process p :

$$(3) W_j^i(p) = \frac{use_j^i(l)}{\sum_{i=l} h_p use_j^i(l)},$$

where:

$l =$ "heating use", "road transport use", "off-road transport use", "other energy use", "non energy use" indicates the specific function of the energy use data, associated to SNAP 97 process p ³¹⁷;

$use_j^i(l)$ is the generic element of the Istat energy use data, i.e. it is the quantity of product j used by the NAMEA activity i for the function l .

By construction the following holds:

$$(4) 0 \leq W_j^i(p) \leq 1 .$$

Finally, the total emissions from SNAP 97 process p allocated to the NAMEA activity i is given by:

$$(5) EMI^i(p) = \sum_{j=1}^{n_p} EMI_j^i(p)$$

In addition to the processes listed at the beginning of the paragraph, the method based on energy use data by activity is applied also to SNAP 97 processes 050103 "Storage of solid fuel", 070600 "Gasoline evaporation from vehicles", 070700 "Automobile tyre and brake wear" and 080800, which refers to industry off road transport. Specifically, since for this processes CORINAIR emissions are not split by energy product as in the above relationship (1), the weights are obtained as follows:

- for process 050103, as the sum of weights for the energy products coal and lignite, (total use applies since emissions derive from storage of specific energy products regardless of their use);
- for process 070600, with the weights calculated for the energy product gasoline for the other road transport processes (070100 to 070500);

³¹⁷ In practice the function "heating" is used to distribute the SNAP 97 processes 020100 and 020300; the function "road transport" is used to distribute the SNAP 97 processes 070100, 070200, 070300, 070400 and 070500.

- for process 070700, as average of the weights derived from each energy product used for the estimates of transport processes 070100-070500;
- for process 080800, with weights for the energy product diesel, function “off road transport”.

2.3.2 Emissions distributed on the basis of CORINAIR background data

Emissions of SNAP 97 processes 030312, 060108, 090202, 090205 and 091001 are distributed on the basis of different activity-related CORINAIR background data.

Specifically:

- SNAP 97 process 030312 “Lime (combustion processes)”; point source emission data, i.e. data collected at specific establishments, are available and the CORINAIR experts’ direct knowledge of the activity of each establishment, and of the methods used to estimate the area components, allows to identify the links with the NAMEA activity responsible for producing the emissions; in addition to the point source emissions there is another component estimated as area source;
- SNAP 97 process 060108 “Other industrial paint application”. The process takes place in NACE activities 28 and 29. Detailed background data based on production and on the percentage content of solvent per unit of production are available as inputs of the 1999 CORINAIR estimates and show that 21% of emissions come from NACE 28 and 79% from NACE 29;
- SNAP 97 processes 090202 “Incineration of industrial wastes (except flaring)” and 090205 “Incineration of sludges from waste water treatment”. The Italian CORINAIR experts estimate that the 2/3 of emissions coming from incineration processes as are due to NACE 90 and that the remaining 1/3 belong to NACE 24 enterprises;
- SNAP 97 process 091001. The methane emissions of process 091001 “Waste water treatment in industry” are estimated through an ad hoc study that includes the economic activities “Manufacture of food products and beverages” (NACE 15), “Manufacture of textiles and textile products (not including wearing apparel)” (NACE 17) “Manufacture of pulp, paper and paper products” (NACE 21), “Manufacture of coke, refined petroleum products and nuclear fuel (NACE 23), “Manufacture of chemicals and chemical products” (NACE 24) and “Manufacture of basic metals” (NACE 27). The total methane emissions of process 091001 are calculated in the study as a sum of the emissions from the six economic activities, and therefore, on the basis of the basic data, it is possible to exactly distribute the total methane emissions among the NAMEA activities 15, 17, 21, 23, 24 and 27. The emissions of N₂O are distributed with the same percentages calculated for methane.

2.3.3 Emissions distributed on the basis of the number of full time jobs by economic activity

Emissions of SNAP 97 processes 060107 and 060405 are distributed on the basis of national accounts data on the number of full time jobs by economic activity.

3 TABLES

The following tables present the Italian NAMEAs air emissions data for 1999 delivered to Eurostat according to the format set in the Eurostat 2002 NAMEA air set of standard tables³¹⁸.

3.1 Notes for filling in the tables³¹⁹

For each table a set of notes explains how to fill it in and what to include (or exclude) under each heading or industry. The general rule is that emission data should be allocated in a way that mirrors the economic data. The economic data should be allocated as specified in the system of national accounts.

Notes for table 1a (sheet '1a-NACEeco') - Economic data by industry from the national accounts

- 1a.1 Industry classification: The proposed industry classification is NACE 2-digit plus extra selective breakdowns (for the following NACE categories: 26, 27, 40, 60, 61) as shown in the sheet NACE-NAMEA. The tables should be filled in by Member States using this classification as far as possible.
If it is not possible to fill in all the details of this classification, the additional interim aggregations of industries should be used that have been 'nested' in the proposed classification (extra interim aggregations of industries are underlined, e.g. '12-14', '15-16' etc.). Aggregations that are not underlined are part of the standard industry classification proposed for NAMEA-Air.
Some voluntary extra selective breakdowns were also added (in NACE 23, 26 and 27, plus the 'of which' positions '24.14', '24.15', '60.24' and '75.22') as requested by Member States at the 4th NAMEA Workshop (20-21 June 2000).
Please note that the table should be filled in according to the most disaggregated level for which both economic **and** emission data are available according to the same level of detail.
- 1a.2 Current prices: Output of industries at basic prices. Unit: Appropriate level of national currency (please specify).
- 1a.3 Current prices: Gross Value Added of industries at basic prices. Unit: Appropriate level of national currency (please specify).
- 1a.4 Current prices: Intermediate consumption of industries at purchasers' prices. Unit: Appropriate level of national currency (please specify).
- 1a.5 Employment of industries in hours worked. Unit: 1000 hours.
- 1a.6 Employment in full time equivalent - Unit: number of jobs.
- 1a.7 Employment of industries in number of persons (employees and self-employed). Unit: 1000 persons.

³¹⁸ The original report to Eurostat included the Table '1bt-NACEtransp') - Emissions from transport activities as well.

³¹⁹ Source: Eurostat "NAMEA set of standard tables – Notes."

- 1a.8 Constant prices: Output of industries at basic prices. Base year 1995. Unit: Appropriate level of national currency (please specify). If this data is not available, please report a volume index instead.
- 1a.9 Constant prices: Gross Value Added of industries at basic prices. Base year 1995. Unit: Appropriate level of national currency (please specify). If this data is not available, please report a volume index instead.
- 1a.10 Constant prices: Intermediate consumption of industries at purchasers' prices. Base year 1995. Unit: Appropriate level of national currency (please specify). If this data is not available, please report a volume index instead.
- 1a.11 Please put here the reference numbers of the comments that you provide. The comments should be entered underneath the table.
- 1a.12 In NAMEA, the economic and emissions data should be consistent with one another and should therefore be reported according to the same level of detail. When available economic or emissions data for industries do not fit the flexible industry classification offered they should be reported under 'Not allocated'. For economic data for recent statistical years this should not be the case (for FISIM see note 1a.13 below) but it may still be the case for the emissions data in Table 1b (air emissions by industries - see also note 1b.11 below). 'Not allocated' in Table 1a should have the same coverage as 'Not allocated' in Table 1b, the only exception being when own-account transport emissions cannot be fully allocated to industries (see also note 1b.9 below). Please make a clear comment about what is included in the 'Not allocated' category in your comments at the bottom of the table.
- 1a.13 When FISIM (Financial Intermediation Services Indirectly Measured) is not allocated to industries it should be reported here (this applies to value added and intermediate consumption only).

Notes for Table 1b (sheet '1b-NACEemis') - Emission data by industry according to NACE rev. 1 and NAMEA definitions

- 1b.1 Please put here the reference numbers of the comments that you provide. The comments should be entered underneath the table.
- 1b.2 Emissions from burning of biomass should be included in the total and allocated to the relevant industries. CO₂ emissions stemming from the combustion of biomass should also be reported separately in the column 'of which CO₂ emissions from biomass'.
- 1b.3 Industry classification: please consult note 1a.1 above.
The table should be filled in at the most disaggregated level at which both the economic **and** the emission data are available.
- 1b.4 Carbon sequestration in forests is **not** to be subtracted from the total emissions to air in forestry. Similarly, 'natural' emissions from managed forests (e.g. NMVOC emissions from living trees) are **not** to be reported here. The NAMEA principle is to record all emissions from economic activities of resident units. In principle, this would include the 'natural' emissions from, and removal of pollutants by, cultivated forests. However, 'natural' removal of pollutants and 'natural' emissions are excluded from NAMEA air due to difficulties in Europe to determine which forests are cultivated and the related emissions (which vary considerably across tree species, with the weather, etc.). See also Table 3 (sheet 3-bridgetable) and the notes to Table 3.

- 1b.5 Fishing should include emissions stemming from national fishing vessels operating abroad. See also below note 3.8 to Table 3 (sheet 3-bridgetable) which provides detail on the differences between NAMEA emission totals and the totals according to international air emission reporting formats. If you do not yet have data according to the NAMEA definitions (residence principle) please add a comment clarifying what the data include and exclude.
- 1b.6 Emissions related to the extraction of natural resources must be included. E.g., emissions connected to flaring of natural gas must be included on top of the emissions from the fuels used in the extraction process.
- 1b.7 Evaporation of substances from stored fuel in connection with refineries should be included in the total emissions from refineries.
- 1b.8 Emissions due to the production of electricity sold on the market should be placed in NACE 40, when electricity production is a principal activity and - if homogeneous branches are used instead of industries - when it is a secondary activity. Allocation of these emissions to the final users of the electricity is a further analysis of the NAMEA data, but lies beyond the definitions of the basic NAMEA framework. Emissions due to the production of electricity for own consumption (own account) should be allocated to the producing industries, even if economic data are based on homogenous branches.

Emissions related to losses due to distribution of natural gas are to be allocated to NACE 40, since they originate from the distributors' networks.

1b.9 Please be aware of the definition of the transport industries in NAMEA. Only emissions that are connected to the activities of commercial transport services are to be included here. Further, emissions connected to activities by national entities abroad are to be included and those stemming from foreign entities operating on the national territory are to be excluded. If you do not yet have data according to the NAMEA definitions (residence principle) please add a comment clarifying what the data include and exclude.

Emissions due to 'own account' transport should be allocated to individual industries. This means that the transport industries only include emissions due to activities connected to market transport services and the own account transport of the transport industries themselves. If it is not possible to allocate all own account transport emissions to industries, please do not allocate these to the transport sector but include these under 'Not allocated'.

In accordance with national accounts, emissions by national residents abroad are to be included and emissions by non-residents on the national territory are to be excluded. These emissions stem from lorries and buses (NACE 60), ships (NACE 61) and airplanes (NACE 62) engaged in international transport activities, as well as from private cars used for tourism (business travel - for households see Table 2b). Emissions by national residents abroad and emissions by non-residents on the national territory are specifically identified in Table 3 (sheet 3-bridgetable). Table 3 identifies the items that make up the differences between the emission totals according to NAMEA and according to international air emission reporting formats. See also notes 3.7 and 3.9 below.

Emissions due to marketed transport services should be allocated to the producers of transport services - i.e. only the transport industries (NACE 60-63) when the data are based on homogenous branches. When data are for (heterogeneous) industries,

transport industries include only emissions related to transport as principal activity. Emissions caused by transport as a secondary activity are allocated to the responsible industries other than transport industries. Allocation of emissions due to marketed transport services to the users of the transport services is a further analysis of the NAMEA data, but lies beyond the definitions of the basic NAMEA framework. However, note that when transport equipment is rented out, emissions are allocated to the industry of the ordering company (or households) and not to NACE 70-74 (NACE 71.1-2 - Renting automobile and other transport equipment).

- 1b.10 Emissions from waste dumping sites: these emissions are to be allocated to the economic activities that are economically responsible for the management of the waste dumping site. This will often be NACE 90. When industries have their own waste dumping sites, the emissions are put under the relevant industry. When economic data related to the public management of dumping sites are reported under NACE 75 (general administration) instead of NACE 90, please put the corresponding emission data accordingly.
- 1b.11 The row 'Not allocated' concerns emissions that cannot be allocated to the flexible industry classification offered in Table 1b. Please make clear comments on the non-allocated emissions. E.g. when available emission data do not fit the industry classification in Table 1b, please report the corresponding data in the row 'Not allocated' and indicate the industries covered in your comments at the bottom of the sheet. 'Not allocated' in Table 1b should have the same coverage as 'Not allocated' in Table 1a (economic data by industry). Should this not be the case, please indicate this in your comments.

Notes for Table 2a (sheet '2a-Heco') - Household consumption expenditure data from the national accounts

- 2a.1 Please put here the reference numbers of the comments that you provide. The comments should be entered underneath the table.
- 2a.2 Constant price: final consumption of households at purchasers' prices. Base year 1995. Unit: Appropriate level of national currency (please specify). If this data is not available, please report a volume index instead.
- 2a.3 Current prices: final consumption of households at purchasers' prices. Unit: Appropriate level of national currency (please specify).
- 2a.4 Classification based on COICOP (classification of individual consumption according to purposes - United Nations 1999).
- 2a.5 Classification based on COICOP (classification of individual consumption according to purposes - United Nations 1999).

Notes for Table 2b (sheet '2b-Hemis') - Household air emissions according to NAMEA definitions

- 2b.1 Please put here the reference numbers of the comments that you provide. The comments should be entered underneath the table.
- 2b.2 The full set of pollutants shown in Table 1b is included here, but pollutants that are not relevant for households are shaded (grey cells do not need to be filled in). Emissions of HFCs and PFCs are only expected in relation to purposes other than transport and heating. No emissions of SF₆ and heavy metals, except for lead (Pb), are expected at all.

- 2b.3 In order to be consistent with the household expenditure in Table 2a, the category 'transport' in Table 2b should include all emissions related to the combustion of fuels used as propellant by resident households. Transport emissions by non-resident households on the national territory should be excluded. Emissions from transport fuels purchased by resident households abroad (tourism) and from transport fuels used for purposes other than transport - i.e. for leisure boats and aircraft, lawnmowers and other tools such as pumps, chainsaws and hedge cutters, etc. - should be included. Therefore, the emissions reported here should differ from the pure transport emissions by households as reported in Table 1bt which applies a strict definition of transport. If the non-transport emissions related to propellant fuel can be separately identified, they should be reported in the row 'of which leisure-gardening equipment' so as to facilitate linking Tables 1bt and 2b.
- 2b.4 The category 'heating' covers emissions from the combustion of fuels for heating houses and flats by households, as well as from fuels used for cooking and producing hot water. Some emissions may not have any corresponding fuel consumption expenditure in Table 2a, e.g. when fuel wood is harvested for own final use by households. If this is the case for your data, please clearly mention this in your comments.
- 2b.5 This category includes solvent emissions from paints, aerosols from sprays and emissions from open fires (for leisure or burning garden refuse). Some countries may also have data for household emissions of HFCs, PFCs, CFCs and HCFCs. Please make clear in your comments what sources of emissions you included here.
- 2b.6 When emissions related to transport or to heating cannot be isolated, please report these emissions in the row 'Not allocated'. Please **do not** attribute these transport or heating emissions to the category 'Other' as this category should not include any transport or heating related emissions.

Notes on Table 3 (sheet '3-bridgetable') - Bridge table between total air emissions in NAMEA and total according to UNFCCC or CLRTAP

- 3.1 Please put here the reference numbers of the comments that you provide. The comments should be entered underneath the table.
- 3.2 A few countries estimate actual emissions of HFCs, PFCs and SF₆ (Tier 2 approach), whereas others use data on the apparent consumption which is in effect estimating the potential future emissions (Tier 1 approach). In the latter case an adjustment should be made taking account of the average economic lifetime of these substances if possible.
- 3.3 The full set of pollutants shown in the other tables is included here, but pollutants for which the UNFCCC/CLRTAP and the NAMEA totals are unlikely to differ are shaded (grey shaded cells do not need to be filled in). Differences are especially expected for the emissions reported under the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC Common Reporting Format (CRF) covers the 6 greenhouse gases (CO₂, N₂O, CH₄, HFCs, PFCs and SF₆) plus 4 indirect greenhouse gases (NO_x, CO, NMVOC, SO₂). For HFCs, PFCs and SF₆ no differences are expected in relation to the territory versus residence principle, but only in relation to actual emissions (Tier 2 approach) versus potential emissions (Tier 1 approach). These differences are to be included under 'Other adjustments' (see also note 3.10 below).

Pollutants reported to UNECE/EMEP under the Convention on Long Range Transboundary Air Pollution (CLRTAP) also include NO_x, CO, NMVOC and SO₂ plus NH₃ and PM (particulate matter) plus several heavy metals and POPs (persistent organic pollutants). Few differences are expected for emissions reported to UNECE/EMEP under CLRTAP. Only NH₃, PM₁₀ and Pb (lead) emissions are to be reported for some cells.

- 3.4 The national emission inventories and the official data reported under UNFCCC and CLRTAP are essentially national territory-oriented - i.e. taking most air emission sources located on the national territory into account and excluding all emissions occurring abroad. International air and water transport emissions are not to be included in the UNFCCC and CLRTAP national totals, but are reported separately. Inventories for the UNFCCC are based on the *Revised 1996 IPCC guidelines*. For CO₂, the total excludes CO₂ emissions from biomass used as fuel and takes carbon sinks (land-use change including changes in soil, deforestation and forest growth) located on the national territory into account. Depending on the size and sign of the various components the resulting net balance (i.e., the net removal of CO₂) will be positive or negative. This net removal of CO₂ should be added to the UNFCCC CO₂ emission estimates (see also note 3.6 below).
- 3.5 NAMEA-type data include CO₂ emissions from biomass used as fuel. Since these are excluded from the UNFCCC total CO₂ emissions (but reported separately), CO₂ emissions stemming from the combustion of biomass are to be added here.
- 3.6 Carbon dioxide removal by carbon sinks should not be deducted from CO₂ emissions in NAMEA. Since the net CO₂ removal is subtracted from total CO₂ emissions in the UNFCCC inventories, CO₂ removal estimates are to be reintroduced here in the column for CO₂. This net CO₂ removal effect may be positive or negative.
- 3.7 In accordance with national accounts, emissions of residents abroad are to be included in the NAMEA emission accounts. These emissions especially stem from lorries, ships and airplanes of national economic units operating abroad as well as from residents driving abroad for tourism. Countries should focus on the most relevant issues as regards their situation - e.g. water transport emissions for countries that have a large fleet engaged in international transport, or land transport for countries for which the emissions of residents driving abroad and emissions by foreigners driving on the territory are likely to differ.
- 3.8 Emissions from national fishing vessels are reported to the UNFCCC totals under '1A4c Agriculture/Forestry/Fisheries'. If significant emissions from national fishing vessels operating abroad are not already included in the UNFCCC (this should be verified especially in relation to the basis for the estimates such as statistics on bunkered fuels), they should be added here.
- 3.9 In accordance with national accounts principles, emissions of non-residents on the national territory are not included in NAMEA. Countries should focus on the most relevant issues - e.g. land transport for countries where road transport emissions by non-residents and emissions of residents driving abroad are likely to differ e.g. because of a large amount of emissions from lorries and cars passing through the country.
- 3.10 Other adjustments could come from non-fuel emissions, such as those mentioned in note 3.2 above or those attributed to the future decomposition of plastic or waste. This row could also show adjustments related to NMVOC emissions from living trees, the emissions/removals of N₂O and CH₄ from the soil in managed forests and emissions of CO₂, N₂O, CH₄, NO_x, NMVOCs and CO from the burning and decay of biomass due to

conversion of forests and grassland to other land uses, which are all to be reported under UNFCCC. Please provide a comment on the types of adjustments you included here (see above note 3.1).

3.11 Emissions from industries as well as households.

3.2 1999 data

Table 1a - Economic data by industry from the National Accounts according to NACE rev. 1 and ESA 95

1999 ITA Italy	Current prices			Employment			Constant prices			Industry specific comments
	Output	Value added	Interme- diate consum- ption				Output	Value added	Interme- diate consum- ption	
	Billion lire			'000 man- hours	full-time jobs	'000 persons	Billion 1995 lire			
Notes	1a.2	1a.3	1a.4	1a.5	1a.6	1a.7	1a.8	1a.9	1a.10	1a.11
Industries, total (including FISIM) 1a.1	3.932.978	1.908.050	2.024.928		23.048.900	22.697	3.634.169	1.706.080	1.928.088	
01-02	83.818	56.992	26.826		1.306.800	1.092	84.616	58.300	26.315	
05	2.342	1.726	617		66.500	38	2.311	1.725	586	
10-12	5.526	5.145	381		9.700	10	5.183	4.801	382	
13-14	7.167	3.532	3.635		33.400	34	6.485	2.891	3.594	
15	135.176	34.333	100.843		426.300	437	135.178	30.097	105.081	
16	22.968	6.740	16.228		49.000	50	21.351	5.788	15.564	
17	80.957	26.310	54.647		390.900	406	79.028	24.768	54.260	
18	50.727	17.525	33.201		329.700	346	46.848	15.835	31.013	
19	40.289	11.165	29.124		215.700	222	37.897	10.188	27.709	
20	32.221	11.418	20.803		193.500	196	31.856	11.328	20.527	
21	35.443	9.322	26.120		101.700	103	41.515	11.216	30.299	
22	41.671	17.613	24.058		202.500	205	38.703	14.909	23.794	
23	36.928	6.705	30.223		25.400	26	34.124	5.716	28.408	
24	113.905	35.030	78.875		239.000	243	115.156	34.328	80.828	
25	54.825	17.907	36.918		199.800	205	56.462	17.725	38.736	
26	68.190	26.453	41.737		311.200	316	64.046	24.067	39.979	
27	64.430	13.239	51.191		153.700	157	75.236	17.054	58.182	
28	115.276	44.000	71.276		610.100	617	109.367	39.836	69.530	
29	152.428	48.558	103.870		548.300	558	139.701	42.457	97.244	
30	7.957	1.393	6.565		18.100	19	8.421	1.575	6.846	
31-32	83.174	27.159	56.015		335.500	347	82.689	27.995	54.694	
33	20.356	9.244	11.112		110.700	111	18.936	8.170	10.766	
34	73.077	16.981	56.096		182.100	185	68.512	15.544	52.968	
35	25.168	9.435	15.733		108.100	110	23.972	6.065	17.907	
36-37	66.148	19.994	46.155		306.300	315	63.375	18.833	44.542	
40-41	83.007	44.570	38.437		147.800	149	81.150	41.603	39.547	
45	214.871	95.506	119.365		1.525.000	1.466	201.333	88.743	112.590	

(continues)

Table 1a (continued) - Economic data by industry from the National Accounts according to NACE rev. 1 and ESA 95

1999 ITA Italy	Current prices			Employment			Constant prices			Industry specific comments
	Output	Value added	Intermediate consumption				Output	Value added	Intermediate consumption	
	Billion lire			'000 man- hours	full-time jobs	'000 persons	Billion 1995 lire			
Notes	1a.2	1a.3	1a.4	1a.5	1a.6	1a.7	1a.8	1a.9	1a.10	1a.11
50-52	449.936	262.604	187.331		3.532.300	3.542	411.036	243.451		167.585
55	126.920	67.368	59.551		1.179.900	989	111.952	60.146		51.806
60	126.055	64.009	62.045		880.600	557	116.654	60.028		56.626
61-63	93.014	36.817	56.197		273.700	280	88.780	33.160		55.621
64	65.725	45.599	20.126		262.500	268	60.204	43.298		16.906
65-67	210.713	114.003	96.709		636.000	643	187.495	110.869		76.626
70-74	553.383	389.211	164.172		2.198.600	2.141	470.571	323.284		147.286
75	156.631	111.122	45.509		1.381.600	1.396	135.321	94.165		41.156
80	114.650	100.310	14.341		1.553.900	1.588	92.962	81.105		11.857
85	178.524	90.382	88.142		1.294.400	1.319	155.641	77.752		77.889
90-93	124.173	69.010	55.163		977.800	972	116.564	66.626		49.938
95	15.209	15.209	-		730.800	1.044	13.538	13.538		0
99	-	-	-		-	-	-	-		-
Not allocated	1a.12	-	-		-	-	-	-		-
FISIM	1a.13	-	-75.589	75.589				-82.901		82.901

Table 1b - Air emissions by industry according to NACE rev. 1 and NAMEA definitions³²⁰

1999 ITA Italy	1 st Priority				2 nd Priority					3 rd Priority			Industry specific comments	
	CO ₂	of which CO ₂ from biomass	N ₂ O	CH ₄	NO _x	SO _x	NH ₃	NMVOC	CO	PM ₁₀	Pb	PM ₁₀		
														tonnes
Notes														
1b.2	377.439,2	4.148,5	125.286,4	1.707.803,5	1.235.855,1	926.540,0	428.495,9	1.088.387,7	3.214.839,0	170.911,7	685,7			
1b.3	13.071,1	10,4	77.004,1	882.944,5	163.727,2	4.068,0	408.236,0	59.496,6	438.113,3	36.957,1	11,8			
1b.4	1.249,4	0,6	56,3	86,2	13.729,7	398,1	4,5	2.658,7	6.172,5	1.493,2	0,3			
1b.5	14,7	0,0	2,4	4.547,9	131,5	4,3	1,1	1.506,5	349,5	13,8	0,1			
1b.6	693,4	3,4	125,7	53,6	6.245,6	231,7	5,3	1.061,8	3.169,1	756,9	0,5			
13-14	2.877,2	26,5	386,4	34.978,0	10.019,7	336,9	71,8	33.699,2	22.206,5	1.155,8	5,3			
15	7,1	0,0	0,8	1,9	74,4	0,8	0,1	33,0	264,5	4,3	0,0			
16	1.718,8	91,9	159,0	3.893,7	4.893,2	178,7	30,0	2.443,8	9.942,1	558,3	2,3			
17	406,0	5,2	53,9	85,2	2.433,4	90,6	23,2	1.453,0	6.893,9	258,1	1,7			
18	402,4	3,6	44,8	80,6	2.082,3	77,9	23,5	47.555,9	6.856,3	214,8	1,7			
19	616,3	4,1	80,2	87,9	3.886,2	141,6	22,4	31.704,6	7.074,7	437,6	1,7			
20	5.872,1	13,9	96,8	1.134,5	2.887,1	585,7	5,6	626,4	2.513,6	357,1	0,5			
21	491,3	3,9	48,9	65,2	2.167,2	77,0	15,9	26.791,3	4.882,0	242,9	1,2			
22	15.357,9	43,6	917,7	4.058,3	26.883,0	72.224,9	232,3	53.425,0	74.359,7	3.092,6	16,6			
23	1.480,8	14,5	25.865,6	27.489,6	3.045,7	5.321,2	7.985,7	50.027,3	14.735,2	2.254,5	5,5			
24	670,2	8,6	73,4	99,9	2.987,3	101,9	22,0	11.376,9	6.778,3	2.881,0	1,6			
25	37.618,3	75,0	2.659,8	1.544,3	112.344,7	67.599,3	60,2	4.265,1	14.070,6	14.844,3	21,0			
26	21.764,2	20,5	339,6	12.782,6	22.947,8	38.476,0	29,4	13.365,3	429.490,6	24.444,1	164,6			
27	1.697,3	44,3	206,8	297,1	8.955,3	330,2	60,4	40.316,3	18.810,7	986,5	4,5			
28	1.195,8	13,1	130,1	195,8	5.742,7	208,2	50,4	48.476,9	15.099,6	622,5	3,7			
29	15,5	0,5	1,7	5,1	69,7	6,1	1,4	79,9	405,9	6,6	0,1			
30	437,6	4,5	52,8	81,5	2.361,7	86,2	21,6	1.360,0	6.435,0	255,5	3,8			
31-32														

(continues)

³²⁰ Pollutants not included in the Italian NAMEA air emissions accounts are excluded.

Table 1b (continued) - Air emissions by industry according to NACE rev. 1 and NAMEA definitions

1999 ITA Italy	1 st Priority			2 nd Priority						3 rd Priority		Industry specific comments
	CO ₂	of which CO ₂ from biomass	N ₂ O	CH ₄	NO _x	SO _x	NH ₃	NMVOC	CO	PM ₁₀	Pb	
	Notes											
	1000 tonnes											
												1b.1
33	127,3	1,0	16,5	31,5	792,7	30,0	9,6	571,4	2.771,2	80,5	0,7	
34	708,5	6,9	55,3	95,2	2.018,6	65,7	21,4	14.171,9	6.362,2	225,5	1,5	
35	167,0	1,8	16,7	23,6	712,3	25,3	5,3	6.861,4	1.727,2	75,0	0,4	
36-37	616,5	6,1	80,3	94,1	3.774,5	140,2	23,9	32.723,5	7.425,6	418,4	1,8	
40-41	179.715,8	2.847,9	6.903,4	267.070,8	203.597,6	582.505,7	150,6	40.950,5	96.543,6	25.387,0	7,7	
45	3.477,3	11,1	597,1	483,3	30.886,0	1.124,1	116,3	58.097,3	40.898,9	6.715,5	8,8	
50-52	22.106,3	252,1	1.992,1	7.586,9	139.716,0	7.029,6	2.436,5	168.939,6	686.624,1	12.181,8	171,2	
55	2.577,2	155,3	240,0	984,4	14.481,4	756,0	240,8	13.644,6	68.536,0	1.209,2	17,2	
60	20.298,5	245,7	1.885,5	3.642,9	140.877,5	7.072,3	857,8	61.141,3	277.201,7	15.251,1	59,1	1
61-63	21.231,4	15,4	555,6	2.569,8	190.651,4	131.213,3	121,4	136.801,5	334.290,7	8.462,0	25,8	1
64	1.089,6	8,5	96,4	224,0	7.197,9	379,8	60,5	3.870,8	18.396,5	734,2	4,2	
65-67	1.181,6	6,8	105,0	409,5	7.321,1	370,6	135,5	7.585,5	38.317,6	624,2	9,5	
70-74	7.441,3	40,5	675,8	2.805,8	46.570,2	2.334,0	951,0	52.541,0	265.875,6	3.830,8	66,9	
75	2.888,0	40,6	295,8	742,0	18.680,8	890,6	161,3	11.927,8	116.877,7	1.331,3	13,7	
80	871,7	13,6	69,6	257,6	4.132,9	206,4	76,8	4.301,8	21.944,4	354,5	5,4	
85	2.375,9	59,8	199,7	936,1	12.404,4	588,5	287,8	15.769,9	81.071,7	926,7	20,4	
90-93	2.907,7	47,1	3.194,7	445.332,5	14.424,5	1.262,4	5.936,7	26.764,7	61.350,9	1.266,4	23,1	
95	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	
99												
Not allocated												

1 Consistency between CORINAIR transport emissions data and the NAMEA residence principle is met partly by construction and partly on the basis of the likelihood of the assumptions introduced (for details see the Istat 2001 NAMEA report, § 4.2.1.1).

Table 2a - Household consumption expenditure data from the National Accounts

1999 ITA Italy	Final consumption		Comments
	Current prices	Constant prices	
	billion lira		
Notes	2a.3	2a.2	2a.1
Households, total	1.302.683	1.169.040	
By COICOP categories			
2a.4			
Transport 07	Transport	163.687	149.450
07.1	<u>Purchase of vehicles</u>	51.399	47.835
07.2	<u>Operation of personal transport equipment</u>	88.708	79.621
<i>of which</i> 07.2.1	Spare parts and accessories for personal transport equipment	-	-
07.2.2	Fuels and lubricants for personal transport equipment	-	-
07.2.3	Maintenance and repair of personal transport equipment	-	-
07.2.4	Other services in respect of personal transport equipment	-	-
07.3	<u>Transport services</u>	23.580	21.994
Heating 04.5	2a.5 <u>Electricity, gas and other fuels</u>	45.341	44.482
04.5.1	Electricity	-	-
04.5.2	Gas	-	-
04.5.3	Liquid fuels	-	-
04.5.4	Solid fuels	-	-
04.5.5	Heat energy	-	-
Other	<u>all other COICOP categories</u>	1.093.655	975.108
Not allocated			

Table 2b - Household air emissions according to NAMEA definitions³²¹

1999 ITA Italy	1 st Priority			2 nd Priority					3 rd Priority		Comments	
	CO ₂	of which CO ₂ from biomass	N ₂ O	CH ₄	NO _x	SO _x	NH ₃	NMVOC	CO	PM ₁₀		Pb
	Notes											
Households, total	98.763,4	4.666,3	9.776,0	41.136,5	298.339,1	27.337,6	7.728,9	637.697,1	2.712.751,4	35.331,1	549,3	2b.1
Transport	38.371,3	36,2	3.435,1	22.135,1	247.469,8	9.029,1	7.728,9	435.447,1	2.304.620,6	13.172,7	548,1	
of which leisure-gardening equipment	39,2	-	0,3	109,0	23,7	10,4	0,1	10.899,9	21.075,9	-	0,8	
Heating	59.867,9	4.630,1	6.340,9	19.001,4	50.869,3	18.308,4	0,0	34.077,8	408.130,7	22.158,4	1,2	
Not allocated	524,2	-	-	-	-	-	-	168.172,3	-	-	-	1
	2b.6											

1 Emissions included in "other" stem from the following CORINAIR processes (the corresponding SNAP 97 code is recorded in brackets): "Paint application: domestic use" (060104), "Domestic solvent use (other than paint application)" (060408).

³²¹ Pollutants not included in the Italian NAMEA air emissions accounts are excluded.

Table 3 - Bridge table between total air emissions in NAMEA and total according to UNFCCC and CLRTAP

Italy ITA 1999	Notes	CO ₂ 1000 tonnes	N ₂ O	CH ₄	NO _x	SO _x	NH ₃	NMVOC	CO	PM ₁₀	Pb	Comments	Rows
Total UNFCCC or CLRTAP air emissions	3,3 Unit Notes	438.875	139.650	1.748.421	1.440.854	892.507	436.218	1.721.616	5.914.492	203.594	1.231	3,1	6
plus CO ₂ emissions from biomass	3,4												7
plus CO ₂ net removal accounted for in UNFCCC total	3,5	8.815											8
plus National residents abroad	3,6	17.712											9
National fishing vessels operating abroad	3,7												10
Land transport	3,8												11
of which – industries													12
- households (tourism...)													13
Water transport													14
Air transport													15
less Non-residents on the territory		10.801	181	519	93.340	61.370		4.469	13.098	2.649			16
Land transport													17
of which – industries													18
- households (tourism...)													19
Water transport													20
Air transport													21
Other adjustments	3,10		4.769										22
Statistical discrepancy			-0										23
Total NAMEA air emissions	3,11	476.203	135.062	1.748.940	1.534.194	953.878	436.225	1.726.085	5.927.590	206.243	1.235		24
<p>1 Source: for CO₂, N₂O and CH₄ the 2003 Italian communication to the UNFCCC; for all other pollutants emission totals are consistent with the CLRTAP methodology. Please notice that emission totals reported here may differ from those published in the EMEP website which are not updated.</p> <p>2 Italian NAMEAs' transport data are consistent with the NAMEA residence principle (for details see the Istat 2001 NAMEA report, § 4.2.1.1), but the breakdown required to fill in the bridge table rows 11-24 is not available. For this reason the emissions related to transport that are included in the NAMEA and not in UNFCCC/CLRTAP calculations are shown in Row 18 (that does not have a row heading in the Table). The emissions reported in Row 18 stem from the following SNAP 97 processes:</p> <ul style="list-style-type: none"> • 080404 - International sea traffic (international bunkers), 080502 - International airport traffic (LTO cycles - <1000 m) and 080504 - International cruise traffic (>1000 m). • 3 Other adjustment includes emissions from the following SNAP 97 processes for N₂O: 1105 - Wetlands and 1106 - Waters. 													

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Rapporto ad Eurostat

Italian NAMEA: 1999-2000 air emission accounts

Angelica Tudini, Giusy Vetrella

1 BACKGROUND AND OUTLINE OF THE REPORT

This report concerns the construction of a set of consistent Italian NAMEA air emission accounts for the years 1990 – 2000. Pollutants covered are: carbon dioxide (CO₂), sulphur oxides (SO_x), nitrogen oxides (NO_x), nitrous oxide (N₂O), ammonia (NH₃), methane (CH₄), carbon monoxide (CO), Non-Methane Volatile Organic Compounds (NMVOC), lead (Pb) and particulate matter (PM10). For each year data are broken down by economic branches and households consumption purposes according to the format set in the Eurostat 2002 NAMEA standard tables.

The project builds on previous Istat NAMEA-related work co-financed by the Commission of the European Communities, specifically:

- the first pilot Italian NAMEA with reference year 1990 (produced in 1999) comprising an Input-Output (I/O) based economic module, environmental accounts for six air pollutants - CO₂, SO_x, NO_x, N₂O, NH₃, CH₄ - as well as the direct intake from nature of virgin materials – endogenous steam, wood and fossil fuels, minerals, biotic materials - by economic activity³²⁴;

*Il testo riportato riproduce integralmente il rapporto originale consegnato all'Eurostat nel 2004. In esso è riportato quanto segue:
The project was coordinated by Angelica Tudini (Istat – Environmental accounts) and carried out by a team including Paolo Panfili, Giusy Vetrella and Angelica Tudini.*

The paragraphs were authored as follows: §§ 1, 2.1 and 3 by Angelica Tudini; §§ 2.2 and 2.3 by Giusy Vetrella (Istat – Environmental accounts).

Giusy Vetrella also calculated energy use data broken down by function on the basis of national accounts energy use data by branch.

The authors wish to thank Riccardo De Lauretis (APAT), Alessandra Milani and Filippo Moauro (Istat) for their substantial contribution to the project. Riccardo De Lauretis provided the CORINAIR emissions data and contributed to the identification of the related NAMEA activities as well as to the definition of many methods to distribute the process emissions to the related NAMEA activities. Alessandra Milani and Filippo Moauro calculated energy use data by branch.

We are also grateful to Maria Smihily (Eurostat), Federica Battellini, Monica Perez, Francesca Tartamella (Istat), Andrea Mercanti (Ministry of productive activities), Andrea Alivernini (Ufficio Italiano Cambi).

³²⁴ See Battellini et al., 1999.

- the 1991 and 1992 NAMEA matrices and the revised 1990 NAMEA, completed in 2001³²⁵, where the NAM was significantly enlarged to reproduce almost completely the one described in the SNA³²⁶ and ESA³²⁷ manuals, the range of pollutants covered was expanded to include CO and NMVOC, and data on resources' intake were revised according to the European guidelines on material flows accounting (MFA);
- the 1999 NAMEA air emission accounts – produced in 2003 – encompassing also two additional air pollutants, Pb and PM10³²⁸.

Three are the main achievements of the new project:

1. improvements in the methodology previously applied to build the air emission accounts;
2. construction of the air emission accounts for years for which data were previously lacking – i.e. 1993-1998 and 2000 – on the basis of the improved method;
3. harmonisation of the air emission accounts previously built for 1990-1992 and 1999 with the new accounts for 1993-1998 and 2000.

As regards the first point, details on the Istat methodology to build the NAMEA air emission accounts are given in Paragraph 2, with particular focus on the important changes introduced in this project.

All NAMEA air emissions data presented according to the format set in the Eurostat 2002 NAMEA air standard tables are given in Paragraph 3.

³²⁵ See Coli et al., 2001.

³²⁶ See United Nations, 1993.

³²⁷ See Eurostat, 1996.

³²⁸ See Tudini – Vetrella, 2003.

2 METHODS AND DATA SOURCES

Istat developed the methodology to build NAMEA air emission accounts mainly over the course of the first two NAMEA-related projects mentioned in the previous paragraph³²⁹. In order to improve some aspects of the Italian NAMEA air emissions methodology, Istat set up and coordinated in 2003 a Working Group of experts from Istat, APAT (the Italian National Agency for Environmental Protection and Technical Services)³³⁰ as well as the Ministry of Productive Activities. Some of the changes devised by the Working Group were introduced in the 1999 estimates³³¹. Further important changes are taken into account in the 1990-2000 time series.

The remainder of this paragraph presents the main features of the process that leads to the Italian NAMEA air emission accounts. Emphasis will be given to the methodological improvements introduced specifically for the time series. Differences with 1999 and 1990-92 data are explained as well.

2.1 From CORINAIR to NAMEA emissions

NAMEA air emission accounts produced by Istat use as main input the Italian CORINAIR air emission data classified according to the process-based SNAP 97 classification. Data are supplied by APAT; besides the regular update of the estimates, APAT frequently revises the emissions time series to take into account methodological developments at the international as well as at the national level. The NAMEA 1990-2000 data use the 2003 CORINAIR time series.

Paragraphs 2.1.1 and 2.1.2 describe some relevant features of the CORINAIR data used for the NAMEA as well as the changes made to the CORINAIR emissions database to make it consistent with the NAMEA principles.

Paragraphs 2.2 and 2.3 describe in detail the activities carried out in order to shift from the CORINAIR process-based classification to the NAMEA economic activity-based classification, namely:

1. the analysis of the qualitative link between each SNAP 97 process and NAMEA activities, i.e. the identification of the NAMEA activities in which a process takes place (§ 2.2);
2. the allocation of the emissions of each SNAP 97 process to the related NAMEA activities (§ 2.3).

2.1.1 *The SNAP 97 processes excluded from the NAMEA*

Out of all the SNAP 97 processes³³², those belonging to SNAP 97 category 110000 are excluded in principle from the NAMEA framework because they refer to emissions from non economic agents and processes related to the absorption of emissions.

³²⁹ See Coli et al., 2001 and De Lauretis – Tudini – Vetrella, 2002.

³³⁰ Formerly known as ANPA.

³³¹ They concern particularly the split by function or type of use in the 1999 Istat national accounts data on energy use by economic activity and households. See Tudini – Vetrella, 2003.

³³² The structure of the SNAP 97 classification includes: 11 source categories, 76 source sub categories and 414 source activities.

In addition to that, the processes listed below are not available in the Italian CORINAIR database used as input for the NAMEA air emission accounts, for at least one of the following reasons:

- the process does not take place in Italy
- the process emits pollutants other than the ten included in the Italian NAMEA
- the emission estimates are not available for Italy

The SNAP 97 processes not available in the Italian CORINAIR database are the following:

010202, 010304, 010305, 010402, 010403, 010404, 010405, 010407, 010501, 010502, 010503, 010504, 010505, 020101, 020102, 020104, 020106, 020201, 020203, 020205, 020301, 020303, 020305, 030106, 030205, 030306, 030318, 030323, 030324, 030325, 030326, 040105, 040204, 040205, 040210, 040304, 040305, 040306, 040307, 040308, 040309, 040406, 040411, 040413, 040414, 040415, 040416, 040522, 040523, 040525, 040526, 040602, 040616, 040617, 040618, 040619, 040801, 040802, 040803, 040804, 040805, 040806, 050301, 060109, 060203, 060204, 060310, 060311, 060402, 060406, 060407, 060411, 060412, 060501, 060502, 060503, 060504, 060505, 060506, 060507, 060508, 081000, 090204, 090206, 090403, 090901, 090902, 091006, 091007, 091008, 100103, 100106, 100201, 100202, 100204, 100205, 100206, 100302, 100303, 100304, 100305, 100408, 100409, 100410, 100411, 100413, 100513, 100601, 100602, 100603, 100604, 100901.

Differences with previous NAMEA air emissions data

1999 No difference.

1990 - 1992 Previous data included the emissions stemming from processes coded 1111 and 1112, respectively referring to “Managed broadleaf forests” and to “Managed coniferous forests”, consistently with the guidelines laid out in the Eurostat NAMEA 2000 manual. These two processes are now excluded in agreement with the notes of the Eurostat 2002 standard tables.

2.1.2 Changes to CORINAIR transport emissions

While CORINAIR emissions relate to the national territory, in the NAMEA framework, consistency with the economic module requires the emissions to relate to resident units. Thus, in order to derive residents’ emissions from CORINAIR data it is necessary:

- to add residents’ emissions abroad, and
- to subtract non residents’ air emissions on the national territory.

In practice the adjustment is only needed for economic activities that engage in international transport – by road, water and air – as well as for tourism consumption. However, in the Italian case, consumption data broken down by COICOP are national territory related and therefore households’ transport emissions are consistent with households’ transport expenditure. Hence, the adjustment is only made for economic activities performing international transport.

The following paragraphs describe the Istat methodology to shift from the national territory related CORINAIR transport emissions to the NAMEA framework based on “resident units”, for road, air and water transport³³³. For each transport mode the two key elements of the adjustment

³³³ The method was almost entirely devised by the Working Group mentioned above.

method are the specific features of the CORINAIR air emission estimates and the transport-related statistics actually available.

In order to facilitate the explanation the following symbols are used:

- $EMI_R(d)$: emissions of Italian residents (R) due to journeys within the Italian territory (d);
- $EMI_NR(d)$: emissions of non residents (NR) due to journeys within the Italian territory;
- $EMI_R_I(i)$: emissions of Italian residents due to international journeys (i) leaving from Italy (I);
- $EMI_NR_I(i)$: emissions of non residents due to international journeys leaving from Italy;
- $EMI_R_A(i)$: emissions of Italian residents due to international journeys leaving from abroad (A);
- $EMI_j(p)$: emissions arising from the use of the energy product j in SNAP 97 process p.

2.1.2.1 Road transport

Road transport processes (SNAP 97 source category 07) of the CORINAIR database include both passenger and goods transport. Since transport statistics typically relate to either of the two components, the first step to derive NAMEA-consistent road transport emissions was to split the CORINAIR road transport emissions data into passenger transport and goods transport.

Passenger and goods transport emissions can be derived directly from the CORINAIR database as follows:

- passenger: SNAP 97 processes 070100 “passenger cars”, 070300 “heavy duty vehicles > 3.5t and buses” only for the part “buses”, 070400 “mopeds and motorcycles < 50 cm³”, 070500 “motorcycles > 50 cm³”;
- goods: SNAP 97 processes 070200 “light duty vehicles < 3.5 t”, 070300 “heavy duty vehicles > 3.5t and buses” only for the part “heavy duty vehicles”

In both cases the following components are included though not singled out: $EMI_R(d) + EMI_NR(d) + EMI_R_I(i) + EMI_NR_I(i)$, i.e. emissions of resident as well as non resident units due to domestic journeys and to international journeys leaving from Italy.

For the NAMEA, instead, the emissions of resident units only, for domestic as well as international journeys regardless of the origin of the trip are needed, i.e.: $EMI_R(d) + EMI_R_I(i) + EMI_R_A(i)$. Specifically, the $R_A(i)$ component refers to two kinds of journeys:

1. international trips leaving from abroad and with destination Italy;
2. international trips entirely abroad

The remainder of the paragraph explains how resident emissions on the Italian territory, $EMI_R(d) + EMI_R_I(i)$, were singled out from CORINAIR data and how additional resident emissions abroad, $EMI_R_A(i)$, were estimated.

2.1.2.1.1 Passenger transport by road

Yearly data on gasoline and diesel consumption for passenger transport by road of non resident units on the Italian territory, use^{NR} , are published by Unione Petrolifera³³⁴; they are one of the components of total passenger consumption by road, $\sum_i use_j^i$. These data allowed to obtain non resident emissions due to gasoline and diesel as follows, for each year and for each process “p”:

$$(1) EMI_{NR_j}(d) + EMI_{NR_j}(i) = W_j^{NR} * EMI_j(p)$$

where:

j = gasoline and diesel

$$(2) W_j^{NR} = \frac{use_j^{NR}}{\sum_i use_j^i},$$

i.e. it is the share of non residents’ consumption of energy product j for passenger road transport on the national territory out of total passenger consumption for the same energy product.

Thus $EMI_R(d) + EMI_{R_I}(i)$ due to gasoline and diesel are obtained by subtracting from CORINAIR passenger road transport emissions the component due to non resident units estimated in equation (1).

Passenger road transport emissions due to the use of liquid petroleum gas are entirely due to resident units for national journeys and can be included as such in the NAMEA.

The part of the emissions due to residents travelling abroad, $EMI_{R_A}(i)$ was estimated by calculating data on gasoline and diesel consumption of Italian tourists abroad based on the following relationship:

$$(3) use_j^R : use_j^{NR} = Exp^R : Exp^{NR}$$

where

use_j^R is the residents’ consumption of energy product j for passenger road transport outside the national territory;

use_j^{NR} is the non residents’ consumption of energy product j for passenger road transport on the Italian territory;

Exp^R is total expenditure of Italian residents abroad;

³³⁴ See “Statistiche economiche energetiche e petrolifere”, Unione Petrolifera, various years. Unione Petrolifera is the Association comprising the main petroleum companies operating in Italy in the refining and distribution of oil.

Exp^{NR} is total expenditure of non resident units on the national territory³³⁵.

Hence, for a given process “p”:

$$(4) EMI_{R_A}(i) = W_j^R * EMI_j(p)$$

where:

$$(5) W_j^R = \frac{use_j^R}{\sum_i use_j^i},$$

i.e. it is the ratio of residents’ consumption of energy product j for passenger road transport outside the national territory out of total passenger consumption for the same energy product.

2.1.2.1.2 Goods transport by road

The components of total goods transport (TG) implicitly included in the CORINAIR emissions are:

$$(6) TG = G_{R(d)} + G_{NR(d)} + G_{R(i)} + G_{NR(i)},$$

i.e. transport of goods by resident as well as non resident units due to domestic journeys and to international journeys leaving from Italy.

New Cronos statistics on road transport supply the data to calculate each individual component of equation (6), both in tonnes (T) and in tonnes*km (Tkm).

Specifically, under New Cronos Theme7 – Transport, domain road, the following data are available:

³³⁵ Both Exp^R and Exp^{NR} data are published as part of national account data on households expenditure.

Symbol	Explanation	New Cronos tables	Selection
G_R(d)	transport of goods for domestic journeys on the Italian territory by resident companies	collection "romegood" Table "rogong" 09. National annual transport by group of goods and type of transport (T and Tkm),	reporting country: Italy
G_NR(d)	transport of goods for domestic journeys on the Italian territory by non resident companies	collection "romecabo" Table "rocacoun" 04. Cabotage transport by country in which cabotage takes place (Tkm) - as from 1999 (Regulation (EC) 1172/98),	partner country: Italy
G_R _i (i)	transport of goods for international journeys leaving from Italy by resident companies	collection "romegood", Table "rogoiulm" 04. International annual transport - goods loaded in reporting country, by type of transport (Tkm)	reporting country: Italy
G_NR _i (i)	transport of goods for international journeys leaving from Italy by non resident companies, i.e. journeys from Italy to the country of the company plus journeys from Italy to a third country	collection "romegood", Table "rogoildm", 02. International annual transport - goods unloaded in reporting country, by type of transport (Mio Tkm) Table "rogogbg1" 16. Cross trade transport quarterly by type of transport (T, Tkm)	reporting country: all available ones except Italy

Since the weight of goods travelling and the length of the journey are important determinants of the emissions, the New Cronos data in Tkm, allow to use the share of each individual component in equation (6) as representative of the share of the correspondent component of the emissions in the relationship:

$$(7) \quad EMI(p) = EMI_{R(d)} + EMI_{NR(d)} + EMI_{R_i(i)} + EMI_{NR_i(i)}$$

i.e.

$$(8) \quad EMI_{R(d)} : EMI(p) = G_{R(d)} : TG$$

$$(9) \quad EMI_{NR(d)} : EMI(p) = G_{NR(d)} : TG$$

$$(10) \quad EMI_{R_i(i)} : EMI(p) = G_{R_i(d)} : TG$$

$$(11) \quad EMI_{NR_i(i)} : EMI(p) = G_{NR_i(d)} : TG$$

The above equations (8) and (10) allowed to calculate the emissions of residents to be included in the NAMEA.

Similarly, the emissions of resident companies for transport of goods outside the Italian territory - $EMI_{RA(i)}$ (to be added to CORINAIR data) were calculated by assuming that they could be related to the transport of goods by resident companies outside the Italian territory, i.e.:

$$(12) \quad EMI_{RA(i)} : EMI(p) = G_{RA(i)} : TG$$

where $G_{RA}(i)$ includes three different kinds of journeys each matching specific New Cronos data:

- International journeys from abroad to Italy - collection “romegood”, Table “rogoildm”, 02. International annual transport - goods unloaded in reporting country, by type of transport (Tkm), reporting country: Italy;
- International journeys within a given foreign country (cabotage): collection “romecabo”, table “rocahaul” 02. Cabotage by hauliers from each reporting country (Tkm) - as from 1999 (Regulation (EC) 1172/98), reporting country: Italy;
- International journeys between two foreign countries (cross trade), collection “romegood”, Table “rogogbg1” 16. Cross trade transport quarterly by type of transport (T, Tkm).

2.1.2.2 Air transport

In the CORINAIR inventory air emissions due to air traffic are included in the SNAP 97 source sub category 08 05 “Air traffic” and broken down into the following processes:

- 08 05 01 Domestic airport traffic (LTO cycles - <1000 m)
- 08 05 02 International airport traffic (LTO cycles - <1000 m)
- 08 05 03 Domestic cruise traffic (>1000 m)
- 08 05 04 International cruise traffic (>1000 m)(i)

All domestic emissions (processes 080501 and 080503) relate to resident companies; therefore they match the component $EMI_{R(d)}$, and can be included as such in the NAMEA.

The estimates of international emissions (processes 080502 and 080504) are based on the number of incoming international flights regardless of the nationality of the company. Hence they match the components $EMI_{RA}(i) + EMI_{NRA}(i)$, i.e. the emissions of resident and non resident companies for international flights leaving from abroad and bound to Italy.

For the NAMEA purposes, the share of emissions due to resident companies out of total international air traffic emissions was assumed to be equal to the share of international incoming flights run by resident companies out of total flights:

$$(13) \quad EMI_{RA}(i) : [EMI_{RA}(i) + EMI_{NRA}(i)] = F_{RA}(i) : [F_{NRA}(i) + F_{RA}(i)]$$

where $F_{RA}(i)$ is the number of incoming flights run by Italian companies and $F_{NRA}(i)$ is the number of incoming flights run by foreign companies given by Istat air transport statistics³³⁶.

Since the number of outgoing flight equals the number of incoming flights, $EMI_{RI}(i)$, i.e. the amount of emissions due to outgoing flights run by resident companies to be added to the CORINAIR data equals $EMI_{RA}(i)$.

2.1.2.3 Water transport

In the CORINAIR inventory emissions due to water transport are included in the SNAP 97 source sub category 08 04 “Maritime activities” and broken down into the following processes:

- 08 04 02 National sea traffic within EMEP area
- 08 04 03 National fishing
- 08 04 04 International sea traffic (international bunkers)

³³⁶ Data source: Istat “Statistiche del trasporto aereo”, (Istat air transport statistics), various years.

The estimate of the emissions of process 080403 - National fishing – take into account the activities of resident companies only; therefore the emissions can be included as such in the NAMEA.

The emissions of process 080402 - National sea traffic within EMEP area – can be split into two parts:

- 080402 (a) emissions due to the use of gasoline; they are entirely included in the NAMEA as they can be attributed to Italian households;
- 080402 (b) emissions due to the use of diesel; they are territory related, i.e. include $EMI_R(d) + EMI_NR(d)$ and have to be turned into resident emissions only.

The share of emissions due to resident companies out of total domestic national maritime emissions was assumed to be equal to the share of goods (in tonnes) moved by sea by Italian ships (domestic traffic) out of total goods moved by sea (domestic traffic):

$$(14) \quad EMI_R(d): [EMI_R(d) + EMI_NR(d)] = G_R(d) : [G_NR(d) + G_R(d)]$$

where $G_NR(d)$ is the weight of goods moved by sea (domestic traffic) by foreign ships and $G_R(d)$ is the weight of goods moved by sea (domestic traffic) by Italian ships³³⁷.

The emissions of process 080404 – International sea traffic – are also due to resident as well as non resident units, $EMI_R(i) + EMI_NR(i)$. In order to turn them into resident emissions only the same method used for national sea traffic was applied. The share of emissions due to resident companies out of total international maritime emissions was assumed to be equal to the share of goods (in tonnes) moved by sea (international traffic) by Italian ships out of total goods moved by sea (international traffic):

$$(15) \quad EMI_R(i): [EMI_R(i) + EMI_NR(i)] = G_R(i) : [G_NR(i) + G_R(i)]$$

where $G_NR(i)$ is the weight of goods moved by sea (international traffic) by foreign ships and $G_R(i)$ is the weight of goods moved by sea (international traffic) by Italian ships³³⁸.

Finally, in order to estimate the emissions due to Italian ships operating abroad, the following method was used. The CORINAIR expert estimated total consumption of diesel and residual oil for domestic as well as international maritime transport (with Italy as origin or destination). For the CORINAIR estimates only consumption that relates to domestic sea transport and to international maritime transport with journeys leaving from Italy is used; consumption data multiplied for pollution-specific and fuel-specific emission factors consistently with international guidelines give emissions by pollutant of process 080404. The difference between total consumption and the quantities included in the CORINAIR emission estimates gives the amount of consumption for international maritime transport leaving from abroad and arriving to Italy. Multiplying this quantity by the same pollutant-specific emission factors applied to estimate the emissions of process 080404 allows to calculate the emissions due to international maritime transport leaving from abroad performed by resident as well as non resident companies, i.e. $EMI_R_A(i) + EMI_NR_A(i)$

In order to derive the amount of resident emissions, $EMI_R_A(i)$, the same Istat maritime transport statistics on the weight of goods moved by sea (international traffic) by foreign and

³³⁷ Data source: Istat “Statistiche del trasporto marittimo”, (Istat maritime transport statistics), various years.

³³⁸ Data source: Istat “Statistiche del trasporto marittimo”, (Istat maritime transport statistics), various years.

Italian ships, used to derive the resident share of the emissions of process 080404 are applied (see equation 15 above) under the assumption that:

$$(16) \quad EMI_{RA}(i) : [EMI_{RA}(i) + EMI_{NRA}(i)] = G_{RA}(i) : [G_{NRA}(i) + G_{RA}(i)]$$

Differences with previous NAMEA air emissions data

In all previous Italian air emission accounts total CORINAIR transport emissions and total NAMEA transport emissions were the same. The CORINAIR national territory – related data and the NAMEA resident principle were matched by introducing some assumptions³³⁹.

2.2 Qualitative link between each SNAP 97 process and NAMEA activities

Table 1 below provides the full list of qualitative links between the SNAP 97 processes included in the Italian NAMEAs and NAMEA activities. The key to ensure a correct match between SNAP 97 process and NAMEA activities is, on the one side, the knowledge of how the emissions are estimated in practice in the Italian CORINAIR and, on the other side, the understanding of the actual structure of the Italian NAM. Therefore, the identification of the NAMEA activities responsible for the emissions of each SNAP 97 process has been achieved through a process-by-process analysis carried out jointly by the CORINAIR and NAMEA experts³⁴⁰.

The first column of the Table 1 shows that some processes are included in the NAMEA at the 6th digit of the SNAP 97 (source activities) while in other cases the 4th SNAP 97 digit (source sub-category) is used. The actual level of breakdown, depends, for each process, on the qualitative link with the NAMEA activities; specifically:

- when all the SNAP 97 processes at the 6th digit of a given source sub-category are linked to the same NAMEA activity, the emission data at the 4th SNAP 97 digit can be used for the NAMEA³⁴¹;
- when at least two SNAP 97 processes at the 6th digit of a given source sub-category are not linked to the same NAMEA activity, emission data at the 6th SNAP 97 digit are needed instead³⁴².

The second column reports the activity codes of the NAMEA classification for which air emission estimates are calculated.

³³⁹ See Coli et al., 2001.

³⁴⁰ See De Lauretis – Tudini – Vetrella, 2002, § 2: “For each process the CORINAIR experts are asked to provide details on:

- the general features of the process (as described in the CORINAIR methodology);
- the way the emission estimates are actually produced for Italy.

The NAMEA experts can identify the NAMEA activities in which the specific process takes place by matching the information obtained on the emission estimates with their knowledge on:

- the internationally agreed upon NAMEA features;
- the specific features of the Italian NAM, particularly the fact that homogeneous industries are used.”

³⁴¹ For example, since all SNAP 97 processes of the source sub-category 010100 (010101, 010102, 010103, 010104 and 010105) are linked to the NAMEA activity 40, emissions of process 0101 are used for the data input.

³⁴² This is the case for example of the source sub-category 010300, since processes 010301, 010302, 010303 are linked to the NAMEA activity 40 and process 010306 is linked to the NAMEA activity 23.

Households' consumption by purpose is shown under NAMEA activities as well; the codes are as follows: transport = 101; heating = 102; other = 103.

Numbers in bold indicate new links compared to the 1999 Italian NAMEA.

Table 1 - Link between the SNAP 97 processes included in the Italian NAMEAs and the NAMEA activities

Processes included in the Italian NAMEAs (SNAP 97 code)	Related NAMEA activities	Processes included in the Italian NAMEAs (SNAP 97 code)	Related NAMEA activities
010100	40	040613	26.1
010200	40	040614	26.2-26.8
010301	40	040615	31
010302	40	050101	10
010303	40	050102	10
010306	23	050103	23, 24, 26.2-26.8, 27, 40
010401	40	050200	11-12
010403	40	050300	11-12
010406	23, 27 (a)	050401	23
010500	60.2-60.3	050402	60.2-60.3
020100	10-95	050501	23
020200	102	050502	23
020300	01, 02, 05	050503	50-52
030100	35, 40	050600	40
030203	27	050700	40
030204	26.2-26.8	060101	34, 35
030301	27	060102	50-52
030302	27	060103	45
030303	27	060104	103
030304	27	060105	28
030305	27	060106	35
030307	27	060107	20, 36
030308	27	060108	28, 29, 30-35
030309	27	060201	28
030310	27	060202	93
030311	26.2-26.8	060301	25
030312	26.2-26.8, 27	060302	25
030313	23	060303	25
030314	26.1	060304	25
030315	26.1	060305	25
030317	26.1	060306	24
030319	26.2-26.8	060307	24
030320	26.2-26.8	060308	24
030321	21	060309	24
030322	27	060312	17
040100	23	060313	19
040200	23, 27 (b)	060314	19
040300	27	060401	26.1
040400	24	060403	22
040500	24	060404	15
040601	20	060405	19, 20, 35, 36, 50-52
040603	21	060408	103
040604	21	060409	50-52
040605	15	070100	01-95, 101
040606	15	070200	01-95, 101
040607	15	070300	01-95, 101
040608	15	070400	01-95, 101
040610	45	070500	01-95, 101
040611	45	070600	01-95, 101
040612	26.2-26.8	070700	01-95, 101

(continues)

Table 1 (continued) - Link between the SNAP 97 processes included in the Italian NAMEAs and the NAMEA activities

Processes included in the Italian NAMEAs (SNAP 97 code)	Related NAMEA activities	Processes included in the Italian NAMEAs (SNAP 97 code)	Related NAMEA activities
080100	75	090207	90
080200	60.1	090208	90
080300	61	090400	90
080402	61, 101	090700	01
080403	05	091001	15, 17, 21, 23, 24, 27
080404	61	091002	90
080500	62	091003	90
080600	01	091005	90
080700	02	100100	01
080800	10-37, 45	100200	01
080900	101	100300	01
090201	90	100400	01
090202	24, 90	100500	01
090203	23	100900	01
090205	24, 90		

(a) NACE divisions 23 and 27 for years up to 1993; NACE 27 only after 1993 because of changes in the Italian industrial structure.

(b) For years up to 1993, 040201 is associated with NACE 23 and 27 while all other 6-digit processes belonging to the SNAP 97 source activity 040200 are linked to NACE 27 only. After 1993, all 6-digit processes belonging to 040200 are linked to NACE 27 only 1993 because of changes in the Italian industrial structure.

On the basis of the links listed in Table 1, the SNAP 97 processes can be split into two groups:

- processes with only one link to the activities of the NAMEA classification;
- processes with multiple links to the activities of the NAMEA classification.

The following paragraphs provide details on how the calculation of air emissions by NAMEA activity is carried out in each case.

2.3 Allocation of the emissions of each SNAP 97 process to the related NAMEA activities

Emissions from all processes linked to one activity only can be directly allocated to the related NAMEA activity without further calculation.

Emissions from all processes linked to more than one activity have to be distributed among the corresponding NAMEA activities.

The methods used to distribute the emissions with multiple NACE associations are dealt with in detail in the following paragraphs and summarised in the Table 2 below. The choice of a specific method depends on the characteristics of the processes themselves as well as on the kind of background information available for them.

In any case, the starting point for the quantitative allocation of emissions with multiple NACE associations is to look at the basic data used to produce the CORINAIR emission estimates as a possible source of information. In practice, three main kinds of data can be used:

- data on emissions by fuel (see § 2.3.1 below);
- activity-related CORINAIR background data (see § 2.3.2 below);

- data on full time employees (see § 2.3.3 below).

Table 2 - Overview of methods used to distribute the emissions of SNAP 97 processes with multiple NACE associations

Type of process	SNAP 97 code	Corresponding NAMEA activities	Method (*)
Coke oven furnaces	010406	23, 27	CB
Combustion in commercial and institutional plants	020100	10-95	E
Combustion plants in agriculture, forestry and aquaculture	020300	01, 02, 05	E
Combustion in boilers, gas turbines and stationary engines	030100	35, 40	CB
Lime (combustion processes)	030312	26.2-26.8 for area emissions; 27 for point source emissions	CB
Coke oven (door leakage and extinction)	040201	23, 27	CB
Storage of solid fuel	050103	23, 24, 26.2-26.8, 27, 40	E
Paint application: manufacture of automobiles	060101	34, 35	CB
Paint application : wood	060107	20, 36	FTE
Other industrial paint application	060108	28, 29	CB
Application of glues and adhesives	060405	19, 20, 35, 36, 50-52	FTE
Passenger cars	070100	01-95, 101	E
Light duty vehicles < 3.5 t	070200	01-95, 101	E
Heavy duty vehicles > 3.5 t and buses	070300	01-95, 101	E
Mopeds and Motorcycles <50 cm ³	070400	01-95, 101	E
Mopeds >50 cm ³	070500	01-95, 101	E
Gasoline evaporation from vehicles	070600	01-95, 101	E
Automobile tyre and brake wear	070700	01-95, 101	E
National sea traffic within EMEP area	080402	61, 101	CB
Industry (off-road transport)	080800	10-37, 45	E
Incineration of industrial wastes (except flaring)	090202	1/3 of emissions to NACE 24 and 2/3 to NACE 90	CB
Incineration of sludges from waste water treatment	090205	1/3 of emissions to NACE 24 and 2/3 to NACE 90	CB
Waste water treatment in industry	091001	15, 17, 21, 23, 24, 27	CB

(*) CB: process whose emissions were distributed on the basis of CORINAIR background data.

E: process whose emissions were distributed on the basis of energy use data by activity.

FTE: process whose emissions were distributed on the basis of the number of full time employees by economic activity.

2.3.1 Emissions distributed on the basis of energy use data by activity

For some SNAP 97 processes with multiple NACE associations (specifically SNAP 97 codes 020100, 020300, 070100, 070200, 070300, 070400, 070500), the emissions for the general process “p” are obtained as the sum of the emissions of each energy product used in the estimates:

$$(17) \quad EMI(p) = EMI_1(p) + EMI_2(p) + \dots + EMI_j(p) + \dots + EMI_{n_p}(p)$$

where:

$EMI(p)$ are the total emissions from SNAP 97 process p ;

$EMI_j(p)$ is the quantity of emissions arising from the use of the energy product j in the SNAP 97 process p ;

$j=1, 2, \dots, n_p$ is the generic element of the group of n_p energy products used for estimating the emissions of SNAP 97 process p .

For the j -th energy product used in process p , it is necessary to find a weight $W_j^i(p)$ that represents the part of emissions to be attributed to each NAMEA activity i in which process p is carried out.

$$(18) \quad EMI_j^i(p) = W_j^i(p) * EMI_j(p)$$

where:

$EMI_j^i(p)$ is the quantity of emissions arising from the use of the energy product j in SNAP 97 process p allocated to the NAMEA activity i ;

$i = 1, \dots, h_p$ is the generic element of the group of h_p NAMEA activities in which the SNAP 97 process p is carried out.

The CORINAIR background data used to estimate the emissions cannot be used to build the weights $W_j^i(p)$ as they are not available with a breakdown consistent with the NAMEA economic activities³⁴³.

A suitable data source to split the emissions of the processes listed above are the Istat national accounts data on energy use by economic activity and households. The data have a number of features that make them appropriate for the purpose of splitting the heating and transport related emissions: they concern the use of a set of energy products that can be linked to the energy products used for the CORINAIR estimates³⁴⁴ and are broken down by NACE economic activities consistently with the NAMEA classification. However, for an optimal use of energy consumption data for NAMEA purposes, the breakdown by function or type of use is needed as well. Specifically, the breakdown into “road transport”, “off road transport”, “heating”, “other energy use”, “non-energy use” appears to suit well the NAMEA needs as long as:

- the function “heating” is consistent with the SNAP 97 processes related to heating, (SNAP 97 category 02);
- the function “road transport” is consistent with the SNAP 97 processes related to road transport (processes belonging to the SNAP 97 category 07).

Since the split by function was originally not available in the Istat national accounts data on energy use, a specific method was devised based on the following main steps³⁴⁵:

³⁴³ For the SNAP 97 processes at issue (see list in the text) the emission estimates are based on aggregate data on energy consumption as well as, in the case of transport, on numerous technical parameters that allow to take into account factors such as the type of engine and the speed in the calculation of emissions.

³⁴⁴ CORINAIR energy products follow the NAPFUE classification whereas the Istat energy products are consistent with the Eurostat energy product classification.

³⁴⁵ This is one of the achievements of the NAMEA Working Group.

1. identification of the five different uses – road transport, off road transport, heating, other energy use, non-energy use – within the National Energy Balance (NEB) data; basic inputs to this calculation included information from APAT on which NEB sections are used to estimate specific CORINAIR emissions as well as information on the contents of the uses in the 1988 Istat energy use Table;
2. assessment of the link between Istat energy products and NEB energy products;
3. calculation, for each Istat energy product broken down by branch, of the breakdown into the five different uses based on National Energy Balance data;
4. balancing.

The method was applied to calculate energy use data by branch and by function from 1992 to 1999. For years 1990 and 1991 the 1992 data were used and for the year 2000 the 1999 data were used.

The availability of energy consumption data by branch, by product and by function allows the calculation of the following weights for the j -th energy product used in process p :

$$(19) \quad W_j^i(p) = \frac{use_j^i(l)}{\sum_{i=1}^{h_p} use_j^i(l)} ,$$

where:

$l =$ “heating use”, “road transport use”, “off-road transport use”, “other energy use”, “non energy use” indicates the specific function of the energy use data, associated to SNAP 97 process p ³⁴⁶;

$use_j^i(l)$ is the generic element of the Istat energy use data, i.e. it is the quantity of product j used by the NAMEA activity i for the function l .

By construction the following holds:

$$(20) \quad 0 \leq W_j^i(p) \leq 1 .$$

Finally, the total emissions from SNAP 97 process p allocated to the NAMEA activity i is given by:

$$(21) \quad EMI^i(p) = \sum_{j=1}^{n_p} EMI_j^i(p) .$$

In addition to the processes listed at the beginning of the paragraph, the method based on energy use data by activity is applied also to SNAP 97 processes 050103 “Storage of solid fuel”, 070600 “Gasoline evaporation from vehicles”, 070700 “Automobile tyre and brake wear” and 080800, which refers to industry off road transport. Specifically, since for this processes

³⁴⁶ In practice the function “heating” is used to distribute the SNAP 97 processes 020100 and 020300; the function “road transport” is used to distribute the SNAP 97 processes 070100, 070200, 070300, 070400 and 070500.

CORINAIR emissions are not split by energy product as in the above relationship (1), the weights are obtained as follows:

- for process 050103, as the sum of weights for the energy products coal and lignite, (total use applies since emissions derive from storage of specific energy products regardless of their use);
- for process 070600, with the weights calculated for the energy product gasoline for the other road transport processes (070100 to 070500);
- for process 070700, as average of the weights derived from each energy product used for the estimates of transport processes 070100-070500;
- for process 080800, with weights for the energy product diesel, function “off road transport”.

Differences with previous NAMEA air emission data

- 1999 The 1999 data on energy use by branch and by function were revised.
- 1990 - 1992 For 1990 the data of the 1998 Istat energy use Table, were used; they included the breakdown by function.

For 1991 and 1992 the split by function of each branch of the 1988 data was applied to the total use by branch of the 1992 data to derive a breakdown by function as well.

2.3.2 Emissions distributed on the basis of CORINAIR background data

Emissions of SNAP 97 processes 010406, 030100, 030312, 040201, 060101, 060108, 090202, 090205 and 091001 are distributed on the basis of different activity-related CORINAIR background data.

Specifically:

- SNAP 97 processes 010406 “Coke oven furnaces”, 030312 “Lime (combustion processes), 040201 “Coke oven (door leakage and extinction)”. Point source emission data, i.e. data collected at specific establishments, are available; the CORINAIR experts’ direct knowledge of the activity of each establishment, as well as of the methods used to estimate the area components, allows to identify the links with the NAMEA activity responsible for producing the emissions; in addition to the point source emissions there is another component estimated as area source.
- SNAP 97 process 030100 “Combustion in boilers, gas turbines and stationary engines”; the part of emissions arising from the use of jet fuel is linked to NACE 35.3 “Manufacture of aircraft and spacecraft”; the remaining part of the emissions is linked to NACE 40 “Electricity, gas, steam and hot water supply”.
- SNAP 97 process 060101 “Paint application: manufacture of automobiles”. The process takes place in NACE activities 34 “Manufacture of motor vehicles, trailers and semi-trailers” and 35 “Manufacture of other transport equipment”. Calculations based on the number of vehicles and motor vehicles as well as on the quantity of paint needed respectively for vehicles and motor vehicles, allow to distribute 98% of the emissions to NACE 34 and 2% to NACE 35.
- SNAP 97 process 060108 “Other industrial paint application”. The process takes place in NACE activities 28-35. Detailed background data on production and on the percentage content of solvent per unit of production are available as inputs of the 1999 CORINAIR estimates and show that 21% of emissions come from NACE 28.51, 6% from NACE

29.7 and 73% from NACE 28 (except 28.51), 29 (except 29.7), 30, 31, 32, 33, 34.3, 35 (except 35.1, 35.3, 35.41 e 35.42). These percentages are used for every year. In order to distribute the 73% of emissions between all the economic activities listed above, yearly data on full time jobs are used (see also the following paragraph).

- SNAP 97 process 080402 “National sea traffic within EMEP area”. In the CORINAIR database the emissions of this process arise from the use of two energy products, gasoline and diesel. Households are responsible for the gasoline part of the emissions while the economic activity NACE 61 (maritime transport) is responsible for the emissions generated by the use of diesel.
- SNAP 97 processes 090202 “Incineration of industrial wastes (except flaring)” and 090205 “Incineration of sludges from waste water treatment”. The Italian CORINAIR experts estimate that 2/3 of emissions coming from incineration processes are due to NACE 90 and that the remaining 1/3 belong to NACE 24 enterprises.
- SNAP 97 process 091001. The methane emissions of process 091001 “Waste water treatment in industry” are estimated through an ad hoc study that includes the economic activities “Manufacture of food products and beverages” (NACE 15), “Manufacture of textiles and textile products (not including wearing apparel)” (NACE 17) “Manufacture of pulp, paper and paper products” (NACE 21), “Manufacture of coke, refined petroleum products and nuclear fuel (NACE 23), “Manufacture of chemicals and chemical products” (NACE 24) and “Manufacture of basic metals (NACE 27). The total methane emissions of process 091001 are calculated in the study as a sum of the emissions from the six economic activities, and therefore, on the basis of the basic data, it is possible to exactly distribute the total methane emissions among the NAMEA activities 15, 17 21, 23, 24 and 27. The emissions of N₂O are distributed with the same percentages calculated for methane.

2.3.3 Emissions distributed on the basis of the number of full time jobs by economic activity

Emissions of SNAP 97 processes 060107 and 060405 are distributed on the basis of national accounts data on the number of full time jobs by economic activity. Moreover, data on the number of full time jobs by economic activity are used as part of the method applied to split part of the emissions of process 060108 (see above).

3 TABLES

The Italian NAMEAs air emission data for 1990-2000 attached to the 2004 Istat report comply with the format set in the Eurostat 2002 NAMEA air set of standard tables (see § 3 in Chapter 7).

They are not included here³⁴⁷. The updated NAMEA air emission accounts are available on the Istat web site (www.istat.it).

³⁴⁷ The 1990-2000 NAMEA air emission data reported to Eurostat in 2004 were published in Istat (2005).

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