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PROCEEDINGS
OF THE SEMINAR ON ECOLOGICAL STATISTICS

Organizzato dalla Conferenza degli Statistici Europei, Organo della Commissione Economica per l'Europa delle Nazioni Unite, e dall'Istituto Nazionale di Statistica

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OPENING SPEECHES

DISCOURS D'OUVERTURE DE M. ROGER GENTILE DIRECTEUR P.I. DE LA DIVISION DE STATISTIQUE DE LA COMMISSION ECONOMIQUE POUR L'EUROPE

Il y a maintenant plus de seize ans que la Conférence des statisticiens européens a inscrit à son programme de travail l'étude des problèmes posés par l'élaboration de statistiques de l'environnement. Commencés sur un rythme plutôt lent, ces travaux ont atteint très rapidement leur vitesse de croisière, et les dix dernières années peuvent être considérées comme une période d'intense activité dans ce domaine.

Au cours de cette dernière période, il a souvent été suggéré lors des réunions d'experts convoquées par la Conférence des statisticiens européens que les statistiques de l'environnement devraient prendre en compte de façon plus systématique qu'actuellement les connaissances scientifiques en matière de biologie ou, plus précisément, d'écologie. Cependant, il n'a jamais été possible d'examiner en détail ces propositions, les participants à ces réunions ne comprenant que pas ou peu de scientifiques, dont la présence aurait été indispensable.

C'est ce qui, entre autres, a conduit la Conférence des statisticiens européens à convoquer ce Séminaire, dont le but premier est de rassembler des statisticiens et des experts de l'environnement, afin d'examiner en détail ce qu'ils pourraient accomplir ensemble en vue du développement futur des statistiques de l'environnement. Ce but devrait être présent à l'esprit des participants tout au long des travaux du Séminaire, aussi bien lors de l'examen des divers documents qui leur sont soumis que lors des débats généraux portant sur les divers points de l'ordre du jour. L'un des résultats du Séminaire pourrait en effet être la présentation à la Conférence de recommandations portant sur les travaux que celle-ci pourrait, ou devrait, inscrire à son programme de travail.

A ce propos, permettez-moi, Monsieur le Président, de rappeler brièvement ce qu'est la Conférence des statisticiens européens. Celle-ci fut créée en 1953 par les directeurs des services nationaux de statistique des pays membres de la Commission économique pour l'Europe. Son but est de promouvoir le développement et l'harmonisation des statistiques nationales afin de permettre aux gestionnaires et aux décideurs aussi bien qu'aux chercheurs et aux scientifiques de disposer de données comparables concernant les différents pays. Son programme de travail couvre l'ensemble des domaines qui peuvent intéresser les services nationaux de statistique, qu'il s'agisse des statistiques économi-

ques, des statistiques sociales et démographiques, des statistiques de l'énergie ou, et c'est là ce qui nous intéresse plus particulièrement aujourd'hui, des statistiques de l'environnement. Il comprend également les questions liées à l'organisation des services de statistique comme, par exemple, l'emploi des ordinateurs.

C'est donc tout naturellement que la Conférence a été amenée à s'intéresser aux statistiques de l'environnement. J'ai dit tout à l'heure qu'elle a commencé à le faire il y a plus de seize ans. Ces travaux devaient aboutir en 1987 à la publication d'un Recueil expérimental de statistiques de l'environnement pour les pays de la CEE. A la suite de cette publication, la Conférence convoqua une réunion destinée à évaluer le résultat de ses travaux. Le rapport final de cette réunion contient, entre autres, les propositions de travaux futurs que la réunion a établies à l'intention de la Conférence des statisticiens européens. Ce sont ces propositions que le Séminaire peut, s'il l'estime nécessaire, amender, voire compléter, afin d'y incorporer ses propres recommandations.

La tâche qui vous attend, Mesdames et Messieurs, est donc importante. Des résultats de vos débats dépendra, dans une large mesure, l'orientation que la Conférence donnera à ses travaux futurs dans le domaine des statistiques de l'environnement.

Je vous souhaite donc un fructueux séminaire et un plaisant séjour à Rome.

OPENING SPEECH BY MR. GUIDO M. REY PRESIDENT OF THE CENTRAL INSTITUTE OF STATISTICS, ITALY

The subject considered by this Seminar is undoubtedly at the centre of discussion and attention in almost every country at the present time.

Every day we are experiencing (and we will undoubtedly continue to experience even more in the future) extremely precarious situations which oblige us to think that the time has come to arrive at last at a wiser approach to environmental problems. We see an irrational utilisation of the various forms of energy, an uncontrolled use of the territory, the spreading of different forms of pollution induced by human activity and particularly disastrous natural events which reveal the existence of a close connection between economic, social and environmental phenomena.

In Italy there has been a growing awareness of the importance of these problems which involved at different times the various institutions, political parties and social organizations.

The most outstanding demonstration of this new awareness is the growing demand (expressed above all in recent years) for highly significant statistical information on the evolution of the different environmental components.

Istat knows only too well that a statistical system must constantly meet, in due time and with appropriate instruments, the requirements for information arising from the society. That is why we have considered for some years now as one of the priority objectives to be reached in the short term, a substantial development of the sector of environmental statistics.

That was the spirit in which the Central Statistical Institute met the request of the Conference of European Statisticians to host the present Seminar. The attention we pay to the problems of the environment dates from some time back; indeed we may say that it originates from the work started by the Economic Commission for Europe and the Conference of European Statisticians at the beginning of the Seventies. We have followed with great interest all the various stages of this work from the Warsaw Seminar in 1973 to the Working Groups on specific problems which were set up a few years ago. Indeed I feel I must point out that the volume published by Istat entitled Environmental Statistics *(which is the first concrete result of our efforts in this sector) owes much, and not merely in terms of formulation, to the activities of the United Nations in the field of environmental statistics.*

We are following very carefully all the efforts being made by the various international organizations in the field of standardized statistical instruments. And we must say that the results achieved in the last few years, in the framework of the Economic Commission for Europe and of the Conference of European Statisticians, from definitions and classifications to methods of measurement and data organization procedures, should be considered as extremely positive. We hope that it may prove possible to go even further in the near future.

Before closing these brief greetings, I would like to say that Istat is at the present time carrying out a survey on the sources of environmental information. As it will be explained in the course of this Seminar, its objective is to ascertain the state of data now existing in Italy. The construction of an environmental information system should start from this first step: in fact data on the environment are scattered among a large number of organizations, public and private, central and local, scientific and economic so that it is difficult to establish a connection not only to set up adequate initiatives of intervention, but even to know what (and where) data are available at the moment.

The creation of the Ministry for the Environment in 1986, together with a renewed commitment by Istat should gradually reduce the obstacles to an effective coordination between all those who produce information. However this is a difficult sector for a statistician to deal with, since the methodological and organizational problems are often different from those met when dealing with economic, social and demographic statistics. A better development of statistical culture among experts on the environment would make the cooperation much easier. An effort should be made to solve all of these problems, among other things because the demand for statistical information on the environment has by now reached vast proportions, especially on the part of citizens who are obliged to live more and more often in very serious situations of degradation of the environment. In fact legislative actions are already moving in this direction, with the recent law setting up the Ministry of the Environment which recognises in a precise way that citizens are entitled to information on the environment.

The presence of a large number of qualified experts from various countries constitutes the fullest guarantee that an extensive and thorough debate will develop on these topics. And this exchange of experiences should enable us to deal better with the problems related to environmental statistics.

Feeling sure as I do of the validity of the results it will be possible to achieve in the next few days, I am very happy to welcome you all here today.

PREFACE

The use of statistical methods and actual data is rather common to sciences in general and to biological disciplines in particular. By contrast, the emerging field of environment statistics to date has only made very limited use of the science of biology in developing its characteristic concepts and taxonomies. Yet, a statistical information system about the environment can *prima facie* certainly be expected to lean to an important extent on biological subject-matter knowledge. At first sight, the branch of ecological science can be seen as being of prime interest to the statisticians of the environment.

We are therefore faced with a surprising situation: environment statistics attempt to describe the state of the environment and its evolution in time, but virtually no systematic use is made of ecology as one of the sciences that aim precisely at scientific knowledge about related matters. The Conference of European Statisticians, when deciding to convene a Seminar on Ecological Statistics, tried to shed more light on the reasons for this surprising situation, including possible ways and means for more mutually beneficial cooperation between statisticians and ecologists in future work on environment statistics.

In planning for the Seminar, it was decided to approach the questions involved under four headings: possibilities and limits of describing ecosystems statistically; biological indicators for the purpose of describing environmental quality and conditions; ecological monitoring; and national experiences with purposes and coverage of ecological statistics, including their linkage to other statistics. The results of the discussion by the Seminar under each of these items are resumed briefly in the remainder of this preface, before the discussion papers are presented.

The possibilities and limits of describing ecosystems statistically

The discussion under this item related primarily to aspects of a general nature. First of all, the Seminar tried to clarify the borderline between environmental statistics on one hand and ecological statistics on the other. The conditions that would have to be met before ecological statistics could be developed in a systematic way constituted the second major theme of discussion. Thirdly, a number of principles were highlighted that would have to be kept in mind if ecological statistics were to be developed.

Statistics about ecosystems are clearly seen as a part of ecological statistics. At the same time, the difficulties in defining ecosystems as well as the need to distinguish between different uses of such statistics were stressed. Ecosystems being systems that are open at all ends and evolving over time, cannot be defined in a rigid manner. However, certain indicators are available that help in many instances. These indicators are often distinct from indicators used for other purposes. Two such other uses were specified, i.e. the description of the state of the ecosystem including its change over time and the description of the regulating mechanisms of the ecosystem.

The participants in the Seminar did not agree on whether statistics on the population of species should be subsumed under ecological statistics. While such statistics are needed for several purposes of nature management, the association of population size with ecosystem functioning may be either too indirect or too unreliable to include them under this heading. The opposite view was that in many cases ecosystem management requires data on the change in the size of certain populations so that a pragmatic, user-oriented system of ecological statistics can but take this need into account.

The Seminar compared the traditionally available body of environment statistics against a broad description of ecological statistics. Available environment statistics primarily cover physical and chemical variables of the natural environment, whether influenced by human activities or not. In addition, data on demographic, economic and social activities are added to different extents and in various forms. Seen in this perspective, ecological statistics appear to be the wider term, as physical and chemical variables also determine ecosystem functioning, and as it is also possible to extend the term «ecology» to social systems.

On the other hand, the inverse relationship can also be argued. Consider the sequence in which reference is made to statistical or other information systems. It can also be said that environment statistics provide a framework within which, if required, scientific information regarding specific issues has to be sought. Ecological information being part of scientific information appears in this context as being more limited in scope than environment statistics.

From a practical point of view, an extension of traditional environment statistics into the area of fauna, flora and habitat statistics would go some way to accommodate also information needs of ecosystem managers. Nevertheless, situations exist in which environment statistics could be simply replaced by ecological statistics, with concomitant changes in information requirements and characteristics. Thus, reliance on practical approaches alone does not answer all the questions.

Any development of ecological statistics would have to satisfy a certain number of conditions, irrespective of which definition of the term is chosen. In the first place, such statistics should enable global statements of the type required by decision-making instances. This condition implies that sufficient systematic subject-matter knowledge is available for the derivation of the corresponding global statistical variables. Considerable scientific knowledge is available on different ecosystems, but it can often only be systematized — if at all — once specific questions are asked. At the same time, examples can be cited in which generalization of available information is possible to the extent that at least some form of overall criteria for the structuring of an information system is at hand.

Such structuring appears as one of the minimum requirements if a statistical information system on ecosystems is to be developed. In this case, the use of ecosystem equilibrium in any static sense has to be avoided. In fact, equilibria change over time, so that they cannot be used as a stable gauge for data evaluation. Finally, ecosystems should not be limited to «natural» ecosystems but should also include those that are influenced by human activities. The notion of «disturbed» versus «undisturbed» ecosystems may help in the decision on which ecosystems to include in the statistical system.

The Seminar did not review all possible approaches to the actual development of ecological statistics. However, two such approaches were referred to. The first is based on requirements as expressed by users of such statistics. This approach has the advantage of being close to user needs, but makes it difficult to preserve data linkage and coherence over time. The second major approach starts from cartographical information obtained through remote sensing, primarily satellite imagery. The basic observation would occur in terms of land cover characteristics. The work required subsequently would consist of linking this information to statistics observed for other units. The Seminar did not evaluate these or other general approaches in detail.

Biological indicators for the purpose of describing environmental quality and conditions.

The discussion led to some clarification of two topics. Firstly, some quality attributes of biological indicators were considered and evaluated in comparison to the same attributes of other enviromental indicators.

Secondly, a brief review was undertaken of situations in which compilation of biological indicators would be the only reasonable way of getting any information at all or in which they offer clear comparative advantages over alternative ways of describing environmental phenomena. In addition to these two topics, difficulties encountered in the elaboration of biological indicators as well as limits of their use were briefly considered.

Three potential advantages of biological over other environmental indicators were emphasized. The most important of them is the relative ease with which biological indicators can be understood and thus used. It was agreed that this is an important quality attribute which extends to practically all user groups of environmental information.

A related advantage is associated with the degree of precision that is characteristic of knowledge in environmental matters. For many reasons a great deal of environmental information has to be used with care as the determinants and/or effects of the described phenomena or situation are not fully understood. In this situation the presentation of the usual environmental data may create an illusion of precision which is not founded on reality. Biological indicators, by contrast, more easily convey the complexity and vagueness of the information. Consequently, they may be more adequate for a given purpose at hand.

A third advantage relates to costs of collection and compilation of environmental information. The possibility of mapping lichens in cities as an alternative to the traditional way of describing urban air pollution by measuring concentrations of ambient air pollutants was cited as a case in point. The mapping of lichens could clearly be done at lower cost and would at the same time produce reliable information on general aspects of urban air quality.

The Seminar did not review comparative advantages and disadvantages of biological indicators in an exhaustive manner. At present, biological indicators may not always become available in a form that complies with the usual quality attributes of statistics, particularly regarding reliability.

Turning to the second major topic of the discussion, the availability of biological indicators in situations in which other reasonable methods of data provision do not exist has to be mentioned in the first place. Examples quoted included the use of bird species in surveying species composition in an ecosystem, the use of indicator species for the purpose of describing salinity levels, and the recognition of oil spills through the observation of their effects on animals.

Similar reasoning holds for the use of biological indicators whenever early warning signals are requested with regard to ecosystem stress. Such signals can only be obtained with great difficulty — if at all —, so that biological indicators at least offer a more practical opportunity than other types of information.

The third situation in which biological indicators are comparatively advantageous can be seen in particularly complex circumstances. In many cases, the pathways on which certain stimuli provoke reactions and certain effects are unknown or only partly known. At the same time, the subject-matter expert may have confidence in the mere description of the final result of the processes involved, although he does not know them in detail. Biological indicators are particularly apt to respond to information requirements in such situations.

If available, biological indicators have to be used with care and should not be seen as satisfying all information needs all on their own. «Description» is the only purpose which biological indicators can serve. Accordingly, if degradation of an environmental situation is documented by a change in a biological indicator, additional research has to be undertaken before anything can be said on the cause-effect relationships involved in the process of degradation.

A couple of further caveats have to be borne in mind when undertaking conceptual development of biological indicators. The first is that useful biological indicators can usually be formulated by the experts once the question is asked to which they should respond. By implication, it is difficult to formulate good biological indicators in anticipation of the question. This circumstance appears to complicate the incorporation of biological indicators into a system of statistical information on the environment, which has to be planned as a system that is capable of replying to future questions.

A second caveat concerns the quality assurance of biological indicators before they can be used by statistical offices. A reasonable degree of confidence in the statistical viability of biological indicators in measuring the underlying situation or phenomena has to be ascertained before the use of indicators by statistical offices can be contemplated.

Ecological monitoring.

The general debate followed the distinction between population monitoring on one hand and habitat monitoring on the other. Population monitoring having been traditionally used in many countries for some time, views were primarily expressed with regard to habitat monitoring.

On the one hand, degradation of habitats appears to an increasing extent as a major cause of threat to species, so that information on changes in the quality of habitats can be expected to be of growing importance. On the other hand, methods exist of generating information on changes in the quality of habitats in a comprehensive way, so that habitat monitoring and related data compilation can be discussed on their basis.

At the same time, the discussion of the approaches showed that the compilation of statistics on the quality of habitats is still fraught with conceptual difficulties and problems in interpretation. Nevertheless, useful results start to emerge. The use of these results for statistical purposes does not appear to be excluded, as the confidence of experts in these results grows, and linkage to other data sets seems to be coming within reach.

Information on changes in the quality of habitats can also be obtained from other sources. In particular, much of the available forest statistics could provide useful information on habitats, if these statistics were deliberately exploited toward this end. The existence and need for further development of biological indicators — primarily species indicators — describing habitat quality was also referred to in this context. Finally, widely available physical and chemical information often permits us to characterize habitat quality to a considerable degree.

The preponderance of habitat monitoring in the discussion did not mean that population monitoring is only of little importance. On the contrary, wildlife resources cannot be managed without information on wildlife populations. Secondly, data on wildlife populations are also an end in themselves, although understanding of the related population dynamics may still be insufficient. Population changes result from many different influences, so that they present a convenient summary variable.

National experiences and applications regarding purpose and coverage of ecological statistics, including their linkage to other statistics.

The detailed consideration of different national experiences enabled the Seminar to draw a number of significant general conclusions. It was noted in the first place that the character of the different practices clearly illustrates differences in the perception of the term «ecological statistics». While the term is evidently being used as a synonym for «environment statistics» in certain countries, it seems to have a much more specific meaning in others.

The discussion also demonstrated that ecological statistics in their narrow sense are embodied in environment statistics in a rudimentary way only. However, in well-defined applications, the introduction of ecological expertise into the conceptual development of environment statistics appears to have influenced the scope and coverage of these statistics considerably.

The conceptual widening of the perspective of environment statistics to cover ecological aspects will only lead to a modification of such statistics, if sufficient instruments are available for the implementation of the related concepts. The introduction of ecological expertise into environment statistics regularly passes through some form of ecological or other environmental monitoring. This circumstance permits the conclusion that no *a priori* impediments exist to a large-scale incorporation of ecological perspectives into environment statistics. In fact, environment statistics are interwoven in many respects with monitoring data, so that the above-mentioned pathway for ecological widenings of environment statistics appears to be well in existence already.

In concluding this discussion, the Seminar also stressed the importance of further interfaces between environment and other statistics. The most important of these additional relationships concerns the borderline between economic and environment statistics.

PAPERS

1 · МЕТОДИЧЕСКИЕ ОСНОВЫ РАЗРАБОТКИ ЭКОЛОГИЧЕСКИХ ПАРАМЕТРОВ, КОТОРЫЕ ИСПОЛЬЗУЮТСЯ В СТАТИСТИКЕ ОКРУЖАЮЩЕЙ СРЕДЫ

Документ, представленный НИКЦЭООС при БАН, Болгария-Подготовленный Проф. С. Недялковым и СТ. Н.С. Тр. Алчевым.

Статистика окружающей среды в НР Болгарии является составной частью государственной статистики. Необходимость ее создания проистекает из конституционного обязательства государственных органов, общественных и хозяйственных организаций и каждого отдельного гражданина по охране окружающей среды. Концепция государственной экологической политики отчетливо выражена в утвержденном 29 июня 1977 г. документе "Основные направления охраны и воспроизводства природной среды в Народной Республике Болгарии". С этим и рядом с другини программно-директивными документами Государственного совета, а также и с усовершенствованием законодательства по охране природных ресурсов, доработана и конкретизирована государственная экологическая политика.

Статистическая методология-это система научно-обоснованных приемов и методов работы для проведения статистического исследования, для исследования общественных явлений и процессов в их массовом проявлении и развитии. При разработке методологии статистики окружающей среды встречаются ряд трудностей. Они происходят от специфики ее объекта, разработки ряда показателей, форм, методов и организационных подходов статистической работы в этой области.

Статистика окружающей среды изучает экосистемы и их развитие. По своей сущности экосистема это биологическая макросистема только более высокого ранга и охватывает в диалектическом единстве две подсистемы-экотоп и принадлежащий ему биоценоз. Биоценоз-организованная группировка из популяции растений, животных и микроорганизмов, обитающих совместно на данной территории, которая характеризуется относительно одинаковыми условиями среды. Экотоп-пространство, заселенное одним или другим видом биоценоза охватывает в основном следующие абиотичные компоненты среды: земляные недра, почвы, воды, воздушные бассейны, климатические и космические факторы.

Это требует соображения, прилаживания к качественным особенностям исследуемых объектов в экосистемах при организации и проведении статистических исследований.

Особенности методологии статистики окружающей среды, проистекают из объектов статистического наблюдения, иерархичного уровня государственных органов, которые его проводят и периодичности наблюдений.

Статистические исследования в НР Болгарии проводятся по нескольким направлениям:

1. Климатическое направление (включая атмосферу). На государственном уровне в НР Болгарии статистически наблюдаются параметры: атмосферное давление, температура, сумма годичной температуры, облачность и влажность (1, с4:10). Параметры характеризуются своими средними, максимальными и минимальными месячными и годичными стоймостями. Метеорологические данные передаются в Центральное статистическое управление из Главнсго управления "Гидрология и метеорология" при БАН.

Для потребностей некоторых ведомств берутся пробы от пунктов наблюдения в городах и около районов, где имеются промышленные предприятия, загрязняющие воздушную атмосферу. Вредные вещества-загрязнители воздуха, установлены нормативно (3,4). Это: серная двуокись, пыль, свинец, сероводород, азотные окиси, аммиак, марганец, сажи, сероуглерод, серная и соляная кислота, фенол, фтор, флуор и неприятные запахи. Взятие пробы совершается по определенному графику. Вычисляются средняя и максимальная среднесуточная концентрация по кварталам и процент проб, которые превышают МДК (предельно допустимые концентрации). Обычно, вычисленные стоимости сравниваются с аналогичными показателями предедуцих кварталов и делаются выводы о состоянии воздуха. Указываются также и метеорологические данные о днях взятия пробы: температура, атмосферное давление, направление и сила ветра, а также какай была погода: тихая, облачная, дождливая, туманная и т.д.

Пока что этой информацией пользуются для санкционирования предприятий-загрязнителей. Предусматривается в будущем автоматизированная обработка результатов проб с целью создания дозиметрического контроля атмосферы в данном населенном пункте и по всей стране.

Недостатком созданной системы наблюдения за состоянием воздуха является то, что не принимается во внимание загрязнение воздуха, проникающего через государственные границы, серными и азотными окисями, соединениями хлора и другими загрязнителями. В нашей стране также выпадают кислые дожди и началось заболевание лесных массивов и увеличение кислотности почв.

2. Второе направление статистического наблюдения охватывает водную среду, т.е. акваторию Черного моря и внутренних рек и реки Дуная. Параметры-длина в км, и водовмещаемая площадь в км2 указаны до границ НР Болгарии.

Для ведомств Главное управление "Гидрология и метеорология" статистически наблюдает ряд параметров: застои воды, водные количества, температуру воды, наносные количества, мутность, химический анализ воды. Водные застои наблюдаются только в Дунае и Черном море, а водные количества и во внутренних реках. Результаты химического состава взятых водных проб - четыре раза в год - не имеют статистической достоверности.

Качественное состояние поверхностных вод и категоризация бассейнов в зависимости от стоимостных значений загрязнителей - объект статистического изучения Комитета охраны окружающей среды. Наблюдается несколько групп показателей: кислородная, минеральная, особенная и биологическая. Результаты статистического исследования служат для сравнения фактической с проектной категорией качества рек.

Качественное состояние подземных вод изучается по местонахождению и виду источника. Исследуются до четырех проб годично по параметрам, входящим в кислородную, минеральную, особенную группу и йонный состав, при этом указываются и нормы, в зависимости от категории загрязнения.

Статистическое изучение водоснабжения для страны и по областям (1 о 562) совершается через следующие показатели: водоснабжение для населенных мест, длина водопроводной сети в км, длина внешнего водопровода в км, количество водопроводных отклонений и поступающая вода - в тыс. куб. м. Эти данные обобщают более тридцати параметров, которые наблюдаются в хозяйственных предприятиях. Статистически отчитывается общее количество полученной воды предприятием, в т.ч. и от собственных водоисточников (реки, подземные воды, водохранилища), от общественной водопроводной сети или от водоснабжаемых систем, в том числе и от отходной воды от других потребителей. Использованная вода наблюдается по потребителям: для питевойводы потребностей, для гидроэлектростанций, для орошения, для производственных нужд.

Объем выброшенных и использованных отходных вод наблюдется в двух направлениях - как водоприемники, в которые выбрасываются (поверхностные водоемы, подземные горизонты и общественная канализация) и как качественное состояние вод - условно чистых, загрязненных, непрочищенных и прочищенных соответственными сооружениями для механического, физико-химического или биологического очищения.

Недостатком созданных систем длш наблюденш за чистотой и качеством вод в нашей стране могут быть указаны следующие констатации:

- Не создан дозиметрический контроль за наблюдением загрязняющих веществ в реках и внутренних водоемах и источниках, которые являются причиной загрязнения.

- Недостаточной является поступающая информация от очищаюих станций. Необходим контроль за эффективностью работы сооружений. Недостаточна информация об обработке тины: стабилизация, обеднение, обезводнение, центрифугирование, фильтрирование, дезинфекцирование, а также об использовании тины - компостирование, сохранение, рекультивация, сжигание, и др.

- Статистическое наблюдение не может определить различные убытки воды и причины потери - несовершенство в технологии, плохое состояние водопроводной сети, утечка из сооружений в домах и т.д.

- Не сопоставляются и не анализируются производственные расходы по водоснабжению и водоочистки и других услуг, связанных с водопользованием различных категорий вод.

- Не применяется функциональный и экологический подход при оценке качества вод. Это означает, что качество воды наблюдается с точки зрения ее употребления человеком и промышленностью, а не с точки зрения возможности, чтобы она была средой для места обитания различных ценных видов рыб, растительности, бентоса, фито - и зоопланктона и также средой для рекреации. Традиционные данные о качестве воды необходимо в будущем модифицировать и раскрывать свойства водных экосистем (например, динамику превращения энергии, цикл питания, кислородный баланс, состав биота, возможность обнаруживания загрязнения, критические пороговые границы биота, степени деградации экосистемы и т.г.).

- Отчет топливного и радиационного загрязнения отходных вод.

- Проникновение загрязнения через государственные границы Черного моря и Дуная.

- Унифицирование нормативов качества поверхностных, подземных и морских вод, с точки зрения возможности сравнения статистических наблюдений со всеми странами Европы.

3. Третье направление статистического наблюдения охватывает литосферу (материнскую среду) и педосферу (почвы). Территория страны и характеристика гор через главные вершины с их высотой над уровнем

моря остаются почти неизменными после Второй мировой войны (1 с. 2).

В отрасли "Сельское хозяйство" статистическая информация охватывает структуру хозяйственной и обрабатываемой земли, в том числе поля, естественные луга, пастбища, стабильные насаждения, карьеры, рудники, неасфальтированные дороги, парки, застроенные площади и дворы (1 с. 342). Ведется отчет освоенных, заброшенных, слабопродуктивных земель, рекультивированных площадей, изъятого цухусного почвенного пласта (6 с. 324). За рекультивированные площади указывается какими они были до этого: открытые рудники, карьеры, шлаковые отвалы, застроенные места, дороги, каналы, водохранилища, пустующие места. Статистически наблюдаются и потребленные химические и биологические средства растительной защиты, химические удобрения, навоз, компост и навозная жидкость (6. с. 331).

Отдельной единицей наблюдения являются площади, занятые защищенными природными объектами - народными парками, заповедниками, природными природопримечательностями, защищенными местностями и историческими местами (1. с. 489).

Статистическое наблюдение о состоянии почв ведется на уровне ведомства институтом почвоведения. В стране составлена карта почв населенных мест. Совершается и анализ содержания азота, фосфора, калия и микроэлементов в засеянных площадях и в зависимости от вида сельскохозяйственной культуры, которой будет засеяна данная площадь, и рекомендуются нормы для химических удобрений. Эта информация недостаточна и не может использоваться для экологических прогнозов. Засаливание и заболочивание почв - продолжительный процесс и принятые вовремя меры могли бы предотворить экономические убытки и потери плодородной земли. Считаем, что с экологической точки зрения важно наблюдать pH почвы, учитывать содержание хлоридов и нитратов в воде для орошения и косвенно прогнозировать засоление почв.

4. Четвертое направление статистического наблюдения охватывает населенные пункты. Рассматривание населенных мест как экотоп предполагает определенные параметры: дома и площадь, которую они занимают, уличные пространства, озелененные места и бытовое обслуживание (вода, канализация, электрификация, теплофикация, бани, прачечные, гостиницы). (1, с. 393, 562).

Рассматрение населенных пунктов как экосистемы требует информацию о населении и его жизненном уровне. Информация о состоянии и изменении населения является результатом регулярных переписей, включительно с конца 1985 года. Направление антропогенного воздействия на окружающую среду определяется рядом факторов: жизненный уровень населения, инфраструктура населенного места.

развитие отрасли материального производства и т.д..

Это воздействие пока не учитывается прямо, а косвенно различными параметрами.

Один из них связан с твердыми отходами - бытовыми, промышленными и сельскохозяйственными. Объектом регулярного статистического наблюдения являются баланс и изменение отходов: наличности в начале года, полученные от других предприятий, текущие отходы в производстве, отходы, переданные другим предприятиям и остатки в конце года. В промышленной статистике учитываются более 54 видов отходов, в сельском хозяйстве - масса удобрений, отходы животного и растительного происхождения и осадки в очищающих станциях. В непроизводственной сфере учитываются новообразованные отходы, переработанные и депонированные бытовые отходы и осадки от станций очишения.

Отходы учитываются только количественно, а как площади они не учитываются, т.е. как земля и то определенной категории и пригодности для использования для народнохозяйственных нужд.

Другим параметром является регистрация шумового уровня городов и наблюдаемых пунктов. В некоторых городах как в Софии, Враце, созданы карты шума и регулярно проводятся предварительные измерения в определенных пунктах.

Загрязнение воздуха в населенных пунктах обязывает создание в будущем системы предупреждения населения о появленние смога, кислых дождей, загрязнения соединениями хлора и др.

5. Пятое направление статистического наблюдения - фитоценоз. Фитоценоз - это самая существенная часть данного биоценоза и определяющее звено в экосистеме - продуцент. Он трансформирует абиотические, неживые химические элементы в живую органическую материю и посредством фотосинтеза включает в эту материю светлую солнечную энергию, которая трансформируется в химическую.

Лесная растительность имеет доминирующее значение и поэтому является объектом подсобного статистического наблюдения. Параметр распределения общей лесной территории по видам лесов учитывает и незалесенные и непроизводительные лесные площади: луга, поляны, дороги, трясины, скалы и др. Залесение, как площади и израсходованные средства, в том числе и залесение около водохранилищ и других земель лесного фонда, также наблюдается по видам насаждений. Подробно отчитывается деятельность рассадников и мероприятия по защите и восстановлению лесов по видам. О размерах промышленной деятельности анализируется добываемая древесная масса и учитывается откормленный скот на пастбищах лесов. Залесенные лесные площади характеризуются по классам возраста, полноте и бонитете и по процентам лесистости и древесного запаса о лесных хозяйствах областей (1 ц. 292. 293).

В флору Ъолгарии входят около 3560 видов высших растений, которые соответственно относятся к 861 видам и 143 семьям. В "Красную книгу НР Ъолгарии" включены 763 вида принадлежащих к 373 родам и 107 семьям, о которых даны сведения, рисунки и хронологические карты. Из них уже исчезли 31 вида, под угрозой исчезновения 153 вида и 574 вида, которые очень редко встречаются.

На государственном уровне наблюдаются количественно урожайность и засеянная площадь сельскохозяйственными культурами, а также доставленные химические удобрения чистого вещества (азотные, фосфорные, калиевые) и химические средства также чистого вещества, в том числе гербициды. Для предприятий и для аграрно-промышленных комплексов, которые используют химические средства, анализируются более подробно химические средства в общем количестве по видам: инсектициды, фунгоциды, фумиганты, гербициды, родентивиды, дефолианты, десиканты, нематоциды. Употребленные для защиты растений биологические средства анализируются по охватываемой площади растений.

В качестве недостатка созданной в стране системы наблюдения за фитоценозом можно назвать:

- Недостаток интегрированных данных о наличии пестицидов в продуктах питания по населенным пунктам и по стране, по видам продуктов и производителей.

- Статистическое наблюдение за наличием нефтопродуктов и тяжелых металлов в продуктах питания и кормах по населенным пунктам.

- Учет радиоактивного загрязнения в продуктах питания и кормах по населенным пунктам.

- Учет использованных химичесхих средств в аграрно - промышленных комплексах и отклонение от предельно допустимых концентраций и накопление ст прошлых лет.

6. Шестое направление статистического наблюдения это зооценоз - сообщество животных организмов, возникщее и обитающее в данном пространстве. Фауна Болгарии очень богата разнообразием животного мира. На территории страны встречаются 35000 видов животных, из которых до сих пор установлено только 18000 видов. В Красную книгу НР Болгарии вписаны только позвоночные животные (костные рыбы, земноводные влечуги, птицы и млекопитающие).

На государственном уровне учитывается количество сельскохозяйственных животных в конце года, продукты, полученные от них, продуктивность, рожденные приплоды от 100 матерей, израсходованный корм для откормки животных и птиц в сельскохозяйственных организациях. Эти же данные даются и по административно-территориальному делению страны. Для ведомственных нужд и аграрно-промышленных комплексов, кроме указанных показателей, наблюдается и состояние и движение сельскохозяйственных животных, распределение животноводческой продукции в торговой сети. В отдельной статистической форме учитываются сельскохозяйственные животные и полученные животноводческие продукты в личные хозяйства населения.

Периодически совершается учет сельскохозяйственных животных, птиц и семейства пчел в общественных организациях и личных хозяйствах.

Учитывается состояние сладководного рыболовства: зарыбение, израсходованные корма для откормки и полученный улов рыбы. Под наблюдением находится также ловля и разселение дичи и рыбы, строительство и поддержка исскуственных сооружений (кормушки, сольницы, рыбные пороги), убитая полезная и вредная дичь (мясо и кожа). Указываются также количества уничтоженных домашннх животных волками и другими хищниками.

На 1.01.1989 г. установлено, что в нашей стране имеется 354 вида птиц. Из них 255 видов гнездятся постоянно или эпизодично, или перед этим гнездились у нас. В "Красную книгу НР Болгарии" записаны 100 видов: которые находятся под угрозой исчезновения, исчезнувшие и редкие.

Совершаются зимние и весенние учеты перелетных птиц и тех, которые гнездятся в нашей стране, по месту их пребывания.

Статистические наблюдения у нас должны охватить в будущем следующие объекты и их параметры:

- Наличие тяжелых металлов в тканях животных /сельскохозяйственные и дичь/, птиц, рыб.
- Наличие пестицидов, а также нефтепродуктов у животных, птиц и рыб.
- Ущерб, нанесенный рыболовству от загрязнения вод.
- Ущерб, нанесенный птицам от загрязнения морских и речных площадей.
- Ущерб, нанесенный животным, птицам и рыбам от радиоактивного заражения.

После анализа болгарского опыта в организации статистики окружающей среды, сделанных выводов и идей на будущее, предлагаем для обсуждения экологическому семинару следующие объекты и показатели для будущих совместных общеевропейских статистических наблюдений:

а) Статистическое наблюдение кругооборота серных азотных окисей через систему показателей:

- выброшенные в атмосферу серные и азотные окиси по промышленным предприятиям в тыс. куб. м/год (т.год);

- преобладающие направления ветров по метеорологическим станциям всего континента и по странам в виде схемы о "розе" ветров;

- максимальная и средняя концентрация серных и азотных окисей в воздухе по метеорологическим станциям в мг/м3;

- активные реакции /pH/ рек, озер, водохранилищ, водяных объектов по пунктам наблюдения;

- осадки по метеорологическим станциям; почвы по лесным хозяйствам, аграрным комплексам - отдельно для орошаемых земель в pH;

- экономические убытки от серных и азотных окисей - в том числе от потери древесной массы, уничтожение и уменьшение урожайности в растениеводстве, от коррозии, от повреждения зданий и памятников, от потери продукции самого загрязнителя.

б) Статистическое наблюдение чистоты больших европейских рек и морей через химический и функчиональный анализ вод. Организация совместных наблюдений о состоянии и качестве вод, например реки Дуная, требует приложения всеми заинтересованными странами Единой методики сбора и обработки результатов, Единой номенклатуры веществ-загрязнителей, а также обмена информацией, совместного дозиметрического контроля чистоты вод. Для европейских морей основным показателем является фотосинтезирующаяся способность водорослей.

в) Статистическое наблюдение кругооборота тяжелых металлов (свинца, меди, железа, марганча, калия, кадмия и т.д.) на примере свинца через следующие показатели по населенным местам:

- средняя и максимальная концентрация в воздухе свинцовых аэрозолей в мг/м3 в населенных местах, на автомагистралях, в предприятиях-загрязнителях;

- количество свинцовых йонов в воде; почве; растениях, в том числе растениях-индикаторах загрязнения данного вида, в тканях животных, рыб, в костях и в органах людей в мг/кг

г) Разработка карт о шуме в больших городах. На основе регистрирования шумовых уровней по наблюдательным пунктам в децибелах по экспериментированной в стране методике созданы карты о шуме в Софии, Враце. Учтены все жилые кварталы и, в зависимости от их отдаленности от дорожных артерий, указаны зоны с одинаковым шумовым уровнем.

Карты о шуме наглядно дают более полную информацию о шумовом загрязнении. они более удобны для использования органами территориального и городского районирования потоков моторных средств передвижения, однако, они более трудоемки и пока не очень распространены в процессе статистических наблюдений.

д) Статистическое наблюдение о создании, движении и использовании твердых отходов в нескольких направлениях: на первом месте учет изменений земной коры, при этом учитывается деятельность предприятий рукодобывающей, угольной и горно-добывающей промышленности через баланс земли по территориальному принципу в декарах, в том числе: открытые залежи, насыпи, шахты, карьеры, для инертных материалов, снова невосстановленные, нерекультивированные земли и т.д. На втором, месте-учет выброшенных твердых отходов от промышленности - шлак, токсические вещества, пепел и др. химические и строительные отходы, путем учета потерянной земли в декарах. На третьем месте - потерянная от бытовых отходов земля в декарах. На четвертом месте должна учитываться потеря земли в сельском хозяйстве в результате водной и ветровой эрозии, от засоления и заболочивания в декарах.

На пятом месте-учет опускающейся почвы, абразии приморских территорий в декарах.

Общее рассмотрение занятых площадей с твердыми отходами должно быть обобщено в балансе земли и сравнено с располагаемой территорией европейских государств и континента.

е) На общеевропейском уровне необходимо статистическое наблюдение и учет защищенных природных объектов в трех категориях - глобальной, европейской и национальной значимости. Необходимо создание "Красной книги Европы" в нескольких томах - о высших растениях, низших растениях, животных, рыбах, птицах, насекомых с их местообитанием.

ж) Предлагаем для обсуждения также проблему статистического наблюдения, после экспериментирования в некоторых европейских государствах, фотосинтезирующей способности древесных видов и изменений рН почв, как индикатора вредности кислых дождей. Альтернативный путь - организация общеевропейского статистического наблюдения и мониторинг очистных сооружений теплоэлектрических электростанций, автомобильного транспорта, промышленных предприятий и химических заводов и косвенным путем - посредством учета капацитета, процента выброшенных газов и преобладающих воздушных течений включить новые статистические параметры, характеризующие чистоту воздуха.

В одном докладе не могут быть анализированы проблемы статистики окружающей среды. С усвоением экологической культуры и привычки, в будущем можно охватить и наблюдать загрязнение окружающей среды нефтепродуктами, химическими средствами о защите растений от вредителей, употребленными химическими удобрениями.

радиоактивностью, ультразвуком, осадками очистных станций, массой навоза в животноводстве и дать показатели их учета.

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SUMMARY

1 - METHODOLOGICAL BASES FOR THE ELABORATION OF ECOLOGICAL PARAMETERS USED IN ENVIRONMENTAL STATISTICS

Authors: S. Nedyalkov and T. Alchev

Paper submitted by the Central Statistical Office, Bulgaria.

Environmental statistics are an integral part of official statistics in Bulgaria. The need to produce these statistics arises from the constitutional obligation to protect the environment. The policy of environmental protection is governed by a number of legal instruments adopted in the '70s.

Some difficulties are encountered in framing the methods of environmental statistics. These difficulties stem from specific features of the subject — systems of indicators on protection of the natural environment, and the forms, methods and organizational aspects of statistical activity in this sphere.

It is the ecosystem that is studied in environmental statistics. An ecosystem is regarded as a biological macrosystem that is a dialectical unity of the ecotope and its biocenosis. It is therefore essential to have regard to the qualitative characteristics of the subjects under investigation when organizing and carrying out statistical research.

The matters investigated in statistical observations of the environment in Bulgaria are the air, the Earth's interior, soils, water resources, noise, topography and protected natural objects, climatic factors, solid wastes, and the vegetable and animal kingdoms. Observations are carried out at both central and departmental levels.

Detailed consideration is given to the statistical observations made in our country and to the ecological indicators that characterize them. The observations are carried out daily in large part, but at various intervals for living organisms.

The units of observation are administrative units, territories, and the whole country. We are unable to organize the observation of separate ecosystems except when they coincide with administrative units (including reserves, protected localities etc.).

The statistical unit coincides with the subjects of statistical study, i.e. observations are made for the parameters of the air, waters, soils, noise, etc.

The qualitative statistical characteristics under observation are defined in written standards. They are essentially indicators of the maximum permissible levels of pollution of the environmental subject under observation, for determination of the quality of the environment, and quantitative indicators in the case of solid wastes, the vegetable and animal kingdoms, mineral resources etc.

Statistical observations in Bulgaria are organized on the sectoral principle — in industry, agriculture and forestry, in health care, in housing and utilities, and in domestic services — by specific subjects in environmental statistics.

Analysis of the content and scope of the indicators, and of the frequency of collection of information for individual subjects, provides a basis for drawing certain conclusions on the improvement of statistical methods both in our country and for general European requirements. The main conclusion is that no use is made of the functional and ecological approaches, which should become the main methodological approaches in environmental statistics. We consider that air pollution extending beyond frontiers should be covered, that acid rain should be recorded, that statistics on the use and quality of the water of the major European rivers and the European marine basins should be improved, and that the use of toxic substances, chemical fertilizers, pesticides and other pollutants in the national economy should be monitored.

RESUME

1 - BASES METHODOLOGIQUES DE L'ELABORATION DES PARAMETRES UTILISES DANS LES STATISTIQUES ECOLOGIQUES

Auteurs: S. Nedialkov et T. Altchev

Document soumis par l'Office central de la statistique, Bulgarie.

Les statistiques écologiques en Bulgarie font partie intégrante des statistiques de l'Etat. La création de ce secteur statistique découle de l'obligation constitutionnelle de protéger l'environnement. La politique de protection de l'environnement est régie par une série de textes réglementaires des années 70.

L'élaboration d'une méthodologie des statistiques écologiques n'est pas chose aisée, vu la spécificité de son champ d'application, qu'il s'agisse d'établir des systèmes d'indicateurs pour la protection de l'environnement ou de définir les formes, les méthodes et les critères d'organisation des activités statistiques dans ce domaine.

Les statistiques écologiques étudient l'écosystème. Celui-ci est considéré comme un macrosystème biologique englobant dans une unité dynamique l'écotope et sa biocénose. D'où la nécessité de tenir compte des caractères qualitatifs de l'ensemble observé lorsqu'on organise et réalise des études statistiques.

En Bulgarie, le champ d'investigation des statistiques écologiques comprend le bassin atmosphérique, les ressources minières, les sols, les ressources en eau, le bruit, le paysage et les sites naturels protégés, les facteurs climatiques, les déchets solides, la faune et la flore. Ces observations sont effectuées à l'échelon de l'Etat et des départements.

Les données d'observation statistique font l'objet dans notre pays d'un examen attentif, au même titre que les indicateurs écologiques qui les caractérisent. Les observations, en grande partie continues, sont effectuées avec une périodicité variable pour les organismes vivants.

Les ensembles statistiques à observer comprennent le territoire des unités administratives, les districts, le territoire national. Nous ne pouvons organiser des activités d'observation des différents écosystèmes que lorsque ceux-ci correspondent à des unités administratives (par exemple les réserves naturelles, les sites protégés, etc.).

A une unité d'observation statistique correspond un champ d'investigation, par exemple les paramètres de l'air, des eaux, des sols, du bruit, etc.

Les caractères qualitatifs selon lesquels est menée l'investigation statistique sont fixés par la réglementation: ce sont les indicateurs des concentrations maximales admissibles de polluants dans l'ensemble observé, pour ce qui est de la qualité du milieu, et les indicateurs quantitatifs correspondant aux déchets solides, à la faune et à la flore, aux ressources minérales, etc.

En Bulgarie, les champs d'investigation statistique sont sectoriels: industrie, agriculture et sylviculture, transports, santé publique, gestion municipale des logements et services d'utilité courante dans les ensembles observés aux fins des statistiques écologiques.

L'analyse du contenu, la portée des paramètres, la périodicité de la collecte de données dans les différents ensembles observés permettent de dégager certaines conclusions concernant l'élaboration d'une méthodologie statistique propre à répondre aux besoins de notre pays comme à ceux de l'Europe tout entière. La principale conclusion est qu'on ne met encore guère à profit les méthodes fonctionnelles et écologiques, qui devraient devenir un outil méthodologique essentiel des statistiques de l'environnement. A cet égard, on estime qu'il faut tenir compte de la pollution atmosphérique transfrontière, suivre de près les pluies acides, améliorer les statistiques concernant l'utilisation et la qualité de l'eau des grands fleuves et des bassins marins européens et surveiller l'utilisation des matières toxiques, des engrais minéraux, des pesticides et autres polluants dans l'économie nationale.

Резюме

1 - МЕТОДИЧЕСКИЕ ОСНОВЫ РАЗРАБОТКИ ЭКОЛОГИЧЕСКИХ ПАРАМЕТРОВ, КОТОРЫЕ ИСПОЛЬЗУЮТСЯ В СТАТИСТИКЕ ОКРУЖАЮЩЕЙ СРЕДЫ

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Статистика окружающей среды в НР Болгарии является составной частью государственной статистики. Необходимость её создания вытекает из обязанности охраны окружающей среды, закрепленной конституцией. Политика охраны окружающей среды регламентирована рядом нормативных документов семидесятых годов.

При разработке методологии статистики окружающей среды встречаются ряд трудностей. Они являются следствием специфики её объекта - системы показателей охраны природной среды, форм, методов и организационных подходов статистической деятельности в этой области.

Статистика окружающей среды изучает экосистему. Последняя рассматривается как биологическая макросистема и охватывает в диалектическом единстве экотоп и принадлежащий ему биоценоз.

Поэтому необходимо считаться с качественными особенностями изучаемых объектов при организации и проведении статистических исследований.

Объектами статистических наблюдений окружающей среды в НРБ являются: воздушный бассейн, земные недра, почвы, водные ресурсы, шум, ландшафт и охраняемые природные объекты, климатические факторы, твердые отходы, растительный и животный мир. Наблюдение ведётся на государственном и ведомственном уровне.

Подробно рассматриваются проводимые статистические наблюдения в нашей стране и экологические показатели, с которыми они характеризуются. Большая часть наблюдений - текущие, а для живых организмов проводится подсчет с различной регулярностью.

Территория наблюдений охватывает административные единицы, округи, страну. Мы не имеем возможности организовать наблюдение отдельных экосистем, за исключением тех случаев, когда они совпадают с административными единицами (в т. ч. заповедники, охраняемые местности и др.).

Единица статистических наблюдений совпадает с объектами статистического изучения, т. е. наблюдаются параметры воздуха, вод, почв, шума и т.д.

Качественные статистические признаки, по которым проводится наблюдение, установлены нормативными документами. По своей сущности они являются показателями предельно допустимых концентраций загрязнения наблюдаемого объекта окружающей среды, когда определяется качество среды, и количественными показателями - в случае твердых отходов, растительного и животного мира, минеральных запасов и др.

Статистическое наблюдение в НРБ организовано по отраслевому принципу - в промышленности, сельском и лесном хозяйстве, транспорте, здравоохранении, жилищно-коммунальном хозяйстве и бытовом обслуживании - по определенным объектам статистики окружающей среды.

Анализ содержания, охват показателей, периодичность сбора информации по отделыным объектам дают основание сделать некоторые выводы относительно усовершенствования статистической методологии, как в нашей стране, так и для общеевропейских потребностей. Основной вывод состоит в том, что не используются функциональный и экологический подходы, которые стать основными в методологии статистики окружающей среды. Считается, что необходимо охватить трансграничное загрязнение воздуха, регистрировать кислотные дожди, усовершенствовать статистику использования и качества воды больших европейских рек и принадлежащих Европе морских бассейнов, следить за использованием токсичных веществ, минеральных удобрений, пестицидов и других загрязнителей в народном хозяйстве.

2 - ХАРАКТЕРИСТИКА И ПАРАМЕТРЫ СТАТИСТИЧЕСКОГО ОПИСАНИЯ ЭКОСИСТЕМ

Подготовлено Екатериной Павловой.

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Введение Определение. Принимается сделанное Одумом (1975 г.) определение экосистемы: "Любое единство, включающее все организмы (т.е. "сообщество") на данном участке и взаимодействующее с физической средой таким образом, что поток энергии создает четко определенную трофическую структуру, видовое разнообразие и круговорот веществ (т.е. обмен веществами между биотической и абиотической частями) внутри системы, представляет собой экологическую систему или экосистему". Из определения следует, что речь идет об объектах статистического описания, компоненты которого находятся в определенных взаимоотношениях, взаимозависимостях и причинно-следственных связях, образуя функциональное целое.

То, что экосистема является открытой и относительно стабильной во времени и пространстве системой, в которой совершается непрерывный круговорот веществ и потока энергии, делает ее очень сложным объектом исследования в отношении доступности, сбора и обработки данных, чем она существенно отличается от существующих отраслей (ресурсных) статистических систем.

В НРБ статистического описания экосистем почти не существует. Характеристику отдельных компонентов экосистем можно найти в статистике разделов "Состояние, использование и охрана земельных ресурсов", где собраны ежегодные отчеты о хозяйственном использовании сельскохозяйственных площадей, проведении противоэрозионных мероприятий, рекультивации нарушенных площадей, использовании биопрепаратов для защиты растений, "Состояние, охрана и воспроизводство лесных ресурсов и ресурсов животного и растительного мира", "Состояние, использование и охрана водных ресурсов", "Состояние и охрана атмосферного воздуха" и др.

Как показывает анализ, этот вид статистического описания рассматривает каждый компонент изолированно, не позволяя дать характеристику всему многообразию биотических и абиотических компонентов и их взаимосвязей.

Целью статистики экосистем является:

- характеристика явлений и процессов между биотическими компонентами и их местообитаниями на базе количественных данных, а также и взаимоотношения с обществом;

- характеристика состояния экосистем и степени воздействия на них (как положительных, так и отрицательных).

Основная задача состоит в том, чтобы:

- обеспечить плановые органы информацией о количественном и качественном состоянии экосистемы;

- обеспечить органы управления и планирования информацией, необходимой для разработки мероприятий по регулированию воздействия человека на среду в целях поддержки, а часто и восстановления оптимальных условий для существования живых организмов;

- определить расходы по охране и поддержке равновесного состояния экосистемы;

- осуществить контроль по выполнению задач, связанных с рациональным природопользованием и охраной природной среды;

- провести сравнительный анализ показателей состояния, охраны и использования экосистем в международном масштабе.

Трудности в достижении определенных целей и выполнении основных задач сводятся к следующему:

1. Недостаточной изученности различных типов экосистем и территориального их распространения.

2. Несовпадению границ экосистем и административных районов, представляющих отчетную информацию.

3. Сравнительно слабой изученности количественного выражения взаимосвязей в экосистеме.

4. Отсутствию экономической оценки большей части компонентов экосистем.

Этапность в разработке системы статистических показателей описания экосистем.

Предлагаются следующие этапы:

1 этап - использование существующих статистических данных, установление которых не представляет трудностей. К примеру, данные о хозяйственной деятельности, связанной с использованием и воспроизводством природных ресурсов, таких, как запасы возобновимых ресурсов, включенные в земельный, лесной, водный и др. кадастры; данные по использованию и потреблению энергетических ресурсов - объем строительных работ, приводящих к изменениям в землепользовании:

происходящие природные процессы и явления; количество и качество отходов и др.

Характеристика всех этих видов деятельностей возможна и она проводится. Известно, что все они оказывают воздействие на экосистемы, например, уменьшая продуктивность почв, лесов, других биологических ресурсов, сокращая площади некоторых ценных в хозяйственном и социальном отношении экосистем, приводя к гибели определенные виды и экосистемы в целом и т.д.

Проблемы статистической отчетности такого рода связаны с определением границ, продолжительности и способов воздействия.

2 этап - показатели статистической отчетности могут быть выражены в виде суммы показателей состояния (в бальной системе) отдельных компонентов. Эта система может быть разработана на основе данных уже существующей статистики. Недостатком этой системы можно считать невозможность включения большого числа показателей, так как все еще не установлены количественные, а иногда и качественные выражения связей и взаимоотнощений между компонентами экосистем.

3 этап - определение представительных экосистем и сбор информации об их состоянии путем стационарных наблюдений. В этом случае, используя возможности технических средств, экосистема высшего порядка может рассматриваться и исследоваться как иерархия подсистем, например, "система передачи энергии", "система движения минеральных веществ" и др. Объем и качество информации стационарных наблюдений позволяют проводить системный анализ, применяя математические модели, учитывающие огромную сложность экосистем.

Предлагаемая структура системы статистических данных для описания экосистем относится к 1 и 2 этапам - с использованием существующей статистической информации и необходимых дополнительных данных.Показатели для описания экосистем подразделяются по типам экосистем (наземные, пресноводные, морские), образуя группы А, Б, В, Г, Д.

А. Наличие и состав

Приводим пример для части наземных экосистем:

1 Лесные экосистемы

1.1 Естественные экосистемы

1.1.1 Хвойные экосистемы

1.1.1.1 Чистые - дается характеристика занятой площади и запасов по отдельным видам деревьев, класса (возраста), бонитета и полноты

1.1.1.2 смешанные с преобладанием хвойных - дается характеристика занятой площади и запасов по отдельным видам деревьев, класса (возраста), бонитета и полноты

1.1.2 Широколиственные экосистемы

1.1.2.1 Чистые - характеристика как в п. 1.1.1.1

1.1.2.2 Смешанные с преобладанием широколиственных пород- характеристика как в п. 1.1.1.2

1.1.3 Смешанные - дается характеристика по занятой площади и запасам, по классу (возрасту), бонитету и полноте

1.2 Искусственные экосистемы (следуют показатели как в п.п. 1.1.1, 1.1.2 и 1.1.3)

2 Травяные экосистемы

2.1 Луговые экосистемы

2.1.1 Естественные

2.1.2 Искусственные

2.2 Пастбищные экосистемы

2.2.1 Естественные

2.2.2 Искусственные

(2.1.1, 2.1.2, 2.2.1 и 2.2.2 - характеристика дается по занятой площади)

Б. Количественные и качественные изменения в результате человеческой деятельности и природных процессов.

Предлагаются следующая классификация и параметры, характеризующие экосистемы:

а/ Условно неизмененные - не подвергающиеся прямому хозяйственному воздействию и использованию.

К этой группе относятся защищенные природные территории с категорией заповедников. Согласно Закону о защите природы в НРБ статутом заповедников пользуются территории или отдельные местности, отличающиеся ценными для науки или же находящиеся под угрозой исчезновения или уничтожения сообщества растительных и животных видов, а также и те формы, которые имеют научное значение, в результате чего они охраняются в их естественном виде. В заповедниках запрещены все действия, нарушающие естественную обстановку и самобытный характер природы в них.

б/ Средне измененные - подвергающиеся хозяйственному воздействию, при нарушении отдельных "вторичных" компонентов, но при сохранении основных связей, изменение которых имеет обратимый характер.

Эта группа включает в себя оставшиеся категории защищенных природных территорий - народные (национальные) парки, природные достопримечательности, охраняемые ландшафты, леса специального предназначения и все остальные экосистемы, имеющие специальный статут, не включенные в лесной фонд.

в/ Нарушенные - находящиеся по интенсивным воздействием и многие компоненты которых изменены. Антропогенные модификации выходят из рамок исходного природного инварианта. Это приводит к существенному нарушению внутренних связей в направлении их необратимости.

г/ Искусственные - полностью преобразованные экосистемы.

В. Примененные мероприятия для охраны и улучшения экосистем, включая биологическую, интегрированную и другие виды борьбы с вредителями и болезнями, облесение, выращивание и др.

Г. Средства для охраны экосистем - включая расходы государства на борьбу с эрозией, рекультивацию, биологическую и интегрированную защиту растений, лесопосадки и мероприятия в охотничьем и рыбном хозяйствах.

Д. Качественное состояние экосистем в определенных районах или отдельных точках - включая информацию, полученную от стационарных наблюдений, в заповедниках или других объектах.

Предлагаемая система построена на основе использования методов и средств для исследования экосистем, их изученности и необходимости в статистической информации.

SUMMARY

2 - CHARACTERISTICS AND PARAMETERS FOR THE STATISTICAL DESCRIPTION OF ECOSYSTEMS

Author: E. Pavlova

Paper submitted by the Central Statistical Office, Bulgaria.

Characteristics and parameters for the statistical description of ecosystems are determined by application of methods used in ecological studies of ecosystems to describe structural and functional relationships in all their diversity, as they exist in natural ecosystems and in anthropogenic ecosystems that have arisen in the application of technology to resources.

The proposed statistical system includes an account of the subject of the research, and definition of the objectives, the purposes and the structure of the systems.

It is ecosystems that are the *subject* of observation (individual organisms, groups of organisms in their totality and the environment as the set of factors conditioning their existence).

The *objectives* of ecosystem statistics are quantitative descriptions of the phenomena and processes taking place between the biological components and their habitat, and in addition their relationships with society, description of the state of ecosystems and the extent of the influences (both positive and negative) on them.

The *main task* is to provide managerial and planning bodies with the information that they need for devising measures to regulate man's influence on the environment with the object of maintaining, and very often of restoring optimum conditions for the existence of living organisms. Close links are maintained with sectoral statistical systems, in particular with social and demographic systems.

The *structure* is worked out by types of ecosystems — terrestrial, freshwater and marine.

The *indicators* for the statistical description of ecosystems are grouped as follows:

A. Presence and composition

Taking terrestrial ecosystems as an example:

1. Forest ecosystems

1.1. Natural
1.1.1. Coniferous
1.1.1.1. Pure (tree species, young, ..., high-grade, ...)
1.1.1.2. Mixed (tree species, young, ..., high-grade, ...)
1.1.2. Deciduous
1.2. Artificial
1.2.1. Coniferous
2. Grassland ecosystems

B. Quantitative and qualitative changes arising from human activity (including descriptions of virtually unaltered, slightly modified, averagely modified, destroyed and artificial ecosystems)
C. Measures for the protection and improvement of ecosystems (including biological, integrated and other forms of pest and disease control, afforestation, cultivation, etc.)
D. Means for the protection of ecosystems
E. The qualitative state of ecosystems in specified areas or at individual points (including information collected at permanent stations in reservations or elsewhere)

The proposed system has been formulated having regard to the methods and tools used in the study of ecosystems, the level of knowledge concerning ecosystems and the statistical information requirement.

RESUME

2 - CARACTERISTIQUES ET PARAMETRES DE LA DESCRIPTION STATISTIQUE DES ECOSYSTEMES

Auteur: E. Pavlova

Document soumis par l'Office central de la statistique, Bulgarie.

Les caractéristiques et les paramètres de la description statistique des écosystèmes sont déterminés en utilisant les méthodes d'étude appliquées en écologie pour décrire les diverses formes de relations structurelles et fonctionnelles qui se manifestent dans les écosystèmes, naturels ou non, sous l'effet des techniques d'exploitation des ressources.

Le système proposé d'indicateurs statistiques comprend la caractérisation de l'objet de l'étude ainsi que la définition des buts, des tâches et de la structure des systèmes.

Le champ d'investigation est celui des écosystèmes (organismes, groupes ou ensembles d'organismes et le milieu en tant qu'ensemble de facteurs conditionnant leur existence).

Le but des statistiques écologiques est de donner une description quantitative des phénomènes et des processus s'établissant entre des composantes biologiques et leur habitat, ainsi que de leurs corrélations avec la société; de définir l'état des écosystèmes et de déterminer l'intensité des effets — positifs ou négatifs — que ceux-ci subissent.

La tâche principale consiste à fournir aux organes de gestion et de planification les informations nécessaires pour élaborer des mesures tendant à règlementer l'action de l'homme sur le milieu afin de préserver et, très souvent, de rétablir les conditions optimales d'existence des organismes vivants. On maintient pour cela des liens étroits avec les systèmes de statistique sectorielle, en particulier dans les domaines social et démographique.

La structure a été élaborée par types d'écosystème: terrestre, en eau douce, marin.

Les indicateurs utilisés pour la description statistique des écosystèmes sont regroupés comme suit:

A. Présence et composition

Exemples d'écosystèmes terrestres:

1. Ecosystèmes forestiers

1.1. Naturels
1.1.1. Conifères
1.1.1.1. Homogènes (essences jeunes ..., hautement fertiles ...)
1.1.1.2. Composites (essences jeunes ..., hautement fertiles ...)
1.1.2. Feuillus
1.2. Artificiels
1.2.1. Conifères
2. Ecosystèmes herbacés

B. Les modifications quantitatives et qualitatives provoquées par l'activité de l'homme (y compris la description des écosystèmes pratiquement inchangés et des écosystèmes peu modifiés, moyennement modifiés, altérés et artificiels).

C. Les mesures de protection et d'amélioration des écosystèmes (y compris les formes biologiques, intégrées et autres de lutte antiparasitaire et phytosanitaire, boisement, plantation, etc.)

D. Moyen de protection des écosystèmes

E. L'état qualitatif des écosystèmes dans certaines régions ou en certains points (cela comprend les informations obtenues par des stations fixes dans des réserves ou d'autres sites).

Le système proposé a été conçu en tenant compte des méthodes et des moyens utilisés pour l'étude des écosystèmes, de l'évolution des connaissances en matière d'écosystèmes et des besoins en information statistique.

Резюме

2 - ХАРАКТЕРИСТИКА И ПАРАМЕТРЫ СТАТИСТИЧЕСКОГО ОПИСАНИЯ ЭКОСИСТЕМЫ

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Характеристика и параметры статистического описания экосистем определены на основе методов, применяемых в экологии при изучении экосистем для описания всего многообразия структурно-функциональных связей, существующих как в природных, так и в антропогенных экосистемах, возникших в процессе техногенного освоения ресурсов. Предлагаемая система статистических показателей включает характеристику объекта исследования, определение целей, задач и структуры систем.

Объектом наблюдения являются экосистемы (организмы, группы или совокупности организмов и среда как совокупность факторов их существования). То, что экосистема является открытой и относительно стабильной во времени и пространстве системой, в которой совершается непрерывный круговорот вещества и потока энергии, делает ее очень сложным объектом исследования с точки зрения доступности, сбора и обработки данных, чем она существенно отличается от существующих отраслевых (ресурсных) статистических систем.

Целью статистики экосистем является: количественная характеристика явлений и процессов, протекающих между биологическими компонентами и их местообитанием, а также их взаимоотношений с обществом; характеристика состояния экосистем и степени воздействия на них (как положительного, так и отрицательного).

Основная задача состоит в обеспечении органов управления и планирования необходимой информацией для разработки мероприятий по регулированию воздействия человека на среду с целью поддержания, а очень часто и восстановления оптимальных условий существования живых организмов. При этом поддерживается тесная связь с отраслевыми системами статистики, в особенности с социальной и демографической.

Необходимо также обеспечить контроль за выполнением задач по региональному природопользованию и охране природной среды.

разработку основ для составления планов по рациональному природопользованию и охране природной среды, а также получение данных для расчета необходимого объема природоохранных средств и эффективности их использования.

Структура разработана по типам экосистем - наземные, пресноводные, морские.

Показатели статистического описания экосистем объединены в следующие группы:

А. Наличие и состав

Пример наземных экосистем:

1. Лесные экосистемы

1.1. Естественные

1.1.1. Хвойные

1.1.1.1. Чистые (древесный вид, молодые,..., высокобонитетные...)

1.1.1.2. Смешанные (древесный вид, молодые,..., высокобонитетные,...)

1.1.2. Лиственные

1.2. Искусственные

1.2.1. Хвойные

2. Травяные экосистемы

Б. Количественные и качественные изменения в результате человеческой деятельности (включают описания условно неизмененных, слабо измененных, средне измененных, нарушенных, искусственных экосистем).

В. Мероприятия по охране и улучшени экосистем (включают биологическую, интегрированную и др. виды борьбы с вредителями и болезнями, олесение, выращивание и др.)

Г. Средства охраны экосистем

Д. Качественное состояние экосистем в определенных районах или отдельных точках (включает информацию стационарных наблюдений в заповедниках или других объектах)

Предлагаемая система построена с учетом используемых методов и средств изучения экосистем, степени их изученности и потребностей в статистической информации.

3 - PLACE DU REPERTOIRE CARTOGRAPHIE DES ECOZONES DANS LE SYSTEME DE STATISTIQUES ECOLOGIQUES

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Document soumis par le Secrétariat général de la Commission interministérielle des comptes du patrimoine naturel, Ministère de l'environnement, France.

Introduction

1. L'inventaire cartographié et numérisé de l'occupation biophysique du territoire, outre son intérêt descriptif immédiat, fournit une base d'extrapolation pour de nombreuses informations sur le patrimoine naturel vivant.

L'analyse du territoire en unités homogènes du point de vue de leur composition bio-physique constitue un élément de cadrage important et, combiné à des cartes topographiques, climatiques et/ou pédologiques, permet de définir des plans de sondage précis pour de nombreuses espèces faunistiques et floristiques.

La sélection, parmi ces espèces d'indicateur de l'état de macro-écosystèmes définis par des unités cartographiques d'occupation du sol, par leur combinaison entre elles, et, le cas échéant, par leur combinaison avec des paramètres extraits des cartes informatisées citées au paragraphe précédent, permet en retour de procéder à des évaluations globales de la santé des milieux naturels.

L'utilisation dans le dispositif d'inventaire de la télédétection par satellite permet enfin, outre l'exhaustivité de la couverture de base, de procéder à des mises à jour périodiques rapides.

I. L'OCCUPATION DU SOL ET LE SYSTEME D'INFORMATION SUR L'ENVIRONNEMENT ET LES RESSOURCES NATURELLES

A. *Représentation et évaluation statistiques des écosystèmes*

2. Les écosystèmes pouvant s'analyser à partir de leurs composants (biotope et biocénose) et de leurs relations, rien n'interdit, en théorie,

d'en faire la statistique via celle de leurs éléments. Quand on dispose des modèles de fonctionnement adéquats, et de l'information pour les nourrir, il est même possible de faire une représentation quantitative dynamique de ces écosystèmes.

Dans la pratique, la modélisation se limite à des espaces restreints (un lac, un bassin versant,...) ou ne prend en compte qu'un nombre limité de paramètres, voire un seul. On établit par exemple des bilans énergétiques, ou des bilans matières.

3. Si l'on veut produire des informations relatives non plus à un système, mais à un territoire quelconque (un pays, une région...) comprenant un certain nombre de systèmes élémentaires, il est nécessaire de pouvoir affecter l'information concernant les éléments à ces systèmes. La solution la plus pratique consiste à utiliser un repérage géographique des données (géocodage). Deux voies sont alors offertes:

— soit on procède au maillage (selon les coordonnées géographiques, par exemple) du territoire;

— soit on identifie des unités fonctionnelles auxquelles on rattachera les données élémentaires.

4. Il convient de noter d'abord que ces deux approches sont fondamentalement complémentaires, et que leur mise en oeuvre dépend des objectifs poursuivis.

5. Des enquêtes par mailles géométriques (points, aréoles ou segments) sont d'usage courant pour l'étude de l'atmosphère, de la faune et de la flore, de la production agricole...

L'enquête TERUTI du ministère de l'Agriculture est de ce type. Elle fournit des informations significatives au niveau national, pertinentes au niveau régional pour les catégories les plus représentées, mais de valeur plus fragile aux niveaux plus fins.

D'autres pays réalisent des inventaires de l'occupation de leur territoire par mailles plus fines (ex.: NORVEGE, SUISSE, PAYS-BAS...) La télédétection par satellite fournit également ses informations radiométriques de base par mailles (les pixels).

6. Le recours à un maillage géométrique présente de nombreux avantages sur le plan de la collecte des données (il permet de réaliser des sondages aléatoires) et de leur traitement sur ordinateur. La combinaison des données maille à maille est aisée et permet des synthèses numériques et cartographiques.

Le maillage engendre bien sûr une imprécision relative qui est fonction de la dimension des mailles. Cette imprécision peut n'avoir aucun inconvénient, si l'on tient compte à la fois de la précision intrinsèque de l'information cartographiée et de la précision utile du résultat recherché.

7. L'amélioration de la précision passe alors par une augmentation du taux de sondage, c'est - à - dire par une réduction de la dimension des mailles, ou/et par une stratification de la population ou du territoire d'étude.

Cette deuxième solution est retenue, par exemple, pour l'Inventaire forestier national pour lequel sont identifiés dans un premier temps les peuplements forestiers par photo-interprétation de photographies aériennes. La carte réalisée sert ensuite de base à l'établissement d'un plan de sondage pour les enquêteurs de terrain.

8. Un méthode de ce type peut être mise en oeuvre à partir de l'inventaire d'occupation du sol de type LAND COVER. Elle consiste à repérer et identifier sur une carte des unités d'occupation du sol homogènes (par exemple: les peuplements forestiers, dans le cas cité précédemment), à décrire l'évolution de leur superficie, voire leur disparition ou leur naissance, à l'aide de la télédétection par satellite, et à les traiter comme des unités d'observation et d'analyse statistiques.

En effet:

— le dessin de leur contour et leur localisation géographique font qu'elles peuvent faire l'objet d'enquêtes;

— elles réalisent la partition exhaustive d'un ensemble qui devient une population de référence;

— leur répertoire est mis à jour périodiquement;

— elles caractérisent des systèmes élémentaires auxquels on peut rapporter, directement ou indirectement (cf. infra), un certain nombre de paramètres.

9. C'est à cette logique d'utilisation d'unités d'occupation du sol comme unités statistiques que correspond le concept d'écozone. L'écozone appartient donc à la fois:

— au champ de la cartographie thématique par le mode de production de l'inventaire de base, et

— au champ de la statistique et de l'évaluation quantitative (et tout particulièrement du système d'information sur le patrimoine naturel) pour un grand nombre d'utilisations.

B. *Ecozones et représentation statistique du patrimoine naturel*

10. Le stockage informatique de la carte d'occupation du sol permet de faire de celle-ci un véritable répertoire statistique. Chaque unité y est identifiée par son contour (stockage dit en mode vectoriel) et/ou les coordonnées géographiques des mailles qui la composent (stockage dit en mode raster). Les écozones peuvent faire l'objet de regroupements géographiques ou thématiques, ou bien être subdivisées par combinaison avec d'autres cartes numérisées.

a. Regroupements d'écozones

11. Les écozones peuvent d'abord être regroupées sur une base géographique par régions géographiques, écologiques, administratives ou tout autre découpage du territoire jugé pertinent pour une étude donnée. L'ensemble des écozones d'un territoire quelconque correspondra aux frontières de celui-ci avec une précision relative d'autant plus grande que ce territoire sera plus étendu. La prise en compte des découpages géographiques et écologiques à petite échelle dans le processus même d'élaboration des écozones assure, en contrepartie, une bonne correspondance dans ces deux cas.

12. Les écozones peuvent également être regroupées selon leur voisinage immédiat, de manière à décrire les macro-écosystèmes qui sont les unités pertinentes de certaines analyses. On peut ainsi dériver du répertoire de base les écozones terrestres bordant les rivières ou les forêts contigües à des cultures. [On notera, dans ce deuxième exemple, que ce n'est pas toujours la superficie des écozones qui constitue le paramètre le plus intéressant, mais que l'on peut également prendre en compte leur périmètre. Dans le cas présent, c'est la longueur des lisières communes aux deux types d'écozones qui peut faire l'objet de traitements statistiques].

13. Les écozones peuvent enfin être regroupées selon les classes et sous-classes de la nomenclature d'occupation du sol (cf. annexe).

b. Subdivision des écozones

14. Regroupables par «région» (secteur, district...) selon leur proximité ou par classe thématique, les écozones peuvent également être subdivisées.

b.1. Combinaison avec des éléments permanents

15. Bien que le relief et la pédologie influent sur la nature des formations végétales, la précision thématique d'un inventaire général des écozones ne permet pas de rendre toujours compte de cette subdivision implicite. Or certaines espèces animales ou végétales sont inféodées à l'altitude, à l'exposition au soleil, à la pente ou à la nature du sol. La mise en évidence, par exemple, de meilleures corrélations espèces-habitats peut alors passer par la définition de fractions d'écozones homogènes selon ces critères.

16. Ce résultat s'obtient en subdivisant les écozones, à l'échelle de leur réalisation, par combinaison avec la carte digitalisée du relief (modèle numérique de terrain), et/ou celle des sols.

b.2. Analyse automatique d'images satellitaires

17. L'analyse automatique des pixels des images satellites permet de faire apparaître des sous-catégories dans le territoire des écozones. Elle permet de distinguer les écozones d'une même famille selon, par exemple, leur indice de végétation (zones naturelles terrestres, zones urbaines) ou de turbidité (lacs, estuaires...).

b.3. Zonages à des échelles plus grandes

18. Les écozones peuvent également être subdivisées par un zonage à échelle géographique plus grande. On fait apparaître alors les éléments d'hétérogénéité de l'écozone (d'échelle plus petite) et on peut suivre leur évolution avec un pas de temps plus court.

19. Les écozones peuvent ainsi être définies de manière emboîtée à différentes échelles. Le choix qui sera finalement retenu dépendra du rapport prix/efficacité recherché... et du budget disponible. On remarquera seulement que des écozones définies à petite échelle constituent un cadrage important mais sont immuables. Inversement, des écozones définies à grande échelle varieront beaucoup, mais l'interprétation de ces variations nécessitera un cadrage plus global. Ajoutons que dans ce dernier cas, le coût, qui est plus ou moins proportionnel à la surface, limite la possibilité d'inventaires de grandes étendues.

20. Pour ces raisons, la Commission interministérielle des comptes du patrimoine naturel préconise, à la suite des travaux de M. LENCO, un inventaire des écozones au 1/100 000e, qui assure un bon compromis entre cadrage (à un coût permettant la réalisation d'un inventaire national dans des délais brefs) et sensibilité. Le programme CORINE LAND COVER de la Commission des Communautés Européennes retient la même échelle.

b.4. Le cas des écozones rivières

21. Dans le cas des rivières, les écozones peuvent théoriquement être définies à l'aide de la télédétection. Dans la pratique, seules les grandes rivières sont actuellement facilement identifiables et cartographiables. Les rivières de plus petite dimension nécessitent le recours à des traitements qui en sont encore au stade expérimental. Il est donc envisagé de définir les écozones-rivières séparément, par segmentation du réseau hydrographique tel qu'il apparaît sur la carte topographique. La segmentation a lieu à l'intérieur de chaque bassin versant, en fonction de l'arborescence du réseau, des variations de débit liées à celle-ci et d'éléments susceptibles de justifier la subdivision d'un tronçon de rivière compris entre deux affluents (barrage, rupture de pente, présence d'une ville...).

22. Une fois ce travail effectué sur une carte informatisée des cours d'eau, on dispose d'une population de segments répertoriés selon leur position dans le réseau hydrographique et susceptibles d'être regroupés soit par zone géographique (bassin versant, région écologique ou administrative...) soit par classe de débit, soit selon une typologie écologique. (I)

23. Les écozones-rivières ainsi définies sont homogènes aux écozones terrestres et peuvent s'intégrer informatiquement à leur répertoire statistique et à leur carte. L'échelle courante de leur utilisation est donc celle du 1/100 000e, mais leur détermination devrait se faire à partir des informations de la carte topographique au 1/50 000e sur laquelle sont représentées la quasi-totalité des petites rivières.

24. Pour certaines analyses, les écozones-rivières pourront être définies de manière plus large, en incluant les écozones associées fonctionnellement aux cours d'eau, se situant par exemple dans le lit majeur.

C. *Utilisation du répertoire cartographié des écozones*

25. La carte numérisée de l'occupation du sol (complétée par celle des rivières) utilisée comme répertoire des écozones constitue une source statistique de base sur le territoire et son évolution et un outil puissant d'organisation de l'information sur le patrimoine naturel, qu'il s'agisse de la collecte des données, de leur synthèse ou de leur modélisation.

a. Collecte des données, sondages

26. Du point de vue de la collecte des données, la carte numérisée de l'occupation du sol constitue un inventaire exhaustif léger permettant en particulier de procéder à l'extrapolation d'informations plus riches (et donc plus longues et plus coûteuses à acquérir) collectées sur des zones choisies selon un plan d'échantillonnage.

27. Plus précisément, la base d'extrapolation pourra selon les cas être constituée du répertoire des écozones, du répertoire des rivières, de leur combinaison sur ordinateur ou de combinaisons diverses avec les cartes informatisées suivantes:

— modèle numérique de terrain (altitude, pente, exposition au soleil);

— limites administratives (y compris zones protégées);

— routes; réseau électrique; réseau ferroviaire;

— aire de réparation d'espèces;

— sols (carte pédologique);

— régions (secteurs, districts,...) écologiques;

— zones climatiques, etc...

28. Les sondages envisageables pourront porter:

— sur les milieux naturels eux-mêmes, définis à une échelle plus fine que celle de l'inventaire général;

— sur les éléments naturels composant ces milieux;

— sur certains milieux test ou éléments naturels indicateurs, dans le cadre des procédures d'évaluation globale.

29. Les échantillons eux-mêmes peuvent être constitués d'observations au sol, mais également d'écozones analysées à plus grande échelle selon les méthodes évoquées précédemment.

Sur une région pour laquelle on a identifié une mutation importante (par exemple, à l'aide de l'imagerie satellitaire) au 1/100 000e, on peut ainsi utiliser, pour un échantillon d'écozones, les images fournies par les capteurs des satellites dits de seconde génération, LANDSAT-TM et SPOT-HRV, qui permettent des analyses à des échelles allant du 1/50 000e au 1/25 000e. On dispose ainsi d'éléments de structure à des échelles correspondant mieux à l'étude de certains phénomènes tels que les mutations du paysage agricole, le mitage urbain, l'artificialisation de la montagne. Disposant de la base d'extrapolation que constitue l'inventaire de l'occupation du sol, ces approfondissements peuvent être faits au moindre coût et dans les meilleurs délais, ce qui autorise des mises à jour fréquentes.

b. Synthèses

30. Au plan des synthèses, on peut décrire l'étendue, les frontières, la composition (biotope, faune et flore), le mode de propriété ou d'utilisation par l'homme et leur variation.

31. Si la trace visible (le faciès) que constituent les écozones d'une certaine catégorie peut être assimilée à un macro-écosystème, on peut également établir des diagnostics de fonctionnement à l'aide d'indicateurs. Les indicateurs s'appliqueront dans d'autres cas soit à des démembrements, soit à des combinaisons d'écozones.

Ces indicateurs pourront être déterminés par sondage et donc, par extrapolation, permettre de réaliser des évaluations globales, au niveau national ou régional.

III. SPECIFICATIONS DE L'INVENTAIRE CARTOGRAPHIQUE ET STATISTIQUE DE L'OCCUPATION DU SOL

32. Les possibilités d'utilisation statistique d'une carte d'occupation du sol sont conditionnées par certaines propriétés de cette dernière. Ainsi, de nombreux inventaires de faune et de flore ont-ils débuté par la réalisation d'une carte ad hoc. L'exemple le plus significatif est celui de l'Inventaire forestier national qui, pour répondre aux exigences élevées de qualité (précision, nombre de paramètres évalués...) qui lui sont propres commence l'étude d'un département par la photo-interprétation de photos aériennes pour définir, à partir d'elles, un plan de sondage rigoureux. (2)

33. Dans le cadre d'un système d'information sur le patrimoine naturel à caractère général, la recherche d'un instrument polyvalent doit être considérée comme une priorité. Loin de réduire les différents domaines à une représentation unique, un tel outil permet de tenter de jeter des passerelles entre eux par l'établissement d'un niveau commun de représentation de l'espace. Pour être véritablement utile, l'outil recherché doit répondre à certaines conditions. Il doit être:

— suffisamment précis dans la délimitation et l'identification des écozones;

— exhaustif et cohérent sur l'ensemble du territoire;

— mis à jour de manière suffisamment fréquente, compte tenu du rythme d'évolution de l'occupation du sol à l'échelle retenue;

— accessible techniquement et économiquement au plus grand nombre d'utilisateurs;

— réalisable à un coût et dans des délais permettant de respecter les quatre conditions précédentes.

Il est clair que ces conditions sont étroitement liées et qu'un «maillon faible» dans cette chaîne affaiblirait l'ensemble du dispositif.

A. *Méthodologie générale: la photo-interprétation assistée par ordinateur*

34. La réalisation d'un inventaire cartographique et statistique de l'occupation du sol répondant aux conditions énoncées ci-dessus n'aurait pu être envisagée, dans un pays comme la FRANCE, avant le lancement des satellites d'observation de la terre. C'est également pour ces raisons qu'a été retenue, comme méthode générale, la photo-interprétation assistée par ordinateur d'images satellitaires développées au ministère de l'Environnement depuis dix ans (3) et récemment testée par la CEE, et appliquée au PORTUGAL (4).

35. La photo-interprétation assistée par ordinateur est une méthode que l'on peut qualifier de mixte.

Le point de départ du travail est une image satellitaire se présentant sous la forme d'une composition colorée conventionnelle dite «fausses-couleurs». Elle est obtenue par restitution des données numériques transmises par les satellites d'observation de la terre, ces dernières ayant fait l'objet de traitements informatiques visant à les corriger géométriquement, éliminer certains défauts de la prise de vue (délignage) et améliorer les contrastes. D'autres traitements permettent de rééchantillonner les pixels et de raccorder des images de traces différentes et/ou prises à différentes dates (cf. M. LENCO, op. cité).

36. Pour procéder à l'interprétation, on dispose par ailleurs, sur une console de visualisation reliée à un ordinateur, d'images traitées arithmétiquement (rapport de canaux permettant de calculer des indices de végétation) ou logiquement (analyse en composante principale).

Enfin, toujours sur console de visualisation, il est possible de réaliser des classifications automatiques des données numériques multispectrales.

Ces divers types de traitements complémentaires des bandes magnétiques des images satellitaires permettent de préciser les contours de certaines zones ou en identifier le contenu. On notera que ces traitements peuvent, pour une région donnée, aussi bien porter sur l'image de base que sur des images prises à des dates différentes ou avec des capteurs différents. L'utilisation, à ce stade des images SPOT, par la connaissance du détail qu'elles apportent, constitue une aide importante pour le photo-interprète.

37. Le photo-interprète utilise également d'autres sources d'information pour réaliser son travail. Il s'agit d'abord de points de contrôle au sol dits «vérités terrain». Il dispose également des cartes topographiques, des cartes thématiques (Cartes de la végétation, cartes écologiques, cartes de l'Inventaire forestier, cartes géologiques, cartes pédologiques) de données statistiques localisées (Recensement général de l'agriculture, enquête TERUTI) ou de photographies aériennes.

38. A l'aide de ces différents outils, le photo-interprète réalise une carte sur un calque sur lequel sont portés au préalable les régions géographiques, les cours d'eau et les limites de bassins versants. Il y dessine le contour des écozones et y inscrit leur code. Ce premier travail fait alors l'objet de vérifications qui sont de deux ordres:

— des vérifications statistiques utilisant des données recueillies par sondage;

— des expertises.

Finalement, le calque vérifié et éventuellement corrigé est numérisé pour être stocké sur ordinateur. L'inventaire numérisé peut dès lors servir à éditer des cartes (à l'échelle de sa réalisation ou à des échelles plus petites) et il est susceptible de faire l'objet de traitements statistiques divers.

39. La combinaison du traitement informatique des images, de leur interprétation visuelle et du recours aux sources d'information cartographiques exogènes semble être aujourd'hui la méthode qui assure le meilleur rapport prix/performance. Encore sa mise en oeuvre pratique doit-elle respecter certaines contraintes.

B. *Précision cartographique et thématique de l'inventaire*

40. la précision doit s'apprécier à la fois sur le plan de la précision cartographique et sur celui de la discrimination thématique (contenu en informations). [On notera toutefois que les deux notions sont fortement dépendantes l'une de l'autre].

a. Taille minimale des écozones

41. L'échelle du 1/100 000^{e} permet d'atteindre, au niveau national, un zonage produisant les unités statistiques recherchées. Celles-ci peuvent être identifiées et représentées jusqu'à une taille minimale de l'ordre de 5 ha, ce qui permet de prendre en compte un grand nombre de petites unités (notament zones humides et villages), qui sont des éléments importants d'évaluation de la diversité des paysages.

42. L'échelle du 1/100 000^{e} ne répond bien sûr pas à tous les besoins. Des zones complexes ou évoluant rapidement doivent être suivies à une échelle plus fine. L'utilisation conjointe des images LANDSAT et SPOT permet de répondre à la double exigence de l'exhaustivité et du détail.

b. Précision cartographique

43. Du point de vue de la précision cartographique, il convient de noter qu'il ne s'agit pas de réaliser une carte traditionnelle, ayant sa fin en soi, mais une carte informatisée, thématique, constituant une base de données et combinée avec d'autres bases de données géocodées ayant des précisions variables.

44. La précision cartographique d'éléments topographiques (relief, cours d'eau) est un facteur de qualité sans équivoque justifiant un investissement en temps important, d'autant plus qu'il s'agit d'éléments permanents ou quasi-permanents et que le travail est fait une fois pour toutes.

En matière d'information thématique, surtout lorsqu'elle concerne des éléments variables — comme le sont les écozones — la rapidité de fourniture des données entre en concurrence avec l'exigence de précision. Le choix de l'échelle en dépend et l'on ne peut envisager aujourd'hui un inventaire de la France au 1/25 000^{e}, ni même au 1/50 000^{e}, à des coûts et dans des délais acceptables.

45. L'utilisation de l'imagerie SPOT panchromatique ou multispectrale, pour toutes les zones présentant une certaine complexité et/ou pour lesquelles il y a une présomption d'évolution rapide, fournira un complément d'information (composition, structure) important, cohérent avec les exigences d'homogénéité et de répétitivité de l'inventaire d'occupation du sol. La possibilité de procéder par sondage sur des échantillons d'écozones analysés à l'aide d'images SPOT permet en outre de réaliser rapidement et à un coût modéré des évaluations, pour des zones d'étendue plus importante, de thèmes particuliers.

46. En outre, son incorporation dans le dispositif est, dès le départ, capitale du point de vue de la définition des modalités d'articulation des différents niveaux de précision. Il est clair que l'inventaire de l'occupation du sol, dans la mesure où il est sans équivalent au niveau national, risque d'être questionné au-delà de ses possibilités. Le contenu informatif d'une opération rapide au 1/100 000^{e} est forcément limité et l'on ne peut justifier son caractère d'instrument de base (base de cohérence cartographique sur l'espace, base d'organisation de l'information statistique) que si un minimum de modules s'ancrant sur cette base commencent à être produits simultanément. Ces modules peuvent provenir de cartes thématiques moins fines (il y en a) ou de la numérisation de cartes thématiques plus fines (mais cette numérisation est peu avancée) ou de statistiques géocodées.

47. Dans cette perspective l'utilisation de l'imagerie SPOT, qui permet d'avancer rapidement dans la voie de l'articulation d'informations à différentes échelles, contribue à relativiser la question de la précision du zonage au 1/100 000^{e} en offrant la possibilité de passer facilement au 1/50 000^{e} voire au 1/25 000^{e} lorsque c'est nécessaire.

c. Mises à jour périodiques et mises à jour tournantes

49. Des instruments de base précis n'ont d'autre fonction que de caler des descriptions intrinsèquement moins précises (mais plus proches de la situation actuelle donc plus précises...).

Le problème se pose avec acuité pour les mises à jour qui doivent pouvoir être réalisées rapidement, faute de quoi leur utilité relative (à celle de l'inventaire de base) n'est pas évidente.

Si l'on considère une portion du territoire ayant des changements significatifs de l'occupation du sol avec un pas de temps de 5 ans, quelle signification — pour la majorité des utilisations — pourrait-on donner à une précision dont l'obtention retarderait la mise à disposition des données de 5 ans?

50. Les nécessités de précision peuvent conduire, pour des raisons de coût, à procéder à des mises à jour tournantes. Ainsi, l'Inventaire forestier national couvre 1/10e de la France chaque année. Département par département, cette solution est tout à fait satisfaisante, et ce, d'autant plus que les départements les plus boisés font, naturellement, l'objet d'un effort particulier.

La contrepartie de cette démarche est que le bilan national instantané qui peut être produit à une date donnée à partir des résultats départementaux est entaché de l'imprécision résultant de l'étalement dans le temps des travaux.

51. On peut penser que pour la forêt les inconvénients de l'inventaire tournant sont minimisés par la lenteur de son évolution. Par contre, pour une approche générale concernant des milieux naturels ou artificialisés divers, ayant leurs rythmes d'évolution propres, dont on veut pouvoir représenter globalement l'état et son évolution, que l'on souhaite comparer entre eux, la réalisation d'un inventaire à une date donnée (ou au moins portant sur une période courte de un ou deux ans maximum) et mis à jour périodiquement et globalement s'impose.

52. Des mises à jour globales, intervenant tous les quatre ou cinq ans, peuvent être réalisées rapidement par fusion sur ordinateur d'images satellites à deux dates. Le repérage des pixels ayant changé d'affectation pendant la période permet alors de limiter le champ des investigations nécessaires à leur identification.

53. A côté de ces mises à jour globales, il est possible de suivre avec une fréquence plus grande et à une échelle plus fine des territoires d'intérêt particulier. Il s'agit d'une part des territoires en mutation rapide, par exemple des parties du littoral en cours d'urbanisation ou des secteurs de la montagne équipés pour le ski. Ces zones peuvent être définies a priori, compte tenu de la connaissance que l'on a de ces phénomènes. Elles peuvent aussi être identifiées à partir de la mise à jour globale au 1/100 000e.

54. Il est également possible, dans le cas d'évolutions diffuses, telles que les modifications de l'utilisation du sol par l'agriculture (intensi-

fication, extensification, abandon d'exploitations) de procéder par sondage à partir de l'inventaire au 1/100 000e. On peut suivre dans ce cas un échantillon d'écozones à une échelle faisant apparaître le parcellaire (1/50 000e ou 1/25 000e, par exemple), avec une fréquence annuelle.

55. Dans les deux cas ci-dessus, les études aux échelles fines peuvent être réalisées soit par photo-interprétation soit par classification automatique portant sur les thèmes concernés.

Pour ces travaux, la France envisage d'avoir recours aux images du satellite SPOT dont la résolution géométrique (20m x 20m en mode multispectral et 10m x 10m en mode panchromatique) est bien adaptée à l'étude du parcellaire et des éléments linéaires.

d. Sensibilité des écozones

56. La taille minimale de l'écozone conditionne non seulement la richesse de la représentation mais aussi l'ampleur des variations que l'on peut enregistrer. Un zonage trop grossier, compte tenu de la variété des paysages à décrire, renseigne mal ou trop tardivement sur les évolutions.

57. La sensibilité de l'outil est également dépendante de la nomenclature utilisée: plus celle-ci est détaillée et plus nombreux seront les mouvements enregistrables.

Le détail de la nomenclature conditionne également les corrélations qui peuvent être calculées entre des écozones et des espèces ayant une certaine probabilité de s'y trouver a priori.

La nomenclature finalement retenue en France par la Commission interministérielle des comptes du patrimoine naturel et celle, voisine, du programme européen CORINE LAND COVER, découlent de la capacité de discrimination des satellites d'observation de la terre dont les images sont prises pour base.

C. *Télédétection et autres sources d'information.*

58. La source d'information «télédétection» est à la fois riche et pauvre et il convient de l'enrichir sans lui faire perdre ses aptitudes spécifiques.

La télédétection fournit dans des délais brefs pour de vastes territoires une information numérique géocodée permettant de réaliser une cartographie assez précise. Cette information peut être acquise fréquemment à un coût au Km² inférieur à toute autre méthode. Elle est synthétique.

59. Cependant, l'interprétation de certains types d'occupation du sol à partir de l'image satellitaire et de ses traitements n'est pas exempte d'ambiguïté et l'identification des éléments linéaires pose souvent des problèmes. Dans ces deux cas l'amélioration «interne» de l'information a un coût qui croît rapidement (ce qui est contradictoire avec le projet de couvrir de grandes superficies). L'intérêt de combiner la source télédétection avec d'autres sources (cartes, photos aériennes, inventaires) est donc indéniable.

60. L'utilisation conjointe des images satellitaires et d'autres sources permet en particulier d'identifier plus facilement la nature des écozones dans les cas délicats tels que les zones urbaines de petite dimension qui peuvent être confondues avec des zones de roches affleurantes, des landes et garrigues boisées dont la frontière avec la forêt est parfois progressive, le vignoble peut être confondu avec des vergers.

Pour essayer de régler rapidement ces problèmes, les cartes de l'Institut géographique national (pour l'humain, les rivières, les réseaux de communication), de l'Inventaire forestier (dans le cas des forêts, landes et garrigues) ou de la Carte de la végétation sont extrêmement utiles. Sont également utiles des sources dont la cartographie implicite est beaucoup moins précise, telles que l'enquête TERUTI ou le Recensement général de l'agriculture. Enfin il existe de nombreuses cartes non exhaustives limitées à des régions et/ou des thèmes particuliers qui peuvent être consultées.

61. Il convient d'éviter cependant plusieurs écueils.

a. En cas d'incertitude ou de divergence sur la nature d'une zone, la date d'obtention de l'information doit être sérieusement prise en compte. L'image satellitaire étant la plus récente, la divergence peut indiquer une modification de l'occupation du territoire qui doit être vérifiée.

b. Dans le cas d'une divergence sur les contours d'une zone pour laquelle il y a concordance d'interprétation, la source télédétection doit être préférée: elle est plus récente et elle servira aux mises à jour ultérieures.

c. Une exception semble devoir être envisagée dans le cas de divergence portant sur des éléments linéaires faisant office de frontière entre deux écozones. Si ces éléments (rivières, lignes de crêtes,...) sont intégrés dans une base de données cartographiques, il convient d'arbitrer en faveur de cette dernière, même s'il y a lieu de penser que l'image-satellite est plus précise. Cet arbitrage (éventuel) «contre» la «vérité» de l'image-satellite facilitera considérablement les possibilités d'utilisation conjointe des différents outils de la base.

[Bien évidemment, cette solution ne s'applique pas s'il y a lieu de penser que la rivière a modifié son cours.]

d. En ce qui concerne l'utilisation de cartes plus précises (échelle plus fine, contenu plus riche), l'intégration des données qu'elles contiennent ne peut être, au niveau de l'inventaire général, que partielle. En particulier:

d.1. Il faut renoncer à faire apparaître (au niveau de l'inventaire général) une information qui ne serait pas susceptible d'une mise à jour selon la même périodicité que celle qu'offre le satellite (par ex: tous les 5 ans).

d.2. A fortiori, il est exclu de prendre en compte nationalement une information qui ne serait disponible que pour une région donnée.

d.3. Il semble préférable d'éviter de s'engager dans la voie de la réalisation d'écozones par synthèse de cartes thématiques particulières. Tout d'abord, une telle combinatoire risque de ne pouvoir se réaliser au niveau national (en supposant qu'une information homogène y existe) que dans des délais longs. En outre, la précision, notamment cartographique, de chaque carte est remise en question par sa superposition avec d'autres, les zonages particuliers étant liés aux thématiques retenues.

62. On voit qu'il n'y a pas une seule synthèse possible. La légitimité de celle obtenue par la méthode à base de télédétection résulte de considérations sur les coûts et les délais et donc sur la cohérence d'ensemble ainsi que sur la possibilité de mises à jour rapides.

NOTES

(1) L'étude d'une telle typologie a fait l'objet de travaux sur la Vire - RECHERCHE ET DELIMITATION DE SECTEURS HOMOGENES SUR LA RIVIERE VIRE - Fédération départementale des associations de pêche et de pisciculture du Calvados/CICPN, Groupe de travail Eaux continentales, Janvier 1986.

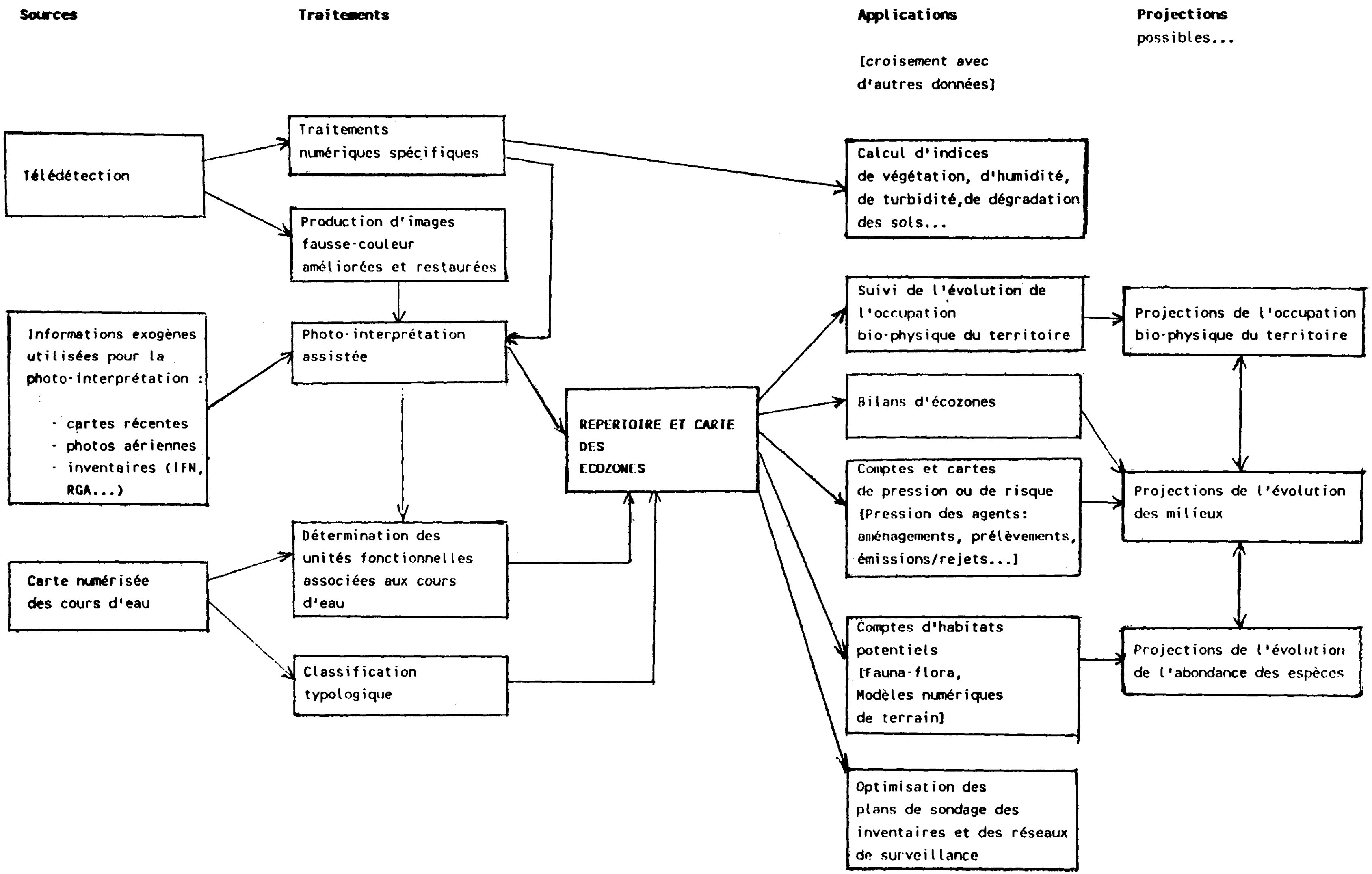
(2) Cf. Les comptes du patrimoine naturel, Chapitre 4, par P. BAZIRE et L. GRUSON.

(3) Cf. M. LENCO, «Utilisation de la télédétection pour la gestion des ressources naturelles», in «Information et ressources naturelles», OCDE, PARIS, 1986, et «Utilisation de la télédétection spatiale pour l'étude de l'environnement», Note interne, Ministère de l'Environnement, NEUILLY, 1986.

(4) Cf. PROJET CORINE, «Land cover; étude de faisabilité», Commission des Communautés Européennes, DG XI, octobre 1987.

ANNEXE 1

PLACE DU REPERTOIRE ET DE LA CARTE DES ECOZONES DANS LA COMPTABILITE DU PATRIMOINE NATUREL



ANNEXE 2

NOMENCLATURE DES ECOZONES

VERSION PROVISOIRE DECEMBRE 1986

M1 TERRITOIRES ARTIFICIALISES

M11 *Zones urbaines et péri-urbaines*
- M111 Zones urbaines cartographiées
- M112 Zones urbaines non cartographiées
- M113 Espaces en mutation et chantiers urbains
- M114 Tissu urbain discontinu

M12 *Carrières, dépôts, chantiers*
- M121 Carrières, mines à ciel ouvert
- M122 Gravières
- M123 Chantiers hors milieu urbain
- M124 Dépôts

M13 *Espaces artificialisés hors zones urbaines*
- M131 Ensembles industriels, commerciaux et autres
- M132 Emprise des réseaux de communication
- M133 Aéroports, aérodromes
- M134 Equipements sportifs et de loisirs

M2 TERRES AGRICOLES

M21 *Terres arables: cultures annuelles*

M22 *Cultures permanentes ligneuses*
- M221 Vignes
- M222 Vergers
- M223 Oliveraies

M23 *Prairies permanentes et artificielles*
- M231 Prairies temporaires et/ou artificielles
- M232 Prairies permanentes
- M233 Pâturages extensifs

M24 *Rizières*

M25 *Associations culturales et ou parcellaires complexes*

M26 *Zones de déprise agricole*

M27 *Bâtiments en milieu rural et espaces associés*

M3 ESPACES TERRESTRES NATURELS OU PEU ARTIFICIALISES

M31 Forêts
- M311 Feuillus (n.c. peupleraies)
- M312 Résineux
- M313 Forêts mixtes
- M314 Jeunes plantations
- M315 Peupleraies, plantations d'eucalyptus
- M316 Coupes rases, coupes à blanc
- M317 Autres terrains boisés
- M318 Zones forestières incendiées

M32 *Espaces végétaux naturels (ni agricoles, ni forestiers)*
- M321 Landes
- M322 Garrigues
- M323 Maquis
- M324 Pelouses d'altitude
- M325 Espaces végétaux naturels divers
- M326 Zones incendiées (maquis, garrigues et landes)

M33 Espaces terrestres sans végétation ou avec peu de végétation
- M331 Plages, dunes, sable
- M332 Roches nues

M4 EAUX INTERIEURES

M41 Zones humides
- M411 Marais à végétation halophile
- M412 Marais salants, salines
- M413 Marais d'eau douce
- M414 Tourbières

M42 Eaux continentales
- M421 Cours et voies d'eau
- M422 Plans d'eau
- M423 Lagunes
- M424 Neiges et glaces pérennes
- M425 Estuaires

M5 MILIEU MARIN

M51 *Zone intertidale*

M52 *Eaux côtières*
M53 *Haute mer*

CARACTERISTIQUES SPECIFIQUES D'HUMIDITE ET EROSION

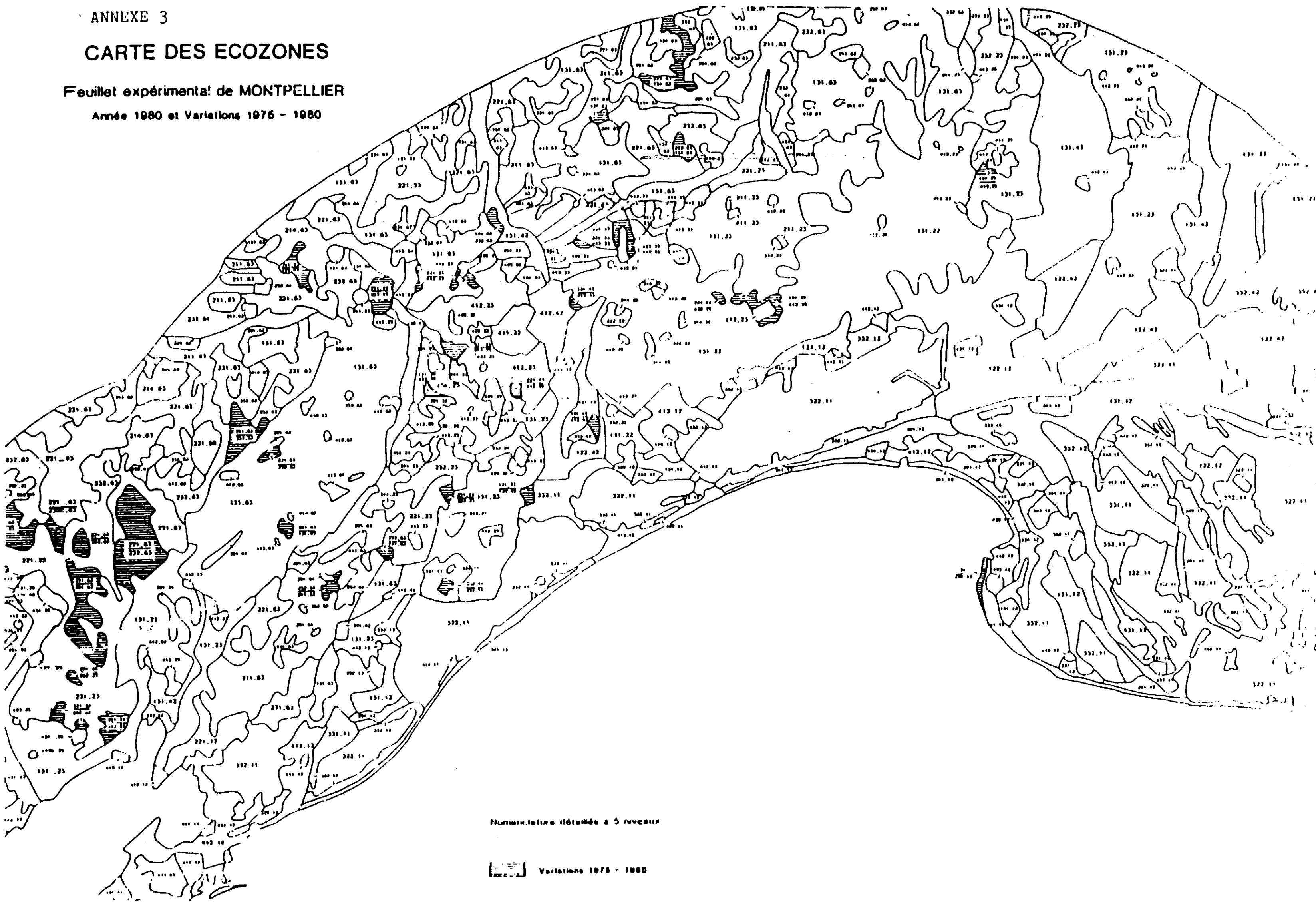
MA Humidité permanente
MB Zones associées aux cours d'eau et aux lacs
MC Humidité non caractéristique
MD Zones à forte érosion

ANNEXE 3

CARTE DES ECOZONES

Feuillet expérimental de MONTPELLIER

Année 1980 et Variations 1975 - 1980



SUMMARY

3 - THE PLACE OF THE INVENTORY OF MAPPED ECOZONES IN THE SYSTEM OF ECOLOGICAL STATISTICS

Author: Jean-Louis Weber

Document submitted by the Ministry of the Environment, France.

The preparation of ecological statistics comes up against the problem of the complexity of ecosystems and the way they function.

The new approach that had to be adopted in order to provide rapid replies to questions on the condition of and changes in ecosystems involved the use of indicators, whose purpose is to limit the number of variables to be monitored.

There are, however, some limits to the indicator method when it is applied to very large areas which are heterogeneous from the point of view of the ecosystems they support. These limits are the result of:

(a) The ratio between the size of the ecosystems and that of the networks used for collecting data on indicators;

(b) The frequency with which data on indicators are collected.

National fauna and flora inventories are often prepared on the basis of networks that are much larger than the ecosystems for which indicators are sought. The fact that the distribution charts which can be drawn up on the basis of the inventories are not on the same scale as the ecosystems (being insufficiently accurate) raises questions as to the representativeness of data from the sample survey, which is what an inventory actually amounts to.

The preparation of national inventories which are sufficiently accurate and whose cost makes it possible for them to be repeated periodically depends on better ecosystem stratification, which will obviously have a geographical dimension and will require a proper description of land cover. This is the background against which France has undertaken to prepare a statistical inventory and a map of the ecosystems in its territory.

The unit of statistical analysis used in the inventory is the ecozone. An ecozone is a macro-ecosystem, which can be identified in a significant area on the reference scale adopted and is stable enough to be used as a unit for data collection and gathering. An ecozone may be a forest, a lake, a section of river which is homogeneous from the point of view of flow rate and biocoenoses, a field or a group of fields, a heath, a quarry, a town or an industrial area.

An ecozone may be characterized on the basis of a predominant feature (water, trees, buildings, etc.) or a combination of features having a characteristic structure (multi-crop mountain areas, suburban areas in the process of change, marshlands, etc.).

The preferred source of information for the compilation of ecozone inventories is the imagery provided by earth sensing satellites.

The method of analysing satellite pictures that is used in France may be described as computer-assisted photo-interpretation of false-colour images which have first been digitally processed for contrast restoration and geometrical rectification.

The photo-interpreter is assisted in his analysis by localized data on the zone in question which are made available by air photographs, topographical maps, vegetation maps, agricultural censuses, forest inventories, etc.

The validity of the thematic map thus produced can be confirmed by subsequent verifications. The map is then digitized for storage on magnetic or optical media (CD-ROM, videodisc, etc.) and/or printed.

In zones which are of particular ecological importance or are undergoing rapid change, the analysis can also be further refined, either by means of computer overlaying of the ecozone map on the corresponding digital terrain model (topographical map) or by using more detailed images. There are plans, for example, to produce a map of France by using LANDSAT-MSS (1:100,000) data, as well as to study a number of sensitive areas using SPOT-HRV images (1:25,000).

The satellite data base may also undergo additional processing in order to highlight and evaluate specific ecozone features, such as plant indices, humidity indices, water turbidity and temperature, soil erosion, etc.

RESUME

3 - PLACE DU REPERTOIRE CARTOGRAPHIE DES ECOZONES DANS LE SYSTEME DE STATISTIQUES ECOLOGIQUES

Auteur: Jean-Louis Weber

Document soumis par le Ministère de l'environnement, France.

Le développement des statistiques écologiques se heurte au problème de la complexité des écosystèmes et de leur fonctionnement.

Une autre voie a dû être trouvée pour fournir des réponses rapides à ceux qui s'interrogent sur l'état et l'évolution des écosystèmes: celle des indicateurs, qui permet de limiter le nombre des variables à observer.

La méthode des indicateurs connaît, cependant, elle aussi des limites quand on veut l'appliquer à de vastes territoires hétérogènes du point de vue des écosystèmes qu'ils supportent. Ces limites tiennent:

a. au rapport existant entre la taille des écosystèmes et celle des mailles employées pour collecter les informations sur les indicateurs,

b. à la fréquence d'acquisition des données sur les indicateurs.

On constate souvent que les inventaires nationaux de faune et de flore sont réalisés selon des mailles beaucoup plus grandes que les écosystèmes pour lesquels on recherche des indicateurs. Le fait que les cartes de répartition que l'on peut établir à partir des inventaires ne soient pas à la même échelle (n'aient pas une précision suffisante) que les écosystèmes conduit à poser la question de la représentativité des observations du sondage que constitue, en réalité, un inventaire.

Il semble, dès lors, que la réalisation d'inventaires nationaux avec une précision suffisante et à des coûts autorisant leur répétition périodique passe par une meilleure stratification du point de vue des écosystèmes. De toute évidence, une telle stratification a une dimension géographique et demande une description convenable de l'occupation du territoire (en anglais: land cover). C'est

dans cette perspective que la France a entrepris de réaliser un répertoire statistique et une cartographie des écosystèmes de son territoire.

L'unité d'analyse statistique du répertoire est l'écozone. Une écozone est un macro-écosystème identifiable sur un territoire significatif à l'échelle de référence retenue et doté d'une stabilité suffisante pour en faire une unité de collecte ou de rassemblement de données. Une forêt, un lac, un segment de rivière homogène du point de vue du débit et des biocénoses, un champ ou un ensemble de champs, une lande, mais aussi une carrière, une ville ou une zone industrielle, sont des écozones.

La caractérisation d'une écozone peut se faire par un élément prépondérant (l'eau, les arbres, les bâtiments...), ou par une combinaison d'éléments dotée d'une structure caratéristique (zone de polyculture de montagne, espace péri-urbain en mutation, marais...).

La source d'information privilégiée utilisable pour la réalisation de l'inventaire des écozones est l'imagerie fournie par les satellites d'observation de la terre.

La méthode retenue en France d'analyse des images satellitaires peut être qualifiée de photo-interprétation assistée par ordinateur d'images fausses-couleurs, ces dernières ayant au préalable fait l'objet de traitements numériques de restauration des contrastes et de rectification géométrique.

Dans son analyse, le photo-interprète s'aide en outre des données localisées disponibles sur la zone considérée: photographies aériennes, carte topographique, carte de la végétation, recensement agricole, inventaire forestier...).

Pour les zones d'intérêt écologique particulier ou en mutation rapide, il est également possible d'affiner l'analyse, soit en croisant informatiquement la carte des écozones avec le modèle numérique de terrain (carte topographique) correspondant, soit en ayant recours à des images plus précises. Ainsi est-il prévu de réaliser la carte de France à l'aide des données LANDSAT-MSS (1/100 000^{e}) et, simultanément, d'étudier un certain nombre d'espaces sensibles avec les images SPOT-HRV (1/25 000^{e}).

Enfin, la base de données satellitaires peut faire l'objet de traitements complémentaires pour mettre en évidence et évaluer certaines dimensions des écozones: indices de végétation, indices d'humidité, turbidité et température de l'eau, érosion des sols...

Резюме

3 - МЕСТО РЕЕСТРА И КАРТЫ ЭКОЛОГИЧЕСКИХ ЗОН В СИСТЕМЕ ЭКОЛОГИЧЕСКОЙ СТАТИСТИКИ

Автор: Жан-Луи Вебер

Документ, представленный Министерством по вопросам окружающей среды Франции

Развитие экологической статистики сталкивается с проблемой сложности экосистем и их функционирования.

Другой подход, который необходимо применять для обеспечения быстрых ответов на вопросы о состоянии экосистем и изменениях в них, связан с использованием показателей, которые позволяют ограничить число переменных для наблюдения.

Однако у метода использования показателей также есть пределы в отношении его применения к весьма широким территориям, разнородным с точки зрения экосистем, которые в них существуют. Эти ограничения связаны с:

а) отношением, существующим между размером экосистем и размером сетей, используемых для сбора данных по показателям;

в) частотой сбора данных по показателям.

Часто приходится констатировать, что национальные переписи фауны и флоры проводятся на основе сетей, которые намного больше, чем экосистемы, для которых ведется поиск показателей. Тот факт, что карты распространения, которые можно составить с помощью переписей, по своему масштабу не соответствуют экосистемам (не имеют достаточной точности), ставит вопрос о характерности данных выборочного обследования, которым фактически является перепись.

Поэтому подготовка национальных переписей, которые обеспечивают достаточную точность и уровень расходов на них, который позволяет периодически повторять их, зависит от повышения точности стратификации с точки зрения экосистем. Совершенно очевидно, что подобная стратификация имеет определенный географический аспект и потребует надлежащего описания покрова земли (по-английски: ланд ковер). Именно с учетом этих аспектов Франция приступила к созданию статистического реестра и карты экосистем на её территории.

Единицей статистического анализа, которая используется в реестре, является экозона. Экозона представляет собой макроэкосистему, которую можно идентифицировать на значительной территории с установленным базовым масштабом и которая характеризуется достаточной стабильностью для того, чтобы использовать её в качестве единицы для сбора и составления данных. Экозоной могут быть лес, озеро, часть реки, которые являются однородными с точки зрения пропускной способности и биоценоса, поле или группа людей, песчаная равнина, карьер, город или промышленный район.

Характеристику экозоны можно проводить на основе одного преобладающего элемента (вода, деревья, здания и т. п.) или на основе сочетания элементов, имеющих характерную структуру (зона многоотраслевого хозяйства в горах, пригородные районы, в которых происходят изменения, болота и т.п.).

Предпочтительным источником информации для составления реестров экозон является изображение, полученное с помощью спутников зондирования Земли.

Метод анализа изображений, полученных с помощью спутников, который используется во Франции, можно описать как автоматизированное дешифрование фотографий с перевернутым цветом, которые сначала были обработаны с помощью цифровых приборов в целях восстановления контрастности и геометрического выравнивания.

Специалист по дешифрованию фотоснимков в своем анализе также использует локализированные данные о рассматриваемой зоне, которые обеспечивают аэроснимки, топографические карты, карты растительного покрова, сельскохозяйственные переписи, таксации лесов и т.п.

Правильность полученных таким образом тематических карт можно подтвердить с помощью последующих проверок. Затем карта преобразуется в цифровую форму для хранения на магнитных или оптических носителях (ЦД-РОМ видеодиски и т.п.) и/или печатается.

Помимо их тематической группировки в соответствии с номенклатурой, экозоны можно также группировать по более крупным экологическим или географическим зонам, административным районам, водосборным районам и т.п.

В зонах, которые имеют особое экологическое значение или в которых происходит быстрое изменение, анализ можно далее усовершенствовать путем наложения с помощью ЭВМ карты экозон на соответствующую цифровую модель территории (топографическая карта) или путем использования более подробных изображений. Так например, имеются планы составления карты Франции с использованием данных спутника ЛАНДСАТМСС (1:100 000), а также изучения ряда чувствительных областей с применением изображений спутника СПОТ-ХРВ (1:25 000).

В базе данных, полученных с помощью спутников, можно также провести дополнительную обработку для выявления и оценки конкретных параметров экозон, таких, как показатели растительности, показатели влажности, температура и мутность вод, эрозия почвы и т.п.

4 - INDICATEURS STATISTIQUES DE LA QUALITÉ DES DENREES ALIMENTAIRES LEUR UTILISATION DANS L'IDENTIFICATION DE L'AFFECTATION DES CHAINES TROPHIQUES

Auteur: Gabriela Borrego

Document soumis par la Division des statistiques de l'environment du GEPAT (Département des études et de la planification de l'administration du territoire), Portugal.

Avant-propos

Dans la nature, le flux d'énergie à travers les êtres vivants provient de l'énergie solaire absorbée par la photosynthèse des plantes. L'homme est à la fois un élément de l'écosystème et le lien final de la chaîne trophique. Dans ces chaînes, l'énergie et les minéraux contenus dans les aliments se transforment et s'incorporent en constituant un cycle fermé. Les problèmes de pollution, créés par les matériaux mis en circulation dans l'environnement par l'homme, jouent donc un rôle extrêmement important dans les corrélations entre les êtres vivants et entre ceux-ci et le milieu physique.

Les indicateurs statistiques de la qualité des denrées alimentaires, qui permettent l'évaluation des quantités de substances indésirables ou toxiques absorbées par l'homme à travers un régime alimentaire moyen, pourront constituer un point de départ vers l'identification de l'affectation des chaînes trophiques d'un système écologique.

Ce document présente un ensemble d'indicateurs statistiques de la qualité des denrées alimentaires et son application à la prise de mesures correctives dans une politique de l'environnement.

Introduction

La contamination des denrées alimentaires par des substances indésirables ou toxiques traduit l'influence négative du développement technologique/économique sur l'environnement.

Le contrôle systématique de la qualité des denrées alimentaires fournit un ensemble d'informations qui, outre son intérêt statistique dans la production des données historiques, permet d'établir le diagnostic des nuisances environnementales. Ce diagnostic pourra conduire à la réalisation d'études spécifiques de l'évaluation de la qualité de l'environnement.

Nous présentons comme exemple un cas technique, qui s'est passé au Portugal et qui montre bien l'importance de l'information statistique comme instrument de décision.

Le cas mentionné concerne une région, où la pratique de la récolte du «moliço» (1) était une activité traditionnelle de grand intérêt, parce qu'elle contribuait à maintenir la circulation des masses d'eau, en évitant ainsi l'envasement progressif des canaux, et qu'elle constituait simultanément une attraction touristique.

Le «moliço» (1) était utilisé comme engrais; l'intérêt économique a fait de cette pratique une activité en déclin, presque inexistante. En même temps, la région a commencé à se développer du point de vue industriel, et est devenue un des grands pôles de l'industrie chimique.

Par la suite, on a voulu reprendre la récolte du «moliço» afin de l'utiliser comme engrais. Mais à ce moment un autre problème s'est posé, qui mettait en cause cette utilisation; les macroalgues et les autres plantes aquatiques absorbent et accumulent les métaux en solution, ainsi que d'autres polluants existant dans le milieu, ce qui empêchait leur utilisation comme engrais.

En effet, quoique les métaux soient des constituants naturels du sol, quelques-uns d'entre eux peuvent être absorbés et transformés par les plantes, et interfèrent (lorsque les niveaux dans le sol se situent audessus de certaines valeurs limite) dans le développement normal des cultures, en en réduisant plus ou moins la productivité.

En ce qui concerne certains métaux, comme le mercure, le cadmium et le plomb, très toxiques pour toutes les formes vivantes, il y a encore un autre problème relatif à la contamination éventuelle des produits agricoles. La qualité sanitaire de ces produits peut être réduite lorsque les teneurs de ces éléments sont supérieures aux niveaux admissibles pour la consommation animale et humaine.

Afin de déterminer si la situation méritait des études plus approfondies, ayant pour but d'évaluer si le risque de dissémination des polluants dans le sol et les cultures était contraire aux bénéfices fournis pour la reprise de l'activité traditionnelle, on a cherché l'information statistique, qui servirait de base à la prise de décision.

Une fois connu que les cultures usuelles de cette zone étaient le maïs, les produits potagers et les fourrages (la base de la nourriture du bétail laitier, produisant du lait d'une haute qualité alimentaire), on a cherché des informations concernant les quantités de métaux lourds et d'autres éléments observés lors de plusieurs analyses de ces denrées.

Des résultats assez faibles ont été obtenus en ce qui concerne les analyses des métaux, dans l'eau de la «ria», dans les bivalves et les poissons, les déterminations de mercure dans les poissons étant prédominantes. A leur tour, les analyses du lait n'ont pas montré l'existence de métaux lourds, et on n'a pas obtenu de résultats dans les analyses des produits potagers.

Etant donné l'insuffisance de l'information disponible, on a choisi d'entreprendre des analyses du «moliço» et des études comparatives, qui ont permis de conclure que:

«L'utilisation du «moliço» dans les sols aiderait à promouvoir la dissémination à tous les écosystèmes de la «ria» des métaux lourds d'origine presque exclusivement industrielle. La persistance dans l'environnement et les voies de transport de ces métaux a conduit à considérer comme nécessaire le contrôle de leur dispersion dans l'environnement, ainsi que la limitation des utilisations du «moliço» aux cas ou il y a des bénéfices sociaux et économiques importants».

Voici un exemple qui montre l'importance de l'information statistique en tant qu'instrument de décision en permettant une réponse en temps utile et une économie des moyens.

Des indicateurs sont en train d'être définis et construits, qui devront être appliqués aux métaux lourds et aux résidus des pesticides dans les denrées alimentaires.

Leur construction devra se baser sur l'information résultant du contrôle systématique des denrées alimentaires, contrôle qui deviendra obligatoire au Portugal, à court délai. La construction des indicateurs présentés sera possible à moyen/long terme.

Définition et construction des indicateurs

Ces indicateurs concernent fondamentalement l'évaluation des métaux lourds et des résidus des pesticides, face au danger qu'ils peuvent représenter pour l'environnement, en atteignant même l'homme à travers la nourriture.

1. Consommation moyenne annuelle, per capita, de chaque denrée alimentaire, au niveau régional (CAHji).

CAHji = (CAj/H)i Kg per capita an^{-1}.

où:

CAj - consommation moyenne annuelle, de chaque denrée alimentaire j, mentionnée dans l'annexe I, pour la région i (Kg an^{-1}).

H - population résidant dans la région i

2. Poids moyen annuel de métal lourd et/ou résidu de pesticide dans les denrées alimentaires d'origine animale, produits potagers, fruits frais et céréales (TMkji).

TMkji = (Rkj x Pj) i mg an^{-1}.

où:

Rkj - concentration moyenne annuelle de la substance k (métal lourd et/ou résidu de pesticide) trouvée dans des échantillons d'une certaine espèce de denrée alimentaire provenant de la région i (mg kg^{-1}).

Pj - poids moyen des échantillons analysés, par an, pour déterminer la substance k; ces échantillons concernent une seule espèce j de denrée alimentaire provenant de la régione i (kg an^{-1}).

3. Poids moyen annuel des métaux lourds dans des poissons d'eau douce ou de mer, pris au long de la côte portugaise (TMPkji).

TMPkji = (Rkj x Pj) i mg an^{-1}.

où:

Rkj - concentration moyenne annuelle du métal lourd k trouvé dans des échantillons d'une espèce donnée j de poisson d'eau douce ou de mer pris dans la région i (mg kg^{-1}).

Pj - poids moyen des échantillons analysés, par an, pour déterminer le métal k; ces échantillons concernent une seule espèce j de poisson pris dans la région i (kg an^{-1}).

4. Concentration moyenne du métal lourd et/ou résidu de pesticide ingéré par an à travers chaque denrée alimentaire j consommée, par habitant, pendant l'année de référence et par région (CMkji).

CMkji = (TMkj/CAHj) i mg kg^{-1} habitant.

où:

TMkj - indicateur défini en 2 (mg an^{-1}).

CAHj - indicateur défini en 1 (Kg per capita an^{-1}).

Note

L'utilisation de cet indicateur, au niveau régional, quoique possible, ne sera pas toujours suffisamment représentative, à cause des difficultés dans la détermination des flux de distribution des produits.

Conclusions

Afin que les indicateurs présentés puissent être utilisés comme instruments de gestion, il faut établir une méthodologie d'application, qui doit tenir compte, d'une part, des normes ou des valeurs directrices concernant les concentrations de certains contaminants dans les denrées alimentaires, et, d'autre part, de l'identification de la région d'où l'information de base provient.

Cette méthodologie se base sur le fait que les contaminants des denrées alimentaires constituent une chaîne, dont le commencement se trouve dans l'élément où ils ont été appliqués et la fin dans l'homme, en tant que point extrême de la chaîne trophique: elle nous permet de conclure, en des situations anormales, qu'il y a des problèmes de contamination de l'environnement, ce qui constitue une alerte menant à des études plus détaillées ayant en vue la prise de mesures correctives.

ANNEXE I

Désignation des denrées alimentaires

Viandes et abats comestibles des animaux des espèces chevaline, bovine, porcine, ovine et caprine, frais, réfrigérés ou congelés.

Autres viandes et abats comestibles, frais, réfrigérés ou congelés, salés ou en saumure, séchés ou fumés.

Poissons d'eau douce et d'eau salée.

Lait et crème de lait, frais, non concentrés ni sucrés.

Lait et crème de lait, conservés, concentrés ou sucrés.

Beurre et fromage.

Produits à base de céréales.

Légumes frais, conserves de légumes, légumes secs.

Fruits frais.

Fruits secs, conserves de fruits.

SUMMARY

4 - STATISTICAL INDICATORS OF THE QUALITY OF FOODSTUFFS - THEIR UTILIZATION IN IDENTIFYING CONDITIONS OF TROPHIC CHAINS

Author: Gabriela Borrego

Paper submitted by the Statistical Division of the GEPAT, Portugal.

The energy flow through living beings in nature originates from solar energy kept in the photosynthesis of plants. Man is an element of the ecosystem and the final link of the food chain. Food chains transform not only the energy embodied in the food but also the minerals included in them and form a closed cycle.

Pollution problems resulting from the materials which man spreads over the environment are relevant regarding the interrelationships between living beings including those with their physical environment.

The foodstuff statistical quality indicators evaluate the quantity of toxic or undesirable matter that may be ingested by man following an average diet. They may be a starting point in identifying the effects of pollution on trophic chains within an ecological system.

The document presents a set of foodstuff statistical quality indicators and its application within the framework of environmental policies aiming at corrective measures.

RESUME

4 - INDICATEURS STATISTIQUES DE LA QUALITE DES DENREES ALIMENTAIRES

LEUR UTILISATION DANS L'IDENTIFICATION DE L'AFFECTATION DES CHAINES TROPHIQUES

Auteur: Gabriela Borrego

Document soumis par la Division des statistiques de l'environnement du GEPAT (Département des études et de la planification de l'administration du territoire), Portugal.

Le courant d'énergie qui traverse les êtres vivants dans la nature a pour origine l'énergie solaire emmagasinée par photosynthèse dans les végétaux. L'homme est un élément de l'écosystème et le maillon final de la chaîne alimentaire. Les chaîne alimentaires transforment non seulement l'énergie incorporée dans les aliments mais aussi les minéraux qu'ils contiennent, et forment un cycle fermé.

Les problèmes de pollution résultant des matériaux que l'homme répand dans l'environnement touchent à la fois les relations réciproques entre organismes vivants et les relations entre ceux-ci et leur environnement physique.

Les indicateurs statistiques de la qualité des aliments servent à évaluer la quantité de substances toxiques ou indésirables que l'homme est susceptible d'ingérer en suivant un régime normal. Ces indicateurs peuvent constituer un point de départ permettant d'identifier les effets de la pollution sur les chaînes trophiques à l'intérieur d'un système écologique.

Le document présente une série d'indicateurs statistiques de la qualité des aliments et des moyens de les utiliser dans le cadre de politiques relatives à l'environnement visant à appliquer des mesures correctives.

Резюме

4 - СТАТИСТИЧЕСКИЕ ПОКАЗАТЕЛИ КАЧЕСТВА ПИЩЕВЫХ ПРОДУКТОВ ИХ ИСПОЛЬЗОВАНИЕ ПРИ ОПРЕДЕЛЕНИИ УСЛОВИЙ ТРОФИЧЕСКИХ ЦЕПЕЙ

Автор: Г. Боррего

Доклад, представленный Португалией

Источником энергии в живых организмах в природе является солнечная энергия, преобразуемая в результате фотосинтеза растений. Человек является одним из элементов этой системы и конечным звеном в трофической цепи. Трофические цепи преобразуют не только энергию, содержащуюся в пище, но также и имеющиеся в них минеральные соли и таким образом представляют собой замкнутый цикл.

Проблемы загрязнения, возникающие в связи с распространением в окружающей среде материалов в результате деятельности человека, влияют и на взаимную связь между живыми организмами, включая их взаимосвязь с физической окружающей средой.

Статистические показатели качества пищевых продуктов отражают количество токсичных или вредных веществ, которые могут оказаться в пище человека, придерживающегося среднестатистической диеты. Они могут стать отправной точкой при определении воздействия загрязнения окружающей среды на трофические связи в рамках экологической системы.

В данном документе приводится целая группа статистических показателей качества пищевых продуктов и обсуждается вопрос о применении их в экологической политике, предусматривающей принятие корректирующих мер.

5 - SOIL CHARACTERISTICS FOR ASSESSMENT OF QUALITY OF LANDS

Authors: I. Atanasov and V. Petrov

Paper submitted by the Environmental Research and Information Centre at the Committee for Environmental Protection, Bulgaria.

Soils and soil cover are important components of the environment and a natural resource of significance for the community as a whole. The complex assessment of the quality of soils and the changes that resulted from human activities are an important part of the system, now in force in Bulgaria, for the observation and assessment of the environment conditions. Soils are a component of the landscape and soil information is widely used for assessing the quality of lands.

At present in Bulgaria we are in the process of collecting statistical information characterizing mainly the balance of lands and their distribution in view of their special use. Lands are categorized depending on their suitability for agricultural plants, meadows, orchards, vineyards, etc., and the data collected can be used mainly for assessing the changes in land use over certain periods of time. Although these statistics are useful, it could be assumed that they would not be sufficient for the assessment of the quality of lands and their suitability for a particular use. That is what necessitates supplementing statistical data by new information, which might be widely used for assessing the capability and suitability of lands.

The first step for constructing the system to assess the quality of lands and the land changes resulting from human activities, is the selection of the quantities and indices which characterize soils and soil cover and give a description of their status. The selection of soil characteristics should be in compliance with the national system for the description of soil qualities, used in large scale soil survey and mapping. In Bulgaria, now large scale maps (1:25,000 and 1:10,000) have been worked out which practically cover the whole territory of the country and involve both cultivated and uncultivated lands. The information provided by the large scale soil maps is the main source for assessing the soil cover conditions. Since large scale maps undergo periodical updating (every 5-10 years), changes in the soil cover can be reliably traced over a large area of the country.

In Bulgaria, for soils and soil cover characteristics we use both data applying particularly to soils and soil cover, and data characterizing the relief, climate, geology of the area and the plant cover. The soil characteristics used to describe the soil cover conditions are shown in table 1.

The content of nutrients in the soil and their uptake by plants are not included in the obligatory indices characterizing the quality of soils, as soil fertility can be easily controlled by contemporary management.

For each of the characteristics, there are a number of parameters to indicate the limits to the variation of soil properties and the extent of deterioration of the quality of soils. Thus, for example, in accordance with their depth, soils are divided into deep (A + B horizon 80 cm), averagely deep (A + B horizon within the limits of 50-80 cm), shallow (A + B horizon varying within 30-50 cm) and poorly cultivated soils having depth < 30 cm. Depending on the organic matter percentage in the A horizon, i.e. in the arable horizon, soils are divided into soils with high humus content (humus percentage higher than 4), middle humus content (humus percentage in the upper layer included between 2.5 and 4.0), low humus content (humus percentage included between 1.0 and 2.5), and soils with very low humus content (less than 1%).

With regard to texture, 7 textural classes and 4 classes of stoniness, were recognized.

The characteristics indicated in table 1 and the parameters of the soil properties are further used to categorize the soils by their suitability for use. To this end, a special matrix has been costructed (table 2) which allows the arrangement of soils according to the constraints limiting their fertility and suitability for agriculture. When arranging soils, their genesis was taken into consideration. This is expressed by separating soils that developed on alluvial deposits from zonal soils and those affected by erosion. That is necessary as each of these soil groups, arranged by their genesis, has separate properties which cannot be considered as a whole. Thus, the scheme of soil grouping reflects the genetic properties of soils and the constraints limiting their suitability for use in agriculture. The main soil properties and constraints can be briefly described as follows:

1. Neutral reaction - pH(H20) varies between 5.6 and 8.2, or pH(KCL) 4.6 - 7.2.

That is the optimal reaction for most of the agricultural crops and for the activity of the soil microorganisms as well.

It follows that with this soil reaction a very rapid decomposition of the chemicals (pesticides and herbicides) might be expected.

2. CaCO3 from the surface of soils.

It determines the slightly alkalic conditions in soils at which the microelements of metal ions like Zn and Fe are not in available form and some of the plants suffer from zinc and iron chlorosis. The active carbonates restrict the application of some fertilizers like urea. They also affect the water regime, soil texture and other properties of the soils.

Carbonates in the soils determine a slightly alkalic reaction. pH in H20 - 7.5 to 8.2 at which many of the soil pollutants causing its acidification are blocked up. The adverse impact of some toxic elements of metals like Cu and others is strongly reduced.

3. Acid soil reaction.

pH in water 5,5 or in KCL 4,5, evokes high mobility of many elements in soil, at which some of them can cause toxicity (A1). This reaction is unfavourable for many agricultural crops. It strongly restricts the nitrification process in soils. It favours the adverse impact on the environment of many chemicals used in agriculture, as under the conditions of this reaction a significant part of them have a raised migration ability.

4. Acid soils with a ratio $\frac{\text{\% clay in B hor.}}{\text{clay in A hor.}}$ more than 1.5.

The high texture differentiation causes poor drainage of soil and creates anaerobic conditions. In combination with the acid reaction, it is quite an unfavourable property for plants, especially in areas with high rainfall over the vegetation period.

5. Middle or high waterlogging.

It causes highly anaerobic conditions in soils and strongly restricts the possibilities of using land for fields, orchards and vegetable gardens. It creates favourable conditions for the pollution of ground water with nitrates when mineral and organic fertilizers are applied.

6. Salinization.

It is a major restriction to the growth and development of many crops. It strongly reduces their yields. Most frequently it occurs in combination with the average and high waterlogging of soils and, in this connection, it represents a serious danger of pollution of ground water with nitrates.

7. Alkalization.

It raises the pH value of soils to above 8.5 and causes the destruction of the soil cation-exchange capacity as a result of which soils become completely unworkable.

8. High percentage of stones in neutral and carbonate soils.

It creates major physical obstacles to the use of soils as fallow land and pastures. In combination with a carbonate content it causes a high overdrainage of soils and worsens their water regimes.

9. High content of stony phase in acid soils.

It creates overdrainage of soils and, along with the acid reaction, it favours the increase of their migration ability, for which reason there is a serious danger of affecting the environment (mainly water) further to the application of chemicals in agriculture and forest management.

The condition of the soils, in relation to their suitability for agriculture, can be expressed by a two-figure code, which allows an easy grouping of soils according to their degree of accomplishment of the soil constraints and the use for this purpose of computer techniques. The application of the above concept to the soil cover of an area of 500,000 ha shows that out of the 452 possible combinations, a total of 45 soil-ecologic units are present in the area. From the latter, 13 combinations make up approximately 90% of the soil cover of the area, and 95% of the soils used in agriculture are grouped in a total of 7 soil-ecologic units. The soil-ecologic grouping carried out in this manner generalizes the immense variety of cartographic soil units and reduces them to several well-founded soil groups differentiated by their qualities for use in agriculture. This facilitates the use of soil information and its interpretation for practical purposes.

The grouping of soils according to our methods can be widely used in the system for the environmental impact assessment of the soil cover. The repeated large scale mapping of soils carried out every 5-10 years in Bulgaria gives us the possibility to trace man-made changes in the soil cover.

The soil groups determined by means of the described methods can be used in models for optimizing land use.

Table 1. Soil characteristics used in Bulgaria for the description of the quality of soils

No.	Characteristics	Units
1.	Soil forming materials	index
2.	Depth of the underlying rock	cm
3.	Depth of the A horizon, or the arable layer	cm
4.	Depth of A and B horizons	cm
5.	Amount of particles < 0.01 mm in A horizon	%
6.	Amount of particles < 0.001 mm in A horizon	%
7.	Amount of particles < 0.001 mm in B horizon	%
8.	Texture index	
9.	Depth of the carbonate deposition	cm
10.	CaCO3 content in A horizon	%
11.	Humus content in A horizon	%
12.	Rock fragments in the arable layer	% of the volume
13.	pH (H20)	
14.	pH (KCL)	
15.	Water soluble salts	%
16.	Electric conductivity	mm
17.	Amount of exchangeable ions in B horizon	% of P
18.	Depth of ground water	cm
19.	Classes of erosion	
20.	Surface waterlogging	
21.	Pollution with heavy metals	

Table 2. Matrix for grouping soils in accordance with their properties

Soil group	Code		Soil Constraints/	
Deep zonal soils (clay fraction 30-60%)	1	1	pH - H20 5.6 - 8.2 neutral reaction	pH - KCL
Deep zonal soils (clay fraction > 60%)	2	2	CaCO3 from the soil surface	
Deep zonal soils (clay fraction 10-30%)	3	3	pH - H20 < 5.5 acid reaction	pH - KCL < 4.5
Meadow soils (clay fraction 20-45%)	4	4	acid soils with a texture coefficient > 1.5	
Meadow soils (clay fraction over 45%)	5	5	average and high waterlogging (B2 + B3)	
Meadow soils (clay fraction up to 20%)	6	6	solonchak salinization	
Eroded soils (E2 + E3)x	7	7	alkalinization	
Shallow soils	8	8	content of stones in neutral and carbonate soils	
Recultivated soils	9	9	high content of stones in acid soils	

xE2 - severe erosion
E3 - very severe erosion.

SUMMARY

5 - SOIL CHARACTERISTICS FOR ASSESSMENT OF QUALITY OF LANDS

Authors: I. Atanasov and V. Petrov

Paper submitted by the Environmental Research and Information Centre at the Committee for Environmental Protection, Bulgaria.

Soils and soil cover are an essential part of the environment and important natural resources. Information about soil properties is an important material for the purposes of land evaluation. The first stage of the land evaluation system should ascertain which land properties are likely to be relevant and can be measured or assessed in order to use them for land evaluation. Such properties have been called land characteristics (FAO, 1976) and data concerning these are often collected in the course of soil surveys, including soil, topographical, meteorological and ecological information.

The first task in land evaluation is to choose and determine what kind of data is needed in order to implement it. Many of the soil properties important in land evaluation are normally collected during routine soil surveys. At present, in Bulgaria, for the purposes of land evaluation on the scale of a separate field and agricultural farm, 22 soil characteristics and soil qualities are used including: soil parent material, soil depth, texture, organic matter content, CaCO3-content, stoniness, soil structure, genetic profile, salinity/alkalinity, pH, base saturation, CEC, clay mineralogy, permeability/infiltration, erosion, ground water depth, and some others. A soil fertility assessment is not necessarily made and usually, the determination of the nutrient status is not included in the procedure of land evaluation. However, in a new context, such as recreational area development, a new soil survey may have to be used to answer the questions for which rather different characteristics or qualities have to be assessed.

Parameters have been fixed for all the characteristics, showing the threshold levels for each of them and the limits at which the soil properties restrict productivity. On the basis of the characteristics and parameters of soil properties, a special scheme for

the evaluation of soils has been developed, in which soils are ordered depending on the productivity limiting factors.

The approximately 750 soil units already identified in this country, at a variety of levels, are gathered with the help of the scheme into 15-19 soil groups with similar productivity and requirements with respect to the methods of cultivation and amelioration. Thus, the enormous number of soil units given in large scale soil maps can be found in comparatively homogeneous and similar soils according to the extent of the limiting factors affecting soil productivity. The application of the described evaluation system, using soil characteristics and soil qualities, to an individual district in Bulgaria proves the system effectiveness. This system can be used for model development which reflects the productivity of crops, and also for the development of a computerized advisory system for productivity management of crops at the level of an individual field. Using this system we can estimate land suitability, as well as land capability.

RESUME

5 - RENSEIGNEMENTS PERMETTANT D'EVALUER LA QUALITE DES SOLS

Auteurs: I. Atanasov et V. Petrov

Document soumis par le Centre d'information et de recherche sur l'environnement du Comité pour la protection de l'environnement, Bulgarie.

Les sols et leur couverture constituent une partie essentielle de l'environnement et une importante ressource naturelle. La connaissance des caractéristiques pédologiques est indispensable à l'évaluation de la qualité des sols. Pour évaluer cette qualité, on détermine d'abord les propriétés pédologiques susceptibles d'être retenues et mesurées ou évaluées. C'est ce qu'on appelle les caractéristiques des sols (FAO, 1976) et les informations à ce sujet sont souvent recueillies au cours d'études pédologique, topographique, météorologique, écologique, etc.).

Lorsque l'on entreprend d'évaluer la qualité des sols, la première tâche consiste à choisir et à déterminer le type d'informations voulues. Un grand nombre de propriétés pédologiques qui jouent un rôle important dans l'évaluation de la qualité des sols sont normalement recueillies au cours d'enquêtes pédologiques ordinaires. A l'heure actuelle, en Bulgarie, pour évaluer la qualité du sol à l'échelle d'un champ ou d'une exploitation agricole, on retient 22 caractéristiques et qualités pédologiques, notamment le matériau originel du sol, la profondeur du sol, la texture, la proportion de matière organique, la teneur en $CaCO_3$, la pierrosité, la structure du sol, le profil génétique, la salinité/alcalinité, le pH, la saturation en bases, la capacité d'échange cationique, la minéralogie argileuse, la perméabilité/infiltration, l'érosion, la profondeur de la nappe phréatique, etc. On n'évalue pas nécessairement la fertilité du sol, et la teneur en substances nutritives n'est habituellement pas déterminée. Toutefois, dans un contexte nouveau tel que l'aménagement d'une zone de loisirs, il peut être nécessaire de procéder à une nouvelle étude pédologique si l'on souhaite connaître des caractéristiques ou des qualités assez différentes.

Pour chaque caractéristique on a déterminé un seuil ainsi que les limites au-delà desquelles la productivité diminue. Sur la base des caractéristiques et des paramètres des propriétés du sol, un plan spécial d'évaluation des sols a été mis au point qui permet de classer ceux-ci en fonction des facteurs limitatifs de leur productivité.

Les quelque 750 unités pédologiques déjà identifiées en Bulgarie, au niveau de la variété, sont rassemblées grâce au plan en 15 à 19 groupes présentant une productivité et des caractéristiques analogues en ce qui concerne les méthodes de culture et d'amélioration. Les très nombreuses unités pédologiques qui figurent dans les cartes du sol à grande échelle peuvent donc être ramenées à des sols relativement homogènes et comparables en fonction des facteurs limitatifs qui affectent leur productivité. L'application du système d'évaluation décrit, en utilisant les caractéristiques et les qualités pédologiques dans un district donné de la Bulgarie, a démontré son efficacité. Le système peut servir à élaborer des modèles qui rendent compte de la productivité des cultures ainsi qu'à mettre au point un système consultatif informatisé pour la gestion de la productivité des cultures arrivées à maturité au niveau d'un champ particulier. Ce système permet d'estimer l'aptitude et la capacité d'un terrain.

Резюме

5 - ОЦЕНКА КАЧЕСТВА ЗЕМЛИ НА ОСНОВЕ ДАННЫХ О ПОЧВЕ

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Почвы и почвенный покров являются существенным компонентом окружающей среды и представляют собой важнейший природный ресурс. Информация о свойствах почвы составляет необходимый базис для оценки земли. Разрабатывая систему оценки земли, необходимо прежде всего установить какие свойства почвы, имеющие отношение к оценке земли, могут быть измерены и использованы с этой целью.

Такие свойства были названы характеристиками земли (ФАО, 1976). Регулярно собираемые данные о состоянии земли содержат информацию о свойствах почв, а также о монографических, метеорологических, экологических и прочих аспектах, связанных с характеристикой земли.

Первоочередная задача оценки земли состоит в выборе круга показателей, с помощью которых эту оценку можно производить. Довольно большой объем данных о свойствах почв, имеющих отношение к оценке земли, собирается в ходе регулярно проводимых обследований почв. В настоящее время в НР Болгарии, в целях оценки земли, регулярно проводятся обследования земель сельскохозяйственных угодий по 22 показателям: важнейший компонент почвы, толщина почвенного пласта, структура почвы, содержание в почве органических веществ, содержание $CaCO_3$, каменистость почвы, генетический профиль почвы, уровень засоленности, кислотность, степень эрозии, глубина нахождения грунтовых вод и некоторые другие. Используемая в настоящее время процедура оценки земли не фиксирует уровни её питательности и таким образом не дает оценки её плодородия.

В современных условиях, однако, требуется, чтобы процедуры оценки земли обеспечивали сбор такого объема данных, который был бы достаточен для проведения и оценки плодородия земли, и ответа на многие другие вопросы, связанные с характеристикой земли.

В отношении многих показателей, по которым собираются в настоящее время данные, были установлены пороговые значения, превышение которых ведет к снижению продуктивности земли. На основе собранных данных о свойствах почв была разработана специальная схема оценки, позволяющая классифицировать земли по уровню их продуктивности в зависимости от ограничивающих продуктивность факторов.

С помощью этой схемы около 750 земельных участков было сгруппировано в 15-19 групп, характеризующихся схожими уровнями продуктивности, и в отношении которых, следовательно, рекомендуется использовать одинаковые методы обработки и повышения плодородия. Применение описанной выше системы оценки земли в различных областях НР Болгарии подтвердило её эффективность.

Эта система может быть использована для прогнозирования урожайности полевых культур, размещаемых на различных землях.

6 - TRENDS IN BIRD POPULATIONS AS AN ENVIRONMENTAL INDICATOR

Author: Pertti Koskimies

Paper submitted by the Zoological Museum, University of Helsinki, Finland

Birds as environmental indicators

Birds are useful biological indicators because they are ecologically versatile and live in all kinds of habitats as herbivores, carnivores and omnivores. The ecology of birds is well known and census and other study methods are well developed compared with most other biological taxa. Last but not least, bird monitoring is relatively cheap because voluntary bird watchers can be used in gathering field data.

What is a biological indicator? It is defined as an organism or ecological community so strictly associated with particular environmental conditions that its presence is indicative of the existence of these conditions.

Although we can safely conclude that birds are responding to quantitative and qualitative changes in their habitat, they are usually not indicators of the primary cause of these changes. Birds are responding most often to secondary changes brought about by a primary cause, being one or more steps removed from the actual phenomenon.

Many times, however, changes in the abiotic regime of an ecosystem, or cause variables, may be overlooked, be too subtle, or be of no interest to be monitored directly. Monitoring of bird populations, or effect variables, is necessary for many purposes, such as describing environmental quality and conditions. So far, birds have been used most successfully to detect and monitor the effects of environmental contaminants — impacts that in many cases would probably have otherwise gone undetected. Bird data have been shown also to reflect broad-scale habitat changes, such as those due to agriculture and forestry.

Biological monitoring, e.g. using birds, has two main advantages compared with non-biological monitoring. Firstly, it allows to detect environmental changes which cannot be observed by measuring physical or chemical parameters and, secondly, it allows to detect and monitor what are often cumulative and non-linear biological consequences of many environmental changes acting simultaneously. The problem with using birds as indicators is separating the myriad of factors that can cause changes in bird populations. The interpretation of monitoring results attempts to solve this problem.

Bird monitoring in Finland

In Finland a large amount of research and planning work has been done to develop a scientifically valid, co-ordinated program of bird monitoring in close connection with other environmental monitoring projects. This work was organized and financed by the Ministry of the Environment.

The basic aim of our program is general monitoring to detect unexpected environmental changes as they occur - thus birds acting as an early warning system of any adverse consequences of man-caused environmental changes.

The mere recognition of environmental changes and problems can never be the final result of monitoring. Such a recognition must always lead to attempts to define and interpret the problem more precisely and to indicate the importance of countermeasures.

Criteria for the bird monitoring program

There are several criteria for the bird monitoring program. It must

1) be continuous
2) be done in the same study areas from year to year
3) use comparable study methods
4) cover as many species as possible
5) cover the whole of Finland
6) cover all habitats, both optimal and marginal
7) detect both short-term and long-term bird population changes
8) be scientifically valid, and
9) have high efficiency.

Monitoring the population of all species makes it possible to recognize environmental changes and evaluate their significance more precisely than by monitoring only a few species, as species with similar ecology are likely to react in a similar manner and, by grouping results, they can be interpreted more reliably.

Distribution between different geographical scales is of utmost importance. Regional patterns are a result of complicated dynamics in a mosaic of local populations. On the scale of local communities, changes may have nothing to do with habitat changes. What happens in a small area over a number of years may be to a great extent stochastic or determined by such factors as site tenacity, weather during winter or migration, fluctuations of food resources, excess production of young in better habitats and so on. Adequate geographical spread of monitoring is important since changes may occur on a regional basis in response to relatively localised environmental changes.

It has been shown a number of times that trends may differ between habitats. Even a broad habitat change can remain undetected, if monitoring does not cover the whole gradient of habitat range. Density and population dynamics in optimal habitats may be the same from year to year although the whole population varies enormously and particular habitats may be more vulnerable than others to man-made activities.

The importance of long-term data should be emphasized, because the scarce long-term data on ecological systems surprisingly often show that short-term data collection is misleading or inadequate.

Monitoring object

The main criteria when selecting the monitoring object are as follows:

1) observed population changes must indicate real environmental changes

2) monitoring is based on methods and data analyses which are scientifically valid

3) populations can be monitored both in natural and man-altered environments

4) monitoring covers as many species, habitats and study areas as possible

5) results are representative for larger areas of similar habitats

6) population size, breeding success, mortality and migratory balance between populations are monitored at the same time

7) bird monitoring can be integrated with other types of environmental monitoring.

The 6th criterion deserves special attention. The pure information on population sizes and densities is rather un-informative, since it provides no clue as to the causes of observed population changes. One should be able to identify the particular population processes which are affected by environmental effects and which seem to be involved in the recorded change. Population ecology of breeding and wintering birds is the most suitable monitoring object.

Counts of migrants include more methodological errors and difficulties in interpreting the data. The areas and habitats where the migrants are coming from are not known precisely and it is difficult to compare the results with data on studies of population ecology and general environmental monitoring, which are organized in particular areas and habitats. In addition, the real population trends can be detected more rapidly by studying breeding populations.

The resident species are extremely important monitoring objects because their changes reveal the changes occurring here in Finland and all of their population processes can be studied throughout the year. When interpreting the results, it is important to analyse the influence of winter weather on mortality, which is possible with the help of long-term winter bird censuses on a number of species and with different weather conditions.

Monitoring methods

There is no single method suitable for all monitoring purposes. Rapid, one-visit census methods are often more suitable than time-consuming, many-visit methods, which the voluntary bird watchers may find nonattractive. With rapid methods we are able to collect more representative samples from different areas and habitats.

The integrated bird monitoring program

The Finnish bird monitoring program consists of subprojects which cover different environmental types and population ecology of bird groups. The following projects are included:

A) Projects monitoring breeding and wintering populations of land birds

1) line transects and point counts of breeding populations
2) line transects of wintering populations

B) Projects monitoring population ecology (populations size, breeding success, mortality and migratory balance) of different species groups

3) waterfowl and wetland birds
4) archipelago birds
5) birds of prey
6) gallinaceous birds
7) box-nesting birds
8) night-singers

C) Projects monitoring population ecology of the entire bird fauna

9) nest-cards for monitoring breeding success
10) standardized mist-netting for monitoring population ecology
11) ringing data for monitoring mortality

D) Project monitoring biocides

12) analyses of biocides in birds.

In addition, there is a special project for monitoring population changes in background areas of natural state situated in different parts of the country. It is carried on in connection with a co-Nordic project of integrated monitoring of the environment. Different monitoring projects have been started in these areas, including the mapping of land bird populations.

Most projects are organized by the Zoological Museum of the University of Helsinki with the help of about 3000 voluntary bird watchers who form a permanent observer network. The Museum published a special book, delivered to all observers, including detailed standard field instructions and computer forms for all the projects.

The Finnish Game and Fisheries Research Institute, Game Division, organizes the monitoring of gallinaceous birds and, together with the Museum, of waterfowl.

The Ministry of the Environment integrates the subprojects with one another and in relation to all the other environment monitoring activities. A basic feature of the monitoring program is that different projects are largely co-ordinated to give utmost opportunity for data record linkage across the projects. There are also institutional connections among monitoring projects and basic research activities in various related fields, which turn to their mutual advantage.

Most projects study population ecology both in intensive and extensive manner. It should be reminded that results from small areas possibly reflect only local trends and they are most suitable for monitoring, if they are considered in different parts of Finland at the same time.

Atlas studies can also be used in monitoring subsequent changes in range, which for many species probably occur on a time scale of some decades. The atlas methodology was greatly improved by the use of a quantitative basis to a greater extent than ever before in Finland. In addition to distribution, population numbers are also being studied.

Data analysis and reporting

In Finland the monitoring data are stored and analysed by computers in the Museum. In the near future the integration between bird monitoring data and other environmental monitoring results obtained by the Ministry of the Environment will be developed. A rigorous scientific analysis of data sets leads to a better use of other data collected within the bird projects, and can indicate possibilities to redirect the sampling scheme etc.

The monitoring results will be published both annually and at longer time intervals and shall be addressed to research bodies and administrators as well as to amateur bird watchers participating in the projects. It is essential that monitoring results be also published in scientific journals.

Interpretation of results

Interpretation of data is the most important part of monitoring for an environmental administration. Advanced knowledge on habitat selection and other aspects of avian ecology provides tools for interpretation.

It must be stressed that any interpretation of monitoring data should be based on scientifically rigorous analyses of the results; monitoring is basically a scientific, long-term analysis of the relationships between Man and his environment. A central point of the interpretation is that there are few ecological reasons to expect only linear relationships beween numbers of a species and features of the environment. Consideration of only linear responses may be misleading because the true relationships are actually more complex.

In fact, there is actually surprisingly little factual or quantitative information about the influence of land management operations on populations of different birds, making it in many cases impossible to pass any sound judgement on the environmental consequences of different operations. The study of habitat correlates is particularly valuable in relation to monitoring because it identifies key habitat elements on which the various species depend. Population changes detected in different species can then be related to any identifiable change in the abundance of the habitat elements concerned, whilst changes that are not consistent with known habitat alterations require some other explanation, such as the presence of a previously undetected environmental change.

The longer-term recording of habitat changes as a byproduct of monitoring projects also provides a convenient source of case histories on the ornithological consequences of habitat alterations. Research studies should probe more than ever before into the quantitative relationship between the long-term population trends and the habitat selection patterns of different bird species. But the problem of scale must be clearly kept in mind. A small-scale manipulative experiment, e.g. a modification in a small area, may be hard to interpret correctly if local population changes cannot be understood without reference to regional habitat changes.

All abundance patterns may not be explainable on the basis of habitat related variables, because fluctuations may be independent of changes in habitat characteristics, e.g. survivorship in wintering areas.

There is a good example from Finland where quantitative data on the habitat selection of forest birds and data on known environmental changes were used to derive predictions about the direction of trends. The change in forest structure, or age and fragmentation, explains about 67 per cent of the variance in the population trend for northern species in Northern Finland. This supports the earlier hypothesis that not only the decrease in the area of old forests but also the fragmentation of large forests played an important role in the population crash of species favouring old forests.

Methods of interpretation

Detailed methods for the interpretation of bird monitoring results are not yet fully developed, although a keen research work is going on e.g. in Finland.

I am going to mention only two basic approaches: first, using data on population processes of single species, and, second, grouping species with similar ecologies into guilds.

After measuring the different population processes independently from one another it is possible to find out, on which one the change in population size is mostly dependent. The analysis is then some kind of key factor analysis.

A rather great amount of data from different habitats and geographical areas is needed to interpret the regional population trends.

The breeding success is most easily measured in passerine birds by nest cards and netting projects. Estimation of annual mortality rates is usually possible only in intensive population studies and some intensively ringed species. The migratory balance between populations is the most difficult procedure to monitor. In Finland, where many species occur near the frontier of their ranges, e.g. prolongation of migration due to weather conditions or population pressure in the central breeding areas may affect the size of the breeding population. According to a recent study many southern species have increased during recent decades in northern Finland, probably due to an overflow of individuals from the increasing population in southern Finland, and partly owing to habitat changes.

An overflow may be temporary but site tenacity may act to attach birds to the site of their first breeding, contributing to the persistence of such overflows. Different methods to measure the influence of immigration and emigration on population sizes also outside the most intensive studies with colour-marked individuals are just being developed in Finland.

The second major approach is the use of guilds or groups of species with similar ecologies. Because many population changes have multiple causes, monitoring specific environmental changes is most rewarding if birds are grouped by e.g. habitat, major strategy of migrating, or feeding. Food sources and breeding niches are among the most important environmental factors determining the suitability of a habitat for a species. I find the concept of management guild used in North America especially promising. It is defined as a group of species that respond in a similar way to a variety of changes likely to affect their environment. The entire guild is treated as a unit to assess the environment's capability of supporting the species in the guild and to monitor trends in the collective populations of those species. In practice, an entire guild is used as an indicator of the quality of a particular zone of a specified habitat.

Some workers have emphasized that rather fine distinctions of the habitat zones required for nesting and feeding can result in more realistic groupings of species that will respond similarly to man-caused changes in their habitats. When guilds are defined more in terms of animals' associations with zones of their habitats than in terms of diets or foraging manouvres, guild members are more likely to respond alike to changes in habitat. In other words, grouping species into guilds should be based entirely on habitat requirements, not e.g. on size which is unrelated to important habitat needs.

However, for practical reasons the system should be kept as simple as possible and to maximize the number of species in each guild. Species that are contained within a single habitat stratum can be expected to be adversely impacted by the destruction of that stratum and favoured by its enhancement. In detail, guild categories should be derived from consideration of those zones of the habitat that are likely to respond in similar ways to various sorts of human-caused perturbations.

In practise, the guild approach has been used so far only for management purposes. Using guilds and a knowledge of possible or factual environmental changes, managers have tried to predict future bird communities and species abundance patterns.

In monitoring the system has to be turned round. After putting the species into a species-habitat matrix, one adds information about measured population changes and defines, in which guild blocks different kinds of changes have occurred. These changes may indicate environmental changes in the very same habitat strata, and this information makes it much easier to look for the cause of change. After this survey, the interpretation can be enhanced by adding the species specific data based e.g. on the analysis of the population model discussed above.

International co-operation

Finally, I would like to mention our recent activities designed to get our monitoring work more efficient and reliable. We are widening the geographical scale of our effort by working together with the other Nordic countries as well as the Soviet Union in a few areas around the Baltic Sea. Thanks to a highly standardized co-operation both in gathering field data and analysing results, we are not only able to monitor the bird population changes in large areas of northern Europe but also to do it much more reliably. Developing this kind of international co-operation should be of primary importance e.g. in the ECE seminars.

SUMMARY

6 - TRENDS IN BIRD POPULATIONS AS AN ENVIRONMENTAL INDICATOR

Author: Pertti Koskimies

Paper submitted by the Zoological Museum, University of Helsinki, Finland.

Birds are useful indicators of environmental changes, because they are ecologically versatile and live in all kinds of habitats as herbivores, carnivores and omnivores. The ecology of birds is well-known and census and other field research methods are well developed compared with most other biological taxa.

The Ministry of the Environment in Finland, with help of the Zoological Museum of the University of Helsinki and the Finnish Fish and Game Research Institute, has organized a nation-wide monitoring system of bird populations based mainly on the voluntary work of about 3000 amateur bird-watchers. There are 12 subprojects in the system: monitoring of land bird populations, winter bird populations, waterfowl and wetland birds, archipelago birds, birds of prey, gallinaceous birds, box-nesting birds, night-singers, breeding success by nest-cards, population dynamics by mist-netting, mortality by bird ringing, and biocides in birds. The basic aims of the system are: to detect unexpected environmental changes, to monitor biological consequences of large-scale, man-made environmental changes, and to monitor bird population changes for conservation purposes.

The monitoring system covers the population ecology of birds as a whole: most importantly, number of breeding pairs, breeding success, mortality and migratory balance between populations are all monitored at the same time. Monitoring is based on methods and data analyses which are scientifically valid, and populations are monitored both in natural and man-altered environments. Monitoring covers as many species, biotopes and study areas as possible and results should be representative for larger areas of similar habitats. The Finnish bird monitoring system has been integrated with other environmental monitoring, e.g. in base areas of natural state.

In Finland all the material is analysed by computers with the aid of programs specifically designed for the work. Long-term

changes in bird populations are more important than annual fluctuations when looking for the reasons of population changes. This interpretation of the results is the most important phase of the monitoring work; one method is e.g. comparison of species having different or similar ecological characteristics. It is very useful to know both the habitat choices of different species and the influence on populations of known changes in the environment. It is also important to understand whether the observed trend is due to a change in the number of breeding pairs or in the reproduction rate.

The results of the monitoring system are published in the annual report covering longer periods.

RESUME

6 - LES TENDANCES DES POPULATIONS D'OISEAUX: UN INDICATEUR DE L'ENVIRONNEMENT

Auteur: Pertti Koskimies

Document soumis par le Musée zoologique de l'Université d'Helsinki (Finlande).

Les oiseaux sont des indicateurs utiles des changements qui surviennent dans l'environnement, car ils sont polyvalents du point de vue écologique et vivent dans toutes sortes d'habitats, selon qu'ils sont herbivores, carnivores ou omnivores. On connaît bien l'écologie des oiseaux et les relevés ainsi que les autres méthodes de recherche sur le terrain les concernant sont plus perfectionnés que pour la plupart des autres taxons biologiques.

Le Ministère finlandais de l'environnement, avec l'aide du Musée zoologique de l'Université d'Helsinki et de l'Institut finlandais de recherche sur la pêche et la chasse, a mis sur pied un système national d'observation des populations d'oiseaux qui repose principalement sur les activités bénévoles d'environ 3000 observateurs amateurs des moeurs des oiseaux. Ce système comprend 12 sous-projets: l'observation des populations d'oiseaux terrestres, des populations d'oiseaux d'hiver, des oiseaux aquatiques et des marais, des oiseaux des archipels, des oiseaux de proie, des gallinacés, des oiseaux de nichoirs, des oiseaux nocturnes, le suivi des taux de reproduction à l'aide de fiches de relevés de nichoirs, de la dynamique de la population par filets aériens, de la mortalité par baguage et des biocides dans les oiseaux. Les principaux objectifs du système sont les suivants: détecter les modifications inattendues de l'environnement, surveiller les conséquences biologiques des modifications anthropiques majeures de l'environnement et observer les changements de la population des oiseaux à des fins de conservation.

Le système de surveillance porte sur l'écologie de la population des oiseaux dans son ensemble et surtout sur le nombre de couples reproducteurs, le taux de reproduction, la mortalité, tandis que le bilan migratoire entre les populations est aussi étudié.

L'observation repose sur des méthodes et des analyses de données scientifiques et les populations sont surveillées à la fois dans le milieu naturel et dans des environnements que l'homme a modifiés. Elle porte sur le plus grand nombre possible d'espèces, de biotopes et de domaines d'étude et les résultats devraient être représentatifs de régions plus étendues qui présentent des habitats analogues. Le système finlandais d'observation des oiseaux a été intégré à d'autres dispositifs de surveillance de l'environnement, par exemple dans des stations de parcs naturels.

En Finlande, toutes les informations sont analysées par ordinateur au moyen de programmes spécialement conçus à cet effet. Pour expliquer les changements démographiques, l'évolution à long terme des populations d'oiseaux importe davantage que les fluctuations annuelles. L'interprétation des résultats est la phase la plus importante du travail d'observation; une méthode consiste par exemple à comparer les espèces aux propriétés écologiques similaires ou différentes. Il est très utile de connaître le choix de l'habitat des différentes espèces et l'influence des modifications connues de l'environnement sur les populations ainsi que de déterminer si l'évolution observée est due, par exemple, à une modification du nombre des couples reproducteurs ou du taux de reproduction.

Les résultats du système d'observation sont publiés et examinés dans des rapports annuels ou portent sur des périodes plus longues.

Резюме

6 - ТЕНДЕНЦИИ В ПОПУЛЯЦИИ ПТИЦ КАК ЭКОЛОГИЧЕСКИЙ ПОКАЗАТЕЛЬ

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Птицы являются удобным показателем изменений в окружающей среде, поскольку они являются подвижными в экологическом отношении и обитают в различных видах окружающей среды, как, например, травоядные, хищники и всеядные. Экология птиц хорошо известна, и переписи и другие методы полевых исследований хорошо разработаны по сравнению с большей частью других биологических таксонов.

Министерство охраны окружающей среды Финляндии с помощью Зоологического музея Хельсинкского университета и Научно-исследовательского института проблем рыбных ресурсов и диких животных Финляндии создало общенациональную систему мониторинга популяций птиц на основе главным образом добровольной работы, которую выполняют приблизительно 3 ООО любителей-орнитологов. В системе имеется 12 подпроектов: мониторинг популяций наземных птиц, популяций зимующих птиц, водоплавающих птиц и птиц, проживающих в заболоченной местности, птиц, обитающих на архипелагах, хищных птиц, куриных птиц, птиц, обитающих в общих гнездах, ночных певчих птиц, определения результатов выведения потомства с помощью регистрации гнезд, определения динамики популяции путем отлова сетями, определения смертности путем кольцевания птиц и биоцида птиц. В число основных целей системы входят: обнаружение неожиданных изменений в окружающей среде, мониторинг биологических последствий крупномасштабных изменений в окружающей среде, вызванных деятельностью человека, и наблюдение за изменениями в популяциях птиц для целей рационального природопользования.

Система мониторинга охватывает экологию популяций птиц в целом; в то же время ведется наблюдение за наиболее значительным количеством пар, выводящих потомство, результатами ведения потомства, смертностью и миграционным балансом между популяциями. Мониторинг осуществляется на основе анализа методов и данных, которые являются правильными с научной точки зрения, и мониторинг популяций осуществляется в естественных и измененных человеком условиях. Мониторинг охватывает максимально возможное число видов, биотопов и областей исследования, и результаты должны быть представительными для более крупных районов аналогичных сред обитания. Система мониторинга птиц в Финляндии была объединена с другими видами экологического мониторинга, например, в основных областях состояния природы.

В Финляндии анализ всего материала производится на ЭВМ с помощью программ, специально составленных для этой работы. При изучении причин изменений в популяциях долгосрочные изменения в популяциях птиц имеют более важное значение, чем годовые колебания. Наиболее важным этапом процесса мониторинга является такое толкование результатов, когда один метод заключается, например, в сопоставлении видов со сходными и разными экологическими свойствами. Информация о выборе среды обитания разными видами, влиянии известных изменений в окружающей среде на популяции и возможность анализа того, обусловлена ли данная тенденция изменениями, например, в числе пар, выводящих потомство, или в результате выведения потомства, имеют весьма важное практическое значение.

Результаты, полученные с помощью системы мониторинга, публикуются и анализируются в годовых отчетах и докладах, охватывающих более длительные периоды.

7 - GAME STATISTICS AS INDICATORS OF POPULATION SIZE AND COMPOSITION

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Paper submitted by the Directorate for Nature Management, Wildlife Research Division, Norway.

Introduction

Game statistics comprise several different types of information concerning hunting and trapping of birds and mammals. Usually they give number of animals shot, number of hunters, and, if relevant, number of licenses issued. They may also include information about the hunters, such as their age, sex and occupation (e.g. Myrberget & Sφrensen 1977, Strandgaard 1978), economic aspects of hunting (e.g. Myrberget 1982), damages caused by game, or numbers and individuals killed by cars or trains. Recordings made systematically by the hunters during the hunt, may also be included. Data on commercial sealing and whaling are, however, usually excluded (Leeuwenberg & Hepbum 1981).

Information about numbers of certain game species killed have been available in several countries for more than 100 years; e.g. country-wide statistics on numbers of large carnivores killed annually, have been compiled in Norway since 1846 (Johnsen 1928). The first obligatory European hunting statistics including all game species, was introduced in Denmark in 1941 (Strandgaard & Asferg 1980). Statistics concerning the number of specimens killed are, however, lacking for several European countries today, e.g. Ireland, Portugal, Italy and Greece (Bertelsen & Simonsen 1986).

What follows is a short discussion of the extent to which game statistics may be used to describe the size and age-sex composition of a game population. Conclusions are primarily based on experiences gained in Norway, but also draw upon some literary sources. We are exclusively concerned with hunting yields and systematic observations made by hunters during hunting.

Sources of error

Bag statistics may contain a greater or lesser degree of accuracy (Leeuwenberg & Hepbum 1981). The most common problems encountered are methodological. Bag statistics may be collected in a variety of ways. Some methods only provide indications of the total size of the yield (e.g. export statistics).

Locally organized, obligatory statistics on larger animals, like the Nordic statistics on killed moose, are more reliable. In Norway, municipal game commissions control that all persons who are issued moose hunting licenses report their yields. Statistics on the number of red deer killed in Norway are collected in a similar manner. On the basis of samples taken from red deer killed in a number of areas, Rolf Langvatn (pers. comm.) has found that the statistics give reliable data on the sex distribution in the yield and the proportion of calves killed. The reliability of obligatory statistics requires that all hunters really send in reports, and that these be correct. This does not appear to be the case with beavers in Norway (Bendixen 1987).

Another method is based on a register of hunters' names and addresses, from which a random sample is chosen, for mailing questionnaires. One problem is that not all of the hunters reply, and that the size of their yields may only be assumed relative to those who have answered (e.g. Couling 1982). In other cases, a hunter may not remember the exact yield. If the hunter has participated in a team, there may be some doubt as to which hunter should report the yield.

Even greater error may occur when statistics are compiled on the basis of voluntary responses from hunting associations; e.g. Swedish bag statistics appear to greatly underestimate the number of small game species killed (Göransson & Larsson 1987).

The official statistics on the number of roe deer killed in Norway, are yet another example of under-reporting. These are, as for moose, based on obligatory reports from municipal game commissions. In 1985-87, statistics were also compiled concerning the number of roe deer killed, as part of the small game statistics, which were based on reports from about 4% of all registered hunters. Official statistics gave only about 55% of the number of roe deer indicated in the small game statistics. However, small game statistics on roe deer may be inflated by 10%, because hunters often cooperate in teams (Statistisk Sentralbyra, pers. comm.).

Although not clearly indicated by published statistics, the basis for the collection of statistics may change with time. The Norwegian statistics on the number of minks killed were, until 1972, based on the number of bounties paid by each municipality. During the 1960's, a steadily decreasing number of municipalities paid out such bounties, so that these statistics are not reliable in later years (Bevanger & Ålbu 1987). In some years, but not all, the Norwegian statistics on red deer killed also included animals killed outside the hunting season, such as animals responsible for extensive crop damage (Langvatn 1988).

Incorrect species identification may occur through honest mistakes, but probably more often in association with active swindle. This applies to statistics on the number of wolves formerly killed in Norway, where many of the bounties paid for wolf pups, in reality concerned the mountain fox (Johnsen 1928). Older Norwegian bounty statistics often included also incorrect species identification of birds of prey. For example, bounties for golden eagle were often paid for rough-legged buzzard. Regarding the number of larger game species killed by permit only, hunters do not report numbers exceeding the number issued on a license. In general, illegal hunting does not appear in official statistics.

Species composition

Generally speaking, hunting statistics do not provide reliable information about the relative relationship between population sizes of different game species, because of differing hunting seasons, hunting methods, hunters' interest, or vulnerability to hunting. Some published statistics lump related species (e.g. the Norwegian statistics on shot ducks, except mallards).

Even when discussing species within one and the same area and with a common hunting season, accurate information on their relative population sizes may be difficult to obtain, because the two species may not be equally easily hunted. However, among waterfowl the most frequently killed species are often those which occur most frequently (Schifferli 1982, Kalchreuter 1987). A bag limit system in America also contains a potential source of error (Patterson 1979). In some areas, different species have different point values from 1 to 10, and each hunter may shoot a maximum of 10 points each day. Many hunters then prefer to shoot several mallards, each with a low point value, than to shoot a single, unusual duck with a point value of 10, in that the last means that the day's hunting must terminate after shooting only one bird.

Long term population changes

Bag sizes are often used to give a «hunting index of population density» (HIPD) in order to describe changes in population sizes, or to compare population densities in different areas (e.g. Picozzi 1968). Information on bag size per hunter, which is often reported in official statistics (e.g. for small game in Norway), may give more reliable results than kill data alone. In certain cases, data are given also on bag per hunter per hunting day (e.g. Myrberget & Sørensen 1977), or number shot as a percent of the number of licenses issued (e.g. Norwegian big game statistics).

In certain situations, changes in HIPD obviously reflect changes in population size. This is surely the case for larger carnivores in Norway (brown bear, wolverine, wolf and lynx), where statistics suggest that a rapid decline occurred from the 1880's, until about 1920. On the other hand, statistics on bears killed in Norway during the last twenty years may not be used to illustrate population developments. All bears are now killed to remove particular individuals responsible for great damage to livestock. The relatively stable, but low quota of bears killed may suggest that the population was given a chance to grow.

Norwegian statistics on the number of cervids killed (Fig. 1), suggest a sharp increase in these populations after World War II, with the exception of some short-term declines. Although the picture presented certainly is largely correct, one must take into account that the relationship between the number of individuals killed and the population size before the start of hunting, may have changed throughout the period. This is most certainly the case for moose, because of a license system that, in later years, leads to a selective culling of particular age and sex classes. In practice this means that one attempts to save females in age groups with high reproduction, and that more calves are shot (Fig. 2). The result has been a population with an increasing rate of reproduction, and thereby increasing sustainable hunting yields.

Where licensed hunting of particular species has been introduced, as in cervids, the «percent yield» gives the number shot relative to the total number of licenses issued. For all of the four cervid species which are hunted in Norway, the percent yield has not displayed any strong tendency toward systematic changes in recent years (Fig. 1), in spite of great variations in the number of animals killed and in the number of licenses issued. This may be related to attempts to adjust the number of licenses to changes in population size. It must also be taken into account that many conditions surrounding hunting practices may have a conservative effect. Therefore, changes in the percent yield provide few indications about changes in the population size. However, the percent yield does suggest that in some parts of the country during recent years, the moose population has declined, when developments in the number of licenses issued are also taken into account (Fig. 3).

Game statistics may also provide indications of large changes in the population sizes of some small game species (see Tapper & Bond 1987). The drastic decline in population sizes and hunting yields of partridge throughout most of Europe, is one example (Potts 1984). Smaller changes are more difficult to document because the relationship between population size and hunting yield may change with time. In addition, the reliability of hunting statistics may vary. Hersteinsson (1987) contends that hunting statistics on Iceland are «generally more likely to reflect changes in prices, farming practices and the distribution of human habitation, than changes in the sizes of the relevant bird populations».

Short-term variation in number

As long as hunting regulations or bag limits do not take into account short-term variations in population size, one may expect that variations in the number of game killed will by and large correspond to variations in population size. As demonstrated by Boyd (1983) in America, a hunter's interest in hunting waterfowl may change with his knowledge of fluctuations in population size and his expectations about the potential bag. When game densities are high, interest in hunting increases, as does the actual hunting yield and the relative encroachment on the game population (Kalchreuter 1984, 1987). One may therefore expect that bag statistics over-estimate short-term changes in game population densities (Angelstam et al. 1985, Lindström in press). Lindén (1977) reported, however, a very good fit ($r>0.93$) between the hunting bag and the autumn densities of forest grouse over a 9-year period in Finland.

Here only some examples of the varied use of bag statistics will be given: Andersen (1957) used them to describe local variations of hare populations in Denmark, and analysed the reasons for this. Game statistics have also been used to demonstrate changes in population size related to diseases or parasites. The effects of scab on populations of red fox in Sweden have been studied in this manner (Lindström in press). Game statistics from the Netherlands suggest that the intensity of fox hunting is higher in years with rabies (Leeuwenberg in press). Jensen (1970) found that the intense extermination of red foxes at Jylland in Denmark to combat rabies, resulted in increased yields of small game like partridges, pheasants and hares (see also Strandgaard and Asferg 1980).

Hunting statistics on roe deer in Norway (Fig. 1) show a decline in the number of animals killed around 1965. Population data indicate that this may have been associated with a high mortality related to extremely severe winter conditions (Hjeljord 1980). One may not exclude the possibility that a simultaneous decline in moose yields (Fig. 1) may have the same cause (Hjeljord 1980). On the other hand, an increased hunting pressure in previous years in order to reduce damage to forests, may have caused a decline in populations, and hence in yields. Fluctuations in the number of wild reindeer shot in Norway (Fig. 1) do not provide reliable data on short-term variations in the population size. The number of licenses issued is, to a greater extent than for moose and red deer, controlled to alter population size. In recent years, this practice led to significant variations in the hunting pressure on wild reindeer.

Some small game populations experience cyclic fluctuations. Game statistics have been used to demonstrate the existence of top years at about 10-year intervals in large parts of North America, every 5-6 years in UK and every 3-4 years in Scandinavia (Keith 1963, Finerty 1980, Potts et al. 1984, Angelstam et al. 1985, Williams 1985). Cycles are in Scandinavia particularly conspicuous among game species which live on small rodents, which themselves are subject to marked cyclic variations in number (Johnsen 1928, Hagen 1952). These 3-4-year variations are also noticeable in the statistics on the total number of small game killed annually in Norway (Fig. 4). This is primarily explained by the fact that populations of ptarmigan, which are the most important small game species in Norway, vary cyclically (Hagen 1952).

Population composition

Cyclic variations in Norwegian ptarmigan populations during the hunting season in the autumn, are primarily related to cyclic variations in the annual production of young birds (Myrberget 1974, 1984). Therefore, the variation in the number of grouse killed in a particular area is probably an indication of varying productivity. An attempt was made to demonstrate this on the basis of material collected on the ptarmigans killed in the Meråker municipality in central Norway, during the period 1963 - 1982 (see Fig. 5). The number of ptarmigans killed in rodent «crash years» was 1917 ± 1018 (± SD), compared with 2773 ± 1058 in other years. The proportion of young ptarmigans in rodent «crash years» was 42.5% ± 17.6%, and 60.8% ± 9.4% in other years. There was a significant correlation between the percentage of young birds in the hunting yields and the number of ptarmigans killed ($r = 0.43$, $P < 0.05$). In years when the number of ptarmigans killed increased, the percentage of young birds in the yield also increased and vice versa ($r = 0.58$, $P < 0.01$). Although all these findings are consistent with cyclic variations in production and autumn population size, the values of r^2 are too low to predict the proportion of young birds shot with any accuracy, from the information available on hunting yields.

The differences between males and females, and adults and young in some small game species are so conspicuous that hunters should be able to report the age-sex composition of their yield. Unfortunately, reporting of this kind is seldom systematically done. However, some studies are made at control stations in the vicinity of important hunting areas, and samples of killed small game are often collected for systematic identification of age (Myrberget 1974, Clausager 1987), but such data are not included in ordinary hunting statistics.

The number of licenses issued for the hunting of big game, as well as the yield data, are often divided into age and sex classes (e.g. Norwegian moose). Short-term changes in productivity from one year to the next may probably be monitored by interpreting such yield statistics. It is more difficult to interpret long-term changes, because the license composition according to age groups is often changed.

In most cases, calculation of the sex distribution on the basis of bag statistics is impossible, because the hunting pressure is not the same for both sexes. Where hunting is the most significant cause of mortality, however, one may use data on sex distribution in the hunting statistics from several years, to calculate the approximate average sexual composition in the population of young animals, as was done for moose in Sweden (Reuterwall 1981).

Hunter observations

A scheme for moose recordings by moose hunters was developed by the Norwegian State Game Institute in the 1960s, i.e. the «Moose Seen». A folder is distributed to the hunting teams. Here, they are to note down each day the number of moose seen and the number of animals shot with respect to age and sex, as well as the number of hunters which has participated. These data may be utilized to get information on composition and size of the population. For instance, an estimate on the sex-ratio is obtained by computing the number of adult bulls observed per adult cow. Similarly, the number of calves observed per adult cow gives information regarding the productivity of the population.

Furthermore, analyses of the number of observations per day may give indications on population fluctuations.

Obviously, this method depends on several assumptions. The most important is that the probability of recording an individual is independent of its sex and age, and that this probability does not depend on the size of the population. It is evident that the probability of recording a bull and cow is only rarely equal. Furthermore, some evidence also suggests that the hunting behaviour may change in relation to the number of animals present. For instance, the area searched per day may be smaller when many animals are present, resulting in relatively fewer observations at high densities.

The precision of the estimates obtained from such data was examined using demographic data from a population of moose in northern Norway. These analyses gave the following major results: (i) Different estimators, constructed to indicate fluctuations in the population size, gave similar results. For instance, the number of moose recorded the first day of hunt and the number of moose recorded during the rest of the hunting period was highly correlated. (ii) The variation in the number of moose seen was correlated with actual fluctuations in the population size. (iii) Greater difficulties existed in estimating changes in the composition of the population, e.g. the number of bulls recorded per cow was too low.

Some care must, however, be taken in generalizing these promising results. Data were collected in an area which seems particularly suitable for the use of this method because the moose density is moderate compared to other areas in Fennoscandia. In some areas, Norwegian moose hunters have also reported observations of brown bears, but the reliability of this method is unknown.

Game statistics and game management

Game statistics may be useful tools in game management. They are of particularly high value for species for which hunting constitutes the main cause of mortality, and for which the kill is regulated by licences. Together with knowledge of the actual development of the populations, kill statistics give important information when management strategies are planned, e.g. for cervid species.

Also for hunted migratory species, bag statistics give important information. This is the case when the hunting strategies are planned for waterfowl following American «flyways» (e.g. Boyd 1983). Due to lack of kill statistics in many European countries, similar planning is unfortunately not possible in Europe.

Conclusions

All game statistics contain a certain degree of error, and must therefore be used with care. In many cases, marked long-term changes in yield indicate corresponding changes in population size. Conspicuous short-term changes in population size may also be reflected in bag size. When statistics also include data on the age of the animal killed, they may provide indications of short-term changes in productivity. However, more direct studies of the age composition of the hunting yield will in general give more reliable results. Observations by moose hunters in Norway during the hunting season provide good data on changes in moose population size.

Game statistics are useful tools in game management, and they often provide data for game research. Therefore, it is a pity that game statistics are not collected in all countries, and that the information included is not always reliable.

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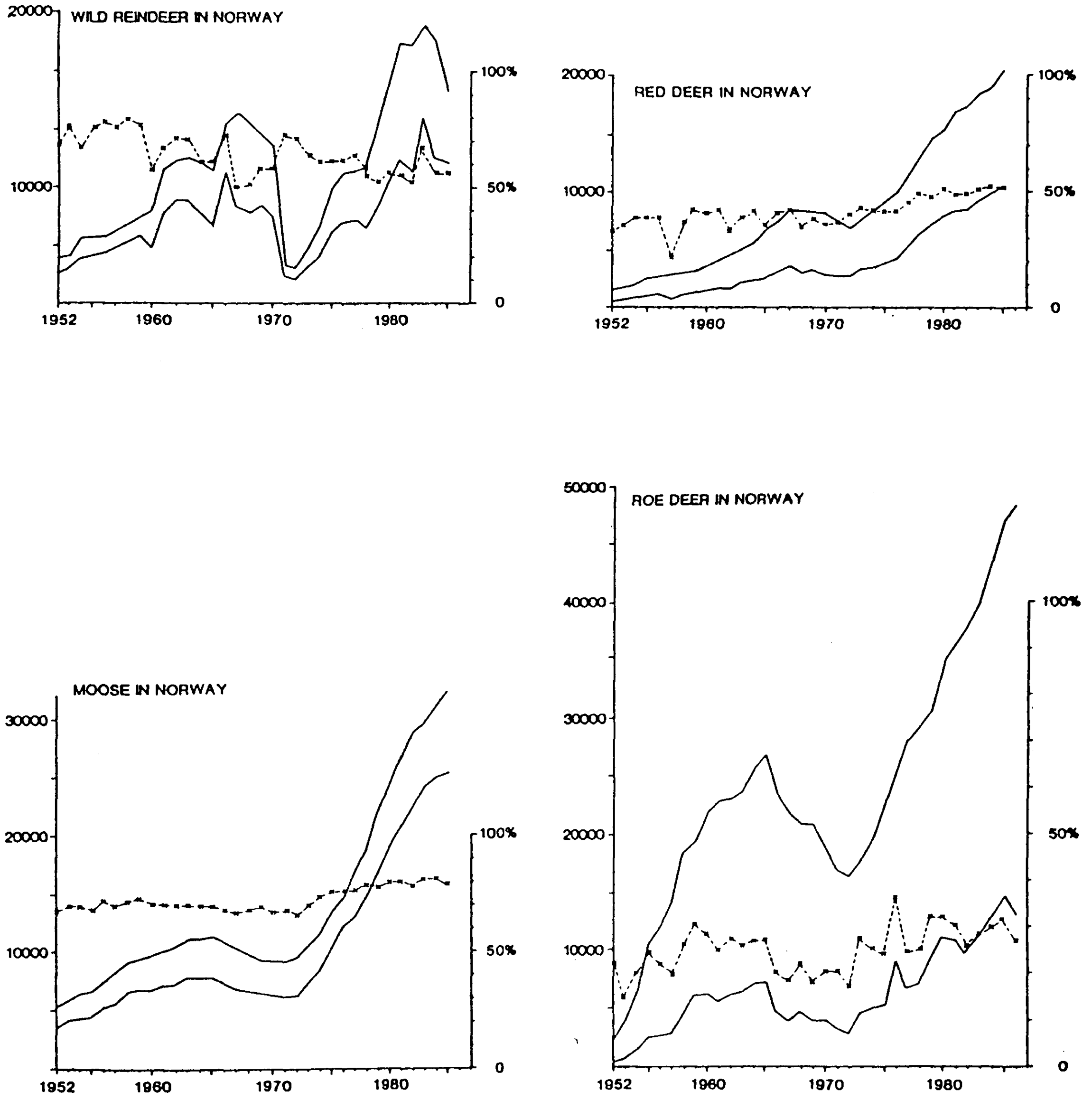

Figure 1. Game statistics on cervids in Norway. Bottom line: yield, upper line: number of hunting licenses issued. The broken line is yield as a percent of the number of licenses (yield percent). Based on data by Statistisk Sentralbyrå (1978, 1986, pers. comm.).

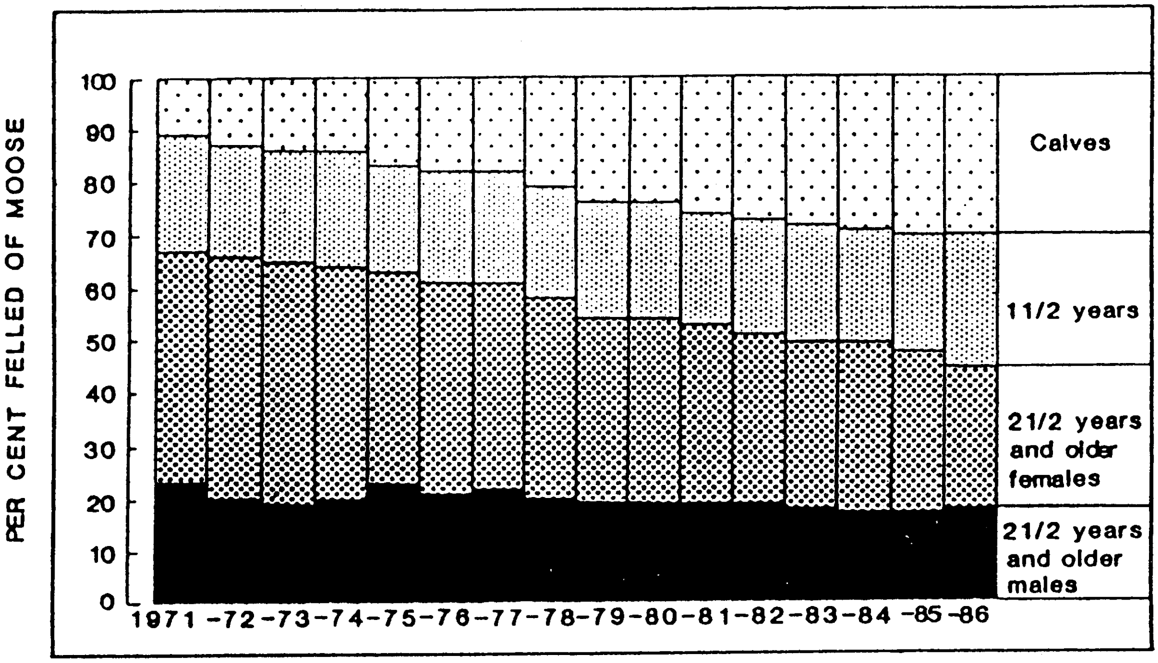

Figure 2. The distribution of moose killed in Norway according to sex and age classes (Statistisk Sentralbyrå 1986, pers. comm.).

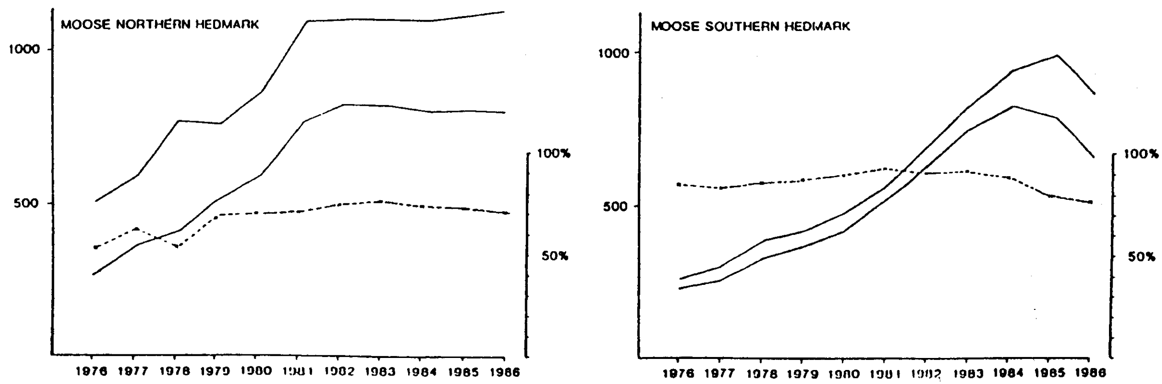

Figure 3. Game statistics on moose from two areas in southern Norway. (Symbols as in Fig. 1). Data provided by Fylkesmannen in Hedmark (pers. comm.).

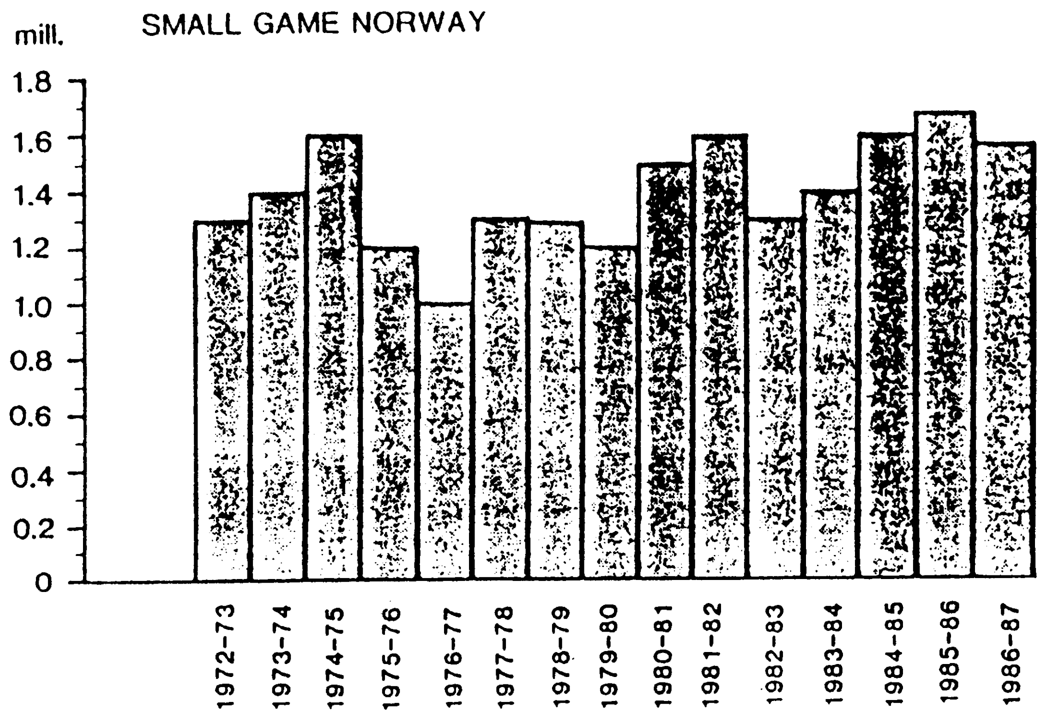

Figure 4. The annual number of individuals killed for all small game species in Norway (Statistisk Sentralbyrå 1986, pers. comm.).

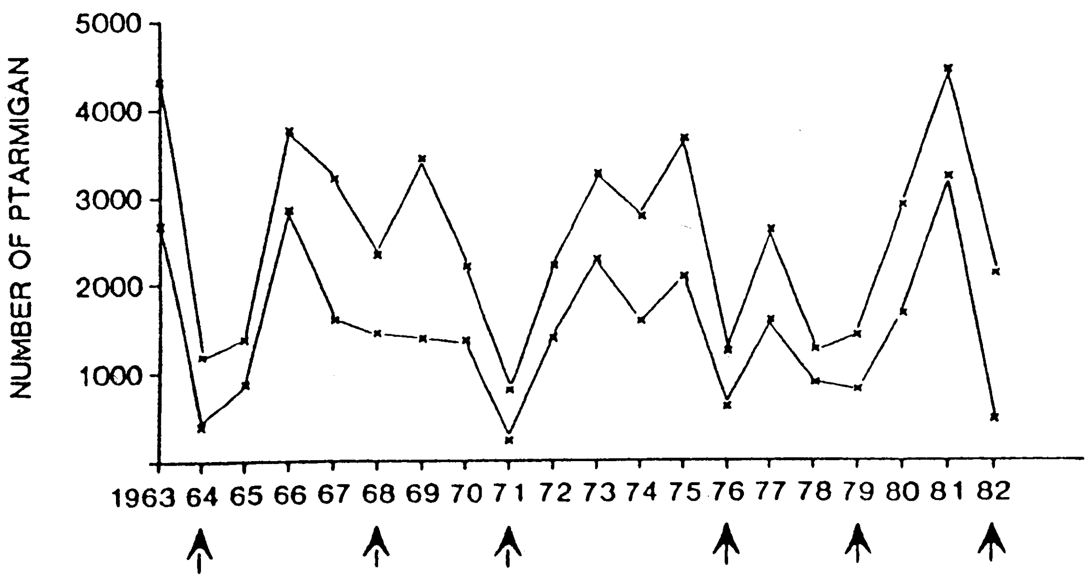

Figure 5. The number of ptarmigans (*Lagopus* spp.) killed in the Meråker municipality (upper line) 1963-82. The bottom line indicates the number of young ptarmigans killed, based on the age composition in samples. The arrows below the x-axis indicate rodent «crash years» (years with conspicous population declines). Data provided by H.I. Lund Tangen (pers. comm.).

SUMMARY

7 - GAME STATISTICS AS INDICATORS OF POPULATION SIZE AND COMPOSITION

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Official hunting statistics in Norway report, when relevant, the number of individuals of the different game species shot, the number of licences granted, the composition of the yield regarding sex and main age groups, and the number of hunters with any yield. Yield and bounty statistics are fairly representative of the main rate of variation in common small game and predatory species with marked, short term (cyclic) population fluctuations, but are poorer indicators of general changes in population levels. Kill statistics for some larger mammals, including great carnivores, reindeer *Rangifer tarandus* and roe deer *Capreolus capreolus* indicate major changes in population levels. However, for reindeer, changes in the number of hunting licenses being granted largely determine the size of the yield. Hunting statistics may in some cases also include observations made by hunters during the hunt (e.g. the number of moose *Alces alces* seen). «Moose seen», as well as yield statistics, tend to show a time-lag in relation to actual changes in the population. These statistics should be supplemented with data on age, body growth rates and reproduction in order to obtain an adequate picture of the composition and «quality» of the population.

RESUME

7 - LES STATISTIQUES DE LA CHASSE EN TANT QU'INDICATEURS DE L'IMPORTANCE ET DE LA COMPOSITION DES PEUPLEMENTS ANIMAUX

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Document soumis par la Direction de la gestion de la nature, Division de la recherche, Norvège.

Les statistiques officielles de la chasse en Norvège indiquent, le cas échéant, le nombre de pièces de gibier abattu par espèce, le nombre de permis accordés, la composition des tableaux par sexe et principaux groupes d'âge, et le nombre de chasseurs ayant abattu du gibier. Les statistiques du gibier abattu et capturé rendent assez fidèlement compte du rythme dominant de variation des populations d'espèces communes de petits animaux et de prédateurs qui connaissent des fluctuations prononcées de courte durée (cycliques), mais sont de médiocres indicateurs des modifications générales de l'importance des peuplements. Les statistiques des tableaux de chasse de quelques grands mammifères, notamment les carnivores de grande taille (renne *Rangifer tarandus* et chevreuil *Capreolus capreolus*), révèlent les variations substantielles de leurs effectifs. Cependant, pour les rennes, le nombre des permis de chasse accordés détermine dans une large mesure l'importance des prises. Les statistiques cynégétiques peuvent aussi inclure, dans certains cas, des observations faites par les chasseurs durant leurs sorties (par exemple le nombre d'élans *Alces alces* aperçus). Les statistiques des «élans observés» ainsi que celles des prises font généralement apparaître un décalage chronologique par rapport aux variations effectives des peuplements. Aussi ces statistiques devraient-elles être complétées par des données sur l'âge, la vitesse de croissance physique et les taux de reproduction pour donner une image représentative de la composition et de la «qualité» des peuplements.

Резюме

7 - СТАТИСТИЧЕСКИЕ ДАННЫЕ ОБ ОХОТЕ В КАЧЕСТВЕ ПОКАЗАТЕЛЕЙ РАЗМЕРА И СОСТАВА ПОПУЛЯЦИЙ

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Официальные статистические данные об охоте в докладе Норвегии, там где это необходимо, включают количество отдельных рас отстрелянных диких животных, количество выданных лицензий, состав ловла по признаку пола и по основным возрастным группам и количество охотников с любой добычей. Статистические данные о добыче охотников и дарах природы являются довольно репрезентативными в отношении основного ритма вариации в общих видах небольших диких животных н хищников с явными краткосрочными (циклическими) колебаниями популяций, но более бедными показателями общих изменений в размерах популяции. Статистика отстрела некоторых более крупных млекопитающихса, включая крупных хищников, северных оленей Рангифер тарандус и косуль Капреолус капреолус указывает на крупные изменения в размерах популяций. Однако для северного оленя изменения количества выданных лицензий на охоту в значительной степени определяют размер добычи. Статистика охоты может в некоторых случаях также включать наблюдения, сделанные охотниками в ходе охоты (например, число встреченных американских лосей Алцес алцес). В статистических данных о численности ""встреченных американских лосей"", а также о добыче, как правило, наблюдается временное отставание по отношению к фактическим изменениям в популяции. Эти статистические данные следует дополнять данными о возрасте, темпах роста тела и воспроизводстве для получения адекватной информации о составе и ""качестве"" популяции.

8 - VEGETATION AND AIR POLLUTION - SPATIAL AND TEMPORAL ASPECTS OF SAMPLING IN ENVIRONMENTAL MONITORING

Author: Sven Brakenhielm

Paper submitted by the Environmental Protection Board, Sweden.

1. THE SWEDISH ENVIRONMENTAL MONITORING PROGRAMME

1.1 *Background*

In Sweden local environmental or «recipient» monitoring near polluters is performed at the cost of the polluter himself whether he is a private person, an industry or a municipality. However, years ago nobody was responsible for monitoring the effects of long-transported atmospheric pollution in remote areas, far away from the emission source. The past few decades have shown that these effects may be as disastrous as those near the source. Generally also we know too little about the normal behaviour of the natural and man-influenced ecosystems to be able to tell what is or is not an alarming change. There is a growing demand, too, for reference data from remote areas when estimating the impact of local air pollution.

Against this background the Swedish National Environmental Monitoring Programme (PMK) was decided on by Parliament in 1977 to be started in 1978 under the auspices of the Environmental Protection Board (Monitor 1985). Its main objectives are:

— to monitor long-term, large-scale environmental changes;

— to collect data on ecosystems, little influenced by man, as reference to other areas;

— to map transport routes of pollutants in and between air, land and water ecosystems.

The PMK now has monitoring activities in air, on land, in freshwater and in the sea. In practice, the aims mentioned above imply that in terrestrial areas the programme is mainly directed towards air pollution and atmospheric changes, e. g. rise of CO_2 from fossil fuels, and their effects on natural ecosystems. The land section conducts monitoring in about twenty areas all over the country, situated along climatic, altitudinal and pollution gradients. These areas are protected as national parks and nature reserves from such direct human impact as forestry, agriculture and grazing by cattle. They contain alpine, forest and wetland natural ecosystems in small watersheds about one Km^2 in size. In them atmospheric deposition, vegetation, soil, ground and surface water, birds, small mammals and persistent contaminants are monitored permanently.

1.2 *Vegetation monitoring - a new activity*

The vegetation subprogramme has been established in most of the reference areas from 1981 to 1986. This is the subprogramme which, along with the soil programme, has the smallest body of experience behind it. Therefore the two still have somewhat the character of pilot programmes under development. As for the vegetation programme it is extremely useful, now that six observational seasons have passed and data have accumulated, to be able to submit it to critical analysis from different points of view, not least the statistical one.

2. LAYOUT OF THE VEGETATION SUBPROGRAMME

After six years, the vegetation subprogramme has stabilized and gained some experience. The vegetation compartments and main variables included into it as well as some characteristics that could be of general interest will be listed below.

2.1 *Vegetation compartments and variables included*

The vegetation subprogramme could be characterized as having a broad scope both as to vegetation compartments included and the time scale planned for (Brakenhielm 1979). After a pilot year in 1981, the programme virtually achieved its present form in 1982, although some variables have been changed or added. At the establishment of a new area, a report with a description of the plant communities and the land-use history is written. The following main parts of the vegetation are now being observed in the programme (Figure 1):

— *Plant communities* are mapped at low frequency (ca 20 years) along taxation lines.

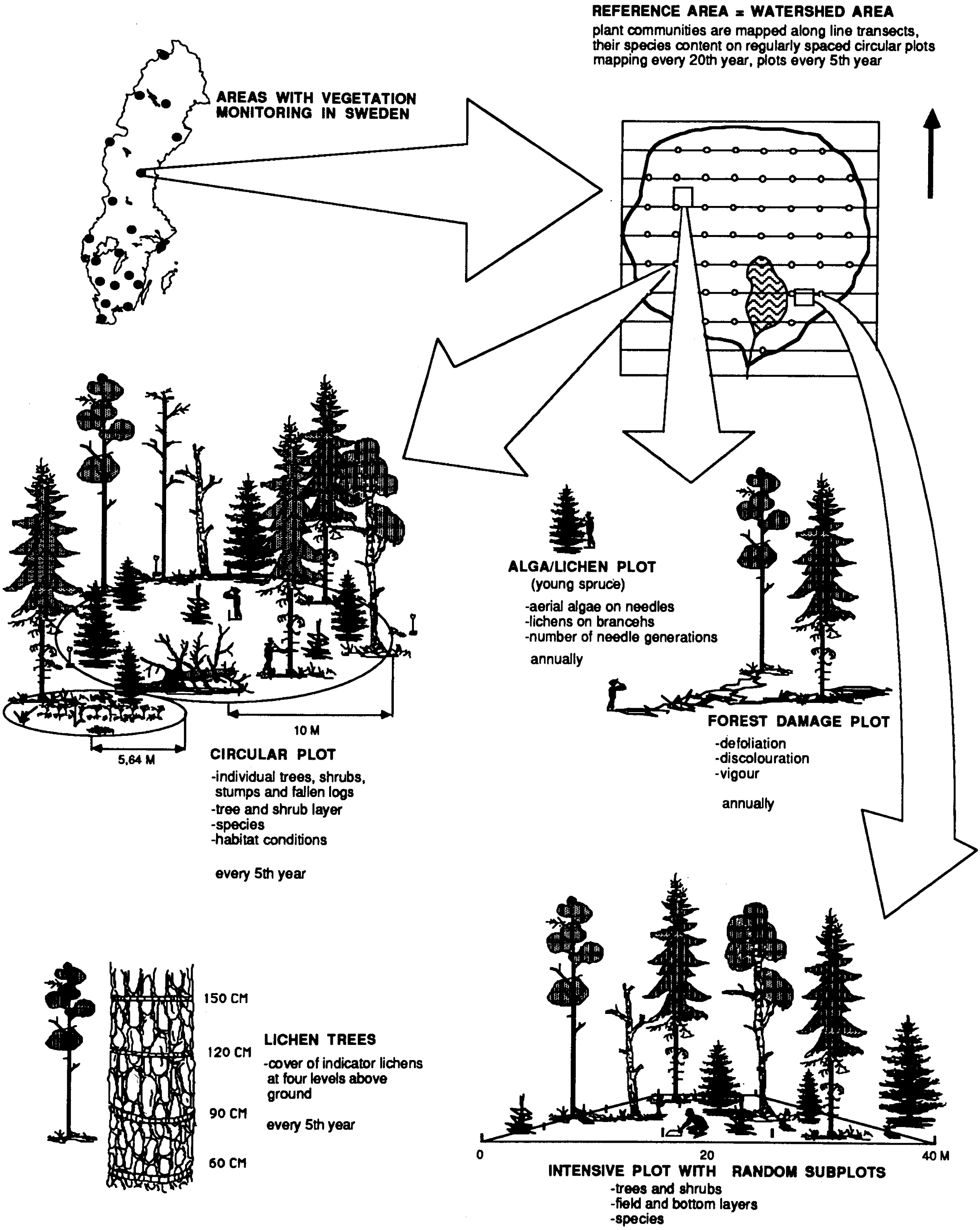

Figure 1: Design of the PMK vegetation monitoring.

— *Vegetation layers* are observed by cover on circular plots distributed along the taxation lines at medium frequency (5 years). They are the tree, shrub, field and bottom layers, the last one consisting of bryophytes and lichens. The field and bottom layers are followed on so-called intensive plots at high frequency (1-5 years).

— *Populations* of all species living on soil including trees and shrubs, except fungi and soil algae, and their cover and fertility (realised sexual reproduction) are observed both on circular and intensive plots. Plants on extreme substrates such as rocks, stumps and logs are excluded.

— *Indicator lichens* of selected species are recorded as to cover and vitality on tree trunks at medium frequency (5 years).

— Defoliation and damage to *conifer crowns* are observed on circular plots at medium frequency (5 years) and on intensive plots at high frequency (1 year).

— *Aerial algae on needles and lichens on branches of young spruce* are observed as to thickness, cover and rate of colonization, at high frequency (1 year). The age of needles is also recorded.

2.2 *Some characteristics*

— *Capacity for permanent observations:* The programme was designed within the stable framework of the PMK so as to run permanently under changing personnel and with an ever-increasing amount of data. Care is taken so that the vegetation studied is not disturbed unduly. Measures in those directions include care in the selection of observers, training and calibration of new ones, a clear and pedagogic field manual, selection of simple and robust field procedures (e. g. Strayer et al. 1986), non-destructive sampling, trampling discipline measures on the plots, and a flexible data handling system. Yet trampling damage has been noted to understorey vegetation on some types of plots with sensitive vegetation. Measures are being taken to counteract it, e. g. by adopting separate plots for tree defoliation and understorey vegetation observation and by increasing the intervals between the visits.

— *Comparable sites:* Plant communities in different parts of the country were selected so as to be comparable with one another. For example the Norway spruce-Scots pine blueberry community is represented from north to south. There are regional variants of the type, but all have a set of species in common (Figure 2).

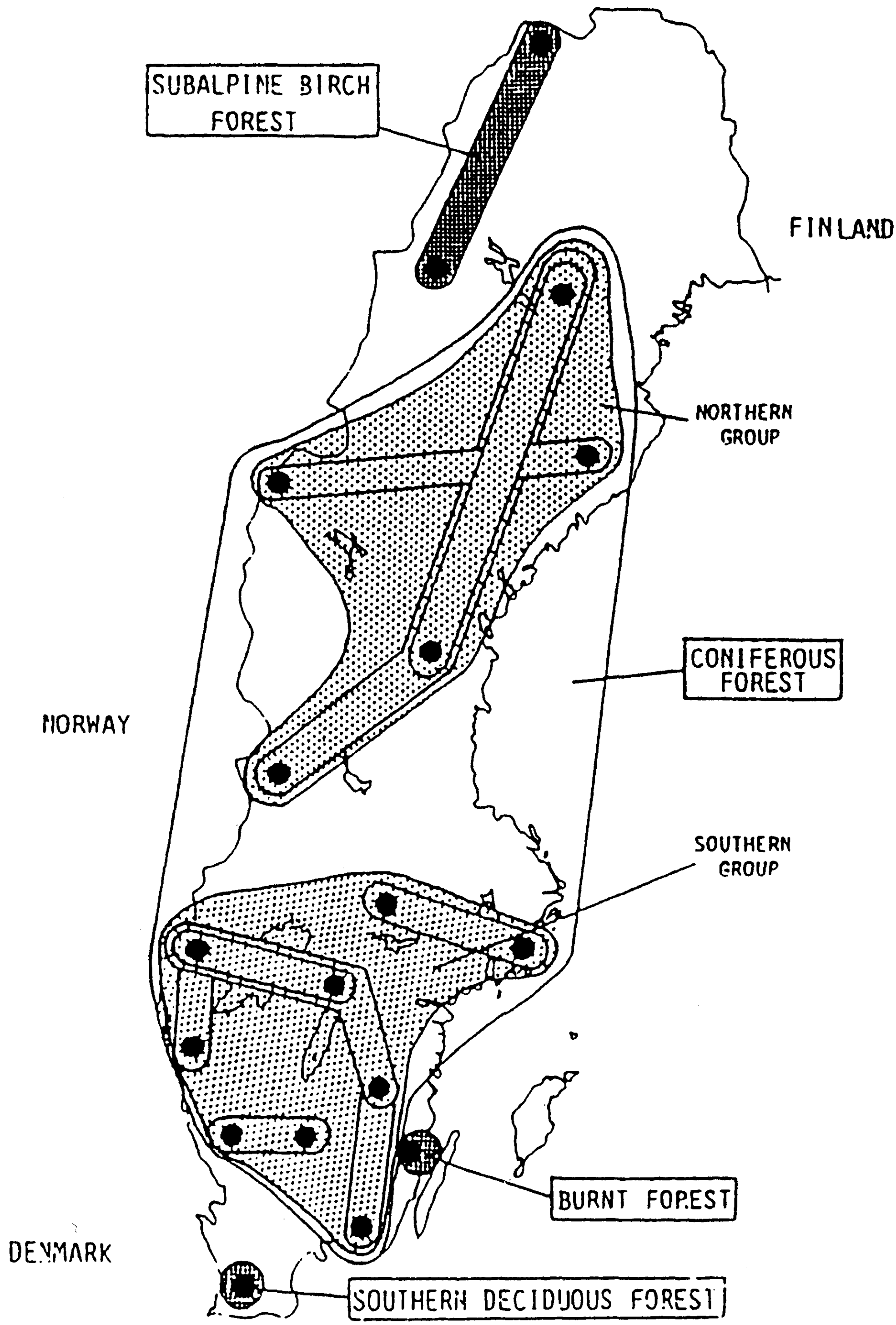

Figure 2. The group structure of understorey vegetation of the PMK reference areas as projected on the map of Sweden. The dots, each representing an intensive forest plot, are hierarchically bundled into groups by contours. The floristic resemblance measured by Jaccard similarity of presence/absence data, fused by weighted pair group method with arithmetic average (WPGMA) and the resulting dendrogram was transferred to the geographical map (Brakenhielm S. and Hajdu L. in preparation.)

— *Indicators of atmospheric changes:* Since it is impossible today to tell which plants will be good indicators in the future, all plant species that can reasonably be determined in the field are included. They are supplemented by some special species and plant parts that have been established as indicators. Plant communities and vegetation layers may also indicate changes on a large scale and are therefore part of the set of indicators.

— *Standardized design and procedures:* The plot configuration and variables are the same in all the reference areas. This proved to facilitate the training and orientation immensly and helped avoid confusion. For example the subplots of all intensive plots are laid out according to the same stratified random pattern (Figure 3).

— «*Service variables*»: Some of the variables must be selected mainly for the reason of giving basic information and data to the other subprogrammes of the PMK, keeping in mind that the whole programme is integrated and based on the ecosystem concept. For example information on vegetation structure, including the tree canopy, is a prerequisite to understand the distribution of atmospheric deposition in a watershed area.

— *Objective independent sampling:* While selection of areas and some of the sample plots and trees are based on subjective judgement, the detailed sampling of variables is objective. Thus the circular plots are sited systematically along the line transects at regular intervals and the subplots of the intensive plots are placed by stratified random sampling. Nor is any estimate permitted to be influenced by earlier estimates on the same plot. Therefore observers are told not to look at the completed field forms from previous observations.

3. SOME STATISTICAL CONSIDERATIONS

3.1 *Sampling design and precision of population estimate*

By combining a regular grid of circular plots all over the area with «intensive» plots (Figure 1) it is possible to keep record of both minute details of plant dynamics and greater changes. Also it is possible to assess the representativity of the intensive plots for the area as a whole. By this design e.g. in forest areas it should be possible to keep record of storm — and insect — generated gaps in the canopy. In many forest types this is the natural way of regenerating the tree stand where fire is not present.

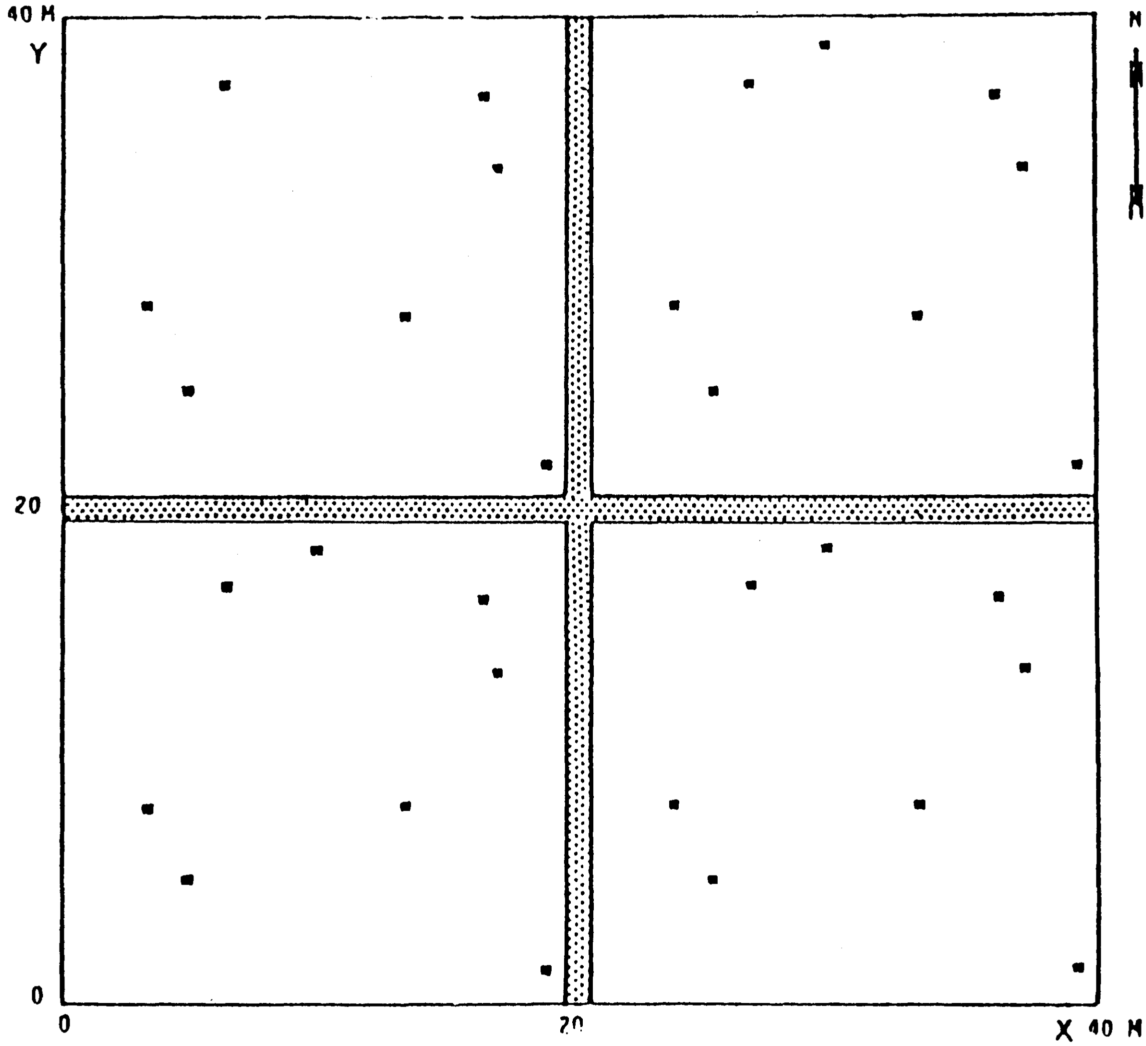

Figure 3. Standard design of the intensive vegetation plot (40x40 m) for trees, shrubs, and understorey vegetation. Trees and shrubs are followed on the whole plot, field and bottom layers on 16 or 32 subplots (0.5x0.5 m). The number of subplots depends on species richness and homogeneity of the plant community sampled. The central hatched cross is a trampling corridor.

Among plant ecologists the so-called species/area curve is often used to determine whether the sample size is adequate to cover the species content of a community (Kershaw 1973). The cumulative number of species added by each new part in a set of so-called nested plots is plotted against the cumulative area. When the species number curve has flattened out, the plant community sampled could be said to be adequately sampled. This procedure could be applied also where one has a number of subplots on a large plot, such as the circular plots in the whole area (Figure 4 top) or the subplots on the intensive plot. Another procedure is to plot the running mean of a variable against the number of subplots added (Figure 4 bottom) (Kershaw 1973). The sample is considered adequate when the curve exhibits no further great changes. As routine for several variables 95% confidence limits are computed in order to give an idea of the precision of the estimate (Figures 5 and 6).

3.2 *Training*

In a programme with observation of vegetation characteristics, where many of the variables are more or less subjective, the training of observers must be a recurring procedure. The most important single variable in PMK-vegetation is cover of plants defined as the vertical projection of all visible living plant parts against the ground.

The PMK observers are trained both by gathering just before the field season doing estimates together on training plots and by the «calibrator» travelling around and visiting the observers on their sites. During the field visit the «calibrator» and the observer make independent estimates, the results of which may be presented in a scatter diagramme (Figure 7) indicating the position of the observer relative to the «calibrator». Most of the PMK observers during one season were close to the «calibrator», but a few of them deviated clearly and systematically and were therefore subject to further training efforts.

3.3 *Data handling*

The data of the PMK vegetation subprogramme are transferred to magnetic tape at the Environmental Quality Laboratory of the Environmental Protection Board in close cooperation with the programmer involved. They are stored in the university computer centre at Uppsala where they are professionally handled. They are activated once a year, after the fresh data of the year have been added. The total volume of

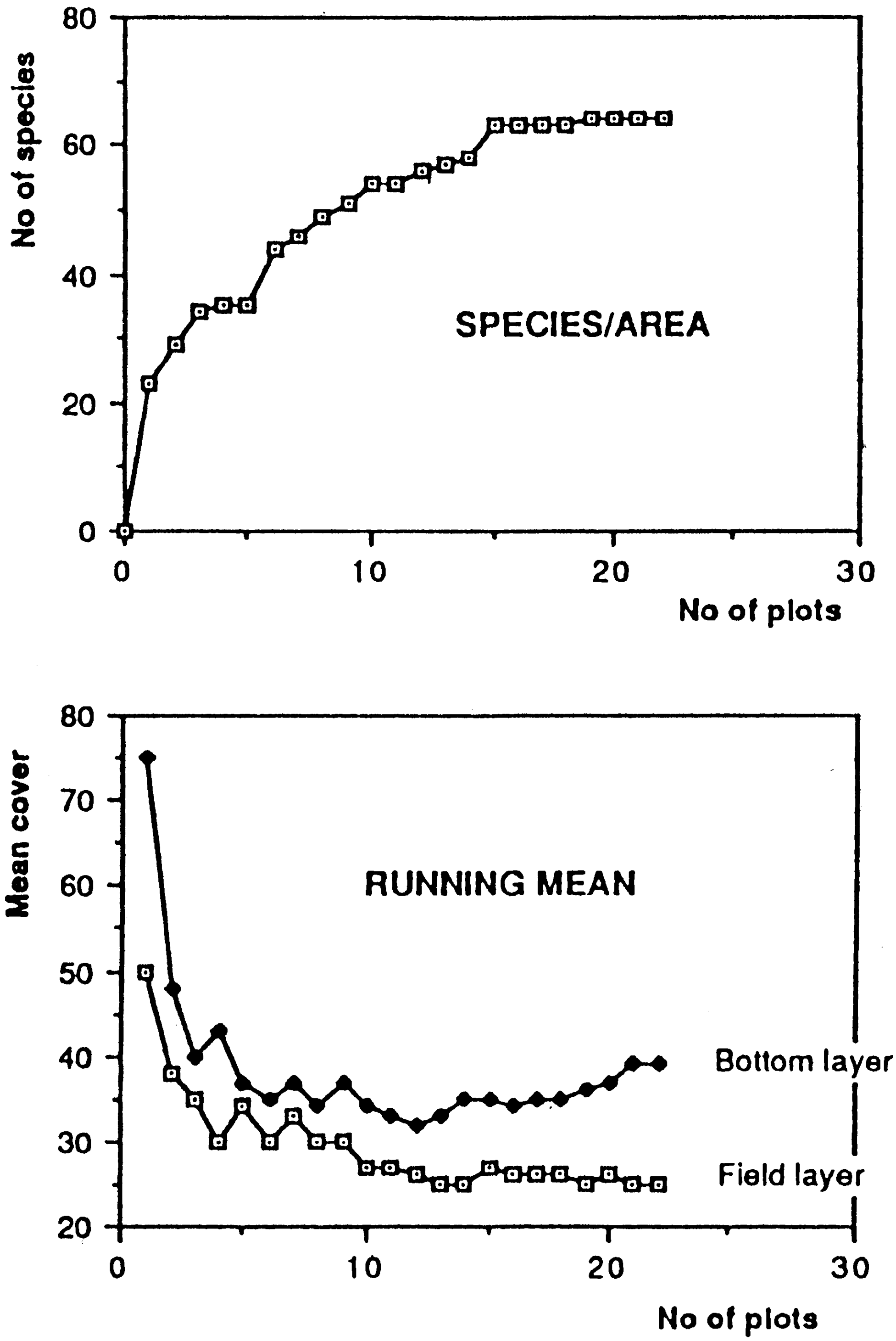

Figure 4. Species/area curve (top) and running mean of cover (bottom) in the field and bottom layers of 22 circular plots in a mixed conifer-blueberry community in the Tiveden reference area. The species/area curve roughly indicates adequacy of species sampling. The running means indicate that the field layer may have been adequately sampled while the bottom layer should need some more plots.

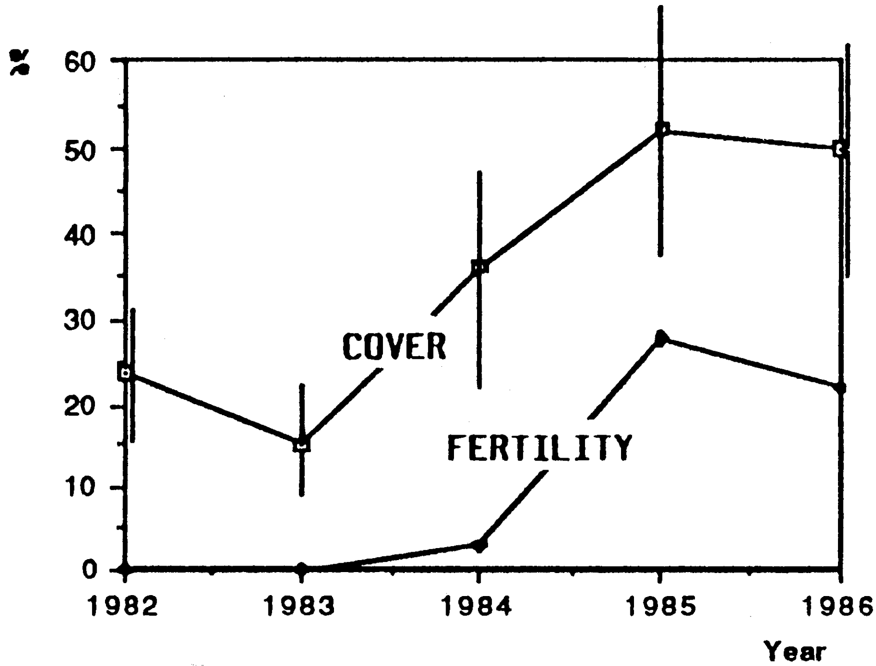

Figure 5. Cover and fertility of blueberry (Vaccinium myrtillus) during five years on an intensive plot in Vindeln, northern Sweden. The small cover and low fertility in 1982 and 1983 were caused by insect larvae feeding on the leaves and flower buds. The 95% confidence limits of the mean cover are indicated by vertical lines.

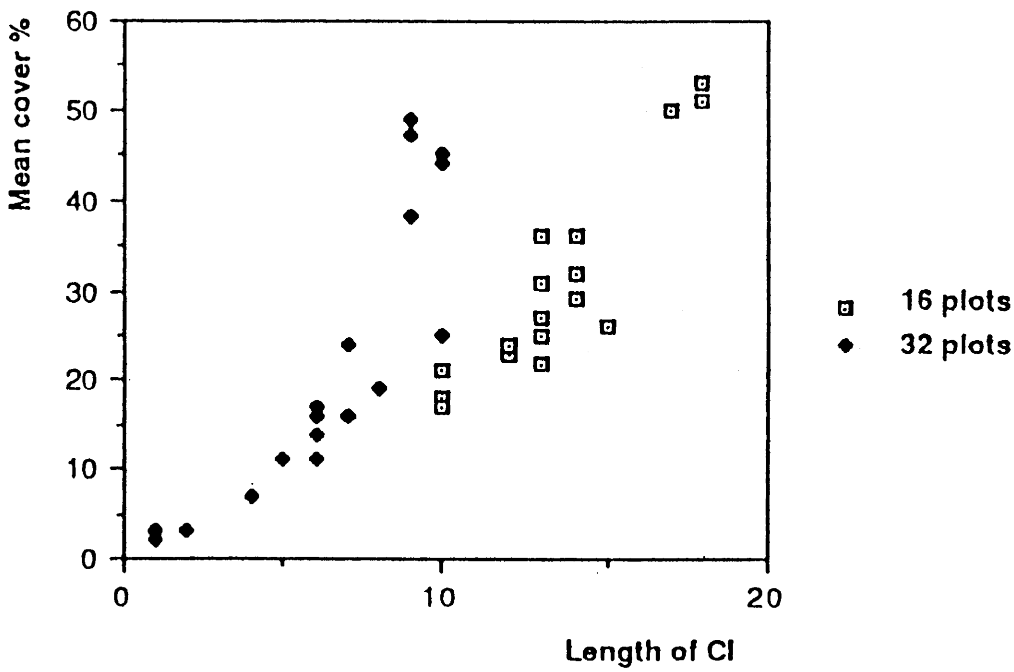

Figure 6. Mean cover of several species on five intensive plots plotted against the length of the 95% confidence intervals of the means. Two swarms of points appear — one from intensive plots with 16 subplots, the other from plots with 32. The positions of the swarms indicate, as could be expected, that the 32 subplot sample has higher precision than the 16 subplot one.

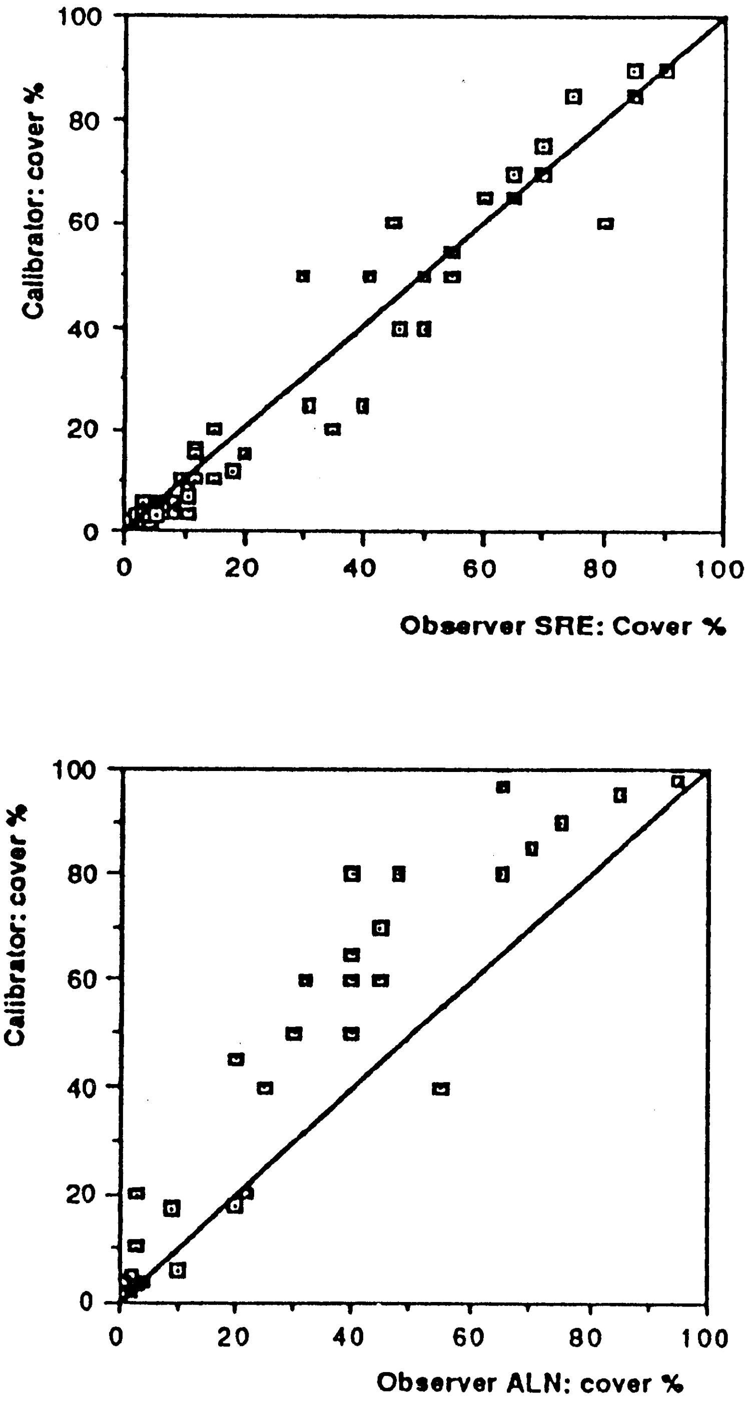

Figure 7. Cover estimates of various species and layers by the «calibrator» and two different observers on intensive plots. The estimates of observer SRE (top) coincided very closely with those of the «calibrator». Observer ALN (bottom) deviated systematically from the «calibrator», almost all his estimates being lower. ALN who is an experienced estimator was on this occasion fresh in the PMK vegetation. The graphs further indicate that both low and high cover values are estimated more precisely than medium ones.

data of this broad programme grows rapidly. The mass of primary data is concentrated into a handy size in two ways. One is to use mean values on different levels, thereby also levelling out local extremes. The other is to analyze and present only those time series that show significant changes through time.

Simple computation methods and untransformed data are preferred to more sophisticated procedures. The main reason is that in data handling it is easy to get lost if one deviates far away from the basic parameters observed. At presentations simple and illustrative graphics are generally used. However, advanced classification and ordination methods are on occasion applied in order to obtain an overview of the great mass of species and plots that are included (Figure 2).

3.4 *What to call the changes?*

All plant populations and plant communities in natural ecosystems are subject to fluctuations of various nature and duration. It is apparently a matter of time scale what you choose to call a change, whether you consider it a trend, a cycle or a fluctuation (Figure 8). A good rule could be to try and get to know which dynamics in the community are caused by the life processes of the dominant organism or organisms. In most PMK communities they are trees which, by human standards, have long life spans. Therefore the analysis of community change should, for all forest areas, in some way be related to the dynamics of the tree stand.

What should be called a trend or something else is a matter of spatial scale as well. The old natural spruce-dominated forests of the PMK areas are mainly a mosaic of patches, each being on some stage of succession or cyclical change depending on some local «disaster» in the past. These events usually include drought, windthrow, snowbreak, fire, grazing by wildlife and attacks by insects or fungi. In some pine-dominated areas there is a slow, long-term development towards spruce dominance in the absence of fire. In the event of a fire, the cycle will start afresh with initial pine dominance and terminal spruce dominance. On a «shorter-term» basis, e.g. about 100/200 years, this change appears to be a long-term trend. On a longer-term basis it looks more cyclical.

3.5 *Natural versus anthropogenic dynamics*

In order to be able to sort out what changes in a reference area are natural and what are anthropogenic, a set of approaches has been adopted:

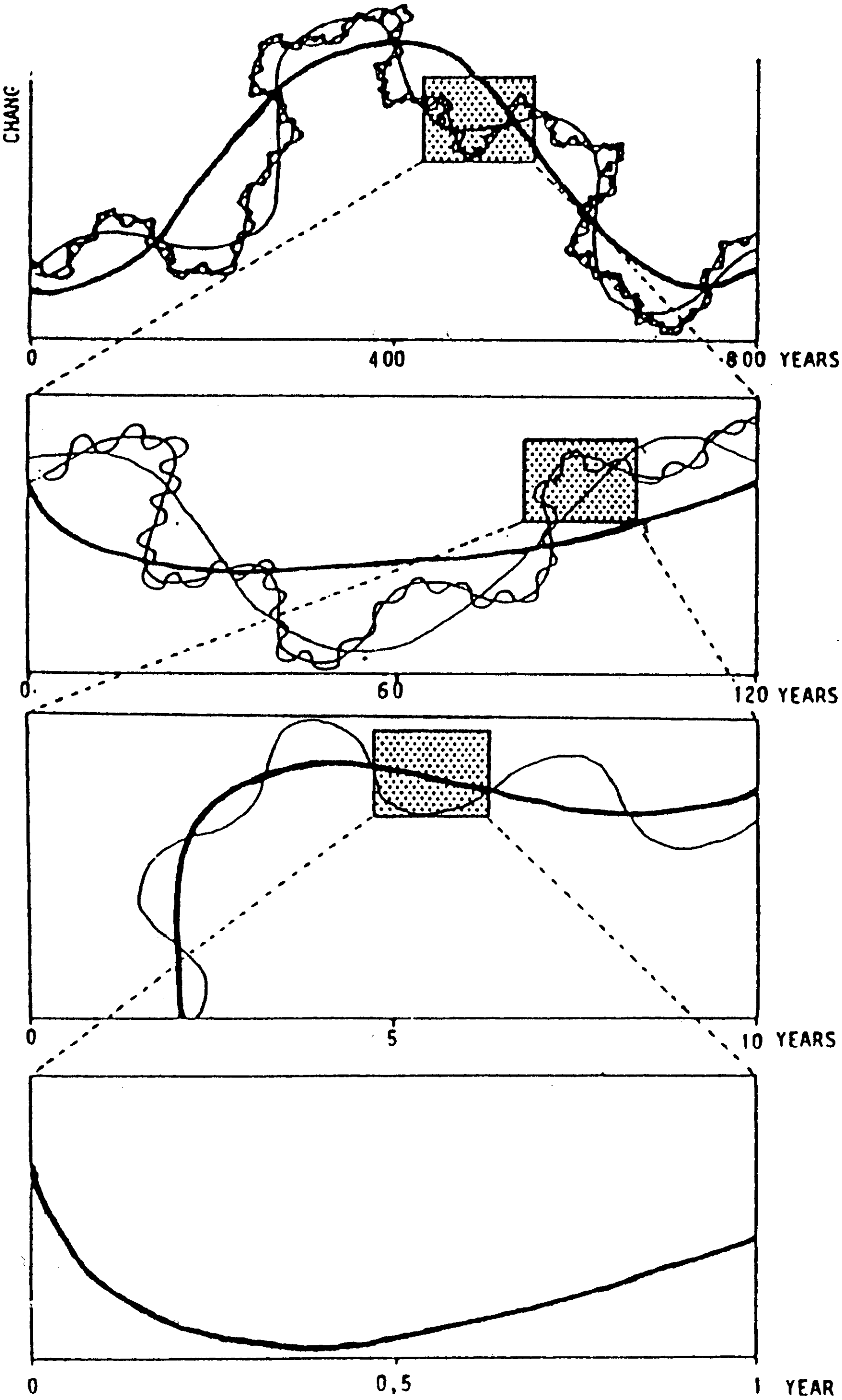

Figure 8. Cyclical change in a biological variable as viewed on different time scales. What appears to be a significant, «alarming» change in a short perspective is just one of several small cycles in the long perspective. The long cycles from the curve next above cannot be perceived during a short-term study and have therefore been omitted from the curve beneath.

First, generally accepted *pollution indicators* may be present on the site and, by their behaviour, reveal that anthropogenic changes are taking place. This approach is particularly valuable during the first monitoring phase, before information on natural dynamics has accumulated. However, so far few wild plants have become «authorized» indicators.

Second, in the PMK, one has access to data from the *other subprogrammes* in the search for factors supporting or rejecting one's own hypotheses. It is very expedient that those data concern both effects on living organisms and concentrations of elements in them and in their environment. Thus distribution of tree stem lichens (Figure 9) and spruce needle algae (Göransson 1986) are fairly well correlated with deposition of SO_4 and NO_3 compounds respectively as measured by the air and precipitation chemical network of the PMK (Granat 1987).

Third, in order to help understand the causes of dynamics it is important to note all *events* that do take place, particularly if they are irregular. Therefore, in the vegetation subprogramme, records of «soft data» are kept, i.e. vestiges of various events in the field. They are then used as an information when changes are analyzed. An example is the almost complete grazing by caterpillars of blueberry (Vaccinium myrtillus) leaves in 1982 and 1983 on a site in Northern Sweden (Figure 5). A problem is that the observer usually only visits the site once a year in summer.

Fourth, important sources of information are *national and regional* and to some extent also *local impact studies*. They may provide complementary or corroborative information of various kinds. A couple of relevant examples concerning forest are mentioned under *3.6.* The National Forest Survey and various recipient studies round polluters should be mentioned on the national and the local level respectively.

Combined information on indicators, other PMK subprogrammes, natural events, and national/regional/local studies may render the vegetation monitoring programme truly effective in establishing what are natural and anthropogenic changes and their relative importance. The main current problem in the PMK vegetation is to keep in touch with all those sources with the limited staff afforded.

3.6 *Comparability with other surveys*

The information content of vegetation data from the reference areas is enhanced by the adoption of variables and a plot design comparable with those used in the National Forest Survey, which focuses on tree species composition, tree vitality, timber store and growth. For several years it has also observed many habitat factors of importance to the trees, including understorey vegetation, soil and soil moisture.

The Forest Survey uses clusters of circular plots placed in a regular grid over the forests of the whole country. The sampling is strictly objective. Some of the plots are occasional, others are permanent. The permanent ones are revisited every five years. Thereby comparison between the natural protected forest of the PMK and the managed forest outside becomes relevant as a means of assessing the representativity of the PMK areas and comparing variables indicating air pollution effects (Figure 10).

Another national study of conifer vitality is that of the National Board of Forestry which, through the regional Boards, has established «intensive», subjectively selected, permanent plots all over the country. The PMK-vegetation lately established the same type of plots in addition to the circular ones. They will be observed yearly, while the circular plots will be observed once every five years.

Lately there has been a growing interest in the PMK-vegetation variables in local environmental impact studies. If the PMK is to fulfil its reference function, it is necessary for at least part of its methods and variables to be used outside the reference areas.

4. CONCLUSIONS

In a programme such as the PMK-vegetation, in order to meet the overriding requirements one has to sample adequately both the vegetation and its variation in an area and follow its changes through a very long, in principle indefinite, time. At the establishment spatial considerations prevail and then gradually, as the time series lengthen, the temporal aspect becomes more important. Compared with a one-instance study, the demand on adequacy and completeness of spatial sampling in a permanent monitoring programme need not to be as high. However, it is important not to lose sight of the spatial variation.

Whether the sampling in time of the PMK-vegetation programme is adequate to meet the needs of environmental protection will be gradually revealed in the future. Those variables that are observed with very low frequency will take several decades before they can show any reasonable trend. It is felt that so far at least the spatial sampling in individual reference areas is adequate. Also the yearly observations of some intensive plots and the forest damage and aerial algae plots cannot practically be more frequent. The question is whether the observations can be less frequent without substantial loss of information.

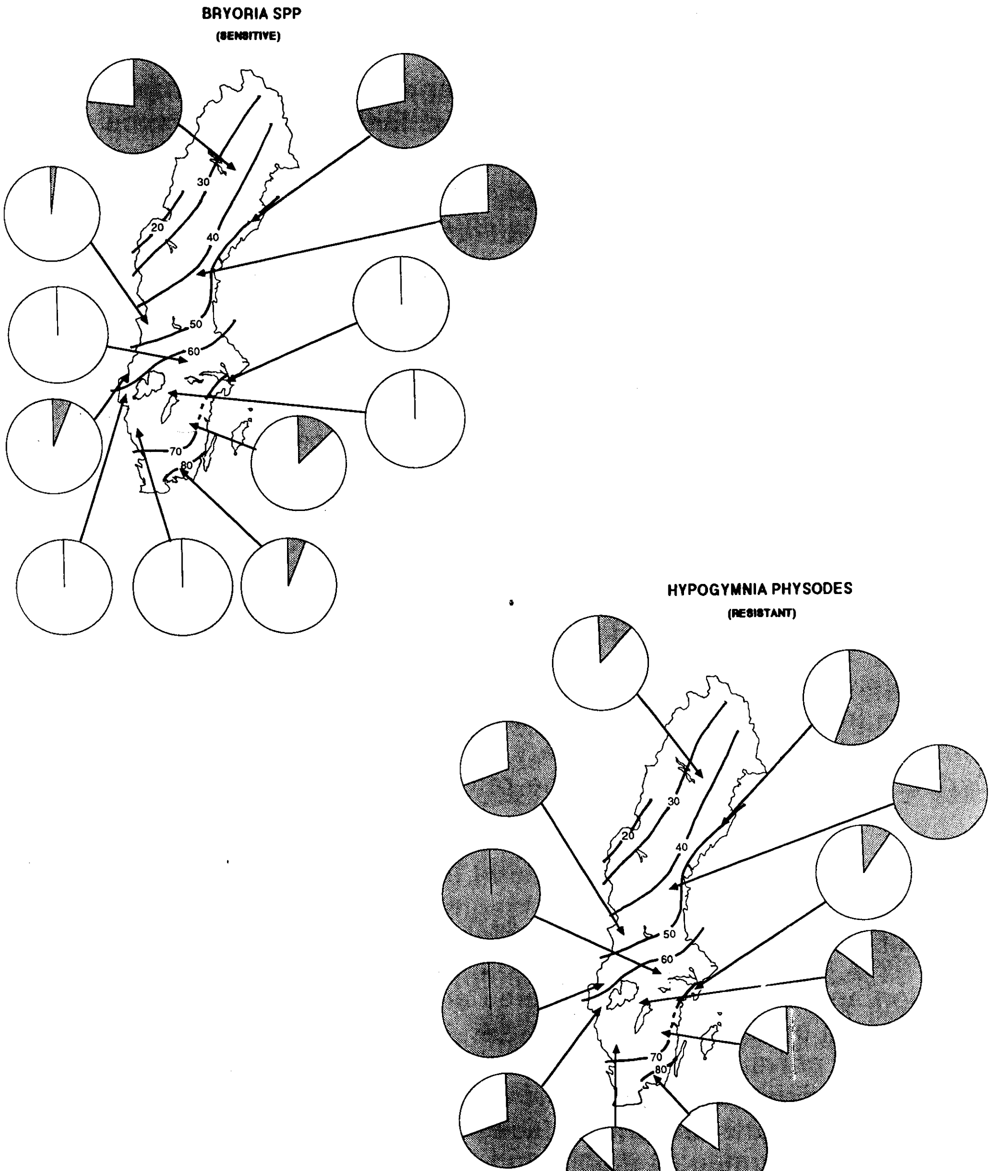

Figure 9. Cover of two epiphytic lichens on Scots pine stems in some of the PMK areas. The areas are situated in a gradient of sulphuric acid measured within the PMK. The isolines represent weighted mean concentration in the 1985 precipitation (Granat 1987). The highest concentration is in the south, the lowest in the northwest. A filled circle indicates cover above 16% of the circumference of the trees, partly filled 15 < 1% and empty circle indicates absence.

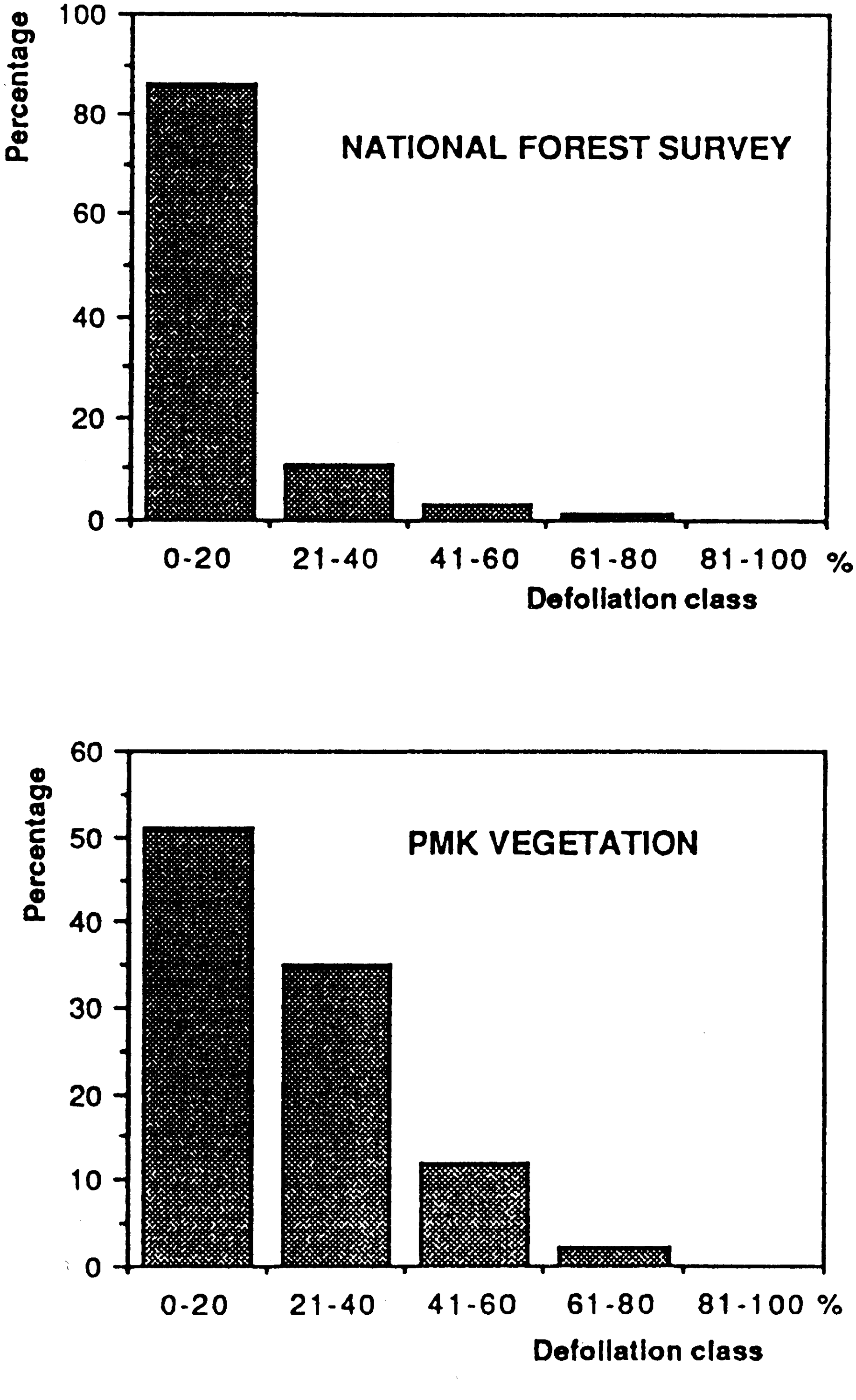

Figure 10. Estimated defoliation of spruce sample trees by the National Forest Survey (top) and the PMK vegetation in 1984, using the same method. Data are from forest region 4 (southeastern Sweden) of the National Forest Survey (Internal report 1987) and the PMK areas in that region (Andersson & Brakenhielm 1985). For several reasons defoliation is higher in the PMK areas. One of them could be that trees with incipient defoliation from old age are removed from managed forests, but not from the protected PMK areas.

Acknowledgement

I wish to thank Mrs Eva Elvers and Mr Bo Justusson at the Statistics Sweden for the initiative of this paper. They also suggested topics of presumed interest to a gathering of ecologists and statisticians. Mr Justusson and Mr Thomas Polfelt, the latter also at the Statistics Sweden, have acted as statistical advisers during the development of the PMK vegetation and for this I wish to express my gratitude.

Sven Brakenhielm

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SUMMARY

8 - VEGETATION AND AIR POLLUTION - SPATIAL AND TEMPORAL ASPECTS OF SAMPLING IN ENVIRONMENTAL MONITORING

Author: Sven Brakenhielm

Paper submitted by the Environmental Protection Board, Sweden.

1. **Background**

The Swedish National Environmental Monitoring Programme (PMK) was decided on in 1978. Its main objectives are:

— to monitor long-term, large-scale environmental changes;

— to collect data on natural ecosystems, little influenced by man, as a reference to other areas

The terrestrial branch of the PMK conducts monitoring in about twenty protected reference areas all over the country, situated along climatic, altitudinal and pollution gradients. They contain natural ecosystems with alpine, forest and wetland vegetation in small watersheds about one Km^2 in size. In them atmospheric deposition, vegetation, soil, ground and surface water, birds, small mammals and contaminants are monitored permanently.

The vegetation subprogramme, which started in 1981, rests on some basic principles:

— sample that covers most of the variation in the watershed area

— as broad an approach as possible within the budget limits as to vegetation indicators; several vegetation levels are represented: communities, layers, species, populations, individuals, organs

— variables/indicators that are both sensitive, basic and robust

— some variables should be comparable to those of the National Forest Survey which makes routine observations on a regular national grid with several thousand sample plots in forest; thus the representativeness for the region and the country as a whole may be assessed

— simple and practical sampling design

— routines, staff recruitment, variables and data treatment and storage that permit permanency — data of at least 200 years must be envisaged.

2. Some indicator variables

Most of the vegetation variables are presently being discussed at a UN/ECE meeting in Sweden with the aim of presenting a recommendation.

The *plant communities* of each area are mapped at low frequencies along taxation lines.

The *species populations* and their above-ground biomass are observed on circular plots distributed regularly along the lines.

Defoliation of conifers is observed using the same visual assessment method as that used for forest surveys in several European countries, mainly according to an EEC recommendation manual on forest damage observations.

Some selected *indicator lichens* are observed on permanent sample tree trunks, the method allowing precise observation of changes.

3. Some questions arising

(1) In general one-instance studies of a spatial distribution of phenomena are easier to perform than prolonged ones. As soon as a study tends to be a long-term involvement, problems concerning sample plot marking and description, staff, funding and data storage present themselves.

(2) Some questions discussed that are relevant to the objective are:

— Is the sample adequate-its frequency, number, size and distribution of plots?

— Are the changes observed significant?

— How large are the natural year-to-year and multiannual fluctuations as compared with those caused by atmospheric pollution?

— At what stage can one speak of a long-term trend?

— How to collect and store in an accessible way «soft» information from the field that is necessary for the analysis and evaluation of changes observed?

— How to handle and systematize the steadily growing stock of «hard» data?

RESUME

8 - LA VEGETATION ET LA POLLUTION ATMOSPHERIQUE — FACTEURS ESPACE ET TEMPS DU PRELEVEMENT D'ECHANTILLONS POUR LA SURVEILLANCE DE L'ENVIRONNEMENT

Auteur: Sven Brakenhielm

Document soumis par l'Office de protection de l'environnement, Suède.

1. **Généralités**

La décision de lancer le Programme national suédois de surveillance de l'environnement (PMK) a été prise en 1978. Les principaux objectifs de ce programme étaient les suivants:

— surveiller les variations à long terme et à grande échelle de l'environnement;

— recueillir des données sur les écosystèmes naturels peu influencés par l'homme, qui puissent servir de référence par rapport à d'autres zones.

Sur le plan de l'environnement terrestre, le PMK assure une surveillance dans une vingtaine de zones de référence protégées réparties dans l'ensemble du pays et situées le long de gradients climatiques, d'altitude et de pollution. Ces zones contiennent des écosystèmes naturels comportant une végétation alpestre, forestière et marécageuse, situés dans des bassins versants peu étendus d'environ un kilomètre carré. Les retombées atmosphériques, la végétation, le sol, les eaux souterraines et superficielles, les oiseaux, les petits mammifères et les contaminants font l'objet d'une surveillance constante.

2. **Quelques variables/indicateurs**

La plupart des variables relatives à la végétation sont actuellement examinées par une réunion de la CEE/ONU organisée en Suède en vue de présenter une recommandation sur ce sujet.

Les *groupements végétaux* de chaque zone font l'objet de relevés à intervalles rapprochés le long de lignes de prélèvement.

Les *peuplements d'espèces* et leur biomasse de surface sont observés à l'intérieur de parcelles circulaires réparties régulièrement le long de ces lignes.

La *défoliation des conifères est observée suivant la même méthode d'évaluation visuelle que celle qui est employée pour les enquêtes sur les forêts menées dans plusieurs pays européens, et qui se fonde pour l'essentiel sur un manuel de recommandations de la CEE concernant la surveillance de la dégradation des forêts.*

Certains lichens indicateurs sont également observés sur des troncs d'arbres servant d'échantillons permanents, ce qui permet une observation précise des variations.

3. **Questions soulevées**

(1) En général, les études ponctuelles de la répartition d'un phénomène dans l'espace sont d'autant plus faciles à réaliser que celles-ci portent sur une longue période. Dès lors qu'une étude tend à se prolonger, des problèmes surgissent en ce qui concerne le marquage et la description des parcelles témoins, le personnel, le financement et le stockage des données.

(2) Le document examine certaines questions ayant trait à l'objectif poursuivi, parmi lesquelles:

— L'échantillonnage est-il suffisant, par rapport à la fréquence des prélèvements et au nombre, à la taille et à la répartition des parcelles?

— Les variations observées sont-elles symptomatiques?

— Quelle est l'importance des fluctuations naturelles enregistrées d'une année sur l'autre et sur des périodes pluriannuelles par rapport à celles qui sont provoquées par la pollution atmosphérique?

— A quel stade peut-on parler d'une tendance à long terme?

— Comment recueillir et stocker de manière aisément accessible des renseignements «informels» provenant d'observations sur le terrain, qui sont indispensables pour l'analyse et l'évaluation des modifications observées?

— Comment gérer et organiser systématiquement le stock sans cesse croissant de données «fixes»?

Резюме

8 - РАСТИТЕЛЬНОСТЬ И ЗАГРЯЗНЕНИЕ ВОЗДУХА ПРОСТРАНСТВЕННЫЕ И ВРЕМЕННЫЕ АСПЕКТЫ ВЗЯТИЯ ПРОБ

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1. ИСХОДНАЯ ИНФОРМАЦИЯ

Решение в отношении национальной программы мониторинга окружающей среды Швеции (РМК) было принято в 1978 году. Её основными целями являются:

- мониторинг долгосрочных, крупномасштабных изменений в охружающей среде;
- сбор данных о природных экосистемах, на которые в незначительной степени повлиял человек, в качестве справочной информации для других областей.
- Наземный отдел РМК проводит мониторинг приблизительно в 20 охраняемых базовых районах по всей территории страны, расположенных в соответствии с градиентами связанными с климатом, высотой и загрязнением. В них содержатся природные экосистемы с альпийской, лесной растительностью и растительностью заболоченных мест в небольших, площадью приблизительно в 1 КМ², водосборных бассейнах. В них постоянно ведется наблюдение за атмосферными осадками, растительностью, почвой, подземными и поверхностными водами, птицами, небольшими млекопитающимися и загрязняющими веществами.

2. НЕКОТОРЫЕ ПЕРЕМЕННЫЕ ПОКАЗАТЕЛИ

В настоящее время большинство переменных, касающихся растительности, обсуждается на совещании ООН/ЕЭК в Швеции с целью выработки рекомендации.

<u>Растительные сообщества</u> каждого района наносятся на карту с низкой частотой в соответствии с таксационной разметкой.

Наблюдение за <u>популяциями видов</u> и их надземной биомассой ведется на круговых участках, равномерно распределенных в соответствии с разметкой.

Наблюдение за дефолиацией хвойных деревьев осуществляется с использованием тех же методов визуальной оценки, что и в обследованиях лесов в некоторых европейских странах, главным образом в соответствии с руководством-рекомендацией ЕКА по наблюдению за ущербом, нанесенным лесу.

Ведется наблюдение за некоторыми выборочными лишайниками-индикаторами на стволах деревьев постоянной выборки - метод, позволяющий вести точное наблюдение за изменениями.

3. НЕКОТОРЫЕ ВОЗНИКАЮЩИЕ ВОПРОСЫ

1) В целом обследования отдельных случаев пространственного распространения явлений проводить легче, чем продолжительные обследования. Как только обследование приобретает долгосрочный характер, возникают проблемы, связанные с разметкой и описанием участков взятия проб, персоналом, финансированием и хранением данных.

2) В числе некоторых вопросов, которые имеют отношение к данной цели, обсуждаются следующие:

- является ли выборка правильной - ее частота, количество, размер и распределение участков?
- имеют ли наблюдаемые изменения важное значение?
- насколько велики естественные, годовые и многолетние колебания по сравнению с колебаниями, вызванными загрязнением атмосферы?
- на каком этапе можно говорить о долгосрочной тенденции?
- как вести приемлемым образом сбор и хранение “чувствительной” информации, полученной с мест, которая необходима для анализа и оценки наблюдаемых изменений?
- каким образом обрабатывать и систематизировать постоянно возрастающий запас “устойчивых” данных?

9 - USE OF BIOCOENOSIS DATA IN WATER QUALITY MONITORING

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Paper submitted by the Water and Environment Research Institute, Finland.

1. Introduction

Monitoring the changes in water quality in a watercourse can be performed through studies on the biotope and/or the organisms living in the water, the biocoenosis.

The state of the biotope can be described by rather simple chemical and physical variables, thus for example, eutrophication may be indicated by phosphorus analyses, acidity shown by pH and alkalinity measurements, etc. Partly for this reason, it is more common to monitor the biotope than the biocoenosis. Monitoring the biocoenosis also requires more versatile professional skills and greater financial resources.

On the other hand, monitoring of the biocoenosis provides more reliable information on the actual effects of loading on the populations of organisms in the watercourse, loading factors being measured as increased concentrations of the biotope. Biocoenosis research can be classified into three groups:

— studies on the population sizes and activity levels of different components of the biocoenosis, e.g. phytoplankton biomass, primary production etc.

— studies of the routes taken by various pollutants in biological chains in water, e.g. mercury in fish, organic chlorine compounds in benthic fauna, etc.

— tests on biological populations, e.g. toxicity testing, AGP-tests, etc.

2. Phytoplankton variables

In monitoring eutrophication of watercourses, the essential factors are the different variables of primary production. The amount of indigenous phytoplankton is commonly used as an estimate of the eutrophication of the watercourse. The easiest way to measure the density of phytoplankton is to determine, directly from the water samples, the content of the photoenergetic pigments, usually chlorophyll *a*. The advantage of the method is the straightforwardness of the analysis, because, as it seems, the biological variable in it can be described accurately by means of chemical determination. The problem is how to calculate an index from the results obtained that might be used as a meausure of eutrophication of watercourses e.g. in environmental statistics. This is due to the fact that the amounts of phytoplankton vary to a great extent, also on a seasonal basis, even in natural oligotrophic water ways. How great a biomass is observed in a lake at a time is dependent on factors such as temperature, lighting, prevailing winds, the contents of nutrients available, the contents of substances with possible inhibitive properties, the number of zooplankton organisms etc. (Wetzel 1975). The plankton community itself also regulates its own growth.

As an index of the phytoplankton, the mean chlorophyll *a* content over the growth season is generally used. This should be determined as a mean of samplings performed frequently enough, but the maximum value of the growth season should also be stated. Based on this procedure, lakes have been classified according to the state of eutrophication and the use of this classification has been recommended (OECD 1982).

Besides the total amount of phytoplankton, the species composition in the phytoplankton is another applicable indicator of eutrophication. Some algae and groups of algae favour watercourses rich in nutrients while others prefer oligotrophic waters. The ratios of these species and groups of species have been utilized to form indices indicating various stages of eutrophication (e.g. Thunmark 1945, Järnefelt 1952, Heinonen 1980). As eutrophication increases, the diversity of the phytoplankton species grows at first, but starts to decline with excessive eutrophication. Such indices are best suited to studies within relatively small geographical areas. For comparisons of larger areas, the indices have proved rather poor indicators. The method is also expensive, as it requires accurate microscopic examination by a well trained person.

In comparison, the primary production of phytoplankton (measured by e.g. radioactive carbon method) is a rather poor determination from the point of view of monitoring. It describes the production process which is dynamic and changes rather quickly (Vollenweider 1969). It might be economically impossible to obtain sufficient observation data.

3. Periphyton as an indicator of eutrophy

The initial stage of eutrophication in a watercourse is rather difficult to detect analytically from the actual watermass. For example, in the phytoplankton the changes are slight. On the other hand, various surface growths react sensitively to even small changes in the nutrient level. Shores and constructions on the shores get slimy and thus cause harm to waterways used e.g. for recreational purposes. The inital stage of eutrophication can best be detected with a periphyton determination (cf. Wetzel and Hough 1973).

Periphyton is determined with artificial substrates placed in the watercourse to be studied. In Finland, the determination of periphyton proved useful in cases when it is particularly difficult to detect eutrophication and chemical determinations performed on watersamples have failed. Among such cases are fish farms which, as a rule, are situated by clean waterways in spots with a great water flow. The periphyton method has been successfully applied to detect the first signs of eutrophication, unnoticed in the watermass itself, but starting to affect the watercourse by making the bottom slimy (e. g. Heinonen 1984, Heinonen and Herve 1984). While the effects of eutrophication are not necessarily detected in water and the primary production, the bottom of a river may be so slimy that the time-consuming development of eggs of salmonid fish no longer succeeds.

Besides rivers, the periphyton method has been applied to lakes in Finland. Eutrophication of lakes has been studied in areas affected by waste waters from communities, as well as from the pulp industry (Kettunen 1983). The results obtained are useful from the point of view of practical water protection.

4. Zoobenthos in water quality monitoring

The composition of zoobenthos in lakes and rivers is affected by the water quality, particularly nutrients in it, oxygen concentration and temperature. Nowadays the studies of zoobenthos form an essential part of the Finnish recipient control studies. The indicator species as well as the total biomass are considered. There seems to be no general relation between the total biomass of the macroscopic zoobenthos and the nutrient level of lakes. Heavily loaded as well as oligotrophic lakes may have small amounts of benthic fauna. In order to meet the needs of monitoring, different bioindices have been developed for lake and river studies.

Bioindices based on benthic fauna can be divided into structural and species level indices. Structural indices like species diversity and dominance indices, which are commonly used in water quality assessment, do not take into account the biology of the species or the absolute biomass of zoobenthos. Species level bioindices, like the one based on the profundal migde larvae (Wiederholm 1980), seem to be more useful than structural bioindices. Application of the Wiederholm's Benthic Quality Index, BQI, to shallow, small or dystrophic lakes may give a problem. Paasivirta (1984) has calculated this index for material collected from some large Finnish lakes.

	BQI		BQI
Kilpisjärvi	4.81	Ruokovesi	2.03
Pääjärvi	4.48	Lievestuoreenjärvi	1.79
Puruvesi	3.85	Vatianjärvi	1.01
Itä-Konnevesi	3.06		

Lake Kilpisjärvi, far in the north, is considered an (extremely) ultraoligotrophic lake. Lakes Pääjärvi and Puruvesi are typical oligotrophic lakes in the Lake District. The lakes with lower values are dystrophic or loaded by effluents. Lake Konnevesi receives fish farm effluents in its eastern part and Lake Ruokovesi is dystrophic. Lakes Lievestuoreenjärvi and Vatianjärvi are polluted by pulp mill effluents.

5. Pollutants in biological chains

Finnish water authorities introduced studies on harmful substances in biota in the mid 1960's with monitoring of mercury and local studies on DDT and PCB in fish.

A nationwide monitoring program, in which water quality is assessed by analysing compounds accumulating in fish, was started in 1978. Every five years, samples are taken of pike, roach and vendace from 71 inland watercourse areas, and pike, cod and Baltic herring from 21 coastal water areas. The samples are analysed for chlorinated hydrocarbons (PCB and DDT - compounds) and heavy metals (zinc, copper, mercury, lead, cadmium) (Miettinen et al. 1985).

Zooplankton and benthic macroinvertebrates have also been analysed for bioaccumulating compounds (e.g. Miettinen and Hattula 1978).

The first studies of mercury in fish revealed that mercury concentration in predatory fish was mostly over 1 mg Kg^{-1} in about 30 recipients of waste waters from pulp and paper mills which used mercury compounds as fungicides and slimicides. In addition, three recipients were affected by waste waters from chlorine-alkali plants which used mercury cells in the production process. The River Kymi, the recipient most loaded by industry, and the area in the Gulf of Finland affected by its outlets, had concentrations of mercury of 2-4 mg kg^{-1} (Miettinen 1974).

The use of mercury compounds in the pulp and paper industry was discontinued in 1968, and water pollution control measures were taken in the chlorine-alkali plants. In the beginning of the 1980's, the mercury concentrations in fish in most of these recipients had declined to below 1 mg Kg^{-1}. A distinctive difference in mercury concentrations in pike was noticed between loaded and unloaded waters.

In the 1970's alarmingly high amounts of mercury in fish were observed in artificial lakes, 9 of which had concentrations over 1 mg Kg^{-1}, and strongly regulated lakes where the mercury concentration was 0.5-1 mg kg^{-1}.

In Finland limitations are posed on the use of fish with high mercury concentrations. Mercury content in fish is also a determinant water quality criterion for inland fisheries.

According to the fish monitoring program, mean zinc concentrations in the whole material grouped according to fish species were about 3.1.-9.7 mg kg^{-1} and copper concentrations 0.15-0.33 mg kg^{-1}. The lowest concentrations were in cod and the highest in vendace. The zinc and copper concentrations in pike were indicators of geographic variation rather than loading, since the values in the unloaded observation sites were mostly higher than those in the loaded ones. The concentrations of cadmium and lead in the fish were low: regularly below 0.01 and 0.05 mg kg^{-1} respectively.

In Finland DDT was used as an insecticide in agriculture up to 1969. PCB is used in the electrical industry, but its use and releases have been restricted effectively since the beginning of the 1970's.

DDT and PCB concentrations in fish were found to be higher in the coastal waters than in inland watercourses. Further, the results showed that the concentrations were lower in both coastal and inland waters in northern Finland than in the southern parts of the country. The highest local DDT concentration in pike was detected in the Archipelago Sea. This reflects the use of DDT in the intensive agriculture of the area bordering the sea. The highest PCB concentrations in pike were observed in the sea area around the outlets of the rivers Kokemäenjoki and Kymijoki, which are heavily loaded. The material collected on pike showed a marked difference in the PCB concentrations between the loaded and unloaded localities, whereas the DDT concentrations were practically the same. During the 1970's the concentrations of both these compounds have decreased to less than one half in most areas.

6. Mussels as indicators

Monitoring some substances of industrial origin that cause a loading on watercourses is particularly difficult because of the fact that they appear in very low, but greatly varying, concentrations even in waste waters and especially in recipients. Monitoring compounds like these in watercourses would require very frequent sampling and this may be financially impossible. The most reliable method is to monitor the trasportation of these compounds in biological chains in recipients (compare chapter 5).

In addition to studying the organisms indigenous to waterways, the occurrence of e.g. metals and organic chlorine compounds can be observed by using test animals. Animals are exposed to the watercourse to be studied for a certain test period. After incubation the concentration of the compounds concerned in them is determined. This method has been used e.g. to monitor the coastal sea areas. As a test animal the common mussel (*Mytilus edulis* L.) has been used (Goldberg 1980). When studying the Finnish inland waterways, the fresh water mussel (*Anodonta piscinalis*) has been successfully used as a test animal. Most studies have been conducted to monitor the recipients of the pulp industry (Heinonen et al. 1986) with the result e.g. that changes in the concentrations of organic chlorine compounds caused by changes in an industrial process can be detected even in the watercourse.

The principle of the method is very simple: mussels caught in a clean watercourse are cultured in plastic baskets in open water of the area concerned for 4 weeks, after which the concentrations of the organic compounds are determined using the soft parts of the mussels. The method can be used to detect and monitor the effects on water of other industrial plants, sawmills, power plants, dumping grounds, junk yards, mines and agriculture as well.

7. Biological populations in testing

Biological populations used for toxicity testing include natural algal and bacterial populations, pure cultures of these, and Daphnia water flea and fish. In most cases the purpose of the studies was to detect any harmful effect of waste waters from pulp and paper industry, metal works and mines on the recipient.

Factors affecting algal growth inhibition have been studied since the mid 1970's. In pulp mill effluents, the typical properties which can potentially inhibit algal growth and production are the pH, colour, toxic compounds and lignin constituents (Eloranta et al. 1984). The experiences of these studies have been used in the preparation of a standard method with *Selenastrum capricornutum* (EC 50 72 h). A method like this using only a single species is practical for screening the toxicity of chemicals and effluents, but its ecological relevance is low. Eloranta and Halttunen-Keyriläinen (1985) have studied the use of indigenous phytoplankton in testing toxicity. The response of phytoplankton to the effluents depended especially on the physiological condition of the phytoplankton community.

Methods measuring the activity of heterotrophic bacteria and the primary production capacity of algae are very sensitive in revealing the extent of the polluted areas and changes in the water quality caused by loading (e.g. Talsi et al. 1984).

Most tests with Daphnia (EC 50 48 h) were performed to classify the toxicity of chemicals, particularly pesticides (Rekolainen 1986) and waste waters (Nikunen and Miettinen 1985). In waste water studies, toxicity values have been used to evaluate toxicity loading by calculating TER (toxicity emission rate) and TEF (toxicity emission factor) values. In pulp mills, debarking and bleaching proved to be the processes producing the most toxic effluents. Considering the volume of the water used in the process, the highest TER value was calculated for old kraft pulp processes. When the amounts of products are included in the calculations (TEF - value), the worst toxicity loader is the sulphite process.

The monitoring of harmful or toxic effects on the biota still has many open questions which need further studying.

8. Conclusions

Experts agree that it is not sufficient to monitor the state of a watercourse using only physical-chemical determinations on the biotope, but it is necessary to complement these with the monitoring of the most important constituents of the biocoenosis. Changes in water quality can also be indicated through biocoenosis. Suitable eutrophication indices are the mean concentrations of phytoplankton (chlorophyll *a*) and periphyton on artificial substrates of the growing season.

Changes in the benthic fauna, particularly changes in the species composition, make a good monitoring object. Monitoring of many bioaccumulating substances and compounds which appear in low concentrations requires studies of the organisms indigenous to the watercourse or organisms incubated in the watercourse being studied for a set time. In many cases, particularly in the recipients of industry, it is necessary to use various biotests and toxicity tests.

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SUMMARY

9 - USE OF BIOCOENOSIS DATA IN WATER QUALITY MONITORING

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Paper submitted by the Water and Environment Research Institute, Finland.

Monitoring of watercourse quality and its changes with time can in principle be directed to the water itself, i.e. the biotope and/or to the organisms living in the water, the biocoenosis. The state of the biotope can be described by rather simple chemical and physical variables, for example eutrophication is indicated by phosphorus analyses, acidity by pH measurement, etc. Partly for this reason, monitoring of the biotope is in fact more common than biocoenosis research, which always requires more versatile professional skills and also greater financial resources.

Monitoring of the biocoenosis, however, provides more reliable information about the actual effects of loading factors, measured as increased concentrations in the biotope, on the populations of organisms living in watercourses. Biocoenosis research can be divided into three groups:

— studies on the population sizes and activity levels of different components of the biocoenosis (e.g. phytoplankton biomass, primary production, etc.)

— studies of the routes taken by various watercourse pollutants in biological chains (e.g. mercury in fish, organic chlorine compounds in benthic fauna, etc.)

— studies in which biological populations are used for testing (e.g. toxicity testing, AGP-tests, etc.).

Most of the work hitherto carried out on biocoenosis in Finland has centred on phytoplankton. In addition to overall population density, an important parameter has also been population structure, which may be a rapid and sensitive indicator e.g. in cases of eutrophication. Corresponding investigations have also been carried out in recent years to study the effects of environmental changes on benthic organisms and fish populations. Methods for investigating these effects on degradation processes are being developed, too.

Fish have been used in the study of bioaccumulating compounds since the late nineteen-sixties, particularly in relation to the accumulation of DDT, PCB and mercury. At the end of the 1970's a monitoring program concerning the accumulation of heavy metals and chlorinated hydrocarbons in fish was initiated in Finnish inland and coastal waters. In another program, bioaccumulation is being studied in the benthic fauna of coastal waters.

Periphyton and mussels have also been used in bioaccumulation studies for investigating the dispersion of organic chlorine compounds from cellulose bleaching in recipient watercourses.

For toxicity testing, natural algal or bacterial populations, pure cultures of these organisms or either Daphnia water fleas or fish may be used as test organisms.

Future developments in the monitoring of watercourse quality will require increased levels of biocoenosis research in addition to biotope studies. In particular these biological methods should be utilized in cases in which simple monitoring of the biotope is clearly insufficient. For example the monitoring of river water quality should be based rather extensively on biocoenosis research, e.g. using periphyton or benthic fauna.

RESUME

9 - APPLICATION DES DONNEES DE LA BIOCENOSE A LA SURVEILLANCE DE LA QUALITE DE L'EAU

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Document soumis par l'Institut de recherche sur l'eau et l'environnement, Finlande.

La surveillance de la qualité de l'eau en milieu naturel et de ses variations dans le temps peut, en principe, être axée sur l'eau elle-même, c'est-à-dire sur le biotope et/ou les organismes vivant dans l'eau, la biocénose. L'état du biotope peut être décrit à l'aide de variables chimiques et physiques relativement simples: par exemple, l'eutrophisation est révélée par des analyses de la teneur en phosphore, l'acidité par la mesure du pH, etc. C'est en partie pour cette raison que la surveillance du biotope est en fait une méthode plus couramment appliquée que l'étude de la biocénose, qui nécessite dans tous les cas des compétences professionnelles plus étendues ainsi que des ressources financières plus importantes.

Cependant, la surveillance de la biocénose fournit des renseignements plus fiables en ce qui concerne les effets réels des facteurs de charge — mesurés sous la forme de concentrations accrues dans le biotope — sur les peuplements d'organismes vivant dans les cours d'eau. Les recherches sur la biocénose peuvent être divisées en trois catégories:

— étude de la taille des peuplements et du degré d'activité des différents éléments de la biocénose (biomasse de phytoplancton, production primaire, etc.);

— étude des itinéraires suivis par divers polluants des cours d'eau dans les chaînes biologiques (par exemple ceux du mercure dans le poisson, des composés organochlorés dans la faune benthique, etc.);

— travaux consistant à utiliser des peuplements biologiques pour des essais (essais de toxicité, essais sur gélose agar, etc.).

La plupart des travaux ayant trait à la biocénose qui ont été réalisés jusqu'ici en Finlande ont été centrés sur le phytoplancton.

Outre la densité de population globale, un important paramètre est également la structure de la population, qui peut être un indicateur rapide et sensible, notamment dans les cas d'eutrophisation. Des travaux de recherche connexes ont aussi été entrepris ces dernières années pour étudier les effets de variations de l'environnement sur les organismes benthiques et les peuplements de poissons. Des méthodes permettant d'étudier l'incidence de ces variations sur les processus de dégradation sont également en cours d'élaboration. Depuis la fin des années 60, des poissons sont utilisés pour l'étude des composés susceptibles de bio-accumulation, notamment le DDT, le PCB et le mercure. A la fin des années 70, un programme visant à surveiller l'accumulation de métaux lourds et d'hydrocarbures chlorés dans les poissons des eaux intérieures et côtières a été mis en oeuvre en Finlande. Un autre programme a pour objet d'étudier les processus de bio-accumulation dans la faune benthique des zones côtières.

Le périphyton et les moules ont aussi été utilisés dans le cadre de travaux de recherche sur la bio-accumulation dont l'objectif était d'étudier la dispersion des composés organochlorés provenant du blanchiment de la cellulose dans les cours d'eau récepteurs.

Pour les essais de toxicité, les organismes témoins peuvent être des peuplements naturels d'algues ou de bactéries, des cultures pures de ces organismes, des daphnies ou des poissons.

L'évolution future de la surveillance de la qualité des cours d'eau rendra nécessaire une intensification des travaux de recherche sur la biocénose en sus des études sur le biotope. Il faudrait en particulier recourir à ces méthodes de surveillance biologique dans les cas où la simple observation du biotope est manifestement insuffisante. La surveillance de la qualité des eaux fluviales, notamment, devrait faire largement appel à l'étude de la biocénose (observation du périphyton ou de la faune benthique, par exemple).

Резюме

9 - ИСПОЛЬЗОВАНИЕ ДАННЫХ О БИОЦЕНОЗЕ В КОНТРОЛЕ КАЧЕСТВА ВОДЫ

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Основное внимание в мониторинге качества водотоков и его изменений во времени можно в принципе сосредоточить на самой воде, т.е. биотопе и/или на организмах, обитающих в воде, - биоценозе. Состояние биотопа можно описывать с помощью довольно простых химических и физических переменных, например показателем эвтрофикации является анализ содержания фосфора, определение кислотности путем измерения показателя Рн и т.п. Частично по этой причине мониторинг биотопа используется чаще, чем изучение биоценоза, для которого всегда требуются более разнообразные профессиональные навыки, а также больший объем финансовых ресурсов.

Однако мониторинг биоценоза обеспечивает более достоверную информацию о фактическом влиянии факторов, создающих нагрузку, которая определяется повышенными концентрациями в биотопе, на популяции организмов, обитающих в водотоках.

Обследования биоценоза можно разделить на три группы:
- обследования размеров популяций и уровней активности различных компонентов биоценоза (например, биомасса фитопланктона, первичное производство и т.п.)
- обследования маршрутов движения различных загрязнителей водотоков в биологических цепочках (например, ртуть в организме рыбы, хлороорганические соединения в бентической фауне и т.п.)
- обследования, в которых для проверки используются биологические популяции (например, проверка токсичности, тесты АГП и т.п.).

Большая часть работы, которая до сих пор была проведена в области биоценоза в Финляндии, была сосредоточена на фитопланктоне. Помимо общей плотности популяции, важным параметром является также структура популяции, которая может быть быстродействующим и чувствительным показателем, например, в случаях эвтрофикации.

В последние годы были также проведены соответствующие исследования с целью изучения воздействия изменений в окружающей среде на популяции бентических организмов и рыбы. Разрабатываются также методы изучения влияния на процессы деградации.

С конца 60-х годов рыба использовалась при изучении биологического накопления соединений, в частности в отношении накопления ДДТ, ПХД и ртути. В конце 70-х годов на территории и в прибрежных водах Финляндии началось осуществление программы мониторинга, касающейся накопления тяжелых металлов и хлорированных углеводородов в организме рыбы. В рамках другой программы изучается бионакопление у бентической фауны прибрежных вод.

В исследованиях, посвященных бионакоплению, были также использованы перифитон и двустворчатые моллюски для изучения распространения хлорорганических соединений в результате обесцвечивания целлюлозы в принимающих водотоках.

Для проверки токсичности на естественных популяциях водорослей или бактерий в качестве организмов-индикаторов можно использовать чистые культуры этих организмов, водяных блох Дафния или рыбу.

Будущие изменения в области мониторинга качества водотоков, помимо изучения биотома, потребуют расширения исследований биоценоза. В частности, эти биологические методы следует использовать в случаях, когда простой мониторинг биотома является явно недостаточным. Так, мониторинг качества речной воды следует проводить довольно широко на основе исследований биоценоза, например используя перифитон или бентическую фауну.

10 - A MONITORING SYSTEM FOR NATURAL FLORA, FAUNA AND THEIR HABITAT

Author: I. Juhasz

Paper submitted by the Ministry for Environmental Protection and Water Management, Hungary.

Well-founded decisions taken in the field of environmental protection, which concern natural and political regional units (from local to national) ought to be based on a goal-oriented information system.

In Hungary, as in many other countries, environmental concerns and problems have arisen also as the consequence of socio-economic development. It became obvious that the importance and role of environmental protection call for the creation of an information system in order to support decisions and to provide a data source for an action-oriented environmental strategy. The creation of such an information system, including the most important environmental factors and harmful effects, was started in Hungary in the recent past.

The Hungarian Environmental Protection Information System (HEPIS) consists of subsystems relating to environmental protection activities and a central system, connecting the subsystems. In HEPIS, all the available data, whether measured or estimated, are collected and processed. These data and elements of information concern almost all important elements of the environment. The central system contains summarized data of the subsystems.

The greater part of the collected data and information are processed in a conventional manner. The computer makes it convenient to analyse different connections, to explore cause and effect relationships, and to prepare appropriate decisions using optimisation methods.

The subsystems of HEPIS are defined more or less following the pattern of sectoral tasks of environmental protection management. We have the following subsystems:

1. Protection of rock-bed and mineral resources
2. Protection of soil
3. Protection of underground and surface waters

4. Air pollution control

5. Protection of natural flora and fauna (not from the point of view of nature conservation)

6. Protection of landscapes (see note under 5)

7. Nature conservation

8. Protection of human settlements

9. Hazardous waste management

10. Noise emission control.

One of the most important subsystems is that for the protection of natural flora and fauna. In its structure and content, the «wild» flora and fauna elements receive most attention at this moment, but the subsystem is designed to contain information in relation to human health and «agricultural» flora and fauna as well.

The natural flora and fauna can be considered as a basis for an economy in which natural values are protected and the related information can point into the direction in which analyses of important effects are required. Natural flora and fauna are reliable indicators of basic changes in the quality of the environment.

These problems are analysed in different publications and appropriate recommendations are made for the solution of given well-defined tasks. Hungarian ecologists — designing the basic structure of the information system — met with many difficulties to find answers to those questions that were derived from the objective of environmental protection. For example, which species or individuals should be chosen for monitoring? How detailed and intensive research ought to be before the changes in the environment can be reliably detected and traced? We also need information on whether an individual or a species carries a genetic modification or migrates between regions.

During the system design work, representatives of different professions like biologists, ecologists and environmental experts worked out very heterogeneous proposals.

Professional compromise was the final solution, of course implying some (tolerable) inadequacy of means. The other part of the problem resides in the sphere of testing. The final goal is to have enough information to show at any moment the environmental quality, as well as its tendencies, of natural flora, fauna and their habitats in both space and time.

The leadership of system design and implementation has been put into the hands of Professor Jakucs at the Institute of Ecology, Kossuth

Lajos University, Debrecen. Many high-level biologists and ecologists of Hungary contribute to this research activity.

The rationale underlying the information system is that it is important to start the monitoring of representative species and individuals of natural flora and fauna in space and in time. Information about changes in the state of the environment of a region or the country as a whole can be derived from the data collected or monitored.

The system is composed of the following main parts:

— set of data collected countrywide from the habitats of selected individuals of characteristic and representative species;

— data for typical regions of special importance; and

— comprehensive ecological data of selected areas.

For the main parts, the information is collected in accordance with the following scheme:

1. Basic collection of the known and protected species in the country.

2. Localized collection from important sample areas:

— systematic sampling

 — detailed survey on test wetlands and terrestrial areas

 — seasonal survey on test wetlands and terrestrial areas

— seasonal sampling in different types of test areas

3. Detailed ecological survey, on

— complex test areas,

— terrestrial test areas,

— wetland test areas.

Two types of questionnaires are used in the information system. One refers to species, the other to places where they exist. These forms can be completed not only *in-situ*, but previous descriptions and results as published can be involved as well.

The survey form for species refers to both data on monitored individuals and data on other relevant aspects of environmental protection (place of occurrence, UTM-grid code, time, status, type, number of individuals, ... etc.). There is a possibility to qualify the existing place, too, with a view to further processing and analysis. This survey form has cases for information on vegetation, soil, water supply, light intensity, cenology-types, microhabitats; and in case of wetlands, type of water, pH, light and oxygen supply... etc.

The survey form for places (habitat) refers to the sites where individuals of species in water and on land exist. In water sites, 34 representative individuals (11 plants, 23 animals), on land sites 33 individuals (15, 18) were under observation, and their data are processed every season. The survey form asks for characteristics of the site and topography, and there are also auxiliary forms for additional information (geography, climatology, human influence, degradation... etc.).

The pilot project using these questionnaire forms has already started. A great quantity of materials has been prepared for computer processing. Regional investigations have started, too, mainly for place (habitat) types and species. The first results are encouraging but it must be taken into account that in the case of national surveys, different types of experts of varying professional background are to be involved. It needs, above other things, an unambiguous code-system and high level cooperation.

In support of computer processing of the questionnaires, code files (for settlements, species,... etc.) have been elaborated and manuals are being completed and disseminated dealing with the methods of surveys and evaluations.

In the topographical system UTM grid-maps are used. The grid size of the country-wide survey is 10x10 km. This size appears to be safe for the elaboration of the materials that were already published. Exact places where data are collected are put on files. All of these places are recorded in ordinal numbers on every 10x10 km grid.

The hardware used at the national scale is a Honeywell-Bull system at the National Computer Service (ASzSz) of Hungary. This project is executed in the framework of HEPIS. Results of individual investigations are elaborated on IBM-PC micro-computers.

The growing data base emerging from these data collections will serve the following uses:

— the analysis of the present state of the environment;

— the analysis of effects of environmental protection measures;

— the identification and forecasting of environmental pollution;

— the establishment of an inventory of protected species and areas; and

— the forecasting of elementary changes in the environment.

SUMMARY

10 - A MONITORING SYSTEM FOR NATURAL FLORA, FAUNA AND THEIR HABITAT

Author: I. Juhasz

Paper submitted by the Ministry for Environmental Protection and Water Management, Hungary.

The importance and the role of environment protection call for the creation of an information system in order to support decisions affecting small or large regions or the country as a whole and to develop long-term strategies. The information system ought to be goal-oriented.

The creation of such an information system including the most important environmental factors and harmful effects was started in Hungary in the recent past. One of the most important parts of the system is the interconnected subsystem of flora and fauna which is gradually being developed. Flora and fauna can be seen as a basis for an economy in which natural values are protected. The respective information indicates the need for the analyses of important effects.

Natural flora and fauna are reliable and exact indicators of basic changes in the quality of the environment. That is why it is important to start the monitoring of natural flora and fauna both in space and in time. Information about changes in the state of the environment of a large region or the country as a whole can be derived from the monitoring data.

The system consists of the following parts:

— a set of data collected countrywide from the habitats of selected individuals of characteristic species, being representative of some sort;

— data for typical zones of special importance; and

— comprehensive ecological data of a chosen area.

Data collection can be performed in two ways: by a survey form referring either to species or to places where they exist. The survey form for species refers to both data on the monitored individuals and data on other relevant aspects of environment protection (geographical, climatological data, etc.).

The survey form for places where individuals of the species are known to exist asks for information on the occurrence of the 34 most characteristic specimens of the flora and fauna at the site concerned.

The survey of individual locations should be done seasonally. It collects the most important information on the selected individual. In addition, the characteristics of the site should be described.

Manuals were prepared that facilitate the computer-aided processing of data.

UTM system grid-maps are used for surveys.

The growing data base emerging from these data collections will serve the following uses:

- the analysis of the present state of the environment
- support of the analysis of effects of environment protection measures
- indication and forecasting of environmental pollution
- inventory of protected species and protected areas
- forecast of elementary changes in the environment.

RESUME

10 - UN SYSTEME DE SURVEILLANCE DE LA FLORE ET DE LA FAUNE ET DE LEUR HABITAT

Auteur: I. Juhasz

Document soumis par le Ministère pour la protection de la nature et de l'environnement (OKTH), Hongrie.

L'importance et le rôle de la protection de l'environnement justifient la création d'un système d'information d'aide aux décisions qui concernent des régions plus ou moins étendues du pays, ou le pays tout entier, et de mise au point des stratégies à long terme. Ce système doit être normatif.

La Hongrie a récemment entrepris de mettre en place un tel système qui rassemble des informations sur les facteurs écologiques et les effets nocifs les plus importants. L'un des éléments principaux, en voie de constitution progressive, en est un sous-système interconnecté concernant la faune et la flore. La faune et la flore peuvent être considérées comme la base d'une économie dans laquelle les valeurs naturelles sont protégées. Les informations obtenues font apparaître la nécessité d'effectuer des analyses des effets importants.

La faune et la flore sont des indicateurs fiables et exacts des modifications fondamentales de la qualité de l'environnement. C'est pourquoi il importe de commencer à les surveiller dans l'espace et dans le temps. Les données ainsi observées permettent de connaître les modifications survenues dans l'état de l'environnement de régions étendues, ou de l'ensemble du pays.

Le système comporte les éléments suivants:

— une série de données rassemblées à l'échelle du pays tout entier concernant l'habitat de certains individus d'espèces caractéristiques, représentatives à un titre ou à un autre;

— des données concernant des zones typiques d'importance particulière, et

— des données écologiques complètes relatives à une aire définie.

La collecte des données peut se faire au moyen de deux types d'enquête: sur les espèces ou sur les lieux où ces espèces exis-

tent. Le questionnaire de l'enquête sur les espèces porte à la fois sur les individus observés et sur d'autres aspects pertinents de la protection de l'environnement (données géographiques, climatologiques, etc.).

Le questionnaire de l'enquête sur les lieux où l'on sait qu'existent des individus des espèces étudiées sert à recueillir des renseignements sur la présence des 34 spécimens les plus caractéristiques de la flore et de la faune sur le site considéré.

L'enquête sur les lieux individuels doit être faite de façon saisonnière. Elle permet de recueillir les renseignements les plus importants sur l'individu choisi. Les caractéristiques du site doivent également être indiquées.

Des manuels ont été rédigés pour faciliter le traitement informatisé des données.

Les cartes employées dans ces enquêtes utilisent la projection UTM.

La base de données qui se constitue peu à peu à partir de ces enquêtes servira aux utilisations suivantes:

— analyse de l'état actuel de l'environnement

— aide à l'analyse des effets des mesures de protection de l'environnement

— indication et prévision de la pollution de l'environnement

— inventaire des espèces et des aires protégées

— prévision des modifications élémentaires de l'environnement.

Резюме

10 - СИСТЕМА КОНТРОЛЯ ФЛОРЫ, ФАУНЫ И МЕСТ ИХ РАСПРОСТРАНЕНИЯ

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Учитывая важное значение и роль, которую играет охрана окружающей среды, необходимо создать информационную систему, чтобы обеспечивать принятие решений, затрагивающих мелкие или крупные регионы или страну в целом, и разрабатывать долгосрочные стратегии. Информационная система должна быть целенаправленной.

Совсем недавно в Венгрии начато создание такой информационной системы, которая охватывает наиболее важные экологические факторы и неблагоприятные климатические воздействия. Одной из основных составных частей такой системы является последовательно разрабатываемая взаимосвязанная подсистема флоры и фауны. Флора и фауна могут рассматриваться в качестве основы той экономики, в которой природные ценности находятся под охраной. Соответствующая информация свидетельствует о необходимости анализа важнейших видов биологического воздействия.

Флора и Фауна являются надежными и точными показателями основных изменений качества окружающей среды. Вот почему важно начать работу по мониторингу естественной флоры и фауны как в пространстве, так и во времени. Информация об изменениях состояния окружающей среды крупного региона или страны в целом может быть получена на основе данных мониторинга.

В эту систему входят следующие части:
- Набор данных, собранных по стране и касающихся мест обитания отдельных характерных видов животных, являющихся репрезентативными;
- данные для типичных зон, имеющих особо важное значение; и
- всеобъемлющие экологические данные по какому-либо конкретному району.

Сбор данных может проводиться двумя путями: путем обследования конкретных видов животных и растений или мест их распространения. Обследование видов предполагает получение данных о наблюдаемых отдельных видах и данных о других соответствующих аспектах охраны окружающей среды (географические, климатологические данные и т.д.).

Обследование мест, где, согласно имеющимся данным, распространены отдельные представители конкретных видов растений и животных, заключается в сборе информации о распространении 34 самых характерных представителей флоры и фауны соответствующего района.

Обследование отдельных мест обитания должно проводиться на сезонной основе.

В ходе его проведения собирается самая важная информация, касающаяся выбранных особей. Кроме того, следует представить описания, характеризующие местность.

Были подготовлены учебные пособия, которые облегчают компьютеризованную обработку данных.

При проведении обследований используются карты с сеткой прямоугольных координат УТМ (в универсальной поперечной проекции Меркатора).

Расширенную базу данных, которая будет создана на основе полученной информации, можно будет использовать в следующих целях:
- анализ современного состояния окружающей среды;
- содействие анализу последствий мер по охране окружающей среды;
- определение и прогнозирование степени загрязнения окружающей среды;
- создание перечня охраняемых видов животных и растений и охраняемых территорий;
- прогнозирование элементарных изменений в состоянии окружающей среды.

11 - AN INFORMATION SYSTEM FOR WATER QUALITY MANAGEMENT

Author: Fausto Maria Spaziani

Paper submitted by the Water Research Institute, National Research Council, Italy.

1. Introduction

The gathering of information concerning the state of water quality in water bodies and the quantity of pollutants contained in them is a prerequisite for identifying suitable improvement tools and for a rational programming of action strategies.

In 1983, as part of its activities in the sector of protecting water resources from pollution, the Water Research Institute of the Italian National Research Council (IRSA) began a nationwide survey of water quality in cooperation with Central Administrations (Ministries of the Environment, Health, Public Works), Regions and numerous Agencies responsible for the management and safeguard of water resources (1, 2, 3).

The survey in question was also a response to the need to verify the changes in water quality brought about by the application of the sectoral regulations which came into force in Italy in 1976 (law no 319 of 10 May 1976 «Regulations concerning the protection of water from pollution»).

The collection of information was based mainly on the water quality data accumulated over the last ten years by the monitoring bodies operating through the national territory.

The acquisition of data was carried out using questionnaire cards designed to allow data to be stored easily in the computer system, set up for filing, processing and providing access to information.

It should be stressed that the water quality data base is only a part, albeit an important one, of the information system required for the implementation and management of the General Improvement Plan laid down by law 319/76 and recently launched by the Ministry of the Environment.

As specified in the law, this Plan must take the form of an operative survey, planning and control tool serving the purposes of the State and is to achieve the objective of water protection and an effective and efficient allocation of funds as they become available.

Briefly, the General Plan should be acknowledged as a scheme having a guiding, promoting, advising and coordinating function, performed through its management structures, which is to guarantee:

— the homogeneous application of the laws governing water protection throughout the national territory;

— the compatibility of objectives, priorities and tools provided for in the regional plans, also within the framework of more general planning guidelines;

— the establishment of criteria and objectives for improving national and multiregional water supply systems;

— the creation of a body of information on which to base laws and technical and administrative regulations for achieving the improvement objectives;

— the rational and fair sharing of funds;

— the respect of target and improvement action schedules.

In view of the above, it is clear that what is needed for the identification of tools and the development of strategies for implementing the General Plan is a broad-based representative knowledge of the various sectors affected by the planning action.

Therefore, for the General Plan to be set up and function, the State must have access to an adequate information base in order to have a continually up-to-date picture of the situation and be able to identify emerging needs, future trends and elements for evaluating the effectiveness of any action taken.

The overall objective is, therefore, to implement an integrated State-Region information service incorporating, if possible, the partial systems already existing at the central and peripheral levels. The sectors involved in the General Improvement Plan which are to be taken into consideration in setting up the system in question include:

— characteristics of the terrain, hydrography, geology, climatology, etc. (general and thematic mapping);

— data on water quality (surface and ground water);

— sources of pollution (inhabitants, agriculture, industry);

— existing public works (water mains, sewers, treatment plants);

— management structures (central and local bodies);

— economic data (investment costs, running costs, benefits).

The information system for the General Improvement Plan has already been implemented with respect to the data referring to the water quality of water bodies, acquired during the survey mentioned above, and the potential sources of pollution of domestic and industrial origin.

It is noteworthy that the water quality data base was set up by IRSA in cooperation with the Ministry of the Environment and with the help of a company specializing in the development of purpose-oriented software.

The characteristics of the data bases set up and the main results obtained are set out below.

2. Water quality data base

As mentioned earlier, in 1983 IRSA began acquiring analytical data on surface water quality from the local authority monitoring structures by questionnaires.

The survey refers to the resolution of 4 February 1977 of the Committee of Ministers for the Protection of Water from Pollution.

The response to the survey, which lasted about two years, can be said to be more than good. Water quality data were collected for 15 Regions: Piemonte, Valle d'Aosta, Lombardia, Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia, Liguria, Emilia Romagna, Toscana, Umbria, Lazio, Abruzzi, Puglie, Sicilia and Sardegna.

As can be seen, the areas comprising the largest Italian river basins have been covered (Po, Tevere, Arno, Adige).

The quality data refer to an observation period lasting from 1973 to 1985, with a significant concentration of information in the 1978-1983 period (more than 80%), and relate to about 1,700 sampling points located on about 600 rivers and 50 lakes and reservoirs. A total of about 150,000 information items were collected.

It should be pointed out that the survey also envisaged the collection of data (questionnaire by Region, Province and Municipality) for an evaluation of the size and the organizational and operational characteristics of the management and monitoring structures set up at the local level for the purpose of water quality control. In this connection very little information has come from the survey. Only a small number of

Regions (Piemonte, Veneto, Emilia Romagna, Puglie, Sicilia and Sardegna) have replied, and they are generally not representative of the territory as a whole.

The greatest difficulties in collecting data have been attributed to organization problems related to the well-known shortage of technicians in the local authorities, particularly at a municipal level.

Side by side with the data collection and storage operations, criteria were selected for the purpose of classifying water bodies in order to arrive at a comprehensive and coordinated interpretation of the analytical material available.

Consideration was given to the main uses to which the water was put as well as to the water quality criteria and standards peculiar to each use.

Reference was made in particular to water for drinking purposes, industrial uses, recreation, bathing, and the maintenance of aquatic life and aquiculture.

In outline, the resulting quality classes point to a decreasing quality level and, at the same time, different uses of the water resources for each class.

In operational terms, in view of the want of analytical data observed to be widely distributed over the territory and having a sufficiently typical frequency, it became necessary to use only the parameters with the greatest sampling and measurement frequency throughout the country and in any case suitable for characterizing the degree of change in water quality.

For this purpose, the proposals contained in the literature and in international regulations were taken into account.

The following parameters were therefore selected: dissolved oxygen, COD, BOD5, ammoniacal nitrogen, total phosphorus and faecal coliforms. For each of these, ranges of values have been laid down to define four different classes of quality arranged in a decreasing order of quality.

The software products to be used in the information system set up for the water quality data base were selected on the basis of their high versatility and flexibility, interactive capability and relational structure [4, 5, 6]. Specifically, QBE (Query By Example) [7, 8] and dBASE III (Data Base Management System) [9] packages were chosen.

The QBE system installed at the IAS (Institute of Space Astrophysics) Computer Centre, to which the IRSA is linked, was used to set up the national data base covering the body of data on running water, lakes and reservoirs available for the whole of the Italian territory.

The second software package, dBASE III, suitable for the operational processing of data on small-capacity machines such as personal computers, was used to develop the individual regional data bases containing information on the quality of water in rivers, lakes and reservoirs located in each of the Regions being considered.

The block diagram of the operation of the overall system presented here for the data bases on water quality and pollution sources is shown in fig. 1.

Various types of query procedures, managed interactively by means of standard display terminals were set up for the purpose of accessing information.

In particular, the inquiry structure developed to assist in the assessment of water quality in water bodies allows the following operations to be performed:

— determination of the statistical parameters typical of the historical series of available data by sampling point and for the period concerned with reference to different water quality indicators;

— study of the changes in water quality characteristics with time;

— assignment of quality classes to the water body as a function of the different uses, considered both individually and collectively.

This processing can be performed by aggregating the stored data by sampling point with reference to the administrative areas (Region, Province, Municipality), the water bodies (river, lake, reservoir) and the hydrographic unit (basin, sub-basin) concerned.

3. Potential pollution data base

The other sector developed in the information system is related to the evaluation of the potential pollution caused by home and industrial sources located within the territory.

This evaluation is an indispensable factor in the preparation of environmental plans, particularly in case of large territorial units, where the direct collection of data which are representative and significant in time and space is technically and economically very difficult.

In practice, it is a question of managing to quantify the pollutant loads affecting the different sections of the water bodies that can be

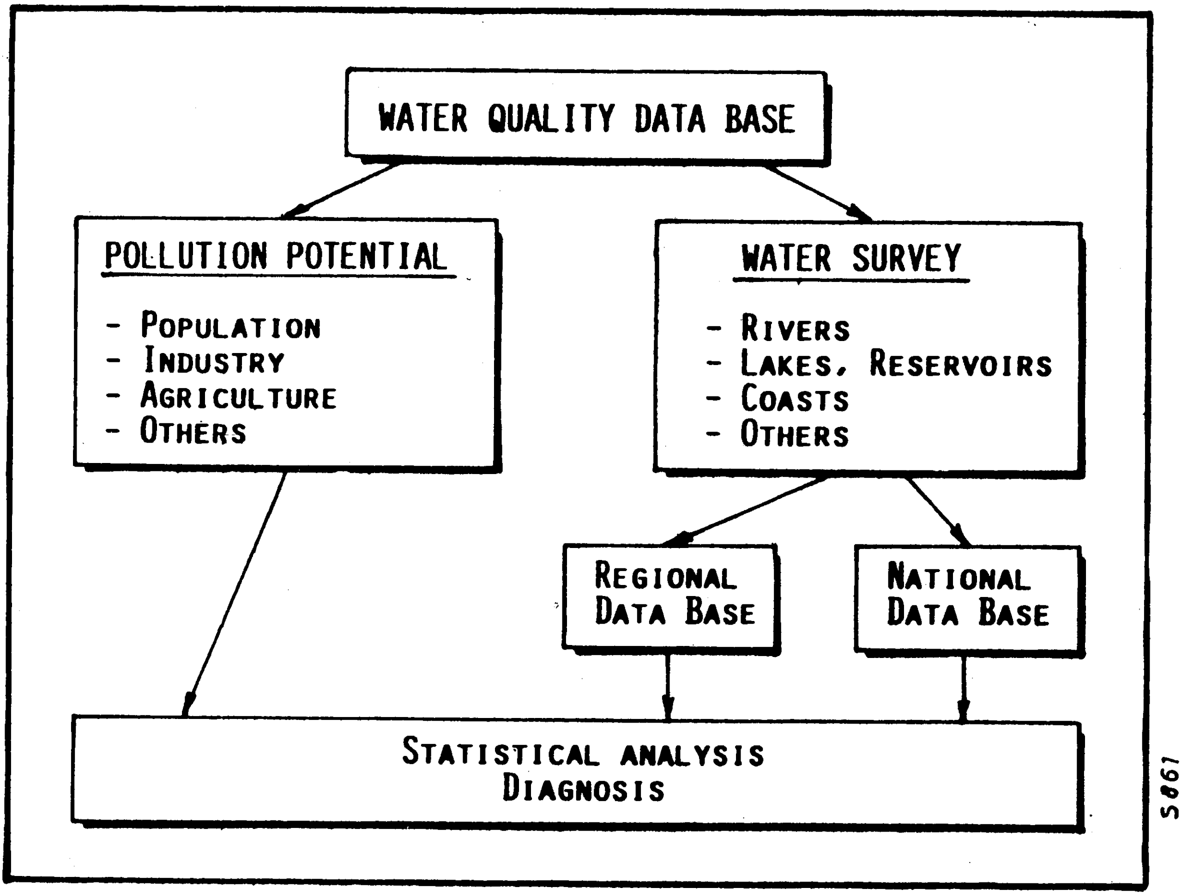
WATER QUALITY DATA BASE
POLLUTION POTENTIAL
- Population
- Industry
- Agriculture
- Others
WATER SURVEY
- Rivers
- Lakes, Reservoirs
- Coasts
- Others
Regional
Data Base
National
Data Base
Statistical analysis
Diagnosis

Figure 1.

attributed to the different sources of pollution, and to map their distribution over the territory concerned.

In this connection, it should be borne in mind that pollutant loads are normally evaluated with a procedure by means of which, using suitable numerical coefficients, the reference units selected for the different sources of pollution generation are converted into load quantities or indexes of the load itself.

For instance, the pollution load due to the resident population is normally expressed in terms of amount of organic substance per person per day.

In view of the heterogeneous nature of the existing situations, in the case of practically all industrial activities a single index is used, the so-called «inhabitant equivalent», the value of which refers to the quantity of organic substances present in effluents from industrial sites compared with that found in domestic sewers. The potential pollutant load ascribable to a given industrial activity is therefore converted, by means of suitable coefficients, from the number of employees in that industry to the inhabitant equivalent number.

A set of such coefficients was developed by IRSA in 1976 [10]. Later on, the coefficients had to be revised and updated to satisfy a twofold need: on the one hand, the advisability, when estimating coefficients, to use data on the characteristics which are more up-to-date and consistent with the present-day productive technology; on the other, to take into account changes in the guidelines for defining the product categories used by ISTAT for census purposes. Basically, the classification of economic activities has been revolutionized in the light of the need for alignment with the proposed EEC classification and the tables of comparison did not allow any of the existing conversion coefficients to be used directly.

The work of revising the coefficients was recently completed and it has thus become possible to evaluate potential pollutant load due to domestic and industrial sources for different levels of territorial aggregation [11].

With regard to the representativeness and significance of population equivalent coefficients as indirect indexes of pollutant load, it must be borne in mind that they are based exclusively on the organic substance content in industrial effluents compared with that present in domestic sewers.

The limits of the pollutant load evaluation using the population equivalent method thus become quite apparent. These limits lie mainly in the fact that industrial effluents are highly dishomogeneous and variable, and organic substances often account for only a small proportion of the true pollutant content, which is often characterized by a high percentage of toxic compounds.

Despite these limits, the resident and population equivalent method is a useful tool for evaluating the extent and distribution of loads over large areas and is justified by the ease with which the required statistical data can be obtained and by the simplicity of the various operations involved.

From the operational standpoint, the evaluation of potential loads of domestic and industrial origin was carried out with reference to the results of the General Population and Industrial Censuses made by ISTAT in 1981.

The information system has been set up using the QBE package, which was used also for the national water quality data base.

Potential pollutant loads may be expressed at different levels of territorial aggregation, e.g. Region, Province, Municipality, hydrographic basin, coastal area [12].

4. Conclusions

As outlined above, the aim is to set up an integrated State-Region information system which can be used as the cognitive base required to develop and manage the General Plan for Water Improvement.

In this context, considerable emphasis will have to be laid during the various stages on the standardization of data acquisition, input and accessing procedures, as well as on the identification of the minimum levels to be guaranteed for the various sectors of interest and the fine-tuning of the information flows.

Furthermore, the experience gained during the various activities involved in setting up the information system will represent a useful body of knowledge on which to draw when designing nation-wide links. This is particularly important in the case of the use and calibration of general and dedicated hardware and the development of software for processing and displaying the information.

It should be borne in mind that the data bases on water quality and sources of pollution represent only a part of the cognitive base of the General Plan. A comprehensive information framework will require suitable supplementary work both in sectors already dealt with and in others of interest to the Plan.

Special reference will have to be made to the results of the surveys provided for in existing legislation, such as the census of surface and ground-water water bodies and the list of public and private discharges, as well as the observations required for setting up the regional water improvement Plans.

With regard to the future development of the information structures, new software packages are already being tested, e.g. SQL (Structured Query Language), 13 and ORACLE, 14 with a view to improving present performance and constructing new data bases.

On the whole in its present configuration, the information system that was briefly outlined above represents a useful term of methodological operational comparison for potential users such as the State, the Regions and other interested Agencies. In this sense, it can also contribute to the construction of a general nation-wide information system which will allow the development of functions for planning and managing action in the various sectors of environmental protection.

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SUMMARY

11 - AN INFORMATION SYSTEM FOR WATER QUALITY MANAGEMENT

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Paper submitted by the Water Research Institute, National Research Council, Italy.

The Italian clean water legislation provides for the preparation of a General Water Purification Plan which is to serve as the national programming instrument for the attainment of the water resource conservation targets. Work on this project has recently been initiated by the Ministry of the Environment.

The satisfaction of these requirements should lead to the creation of a computerized base in which the cognitive framework reflecting the actual condition of the country's water resource systems is organized.

The base is to be a kind of continuously updated photograph of the situation.

The sectors that will have to be taken into account by the Plan include:

— The characteristics of the area concerned, its hydrography, geology, climatology, etc. (basic and thematic cartography);

— Data on the quality of water bodies (surface and groundwater);

— Sources of pollution (population, agriculture, industry);

— Existing works (water treatment systems, aqueducts, sewers, purification systems);

— Management structures (central and local bodies);

— Economic data (investment costs, operating costs and profits).

The short and medium term objective is to produce an integrated computerized State-Region system structured in the form of a data bank which, as far as possible, draws upon the systems already in existence at the central and peripheral levels.

At present, this computerized system has definitely taken shape in the form of data banks on the quality of surface water

bodies and the sources of civil and industrial pollution. The information on quality relates to inland surface waters and was collected during a nation-wide survey which IRSA has been making since 1983 in collaboration with the central administrations, the regions and the many bodies responsible for water management and conservation.

The surface of the major Italian basins (Po, Tiber, Arno, Adige) has been covered.

The data on quality relate to observations made between 1973 and 1985, with a heavy concentration of information in the 1978-1983 period (over 80 per cent), covering approximately 1,700 sampling points on almost 600 rivers and 50 lakes and water basins. In all, approximately 150,000 items of experimental information are available.

With regard to sources of pollution, which represent the second sector developed in the data bank, archives of data collected in the general censuses of population and industry carried out by ISTAT, particularly in 1981, have been installed at IRSA.

At the same time, the conversion coefficients needed to assess pollution loads in population equivalent terms have been determined.

On the basis of these coefficients, the potential pollution loads from civil and industrial sources have been assessed for areas of different size.

The data bank on water quality and pollution sources briefly described in the report is only a part, although a very important one, of the information base needed for the elaboration and management of the General Water Purification Plan.

RESUME

11 - UN SYSTEME INFORMATISE POUR LA GESTION DE LA QUALITE DES EAUX

Auteur: Fausto Maria Spaziani

Document soumis par l'Institut de recherche sur les eaux du Conseil national des recherches, Italie.

La législation italienne concernant la sauvegarde des eaux contre la pollution prévoit la rédaction d'un Plan Général d'Assainissement des Eaux, qui doit constituer l'instrument de la programmation nationale dont l'utilisation va permettre d'atteindre les objectifs de sauvegarde des ressources hydriques. L'activité de formation de ce projet a été récemment mise en route par le ministère de l'Environnement.

La satisfaction des exigences doit mener à la création d'une base informatisée dans laquelle seraient organisés les cadres cognitifs correspondant à la réalité des systèmes de ressources hydriques existant dans le pays.

Cette base doit être une sorte de photographie de la situation mise à jour continuellement.

Il est opportun de signaler parmi les secteurs d'intérêt du Plan dont il faudra tenir compte:

— les caractéristiques du territoire, l'hydrographie, la géologie, la climatologie, etc. (cartographie de base et thématique);

— les données de qualité des corps hydriques (eaux superficielles et souterraines);

— les sources de pollution (population, agriculture, industrie);

— les ouvrages existants (systèmes de traitement des eaux, aqueducs, égouts, systèmes d'épuration);

— les structures de gestion (organismes centraux et locaux),

— les données économiques (coûts d'investissement, d'exercice et bénéfices).

A court et à moyen terme, l'objectif est de réaliser un système informatisé intégré Etat-Régions, structuré sous forme de Banque de données relative aux systèmes existant déjà au niveau central et périphérique.

Actuellement, on dispose des données sur la qualité des corps hydriques superficiels et sur les sources de pollution d'origine civile et industrielle.

Les informations sur la qualité se réfèrent aux eaux superficielles intérieures et ont été recueillies au cours d'une enquête menée par l'I.R.S.A. à l'échelle nationale dès 1983 et effectuée en collaboration avec les Administrations Centrales, les régions et les nombreux organismes responsables de la gestion et de la sauvegarde des eaux. On a couvert les surfaces des bassins italiens les plus importants (Pô, Tibre, Arno, Adige).

Les données de qualité concernent une période d'observation comprise entre 1973 et 1985, avec une grande concentration de l'information dans la période 1978-1983 (au-delà de 80%), et se réfèrent à 1.700 points d'échantillonnage environ distribués sur presque 600 fleuves et 50 lacs et bassins d'eau. Au total, on dispose de 150.000 informations expérimentales environ.

Pour ce qui concerne les sources de pollution, qui représentent le deuxième secteur développé dans la Banque de données en question, on a installé auprès de l'I.R.S.A. des archives des données relevées à l'occasion des Recensements Généraux de la Population et de l'Industrie menés par l'ISTAT, au cours de l'année 1981 particulièrement.

En même temps, il a été procédé à la détermination des coefficients de conversion nécessaires à l'évaluation des charges polluantes en termes de population équivalente.

Sur la base de ces coefficients il a donc été procédé à l'évaluation des charges polluantes potentielles provenant des sources civiles et industrielles pour différents niveaux d'agrégation territoriale.

La Banque de données de la qualité des eaux et des sources de pollution décrite de manière synthétique dans ces pages ne représente qu'une partie, bien que de grande importance, de la base cognitive nécessaire à la construction et à la gestion du Plan Général d'Assainissement.

Резюме

11 - АВТОМАТИЗИРОВАННАЯ СИСТЕМА КОНТРОЛЯ ЗА КАЧЕСТВОМ ВОДЫ

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Законодательством Италии в области охраны водных ресурсов от загрязнения предусмотрено составление Общего плана очистки вод, который должен служить национальным программным документом для достижения целей в области сохранения водных ресурсов. Министерство охраны окружающей среды недавно приступило к работе по этому проекту.

Разработка задач и оперативных стратегий Общего плана очистки вод, безусловно, создает широкие потребности в информации, которые не одинаковы во многих секторах, заинтересованных в программной деятельности.

Удовлетворение этих потребностей должно вести к созданию автоматизированной базы, в которой содержится основа информации, отражающей фактическое состояние национальных водохозяйственных систем. Такие системы представляют основные базовые планы для разработки деятельности по рациональному использованию и охране водных ресурсов.

Эта база должна быть своего рода постоянно обновляемым изображением положения, которое позволит лицам, отвечающим за общий план, выявлять новые возникающие потребности, текущие тенденции и элементы, с помощью которых можно оценивать эффективность мер.

Что касается состава этой автоматизированной базы в числе секторов, которые представляют интерес для плана и которые необходимо учитывать, можно назвать следующие:

- характеристики соответствующего района, его гидрография, геология, климатология и т.п. (базовая и тематическая картография);
- данные о качестве водоемов (поверхностных и подземных);
- источники загрязнения (население, сельское хозяйство, промышленность);

- существующие объекты (системы обработки вод, акведуки, канализационные коллекторы, системы очистки);
- структуры управления (центральные и местные органы);
- экономические данные (инвестиционные затраты, эксплуатационные расходы и прибыли).

В краткосрочном и среднесрочном плане цель заключается в создании комплексной автоматизированной государственно-районированной системы в форме банка данных, в котором, насколько это возможно, используются уже существующие системы на центральном и периферийном уровнях.

В настоящее время появилась возможность обеспечить конкретную реализацию этой автоматизированной системы в форме банков данных о качестве поверхностных водоемов и о коммунально-бытовых и промышленных источниках загрязнения.

Научно-исследовательский институт водного хозяйства (ИРСА) Национального научно-исследовательского совета (ННС) в сотрудничестве с министерством охраны окружающей среды осуществили техническую и организационную работу на различных этапах.

Что касается содержания баз данных, сбор информации о качестве внутренних поверхностных вод проводился в ходе общенационального обследования, которое ИРСА проводит с 1983 года в сотрудничестве с центральными и районными администрациями и многими органами, ответственными за рациональное использование и сохранение водных ресурсов.

Фактически можно сказать, что была охвачена площадь основных бассейнов Италии (По, Тибр, Арно, Адидже).

Данные о качестве относятся к наблюдениям, сделанным с 1973 до 1985 год, при этом значительный объем информации относится к периоду 1978-1983 годов (более 80%), охватывая приблизительно 1 700 участков взятия проб почти на 600 реках, 50 озерах и водных бассейнов. Всего имеется приблизительно 150 тыс. элементов экспериментальной информации.

В отношении источников загрязнения, которые составляют второй сектор, разработанный в банке данных, в ИРСЕ были созданы архивы данных, собранных в ходе общих переписей населения и промышленности, проведенных ИСТАТ, в частности в 1981 году.

В то же время были определены переводные коэффициенты, необходимые для оценки уровня загрязнения в пересчете на эквивалентное население.

На основе этих коэффициентов потенциальные уровни загрязнения из коммунально-бытовых и промышленных источников были оценены для районов разных размеров.

12 - AIMS AND TOOLS FOR THE MANAGEMENT OF STATISTICAL INFORMATION REGARDING THE ATMOSPHERIC ENVIRONMENT IN ITALY

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Paper submitted by ENEA, Study Directorate Italy.

1. Introduction

Good information is of paramount importance to the analysis, assessment and management of air quality. By «good» we mean a set of features, to be discussed below, which allow information to contribute positively to a successful solution of the problems posed.

With regard to atmospheric pollution, the mass of available information, including statistical data, can initially be divided into two large areas: information relating to emissions of polluting substances, i.e. the characterization (both qualitative and quantitative) of the polluting substances which are released into the atmosphere, at the time when they are discharged from a source (a stack for instance), and information relating to the concentrations of pollutants. In the case of concentrations, the secondary pollutants, produced by physical/chemical transformations during the dispersion process (e.g. sulphur and nitrogen acids and salts, ozone, etc.) ought to be taken into consideration together with the primary pollutants emitted directly into the atmosphere (e.g. sulphur and nitrogen oxides, heavy metals, organic compounds, etc.).

In a schematic representation of the atmosphere as an open system (i.e. one which exchanges energy and matter with other environmental media), the concentrations of harmful substances depict the state of the atmosphere or, alternatively, the degree of pollution.

Emissions, on the other hand, can be considered as input into the system, i.e. the agents altering its state, mediated by phenomena such as winds, atmospheric turbulence, physical/chemical transformations and depositions.

In respect of both emissions and concentrations of pollutants, the information is qualified by a set of attributes, which determine its «goodness». Below an attempt will be made to list a few of these attributes.

The first and perhaps most important characteristic of information is the source from which it originates. Often, the knowledge of the source of information allows to deduce its characteristics further and even make an initial appraisal of its goodness. Environmental data can be separated into two types according to their origin: administrative data, produced by public authorities, and scientific data, gathered by scientific agencies for study and research purposes (cf. ISTAT, 1984). It is clear that the different purposes for which the two classes of data are intended influence the nature of the information derived therefrom. Data from administrative sources usually refer to special provisions which should, therefore, guarantee (at least in theory) that uniform methods have been adopted throughout and that there is some degree of continuity in the survey. In the case of information of a more scientific nature, it is clear that one generally cannot expect homogeneity and continuity, except in co-ordinated activities (e.g. the CNR — Italian National Research Council — «special projects»), which frequently involve extensive efforts in the acquisition and organization of information referring to the environment.

In addition to the source, there are other characteristics qualifying information in general, and hence also data on air pollution; a tentative list is given below, with a reminder that the various headings are interdependent:

— Reliability, or the degree of trust one can place in the quality of information;

— compatibility, or the possibility of using it in conjunction with other information, for instance from a different source, both as regards the intrinsic characteristics and the physical supports (this latter characteristic may involve the possibility of processing on personal computer, or by standard software, etc.);

— capacity of representation, or the extent to which the information «captures» the properties of interest (for instance, the concentration of a pollutant found by a measurement station may or may not be representative of the pollution affecting a certain area, depending on the meteoclimatic and orographic conditions as well as the degree of precision one wishes to obtain);

— «usability»: in this context a property linked to the organization and management of information, which affords its appropriate and flexible use by several users, possibly having different needs and skills;

— updating possibilities: since the atmosphere is a dynamic system, all magnitudes (in particular those characterizing its pollution) vary in time; it is therefore essential that the temporal evolution of the properties in question be known, and that they be regularly updated.

Clearly, an appropriate use of automatic and computerized systems for the survey, collection, updating and general management of information usually enhances the goodness of information in terms of the above-mentioned characteristics.

One condition which is at least as important as the goodness of information is the ability to make an appropriate use and an adequate transfer of it. This becomes a crucial factor in those cases (and air pollution falls into this example) when technical/scientific and statistical information must be transferred to «outsiders» in a link which should be routinely established between technical and «political» competences on the one side, and environmental issues and public opinion on the other. With reference to the latter link of unquestionable social importance, the mass media play an essential and very delicate role. On this point, we believe it interesting to refer to several observations made on the mass media by E. Diamond (1985), a journalist and Political Sciences lecturer at the Massachusetts Institute of Technology, in relation to the perception of environmental risk. According to Diamond, the mass media are geared towards novelty and the ability of novelty to «make news» — a normal landing is not news, whilst an air accident occurring during landing is. They are dependent on the type of information source referred to; in general, they are neither technical nor specialist; they have small and limited amounts of time, space, resources to organize and «digest» information. This makes it necessary for them to devise and put into practice efficient methods for the organization and representation of information by «insiders», in such a way as to minimize the erosion of the actual information during its two-stage transmission from the engineers to the mass-media, and from here to the public.

Below, we shall briefly look into some aspects of information on emissions and concentrations of air pollutants, referring to activities launched within the framework of the ENEA VESE project.

2. Estimation of air polluntant emissions

ENEA, within the framework of the VESE project (Valutazione degli Effetti Ambientali e Socioeconomici dei Sistemi Energetici), has embarked in a study programme having the objective of compiling a national inventory of air pollutant emissions and designing an information system to manage and update this inventory. Five pollutants are considered in this phase, because of their importance and availability of information, i.e. sulphur oxides (SO_x), nitrogen oxides (NO_x), total suspended particles (TSP), carbon monoxide (CO) and volatile organic compounds (VOC). The estimates refer to emissions from combustion processes which are generally the most significant.

The pollutant emissions resulting from combustion processes may be approximated to some extent, once the main chemical and physical features of the fuel used, the methods of the combustion process and, lastly, the presence and efficiency of any anti-pollution devices or techniques, are known. The more detailed this information is, the more reliable the choice or definition of a suitable emission factor are and the more precise are, as a consequence, the emission estimates. It could be pointed out also that overall emissions of air pollutants, such as those considered here, cannot be obtained in any way than by estimation, since other methods for their evaluation, for example continuous monitoring at the source, cannot cover the entire field in question.

When estimating emissions, the spatial and temporal disaggregation to be used has to be determined. To date, emissions have been estimated countrywide for 1976, 1980 and 1984. A disaggregated estimate by regions was also performed for 1980 (Bocola and Cirillo, 1986). Also available are SO_x and NO_x emissions at province levels, for the same year.

The estimation of emissions is based on an information system. The system, which can also be utilized on a personal computer, combines an easy use with a flexible and effective organization. An effort was made to attain this goal through both the planning and implementation of an interactive consultation and management procedure, and the generation of an efficient listing of emissions allowing both the sensitivity analysis and study of several scenarios, while fully protecting the primary information contained in the data base proper (Figure 1). The largest spatial disaggregation envisaged for the information is by province.

Figure 2 shows the breakdown of air pollutant emissions from combustion processes for 1980 by economic sector. Figure 3 gives an idea of the pattern of overall emissions in Italy during the period from 1976 to 1984. It is important to note that the overall picture masks the marked variation that exists among different locations in the peninsula, which could already be noticed from the regional estimates (cf. provincial SO_x and NO_x emissions reported in Figures 4 and 5). Furthermore, the annual emissions completely conceal any seasonal fluctuation in emissions, as well as daily changes.

Subsequent to this initial effort to quantify systematically the emissions of the five main air pollutants and prepare at the same time an adequate information system, it may be concluded that the situation apparent in Italy was not found to be particularly favourable. Indeed, a price is being paid for the institutional and organizational shortcomings affecting the sector of environmental protection, which have so far impeded the creation and development of a national service equipped for the collection and systematic processing of data of interest. Furthermore, no census or recording of emissions was ever performed locally or regionally, with the exception of a few census studies performed on the initiative of some province or region and, for study purposes, by ENEA. The difficulty of collecting basic information, such as that relating to the quantity and type of fuel used, was found to be generally proportional to the spatial disaggregation involved.

For these reasons, and owing also to the fact this is the first attempt to deal systematically with the problem on a national scale, the estimates discussed here are preliminary and need to be extensively reviewed. These remarks apply especially to the emissions of pollutants, such as nitrogen oxides, for which the emission factors are particularly uncertain.

3. AIR QUALITY

Data on air quality depend on measurements of ambient air concentrations, which are carried out by means of automatic survey systems. Information has been published by agencies and laboratories running survey networks, in bulletins, technical reports and articles in technical-scientific journals. Information pertaining to the last ten years was used in collecting and organizing these data.

The survey, whose initial results are reported in a document prepared by the «Direzione Centrale Studi» for the Ministry of the Environment (ENEA, 1986), may be further extended and completed in the future, if more resources become available and if solutions can be found to overcome various obstacles, which often render access to data sources difficult if not squarely impossible in our country. In this context, the reliability of measurements and their processing may also be checked and, wherever necessary, data may be consulted as they are recorded by the survey systems.

The networks for surveying atmospheric pollution were set up in the early Seventies and purported to check that the concentration of certain pollutants in the air, primarily sulphur dioxide, did not exceed legal limits. Various mandates were established for managerial purposes: State authorities of the provinces (Provincial Laboratories for Health and Hygiene); more recently, Local Health Units, town councils and similar regional authorities; and ENEL (the Italian Electric Utility Board), in compliance with law 880/1973. Survey networks were set up in the industrial sector — on the initiative of individual companies or consortia — for «internal use». Thus, data collected through these networks are not necessarily publicly available.

In Italy, at least 66 survey networks have been set up. The number of measurement stations is 357 for sulphur dioxide (SO_2), 124 for total suspended particles (TSP), 48 for nitrogen oxides (NO_x), 25 for total sulphur (Stot), and 51 for other pollutants such as carbon monoxide, ozone (O_3), hydrocarbons (HC), hydrogen sulphide (H2S) and hydrogen fluoride (HF). Generally, the networks are equipped with meteorological stations (several have up to four), and are located practically throughout the whole country, with a higher density in areas with important industrial settlements. However, several regions lack networks, primarily in the central-southern parts of the country.

The working capacity and actual performance of networks and related survey services vary considerably in Italy. There is not sufficient information on the territorial coverage of each network, nor on interruptions in the work of the stations. Frequently, the distribution of measurement stations does not seem to take adequate note of inhabited areas.

Within these limits, though, the survey results provide an interesting — albeit partial — picture of air pollution in Italy. In particular, there is some useful information available on the temporal pattern of pollutant concentrations examined and the compliance or noncompliance with the corresponding legal restrictions in different areas of the country. Finally, information is obtained about the methodologies adopted so far for collecting and processing data as well as about the working methods of laboratories. It is to be hoped that the latter will be used to complete the survey and set in motion a process to standardize, rationalize and step up activities in monitoring and control.

By way of example, Figure 6 shows the annual median and 98-percentile of the average daily concentrations of sulphur dioxide, found in four out of ten stations in the city of Milan during the period from 1978 to 1985. The Figure compares the actual data with the corresponding limits established by the DPCM of 28.3.83, which are 80 μg/m3 (equivalent to 0.030 ppm) and 250 μg/m3 (equivalent to 0.095 ppm), respectively. The Figure clearly shows that legal limits are usually exceeded and that concentrations have decreased even if these characteristics may have come to a halt lately.

To conclude this brief description of the collection of statistical information pertaining to air quality in Italy, it seems that the considerable lack of uniformity in data measurement, processing, presentation and assessment methods as adopted by different laboratories and local and regional authorities was confirmed once again. The failure of past endeavors to standardize such methods on a national scale was corroborated, together with the urgent need for efforts to co-ordinate work, centered around the drawing up and recommendation of criteria and guidelines for pollution surveying services, and the preparation of efficient and transparent indicators of air quality, also bearing in mind the experience gained in other countries (Malatini and Pinchera, 1986). This is a task which calls for the creation of a workable organism, equipped with the necessary technical, financial resources and personnel and able to carry out its activities efficiently and uninterruptedly.

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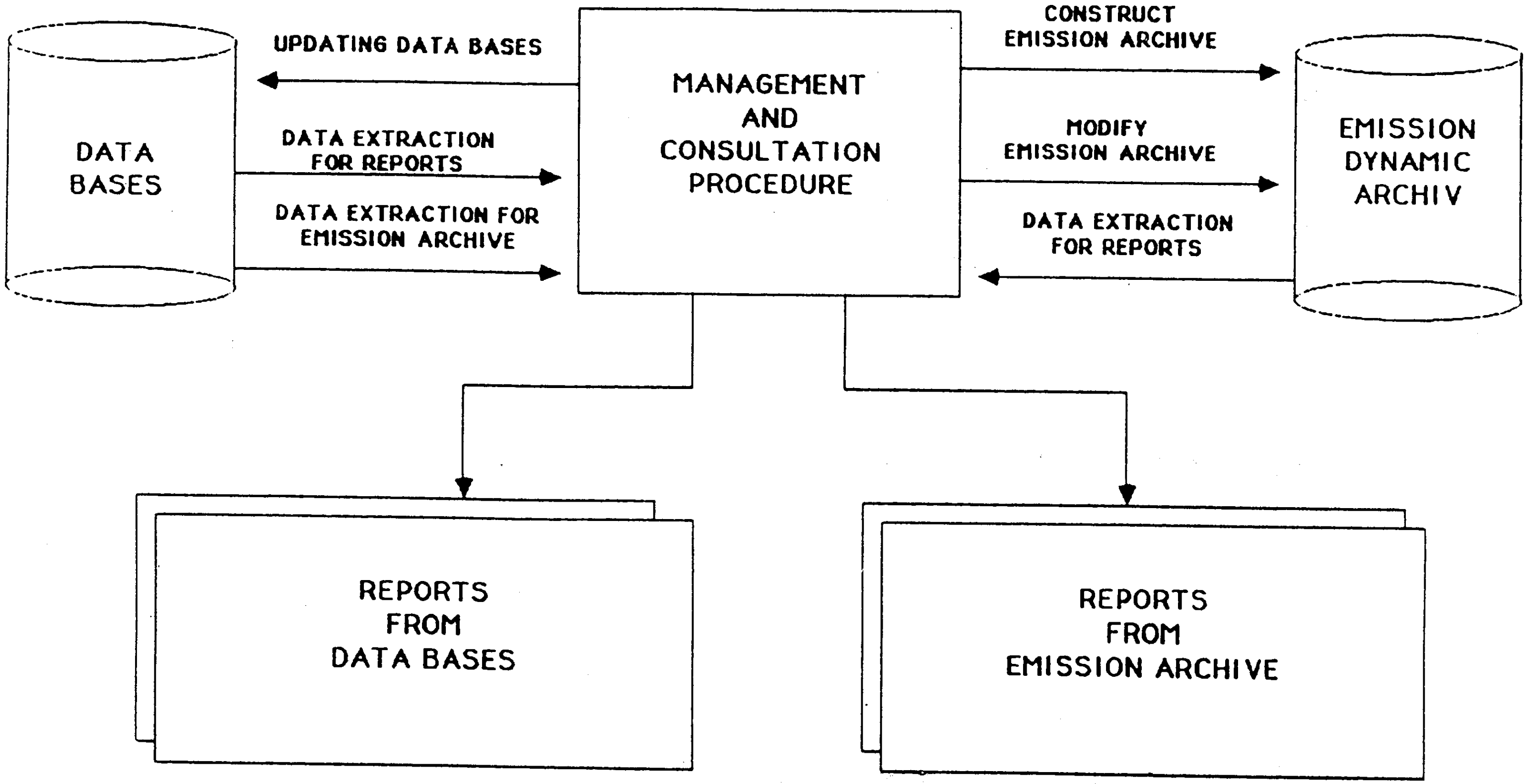


Figure 1. Structure of the information system.

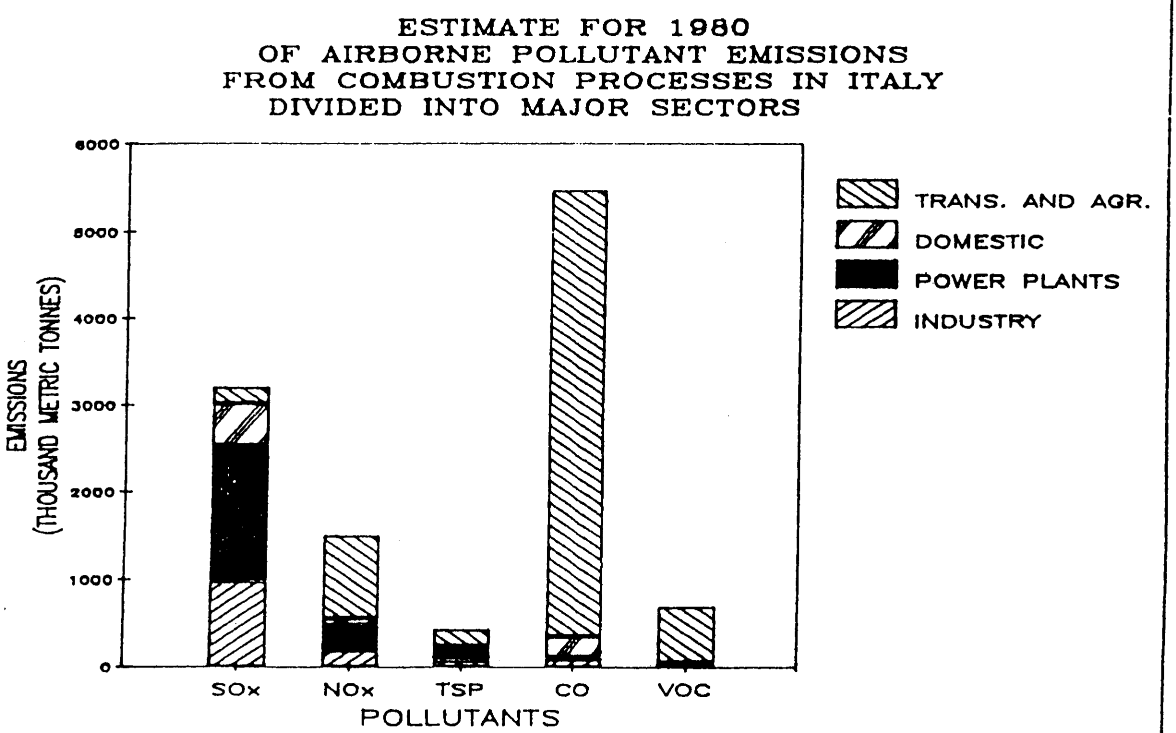


FIGURE 2.

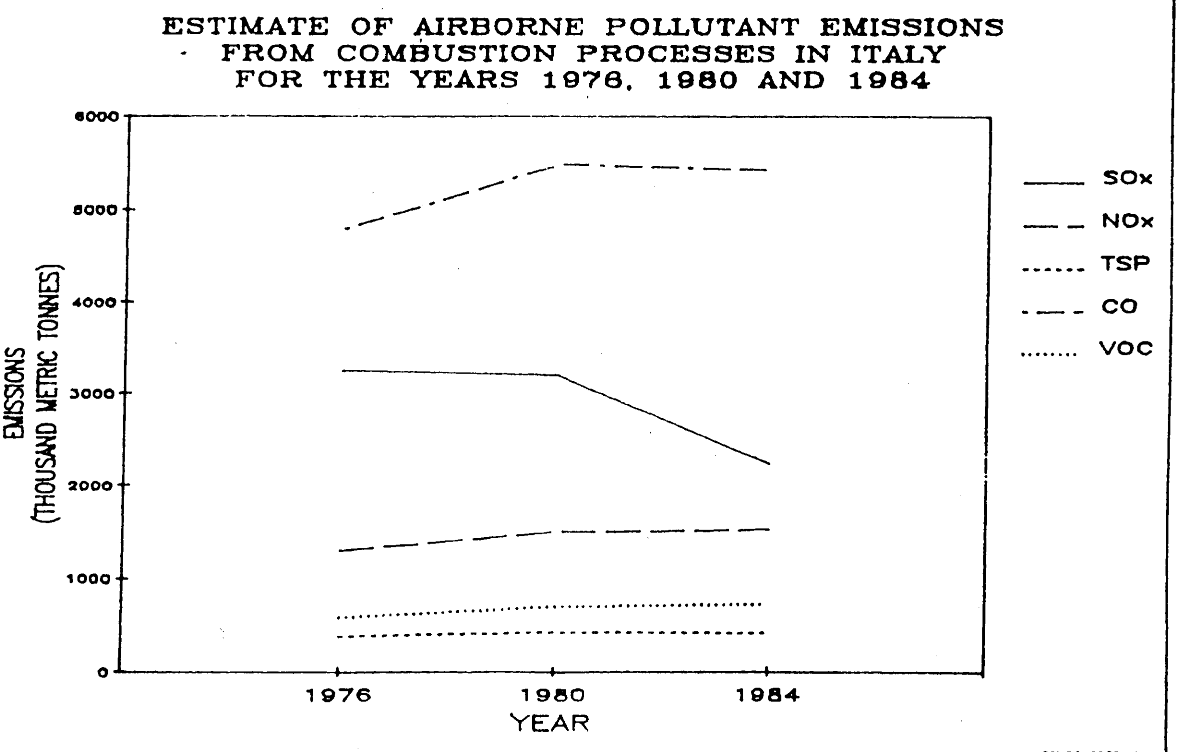
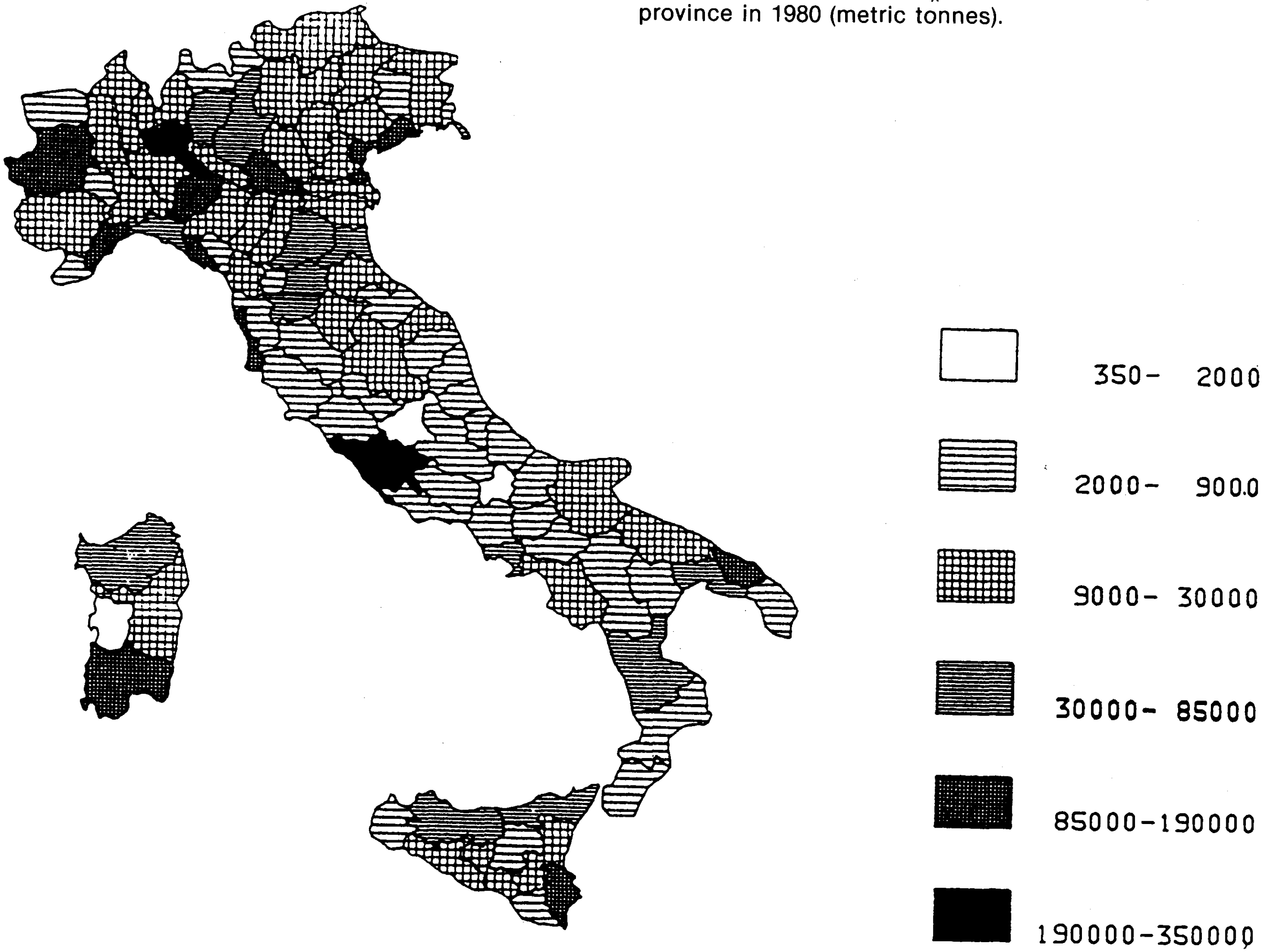


FIGURE 3.

Figure 4. Estimate of SO_x emissions in Italy from combustion processes by province in 1980 (metric tonnes).



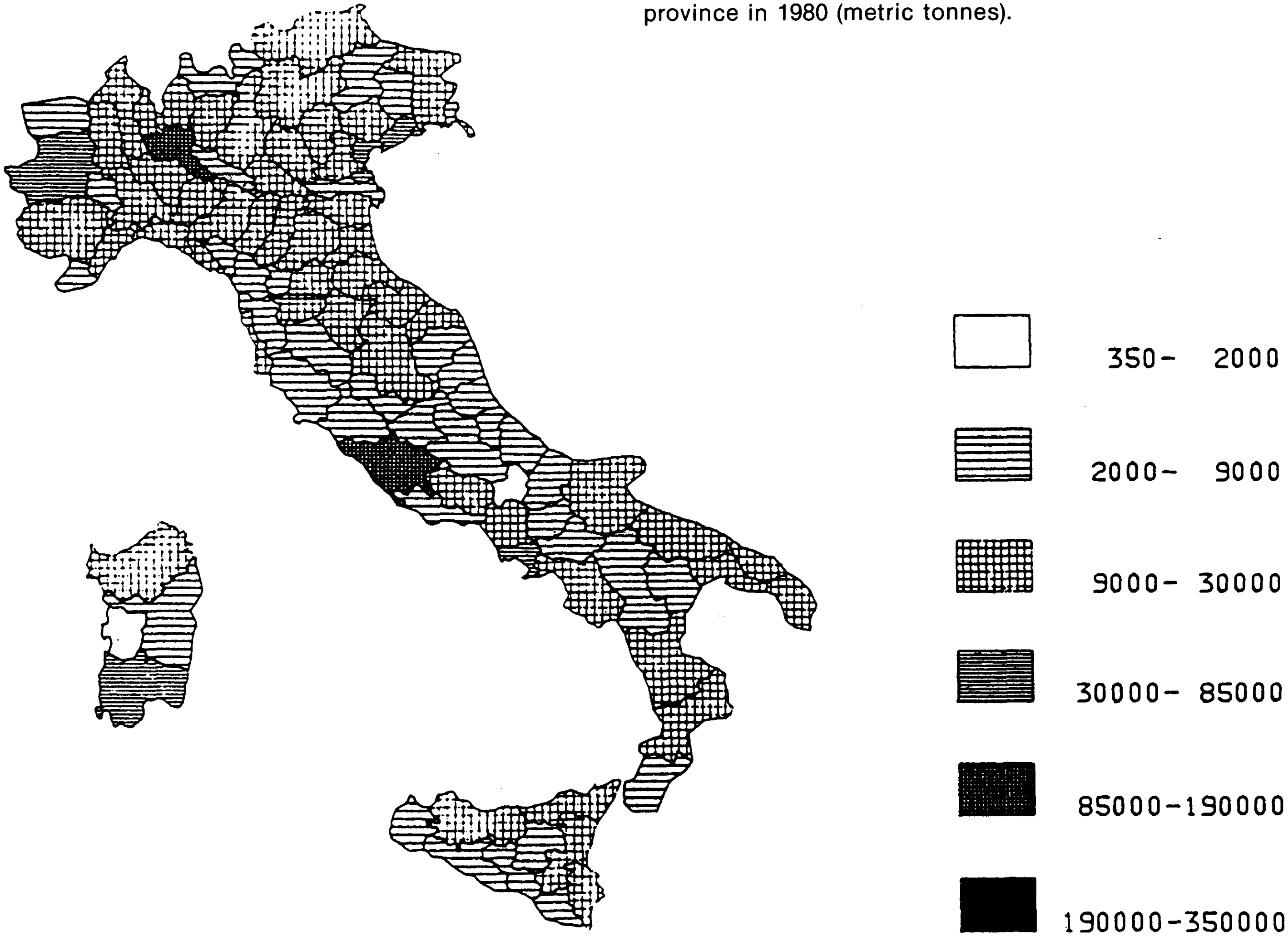


Figure 5. Estimate of NO_x emissions in Italy from combustion processes by province in 1980 (metric tonnes).

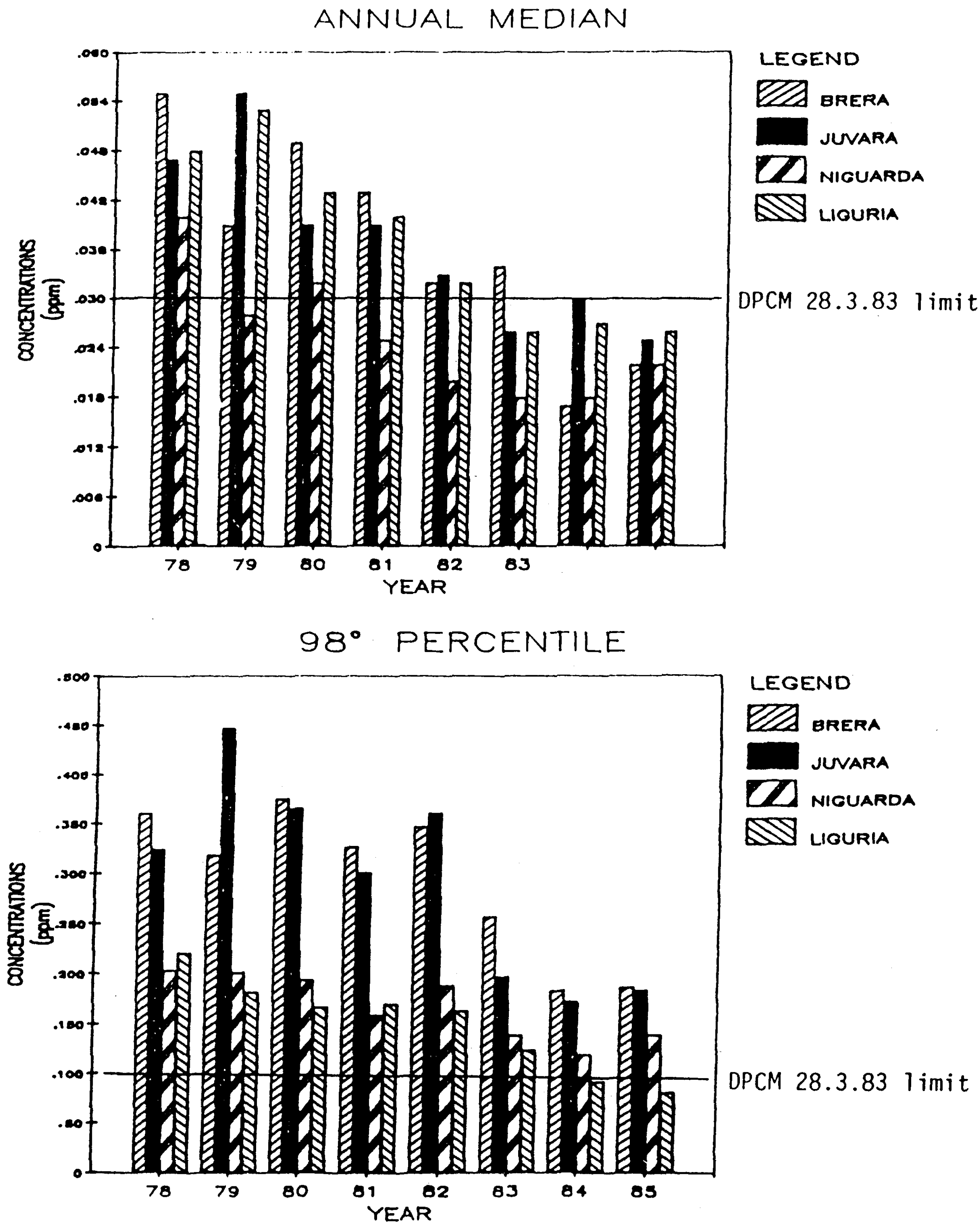


Figure 6. City of Milan, SO_2: trend of annual median and 98° percentile for average daily concentrations in 4 stations during the period 1978-1985.

SUMMARY

12 - AIMS AND TOOLS FOR THE MANAGEMENT OF STATISTICAL INFORMATION REGARDING THE ATMOSPHERIC ENVIRONMENT IN ITALY

Authors: W. Bocola, M. C. Cirillo, G. C. Pinchera

Paper submitted by ENEA, Study Directorate, Italy.

This paper presents a few remarks about the organization and use of information allowing to describe the air quality situation in Italy.

The main issues in the management of statistical information concerning the atmospheric environment, as well as other environmental sectors, are:

— systematic collection, organization and updating of information and data,

— continuous, objective and transparent transmission of this information to decision-makers and the general public.

The paper goes on to describe an information system, also available on personal computer, designed to store the basic information needed to estimate emissions of air pollutants (e.g. fuel consumption, emission factors etc.), and calculate the emissions. The first results relative to the emission of the five main air pollutants (sulphur oxides, nitrogen oxides, total suspended particles, carbon monoxide and volatile organic compounds) are also presented with reference to administrative areas (regions and provinces) and the EMEP grid system which is being used in long-range transport studies of air pollutants in Europe.

The activity concerning the systematic collection and organization of air quality data in Italy is also described. Work is still in progress, in respect of both the acquisition of data and the design and implementation of the system for the storage, management and effective presentation of information. The work done up to now points to a few problems regarding the homogeneity and reliability of information obtained from different measurement networks.

In our opinion, greater co-ordination is needed in the management of information relating to air pollution. This co-ordination should be oriented both towards networks and data collection systems, and towards the preparation of effective methods for the organization and presentation of information.

RESUME

12 - OBJECTIFS ET INSTRUMENTS DES STATISTIQUES SUR LES CONDITIONS ATMOSPHERIQUES EN ITALIE

Auteurs: W. Bocola, M. C. Cirillo, C. Pinchera

Document soumis par l'ENEA, Direction centrale des études, Italie.

Le document offre certaines considérations sur l'organisation et l'utilisation des informations qui permettent de faire le point de la situation concernant la qualité de l'air en Italie.

Les principales questions qui se posent à propos de la gestion de l'information statistique sur le milieu atmosphérique ainsi que d'autres secteurs de l'environnement sont les suivantes:

— Collecte, organisation et mise à jour systématiques de l'information et des données,

— Transmission continue, objective et transparente de cette information aux décideurs et au public.

Le système d'information décrit ici, qui est également accessible sur ordinateur personnel, vise à la fois à stocker les informations de base nécessaires pour établir des estimations des émissions de polluants atmosphériques (par exemple la consommation de carburant, les facteurs d'émission, etc.), et pour calculer ces émissions. Les premiers résultats concernant les émissions des cinq principaux polluants atmosphériques (oxydes de soufre, oxydes d'azote, ensemble des particules en suspension, oxyde de carbone et composés organiques volatils) sont également présentés par division administrative (régions et provinces) et en référence au réseau EMEP qui est utilisé pour les études sur le transport à longue distance des polluants atmosphériques en Europe.

Le document contient également une description des activités liées à la collecte et à l'organisation systématiques des données sur les mesures de la qualité de l'air en Italie. Les travaux se poursuivent en ce qui concerne le rassemblement des données ainsi que la conception et l'application du système d'information qui sera utilisé pour le stockage, la gestion et la présentation de cette information. Les résultats obtenus jusqu'ici font apparaître

certains problèmes liés à l'homogénéité et à la fiabilité de l'information provenant des différents réseaux effectuant les mesures.

Il semble qu'une plus grande coordination soit nécessaire dans la gestion de l'information relative à la pollution atmosphérique. Il faudrait que cette coordination soit axée sur l'élaboration et l'application de directives pour la gestion des réseaux de mesure et des systèmes de collecte des données, ainsi que sur la mise au point de méthodes efficaces pour l'organisation et la présentation de l'information.

Резюме

12 - ЦЕЛИ И СРЕДСТВА ПОДГОТОВКИ СТАТИСТИЧЕСКОЙ ИНФОРМАЦИИ ПО АТМОСФЕРНЫМ УСЛОВИЯМ В ИТАЛИИ

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В этом докладе содержатся некоторые выводы, касающиеся организации и использование информации, позволяющей описать качество окружающего воздуха в Италии.

Основными вопросами в области управления статистической информацией, касающейся состояния окружающего воздуха, а также других экологических сред, являются следующие:
- систематический сбор, составление и обновление информации и данных;
- непрерывная, объективная и открытая передача всей этой информации лицам, ответственным за принятие решений, и широкой общественности.

В этом документе мы описываем информационную систему, доступную и для персональных компьютеров, в задачу которой входит как хранение основной информации, необходимой для оценки выбросов атмосферных загрязняющих веществ (например, данных о потреблении топлива, коэффициентов вредности производства и т.д.), так и проведение расчетов для определения количества газообразных отходов. Первые результаты, касающиеся выбросов пяти основных атмосферных загрязняющих веществ (окислов серы, окислов азота, взвешенных твердых частиц, окиси углерода и летучих органических соединений), также представлены применительно к административным единицам (районам и провинциям) и системе координат ЕМЕП, которая используется при проведении исследований переноса атмосферных загрязняющих веществ на большие расстояния в Европе.

Кроме того, описывается деятельность, касающаяся систематического сбора и объединения данных об измерениях качества окружающего воздуха в Италии. В настоящее время продолжается работа и по сбору данных, и по проектированию и созданию информационной системы, предназначенной для хранения, управления и эффективного представления информации. К настоящему времени в результате этой деятельности выявились некоторые проблемы, касающиеся однородности и надежности информации, которая получена из различных сетей измерительных станций.

Мы считаем, что для управления информацией об атмосферных загрязняющих веществах требуется большая координация деятельности. Скоординированная деятельность должна быть направлена на разработку и практическое применение основных принципов управления сетями измерительных станций и системами сбора данных, а также на разработку эффективных методов организации и представления информации.

13 - MONITORING WILDLIFE HABITAT - A CRITIQUE OF APPROACHES

Author: Mel Schamberger

Paper submitted by the National Ecology Research Center, Fish and Wildlife Service, U.S.A.

Introduction

Modern man is increasingly interested in the status of his surroundings; we constantly evaluate changes that occur in those things that influence our lives. We monitor weather patterns, chemicals in the air, water, soil, ocean currents, minerals, crops, and the economy. Monitoring data often are used for predictive purposes. The field of wildlife science is no different; there is substantial interest, worldwide, in wildlife monitoring, to better understand and predict natural systems.

Monitoring of wildlife historically has focused on animal populations (e.g., Miller and Gunn 1981; Halverson 1984; Miller 1984; Cooperrider et al. 1986) or on vegetation as it relates to wildlife populations (e.g., Bell and Atterbury 1983; Estes and Thorley 1983). Researchers conducting inventories to determine timber status and condition for lumber soon discovered that such inventories, with little additional effort, could be used to inventory and monitor wildlife habitat as well (e.g., Grelen and Lewis 1978; Barnes 1979). The advent of satellite imagery has added a new dimension to our ability to monitor both wildlife populations and their habitat. New techniques are being developed to radiotrack individual animals using satellite transmitters. Vegetation and other landscape features are routinely being remotely sensed (Mayer 1984), and capabilities are rapidly increasing as resolution improves (Woodcock et al. 1982). The technology now exists to include additional data themes, including landform and spatial considerations, which greatly expands the opportunities for wildlife habitat monitoring.

In this paper I explore reasons why modern societies should be concerned about wildlife habitat monitoring, provide a rationale for habitat monitoring as compared to the monitoring of animal populations, and discuss some techniques that greatly expand the capability to monitor habitat.

Why monitor wildlife and their habitat?

The interest in wildlife monitoring ranges from practical to ethical to legal. Many wildlife species provide economic returns to individuals and nations, and this ensures their success and propagation. The need to obtain information about these species is evident, and the self-interest of those involved ensures that adequate data are obtained for management purposes.

Species without economic importance, however, have not fared so well. Human activity during the past 300 to 400 years has resulted in an increased extinction rate. The geologic record for the Pleistocene, a period with a relatively high natural extinction rate, demonstrates that three species of birds and mammals were lost per 100 years (Opler 1977). Opler (1977) noted that, in the United States, during the 100-year-period from 1860 to 1960, 160 species (plant and animal) vanished, which is much higher than the extinction rate of the Pleistocene. Plant species also are vanishing rapidly. Kepler and Scott (1985) noted that, in Hawaii, 1,172 of the 1,765 known species of vascular plants are either extinct, endangered, or rare. Plants, in addition to their inherent value, provide the basic structural habitat components for most terrestrial wildlife species. Meyers (1983) estimated that, worlwide, about 1,000 species of plants are being lost annually.

The world conservation community is extremely concerned about this alarmingly high extinction rate. Scientists decry the loss of genetic diversity resulting from species extinctions, and the general loss of species richness on this planet. Although some recent extinctions have occurred as a result of overexploitation, the introduction of feral animals, or other causes, most wildlife losses appear to be a direct result of habitat loss or alteration (Meyers 1983). Habitat is the very basis for species survival. Thus, the monitoring of habitat can provide early warnings that can help preserve all life forms on earth: man should not knowingly be responsible for destroying these unique forms. Previously «unimportant» species have subsequently provided important contributions to human health and welfare.

At the practical level, scientistis have found that plants and animals often are more sensitive to air, water, and soil degradation than are humans. Thus, they may serve as early warning sentinels of impending danger, such as the sensitivity of raptor populations to DDT, aquatic life to degradation of water quality, and terrestrial vegetation to air pollution. As degradation occurs, the first species to be lost usually are not the dominant and obvious, but rather the inconspicuous and often overlooked members of the ecosystem. Thus, monitoring of wildlife habitat may provide important insights to the general health of our environment.

From a legal perspective, many developed and developing nations have legislation that provides some protection from environmental degradation. In most instances, however, it is incumbent upon agencies or individuals to prove that a proposed development action is environmentally damaging, rather than on the developer to prove that it is not. Rarely are data available in advance to provide the assessments and predictions needed to protect environmentally sensitive areas. Habitat monitoring can provide a data base from which informed decisions can be made, and to support legislation. Finally, monitoring also can provide the long-term ecological records needed to distinguish natural variation from man-induced perturbations.

Monitoring concepts

Wildlife habitat monitoring was not possible until species and habitats were described, and classification systems and inventory methods were developed. By monitoring I mean inventories (in this case, of wildlife habitat) conducted in precisely the same manner at different points in time. In the United States, classification, inventory, and impact assessment predominated in much of the literature in the past 30 years; now monitoring is becoming increasingly important as we move to more intensive management of wildlife resources (e.g., O'Neil and Schamberger 1983).

Monitoring, however, is not an end unto itself. Clear objectives must be established to focus the data gathering, and the data must be interpreted in a manner consistent with the techniques used to gather that information. Halvorson (1984) notes and discusses four essential elements in a monitoring program: (1) long-term data to bracket variability; (2) a statistically valid design that is sensitive to trends; (3) cost-effectiveness; and (4) ecological appropriateness. Monitoring should be approached systematically. Salwasser et al. (1983) identified steps to follow in setting up a monitoring program: set monitoring objectives, identify what is to be evaluated, collect the data, and analyze the results.

The study must be focused on two basic questions: (1) What do I monitor? and (2) How should I monitor it? The «what» is first a decision to monitor either populations or habitat. Population monitoring addresses the trends and status of animal numbers, but provides little or no data about the ability of the land to support the species. Conversely, habitat monitoring provides no information about population levels, but does provide information about habitat availability that is valuable for species management. Habitat monitoring refers to measurements of the physical, chemical, vegetative, spatial, and landform components of the environment that are important to species survival and propagation.

Habitat monitoring assumes that measurements of the environment, not the species, will provide the data necessary to meet the objectives of the monitoring study. The presence of suitable habitat, however, does not guarantee the presence of the population of interest. Therefore, habitat monitoring must be supplemented at some point with census information to ensure that the populations are indeed related to the habitats being monitored. Both types of monitoring are needed, and each addresses specific problems.

Some investigators have used population monitoring as a measure of habitat quality. Only in very narrow circumstances is such an approach warranted. Populations fluctuate for a variety of reasons, including events that may occur at some distance from the study area. Populations may increase or decrease while habitat carrying capacity remains constant. Van Horne (1983) cited several examples where population densities were inaccurate estimators of habitat quality. Overexploitation, disease, or catastrophic weather events can dramatically reduce populations. The black-footed ferret, for example, was once widespread over the prairie grasslands of the United States. By the 1980's, the species had been reduced to a single known breeding colony near Meeteetsee, Wyoming, with a population of approximately 130 animals. Canine distemper apparently infected the colony, dramatically reducing the population to a point that a decision was made to remove all known remaining animals from the wild for captive breeding; only 19 animals remained alive in 1986. Field surveys have indicated that extensive habitat remains in the Meeteetsee area, thus nonhabitat factors seemed to limit this population. Although there are instances where population monitoring (as opposed to habitat monitoring) can be indicative of habitat quality, the dynamics of the population must be clearly known, and all other factors influencing population size must be evaluated and discounted as possible causes of population change.

Habitat monitoring components

Wildlife habitat has two important components that can be monitored: the physical area of land available and the quality of that area in terms of its ability to provide the necessary food, cover, and other resources needed for species survival and propagation. A monitoring program can address either or both of these components. The area measurement is usually the easier of the two to obtain; the quality factor often is very difficult to measure.

At the most general level, habitat monitoring may be nothing more than monitoring the size and location of vegetative or cover types, for example, the acreage of wetlands, deciduous forests, or tropical rainforests. The monitoring of gross vegetative types is useful in those situations where it can be assumed that the mere presence of that vegetative type, regardless of variations in vegetative composition and structure, is sufficient to provide all life requisites for the species or group of species; it assumes that the quality of the habitat is important. Aerial photography is ideally suited for the monitoring of vegetative types; although field surveys can be used to monitor the size of vegetative types, the level of accuracy is less than with aerial photography. All that can be said from this type of monitoring is that there is a certain number of acres of a specific vegetative type that has the potential to support certain wildlife species. In some situations this is adequate, particularly in situations where the natural vegetation is not significantly altered by human factors. Unfortunately, most areas of the globe have now been significantly influenced by human activity; various degrees of degradation have occurred, and these habitats are no longer functioning at their biological potential. As a result, the second characteristic, that of habitat quality, must be addressed.

A substantial literature base is being generated about the dependency of wildlife on the structure and species composition of dominant vegetation, such as dominant tree species in a forest (Rotenberry 1985). For example, Franzreb (1978) reported that five species of insectivorous birds preferred one species of conifer over another. Gutzwiller et al. (1983) reported that habitat structure seemed to be more significant than vegetative composition in the selection of breeding sites by woodcock, and Robbins (1978) reported that habitat variables were useful in predicting habitat use for 8 of the 20 species of nongame birds included in his analysis. Other studies have demonstrated that the diversity of species of birds in terrestrial habitats is correlated with floristics (Holmes and Robinson 1981; Robinson and Holmes 1984), and that individual habitat variables are correlated with habitat use by avian species (Anderson 1981). I conclude that in some, but not all, instances habitat variables related to vegetative structure or compositions can be used to define habitat quality.

One prerequisite for wildlife habitat monitoring is that scientists must know enough about the ecology of the species to develop a set of habitat criteria to define the needs of the species and that are suitable for monitoring. A criticism of this approach is the simple fact that, for the majority of species, quantitative information linking the species to its habitat is just not available. Halvorson (1984) noted «For very common species, it is possible to accurately predict their presence, or even their abundance, from secondary indicators such as vegetation type or structure.». Monitoring for such species can be based on habitat factors, but researchers must be careful not to extend habitat monitoring beyond the knowledge of species-habitat relationships.

Habitat monitoring approaches

The application of habitat concepts to monitoring activities is based on the integration of species habitat relationships information into a set of monitoring criteria that provides a reasonable and accurate depiction of the habitat needs of the species. There is a growing body of literature that facilitates the approach outlined above, including the development of models that quantitatively relate habitat features to the presence or absence of species and to habitat quality (e.g., Schamberger and Turner 1986; Verner et al. 1986).

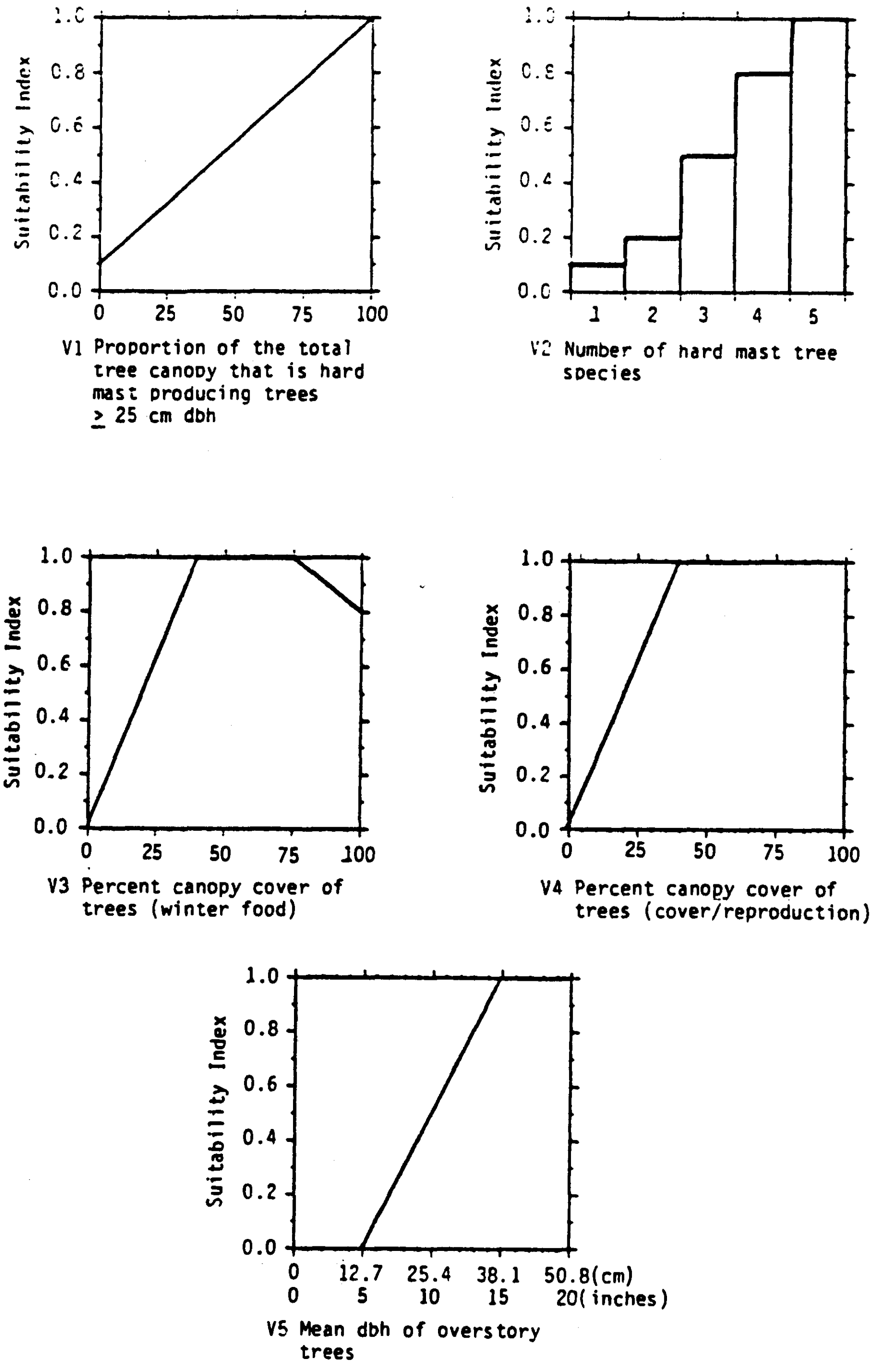
— *Habitat Models*

Determining habitat quality for species is extremely difficult and is one of the major shortcomings of habitat monitoring. The investigator must select some criteria or characteristics of the habitat that directly or indirectly influence the species or population of interest. Usually this involves some type of modeling activity. The pitfalls of using models are numerous, and include the problem of using a small number of variables to represent a complex system, choosing incorrect or inappropriate variables to represent that system, and improperly defining the boundaries within which the model can operate (Capen 1981; Romesburg 1981; Suter et al. 1987). However, using a habitat approach requires that some subset of the real world be used as the basis for selecting monitoring variables.

Our Center has worked for the past 10 years developing habitat information into a form suitable for inventory and impact assessment. Habitat suitability index models have been developed that outline the important habitat needs of species based on functional relationships called suitability indices (U.S. Fish and Wildlife Service 1980). These models estimate, on a scale of 0 to 1, the relative habitat quality of an area for a species of interest. An example is the habitat model for the gray squirrel (*Sciurus carolinensis*) (Allen 1987), which contains five variables that define habitat suitability for this species in the eastern United States (Figure 1). These same variables could provide the basis for monitoring gray squirrel habitat. Over 140 models of this type have been published by the U.S. Fish and Wildlife Service for use in impact assessment and habitat analysis studies; they should be applicable to habitat monitoring studies as well. One shortcoming of these models is that they often focus only on a portion of the life requisite needs of the species, such as wintering or breeding habitat. A robust monitoring program should ensure that all habitat requirements are monitored. The basic assumption in this approach is that the habitat, as described by the variables selected for monitoring, will support the species being monitored.

— *Remote Sensing*

Remotely sensed data are very useful (and sometimes essential) in monitoring both habitat size and, in some cases, habitat quality as well. Early applications of remote sensing data were based primarily on structural features of the habitat. LANDSAT data have been used to classify vegetative cover types (e.g., Botkin et al. 1984) and those classifications have been used to monitor wildlife habitat. Habitat for species that have extensive ranges requiring multiple cover types is easily monitored using aerial photography. For example, Cannon et al. (1982) used LANDSAT data to monitor lesser prairie-chicken (*Tympanuchus pallidicintus*) habitat in Oklahoma, based on vegetative cover classes. Such studies monitor the size of major vegetative associations, providing data for the size component of overall habitat availability. Big game animals are particularly well suited for such monitoring. Examples include habitat mapping for elk (*Cervus canadensis*) in norheastern Oregon (Isaacson et al. 1982), aerial habitat census for the gray kangaroo (*Macropus gigantus*) in southern Queensland (Hill and Kelly 1987), seabird habitat mapping by Haney (1986), and many others (e.g., Saxon 1983; Pojar 1984; Craighead et al. 1986). LANDSAT and other aerial imagery also have tremendous potential to provide information concerning the quality of the habitat as well as providing information on size. Asherin et al. (1979) demonstrated that habitat quality can be assessed simultaneously for several species over large areas, using color infra-red aerial photography.



$$\text{Winter Food Index} = (SIV1 \times SIV2)^{1/2} \times SIV3$$

$$\text{Cover/Reproduction Index} = (SIV4 \times SIV5)^{1/2}$$

Figure 1: An example of habitat variables for the gray squirrel that are suitable for habitat monitoring (from Allen 1987).

Remote sensing also offers exciting opportunities for wildlife biologists to engage in habitat monitoring at a landscape scale. Applications include monitoring single variables as well as monitoring complex habitat requirements. For example, Cooch et al. (1976) determined that breeding success of the snow goose (*Chen hyperborea*) is dependent on, among other factors, the timing of ice-out on the breeding grounds. They used satellite imagery to correlate ice-out with breeding success and determined that, in years when ice covered the area late in the breeding season, breeding success was very poor. Such information, obtained early in the year, has direct management implications in the setting of restrictive hunting regulations in years when breeding success is predicted to be low, based on annual monitoring of spring ice conditions on the breeding areas. Stephenson and Brown (1980) used snow cover as a variable in predicting population sizes of Abert's squirrel (*Sciurus aberti*). Excessive snow cover decreases food availability and thus increases winter mortality for the Abert's squirrel. For both of these species, snow cover obviously is not the only factor that can reduce habitat suitability, but is one factor that can serve as a habitat variable in monitoring studies.

In spite of the exciting opportunities available with remotely sensed data, certain shortcomings must be noted, the first of which is the availability of photographic coverage. Photos may not be available for all areas of interest or persistent cloud cover may interfere with obtaining quality photos during certain seasons of the year. Photos may not be available for areas with high military sensitivity. Costs to obtain and interpret the photography are often high, and good quality control procedures are necessary to ensure accurate interpretation. In addition, habitat requirements for some species cannot be adequately monitored from photographic images, given today's knowledge of species-habitat relationships. For example, a habitat model for the ruffed grouse (*Bonasa umbellus*) contains the variable «average lowest branch height of conifers» (Cade and Sousa 1985). This variable would be extremely difficult to obtain from high-altitude aerial photography, although some surrogate variable might be developed that would infer this characteristic of the habitat from aerial photography. The point is, resolution obtainable from aerial photography may not be adequate to identify all important habitat features.

— *Species Groups*

At times the researcher is interested in monitoring habitat for something more than a single species, such as habitat for waterfowl, big game animals, or passerine birds. In most such studies, detailed characteristics of the habitat for individual species are overlooked in favor of more generalized characteristics, such as size or numbers of wetlands for waterfowl, amount of escape or reproductive cover for cervids, or acres of forest for passerine birds. This is not necessarily bad, but it limits the information about individual species, and if a species begins declining, the monitoring effort will provide few insights as to why. The same necessity to know critical elements of the life history exists with species groups as with single species, but aggregating their needs into a set of measurable characteristics is exceedingly difficult. Substantial effort is required to clearly outline the habitat needs of all species included in the group before determining the variables to be monitored.

Species richness and species diversity sometimes are used to monitor habitat. Both indices rely on population measurements and such measurements alone should not be used to monitor habitat; they should be used in conjunction with habitat measurements.

Use of statistics in monitoring

The discipline of statistics plays an important role in the development of wildlife habitat monitoring techniques and in the interpretation of data obtained from monitoring studies. Biological sampling is extraordinarily tricky, and sampling habitat is a particularly difficult process. Monitoring must accurately and quantitatively describe the habitat requirements. Sampling habitat variables requires sound statistical approaches, and the presence of natural variability must somehow be captured in sampling design. Johnson (1981) provides guidance to biologists in designing studies with appropriate statistics. Multivariate and discriminant function analyses can demonstrate important relationships between habitat variables and species response, and can be used to improve biological assessment and monitoring techniques. Statistical reliability is needed to determine natural variability from perturbations to the ecosystem. Suter et al. (1987) cited the need to clarify relationships between habitat and populations, and to assign probabilities in risk assessments. Good statistical design permits the gathering of the appropriate amount of data to meet study needs but yet not provide an «overkill» in data gathering that results in excessive costs.

Conclusions

The exploitation of natural resources has dramatically changed the landscape of the earth. These changes have negatively impacted many species of wildlife as a result of habitat alteration. The monitoring of habitat change is a prerequisite to sound habitat management. The use of remote sensing techniques, coupled with advances in our knowledge of species-habitat relationships, offers great promise for monitoring and managing wildlife resources.

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SUMMARY

13 · MONITORING WILDLIFE HABITAT — A CRITIQUE OF APPROACHES

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The monitoring of natural resources is receiving increased emphasis as we recognize that they are not infinite and that good stewardship is essential. Wildlife is one natural resource that often is low on the list of priorities, yet it is increasingly recognized as an important component of our global resources.

Naturalists have long recognized that wildlife cannot exist in a natural state without adequate habitat. Although a great deal of effort has been directed at the monitoring of wildlife populations, only recently has much attention been focused on the monitoring of habitat. This is a logical evolution of science, because one cannot effectively monitor habitat until the life requirements of the species are known. An example of habitat complexity is readily noted in migratory avian species, which require one set of habitat conditions during the reproductive season, another set during the migration period, and yet another set during the wintering period. Scientists have rarely defined and documented these complexities for even the most common species. Thus, the task of monitoring wildlife habitat has several dimensions and will remain an evolving science until we better understand the wildlife resource. However, this should not dissuade us from attempting to define, in quantitative terms, and monitor those conditions needed to ensure survival of wildlife.

Habitat monitoring is clearly distinct from population monitoring, the latter being an effort to count, by census or sampling techniques, the numbers of individuals or species in a specified area. Conversely, habitat monitoring is an effort to monitor the physical conditions that provide life support for the species, giving the underlying assumption that if the habitat is available, the species will respond and fill that habitat with viable populations.

Techniques for habitat monitoring are highly varied and depend on the species involved, geographical area under consideration, and resources available. At a very gross level, habitat monitoring may be little more than the monitoring of major vegetative associations. For example, scientists are becoming increasingly alarmed at the real and potential losses of wildlife species in neotropical forests. The greatest threat to these species is the physical removal of tropical forests; hence monitoring of habitat for these species becomes a task of monitoring the size and distribution of specified forests. However, this approach oversimplifies the concept of habitat monitoring. If one is interested in species ecology, and the species of interest is an avian migrant, then a simple monitoring of tropical forests only provides information about a portion of the life requirements of that species. Given that in some instances such a gross level of monitoring is all that is needed, time series analysis of aerial photography is an excellent mechanism to monitor the changes in hectares of specified vegetative associations, which are surrogate measures for habitat.

At the site-specific level, habitat monitoring can be approached from several perspectives. One common approach returns to the concept of monitoring populations as a method to determine habitat availability. Unfortunately, many researchers fail to recognize that population levels of a given species may or may not reflect habitat quality or habitat availability. Weather, predation (natural or man-induced), contaminants and other factors can reduce populations. Thus, a population reduction may indeed not be habitat related, yet a monitoring of populations alone will not make this evident. Habitat monitoring also has been approached from the perspective of monitoring the number of species (species richness) or some measure of species diversity.

Another method of monitoring habitat is to identify and monitor the habitat components that compose quality habitat for a species or species group. This approach requires that habitat requirements of the species be well known and documented and that the habitat components be aggregated into some type of habitat model. This approach results in the identification of a list of important habitat attributes that can be identified and measured independent of the presence of the species. Habitat variables include vegetative cover, density, type, and structure; presence of physical habitat needs such as water, den sites, or topographic features; and other variables that describe habitat needs of the species. Such a monitoring approach can be used at the site-specific level or can be adapted for use with aerial photo interpretation, although the latter method, by nature of the information available, will be less precise than on-site measurements.

RESUME

13 - SURVEILLANCE DE L'HABITAT DE LA FAUNE ET DE LA FLORE: ETUDE CRITIQUE DES METHODES

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Document soumis par le Centre national de recherches écologiques du Service pour la pêche et la nature, Etats-Unis d'Amérique.

La surveillance des ressources naturelles bénéficie actuellement d'une attention accrue, dès lors qu'il devient manifeste que ces ressources ne sont pas infinies et qu'une bonne intendance est indispensable. La faune et la flore sont une ressource naturelle qui figure souvent au bas de l'échelle des priorités, mais il est de plus en plus largement admis qu'elles représentent une composante importante de nos ressources mondiales.

Les naturalistes ont pris conscience il y a déjà longtemps de ce que la faune et la flore ne sauraient exister à l'état naturel sans un habitat adéquat. Cependant, si des efforts considérables ont été déployés dans le domaine de la surveillance des peuplements naturels, ce n'est que depuis une date récente qu'on s'intéresse de près à l'observation de leur habitat. Il s'agit là d'une évolution logique de la science, étant donné qu'il est impossible de procéder à une véritable surveillance de l'habitat des espèces tant que leurs conditions de vie ne sont pas connues. La complexité de l'habitat ressort clairement de l'observation des espèces d'oiseaux migrateurs, par exemple, qui ont besoin d'un type d'habitat pendant la saison de la reproduction, d'un autre pendant la période de migration et d'un troisième durant celle de l'hivernage. Les scientifiques se sont rarement attachés à définir et à documenter ces questions complexes, même pour les espèces les plus communes. La surveillance de l'habitat de la faune et de la flore sauvages est donc une tâche aux multiples dimensions et demeurera une science en évolution jusqu'à ce que nous comprenions mieux cette ressource. Cependant, il ne faudrait pas pour autant renoncer à tenter de définir en termes quantitatifs et d'observer de près les conditions requises pour garantir la survie des espèces sauvages.

La surveillance de l'habitat est de toute évidence distincte de celle des peuplements: cette dernière consiste à dénombrer, par des techniques de recensement ou d'échantillonnage, des spécimens ou des espèces dans une zone déterminée, tandis que la première vise à observer les conditions physiques qui fournissent aux espèces leurs moyens d'existence, en partant de l'hypothèse sous-jacente que, s'il existe un habitat, les espèces s'y installeront et y établiront des peuplements viables. Cette hypothèse est assortie bien entendu de restrictions importantes: en effet, si les besoins en matière d'habitat ne sont pas pleinement documentés, il est difficile de définir l'habitat qui doit faire l'objet d'une surveillance.

Les techniques permettant d'observer l'habitat sont extrêmement variées et dépendent des espèces concernées, de la zone géographique considérée et des ressources disponibles. A un niveau très rudimentaire, la surveillance de l'habitat peut n'être guère plus que l'observation d'importants groupements végétaux. Par exemple, les scientifiques s'inquiètent de plus en plus des disparitions effectives et des risques de disparition d'espèces de faune et de flore dans les forêts néotropicales. La principale menace qui pèse sur ces espèces tient à l'élimination physique des forêts tropicales; aussi la surveillance de l'habitat de ces espèces consiste-t-elle à observer la taille et la répartition de forêts déterminées. Cependant, cette méthode ne fait pas pleinement droit à la notion de surveillance de l'habitat. Lorsqu'on s'intéresse à l'écologie d'une espèce et que l'espèce en question est un oiseau migrateur, la simple observation des forêts tropicales fournit des renseignements qui ne concernent qu'une partie des moyens d'existence de ladite espèce. Si, dans certains cas, ce type de surveillance globale répond parfaitement aux besoins, l'analyse de séries chronologiques de photographies aériennes est, par contre, un excellent moyen de surveiller les changements qui surviennent dans des groupements végétaux couvrant plusieurs hectares, et peut remplacer les mesures directes de l'habitat.

Резюме

13 - КОНТРОЛЬ СРЕДЫ ОБИТАНИЯ ДИКИХ ЖИВОТНЫХ: КРИТИКА ПОДХОДОВ

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Мониторингу природных ресурсов уделяется все больше внимания по мере того, как нам становится ясно, что они не бесконечны и что важное значение имеет их рациональное использование. Дикие животные являются одним из природных ресурсов, которому часто придается второстепенное значение, и тем не менее всё больше признается, что он является важным компонентом наших глобальных ресурсов.

Биологи давно признали, что дикие животные не могут существовать в естественном состоянии вне соответствующей среды обитания. Хотя значительные усилия были направлены на мониторинг популяций диких животных, лишь в последнее время внимание было сосредоточено на мониторинге среды обитания. Такое развитие науки является логичным, поскольку невозможно эффективно осуществлять мониторинг среды обитания до тех пор, пока неизвестны жизненные потребности видов. Наглядный пример сложности среды обитания отмечается в случае видов мигрирующих птиц, которым требуется один набор условий окружающей среды в течение сезона воспроизводства, другой набор - в период миграции и третий - в период зимовки. Ученые редко определяли и отражали в документах эти сложности даже для наиболее часто встречающихся видов. Поэтому задача мониторинга среды обитания диких животных имеет несколько аспектов и будет оставаться развивающейся отраслью науки до тех пор, пока мы не получим более всесторонние знания о жизни диких животных. Однако это не должно препятствовать нашему стремлению определить с количественной точки зрения условия, необходимые для обеспечения выживания диких животных, и вести наблюдение за ними.

Мониторинг среды обитания существенно отличается от мониторинга популяций, при этом последний заключается в подсчете с помощью переписей или методов выборочного обследования численности особей или видов в конкретном районе. Напротив, мониторинг среды обитания заключается в наблюдении за физическими условиями, которые обеспечивают средства существования для видов, исходя из основополагающего предположения, что, если имеется среда обитания, виды отреагируют на это и заполнят эту среду жизнеспособными популяциями. Такое предположение, безусловно, имеет значительные ограничения, поскольку, если мы не в состоянии полностью обосновать потребности в среде обитания, невозможно определить среду обитания, за которой необходимо вести наблюдение.

Методы мониторинга среды обитания весьма разнообразны и зависят от соответствующего вида, рассматриваемого географического района и имеющихся ресурсов. В его весьма общем виде мониторинг среды обитания может несколько выходить за рамки мониторинга крупных растительных сообществ. Например, среди ученых все больше вызывает обеспокоенность реальная и потенциальная потеря видов диких животных в неотропических лесах. Наибольшую угрозу для этих видов представляет физическое уничтожение тропических лесов; поэтому задачей мониторинга среды обитания этих видов становится наблюдение за размером и распространением конкретных лесов. Однако такой подход слишком упрощает концепцию мониторинга среды обитания. Если интерес представляет экология видов и конкретным видом являются перелетные птицы, то простой мониторинг тропических лесов обеспечивает информацию лишь о части жизненных потребностей этого вида. Учитывая, что в некоторых случаях необходим лишь такой общий объем мониторинга, анализ временных рядов данных аэрофотосъемки является прекрасным механизмом наблюдения за изменением площади конкретных растительных сообществ, которые представляют собой альтернативный показатель состояния среды обитания.

На уровне конкретных участков мониторинг среды обитания можно вести в нескольких аспектах. Один общий подход связан с концепцией мониторинга популяций как метода определения наличия среды обитания. К сожалению, многие исследователи не согласны с тем, что размеры популяции данного вида могут отражать качество среды обитания или ее наличие. Погодные условия, распространение хищников (природное или вызванное человеком), загрязнители и другие факторы могут сокращать популяции. Поэтому сокращение популяций в действительности может быть не связано со средой обитания, и в этом случае одного мониторинга популяций будет не достаточно для определения этого. Другой подход к мониторингу среды обитания связан с наблюдением за численностью видов (видовое изобилие) или определенным показателем видового разнообразия. Эти методы мониторинга среды обитания ограничены теми же концептуальными недостатками, которые были указаны выше.

Другой метод мониторинга среды обитания заключается в идентификации и наблюдении за компонентами среды обитания, которые составляют качественную среду обитания для видов или группы видов. Для такого подхода необходима полная, документированная информация о потребностях видов в среде обитания и обобщение компонентов среды обитания в некоторый тип модели среды обитания.

Этот подход приводит к составлению перечня важных атрибутов среды обитания, которые можно идентифицировать и измерять независимо от наличия видов. В число переменных среды обитания входят растительный покров, плотность, тип и структура; наличие физических потребностей в среде обитания, таких, как вода, участки расположения берлог или топографические характеристики; и другие переменные, которые описывают потребности видов в среде обитания. Такой подход к мониторингу можно использовать на уровне конкретных участков или приспособить для использования при толковании данных аэрофотосъемки, хотя последний метод по характеру имеющейся информации будет менее точным, чем измерения на местах.

Ни один подход к мониторингу среды обитания не может быть правильным во всех случаях. При выборе подходов к мониторингу необходимо учитывать уровень разрешения данных, средства имеющиеся для обследования, важность принимаемых решений в отношении природных ресурсов и биологические взаимосвязи.

Полное понимание биологической системы, за которой ведется наблюдение, имеет первостепенное значение для разработки правильной схемы обследования в ходе мониторинга.

14 - EXPERIENCE WITH ENVIRONMENT STATISTICS IN THE NATIONAL ENVIRONMENTAL MONITORING SYSTEM

Author: Alexander N. Sadovski

Paper submitted by the Environmental Research and Information Centre, Bulgaria.

The Bulgarian Government has developed and approved a number of programme documents on environmental protection and rational use of the national resources. In 1975, the Council of Ministers of the People's Republic of Bulgaria made a decision for establishment of a National Environment Monitoring System.

The objective of this system is to provide, by the use of contemporary computer technique and automation tools, timely and reliable information on the basis of which assessments can be made of the condition of the environment, prediction of events and improvement of nature protection and natural resources management, both at a regional and at a national level.

The National Environment Monitoring System has been developed as a management information system which collects, stores and presents information in a form convenient for use. It also provides alternative suggestions and recommendations and works out in real time management decision for solving certain problems. For the time being, the system comprises the following environmental components: atmosphere, fresh and sea-water, land/soil surface. For the future it is planned to include flora, fauna, earth entrails and inhabited areas.

The system is organized at two levels. At a national level, a Central Control Unit is functioning, and in 16 districts regional control units have been built up. A network of points for observations of the ambient air and of surface water has been established. At each point, regular observations are carried out on a given number of obligatory and specific characteristics of the air and water condition and pollution. The results from the measurements and analyses are processed and published in quarterly bulletins to provide information to governmental bodies, research institutes, project organizations, etc.

By its structure the information is organized in a distributed hierarchical data base at two levels:

— A central data base in the Central Control Unit;

— regional data bases in the District Control Units.

Analogously, the hardware for information processing represents a distributed system, which includes the following:

— Main-frame computer for processing and maintaining a large data base for solving complex computational and optimization problems, servicing the Committe of Environmental Protection;

— Computing complexes of 16- and 8-bits microcomputers, servicing the Regional Inspections for Environmental Protection.

The data transmission is accomplished via telex lines, but for the future, the establishment of a terminal network is envisaged, as well as the use of direct lines for teleprocessing of data.

For providing informational services, two types of classifiers and nomenclatures are used:

—Unified common classifiers (registers) are created and maintained in the National Statistics Department;

— Registers, which are specific for the activities of environmental protection were created and are maintained by the Environmental Research and Information Centre of the Committee for Environmental Protection.

The categories of information of the system comprise: air pollutants' emissions from stationary sources (industrial, agricultural, communal), waste-water from stationary sources, solid wastes (as a result of industrial activities and consumption), air quality (concentration of air pollutants), water quality, land/soil quality.

As a result of the system's functioning, data have been collected over a 12-year period regarding 17 air basins and urban areas with respect to dust, sulphur dioxide, nitrogen oxides, lead-aerosols and other specific pollutants. The water of 13 rivers, the Danube and the Black Sea coast have been studied for active reaction, dissolved oxygen, undissolved substances, ammonium and nitrate nitrogen, hydrogen sulphide, heavy metals, biological and other characteristics. The established computerized data base makes possible the performance of statistical analyses, and the development of mathematical models for various purposes and decision-making.

Different statistical methods have been used, like a descriptive statistical analysis, empirical distributions, regression analysis, time-series analysis, principal components analysis, cluster analysis, principal coordinates analysis, redundancy analysis and analysis of asymmetry. For their application, corresponding software has been developed. Each of the above methods serves specific purposes of investigation and reveals a certain aspect of the relationship between man on one side and organic and inorganic nature on the other.

One of the problems of interest, which can be solved using available statistics on the environment, is the search for mutual dependencies between air pollution indices and common meteorological characteristics. It is necessary that a minimal set of meteorological indices should be determined beforehand in order to characterize to a sufficient extent the total variation. The predictor variables should be independent or quasi-independent, so that multiple regression analysis could be successfully applied.

The principal components analysis aims at extracting fewer mutually uncorrelated factors. Subject to this analysis are the monthly data from meteorological observations carried out over a 7-year period at 11 experimental sites and comprising the following variables:

1. Mean air temperature (C)
2. Mean maximum air temperature (C)
3. Mean minimum air temperature (C)
4. Mean soil temperature at a depth of 10 cm (C)
5. Duration of sunshine (hours)
6. Mean velocity of wind (m/sec.)
7. Mean relative air humidity (%)
8. Mean rainfall (mm)
9. Number of days with rainfall over 0.1 mm

These data have been processed on a computer proceeding from the correlation matrix

$$\mathbf{R} = \| r_{jk} \|.$$

It shows that the nine variables can be split into three groups with highly significant correlation within groups, but almost no correlation between the groups:

group A /1,2,3,4,5,7/,
group B /8,9/,
group C /6/.

The characteristic equation $| \mathbf{R} - \lambda . \square | = 0$ is solved and the orthogonal eigenvectors $L_j = (l_{j1}, l_{j2}, ..., l_{j9})$ corresponding to the eigenvalues λ_j are obtained. The principal components z_j are linear combinations of the original variables x_k with loadings equal to the corresponding eigenvectors.

$$z_j = \sum_k l_{jk} x_k \qquad (j = 1,2,...,9).$$

The correlation coefficients between the j-th principal component and the k-th original variable are defined by the formula

$$r(z_j, x_k) = \sqrt{\lambda_j}\, l_{jk}.$$

The five largest eingenvalues obtained from the analysis explain 98.42% of the total variance (Table 1). The three principal components temperature, rainfall and wind (Table 2) cover 92.29% of the variance, which shows that three factors are sufficient to characterize the meteorological conditions of a given area. The fourth and the fifth components cannot be easily interpreted, and their joint contribution is negligible.

It may be concluded that the models for prediction of air pollution should include at least one factor from the stated three groups. Out of practical considerations, the factors selected are mean air temperature, mean rainfall and mean wind velocity. Further investigations will make possible the extension and improvement of the models.

Another example for the use of environmental statistical data is the investigation of ambient air pollution in inhabited areas. Time-series analysis of monthly data of mean dust and sulphur dioxide concentrations in air (mg/m^3) was carried out for the town of Pleven. The records cover the 1978-1987 period.

The trend was estimated by linear regression and is expressed by the following equations:

a/ dust concentration

$$\hat{y}_t = 0.403 - 0.00123\, t$$

b/ sulphur dioxide concentration

$$\hat{y}_t = 0.0433 - 0.000272\, t,$$

where t is the time given in months after t_o = June 1978.

After subtracting the trend, the difference y_t - $\hat{y}_t$ is considered as a stationary time-series of the kind

$$y_t - \hat{y}_t = \sum_i C_{it} = \sum_i A_i \cos(\omega_i t - \Theta_i),$$

where A_i is the amplitude, ω_i - angular frequency, Θ_i - the phase.

After carrying out a Fourier analysis, the following values of the time-series parameters have been obtained:

a/ dust concentration - with two periodic components

$C_5 : A_5 = 0.1007$	$\omega_5 = 0.29089$	$\Theta_5 = -1.3251$
$C_{18} : A_{18} = 0.1356$	$\omega_{18} = 1.04720$	$\Theta_{18} = 1.1316$

b/ sulphur dioxide concentration - with three periodic components

$C_1 : A_1 = 0.02060$	$\omega_1 = 0.05818$	$\Theta_1 = -0.4385$
$C_z : A_z = 0.01903$	$\omega_z = 0.11636$	$\Theta_z = 0.7066$
$C_9 : A_9 = 0.02830$	$\omega_9 = 0.52360$	$\Theta_9 = 0.8846$

The remaining amplitudes could be considered close to zero and do not make a significant contribution to decreasing the error variance.

These results indicate that some periodical fluctuations exist in ambient air pollution, which can be reliably estimated if considerably longer time-series were available. The results are encouraging, as it is visible that in this urban area the mean monthly concentration of pollution gradually decreases.

Another equivalent option for the presentation of time-series would be using autocorrelation functions of the type

$$y_t = a_o + a_1 t + b_1 y_{t-1} + \dots + b_k y_{t-k}.$$

Related work is presently in progress.

Table 1. Eigenvalues and eigenvectors

Principal component	1	2	4	5	5
Eigenvalue	5.5929	1.7056	1.0076	0.3016	0.2499
Cumulative %	62.14	81.09	92.29	95.64	98.42
1	0.4156	0.0985	0.0128	0.0074	—0.2140
2	0.4170	0.0638	—0.0141	0.0293	—0.1730
3	0.4067	0.1462	—0.0067	—0.0130	—0.2752
4	0.4114	0.1256	—0.0029	—0.0128	—0.1965
5	0.4037	0.0097	0.0139	0.1436	0.1763
6	—0.0305	—0.1952	0.9542	—0.0692	—0.2057
7	—0.3517	0.2427	—0.1662	—0.2028	—0.7865
8	0.0049	0.6980	0.1721	—0.6023	0.3431
9	—0.1764	0.6039	0.1778	0.7546	0.0108

Table 2. Correlation between principal components and original variables

Principal component	1	2	3	4	5
1	0.9829	0.1286	0.0128	0.0041	—0.1070
2	0.9862	0.0833	—0.0142	0.0161	—0.0865
3	0.9618	0.1912	—0.0067	—0.0071	—0.1376
4	0.9729	0.1640	—0.0029	—0.0070	—0.0982
5	0.9547	0.0127	0.0140	0.0789	0.0881
6	0.0721	—0.2549	0.9578	—0.0380	—0.1028
7	—0.8317	0.3170	—0.1668	—0.1114	—0.3932
8	0.0116	0.9116	0.1728	—0.3308	0.1715
9	—0.4172	0.7887	0.1785	0.4144	0.0054

SUMMARY

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The Bulgarian Government has developed and approved a number of programme documents on environmental protection and rational use of the natural resources. In 1975, the Council of Ministers of the People's Republic of Bulgaria made a decision for establishment of a National Environment Monitoring System. The objective of this system is to provide, by the use of contemporary computer technique and automation tools, up to date and sound information on the basis of which assessments to be made the condition of environment, prediction of events and improvement of nature protection and natural resources management, both at a regional and national level.

A network of points for observation of the ambient air and surface water has been established. At each point, regular observations are carried out on a given number of obligatory and specific characteristics of the air and water condition and pollution. The results from the measurements and analyses are processed and published in quarterly bulletins to provide information to the governmental organs, research institutes, project organizations, etc.

As a result of the system's functioning, data over 12 years have already been collected for the condition of 17 air basins, and the pollution of urban areas with dust, sulphur dioxide, oxides of nitrogen, lead-aerosols and other specific pollutants has been investigated. The water of 13 rivers, the Danube and the Black Sea coast has been studied for active reaction, dissolved oxygen, undissolved substances, ammonium and nitrate nitrogen, hydrogen sulphide, heavy metals, biological and other characteristics. The data base gives possibilities to perform statistical analyses and develop mathematical models for various purposes and decision-making.

Different statistical methods have been used as follows: descriptive statistical analysis, empirical distributions, regression analysis, time-series analysis, principal components analysis, cluster analysis, principal coordinates analysis, redundancy analysis and analysis of asymmetry. For their application, corresponding software has been developed. Each of the above methods is used for specific purposes of the investigation and reveals a certain aspect of the «man - organic and inorganic nature» relationships.

Using the analysis of time-series the trend and periodical fluctuations of the ambient air pollution with sulphur dioxide in urban areas has been established. The principal components analysis applied to a complex of meteorological data and data on pollution allows the extraction of a minimum set of indices characterizing to a sufficient extent the total variation. The report includes results from the use of other statistical techniques on environmental data.

The results obtained and the extended possibilities for application of the above-stated univariate and multivariate statistical methods in the environmental investigations, give us reasons to affirm that the grounds of a new scientific area, the so-called ecological statistics, have been set up. The present seminar will contribute to the affirmation and further development of this new field.

RESUME

14 - EXPERIENCE CONCERNANT L'UTILISATION DES STATISTIQUES ECOLOGIQUES DANS LE SYSTEME NATIONAL DE SURVEILLANCE DE L'ENVIRONNEMENT

Auteur: Alexander N. Sadovski

Document soumis par le Centre de recherche et d'information sur l'environnement, Bulgarie.

Le Gouvernement bulgare a mis au point et approuvé un certain nombre de descriptifs de programmes sur la protection de l'environnement et l'utilisation rationnelle des ressources naturelles. En 1975, le Conseil des ministres de la République populaire de Bulgarie a décidé d'établir un système national de surveillance de l'environnement. L'objectif de ce système est de fournir, à l'aide de techniques informatiques modernes et de moyens automatisés, des renseignements à jour et fiables qui puissent servir de base à des évaluations de l'état de l'environnement, à la prévision des événements susceptibles de se produire, à une meilleure protection de la nature et à la gestion des ressources naturelles, et ce, aux niveaux tant régional que national.

Un réseau de points d'observation de l'air ambiant et des eaux superficielles a ainsi été mis en place. Chaque point permet de faire des observations périodiques portant sur un certain nombre de caractéristiques générales et particulières de l'état et de la pollution de l'air et de l'eau. Les résultats des mesures et des analyses effectuées font l'objet d'un dépouillement et sont publiés dans des bulletins trimestriels destinés aux organes gouvernementaux, aux instituts de recherche, aux organismes chargés d'exécuter des projets, etc.

Grâce à la mise en service de ce système, des données sur l'état de 17 bassins aériens sont recueillies depuis déjà 12 ans et des recherches ont été faites sur la pollution des zones urbaines par la poussière, le dioxyde de soufre, les oxydes d'azote, les aérosols de plomb et d'autres polluants particuliers. Les eaux de 13 rivières, du Danube et du littoral de la mer Noire ont fait l'objet d'observations visant à étudier les réactions actives, l'oxygène dissous, les substances non dissoutes, l'ammonium et l'azote sous forme de nitrate, le sulfure d'hydrogène et les métaux lourds, ainsi que les caractéristiques biologiques et autres. La base de données informatisées qui a été établie peut être utilisée pour les analyses statistiques, l'élaboration de modèles mathématiques destinés à divers emplois et la prise de décisions.

Différentes méthodes statistiques ont été employées, parmi lesquelles: l'analyse statistique descriptive, les distributions empiriques, l'analyse de régression, l'analyse de séries chronologiques, l'analyse en composantes principales, l'analyse de groupement, l'analyse en coordonnées principales, l'analyse de redondance et l'analyse d'asymétrie. Pour l'application de ces méthodes, un logiciel correspondant a été mis au point. Les méthodes susmentionnées répondent chacune à des objectifs particuliers des travaux de recherche et révèlent un aspect déterminé des relations entre l'homme et la nature tant organique qu'inorganique.

Le recours à l'analyse de séries chronologiques a ainsi permis de faire apparaître la tendance générale et les fluctuations périodiques de la pollution de l'air ambiant par le dioxyde de soufre dans les zones urbaines. L'analyse des composantes principales appliquée à un ensemble de données météorologiques et de données sur la pollution permet d'extraire une série minimale d'indices suffisants pour déterminer la variation totale. Dans le rapport sont indiqués les résultats obtenus grâce à l'application d'autres techniques statistiques aux données relatives à l'environnement.

Les résultats enregistrés et les possibilités accrues d'utilisation des méthodes susmentionnées d'analyse statistique à une et à plusieurs variables dans les travaux de recherche sur l'environnement donnent à penser que les bases d'un nouveau domaine scientifique, celui des statistiques dites écologiques, ont été mises en place. Le séminaire prévu devrait contribuer à l'affirmation et au développement ultérieur de ce nouveau domaine.

Резюме

14 - ОПЫТ РАЗРАБОТКИ ЭКОЛОГИЧЕСКОЙ СТАТИСТИКИ В РАМКАХ ГОСУДАРСТВЕННОЙ СИСТЕМЫ КОНТРОЛЯ ОКРУЖАЮЩЕЙ СРЕДЫ

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Правительство НР Болгарии разработало и приняло ряд программных документов по охране окружающей среды и рациональному использованию природных ресурсов. В 1975 г. Совет Министров НР Болгарии принял решение о создании национальной системы мониторинга окружающей среды. Цель создания этой системы состоит в получении, на основе использования современных технических средств, своевременной и достоверной информации о состоянии окружающей среды, на основе которой можно было бы прогнозировать и планировать, как на общенациональном уровне, так и на уровне отдельных областей, изменения состояния окружающей среды, меры по её защите и рациональному использованию природных ресурсов.

В настоящее время создана сеть пунктов наблюдения за состоянием атмосферного воздуха и поверхностных вод. В каждом из этих пунктов проводятся регулярные наблюдения по заданному обязательному набору показателей, характеризующих состояние, и публикуются в ежеквартальных бюллетенях, которые используются правительственными, научно-исследовательскими, проектными и прочими заинтересованными организациями и учреждениями.

В результате функционирования этой системы были накоплены данные за последние 12 лет о состоянии 17 воздушных бассейнов. Собирались также данные о загрязнении воздуха в городах двуокисью серы, окислами азота, частицами свинца и других загрязнителей. Состояние воды 13 рек, Дуная и побережья Черного моря контролировалось на предмет активности реакции окисления, наличия в воде кислорода, взвешенных частиц, аммиака и нитратов, сернистых соединений, тяжелых металлов, оценивалось также биологическое и другие состояния воды. Имеющаяся автоматизированная база данных позволяет проводить статистический анализ состояния окружающей

среды, разрабатывать математические модели, используемые при обосновании решений по рациональному использованию природньх ресурсов.

Для анализа данных применяются различные статистические методы: описательный статистический анализ, эмпирические распределения, регрессионный анализ, анализ временных рядов, анализ с использованием основных компонентов, кластерный анализ, метод основных координат, анализ избыточности и анализ асимметричности. Для автоматизации этих методов было разработано специальное программное обеспечение. Каждый из перечисленных выше методов используется для специфических целей исследования и позволяет глубже разобраться в отдельных аспектах отношений человека с органической и неорганической природой.

Так, например, на основе анализа временных рядов был выявлен тренд и периодические колебания уровня загрязнения атмосферного воздуха двуокисью серы в городах и населенных пунктах. Метод основных компонентов, использованный для анализа совокупности метеорологических данных и данных о загрязнении окружающей среды позволяет рассчитывать минимальный набор показателей, достаточно достоверно характеризующих степени вариации общего уровня загрязнения. В докладе содержится также описание результатов использования других методов статистического анализа данных об окружающей среде.

Полученные результаты, а также широкие возможности использования упомянутых выше статистических методов для проведения исследований в области окружающей среды, позволяют утверждать, что заложены основы нового направления научных исследований - экологической статистики. Настоящий семинар будет способствовать становлению и дальнейшему развитию этой новой области знания.

15 - ECOLOGICAL MONITORING AS A PART OF THE FINNISH NATIONAL FOREST INVENTORY

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Paper submitted by the Forest Research Institute, Finland.

Development of a forest inventory in Finland.

Forest inventories have been carried out on a national scale in Finland since 1921 (Ilvessalo 1927). Before that time, certain long-term statistics on state-owned forests were recorded. A map of the Finnish timber reserves in 1850, for instance, was reconstructed from these sources.

The National Forest Inventory (NFI) was established by Prof. Y. Ilvessalo. Repeated about once every decade, the NFIs were originally made as line transect surveys. In the first two inventories the lines running in a SW-NE direction were spaced at 26 km intervals. In the 3rd NFI (Fig. 1) the line density varied and 6.5, 13, 16 and 20 km line intervals were used in different parts of the country (see Ilvessalo 1943, Kujala 1964). A method based on systematic blocks, with tracts forming the sampling units (Fig. 2), was adopted in the 5th NFI (Kuusela & Salminen 1969). From the 5th NFI (carried out in 1964-1970) to the 8th NFI, which was started in 1985, the tracts were moved systematically to a new location each time. The shape and size of the blocks varied in successive NFIs. In the 8th NFI, however, part of the sample was established as permanent plots.

Kuusela (1981) described the purpose and contents of the recent NFIs as follows:

«The aim of current methods of national forest inventory is to estimate resources in order to exploit the existing timber stocks or to grow and harvest timber on the land available for the purpose. The principal characteristics to be estimated have therefore been:

— The land area under tree stands available for tree growing.

— The site quality of the forest and potential forest land.

— The timber stock or growing stock, by tree species and timber assortments, measured in stem or timber assortment volume, on forest land and site quality classes.

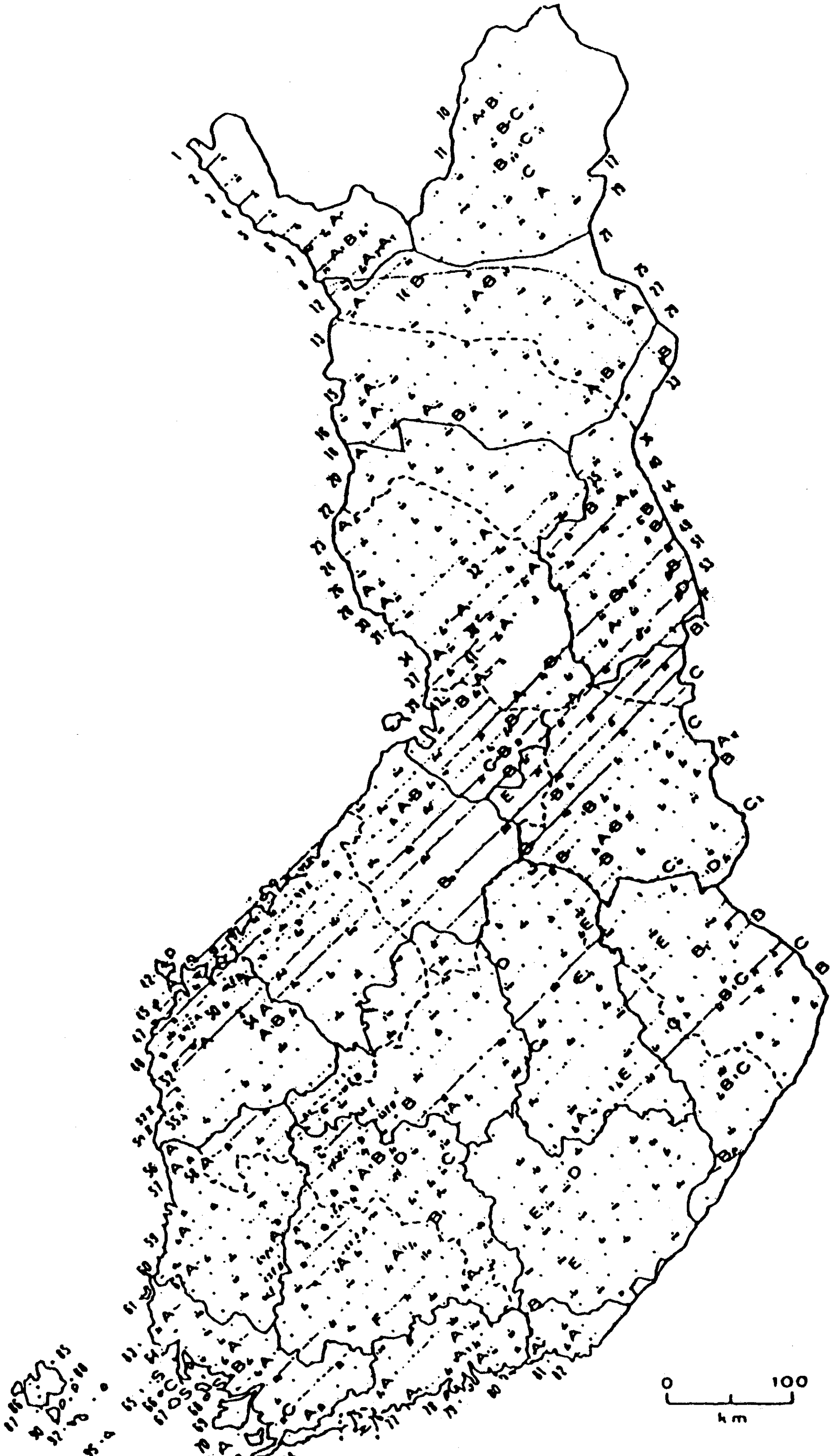

Fig. 1. Inventory lines of the 3rd national forest inventory (NFI) in 1951-53, (Kujala 1964).

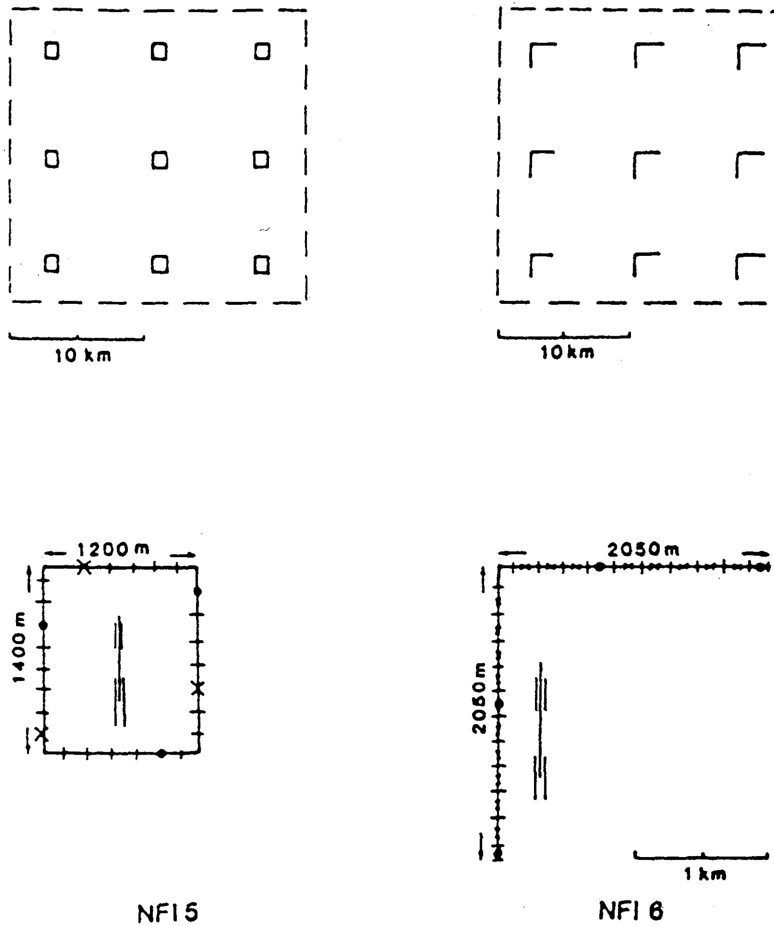

Fig. 2. Blocks and tracts of the 5th and 6th NFI (Kuusela & Salminen 1969 and Salminen 1981). Symbols in Fig. 3.

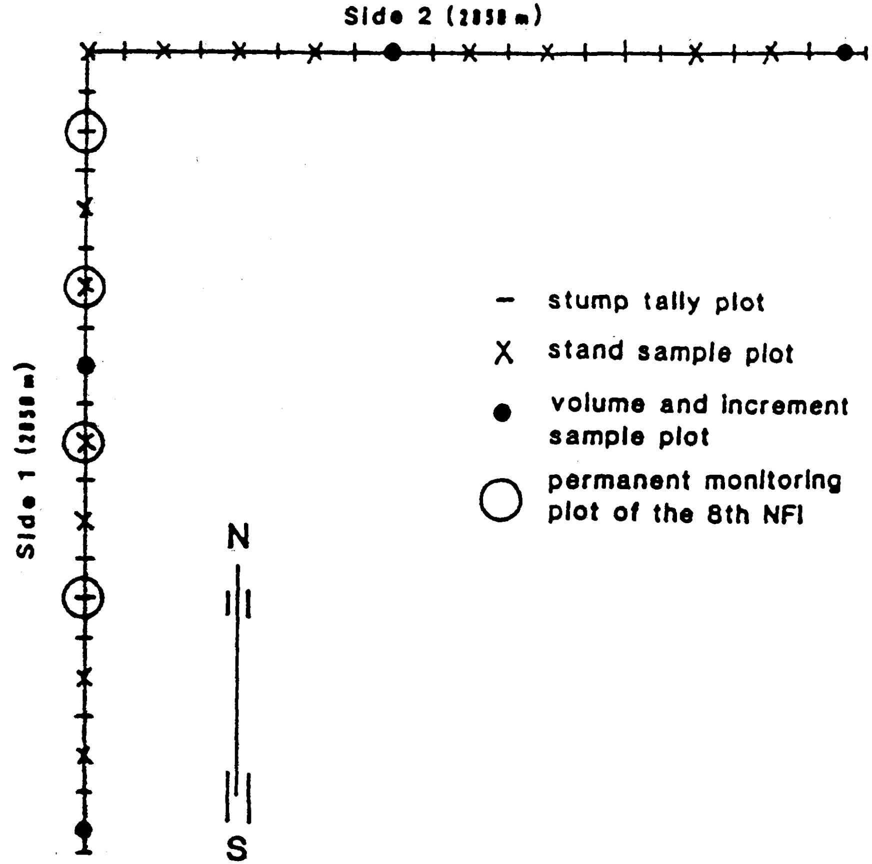

Fig. 3. A tract with sample plots of the type used in the 7th and 8th NFI.

— The age and development stage composition of the timber stock or growing stock.

— The site and other characteristics which describe the logging and transport conditions.

— The increment of the growing stock, the increase of timber assortments in it and drain of growing stock and timber assortment volume.

— The amount of timber to be exploited or to be harvested on the basis of the sustained yield.

— The need for silvicultural and forest improvement measures.

The key characteristics have been the volumes of tree stems and timber assortments.

In those countries where forestry plays an important role in the national economy, current inventory methods have reached a stage where they provide information with the quality and accuracy needed to plan the utilization of forests and control the development of forest resources».

Besides fulfilling its ordinary function between 1921 and 1987 the NFI produced a time series which monitors certain changes in forest ecosystems, i.e. forest land of higher or lower productivity and waste land. Thus, more than 87% of the total land area in Finland has been partly monitored for already over 60 years.

2. Structure of the recent NFI

The land area is covered by 8x8 km, rectangular inventory blocks, the location of which is determined by map coordinates (and a.s.l.) data. The sample taken from a block is a tract, which is a 4100 m long line located in the block (Fig. 3). There are sample plots (centre points) at 100 m intervals, totalling 41, along the tract. There are three different categories of sample plot: volume and increment plots (4/block), stand sample plots (17), and stump tally plots (20). The number and intensity of the measurements carried out on the plots decrease in the listed order. The total number of tracts in the 6th NFI which are at least partly located on land was 3844. There was a total of around 110,000 sample plots where observations concerning site class and stand quality were made on the basis of about 30 or more variables. More than 53,000 sample trees were accurately measured on about 8,100 increment plots (Salminen 1981).

In Southern Finland the NFI is based on blocks and tracts spaced at 8 km intervals. In Lapland, north of latitude 66°N, a sparser network of blocks is used and sampling is done with the help of aerial photos (Poso & Kujala 1978).

The main results of the NFI are site, stand and sample tree characteristics. These are mainly published and used as average values for the whole country or for the forestry board districts (650,000 -7,200,000 ha in area) (see Fig. 6, for instance). The standard errors of the larger site class areas or total growing stock, for instance, are about ±0.5% for the whole country, and about ±2.5% for areas of the 500,000 ha size class (Kuusela & Salminen 1969).

Each new NFI begins from the southern forestry boards and it takes 6-8 years to cover the whole country. The 8th NFI was started in an exceptional way: the permanent sample plots for the whole country were first established in 1985-1986 (Fig. 4). The NFI publishes its results as statistical tables, first for separate forestry boards and finally for the whole country. The yearbook of forest statistics (Metsätilastollinen vuosikirja), which is part of the official statistics of Finland, also contains a lot of data from the NFI. Statistical forestry maps have been regularly published on the basis of NFI data (Ilvessalo 1930, 1960, Suomen Kartasto/Atlas of Finland 1925, 1960, 1976, Salminen 1981).

3. Ecological monitoring and NFI

The idea of connecting an ecological monitoring system to a forest inventory is not a very new one. In Finland it was realized on a large scale during the 3rd NFI in 1951-1953. A biologist was recruited for each inventory group and a lot of basic data on vegetation, plant and animal distributions and general ecology was collected. A reliable picture of the distribution of site types (forests and mires), as well as the most important plant species, was obtained (Ilvessalo 1956, 1960, Kujala 1964).

The contribution of biologists in the 3rd inventory, however, has not yet been fully exploited. Despite certain methodological flaws and uneven inventory results, some new findings (see Päivänen & Gustavsen 1986) can be expected as soon as the huge archives will be processed ready for computer analysis. In the planning of fresh attempts to create a monitoring system, both the experiences of the 3rd NFI and its data have been of remarkable value. Between the 4th and the 7th inventory, the NFI was developed into a modern system designed to provide information for the control of timber resources, i.e. growth, use and budget. At the same time the sampling and data processing methods fulfilled the high demands of other users, too.

By the late 1970's the need for ecological monitoring became more and more evident in Finland. Environmental changes were rapid and pollution had already become a local problem. After its very effective decades, 1960 and 1970, forestry had to start taking into account the environmental, recreational and side product values of forests and mires. Research and information on these aspects were demanded. At the same time a lot of monitoring work was being done in separate, regular field inventories without any coordination with the NFI.

4. Working model of an ecological monitoring system

As ecological monitoring is designed to be a system that provides information about the structural and functional state of an ecosystem, as well as the quality of the environment on a regional scale, there are three major groups of problems: (1) determination of the parameters to be measured or observed, (2) carrying out the sampling, and (3) data control. In our case the benefits as regards sampling and data processing available from the NFI were considered to be decisive. We also had to adapt the contents of the monitoring system to the practical work of the NFI. The planning work started from the general scheme of the ecosystem. Important structures and functions of forest and mire ecosystems which could be depicted with the help of simply and quickly measurable parameters, the necessary field work being done by one biologist at the working place of the NFI field group, were first determined. In addition, convenient bioindicators that could be sampled at the same time were also sought.

The list of desired observations and measurements was first prepared by a team of specialists in forestry and biology. The recommendations of this group, set up on the initiative of the Finnish Academy of Sciences (Academia Scientiarum Fennica, Kuusela 1979), were tested in an inventory made during the summers of 1981-83 on about 340 permanent NFI sample plots in Northern Karelia. The plots were located in the large experimental area of intensive timber growing in the state forests of the Nurmes district (see Sevola 1983). The density of the network of NFI tracts in this area was increased, permanent sample plots established and a suitable locating system developed. The biological monitoring program (see Reinikainen et al 1987) carried out on these sample plots had almost the same observations and sampling procedures as the program which was added to the 8th NFI in 1985. The methods and time table, as well as the consumption of resources, were studied in detail during the Nurmes phase. These sample plots, covering about 130,000 ha in Northern Karelia (Fig. 4), are now being used as an intensive monitoring network within the NFI.

The project «The effect of air pollution on forest ecosystems in Finland» (ILME, see Finnish Research Project on Acidification... 1985) was started in 1984. The decision was made to use the NFI system for basic damage inventory and mapping work, deposition sampling and as a network of extensive monitoring. The program of ecological measurements, observations and sampling was prepared by specialist groups from the Forest Research Institute. Twelve junior biologists were recruited and trained in field work. The organization and finance were coordinated by the NFI.

5. Ecological program connected to the permanent NFI sample plots.

After some years of experimental activity, the NFI established its own permanent sample plots network as follows: (1) sample plots were located in clusters of four plots along every fourth tract (Fig. 3), (2) circular plots were 300 m² in area and the sampling covered the total potential forestry land, and (3) sample plots were kept secret from their landowners and their position located only on maps and using a fixed point system. Finally, after the 1985-86 field work, the number of permanent sample plots totalled 3009 (Fig. 4).

Compromises between the ordinary NFI and the potential users of the ecological data resulted in the following additional program, which was carried out on these plots (Figs. 3, 4 and 5) during the 1.5-2 h period used per plot (Reinikainen et al 1988):

(1) Precise determination of site type, including the use of vegetation mapping and the most sensitive botanical site typology instead of the rather crude site classification normally used in the NFI (see Kuusela & Salminen 1969).

(2) Determination of the soil type and measurement of the depth of the humus layer (humus or peat).

(3) Quantitative vegetation analysis; species composition was noted on the whole 300 m² plot, and their abundance estimated on 4-6 permanent sample quadrats (2 m²) within the plot.

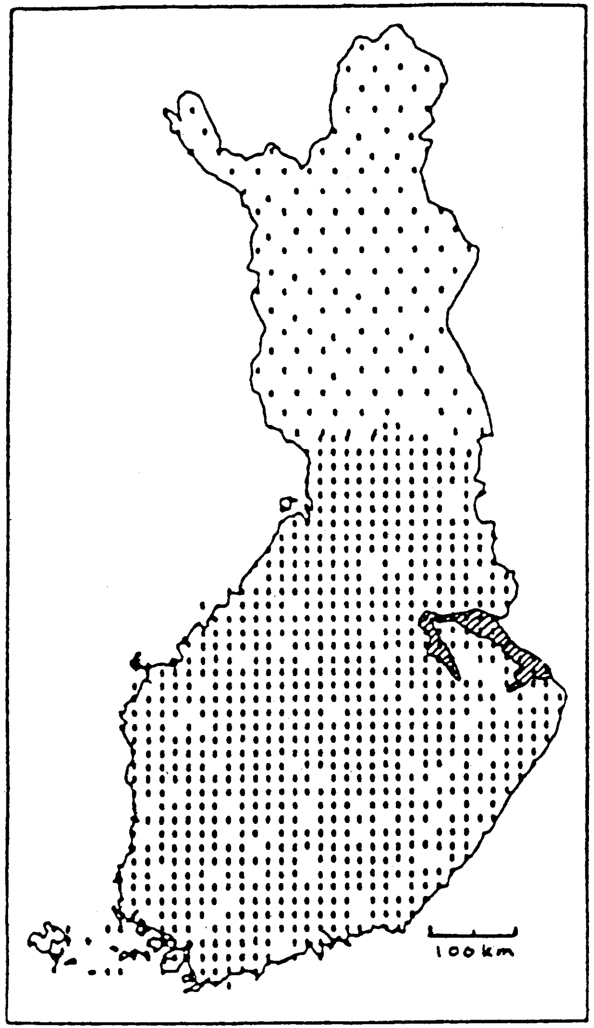

Fig. 4. The tracts of the 8th NFI (1985-1986), each containing 1-4 permanent sample plots for ecological monitoring. The area where test inventories were carried out in 1981-1983, the Nurmes area, is striped.

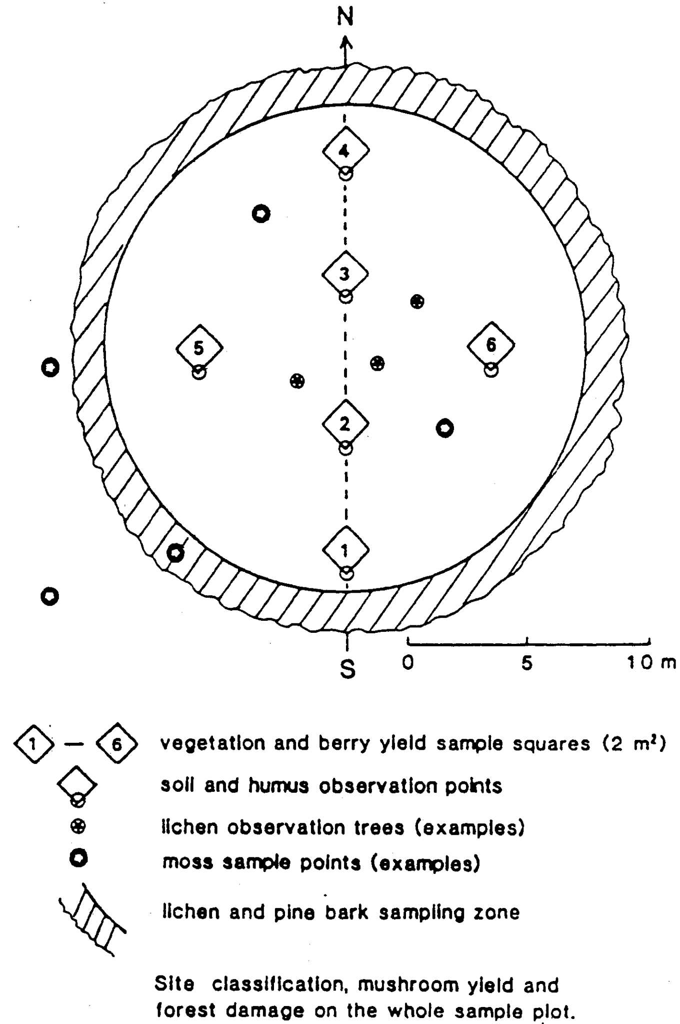

Fig. 5. An example of ecological observations made in addition to stand measurements on a permanent, ecological monitoring sample plot in the 8th NFI.

(4) Structural analysis of the plant community by means of horizontal and vertical dimensions of different vegetation layers.

(5) Estimation of actual and potential yield of four economically important berry species.

(6) Sampling of mushroom flora and estimation of the standing yield, especially that of commercial species.

(7) Qualitative and quantitative estimation of forest damage. Symptoms and the possible causes were coded separately. Special attention was paid to the general vitality of conifers and any decrease in their needle biomass. The defoliation method recommended by the UN (UNEP and UN-ECE) was used in the estimation (see Jukola-Sulonen et al. 1987).

(8) Estimation of the occurrence of epiphytic bioindicator lichens on conifers; fifteen species with a certain value as air pollution indicators were quantitatively estimated on sample trees.

(9) Sampling of forest mosses (*Hylocomium splendens* or *Pleurozium schreberi*), epiphytic lichen species (*Hypogymnia physodes*, primarily) and Scots pine bark for the chemical analysis of aerial deposition and its different components.

(10) Photography of sample plots by a standard method.

(11) Observations of certain animals (reptiles, amphibians, game birds and ant heaps) on the sample plots and while walking to the plots. The amount of time used per separate working phase, as well as other time-consuming tasks, was also noted in this connection.

Data were entered on forms especially designed for direct data processing. These were first checked and the data then recorded at the Forest Research Institute.

6. Use of ecological NFI data

The whole system, established in 1985-1986, will become a real monitoring system when the survey is repeated in 1991-92. However, the bulk of the huge data is already in use within special themes, the most important being the project «The effect of air pollution on forest ecosystems in Finland» (ILME).

As a first and most urgent result, statistics and maps on forest damage - especially the defoliation of conifers and the distribution of epiphytic lichens - have been published (Jukola-Sulonen et al 1987, examples in Fig. 6). The samples taken for the international survey of

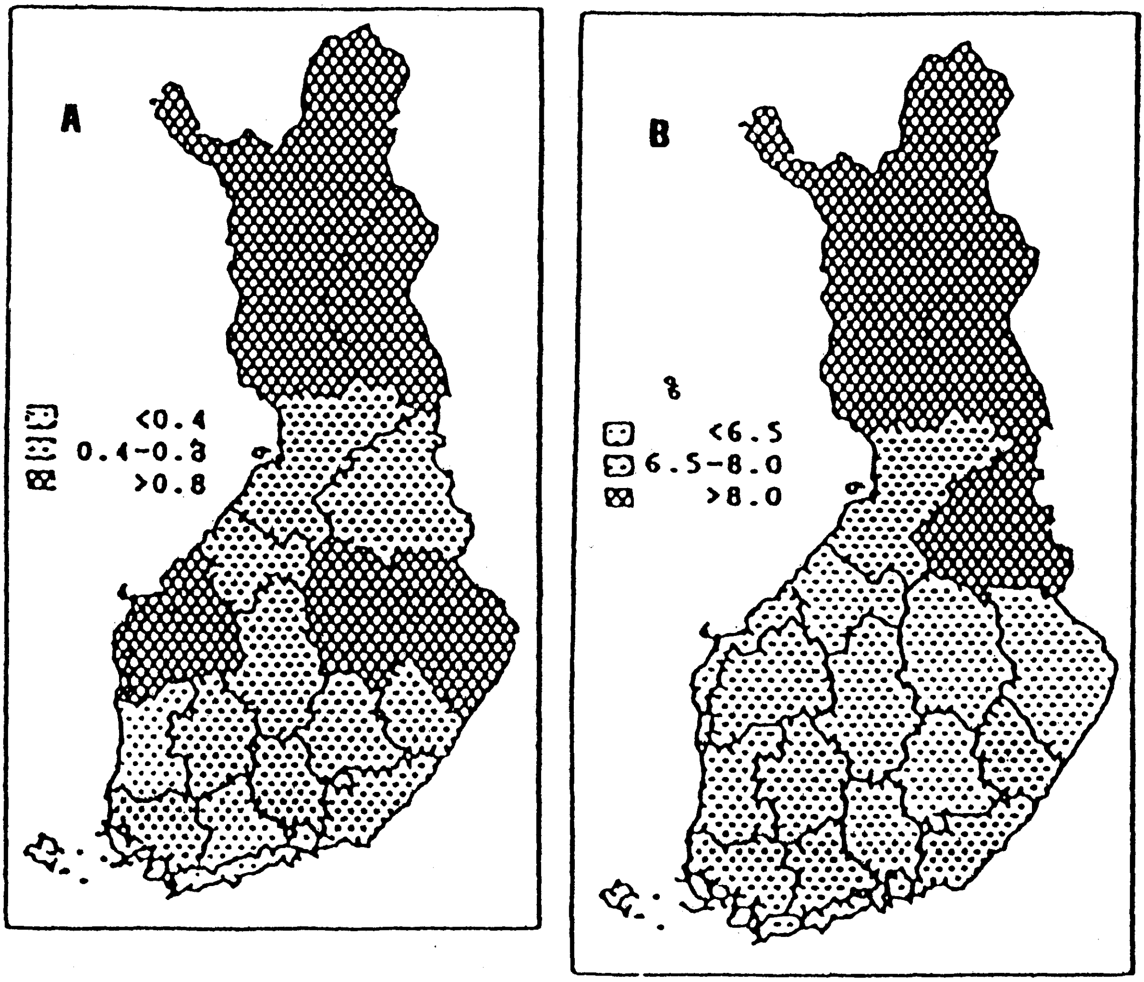

Fig. 6. Results of environmental monitoring obtained with the network of permanent NFI sample plots, examples:
a) the occurrence of beard-like lichens (*Usnea, Alectoria, Bryoria*) in stands less than 100 yrs old (less than 120 yrs in Lapland) in different forestry board districts;
b) average needle loss percentage (defoliation) of Norway spruce (source Jukola-Sulonen et al 1987).

atmospheric heavy metal deposition have been analysed as part of the same project, and the results were recently published (Rühling et al 1987).

The network of permanent sample plots has been used by the ILME project since 1985. About 100-150 plots were selected for intensive observations and sampling repeated at short intervals (daily, weekly, monthly), and about 600 plots for yearly monitoring.

The data on site classification, vegetation, berry yield classification and mushroom yields are being processed as part of special projects at The Finnish Forest Research Institute. Treated as part of the NFI, and using the generalizing framework of the NFI, these data are able to give answers about larger regions. With certain premises we can also obtain equations and models for better monitoring with fewer parameters.

Up till now, the NFI data were not used very much outside forestry. Individual parts of forest and mire ecosystems have been monitored separately in independent projects without any visible coordination. For instance, the mapping of flora, line surveys of bird fauna, winter bird censuses and monitoring of game animal populations have produced time series that could obtain considerable benefit from the generalizing network provided by the NFI (see Järvinen et al 1977).

An integrated enviromental monitoring was recently started in the Nordic countries (see Guidelines for integrated... 1987). This new type of monitoring is based on the use of a watershed area as a functional unit, the sampling primarily being done for flow, accumulation and budgeting of elements, especially pollutants. Later on many kinds of biological monitoring can be added to this system. In Finland, close cooperation between the NFI and integrated monitoring is considered to be necessary, starting from the selection of suitable watershed areas and continuing to the generalization of the results. Ten forest-dominated experimental basins, varying in size from some ten hectares to several km^2, which are in as near a virgin state as possible, have been selected and sampling has started in four areas.

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SUMMARY

15 - ECOLOGICAL MONITORING AS A PART OF THE FINNISH NATIONAL FOREST INVENTORY

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Paper submitted by the Forest Research Institute, Finland.

Forest inventories have been carried out on a national scale in Finland since 1921. Repeated at 6-8 year intervals, they were originally made as line transect surveys. In 1964 a method of systematic plots was adopted. The idea of an integrated ecosystem survey within the framework of a National Forest Inventory (= NFI) was suggested from time to time and was partly realized in the 3rd NFI in 1951-53. A further attempt, however, was not made until 1980, when it was planned to be incorporated in the 8th NFI to be carried out in 1985-90. It was justified by the planned use of a NFI system offering statistics to generalize the ecological data and an organization to overcome the financing problems.

In 1985-86, the network of permanent sample plots was established. Measurements for forestry and ecological monitoring were made at the same time. The work carried out by the biologist in the inventory groups was as follows: (1) a precise determination of site type; (2) vegetation analysis; (3) structural analysis of plant community; (4) determination of soil type and humus layer; (5) estimation of berry yields and potential productivity; (6) sampling of mushroom flora and standing yield; (7) estimation of forest damages; (8) estimation of the occurrence of epiphytic indicator lichens; (9) sampling of mosses, lichens and tree bark for deposition analyses; (10) observations of certain animals, and (10) photography of sample plots. Each plot was 300 m² in area and they enumerated 3009 in total. The time used at each sample plot was 1.5-2 hours.

The data obtained from the permanent sample plots of the NFI are to be used in numerous studies, but most opportunely in the project «The effect of air pollution on forests». Monitoring of pollution effects has been carried out within the network of permanent plots since 1985. The whole system becomes a real monitoring system, when the survey will be repeated in 1991-92.

RESUME

15 - LA SURVEILLANCE DE L'ENVIRONNEMENT EN TANT QUE CONTRIBUTION A L'INVENTAIRE DU PATRIMOINE FORESTIER FINLANDAIS

Auteur: Antti Reininkainen

Document soumis par l'Institut de recherche forestière, Finlande.

La Finlande réalise des inventaires du patrimoine forestier à l'échelle nationale depuis 1921. Ces inventaires, qui sont renouvelés tous les six à huit ans, étaient à l'origine réalisés par sondages sur bandes rectilignes d'essai. En 1964, une méthode faisant appel à des placettes systématiques a été adoptée. L'idée de procéder à une étude intégrée des écosystèmes dans le cadre d'un Inventaire forestier national (IFN) a été suggérée de temps à autre et en partie mise en pratique lors du troisième Inventaire en 1951-1953. Toutefois, il a fallu attendre 1980 pour que soit faite une nouvelle tentative en ce sens et que l'on envisage d'incorporer cette étude au huitième Inventaire qui devait être réalisé entre 1985 et 1990. C'était justifié par le fait qu'il était prévu d'utiliser le système de l'IFN qui fournissait des statistiques pouvant être élargies aux données écologiques et offrait une structure permettant de surmonter les problèmes de financement.

Le réseau de placettes permanentes a été établi en 1985-1986. Les mesures nécessaires pour la surveillance des forêts et de l'environnement ont été faites en même temps. Les travaux du biologiste des équipes chargées de l'Inventaire ont été les suivants: 1) détermination précise de l'écotype, 2) analyse de la végétation, 3) analyse structurelle de la communauté végétale, 4) détermination du type de sol et de la couche d'humus, 5) estimation de la végétation de plantes à baies et de la productivité potentielle, 6) échantillonnage des espèces de champignons et du volume du peuplement, 7) estimation des dégâts causés à la forêt, 8) estimation de la formation de lichens épiphytes caractéristiques, 9) échantillonnage de mousses, de lichens et d'écorce aux fins d'analyses des dépôts, 10) observation de certains animaux, 10) photographie des placettes. Chacune de ces placettes a une superficie de 300 m² et on en compte au total 3009. Le temps passé sur chaque placette a varié entre une heure et demie et deux heures.

Les données tirées des placettes permanentes d'observation de l'IFN doivent être utilisées dans de nombreuses études, mais surtout dans le projet relatif à l'effet de la pollution atmosphérique sur les forêts. La surveillance des effets de la pollution est effectuée à l'intérieur du réseau de placettes permanentes depuis 1985. Tout le système servira de dispositif de surveillance lors de la nouvelle étude en 1991-1992.

Резюме

15 - НАБЛЮДЕНИЕ ЗА ОКРУЖАЮЩЕЙ СРЕДОЙ КАК ВКЛАД В ДЕЛО ИНВЕНТАРИЗАЦИИ ЛЕСНОГО ДОСТОЯНИЯ ФИНЛЯНДИИ

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Таксация леса проводится в национальном масштабе в Финляндии с 1921 года. Повторяясь с интервалом 6-8 лет, первоначально она проводилась в качестве обследования линейной трансекты. В 1964 году был принят метод систематических участков. Предложение о проведении интегрированного обследования экосистем в рамках национальной таксации леса (= НТЛ) неоднократно выдвигалось и частично было реализовано в ходе третьей НТЛ в 1951-1953 годах. Однако дальнейших усилий не предпринималось до 1980 года, когда было запланировано включить её в восьмую НТЛ, которую предстояло провести в 1985-1990 годах. Это было обосновано плановым использованием системы НТЛ, обеспечивающей статистику для обобщения экологических данных и организационные рамки для решения финансовых проблем.

В 1985-1986 годах была создана сеть постоянных участков взятия проб. Измерения для лесного хозяйства и экологического мониторинга проводились одновременно. Биолог, входивший в состав инвентаризационных групп, выполнял следующую работу: 1) точное определение типа участка; 2) анализ растительности; 3) структурный анализ растительного сообщества; 4) определение типа почвы и слоя гумуса; 5) оценка урожая ягод и потенциальная продуктивность; 6) взятие проб грибной флоры и урожая на корню; 7) оценка ущерба, нанесенного лесу; 8) оценка распространения и эпифитных лишайников-индикаторов; 9) взятие проб мхов, лишайников и древесной коры для анализа осаждения; 10) наблюдение за некоторыми животными; и 11) фотографирование участков взятия проб. Площадь каждого участка составляла 300 м² и всего их насчитывалось 3 009. На каждый участок взятия проб было затрачено 1,5-2 часа.

Данные, полученные с постоянных участков взятия проб НТЛ, предстоит использовать в многочисленных исследованиях, но, вероятнее

всего, в проекте ""Влияние загрязнения воздуха на леса"". Мониторинг влияния загрязнения осуществлялся в рамках сети постоянных участков с 1985 года. Вся система будет использована для мониторинга при повторном проведении обследования в 1991-1992 годах.

16 - A NEW LAND EVALUATION IN HUNGARY BASED ON ECOLOGICAL POTENTIAL

Author: Lázló Góczán

Paper submitted by Hungary.

In Hungary, a new land evaluation was introduced by a Government decree.

Under the new system, plots of land will receive a so-called «score of habitat», ranging from 1 to 100 in the inventory. The rank expresses the quality of land in relation to the Hungarian habitat of highest productivity. The score of habitat, however, does not meet all requirements of a modern land evaluation. For instance, no answer is given to the question for which crop(s) the evaluated habitat is suitable and what the degree of suitability is.

On the other hand economic value of land also has to be determined in the new system, a component of which is the «location-dependent rent». This can in turn only be determined in an objective way, if a detailed subdivision of the country by agro-ecological area is available.

Agro-ecological micro-regionalization is also required as a consequence of a decree by Government, commissioning the Hungarian Academy of Sciences to elaborate a model for the rational use of land. The Geographical Research Institute of the Hungarian Academy of Sciences submitted a proposal for the joint solution of the problems mentioned. The Academy accepted the proposal.

In terms of the plan of work, a team determines land suitability for each of the six major economic crops for unit areas of 25 ha, which are of appropriate size for farms. The team also specifies the degree of suitability for the given crops. Based on this detailed survey, types of agricultural habitat are delimited. The analysis of their homogeneity regarding spatial pattern and quality allows the delineation of agro-ecological regions. This paper deals with the first stage of activities as performed in the Geographical Research Institute.

Method

Micro-regions are delimited in several phases. Firstly land suitability is determined for square grid units of the size of 25 ha, for each county. During the second phase, the spatial patterns of land suitability grades are analysed in relation to individual plants and grouped into regions. A large amount of data had to be processed, in the first phase, making computerization necessary.

Among the evaluation criteria, relief was described in terms of 160 states, differing in slope, exposure and dissection of terrain. For climate, heat and water supply are considered. Heat supply is represented by 30-year averages of monthly temperatures during the period from March to October, while water supply is described by monthly precipitations in the period from March to September. For temperature, 112 states are coded and for precipitation 168 states are identified. Soil properties are grouped into five compound parameters. Genetic soil type was combined with humus conditions, parent material with soil depth, soil pH with $CaCO_3$ conditions, while texture and groundwater conditions appear as separate parameters. Altogether 576 states of soil properties are recorded. The resulting data base is stored on magnetic diskette and used in Commodore 64 personal computers.

In the second stage, suitability indicators are compiled. The coded ecological parameter values are regrouped according to the satisfaction and the degree of satisfaction of ecological requirements, i.e. whether the individual conditions are excellent, good, medium, restrictive, highly restrictive or totally unsuitable regarding the ecological demands of the crops in question. The resulting grades represent the weighting of conditions according to ecological demands. The ecological requirements of the six economic crops (wheat, maize, sunflower, sugar-beet, lucerne, and grape) were compiled from the literature. The suitability indicators for individual crops are stored on diskette.

In the third phase, Zoltán Técsy, the computer expert of our team, prepared an algorithm and a program for assessment, thus providing all the necessary conditions of computer processing. Then data collection started for each unit of 25 ha from maps. The data were recorded on sheets. As primary sources of data, thematic maps of various scales, laboratory data for defined sites and meteorological data were available. For each map sheet, 21 data sheets had to be filled in (since we had 21 factors). The code numbers of the input computer were compared for each unit with the code numbers stored in the table of suitability indicators, weighted with suitability grades and summed up for each factor or evaluation criterion. Weighted scores were thus computed for the area units, which were subsequently grouped into 10 equal classes numbered from 0 to 9.

In the final phase of land capability analysis, computer printing on maps occurred. These computer-printed land capability maps are stored on diskettes. In each square grid of the map, the grade of ecological suitability is indicated for all crops by figures ranging from 0 to 9. The result is a series of assessement maps, quantitatively expressing land suitability for each crop. This phase is followed by the drawing of the micro-regions.

First, a type of assessment map was printed, which showed the highest suitability grade in each of the 25 hectare units, irrespective of the crop the figure refers to. Next, a map is printed, on which the name(s) of the crop(s) are shown, for which the 25 hectare unit in question is most suitable.

Cutting off the coordinates from these sheets, the whole county area can be put together in a continuous map. Choosing different colours for the various combinations of crops, the map is coloured.

In the next phase, transparencies are used in overlay technique and areas are delimited on the map where similar crops are indicated. In this way, types of agricultural habitat are identified and delimited.

In the final stage of establishing the micro-regions grouping is based on the areal pattern of types of agricultural habitat. At the present stage of our work, we create agro-ecological micro-regions according to (i) the spatial and qualitative homogeneity of agricultural habitats, (ii) the occurrence of marker or characteristic crops, and (iii) the difference in the predominant rank numbers assigned as explained above. It is to be noted that objective delineation of micro-regions will be possible applying cluster analysis on a macro-computer. However, this technique seems to be reasonably applicable by if the survey of land capability is completed on a sub-national level, for instance, for the whole of Transdanubia. County boundaries do not reflect the boundaries of ecological regions and, therefore, micro-regions cannot meaningfully be defined for smaller areas. The conclusion could be that the regional boundaries as presently established will undergo minor modifications only.

During our work, we so far assessed land suitability for 6 crops (wheat, maize, sunflower, sugar-beet, lucerna and grape) in 4 counties. The corresponding square grid maps are now available in print and also stored on 5 1/4 inch diskettes.

On the basis of the coloured agricultural habitat maps and the maximum suitability maps, agro-ecological maps were produced on transparencies. They show that:

— In *Györ-Sopron county*, we identified 104 types of agricultural habitats and eight regions with 6 sub-regions.

— In *Komárom county*, 37 types of agricultural habitats were distinguished, which gave rise to six micro-regions.

— In *Vas county*, 41 types of agricultural habitat made up eight micro-regions, including four subregions.

— In *Veszprém county*, the rather different and extremely heterogeneous habitats from the point of view of both spatial distribution and quality, were grouped into 55 habitat types and four regions.

For the counties of Komárom and Györ-Sopron, large, contiguous and homogeneous types of agricultural habitat emerged. In Vas county, both homogeneous and heterogeneous habitats of medium size were found.

The relatively highest levels of land capability and suitability for a large range of crops are observed in *Györ-Sopron*. While a wide range of crops can be grown in Veszprém county, the conditions of ecological potential in the county are such that yields are low.

Little over 70 per cent of the 93,000 Km^2 area of Hungary are used by agriculture (forestry excluded). The four counties studied make up for 15 per cent of the area and represent 13.5 per cent of total agricultural land. To date, the assessment of ecological suitability for the cultivation of six crops involved 35,789 units of 25 hectares. We plan to assess the remaining 226,390 units by 1995.

In the following, the new complex land evaluation system will be described for Hungary. The system also includes a method to calculate the price of land.

Firstly, the impact of the ecological potentials of the agricultural habitat on fertility is evaluated. This part of the work is the *ecological evaluation of habitat*. It is followed by the *complex land evaluation* proper, which considers the fertility and cultivability of land together.

The evaluation of habitat is composed of the assessment of soils, relief, water utilization and agro-climate. In the first step, the genetic soil map and the cartogram of soil properties influencing fertility have to be prepared for the area under study at scale of 1:10.000.

The second step is devoted to soil evaluation in accordance with a score system that was elaborated in 1970 by Pál Stefanovits and co-workers, who were commissioned by the Ministry of Finance. The system is used with minor modifications of the range of scores for soil types, and the corrective effects of parent material were re-evaluated for our purposes.

The system is founded on the consideration that the score range attributed to the genetic soil types empirically correlates with the average yields in the 1920s and 1930s. Thus, through correcting the range of scores by soil varieties, the qualitative differences between soils can be quantified. The highest quality soil scores 100, scores ranging from 1 to 100. During evaluation, the upper value of 100 is reduced on the basis of knowledge about restrictive properties of soil varieties, resulting eventually in the assessed score.

The second component of habitat is relief. Among its impacts on fertility only those are evaluated which are not reflected in soil properties and, consequently, the danger of multiple consideration of a given factor is excluded. The negative influence of relief is regarded as manifesting itself in surface run-off of precipitation water. Evaluation is carried out through the computation of hydropedological functions based on rainfall simulation data. Restrictions due to slopes of agricultural patches as mapped and the corresponding average slope lengths are also taken into consideration. The assessment of adverse effect of relief may give rise to a correction of the previously determined soil score.

As a third component affecting fertility, the amount of precipitation water available for plants is evaluated. For the purpose of defining correction values for water utilization, hydro-pedological functions are computed automatically from permeability data, which are being generated through rainfall simulation experiments. The useful water capacity of 1m solum is determined in laboratory tests. The restrictive effect of water availability on fertility is taken into consideration through the reciprocal of disposable water capacity, which is used for the calculation of the correction value for water utilization. Hydrological considerations also include the survey of soil patches affected by frequent occurrence of excess water or by strong water seepage on valley bottoms and slope feet.

The fourth component of agricultural habitat is agro-climate. Its adverse effect on fertility is partly taken into account through evaluating the climatic suitability regions (N. Bacsó and G. Szász) and partly through giving scores to local occurrence of frost, fog and exposure.

When all essential factors influencing fertility are assessed, the score for a given agricultural habitat is defined as the soil score, corrected for soil variety, and reduced by correction values for the other restrictive ecological factors.

The fertility of the agricultural habitat is assessed by the final score of habitat. The cultivability value, the second component of land quality, manifest in cohesion, stoniness, and steepness of slope, and influencing the cost of cultivation, cannot be determined in this way.

The cultivability value of the habitat is an economic characteristic of the habitat. As such, it can only be determined from the analysis of production yields. The ratio of production value and the quality of habitat, if it can be calculated, constitutes a good indicator or complex expression of the fertility and cultivability values of the habitat, i.e. the ecological value of habitat quality. Thus, it has to be seen as a component of its economic value.

There is an additional component of habitat value, the relative economic location of the habitat, i.e. its distance from the market and transport network. In spite of the fact that this location value has an objective existence, according to the expertise of economists, there is no need to determine it under the conditions of the present economic management, as its influence is compensated by the uniformity of state procurement prices all over Hungary.

When solving the problem, it has to be taken into consideration that two out of three production factors generating the cultivation value (labour and capital) are registered in various accounts, while the ratio of habitat and production value is estimated from the scores of the patches of agricultural habitat.

In order to include the indicators of different type into a data matrix suitable for mathematical treatment, the gross cultivation value and the invested direct and indirect labour capital costs have to be expressed in numerical form for each large farm plot. The scores of agricultural habitat determined for patches have to be averaged out, suitability weighted by the area of the individual plots.

Having experimented with several mathematical models, Iván Benet, agricultural economist, decided upon an adapted version of a Cobb-Douglas production function in order to determine how the habitat contributes to the production value of crop cultivation. A program was prepared for the solution of this four-variable exponential function by the computer, and the function was estimated with data from two co-operative farms. One of them is located on flat land, and the other in a heavily dissected hilly region with chernozem soils. The second offered the opportunity to measure the influence of relief on agro-ecological value.

Among the resulting volume elasticity coefficients, we needed the habitat elasticity coefficient. It expresses the share of the production value which is attributable to the habitat. The habitat elasticity coefficient, as a complex indicator of the ecological and economic value of the habitat, is suitable for the calculation of a unit price value, the current interest rate valid for long-term deposits is applied, and a sum is achieved that represents the annual crop cultivation value produced by the habitat.

In conclusion, the method described above provides scores for the ecological value of agricultural habitat and, at the same time, expresses the ecological and one kind of economic value of the habitat in money terms. For these reasons, the method can be called a complex land evaluation.

In the complex method for land evaluation, land price is computed by the following formula of the adapted Cobb-Douglas production function:

$Y = a\ S^{\alpha}\ L^{\beta}\ K^{\gamma}$, where

Y is gross crop production value

a is the so-called efficiency factor

α, β, γ are elasticity coefficients

S is the score of agricultural habitat weighted by area

L is labour investment in money units

K is capital investment

$\alpha + \beta + \gamma \cong 1$ is the volume elasticity coefficient.

Land price depends on three factors:

— crop cultivation yield per unit area

— habitat elasticity coefficients (α)

— actual interest rate, according to the following formula:

$$\text{Basic land price} = \frac{Y}{T} \cdot \alpha \cdot \frac{1}{k} \quad \text{where}$$

T is agricultural land in hectares

Y is crop cultivation yield in the area in question (money units)

K is interest rate

SUMMARY

16 - A NEW LAND EVALUATION IN HUNGARY BASED ON ECOLOGICAL POTENTIAL

Author: Lázló Góczán

Paper submitted by Hungary.

Presently, the almost 200-year-old land evaluation in «Goldkronen», dating back to the times of the Austro-Hungarian Monarchy, is being replaced by a new complex land evaluation system for Hungary.

To ensure continuous updating, this system evaluates separately the ecological component of land value, changing relatively slowly, and the economic component affected by rapid changes. The differences in the ecological quality of land are expressed in agricultural habitat scores. The best agricultural habitats in Hungary receive 100 scores, and the worst 1 score. This evaluation is founded on the positive relationship between basic fertility of land and the yields of crops grown on a given tract of land.

When determining the agricultural habitat scores, the endowments of the agricultural habitat primarily controlling fertility are taken into consideration, including major soil properties, slope conditions, exposure and agrometeorological factors.

Agricultural habitat scores, while describing relative qualities of tracts of land in comparison, do not inform about the suitability of land for the cultivation of certain crops or about the degree of such suitability.

With his team, the author elaborated a computer-aided method for the assessment of land capability for crop cultivation on agricultural land. The concept is the following:

A 25-hectare interval grid is superimposed on the thematic maps of agricultural areas. For each 25-ha unit the degree of suitability for the cultivation of some major economic crops is determined and arranged on a scale ranging from 9 to 0. The result of the assessment is automatically plotted in the form of a grid map and saved on diskette. Finally, a cumulative evaluation is also made by the computer and, as a result, in each 25-hectare

areal unit the crop(s) are indicated which can be cultivated most favourably on the given tract of land. Juxtaposing grid map sheets, the ecological capability map of crop cultivation is produced for a county.

During the procedure, a computer-stored data base is compiled which contains, in coded values, the ecological parameters controlling the cultivation of the various crops to various extents. Separately, coded suitability indicators reflecting the ecological requirements of crops are tabulated.

For the combination of the data base and the suitability indicators an assessment algorithm and an assessment program were prepared. The program handles the ecological data collected by the researcher for each 25-ha unit of the area studied.

The data sheet shows the codes of the conditions which are found in the area studied. The program confronts the ecological endowments in the 25-ha units with the ecological requirements of the individual crops. The results are indicated in the grid squares by figures ranging from 9 to 0.

The mosaic appearance of the cumulative map of land capability for crop cultivation is reduced by a homogenizing program. This step produces agricultural habitat types. A repeated areal grouping of agricultural habitat types allows the delimitation of agroecological microregions. The identification of agroecological microregions serves the planning of agriculture on the one hand and promotes the calculation of location-dependent differential rent in economic land evaluation. The government authority responsible for land evaluation accepted that the land capability for crop cultivations is an important component of land evaluation in the new survey.

The author and his team which was commissioned by the Hungarian Academy of Sciences, completed the assessment described above and the delimitation of microregions for four counties of Hungary. The areal data base and the assessed ecological potential represented on the grid maps constitute an informational system of agricultural habitats. Both the data base and the assessment are stored on diskettes in retrievable form.

Since this system allows a better adjustment in cultivation to ecological conditions for all farms, it provides a basis for environmental management reducing damage to the environment. In this respect, our information system on agricultural habitats will in the future be integrated into a comprehensive information system for environmental protection and management.

RESUME

16 - UNE NOUVELLE EVALUATION DE LA QUALITE DES SOLS EN HONGRIE FONDEE SUR LE POTENTIEL ECOLOGIQUE

Auteur Lázló Góczán

Document soumis par la Hongrie.

Le système d'évaluation des terres en Goldkronen, qui est vieux de près de 200 ans, et date de l'époque de la monarchie austro-hongroise, est actuellement remplacé par un nouveau système d'évaluation complexe.

Pour assurer une mise à jour régulière, on évalue séparément la composante écologique de la valeur des terres qui évolue relativement lentement et la composante économique qui, elle, change rapidement. Les différences constatées dans la qualité écologique des sols sont exprimées en points attribués aux habitats agricoles. Les meilleurs habitats agricoles en Hongrie reçoivent 100 points, les plus mauvais un seul. Le calcul est fondé sur la relation positive qui existe entre la fertilité fondamentale des sols et les rendements des cultures pratiquées sur une parcelle donnée.

Lors de la détermination du nombre de points à attribuer, on tient compte des caractéristiques de l'habitat agricole qui déterminent surtout la fertilité, notamment les principales propriétés du sol, la pente, l'exposition et les facteurs agrométéorologiques.

Tout en décrivant les qualités relatives comparées des différentes parcelles, ce système de points ne fournit pas d'informations sur l'adéquation des sols à certaines cultures ou sur la mesure dans laquelle ils s'y prêtent.

Avec ses collaborateurs, l'auteur a mis au point une méthode d'évaluation assistée par ordinateur du potentiel de production des terres agricoles. Cette méthode est la suivante:

Une grille à carrés élémentaires de 25 ha est superposée sur les cartes thématiques des zones agricoles. Pour chaque unité de 25 ha, le degré d'adéquation du sol à certaines grandes cultures économiques est déterminé et classé suivant une échelle allant de 9 à 0. Le résultat de cette évaluation est automatiquement res-

titué sous forme d'une carte quadrillée et conservé sur disquette. Enfin, une évaluation récapitulative est aussi faite par ordinateur, ce qui permet d'indiquer pour chaque unité de 25 ha les cultures les plus appropriées sur la parcelle considérée. En juxtaposant les différentes feuilles quadrillées, on peut déterminer la carte des possibilités écologiques de culture d'un district.

Au cours de cette procédure, il est établi une base de données informatisée qui contient, en valeurs codées, les paramètres écologiques qui déterminent la culture de divers produits à des degrés divers. Les indicateurs d'aptitude codés qui reflètent les exigences écologiques des cultures sont tabulés séparément.

Pour assurer la combinaison de la base de données et des indicateurs d'aptitude, un algorithme et un programme d'évaluation ont été établis. Le programme traite les données écologiques recueillies par le chercheur pour chaque unité de 25 ha de la zone étudiée.

La fiche technique indique les codes des conditions qui sont déterminées dans la zone étudiée. Le programme compare les caractéristiques écologiques des sols dans les unités de 25 ha avec les exigences de telle ou telle culture. Les résultats sont indiqués dans les carrés de la grille à l'aide de chiffres allant de 9 à 0.

L'aspect de mosaïque de la carte récapitulative d'aptitude culturale est atténué par un programme d'homogénéisation. Cette opération détermine les types d'habitat agricole. Le groupement répété par aires des types d'habitat agricole permet de délimiter des microrégions agro-écologiques. L'identification de ces dernières sert à planifier l'agriculture et favorise par ailleurs le calcul de la rente différentielle liée à l'emplacement dans l'évaluation économique des terres. Les organismes publics responsables ont reconnu que la détermination de l'aptitude culturale des sols est un élément important de l'évaluation des terres dans la nouvelle étude.

L'auteur et ses collaborateurs qui ont réalisé ces travaux pour l'Académie hongroise des sciences ont achevé l'évaluation décrite ci-dessus et la délimitation de microrégions pour quatre districts du pays. La base de données aréolaires et le potentiel écologique évalué représenté sur les cartes quadrillées constituent un système d'information sur les habitats agricoles. La base de données et les résultats de l'évaluation sont mis sur disquettes afin de faciliter la saisie de l'information.

Резюме

16 - НОВАЯ СИСТЕМА МЕЛИОРАЦИИ ЗЕМЕЛЬНЫХ УГОДИЙ, ОСНОВАННАЯ НА АНАЛИЗЕ ЭКОЛОГИЧЕСКИХ ВОЗМОЖНОСТЕЙ

Автор: Ласло Гозцан

Доклад, представленный Венгрией

В настоящее время двухсотлетняя система бонитировки земельных угодий ""Гольдкронен"", которая относится к периоду австро-венгерской монархии, заменяется новой сложной системой бонитировки земельных угодий в Венгрии.

Для обеспечения постоянного обновления результатов эта система позволяет оценивать отдельно экологический компонент стоимости земли, которая изменяется относительно медленно, и экономический компонент, на который влияют быстрые изменения. Различия в экологическом качестве среды, которую составляют сельскохозяйственные угодья, выражаются в баллах. Самые лучшие сельскохозяйственные районы в Венгрии получают 100 баллов и самые худшие - 1 балл. Такая оценка основана на положительной взаимосвязи между базовым плодородием земли и урожаями культур, выращиваемых на данном участке земли.

При определении количества баллов для сельскохозяйственных угодий учитываются возможности сельскохозяйственных угодий главным образом в отношении плодородия, включая основные свойства почв, условия уклона рельефа, влияние климатических и агрометеорологических факторов.

Характеристика сельскохозяйственных угодий в баллах, описывая относительное качество сопоставляемых участков земли, не обеспечивает информации о пригодности земли для возделывания определенных культур или о степени такой пригодности.

Вместе со своей группой автор разработал метод оценки, с помощью ЭВМ, пригодности земли для возделывания культур на сельскохозяйственных угодьях. В этом методе используется следующая концепция:

На тематические карты сельскохозяйственных районов наносится

сетка с интервалом 25 га. Для каждой единицы площадью в 25 га определяется степень пригодности для возделывания некоторых основных экономических культур и отмечается на шкале в диапазоне от 9 до 0. Результат оценки автоматически составляется в форме карты с координатной сеткой и хранится на дискете. И наконец, с помощью ЭВМ также проводится кумулятивная оценка, и в результате этого в каждой районной единице площадью 25 га указывается культура (культуры), для возделывания которой существует наиболее благоприятное условие на данном участке земли. Путем наложения на карту листов с координатной сеткой составляется экологическая карта пригодности земли для возделывания культур для всей территории страны.

При применении этого метода создается автоматизированная база данных, в которой содержатся в закодированной форме экологические характеристики, определяющие возделывание разных культур в различной степени. Отдельно от этого в форме таблиц составляются закодированные показатели пригодности земли, отражающие экологические потребности культур.

Для интеграции базы данных и показателей пригодности земли были составлены алгоритм оценки и программа оценки. С помощью программы производится обработка экологических данных, собранных исследователем для каждой из единиц площадью в 25 га изучаемого района.

На листе данных указаны коды условий, которые существуют в изучаемом районе. Программа позволяет сопоставлять экологические характеристики земель в единицах площадью 25 га с экологическими потребностями отдельных культур. Результаты отмечаются в клеткак координатной сетки с помощью коэффициентов, изменяющихся в пределах от 9 до 0.

Разброс значений кумулятивной карты пригодности земли для возделывания культур сокращается с помощью гомогенизирующей программы. На этом этапе определяются типы сельскохозяйственных угодий. Повторная районная группировка типов сельскохозяйственных угодий позволяет разграничить агроэкологические микрорайоны. Идентификация агроэкологических микрорайонов служит целям планирования сельскохозяйственной деятельности, с одной стороны, и помогает производить расчеты дифференциальной ренты, зависящей от местоположения, при экономической оценке земель. Государственный орган, отвечающий за бонитировку земельных угодий, решил, что пригодность для возделывания культур является важным компонентом оценки земельных ресурсов в новом обследовании.

Автор и его группа, назначенные Академией наук Венгрии, завершили описанную выше оценку и разграничение микрорайонов для четырех растей Венгрии. База районных данных и оценка экологического потенциала, представленная на картах с координатной сеткой, составляют систему информации о сельскохозяйственных угодиях. Как база данных, так и оценка хранятся на дискетах в форме, позволяющей вести поиск данных.

Поскольку эта система позволяет лучше учитывать экологические условия при возделывании культур на всех фермах, она обеспечивает основу для рационального природопользования, сокращая ущерб, наносимый окружающей среде. В этом отношении наша система информации о сельскохозяйственных угодьях будет включена в общую информационную систему для охраны и рационального использования окружающей среды.

17 - LE SYSTEME D'INFORMATION SUR L'ENVIRONNEMENT EN ITALIE: PROBLEMES ET PERSPECTIVES

Auteur: Lucio Sabatini

Document soumis par l'Institut National de Statistique, Italie.

En Italie, la situation de l'information est caractérisée fondamentalement per une extrême parcellisation des sources, et par une production de données très importante au plan quantitatif, mais qui ne sont pas toujours fiables.

En effet, les données sur l'environnement existent pour de très nombreux sujets et sont parfois même nombreuses, mais il est généralement très difficile d'en repérer la source. Cette situation est conditionnée en partie par l'ampleur de la matière, mais surtout par la grande quantité de sources potentiellement utilisables (Ministères, Etablissements publics, Régions, Collectivités locales, Institutions scientifiques, etc.); et ce nombre s'explique, à son tour, par l'extrême fragmentation des compétences dans le domaine de l'environnement. Même si la source est identifiée, il faut, en un deuxième temps, avoir accès aux données, car les données produites ne sont pas toujours destinées à être diffusées. Il faut ensuite tenir compte du fait que sur de nombreuses matières les données sont rares, que dans certains cas leur carence est absolue, et que d'autre part il n'est pas rare de constater que des informations sont produites en double (produits semblables par des organismes différents).

Un autre aspect enfin: on n'utilise pas toujours des méthodes de relevé et de traitement des données qui donnent les meilleures garanties de qualité, et en outre nous sommes encore très loin d'une diffusion étendue d'instruments méthodologique standardisés.

La situation, telle que nous venons de l'esquisser, est évidemment un gros obstacle à la mise en place et à l'application d'une politique de l'environnement efficace, et à l'élaboration d'un programme global d'intervention. Plus précisément, il est très difficile, dans ces conditions, de fixer des objectifs, de définir des priorités, d'articuler les actions au plan territorial, de quantifier en termes économiques les besoins et les mesures d'intervention. Et l'on a surtout éprouvé le manque d'un ensemble coordonné d'informations en 1986, lors de la création du Ministère qui aurait pour tâche exclusive et spécifique de gérer le secteur de l'environnement. Ce n'est pas un hasard si le programme de sauvegarde de l'environnement pour la période 1988-1990, présenté par le Ministre de l'environnement au Parlement en octobre 1987 a été extrêmement difficile à élaborer, bien que ne contenant que des indications générales. En outre, ce n'est pas un hasard si l'Italie ne dispose pas encore d'un rapport périodique sur l'état de l'environnement (il y a un an seulement que le Ministère de l'Environnement a présenté un rapport préliminaire sur ce thème).

La situation exige donc des actions d'urgence, radicales; mais il ne s'agit pas de développer des initiatives isolées, encore que traitées en profondeur: il s'agit de présenter une proposition stratégique à long terme, c'est-à-dire de définir un système d'informations sur l'environnement et de le mettre en place selon des délais et des modes préétablis.

En première approximation, nous pouvons définir ce système comme un ensemble d'informations régulièrement relevées et traitées selon des méthodologies standardisées et à l'aide d'instruments informatiques appropriés,d'après des définitions et des classifications précises, par différents organismes coordonnés entre eux selon un programme défini.

Il s'agit là d'une définition qui, d'une part privilégie la phase de saisie des données, et d'autre part se concentre sur la qualité des données, parce que ce sont justement les points «faibles» observés actuellement en Italie en matière d'information sur l'environnement. En d'autres termes, le problème fondamental n'est pas tant de pouvoir disposer et utiliser des technologies informatiques adéquates aux différents stades, mais plutôt de faire affluer aux différentes filières, d'une manière régulière, des informations confectionnées selon des méthodologies correctes. Par conséquent, nous ferons abstraction, ici, de toutes les questions, importantes certes, mais non pas prioritaires, liées à la création de systèmes de banques de données, de gestion des données, d'interface avec les usagers, etc.

Les matériaux qui peuvent constituer la structure portante d'un système d'informations sur l'environnement ainsi défini (à situer dans une succession temporelle qui n'est par forcément rigide) sont:

a) l'inventaire des sources d'information existantes

b) la collecte et l'analyse des méthodologies de relevé et de traitement des données

c) le contrôle de la fiabilité des données

d) un examen global des nouveaux besoins d'information

e) les modifications à apporter aux relevés déjà en cours

f) la mise en place de nouvelles enquêtes

g) l'élaboration de définitions, classifications, méthodologies standardisées

h) la diffusion, étendue dans toute la mesure du possible, des données sur l'environnement

i) la coordination de l'activité statistique ou, quoi qu'il en soit, de production des données statistiques dans le cadre de l'Administration Publique et dans les organismes internationaux.

A) *L'inventaire des sources d'information existantes.*

Actuellement, en Italie, les organismes produisant des informations sur l'environnement sont très nombreux, mais appartiennent tous à deux typologies fondamentales:

aa) pour répondre à des obligations normatives précises ou bien pour des besoins de gestion de l'Administration Publique,

ab) aux fins de la recherche scientifique.

Il n'y a actuellement aucun inventaire général des sources d'information, encore que, bien évidemment, on sache, au moins dans les milieux le plus directement intéressés, quels sont les organismes qui produisent la majeure partie des informations existantes. Ce qui fait défaut, c'est surtout une liste détaillée et complète des données produites et disponibles.

Cette carence constitue certainement le premier obstacle, parfois insurmontable, que l'on rencontre lorsque l'on veut mettre en place des politiques de l'environnement, et, naturellement, lorsque l'on doit préparer le Rapport sur l'état de l'environnement.

Pour pallier cette situation, l'Institut National de Statistique, en accord avec le ministère de l'Environnement, s'est occupé de lancer une enquête sur les sources d'information. En substance, on a d'abord défini les organismes les plus importants, pour la production des données, et on leur a envoyé un questionnaire (un par recherche effectuée).

On a donné au concept de source une acception très large: tout relevé, toute étude, recherche, et plus en général toute activité, même administrative, permettant de recueillir des infomations quantitatives dans le domaine de l'environnement, traduisibles en données statistiques. Le questionnaire porte sur les points suivants: description de la recherche, périodicité de la saisie des informations, années auxquelles se réfèrent les informations, couverture territoriale des informations, niveau territorial minimum auquel se réfèrent les informations, niveau de traitement des informations, support sur lequel les informations sont enregistrées, degré et mode de diffusion des informations, mention des organismes qui effectuent matériellement, le relevé des informations.

Lorsque les réponses ne seront pas satisfaisantes ou feront totalement défaut, l'enquête sera complétée par des entretiens au siège des organismes en question. Grâce aux résultats obtenus, on pourra construire des Archives automatisées qui auront deux fonctions: identifier immédiatement qui produit les données (et quelles données) sur un sujet donné, définir les secteurs où a été observée une carence quantitative et qualitative, afin de prévoir les actions appropriées.

Il faudra par la suite faire face au problème de la mise à jour des archives. Deux solutions sont possibles, qui ne sont pas nécessairement incompatibles: 1) répéter périodiquement l'enquête; 2) faire en sorte que les organismes déjà soumis à l'enquête communiquent eux - mêmes les nouvelles recherches, ou les changements, ou les données complémentaires.

B) *La récolte et l'analyse des méthodologies de relevé et de traitement des données.*

C) *Le contrôle de la fiabilité des données.*

D'après les résultats de l'enquête sur les sources d'information, il faudra procéder à la saisie des méthodologies déjà utilisées pour le relevé et le traitement des données, en analyser le contenu pour contrôler qu'elles correspondent bien à ce qui est indiqué par des normes ou des standards nationaux ou internationaux, contrôler en définitive le degré de fiabilité des données produites jusqu'à présent et disponibles, et leur niveau de comparabilité, au point de vue temporel et territorial.

D'après ce que l'on sait à ce propos sur la situation actuelle, à la lumière de différentes expériences telles que, par exemple, la préparation de la «Note préliminaire au rapport sur l'état de l'environnement» et du volume Istat «Statistiques sur l'environnement», on peut considérer que nous sommes bien loin d'une situation idéale: les méthodologies employées pour le relevé et le traitement des données sur les phénomènes environnementaux sont en effet assez dépourvues d'uniformité, ou encore ne répondent pas parfaitement aux standards optimaux, et cela même en présence de prescriptions normatives précises.

Il faut toutefois traiter à part les données, découlant d'enquêtes sur des phénomènes économiques et sociaux, qui peuvent avoir trait à l'environnement ou, de toute façon, intéresser plus ou moins directement l'environnement. Tel est le cas, par exemple, pour les données fournies par les Recensements ou par les enquêtes courantes sur les entreprises ou sur les familles qui donnent lieu aux statistiques industrielles, agricoles, démographiques, etc. En effet, l'Istat suit depuis longtemps la production statistique des procédures fiables et standardisées.

D) *Un examen global des nouveaux besoins d'information.*

E) *Les modifications à apporter aux relevés déjà en cours.*

F) *La mise en place de nouvelles enquêtes.*

La vérification de ce qui existe en matière de données sur l'environnement, et surtout de la façon dont ces données sont réalisées, permet d'arriver à connaître ce qui est encore nécessaire. Il s'agira, en substance, de procéder à l'élaboration d'un programme détaillé d'enquêtes sur l'environnement, auquel participeront tous les organismes actuellement déjà engagés dans, ou délégués à, la production, sous toutes ses formes, d'informations sur l'environnement. Selon les cas, il faudra apporter des modifications aux relevés existants, ou mettre en place de nouvelles enquêtes.

Par conséquent, si l'on n'est pas arrivé à la conclusion des phases précédentes, il faudrait en général éviter d'intervenir dans cette direction, à moins de raisons particulières, comme dans les cas de besoin extrêmement urgent d'informations.

C'est justement cette situation particulière qui porte sur plusieurs domaines, et qui est accompagnée d'une absence presque totale d'informations, qui a poussé l'Istat à élaborer une stratégie d'intervention sur les enquêtes courantes. En suivant, justement, cette stratégie dans le cadre du secteur des statistiques industrielles, on a obtenu des résultats importants, tels que l'insertion dans certains modèles de relevé de questions sur l'utilisation de l'eau, sur la production et le traitement des déchets, sur les dépenses engagées pour la protection de l'environnement par les entreprises industrielles. Il s'agit d'une activité très fructueuse, à étendre dès que possible à d'autres secteurs, mais sur laquelle il faut être très prudent.

G) *Elaboration de définitions, classifications et méthodologies standardisées.*

Parallèlement à toutes les activités mentionnées aux points précédents, il faut élaborer des définitions, des classifications et plus généralement des méthodologies de relevé et de traitement des données standardisées et à jour, qui tiennent compte des toutes dernières connaissances.

Certains de ces instruments existent déjà dans les dispositions législatives actuelles concernant les matières de l'air, de l'eau et des déchets; il s'agit de les compléter (et de les modifier le cas échéant), en utilisant en particulier ce qui est produit à cet égard par les différents organismes internationaux qui ont pour objectif prioritaire de standardiser les procédures. Mais on ne peut bien résoudre ces problèmes qu'en assurant une collaboration vaste et rigoureuse entre le statisticien de l'environnement et l'expert des différents secteurs spécifiques de l'environnement.

H) *La diffusion.*

A cet égard, la situation en Italie est encore tout à fait insuffisante.

La circulation des données au sein des organismes, et surtout entre organismes, et plus en général entre producteurs et utilisateurs potentiels, est actuellement très limitée.

La situation s'avère encore plus critique si l'on veut considérer des formes importantes de diffusion, comme les publications spéciales. Les publications sont très rares, et surtout il n'existe pas de périodiques contenant des données sur tout l'ensemble des thèmes de l'environnement. A deux exceptions près, qui en sont à leurs débuts: le volume «Statistiche Ambientali» (Statistiques sur l'environnement), dont le premier numéro a été publié par l'Institut National de Statistique en 1985, et la «Nota preliminare alla relazione sullo stato dell'Ambiente» (Note préliminaire au rapport sur l'état de l'Environnement). D'autre part, cette même loi reconnaît aux citoyens le droit d'accéder aux informations sur l'état de l'environnement disponibles, conformément aux lois en vigueur, dans les bureaux de l'administration publique».

C'est précisément en application de cette norme que le Ministre de l'Environnement a récemment proposé de constituer une Agence pour les informations et l'éducation sur l'environnement.

l) *La coordination.*

Ce n'est que si l'on parvient à établir une liaison étroite et efficiente entre les nombreux organismes intéressés par la récolte et l'utilisation des données sur l'environnement que l'on pourra assurer le succès des actions d'intervention, et en général le bon fonctionnement du système d'informations. L'exposé qui précède montre que le travail à accomplir dans cette direction est considérable. En effet, dans le cadre de l'Administration Publique, de nombreuses initiatives sont lancées, qui toutefois s'insèrent difficilement, en réalité, dans le cadre d'autres initiatives analogues produites par d'autres organismes publics. Sans oublier que la législation italienne a délégué ou transféré un grand nombre de compétences sur l'environnement de l'Etat aux Régions et aux Collectivités Locales; or, si cette décentralisation peut entraîner des conséquences positives indubitables, pour la mise en place et le déroulement d'actions pratiques, elle ne peut qu'encourager, d'autre part, la fragmentation des centres de récolte et de production des données.

En conclusion, la construction d'un système d'informations sur l'environnement passe par certaines étapes, pour atteindre différents objectifs reliés les uns aux autres.

La situation présente est bien loin de ce que le système d'information entend proposer, et donc le chemin à parcourir est très long; mais les temps sont mûrs. En effet, on est désormais parfaitement conscient, en Italie, que sans un système d'informations équilibré, la construction et la réalisation d'une politique de l'environnement efficace se heurtera à des difficultés parfois insurmontables. L'Institut National de Statistique est depuis plusieurs années conscient de ce fait, et ce n'est pas un hasard si le ministère de l'Environnement a récemment proposé, dans le cadre du Programme de sauvegarde de l'Environnement 1988-90, déjà cité, «la réalisation du système d'informations sur l'environnement visant à promouvoir, à organiser et à rationnaliser la connaissance de l'environnement, en vue, plus particulièrement, de planifier les interventions sur le territoire, de contrôler les conditions qualitatives et quantitatives des ressources naturelles, et de vérifier l'efficacité des dépenses publiques pour la sauvegarde de l'environnement».

SUMMARY

17 - THE COMPUTERIZED INFORMATION SYSTEM ON THE ENVIRONMENT IN ITALY: PROBLEMS AND PERSPECTIVES

Author: Lucio Sabatini.

Paper submitted by the National Statistical Institute, Italy.

The characteristic features of the information situation in Italy are essentially the extreme fragmentation of sources and the generation of data which are impressive in quantity but not always reliable from the qualitative point of view.

Environmental data are available under a very wide range of heads and on occasion even in substantial quantities, but it is generally very difficult to identify the sources.

This situation accordingly requires urgent and radical measures which will nevertheless have to form part of a long-term strategy involving a computerized information system on the environment.

By way of a rough initial description, this type of system may be said to comprise a body of information regularly collected and processed by means of standard methodologies and using appropriate data processing instruments, on the basis of precise definitions and classifications, by different bodies acting in coordination with each other and in accordance with a predetermined programme. The «bricks» which can be used to build the supporting structure of a computerized information system on the environment are listed below:

— An inventory of information sources already in existence;

— Collection of data and relevant survey methodologies;

— Verification of the reliability of data;

— An overall review of new information requirements;

— Elaboration of definitions, classifications and standard methodologies;

— Modifications to ongoing surveys;

— Launching of new surveys;

— The widest possible dissemination of data on the environment;

— The co-ordination of statistical activities or at least of the generation of statistical data in the public sphere and with international organisations.

For some time now the National Statistical Institute has been taking concrete steps in the directions outlined above. After defining the initial procedure to be adopted in order to identify existing computerized information sources, the Institute devised a questionnaire, in simple but analytical form, with the aim of verifying the essential characteristics of the information held by a select but broadly representative number of authorities operating in the environmental field (mainly Ministries, Regions, Local Authorities and CNE (National Energy Committee). The inquiry will start this year.

The National Statistical Institute has also adopted other approaches the first of these being to introduce into current surveys questions relating to specific environmental issues. It has also been possible to introduce into statistical industrial models questions on the use and discharge of water, on the generation and disposal of waste and on the costs incurred by enterprises on evironmental protection. The second approach is to step up the dissemination of information on the environment by the periodic publication of a range of environmental data. In this respect, the volume «Statistiche Ambientali» (Environmental Statistics) was published by ISTAT (National Statistical Institute) two years ago and a new edition is scheduled for the coming year.

RESUME

17 - LE SYSTEME D'INFORMATION SUR L'ENVIRONNEMENT EN ITALIE: PROBLEMES ET PERSPECTIVES

Auteur: Lucio Sabatini

Document soumis par l'Institut National de Statistique, Italie.

La situation de l'information en Italie se caractérise essentiellement par une pulvérisation extrême des sources et par une production de données remarquable du point de vue quantitatif, mais pas toujours fiable du point de vue qualitatif.

En effet, les données sur l'environnement existent sur de très nombreux arguments et sont parfois même en nombre considérable, mais il est très difficile, en général, d'en repérer la source.

Cette situation exige, en conséquence, des interventions radicales urgentes, qu'il faudrait toutefois insérer dans le cadre d'une proposition stratégique à long terme, c'est-à-dire dans un système informatisé de l'environnement.

Nous sommes en mesure de définir ce type de système, en première approximation, en tant qu'ensemble d'informations régulièrement relevées et traitées, au moyen de méthodologies standardisées et en utilisant des instruments informatiques appropriés, sur la base de définitions et de classifications précises, par des organismes divers coordonnés entre eux et selon un programme défini. Les «briques» qui peuvent constituer la structure d'appui d'un système informatisé de l'environnement sont:

— l'inventaire des sources d'information existant déjà;

— la collecte des données et des méthodologies de relevé afférentes;

— le contrôle de la fiabilité des données;

— un examen global des nécessités d'information nouvelles;

— l'élaboration de définitions, de classifications, de méthodologies standardisées;

— les modifications aux relevés déjà en cours;

— la mise en marche de nouvelles enquêtes;

— la diffusion, aussi étendue que possible, des données concernant l'environnement;

— la coordination de l'activité statistique ou, en tout cas, de celle de production de données statistiques dans le cadre de la Fonction Publique et auprès des organismes internationaux.

Dans cette direction l'Institut National de Statistique avance concrètement depuis un certain temps. Après avoir défini, en effet, la première démarche à effectuer pour repérer les sources informatisées existant déjà, il a été procédé à l'élaboration d'un questionnaire, simple mais analytique, dans le but de vérifier les caractères essentiels de l'information détenue par un nombre sélectif, mais largement représentatif, d'organismes opérant dans le domaine de l'environnement (surtout Ministères, Régions, Organismes locaux, CNE).

D'autres directions ont été, en outre, parcourues par l'Institut National de Statistique. La première est celle qui permet d'insérer, dans des enquêtes courantes, des questions concernant des thèmes spécifiques relatifs à l'environnement. Il a été ainsi possible d'introduire dans les modèles des statistiques industrielles des questions sur l'utilisation et le refoulement de l'eau, sur la production et sur l'écoulement des déchets, sur les coûts auxquels ont fait face les entreprises pour la sauvegarde de l'environnement. La deuxième direction est celle qui permet d'accroître la diffusion de l'information sur l'environnement par la publication périodique d'un ensemble de données concernant l'environnement. Le volume «Statistiche Ambientali» (Statistiques de l'Environnement) a justement été publié par l'Istat il y a maintenant deux ans; une nouvelle édition est prévue pour l'année prochaine.

Резюме

17 - АВТОМАТИЗИРОВАННАЯ ИНФОРМАЦИОННАЯ СИСТЕМА ПО КОНТРОЛЮ ЗА ОКРУЖАЮЩЕЙ СРЕДОЙ В ИТАЛИИ: ПРОБЛЕМЫ И ПЕРСПЕКТИВЫ

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Характерными особенностями положения в области информации в Италии являются в основном крайняя раздробленность источников и составление большого количества данных, которые не всегда являются достоверными с качественной точки зрения.

Данные об окружающей среде можно получить по весьма широкому кругу аспектов и иногда даже в большом количестве, но в целом весьма трудно определить их источники.

И наконец, методы, используемые для сбора и обработки данных, не всегда обеспечивают оптимальную гарантию качества, хотя в то же время стандартные методологические средства применяются далеко не повсеместно.

Поэтому такое положение создает необходимость в принятии срочных и радикальных мер, которые, тем не менее, должны составлять часть долгосрочной стратегии, связанной с автоматизированной информационной системой по вопросам окружающей среды.

В качестве начального общего описания можно сказать, что этот тип системы включает массив информации, сбор и обработка которой проводятся регулярно с помощью стандартных методов и с использованием соответствующих средств обработки данных на основе точных определений и классификаций разными органами, координирующими друг с другом свою работу, которую они осуществляют в соответствии с заранее определенной программой. Ниже перечислены ""конструкционные элементы"", которые можно использовать для создания вспомогательной структуры автоматизированной информационной системы по вопросам окружающей среды:
- перечень уже существующих источников информации;
- сбор данных и соответствующие методологии обследования;

- проверка достоверности данных;
- общий обзор новых потребностей в информации;
- разработка определений, классификаций и стандартных методологий;
- изменения проводящихся обследований;
- начало новых обследований;
- по возможности максимально широкое распространение данных об окружающей среде;
- координация статистической деятельности или, по меньшей мере, составления статистических данных на государственном уровне с международными организациями.

В настоящее время Национальный статистический институт в течение определенного периода осуществляет конкретные меры в вышеуказанных направлениях. После определения первоначального метода, который следует использовать для выявления существующих автоматизированных источников информации, Институт разработал вопросник в простой, но аналитической форме, с целью проверки основных характеристик информации, содержащейся в выборочном, но широко репрезентативном круге органов, действующих в области окружающей среды (главным образом, министерства, регионные и местные органы управления и НКЭ (Национальный комитет по вопросам энергетики).

Национальный статистический институт также использовал другие подходы в рамках автоматизированной информационной системы, первый из которых заключается во включении в текущие обследования вопросов, касающихся конкретных экологических проблем. Появилась также возможность включать в статистические промышленные модели вопросы об использовании и сбросе вод, об образовании и удалении отходов и о расходах предприятий на цели охраны окружающей среды. Второй подход заключается в расширении распространения информации об окружающей среде путем периодической публикации целого круга данных об окружающей среде. В этом отношении следует отметить, что ИСТАТ (Национальный статистический институт) два года назад выпустил том “Статистике Амбиентали” (Статистика окружающей среды) и что на следующий год запланирован выпуск нового издания.

18 - ENVIRONMENTAL EXPENDITURE IN ITALIAN STATE AND REGIONAL PLANNING

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Paper submitted by the Ministry of Environment, Italy.

1. Introduction

In this paper we try to offer a panoramic view of the environmental expenditure disbursed in Italy during the last 5 years, that is from the time this item started to assume effective importance in the public balance sheet. In this work particular emphasis is given to the investments coming through the FIO - *Fondo Investimenti e Occupazione* - (Fund for Investment and Employment) as the character of the statistical data given, i.e. the fact that they refer to amounts of cash and its allocation to sectors constitute their high reliability. The FIO is an organ created by the *Ministero del Bilancio* (Ministry for the Budget) for the distribution of public expenditure so as to favour investment and employment.

Other state and Regional environmental expenditure referred to in this work are in fact taken from the Budget Forecast.

There still does not exist a homogeneous Budget classification of environmental expenditures. They have therefore been compiled for the purposes of this paper by examining individual «headings» (chapters) and assessing their connection with environmental problems. The classification by sector is not as definite and certain as for FIO investments. Besides, expert forecasts had to be verified in the light of balance sheet figures, which was difficult to do because some Regions, at the time of the study, had not yet supplied their final balance sheets.

From the point of view of the relevant statistics, the results presented here are the fruit of a notable empirical effort. In fact, the figures for environmental expenditures have been treated until now as «residual» items under other headings in the balance sheet. It therefore gives great satisfaction to see the draft law of the Ministry for Environment which provides for a separate attachment on environmental expenditures to the state and the regional budgets. Articles 2 and 3 of the draft law say in fact: «a sheet attached to the estimates of the Ministry for Environment (art. 2 and for regional budgets art. 3) contains a reclassification for the law and for the planning of the chapter for current expenditure and for the finalized Capital Account:

a) to the defence and to the protection and recovery of the environment;

b) to the realization of works or operations which produce the relevant effects on the environment, putting in particular evidence the quota destined to the study of the environmental impact and to those dedicated to the implementation of operations to protect the environment (and art. 3):

c) to the creation of permanent regional schools for professional training in the techniques relating to the security and for the defence of the environment».

2. The dimensions of environmental expenditure in Italy (1)

Public environmental expenditures fall in the competence of different institutions. In this paper, state expenditure (forecasts are net of FIO expenditures) regional expenditure (known up to the end of 1983, and estimated to be 1.500 billions per year from 1984 to 1986) and FIO investments (the figures of financial allotments are known up to 1985; for 1986, the forecast reserves have been used, which implies that the actual expenditures are probably higher) have been examined.

From the data collected (Table 1), it emerges that total expenditures increased up to 1983, decreased by about 500 billions in 1984, and increased again to a level of about 4000 billions in 1986.

State expenditure is forecast in the Budget as constantly increasing in monetary terms. On the other hand, FIO expenditures declined considerably (by almost 50%) in 1984, while the allocation of financial funds to antipollution of 1,100 billions in 1985 was carried to the higher level of about 1,300 billions.

Table 1. Environmental expenditure by institutional sector (Expert forecast - *billions of Lire*)

	1981	1982	1983	1984	1985	1986
State (Net of FIO)	851	1,062	1,011	1,017	1,187	1,476
FIO	—	420	1,010	563	1,300	1,000[a]
Regions	1,414	1,462	1,450	1,500[b]	1,500[b]	1,500[b]
Total	2,265	2,944	3,471	3,080	3,987	3,976

Note: The State expenditures for the years 1984-86 include transfers to the regions with destinations tied to the environmental sector.
a Reserved for the Water Purification Department
b Estimate

Regional expenditures finally settled during the years 1981 to 1983 at a level of around 1,450 billions per year. It can, therefore, be assumed for the years 1984 to 1986 that the average amount per year was around 1,500 billions.

In Table 2, expenditures are shown as a percentage of GNP. The reduction in 1984 shows up clearly, while the recovery in 1985 by about 700 billions does not take the total to its 1983 level. From the figures emerge (i) a constant decrease starting from 1981 in state expenses net of natural calamities; (ii) a slight increase of regional expenditure in 1982, while (iii) an overall stability can be attributed to the total value of investments which are effected through FIO.

During the period 1981-1985, state expenditure gross of natural calamities shows a stable level around 2,300 billions (with a peak of 2,600 billions in 1985). Net of expenditures for natural calamities, the level fluctuates more, so that the hypothesis can be advanced that expenditures for natural calamities have a priority (Table 3), giving the expenditures for other purposes the character of residual. With regard to composition, the costs of natural calamities represent 50% of total expenses. The remaining 50% are predominantly devoted to the «defence of the soil and the hydrogeological structure».

Reasoning in real terms, however, environmental expenditures as a percentage of total state expenditure («final expenditure») were halved between 1981 and 1985. Including natural calamities, it passed from 1.3 to 0.77%, excluding them from 0.72 to 0.35% (Table 4). Therefore, at a central level (FIO remaining excluded), environmental expenditures do not keep the average speed of total state expenditures. As a percentage of GNP, in any case, total expenditures assume a value oscillating between more than 0.6% (1983) and 0.5% (minimum value in 1984).

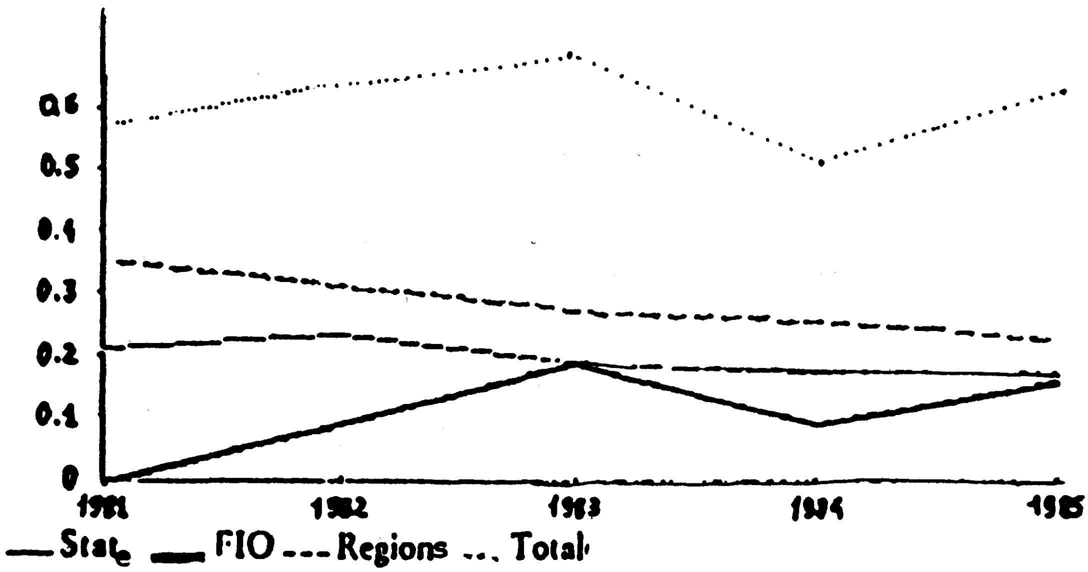
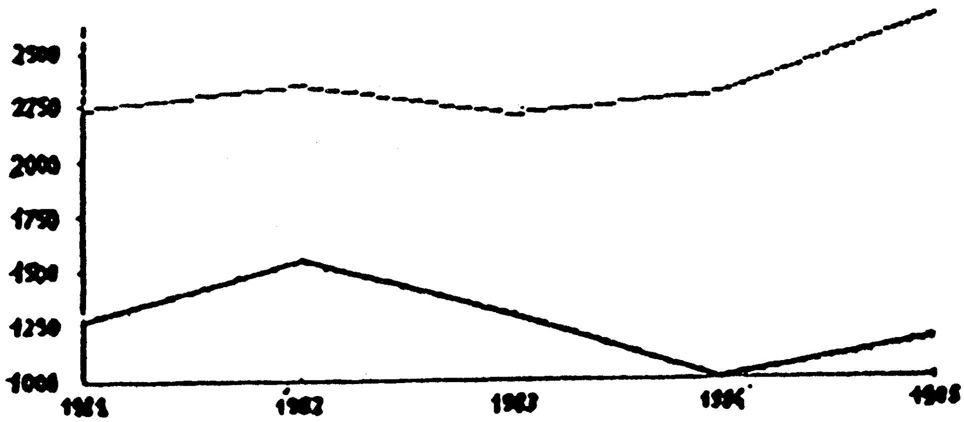


Figure 1. Environmental Expenditure as a percentage of PIL (GNP).



--Expenses incl.nat.calamit— Expenses excluding natural calamities

Figure 2. State Expenditure for the Environment (in Billions).

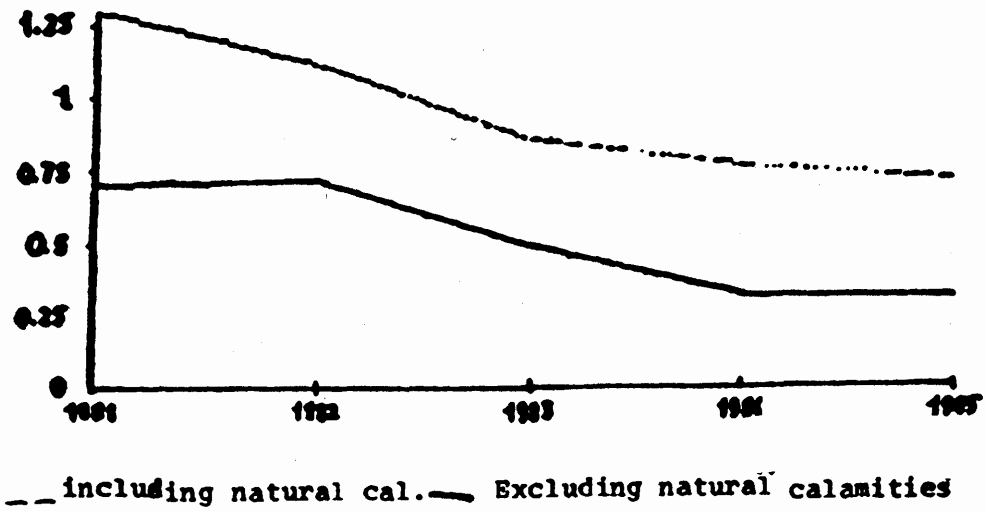


Figure 3. State Expenditure for the Environment of final expenses.

Total nominal expenditures per head passed from around 40,000 Liras in 1981 to about 70,000 Liras in 1986 (Table 5). If we consider 1985 as an example, the 67,000 Liras per head spent were shared between the state and FIO with around 20,000 Liras each, the largest share of 26,000 Liras coming from regional expenditures.

On the basis of a first approximation of order of magnitude we believe that the percentage is likely to rise to about 1% of GNP, if we include environmental expenditures made by other public bodies, municipalities in particular, and by the private sector.

For the purpose of a comprehensive forecast, we can observe the market of pollution abatement equipment: *Anima* (National Association for Mechanical Industry - varied and alike) estimates that about 3,700 billions are invoiced per year in relation to purchase of such equipment. On the basis of market research, it states that «the entire market of products and of technology for pollution cleaning and the protection of the environment is valued in Italy for 1985 at 3,000 billion Liras and this comprises the apparatus and systems for the decontamination of soil and purification of water and this part represents around 50% of the entire sector for the ecology industry». The association also believes that in the next three years the value of the treatment of solid waste will exceed 2,000 billion Liras (i.e. an average of seven hundred billions per year).

For valuing environmental expenditures it is possible to add to the turnover for pollution abatement the state and regional expenses, excluding, however, any expenditure for pollution clean-ups by the State and the Regions. Also on the basis of previous valuations, we believe that this amount will add up to about 1,000 billions, so that we reach an estimate for total environmental expenditures of 6,700 billions (which does not include, among others, a great deal of plan operating expenses regarding pollution clean-ups). The total is composed of 4,400 billions of invoices for pollution clean-ups (including solid waste) and 2,300 billions of regional and state expenditures net of expenditure for pollution clean-ups.

The hypotheses adopted are in part «heroic», but we maintain that the order of magnitude of the estimate is justifiable on the basis of the available data.

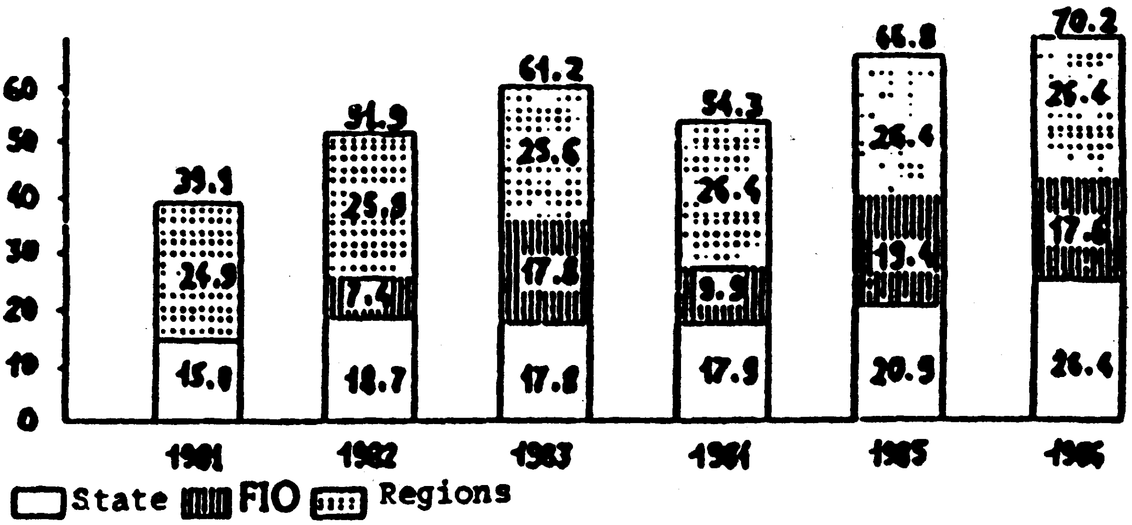


Figure 4. Environmental Expenditure per head in Thousand of Liras.

3. Environmental investments

The definition of «environment» which we have utilized in order to examine environmental investments combines different aspects regarding purification of water, management of solid waste, hydraulic lay-out, purification of the air, preservation of soil, etc.

The evolution of environmental investments over time followed the corresponding regulatory activities of the Government. The purification of water was the first subject of regulations, and it constitutes one of the early fields selected for investment. On the other hand, the subject of air quality still waits for credible, organic and workable laws, as there is an almost complete absence of regulation. Another environmental sector which will develop in the next few years is that of noise as emphasised in the three-year plan to safeguard the environment issued by the Minister of the Environment.

Before analyzing the quantitative dimension of environmental investments, we can describe some prevailing tendencies of the sector:

1. The environmental sector can justifiably be considered a mature investment sector. FIO investments show an investment/employment ratio which is not very high and equal to about 40 millions. 1985 FIO financing of 1,100 billions created direct sectorial employment of about 26,000 units relating only to building-yards.

2. The initial phase of establishing a basic territorial network of pollution abatement can now be considered as being achieves. The current situation permits to control the coarsest types of pollution and to acquire information for a more comprehensive management of the environment. The macroeconomic costs of this development were rather small.

3. Nevertheless, it will be a long time before we can consider that the detailed structural base necessary for conducting a coherent and comprehensive environmental policy even with regard to basic requirements is accomplished. From this point of view Italy presents a choking «bottle-necked» picture of management of extreme intricacy. The situation related to water purification plants can serve as an example. Even when produced in large numbers, they did not improve the quality of water supply commensurate with the installed treatment capacity, due to the inefficiency and inability of management. Of the 63 millions of population equivalent installed, only 58% are in service. The empirical evidence presented by the Water Department appears to confirm the impression that investments made up to now did not fully exploit technical innovation but, according to the peculiar characteristics of the sector, followed a line of traditional operations.

4. As a consequence of this situation, there is partial saturation regarding heavy interventions in the water and territorial sectors, while the waste sector is very far from being adequately equipped.

5. In the public and even more in the private sector, there is increasing emphasis, besides the stress on environmental engineering, on management characteristics of a more ambitious environmental policy. The trend which is slowly emerging foresees a major expansion during the next few years and expects intervention through the application of innovative technology, requiring higher qualification of the labour force employed.

6. In accordance with the above, the virtually complete absence of what could be called «Clean Technology» becomes a major feature of the situation.

Environmental investments are generally characterized by «additions» to the existent production or equipment system in order to minimize the negative impact of emissions on the environment, rather then by «add-on» technology i.e. modifications of production plants or processes which are not integrated in the production process.

4. Public environmental investments · global picture

We have tried to give, in this part of the paper, a global quantitative dimension of the sector. This is not an easy problem to solve as the data available are very heterogeneous and do not enable the compilation of complete temporal series. That is why we have to emphasize that the quantifications at a global level are only broadly indicative of the monetary inputs into the sector. If we consider the results obtained, we see that expenditure on capital account is at least partially obtainable for central (Government) expenditure, but not as far as the regional expenditures are concerned. We can eventually only estimate such expenditure for local bodies. The great uncertainty in recognizing expenditures for the protection of the environment could be lessened and perhaps completely eliminated if the recent proposal made by the Ministry for the Environment was accepted, namely to single out in the Budget and Balance Sheets current account and capital account items for environmental protection.

In order to make the estimates shown in Table 6, we have used data which have been drawn from single chapters of the State Budget and from FIO funds for investments at the national level. Census data have been used for the Regional level and the requests made by the local bodies to the *Cassa Depositi e Prestiti* (Fund for Deposit and Loans) for health and hygienic works — so far, we had only considered purification of sewage water at the town level —. The dimension of public expenditure for environmental investments is in the order of 4,500 billions in 1983 and '84 and more than 5,700 billions in 1985. In percentage of GNP, the expense for investments reached 0.85% in 1983 and '85, and decreased to 0.75% in 1984.

In the same year, FIO allocations for environmental protection registered a decline. Table 7 shows the percentages of investments as funded by the three categories. We can see that activities of the municipalities are the most sizable in 1984 (37%) and the second most important, after those of the Government, in 1983. This statement, however, is based on data limited to investments for health and hygienic works.

Table 6. Estimate of global public investment in the environmental sector (*billions of lire current value*)

	1981	1982	1983	1984	1985	1986
State[a]	760	1,389	1,891	1,321	2,226	2,200[b]
Regional	n.d.	1,143	1,305	1,589	1,300[b]	1,300[b]
Cities, towns	n.d.	n.d.	1,405	1,685	2,268	n.d.
Total	—	—	4,601	4,596	5,794	—

a Capital account expenditure, net of transfers to regions and including FIO.
b Estimate

Table 7. Composition of environmental investments by institutional body (*per cent*)

	1983	1984	1985
State	41	28.7	38.4
Regions	28.4	34.6	22.4
Municipal authorities	30.6	36.7	39.2
Towns or cities			
Total	100	100	100

As stated before, it is impossible to make a sectorial comparison of investments at different levels of Government, as the categories are not homogeneous. At the Government level, however, data can be obtained, and the classification that can be deduced from the budget results in the following categories:

1. Protection of soil water resources (works for the consolidation of the soil, sewerage, conservation of shores, protection of built-up areas, dam construction, etc.);

2. Water supply (sewerage, waste water treatment installations, acqueducts, etc.);

3. Protection of nature (intervention against pollution, except waste water treatment, natural parks);

4. Forests.

With this classification, the investments for waste water treatment, for example, cannot be singled out. The same problem arises for water resources and water supply systems.

Government

The national expenditure on capital account, net of FIO intervention, has progressively diminished in nominal terms, starting from 1982, although there was a slight increase in 1985. The decrease has of course been more remarkable in real terms. This feature is, however, counterbalanced by the environmental investments made by FIO.

Among the expenditures on capital account by the Government (Tables 8 and 9), we can see that more than 70% of the investments made in 1981 and 1984 have gone into soil protection. Such expenditures for the purpose of water resource account for negligible figures in 1983, both in absolute and in percentage terms, but have increased their relative importance since by about 50 p.c.

Table 8. State expenditures for the environment on capital account (*billions of lire, current value*)

	1981	1982	1983	1984	1985
Soil protection and Hydrogen set-up	580	770	906	627	639
Water works	585	638	137	208	283
Protection of Nature	5.4	5.1	8	24	13
Forests	20	19	121	16	37
Total	1,190.4	1,432	1,172	875	972
Transfers to Regions	430	487	291	117	43
Total net of transfers	760	945	881	758	929
FIO	—	420	1,010	563	1,297
Total Central Expenditure	760	1,365	1,891	1,321	2,226

Table 9. Composition per sector of state expenditure on capital account, net of FIO (*per cent*)

	1981	1982	1983	1984	1985
Soil protection	48.7	53.7	77.3	71.6	65.7
Water Works	49.2	44.6	11.7	23.8	29.1
Nature Protection	0.4	0.3	0.6	2.7	1.3
Forests	1.7	1.4	10.4	1.9	3.9
Total	100	100	100	100	100

Regions

The regional expenditure shows, at least in nominal terms, a tendency to increase. The major share of regional investment is related to aqueducts, sewerage and other health and hygienic works. Nevertheless, the regional expenditures on capital account for the forest sector are at least one third above the total final expenditures by the Government (including current items) made for the same purpose during the same years.

Municipal Authorities

Investments into health and hygienic works become more and more important, to the point of almost doubling from 1981 to 1985 in terms of the loans registered by towns and provinces from the Fund for Deposits and Loans. The related investments have primarily materialised in the North of Italy.

5. Environmental investments by FIO

The environmental sector has attained an important position among the requests for financing directed to the Investment and Employment Fund (FIO). In 1985, 35% of all requests related to this area. In the same year, more than 40% of the total appropriation of the Fund financed environmental projects (Table 10). As the activity of the Fund allows us to individualize very clearly the characteristics of the sector, we can analyze the individual requests for investments, as well as the funds that have been distributed.

Table 10. Requests for environmental projects and aggregate request total presented to FIO: approved financing (*billions of lire*)

	requests presented to FIO		requests for environmental projects				projects financed		environmental projects financed			
	N.	MLD	N.	%	MLD	%	N.	MLD	N.	%	MLD	%
1982	*	14,000.00	52	*	7,800.00	55	21	870.00	7	40	361.70	4
1983	317	13,168.65	62	19.5	2,725.73	20	60	2,079.44	23	38	1,010.18	48
1984	414	14,939.49	127	30.6	3,603.65	24	89	2,911.21	21	23.6	527.78	18
1985	441	15,491.66	185	42	5,499.00	35	117	2,989.92	46	39	1,297.71	43
1986	643	20,027.00	293	45	7,608.10	37.9	*	*	*	*	*	*

N = number of projects
MLD = billions of Lire
* Data not available

5.1 *Investment requests*

We look upon the requests for financing presented to FIO as an expression of the needs for environmental investments in different sectors. This assumption allows us to draw inferences as regards the approach to environmental investments followed by the public administrations.

Public Administrations appear to show a greater planning capacity in the presence of division reserves towards which substantial further resources can be canalized. The knowledge of needs expressed in the presence of departmental reserves also contributes to discredit the myth that FIO procedures (which foresee that the prospective incomes from the proposed investment have to be confirmed by the results obtained from a cost/benefit analysis of the project) would be too heavy and complicated and would consequently hamper the access of local bodies to the Fund.

With regard to estimating the capital stock which would be necessary to restore an acceptable quality of the environment, the requests for funding directed to FIO do not provide an entirely satisfactory indicator. In fact, requests to FIO (Table 11) sometimes show an increase in nominal terms, but more often in real terms. The annual consistency of the requests expresses both the amounts concerning new projects and the amounts regarding projects that have been presented in the past years but have not so far been financed. However, as most investments are intended to restore a degraded stock (soil sector) or counterbalance the negative impact of a flow of pollution that can be assumed to be more or less constant over time, the need for investments should tend to decrease in the short term (before replacement of investments occurs) except for particular situations, such as accidents, natural disasters or massive modifications of processes which tend to affect the respective environmental stocks and flows.

Table 11. Investment needs for the environment by Region (*billions of lire*)

Regions	Financing requested							
	1983	%	1984	%	1985	%	1986	%
Abruzzi	63.17	2.3	160.36	4.4	264.26	5	842.3	11.1
Basilicata	80.70	2.9	134.07	3.8	115.70	2	494.4	6.5
Calabria	—	—	347.36	9.7	171.53	3	300.6	4.8
Campania	47.66	1.7	215.37	6	161.12	3	919.6	12.1
Emilia-Romagna	106.26	3.9	361.61	10	529.71	10	432.3	5.7
Friuli-V. Giulia	38.96	1.4	65.51	1.9	145.05	3	85.7	1.1
Lazio	256.63	9.5	258.47	7.2	111.72	2	548.3	7.2
Liguria	47.17	1.7	22.50	0.6	183.25	3.5	286.6	3.5
Lombardia	261.57	9.7	105.59	2.9	536.09	10	689.8	9
Marche	310.23	11.3	462.90	12.9	357.96	7	180.6	2.4
Molise	32.49	1.2	34.08	0.9	96.40	1.5	107.3	1.4
Piemonte	291.08	10.7	278.13	7.7	503.53	9	537.6	7.1
Puglia	203.52	7.4	136.61	3.8	301.26	6	179.9	2.3
Sardegna	33.25	1.2	183.36	5	285.02	5	249.2	3.3
Sicilia	70.81	2.6	175.83	4.8	187.70	3.5	145	1.9
Toscana	313.45	11.6	—	—	547.75	10	358.9	4.7
Umbria	31.17	1.1	51.04	1.4	29.24	0.5	89.3	1.2
Valle d'Aosta	30.87	1.1	61.00	1.7	59.70	1	44.9	0.6
Veneto	506.68	18.7	549.86	15.3	836.09	15	973	12.8
Trentino-A. Adige	—	—	—	—	—	—	97.8	1.3
Total	2,725.73	100	3,603.65	100	5,423.20	100	7,608.1	100

The variations in needs (Im) can be identified by deducting from the requests presented at time t + 1 ($I_t + 1$) the difference between the requests presented at time t (I_t) and the funds distributed in the same period (F_t). The variation of needs in nominal terms would then be equal to:

$$I_m = I_{t+1} - (I_t - F_t).$$

Data generated according to this formula show that the requests concerning hydraulic works and water supply systems, soil protection and forestation have constantly diminished over time, probably because of a progressive saturation (at least in the first two sectors), as they obtained from the fund during its initial years of operation the highest share of total funds for purposes of environmental protection. It should be noted that in the years under review the degraded environmental stocks were not affected by exceptional disasters which would have increased the need for restoration.

Waste-water treatment and waste disposal show, on the other hand, a fluctuating trend which is strictly connected with the sectors' reserves. The need for waste-water treatment in particular seems to decrease in 1984, while increases considerably and durably with requests for more than 3,000 billions in 1985 and in the vicinity of 4,000 billions in 1986. The requests for funding waste disposal facilities appear to settle down only in 1986, with requirements amounting to about 1,500 billions.

These items naturally inflate the global amount requested of FIO for environmental protection investments, which has, in fact, passed from 2,700 billions in 1983 to 7,600 billions in 1986, representing an average annual increase of 29.3%.

The requests for environmental investments made by the regions (Table 12) show an almost unchallenged prevalence for the region of Veneto during the years from 1983 to 1986. In 1986, 40% of the total requests emanated from the regions of Northern Italy.

Table 12. Finance requests by sectors (*billions of lire*)

Sector	Finance requested							
	1983	%	1984	%	1985	%	1986	%
Water systems	996.83	36.6	1,206.58	33.5	1,199.51	22	1,030.7	13.5
Env. defence	48.45	1.8	76.96	2.1	271.17	5	—	—
Water protection	208.00	7.6	225.20	6.2	—	—	212.5	2.8
Soil protection	298.27	11	834.46	23.1	687.53	13	640.9	8.4
Pollution cleaning	977.91	35.9	105.74	3	3,115.74	57	3,998.5	52.6
Waste disposal	41.97	1.5	175.10	4.9	130.48	2.5	1,512	19.9
Woodland	138.04	5	88.84	2.5	94.48	1.5	89.6	1.2
Sewage/built-up area	16.26	0.6	890.77	24.7	**	**	123.9	1.6
Total	2,725.73	100	3,603.65	100	5,499.00	100	7,608.1	100

** The sewage item is included in the pollution cleaning sector.

With regard to projects proposed by type of administration (Table 13), most are made by the Regions and not by the Central Administration. A curious side-effect, perhaps of departmental incentives is that during

1986 (Table 13) requests were presented also by administrations not qualified to make them directly. Most of the applications during 1986 were under the minimum amount of 10 billions which is a necessary requisite for FIO financing.

Table 13. Request for investment to FIO for proposing administration (*billions of Lire*)

		Central A.	Regional A.
	V.A.	640	2,085
1983	% total	9.7	31.7
	% Env.	23.5	76.5
	V.A.	1,010	2,593
1984	% total	12.6	37.4
	% Env.	28	72
	V.A.	319	7,288
1986	% total	5.3	51.9
	% Env.	4.3	95.7

5.2 *FIO Financing*

Since the institution of the Fund, the allotment of investments to the environmental sector indicates that the biggest share went into waste water treatment: the total amount at current prices summing up to about 1500 billions of lire. The other sectors which obtained great relief are hydraulic installation (Table 14) and water supply systems. Very low amounts have until now been allocated in waste disposal facilities. The regions which have profited most from FIO financing are Veneto, followed by Tuscany, Piedmont, Lombardy and Emilia (Table 15).

Table 14. Environmental projects approved per sector (*billions of Lire*)

Sector	1983	%	1984	%	1985	%
Water Works	408.04	40.5	286.68	50.9	98.582	7
Environmental Protection	—	—	15.95	2.9	—	—
Water Protection	—	—	75.00	13.5	—	—
Soil Protection	* 61.23	6	48.70	8.6	104.581	8
Pollution Cleaning	489.60	48.5	—	—	1,090.222	84
Waste Disposal	—	—	67.22	12	—	—
Woodland/Forest	51.310	5	31.47	5.5	12.334	1
Sewage	—	—	37.56	6.6	**	—
Total	1,010.18	100	527.78	100	1,297.719	100

* Including a project for coastal protection

* * Included in the item for pollution cleaning

Table 15. Environmental projects approved per Region (*billions of Lire*)

Region	1983	%	1984	%	1985	%
Abruzzi	29.80	3	12.96	2	34.47	3
Basilicata	29.30	2.9	14.62	2.4	57.93	4
Calabria	—	—	80.27	14	10.50	1
Campania	—	—	—	—	35.00	3
Emilia-Romagna	46.26	4.6	93.39	16.6	143.50	11
Friuli-V. Giulia	18.93	1.9	27.75	4.9	63.35	5
Lazio	24.00	2.4	—	—	43.97	3
Liguria	47.17	4.7	—	—	25.90	2
Lombardia	137.87	13.7	—	—	159.84	12
Marche	53.78	5.3	50.10	9	115.80	9
Molise	22.23	2.2	62.73	11	17.79	1
Piemonte	36.00	3.5	91.93	16.3	171.09	13
Puglia	107.24	10.6	—	—	—	—
Sardegna	27.25	2.7	18.38	3.3	36.82	3
Sicilia	70.81	7	—	—	26.55	2
Toscana	213.70	21.2	—	—	144.73	11
Umbria	14.67	1.4	17.17	3	—	—
Valle d'Aosta	30.78	3	—	—	48.00	4
Veneto	100.39	9.9	98.48	17.5	163.48	13
Totale	1,010.18	100	562.58	100	1,279.72	100

6. Environmental expenditure: some observations

The characteristics of Italian public expenditure for the environment seem to be the following:

1. *Relevant dimensions*. The global expenditure of the central state and regions combined oscillates around 1/2 a percentage point of GNP. According to an estimate — necessarily approximative due to the lack of data — the global expenditure of the other public bodies (most of all the municipal authorities), and the turnover of private firms operating in the pollution cleaning and waste control sectors, carry state expenditures to a level around 1% of GNP. Thus, Italy is roughly in line on this respect with other countries of the European Community.

2. *The absence of an effective expenditure policy.*

Assuming that total Italian expenditures for environmental protection are sufficient, if you look for «who» spends, you will find a large number of entities and institutions which carry out this spending. At the level of central Government, there are twelve Ministries. The regions undertake their own expenses, including those of transfers from the state, and so do the municipal authorities and other institutions on the territory.

The coordination of these expenditures has been deficient and any given intervention policy is subject to diverse interpretations according to the view point of the entity deciding on the matter. This situation should improve once the envisaged coordination by the Ministry for the Environment becomes effective. The Ministry, in fact, has promoted a three-year Environment Plan which foresees that the expenditure policy must be strictly coordinated at the central level. In the action plan for the next three years, interventions are foreseen in crucial sectors of environmental pollution. Some of the required allowances have already been included in the Budget. Particular attention has been given to initiatives that create employment and utilize technology for the management of the environment.

This move by the Ministry has been a notable step forward in the management of a sector which, up to now, has presented «pockets» of inefficiency. From an examination of past trends, the expenditure reflects in fact inefficiency in its territorial distribution. If the regional distribution is examined, it is noted that the connection between the actual amounts to be spent and the environmental characteristics, which determine the extent of the needs of the area receiving funds, is not clear. The regional share in expenditure does not differ greatly from region to region, regardless of the level of pollution - which actually varies greatly from one region to another.

If we examine the relation between regional expenditure and regional GNP it appears that a region badly polluted with relatively high GNP like Lombardy spends relatively much less than regions which are scarcely polluted and have a comparatively low GNP, such as Basilicata.

Given that the actual expenditures are mainly directed to pollution control operations it emerges that, on one side, the share of environmental protection expenditure in total final expenditures is broadly satisfactory, and on the other, the adaptation of regional expenditures to qualitative considerations that should be the basis of an efficient environmental expenditures is not. This inefficiency which we see is not only due to examples of wasted resources (think, for example, of expenses for the construction of water treatment plants that have never even started functioning), but also to the strangling institutional bureaucracy which unfairly favours one department at the expense of another. It is well known, in fact, that small regions are aided by special laws, and those in Southern Italy enjoy a relatively favourable consideration when funds are distributed. Such criteria are certainly applicable when aims of economic development and equal opportunities are concerned, but they reveal themselves to be distorting when the sector to which the resources are directed presents characteristics and peculiarities which require specific criteria in order to rationalise interventions.

From what is said the necessity emerges to resolve the problems of management «bottlenecks» with the application of careful control criteria regarding the efficiency of the investments made. Above all, a solution at the central level of expenditure could be to give more power to the Inspectorate of the *Ministero del Bilancio* to make detailed controls (audits) in order to ensure that all projects financed by public funds function correctly. In addition, the financial aid which is not distributed equally and evenly across all areas, is tied to the peculiarities of the problems under discussion within the FIO decision-making.

This is probably due partly to the specificity of the Fund (which, as noted, takes into account both the needs of the regions and the needs of the sectors) and partly to its practice, decidedly new for the Italian administration, whereby a cost-benefit analysis is requested prior to any prospective investment.

The preparation of this analysis requires that the returns from the proposed investment should be assessed, thus permitting answers to specific questions, and enabling the administration concerned to specify the scheme of the project, including its relationship with the specific local needs. Besides, the evaluation of benefits and costs has given the opportunity to collect an important amount of information relative to a sector management of which constitutes a quite new experience for our Country.

NOTES

(1) For a more detailed explanation see E. Gerelli, R. Cellerino, G. Ghessi, «How much we spend for the environment in Italy». ENEL Congress. «Energy and the Environment», Milan, December 1985 and E. Gerelli, R. Cellerino, G. Pisauro, «Public Expenditure for the Environment», Office of the Minister for Ecology, 1985.

SUMMARY

18 - ENVIRONMENTAL EXPENDITURE IN ITALIAN STATE AND REGIONAL PLANNING

Author: Rita Cellerino

Paper submitted by the Ministry of Environment, Italy.

The impact of environmental policies on public budgets is examined with regard to national and regional Italian budgets.

Owing to the sharing of environmental functions among different levels of government, environmental revenues and expenditures are not easily aggregated. In our paper, we examine the situation of expenditure data and, for the local level, the yield of environmental charges. At present, the situation is not clear as to the availability of expenditure data, because more than 8000 institutional bodies are allowed to spend money in the environmental sector. Our paper examines the characteristics of the expenditure classification used in national and regional budgets. A case study illustrates the practices followed in municipal budgets.

Suggestions are made to improve the budget documents from the point of view of their statistical use.

In the second part of the paper, the budget situation for the environmental sector is examined from an economic point of view. The paper concludes with an examination of the efficiency of expenditures and revenues and their impact on national environmental policies.

RESUME

18 - LES DEPENSES POUR L'ENVIRONNEMENT EN ITALIE DANS LA PLANIFICATION NATIONALE ET REGIONALE

Auteur: Rita Cellerino

Document soumis par le Ministère de l'Environnement, Italie

Les incidences des politiques de l'environnement sur les budgets publics sont examinées dans le cas du budget de l'Etat et des budgets des régions en Italie.

Du fait que les fonctions en matière d'environnement se trouvent partagées entre différents échelons de l'Administration, il n'est pas facile de faire le total des recettes et des dépenses dans ce domaine. L'auteur du document examine la situation en ce qui concerne les données relatives aux dépenses et, à l'échelon local, le rendement des redevances pour l'environnement. A l'heure actuelle, la situation est confuse, du moins en ce qui concerne la disponibilité de ces données; en effet, plus de 8000 organismes sont habilités à engager des dépenses pour la protection de l'environnement. L'auteur étudie les critères de classification des dépenses appliqués dans les budgets de l'Etat et des régions. Les pratiques en vigueur pour les budgets municipaux sont illustrées à l'aide d'une étude de cas.

Des propositions sont faites pour rationaliser davantage les documents budgétaires du point de vue de leur utilisation statistique.

Dans la deuxième partie du document, l'auteur examine d'un point de vue économique la situation budgétaire, telle qu'elle apparaît pour le secteur de l'environnement. L'ampleur et la répartition sectorielle des dépenses engagées pour la protection de l'environnement sont illustrées par des exemples.

Le document se termine par un examen de l'efficacité des dépenses et des recettes et de leurs incidences sur les politiques nationales de l'environnement.

Резюме

18 - ВЛИЯНИЕ ПОЛИТИКИ В ОБЛАСТИ ОКРУЖАЮЩЕЙ СРЕДЫ НА ГОСУДАРСТВЕННЫЙ БЮДЖЕТ

Автор: Рита Челерино

Документ, представленный Италией

Вопрос о воздействии политики в области охраны окружающей среды на государственный бюджет рассматривается с точки зрения национальных и региональных бюджетов Италии.

В связи с тем, что функции в области охраны окружающей среды разделены между различными органами управления на различных уровнях, определить доходы и расходы, связанные с мерами по охране окружающей среды, весьма не просто. В настоящем документе мы рассматриваем положения с данными о расходах и, на местном уровне, вопрос о штрафах за загрязнение окружающей среды. В настоящее время ситуация здесь весьма сложная, по крайней мере в том, что касается получения данных о расходах, поскольку более 8000 государственных органов и учреждений имеют право на расходование средств в области охраны окружающей среды. В нашем документе рассматриваются характерные признаки классификации расходов, используемой в рамках национального и региональных бюджетов. Анализ конкретного случая дает представление о практике использования средств из муниципальных бюджетов.

В документе содержатся предложения по рационализации бюджетной документации с точки зрения ее использования в статистических целях.

Во второй части документа вопрос о распределении бюджетных средств, необходимых для охраны окружающей среды, анализируется с экономической точки зрения.

Приводятся данные, свидетельствующие о размерах расходов на охрану окружающей среды и их посекторальном распределении. В заключение дан анализ эффективности расходов и доходов, а также их воздействия на национальную политику в области охраны окружающей среды.

19 - ЦЕЛИ, ТЕМАТИКА И СРЕДСТВА СТАТИСТИКИ ОКРУЖАЮЩЕЙ СРЕДЫ В СССР

Записка подготовленная Государственным комитетом СССР по статистике.

Статистика окружающей среды в СССР представляет собой составную часть государственного управления охраноый природы.

Статистика окружающей среды призвана обеспечить достоверный и эффективный контроль деятельности по охране природы и рациональному использованию природных ресурсов, изменений качественного состояния природных сфер в результате антропогенного воздействия, эффективности расходования ресурсов, направляемых на природоохранные цели.

К настоящему времени в основных чертах сложилась система показателей статистики окружающей среды, обеспечивающая выполнение данной отраслью своих важнейших функций, к которым относятся:
- контроль за ходом реализации плановых расчетов;
- информационное обеспечение предплановых расчетов в области охраны природы и рационального использования природных ресурсов;
- обеспечение государственных органов и общественности информацией о рационализации природопользования, о мерах по предотвращению или уменьшению вредного антропогенного воздействия на окружающую среду;
- информационное обеспечение работ по созданию кадастров природных ресурсов (водного кадастра, лесного кадастра, земельного кадастра);
- проведение экономико-статистического анализа актуальных экологических проблем и эффективности их разрешения;
- контроль за выполнением природоохранных мероприятий, вытекающих из взятых СССР международных обязательств (например, мероприятий по охране от загрязнения бассейнов Балтийского и Черного морей).

Традиционно статистика окружающей среды складывалась в соответствии со структурой управления охраной природы. Она включает девять разделов, касающихся преимущественно различных компонентов природной среды, а также осуществления природоохранных мер:
1. Охрана и рациональное использование водных ресурсов.
2. Охрана атмосферного воздуха.
3. Охрана и рациональное использование земельных ресурсов.
4. Охрана лесных ресурсов.
5. Сохранение и воспроизводство ресурсов животного и растительного мира.

6. Охрана заповедных территорий.
7. Охрана и рациональное использование минеральных ресурсов.
8. Ввод в действие природоохранных объектов.
9. Затраты на охрану природы и рациональное использование природных ресурсов.

Раздел "Охрана и рациональное использование водных ресурсов" нацелен на статистическое отражение водообеспеченности страны в целом и отдельных регионов, водопользования и водоохранных мер. Учитывается забор и использование воды на нужды народного хозяйства и населения, сброс и очистка сточных вод.

Раздел "Охрана атмосферного воздуха" разработан применительно к антропогенному воздействию на воздушный бассейн. Объектами учета являются источники загрязнения атмосферного воздуха - стационарные и передвижные. Показатели этого раздела характеризуют вредные выбросы в атмосферу (без очистки и после прохождения очистных сооружений), обеспеченность предприятий пылегазоочистным оборудованием, эффективность работы очистных установок.

Раздел "Охрана и рациональное использование земель" содержит характеристики состояния земель, противоэрозионных, противоселевых, противооползневых мероприятий, а также рекультивации земель.

В разделе "Охрана лесных ресурсов" изучаются лесозащитные мероприятия, работы по лесовосстановлению и уходу за лесом.

Разделы "Охрана и воспроизводство ресурсов животного мира" и "Охрана заповедных территорий" предназначены для изучения охраняемых территорий (заповедников, заповедно-охотничьих хозяйств, природных национальных парков) и биотехнических мероприятий по сохранению и воспроизводству диких зверей и птиц.

Раздел "Охрана и рациональное использование минеральных ресурсов" содержит показатели рациональности и комплексности добычи и извлечения минеральных ресурсов.

Раздел "Ввод в действие природоохранных объектов" предназначен для изучения строительства и установки природоохранных мощностей в натуральном выражении (в основном, за счет капитальных вложений).

В разделе "Затраты на охрану природы и рациональное использование природных ресурсов" изучаются объемы капитальных вложений, затрат на капитальный ремонт и текущих затрат, на природоохранные мероприятия, а также операционные расходы на ведение лесного хозяйства. учитываются все затраты, осуществляемые как за счет государственных капитальных вложений, так и за счет собственных средств предприятий и организаций.

Практическую основу статистики окружающей среды составляют формы отчетности, заполняемые предприятиями и организациями, деятельность которых связана с эксплуатацией природных ресурсов, вредным воздействием на окружающую среду или осуществлением природоохранных функций.

По большинству форм отчетности разработка сводных отчетов централизована в органах государственной статистики. В этих случаях предприятия и организации представляют информацию на утвержденных Государственным комитетом СССР по статистике бланках в вычислительные центры органов государственной статистики по месту своего нахождения, где происходит разработка сводных отчетов. Сводные отчеты из областных управлений статистики поступают в республиканские вычислительные центры, где они контролируются, обобщаются и представляются в Главный вычислительный центр. Там осуществляется завершающая стадия разработки статистической информации для представления правительственным, плановым и хозяйственным органам страны. Наряду с представлением статистической информации в центральные органы местные статистические органы осуществляют информационное обеспечение соответствующих региональных органов управления.

Обработка ряда форм статистической отчетности централизована на уровне Главного вычислительного центра, где сводные отчеты разрабатываются на основании сводных данных отдельных министерств (о лесозащите и др.).

В ряду случаев получение сводной информации на основании форм статистической отчетности является функцией министерств и ведомств (разработка сводных отчетов об использовании водных ресурсов централизована в органах Министерства мелиорации и водного хозяйства СССР, о рекультивации земель - в органах Государственного агропромышленного комитета СССР). Статистические органы осуществляют контроль качества и сроков разработки указанных сводных отчетов.

Статистическая отчетность по вопросам природоохранной деятельности является основным источником получения информации на всех уровнях управления.

Вместе с тем, углубленное изучение проблем, получение качественных характеристик состояния окружающей среды, выявление возможностей и действительной загрузки мощностей очистного оборудования, эффективности проведения природоохранных мероприятий, ущерба, наносимого загрязнением природной среды, в том числе, ущерба здоровью населения, осуществляется на основе специально проводимых единовременных обследований, монографических исследований.

По мере совершенствования статистики окружающей среды получает развитие комплексный подход к анализу процессов взаимодействия человека с окружающей природной средой. Это достигается расширением разрезов разработки исходных статистических данных и выделением в экономическом анализе территорий и экологических систем.

В докладах, представляемых в органы управления, комплексно рассматриваются вопросы охраны окружающей среды в союзных республиках и отдельных городах. Так, например, в докладе, посвященном охране окружающей среды и рациональному использованию природных ресурсов Узбекистана, анализируются вопросы рациональности водопользования, охраны атмосферного воздуха, рациональности и комплексности добычи и переработки руды и угля, рекультивации земель, развития заповедного дела.

В материалах, представленных Государственным комитетом СССР по статистике на основе экономико-статистического анализа статистических данных, показано, что в республике сложился напряженный водный баланс, выявлены ведущие факторы, влияющие на водопотребление, и вскрыты резервы экономии водных ресурсов региона. К анализу были привлечены данные гидрологических и гидрохимических наблюдений за ряд лет, касающихся поверхностных и подземных вод региона.

При анализе охраны атмосферного воздуха статистические данные о вредных выбросах в воздушный бассейн сопоставлялись с данными мониторинга о загрязненности атмосферы.

Выявлено влияние геологоразведочных работ и капитального строительства на землепользование в республике, а также на плановые и фактические объемы работ по рекультивации земель.

В аналитической работе поднимаются вопросы состояния и охраны окружающей среды в отдельных городах и областях с наиболее острой экологической обстановкой, в сочетании с широким спектром социальных вопросов.

В информации, посвященной загрязнению и охране окружающей среды в Мурманской области, статистические данные о воздействии на природные водные ресурсы и атмосферный воздух, принятых природоохранных мерах в разных сферах сопоставляются с данными социально-демографической статистики о заболеваемости детских и взрослых контингентов по отдельным видам болезней.

Все более распространяется практика выделения в экономико-статистическом анализе отдельных экологических систем и их комплексного рассмотрения.

Широкий отклик получил доклад об охране природной среды озера Байкал, в котором поднимались вопросы водных ресурсов бассейна озера, охраны атмосферного воздуха в регионе, охраны лесных и рыбных ресурсов, создания и функционирования заповедников и национальных парков.

Материалы, представленные Государственным комитетом СССР по статистике, были использованы органами управления при принятии решения о перепрофилировании Байкальского целлюлозно-бумажного комбината с целью коренного улучшения охраны окружающей среды региона.

В аналитических материалах рассматривается экологическая обстановка в районе многих других природных комплексов, например, Ладожского озера, озера Севан, Балтийского, Черного и Азовского морей, реки Волга и других.

Так, в докладе, посвященном мерам по предотвращению загрязнения бассейнов Черного и Азовского морей, дается оценка воздействия на природную среду региона. При этом учитывается доля отдельных рек, впадающих в эти моря (Дон, Кубань и другие), в общем объеме загрязненных стоков, выделяются основные объекты, загрязняющие гидросферу, и выполнение ими водоохранных мероприятий. К анализу привлечены материалы мониторинга водных объектов (о загрязненности рек и морей), санитарно-эпидемиологической службы (о эпидемиологическом состоянии региона), а также смежных отраслей статистики: капитального строительства (о ходе строительства водоохранных объектов) и жилищно-коммунального хозяйства (об обеспеченности городов водой питьевого качества).

В СССР взят курс на резкое сокращение отчетности и уменьшение документооборота, поэтому расширение возможностей аналитической работы достигается, как правило, без увеличения нагрузки на отчитывающиеся предприятия. Применяется дополнительная разработка исходных статистических данных с целью выделения определенных объектов или регионов.

В последнее время большое внимание уделяется вопросам международных сопоставлений в области статистики окружающей среды.

Дополнительный импульс этим работам дала подготовка экспериментального сборника по статистике окружающей среды ЕЭК ООН (а также аналогичного сборника по странам-членам СЭВ). Это направление работы наталкивается на серьезные трудности, вызванные тем, что методология расчета многих показателей в разных странах существенно отличается друг от друга. Несмотря на это, межнациональные сопоставления делаются не только на уровне международных организаций, но и в нашей стране. В докладе, посвященном эффективности использования затрат на охрану природы и рациональное использование природных ресурсов, приведены сравнения уровня и структуры расходов с США.

Учитывая опыт работ в этой области, проводимых в СССР, а также подготовки экспериментального сборника ЕЭК ООН, СССР предполагает дальнейшее расширение работ по уточнению методологии статистики окружающей среды, особенно по таким разделам, как статистика отходов и некоторые другие.

SUMMARY

19 · OBJECTIVES, TOPICS AND TOOLS OF ENVIRONMENT STATISTICS IN THE USSR

Paper submitted by the Central Statistical Office, USSR

1. The purpose of environmental statistics in the USSR is to provide information for economic-statistical studies on environmental protection and the rational exploitation of natural resources, including:

— Pre-planning calculations;

— Verification of planned target fulfilment;

— Preparation of natural resource inventories;

— Regional analyses of the environmental situation;

— Estimates of the effectiveness of nature conservancy measures at the sectoral and departmental levels;

— Study of the influence of environmental factors on the national wealth and human health.

2. The scope of environmental statistics includes:

— The protection of atmospheric air;

— The protection and rational exploitation of water resources;

— The protection, rational exploitation and reproduction of forest resources;

— The protection and reproduction of wild animals and birds;

— The protection and rational exploitation of land resources;

— The protection of reserves and other protected lands;

— The protection and rational exploitation of mineral resources.

3. Environmental statistics are based on the accountability (obligation to report) of enterprises and organizations that exploit natural resources in the course of their basic activity that affect spheres of the environment and that carry out nature conservancy measures. It is the official responsibility of accountable enterprises to submit reports in due form.

Special surveys are conducted (simultaneous sample surveys and full-scope surveys, situation stocktaking, and public opinion polls) for the purpose of obtaining fuller information on a number of pressing problems in the use of natural resources, for example assessment of the effect of environmental pollution on human health, and of the effectiveness of purification plants, study of the special features of environmental protection in ecologically vulnerable regions, and of the social aspects of nature conservancy.

Data obtained by monitoring the natural environment are used in analytical studies to calculate the quality indicators of atmospheric air and natural water bodies; there are also prospects for the application of such data to soil quality.

RESUME

19 - BUTS, THEMATIQUE ET MOYENS DES STATISTIQUES ECOLOGIQUES EN URSS

Document soumis par l'Office central de statistique, URSS.

1. Les statistiques écologiques en URSS ont pour but de fournir des informations permettant d'effectuer des travaux de statistique économique dans le domaine de la protection de l'environnement et de l'utilisation rationnelle des ressources naturelles, notamment pour:

— Etablir des estimations avant planification,

— Veiller à l'accomplissement des tâches prévues par le plan,

— Etablir les cadastres des ressources naturelles,

— Analyser l'état de l'environnement dans diverses régions,

— Evaluer l'efficacité de la protection de l'environnement à l'échelon du secteur et du département,

— Etudier l'influence des facteurs écologiques sur le patrimoine national et la santé publique.

2. En statistiques écologiques, le champ d'investigation est le suivant:

— Protection de l'atmosphère,

— Protection et utilisation rationnelle des ressources en eau,

— Protection, utilisation rationnelle et reproduction des ressources en bois,

— Protection et reproduction des animaux sauvages et des oiseaux,

— Protection et utilisation rationnelle des ressources foncières,

— Protection des réserves naturelles,

— Protection et utilisation rationnelle des ressources minières.

3. Les statistiques écologiques s'appuient sur les rapports rédigés par les entreprises et les organismes qui exploitent des ressources naturelles pour leur activité de base, influent sur les milieux naturels et mettent en oeuvre des mesures de protection de la nature. Les entreprises concernées ont l'obligation publique d'en rendre compte dans des formes établies.

Afin d'obtenir des données détaillées sur diverses questions d'actualité relatives à la gestion du milieu naturel — par exemple l'évaluation des effets de la pollution de l'environnement sur la santé publique, l'efficacité des installations d'épuration, l'étude des aspects particuliers de la protection de l'environnement dans les régions écologiquement vulnérables, l'étude des aspects sociaux des activités de préservation de la nature — on effectue des enquêtes spécifiques (études ponctuelles par échantillonnage et études globales simultanées, établissement d'inventaires, sondages d'opinion).

Le travail d'analyse s'appuie sur des données d'observation du milieu naturel pour calculer dès maintenant les indicateurs qualitatifs de l'atmosphère et des masses naturelles d'eau, et l'on compte que plus tard ces calculs pourront être étendus au couvert végétal.

Резюме

19 - ЦЕЛИ, ТЕМАТИКА И СРЕДСТВА СТАТИСТИКИ ОКРУЖАЮЩЕЙ СРЕДЫ В СССР

Записка, подготовленная Государственным комитетом СССР по статистике

1. Целью статистики окружающей среды в СССР является информационное обеспечение экономико-статистических работ в области охраны окружающей среды и рационального использования природных ресурсов, а именно:
- предплановых расчетов;
- контроля за выполнением плановых заданий;
- составления кадастров природных ресурсов;
- анализа состояния окружающей среды в отдельных регионах;
- оценки эффективности природоохранной деятельности в отраслевом и ведомственном разрезех;
- изучения воздействия факторов окружающей среды на национальное богатство и здоровье населения.

2. Статистика окружающей среды рассматривает вопросы:
- охраны атмосферного воздуха;
- охраны и рационального использования водных ресурсов;
- охраны, рационального использования и воспроизводства лесных ресурсов;
- охраны и воспроизводства диких зверей и птиц;
- охраны и рационального использования земельных ресурсов;
- охраны заповедных территорий;
- охраны и рационального использования минеральных ресурсов.

3. В основе статистики окружающей среды лежит отчетность предприятий и организаций, которые в ходе своей основной деятельности используют природные ресурсы, воздействуют на природные сферы и осуществляют природоохранные мероприятия. Представление отчетов по установленным формам является государственной обязанностью отчитывающихся предприятий.

В целях получения углубленной информации по ряду актуальных вопросов природопользования, например, оценки воздействия загрязнения окружающей среды на здоровье населения, эффективности работы очистного оборудования, изучения особенностей охраны окружающей среды в экологически уязвимых регионах, социальных аспектов природоохранной деятельности, проводятся специальные обследования (единовременные выборочные и сплошные обследования, инвентаризации, опросы общественного мнения).

К аналитической работе привлекаются данные мониторинга природной среды, на основе которых рассчитываются качественные показатели состояния атмосферного воздуха, природных водных объектов, а также, в перспективе, почвенного покрова.

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