SOSIALE OG ØKONOMISKE STUDIER 65

NATURAL RESOURCE ACCOUNTING AND ANALYSIS

THE NORWEGIAN EXPERIENCE

1978—1986

NATURRESSURSREGNSKAP OG ANALYSER

NORSKE ERFARINGER

1978—1986

KNUT H. ALFSEN, TORSTEIN BYE AND LORENTS LORENTSEN

STATISTISK SENTRALBYRÅ
CENTRAL BUREAU OF STATISTICS OF NORWAY

SOSIALE OG ØKONOMISKE STUDIER 65

NATURAL RESOURCE ACCOUNTING AND ANALYSIS

THE NORWEGIAN EXPERIENCE 1978—1986

NATURRESSURSREGNSKAP OG ANALYSER

NORSKE ERFARINGER 1978—1986

KNUT H. ALFSEN, TORSTEIN BYE AND LORENTS LORENTSEN

STATISTISK SENTRALBYRÅ
OSLO - KONGSVINGER 1987

ISBN 82-537-2560-4
ISSN 0801-3845

EMNEGRUPPE
10 Ressurs- og miljøregnskap og andre generelle ressurs- og miljøemner

ANDRE EMNEORD
Miljømodell
Miljøøkonomi
Naturressurser
Ressursforvaltning
Samfunnsplanlegging

Forsidebilde: Torstein Bye

Preface

This report on the Norwegian experience in natural resource accounting has been written at the request of the Ministry of Environment in Norway. The accounting system was developed in the late 1970s, and is presently operated by the Central Bureau of Statistics. The report focuses on the achievements, roles and responsibilities of the two institutions most closely connected with the development, maintenance and use of the accounting system: the Ministry of Environment and the Central Bureau of Statistics. Other institutions are only mentioned in passing.

As a background for evaluating the Norwegian natural resource accounting system we found it necessary to broaden the scope to include a more general discussion of natural resource philosophies and policies. The views presented on this and other subjects in this report reflect the views of the authors.

The Central Bureau of Statistics, Oslo, 20 November 1987.

Gisle Skancke

Forord

Denne rapporten om de norske erfaringene med naturressursregnskaper er skrevet på oppdrag fra Miljøverndepartementet. Det norske regnskapssystemet for naturressurser ble utarbeidet i slutten av 1970 årene. Statistisk Sentralbyrå har siden videreutviklet og oppdatert regnskapene og foretatt analyser av naturressurs og miljøforhold. Rapporten fokuserer spesielt på den rolle Statistisk Sentralbyrå og Miljøverndepartementet har ved utarbeidelse og bruk av ressursregnskapene.

For å kunne evaluere det norske regnskapssystemet for naturressurser har forfatterne funnet det formålstjenlig å ta utgangspunkt i en mer generell diskusjon av naturressursfilosofi og ressurs- og miljøpolitikk. Synspunktene i rapporten står for forfatternes regning.

Statistisk Sentralbyrå, Oslo, 20 november 1987.

Gisle Skancke

Contents

List of Tables

Standard signs used in the tables are:

- . Not possible
- .. Not available
- \- Nil

List of Figures

Chapter 1

INTRODUCTION

Today there is perhaps nobody on earth who does not face some problems of environmental stress in his or her everyday life. Both in industrialized and developing countries the city-dweller breathes air polluted by exhaust fumes, the industrial workers inhale noxious fumes and carginogens, any citizen might be exposed to leakages from hazardous waste transportations or dumps and the nature lover sees lakes and forests despoiled by acidification. In addition, the citizens of developing countries face the effects of resource mismanagement such as soil erosion, deforestation, desertification and shrinking stocks, not only of inventory resources like oil and minerals, but also of biotic resources of games and fish. Pollution and mismanagement of natural resources is, however, by no means a 20th century phenomenon. The Romans died of lead poisoning from leaded drinking pots and tooth fillings, the Mesopotamians died of famine as a result of land salination and the Londoners of the 19th century were afflicted by smog and inadequate disposal of wastes and sewage. The problems have spread and grown immensely in magnitude as a result of 20th century's economic and population growth. The awareness of environmental problems and the ability to control the development have also grown. Is then the overall resource and environmental situation better or worse than before? There is no simple answer to this normative question. Resource and environment statistics and accounting can only provide some of the information necessary for such an evaluation.

The public awareness and concern for natural resource and environmental issues were given impetus in the late 1960s and early 1970s as problems became severe enough to become generally evident, fueled by popular doomsday reports announcing "limits to growth" and "the silent spring". This green wave put focus on the interrelationships between economic activities, natural resource depletion and pollution. Stripped of all its exaggerations the capital message of the green wave was that economic growth measured by the conventional definition of income is a deficient measure of social development. National accounting figures do not reveal deteriorations (or improvements) of the stocks of natural resources. In particular the conventional growth measures are deficient in evaluating changes in (non capitalized) resources like the quality of air, water and land surface. Availibility of certain amounts of these resources are not only important to economic development, below critical levels they become essential to subsistence. A single-minded pursuit of traditional economic growth might therefore not only give an unbalanced development, but in the long run even be self defeating.

Norway was among the first countries to establish a separate political body to deal with these questions. The Ministry of Environment (MoE) was established in 1972. It was recognized from the beginning that the Ministry needed data and research as a foundation and background for policy formulation and decisions. It was decided that natural resource accounts should be elaborated as a coherent framework for the information needed. Several OECD and ECE conferences in the early 1970s gave some guidelines. From 1978 the Central Bureau of Statistics (CBS) has been responsible for the development and maintenance of these accounts. The intension was that the accounting system should supplement national accounts with information on natural resources in order to make it possible to integrate resource and environmental considerations into traditional economic and social planning. The Norwegian ambitions have thus been high.

Fourteen years after the Ministry of Environment was established and eight years after the work on natural resource accounting and analysis started in the CBS, the MoE initiated a project to review the Norwegian approach and to discuss its successes and failures. This report deals mainly with the CBS work on natural resource accounting and analysis, but as a background the report also contains a short overview of the philosophy behind natural resource and environmental policies and the role of MoE. The experience so far forms the basis for a critical review. Finally, some perspectives for the future work on resource accounting and analysis are drawn.

Chapter 2

ELEMENTS OF A RESOURCE AND ENVIRONMENT PHILOSOPHY

2.1 Man's struggle to control the future

Man has always worried about the future. In prehistoric days the immediate problems were how to get the next meal and where to find shelter. Gradually, the horizon and the possibilities of controlling the future have widened. For instance, agriculture extended the planning horizon to at least the next growing season. The trend has continued up until our own time, with our emphasize on education and research – a fairly sophisticated way of trying to control the future. Concern for our environment and the resources of the Earth can be seen as just another step in this direction. Questions of where we are going to get the oil from in the next century and the long-term development of the global climate are similar to the original questions of where to get the next meal and where to find shelter.

There are good reasons for the present upsurge in the awareness and concern for the environment and the natural resources. One such reason is the steadily increasing volume and intensity of economic activity in today's societies. Collectively, man can now, intendingly or unintendingly, for the first time in history make a large scale impact on the global resource situation and the global environment. Oceans can be emptied of fish and the climate might be altered significantly due to human activity (Tickell, (1986), Jones et al., (1986)). Furthermore, problems with a deteriorated environment or scarcity of natural resources can no longer be solved by simply moving on to the next region, country or continent. Mismanagement of natural resources and the environment has for this reason much more agonizing effects today than ever before in the human history. Proper management of the natural resources and the environment are therefore realized as mandatory if people are to survive on Earth. The potential catastrophic effects of a failure to take proper care of the environment, makes it rational to hedge against events which today might be judged to have only a low probability of occurring. A substantial increase in the global temperature due to too much carbon dioxide in the atmosphere ("greenhouse" effect) is a possible event of this nature. The depletion of statospheric ozon is another.

Not only the volume of human activity has increased; also the character of the societies has changed. The social regulation of the the highly industrialized societies of today are much stronger than they were in the last century. This is partly due to equity and efficiency goals of the societies, but also reflects technological changes, perhaps in particular in the transportation and communication sectors. As the societies have grown more complex, the possible side-effects of the various regulations and laws are more difficult to assess. Regulations and policy actions aimed at solving income, efficiency and settlement problems in the society might have unintended consequences for the allocation and use of important resources or the environment. A rather wellknown example is the support given to the agricultural sector. This has led to a widespread system for indirectly subsidizing the pollution of water by encouraging an environmentally unsound intensity of soil use, fertilizers and pesticides in the agricultural sector, which in turn requires more support from the society in order to clean up the mess. Another more spesific Norwegian example of the target conflicts between traditional social and economic planning and the rational management of natural resources and the environment, is the indirect subsidies given to the power intensive industries through the provision of cheap electric power. Being an export oriented sector, it is deemed important for the Norwegian economy, but it is at the same time one of the most polluting sectors. Thus, the increasing interdependencies and complexity of the industrialized societies, together with the increased level of activity, has made it urgent for the authorities to formulate a resource and environment policy.

Seen in a historic perspective increased interdependencies and activity levels are new reasons for the recent concern over natural resources. A third reason, related to the previous ones, is the increased standard of living that most industrialized nations has experienced after World War II. This increase has been accompanied by an increased awareness of pollutions of all kinds (noise, smell, radiation, wastes etc). The demand for a clean environment is stronger now than before, just like demand for other consumption goods has increased over time. In addition, environmental quality is probably a superior good, i.e. a good with an income elasticity above one, thus implying an increase in the demand for a better environment over and above the general increase found for most other consumption commodities. This also means that pollution abatement, protections and other environmental actions often favour the wealthy who reap the benefits, whereas costs often are more evenly distributed among income classes. Smoke from the chimney signals jobs to the unemployed, but deterioration of the environment to the upper middle class.

Medical and nutritional research has prolonged the life expectancy of most people in the industrialized world, by eliminating many of the most threatening environmental hazards, like contaminated drinking water and food and by controlling epidemic diseases like tuberculosis, smallpox etc. Instead new, mostly manmade, pollutants have taken their place as the most obvious environmental hazards. Bacilli have been replaced by sulphur oxides (SO_x), nitrogen oxides (NO_x), lead (Pb), cadmium (Cd), mercury (Hg) and other health-threatening substances. Technical progress has made it possible and relatively easy to monitor and measure the quality of the environment. Damage functions are not so easily assessed, but medical and statistical indications of linkages between deteriorated environmental quality and health effects are many.

2.2 Management of natural resources

There seems to be many good reasons for the interest in proper management of natural resources. The question then arises whether or not the traditional market mechanism is capable of allocating natural resources and managing the environment. In other words; why do we have to worry about natural resources, why can we not leave it to the market? After all, the market mechanism has proved to be very efficient in allocating many other scarce resources.

If natural resource management is an appropriate area for government intervention, it must be because, in the absence of government intervention, resources are misallocated; e.g. the environment might be excessively polluted, or the extraction profile of material resources might be non-optimal in the sense that the intertemporal welfare of people is not maximized. A complete and convincing treatment of the subject of government intervention in natural resource markets requires a detailed discussion of individual characteristics of each and every important natural resource. This is so because of the inhomogeneity of natural resources taken as a group. Here we shall limit ourselves to point out a few general reasons why the management of natural resources cannot safely be left to the market mechanism.

- The first reason is the existence of external effects – or externalities – which are often associated with the exploitation of natural resources, in particular environmental resources. Externalities occur when the actions of one economic agent affects the welfare of another economic agent and the latter is not compensated for the damage. In order to internalize the externalities, some form of government or collective intervention is usually needed. Typical examples are pollution of air and water. Here, one economic agent – a firm or a consumer – reduce the welfare of other economic agents by increasing the production costs of firms requiring clean air and water for production purposes, or by reducing the health of individuals, reducing recreational possibilities and increasing the maintenance cost of buildings and other equipment. Since the emission of pollutants to air and water frequently is free, externalities are certainly not adequately internalized.

- A second reason for government intervention is the non-existence of property rights to many natural resources. The lack of an owner or body responsible for the administration of the resource means that there is free access to the resource and that the exploitation is regulated by crowding out mechanisms or saturation. No individual user of a free resource has an incentive to adjust for the costs his activity incur on other agents. For the market to function properly it is a necessary, but generally not sufficient, condition that every traded commodity should have an owner. Without an owner or market administrator over-exploitation of the resource is unavoidable. Harvesting of biotic resources, e.g. fishing in international waters, provides a good example where quotas or participation fees are necessary to achieve an optimal use of the resource over time.

- The optimal allocation of natural resources often requires very long-term planning in order to assure an efficient and fair distribution of welfare over time (e.g. among different generations). Even in situations where there exist owners of the resource and the exploitation of the resource have only minor externalities, one frequently find that markets misallocate the natural resource over time. This is usually due to the myopia of the economic agents involved, i.e. planning horizons and discount factors of private owners do not generally coincide with those of the society. Examples are the markets for oil, metals and many other raw materials. The cartels prevailing in these market are often found to defend too high resource prices, thus imposing too low consumption of the resources and too early use of expensive substitutes. Over time this has caused the resource price to fluctuate over very wide ranges; a sign of inefficiencies in the market.

- A final reason for government intervention in the management of natural resources has to do with the income distribution resulting from a free market solution. Natural resources are often looked upon as patrimonial assets belonging to a nation as a whole, not indiviuals or individual groups. Hence, it is felt to be unfair when only a selected few of the citizens are in a position to enjoy the royalities associated with the exploitation of natural resources. Rather, the resources should be managed as the wealth of the nation; a proper task for a government. The oil reserves in the North Sea is an example of a resource where this might be the main reason for government intervention.

2.3 The aim of natural resource policies

There seems to be good reasons for insisting upon regulation of the extraction and use of natural resources by the central authorities responsible for the welfare of people. The goal of natural resource and environment policies must be the rational allocation of resources over time and among citizens, taking into account externalities associated with the extraction and consumption. This does not mean that it should be the aim of the regulating authorities to conserve material resources or reduce pollutions as much as possible. Optimality is a key word in resource and environment policy, as it is in management of all types of scarce resources. Thus, it could also be the responsibilty of the government to encourage the use of underused or unexploited resources or services from nature. However, unnecessary deterioration of mans surroundings and wasteful use of materials should of course be avoided.

An environment and resource policy must be concerned with unusually long-term phenomena. This is both because the use of non-renewable resources affects all generations, and because the society needs time to find substitutes for exhausted natural resources. Furthermore, the consequences of mismanagement of natural resources are frequently impossible to envisage without applying long term forecasting and planning techniques. Effects of mismanagement of natural resources must often be hedged against long before the effects of misallocation can be felt, cfr. the greenhouse problem. "Envisage and prevent" rather than "detect and cure" can be a slogan for sound environmental management.

Any policy of natural resource management must recognize the fact that economic and social planning in general have impacts also on the allocation of natural resources. The authorities regulating natural resources must therefore seek to integrate the evaluation of resource and environmental impacts of general economic activity into the traditional social and economic planning process, both at a national, regional and sectoral level. Given the large number of natural resources and the many aspects or dimensions of the environment that can be of interest, it is crucial that the governing authorities concentrate their efforts on important, essential areas. Suggested priority areas within resource management, pollution abatement and protection on a national level are discussed in chapter 7 of this report. In addition, Norway should of course contribute to the solution of severe global problems – in particular the control of greenhouse gases – and regional problems, like acid rain and management of shared biotic resources.

2.4 Implementation of natural resource policies

There are several preconditions for developing and implementing a sound resource and environment policy. *First*, a thoroughly theoretical understanding of the topic is basic. *Second*, monitoring and data collection is necessary for surveillance and modelling. *Third*, analyses of policy options should be performed, using models sophisticated enough to allow a reasonably good evaluation of costs and benefits of different policy options. *Fourth*, the implementation of an environment and natural resource policy of course requires organizational structures and bodies adapted to the task and equipped with adequate instruments. These bodies must be able to communicate and interact with the traditional planning apparatus to ensure that environmental and resource aspects are integrated into or at least coordinated with the more traditional social and economic plans.

Both the formulation and the implementation of a resource and environment policy as described above requires access to data on reserves by quality classes, consumption of natural resources, pollution, quality of the environment and damage functions. The data should be presented in a coherent fashion and should be possible to link to other data and statistics employed in the overall social planning process. The natural resource accounting system described and discussed in this report, is meant to satisfy some of these demands. In the following the system will be described in more detail. Examples of natural resource accounts for Norway will briefly be described together with various examples of the use of the accounts for analyses and budgeting purposes.

Chapter 3

CLASSIFICATIONS OF NATURAL RESOURCES

3.1 The concept of "natural resources"

"Natural resource" is a concept that is intuitively understandable, but difficult to define with great precision. We will not attempt to give a precise definition embracing all natural resources. Instead we shall discuss some attributes of natural resources in section 3.1 and return to more precise and operational definitions and classifications in sections 3.2 – 3.5.

In order to narrow the meaning of "natural resources", most authors take as a starting point the production and consumption activities. Most production activities can be described as skilled application of energy to materials in order to transform them from their natural forms into useful commodities. Having served their purpose, the materials are returned to the environment. Thus, economic activity starts and ends with nature; first extraction from nature, then discharges to nature. Economic activities neither create nor destroy materials – they merely transform and move them. While resource economics is concerned with the optimal extraction of material resources from nature, environmental economics is about the optimal discharge of wastes to – and preservation of – nature. In addition to be a source of raw materials and a receptor for waste materials, nature also provides recreational and aesthetic services. The theories of optimal use of these services are also part of resource and environmental economics.

The materials exploited by man together with the different kinds of services provided by nature (e.g. air to breath, water to drink, land for agriculture, housing and factories, sites for waste disposal), constitute what are called natural resources. Some natural resources, like air and water and to some extent land, are essential for man's survival. Others, like crude oil, forest, fish etc., are important factors in economic activities – but can be substituted.

Despite the huge variation among natural resources they can all be characterized by a common property: Natural resources can not be created by man and mismanagement of them might have very long-term consequences – in some cases for all life in the biosphere. Consequences of political and economic mismanagement or misadventures (e.g. wars and recessions) can sometimes be felt several decades; serious mismanagement of important natural resources can have agonizing effects several generations into the future. A depleted non-renewable natural resource is – in practical terms – lost for future generations. Large perturbations of the climate due to excessive pollution may have catastrophic consequences for human beeings – if not for all living species. Thus, proper management of natural resources is an important and complex issue that requires and deserves attention both from national authorities and international agencies.

3.2 Classifications of natural resources

Natural resources can be classified along several dimensions. For instance according to the property right of the resource (privat or public), whether there exists a market for the resource, whether the resource is renewable or not, or according to the "essentiality" of the resource. A useful classification into two broad groups is:

- Material resources
- Environmental resources

3.2.1 Material resources

Material resources are tangible resources that may be extracted or harvested from nature, i.e. dead materials or living species in their natural form. The quality of a material resource is often important, but it is the total stock availible that usually is a limiting factor and therefore of most concern. This is in contrast to environmental resources, to be discussed below, where it is the quality or the state of the resource that has the greatest impact on man.

It is useful to subdivide material resources into three subgroups:

- Mineral resources
- Biotic resources
- Inflowing resources

a) Mineral resources

Among mineral resources are counted petroleum resources like crude oil, natural gas and coal, together with metals and other minerals and non-renewable materials. The main characteristics of mineral resources are that they are non-living and non-renewable.

The term "non-renewable" requires some comments. Like many concepts in the social sciences it is a bit "fuzzy" at the edges. Nature is of course permanently regenerating minerals like petroleum. However, the production rate is usually very much slower than the rate of extraction. On the other hand, material resources are not really consumed – they are only transformed into other objects containing just as much iron, aluminium etc. as the original material employed as input. The only true non-renewable resource from this point of view is energy. (Even energy is conserved if the system studied is taken to be large enough). The point is that once extracted, the material resource is usually no longer available in the same easy manner as it was from nature. (Counter examples might be extracted inventories of mineral resources or iron rich waste disposal sites which clearly are easily accessible mineral resources, but are nevertheless not counted as natural resources).

b) Biotic resources

Biotic resources consist of living species, for instance wood and fish. They are conditionally (or potentially) renewable resources. The term "replenishable resource" is also sometimes used. The stock of conditionally renewable resources are, of course, physically limited at any specific point in time, but under proper conditions they will yield repeated flows of services.

Together non-renewable and conditionally renewable resources constitute ***exhaustible*** resources; i.e. resources where it is possible to find a pattern of exploitation that makes their natural supplies approach zero. Even with careful exploitation, present extraction of exhaustible resources will have an impact on future stocks and potential harvests. Thus, management of these resources raises important and difficult questions about measurement and weighting of the welfare of future generations and time preferences for consumption.

c) Inflowing resources

Inflowing resources are solar radiation, ocean currents and the hydrological cycle. The gravitational field of the Earth should also be counted as an inflowing resource. The only economically important inflowing resource in Norway at present is hydro power. Inflowing resources are for all practical purposes renewable resources. Exploitation of the resource today have minimal consequences for the availability of the resource tomorrow, and it is virtually impossible to extinguish the stock.

All life in the biosphere ultimately depends on inflowing resources, e.g. radiation from the sun. Thus, it can be argued that harvest of biotic resources and exploitation of other material resources are indirectly extraction of inflowing resources. However, the classification of natural resources is normally done at the stage where the resource is first utilized by man. Hence, one and the same physical resource can be classified differently depending on how and where the resource first enters the production or consumption process. An example of this is water, which is counted as an (inflowing) material resource for hydro power generation, but as an environmental resource for inland recreational fishing.

3.2.2 Environmental resources

What distinguishes environmental resources from material resources is that they mainly provide services instead of providing goods used as input factors in the economy. Furthermore, the quality of an environmental resources is of great importance. Usually there are no property rights associated with the services and no direct costs connected to the consumption or use of the services. Examples are air and water as waste disposal media and land used for recreational purposes. Air, water and land can in some contexts be classified as material resources, but they are classified as environmental resources when the quality or state of the resource determines their usefulness. Some further characterizations of environmental resources are:

- Environmental resources are conditionally renewable; proper management and use of the resource can ensure an, in practical terms, unending flow of services.
- Services from air, water and soil are prerequisites for human life, and as such not possible to substitute. While most material resources are substituteable, important environmental resources do not have this attribute. For this reason mismanagement of environmental resources is potentially far more serious than mismanagement of material resources.
- While most material resources are bought and sold in markets, environmental resources are rarely traded, and therefore do not have a price. Although the markets for material resources often are imperfect, the market price still offers information of value to the consumers and resource managers. A similar information system is lacking for environmental resources, thus complicating the management of these resources and creating a need for imposing markets or regulations to signal to the consumers that not all uses of these resources are free and costless.

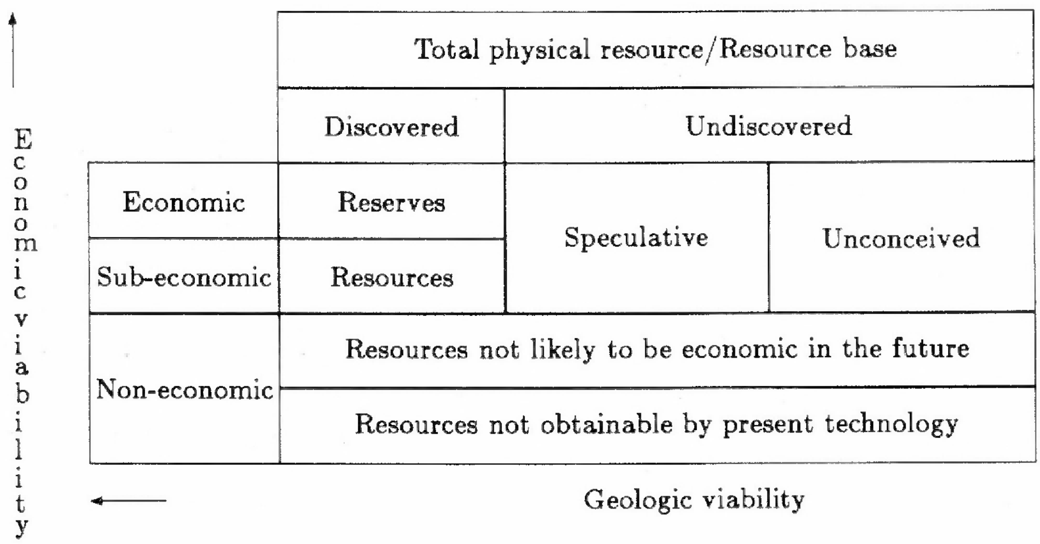
From the above it is clear that environmental resources differ from material resources in several important respects. This is of course reflected in the way information of the two classes of resources are organized. Therefore, the resource accounts for material and environmental resources are discussed separately, first with regard to principles in this chapter, then from a more practical point of view in chapter 4.

3.3 Reserves of material resources

A material resource has several attributes that, in addition to the size of the stock, might be of importance to the usefulness of the resource. Some of these are location, price and extraction cost. Furthermore, the certainty with which this information is known is of interest. Some fundamental aspects of material resources are illustrated below in what is known as McKelvey's box (Figure 3.1).

Clearly, known, economically extractable resources are of primary concern. This subset of the resource base is called the *reserves* (or *proven reserves*) of the resource. They are often further subdivided into developed and non-developed reserves. However, not all kinds of reserves are of equal importance in a management context. For instance, a reserve can be relatively unimportant due to the limited impact on human welfare, or because of easy access and abundancy of the reserve or substitutes. In particular, an important task for the resource managing authorities is to develop criteria for selecting those natural reserves that needs managing. The economic importance of the natural resources and the importance to the quality of human life could be two broad criteria in the selection process when the types and the degree of details of resource accounts are determined.

Figure 3.1: McKelvey's box.



Accounts, both for material and environmental resources, serve as a coherent framework for organizing data needed for the management and administration of important natural resources. It should be underlined, however, that it is just as important to develop a theoretical framework for analyzing the data and to be able to work out recommendations for how to manage the resources in an optimal or reasonable manner as it is to collect and organize the data. If administrative and political bodies are not able to pursue a resource and environment policy based on well founded analyses, the data alone is of little value.

3.4 Material resource accounts

Material resource accounts are coherent descriptions (i.e. unbiased estimates) of resource bases (total stocks), reserves and use of materials. The accounts are kept in physical units, but should be supplemented with information on prices. The principal structure of a material resource account can be illustrated as in Table 3.1.

The accounts for various material resources differ with respect to emphasis on the different parts (I, II and III) of the accounts. A biotic resource like fish requires a relatively detailed reserve account (part I) with specification of age structures and localization of the different classes and types of fish stocks. Part III of the fish account – use of the resource – is, however, quite simple, since few sectors use fish as an input factor in their production. For energy the situation is quite the opposite since energy is an important input factor in almost all production sectors. The reserve part (part I) is relatively simple, while part III – use of the resource – is rather detailed. In a similar manner, the importance of foreign trade of the resources determines the emphasis put on the trade part of the account (part II). This will be illustrated with examples from the Norwegian accounting

Table 3.1: Structure of material resource accounts.

I. Reserve accounts:	
Beginning of period:	Resource base Reserves (Developed, Non-developed) Total gross extraction during period Adjustments of resource base (New discoveries, reappraisal of old discoveries) Adjustments of reserves (New technology, cost of extraction, transport etc., price of resource)
End of period:	Resource base Reserves (Developed, Non-developed)
II. Extraction, conversion and Trade accounts:	
	Gross extraction (by sector) – Use of resource in extraction sectors
	= Net extraction (by sector) Import (by sector) – Export (by sector)
	= Net import (by sector) Changes in stocks
For domestic use:	Net extraction + net import +/– changes in stock.
III. Consumption accounts:	
	Domestic use (final use category, commodity)

system in chapter 4.

3.5 Environmental resource accounts

The environmental resource accounts should contain information of the state or quality of the resource at the beginning and end of a time period, together with information relevant for explaining the change in the state. "State of the environmental resource" must here be understood to mean a description of several of the more important (to mankind) attributes of the resource, such as consentration of major pollutants, the agriculturale potential of a piece of land or the recreational value of a landscape.

Frequently, the geographical dimension is of importance in assessing the effects of a deteriorated environment on people's condition of living. Unfortunately, the demand for spatially distributed data can make the development and use of a comprehensive environmental account prohibitively expensive. Two solutions are then available:

1. Data on the state of the environmental resource for relatively small "problem areas" can be collected. The remedy for these types of problems are, however, often of local nature, and hence not of prime concern for the national authorities.

2. Instead of monitoring the actual state of an environmental resource, crude indicators of the state of the environment can be measured or calculated from other available data. Hence, useful information on air pollution may be obtained from data on emission levels. This might indicate which sectors of the economy contributes to which type of pollution, thus making it possible to develop a national policy for fighting exessive pollution of various types without monitoring in detail the state of the environment at every location.

Unlike material resource accounts with their more or less prescribed structure, the environmental accounts are of a more "free style" and ad hoc nature. The content and structure of the accounts are tailored especially for each environmental resource and the problems associated with the management of these resources. This lack of a common conceptual framework is in a sense worrysome. The collection of the information necessary to make rational decisions about the utilization of the environmental resources is more vital than for material resources, due to their importance and lack of adequate substitutes. Development of a set of key indicators and early warning systems based on monitoring, deduced information and forecasting might be more adequate than detailed and coherent accounts.

Chapter 4

THE NATURAL RESOURCE ACCOUNTING SYSTEM

4.1 Introduction

The work on the natural resource accounting system in the Central Bureau of Statistics of Norway (CBS) was initiated in 1978 at the request of the Ministry of Environment (MoE). In selecting the resources for which pilot natural resource accounts should be developed, several criteria were considered:

- The resource should be economically or politically important.
- Primary statistics for the resource should be available or possible to establish at "reasonable costs".
- The introduction of resource accounting was not uncontroversial. It was therefore important to the MoE to prove the viability of the resource accounting system quickly. For the same reason it was important to develop accounts for several different resources.
- The definitions of sectors and commodities in the resource accounts should, if possible, follow the definitions of the National Accounts. While the National Accounts are kept in monetary units, the resource accounts are kept in physical units. By combining the two, it is possible to obtain price indices for many of the natural resources, and also to link resource use to economic activity.

The selection of material resources for pilot studies was thus not governed entirely by the selection criteria mentioned in section 3.3, but was based on practical and political considerations as well.

It was decided from the start to distinguish between accounts for material resources and accounts for environmental resources; both because the two types of accounts have to be different from a practical point of view, but also because complete accounts for environmental resources in many cases would be less meaningful (cfr. the discussion in section 3.5). Below are presented examples of both types of accounts. Among the material accounts, the energy accounts are emphasized, but accounts for fish, forest and minerals are also included. The accounts for land use and air are presented in the section on environmental accounts together with some comments on what have been done with regard to solid and hazardous waste, noise and radiation. The presentation is illustrated with selected data from the various accounts.

4.2 Material accounts

In chapter 3, material resources were divided into the following groups:

1. Mineral resources

2. Biotic resources

3. Inflowing resources

The only inflowing resource treated in the Norwegian material resource accounting system is hydro power, which is included in the energy accounts. These accounts also cover mineral resources like coal, oil and gas together with the (biotic) resource of fuel wood.

In addition, there has been developed separate (reserve) accounts for the following mineral resources: iron, titanium, copper, zink, lead, pyrite, sand, gravel and stone. Among the biotic resources, fish and forest are covered in the Norwegian system.

4.2.1 Energy accounts

The resource base estimates and the estimates of the energy reserves contitutes the first part of the energy accounts (cfr. McKelvey's box – figure 3.1 and table 3.1). The resource base estimates have to be adjusted whenever new discoveries are made or estimated resources are revalued. The estimate of the energy reserves; i.e. the part of the resource base that can be profitably exploited with present technology, prices and cost levels, might be affected by adjustments in the resource base estimates. In addition the reserves will vary with technological development, exploration costs, extraction costs, transportation costs and the market price of the products. The reserve side of the energy accounts is divided into non-developed and developed reserves. Correcting for adjustments and extraction over the period gives new estimates at the end of the period.

The next two parts of the energy accounts describe the extraxtion and use of energy within the economy. The definitions of commodities and sector aggregates are identical to the definitions in the National Accounts. Most of the day to day interest in the accounts is tied to the use of data from this part of the accounts, for monitoring and planning purposes.

The description of the extraction sectors in Part II of the account covers the energy commodities coal, coke, fuel wood, crude oil, natural gas, various refinery products and electricity (both firm and surplus power). Production (or rather conversion) levels and net output of primary energy (own input in conversion sectors deducted) are compiled in this part of the accounts, which also gives data on international trade with energy commodities and changes in inventories.

Net energy extracted, corrected for trade, changes in inventories and conversion losses, constitutes deliveries of energy to Norwegian industry and the household sector. Since energy is an important input factor in nearly all production sectors, this part of the energy accounts (Part III) is rather detailed. The number of production sectors covered are approximately 140 (i.e. the number of sectors in the model MODIS IV, Bjerkholt and Longva (1980)).

Energy accounts have been developed for all years since 1976. The tables 4.1 – 4.4 and figures 4.1 – 4.3 illustrate the 1985 accounts on an aggregated commodity and sector level.

Table 4.1: Reserve account for energy. 1985.

	Non-renew. reserves			Renew. reserves	
	Coal	Crude oil	Natural gas	Hydro power	Bio-mass
	Mill.t	Mill.t	Bill.t	TWh	Mill.m^3
Non-dev. res. 1/1-1985	-	291	128	60.6	.
Revaluation	-	0	- 1	-	.
Planned developed	-	65	6	-	.
Developed	-	-	-	- 1.5	.
Non-dev. res. 31/12-1985	-	356	133	59.1	.
Dev. reserves 1/1-1985	30.0	359	271	99.7	5
Revaluation	-	56	9	-	-
New development	-	-	-	1.5	.
Extraction	- 0.5	- 38	- 27	-	.
Dev. reserves 31/12-1985	29.5	376	254	101.2	5
Non-dev. and dev. reserves 31/12-1985	29.5	732	387	160.3	5
Non-dev. and dev. reserves 31/12-1985 in PJ	829	30964	14087	577	42

4.2.2 Mineral accounts

Pilot accounts for iron, titanium, copper, zink, lead, pyrite and stone, sand and gravel have been developed for selected years in the 1970s. Since only a few production sectors employ these minerals as inputs in their production, it is of course necessary to compile deliveries only to these few sectors. Economically, the minerals are of minor importance in Norway. For this reason, only the reserve part of the accounts are updated on a yearly basis. Reserve estimates are compiled for the years 1980 – 1985.

Figure 4.1: Extraction of energy. 1976–1986. PJ.

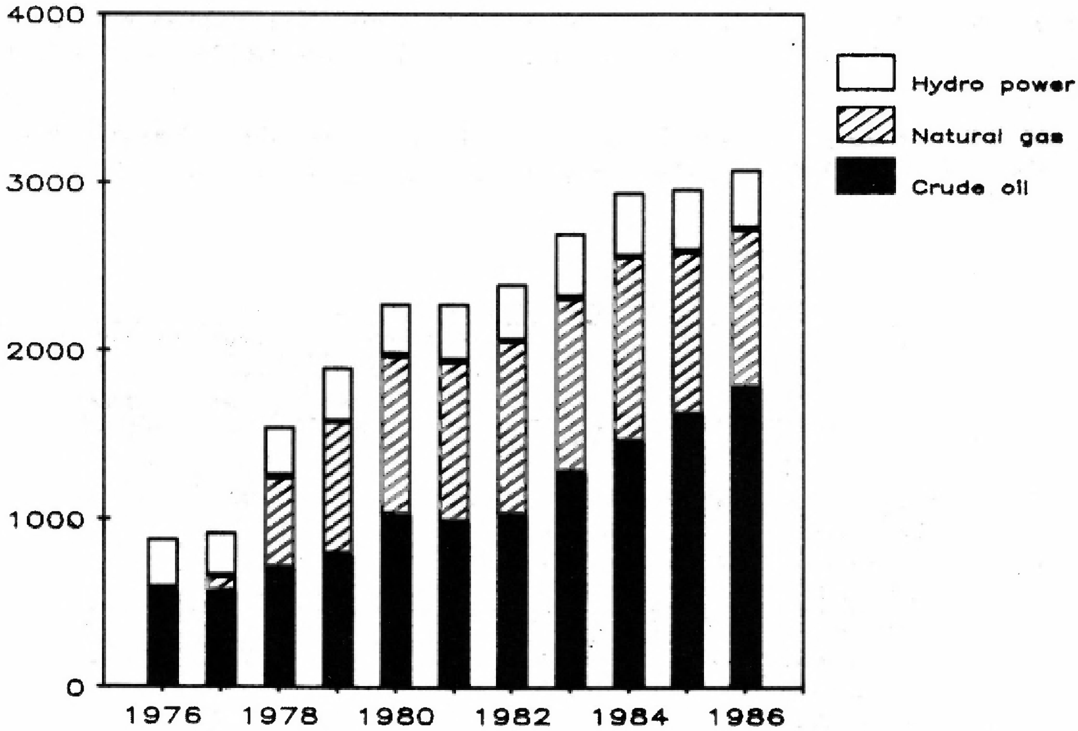


Table 4.2: Extraction and conversion of energy. 1985. PJ.

	Total	Coal	Coke	Bio-mass	Crude oil	Natural gas	Refinery products	Hydro power
Extraction	2980	14	-	-	1625	971	-	370
Use in conversion	- 47	-	-	-	-	- 38	- 2	- 7
Import	447	26	33	0	64	-	309	15
Export	-2460	- 7	- 6	0	-1379	-922	- 129	-17
Changes in invent.	- 6	- 4	- 1	.	- 1	.	0	.
Primary supply	914	30	26	0	308	10	178	362
Refineries	- 45	-	6	-	- 137	-	279	- 1
Other conv. or supply	3	-12	9	30	-	-	5	1
Losses, stat. error	- 6	3	- 3	-	8	-10	12	- 30
Use outside conv. sect.	896	21	38	30	-	-	475	332

Table 4.3: Use of energy outside the extraction and conversion sectors. 1985.

	Coal	Coke	Bio-mass	Gas	Gaso-line	Kero-sene	Light fuel	Heavy fuel	Elect-ricity
	1000 tons	1000 tons	1000 t.o.e.	1000 tons	1000 tons	1000 tons	1000 tons	1000 tons	GWh
Agric. and fishing	5	-	-	-	21	3	559	17	779
Mining	-	1	-	0	0	0	39	28	905
Manufacturing	718	11 989	304	874	20	3	320	508	43 382
Man. paper prod.	-	-	176	-	0	-	3	67	5 429
Energy int. manuf.	373	1 007	2	859	2	1	49	201	30 374
Other manufact.	345	191	126	15	18	2	268	239	7 579
Build., constr.	-	-	-	-	9	1	417	1	706
Tranportation	-	-	-	-	91	440	1 634	3 435	1 411
Railroad etc.	-	-	-	-	-	-	20	-	660
Other dom. tr.	-	-	-	-	49	-	443	-	-
Foreign shipping	-	-	-	-	-	-	706	3 281	-
Air transport	-	-	-	-	-	440	-	-	-
Post and telecom.	-	-	-	-	42	-	33	-	751
Trade, services	-	-	-	-	412	11	522	16	14 396
Households	18	28	416	2	1 130	224	351	21	30 632
Total	741	1 227	720	876	1 683	682	3 842	4 026	92 211

Figure 4.2: Use of energy outside extraction and conversion sectors. By sectors. 1976–1986. PJ.

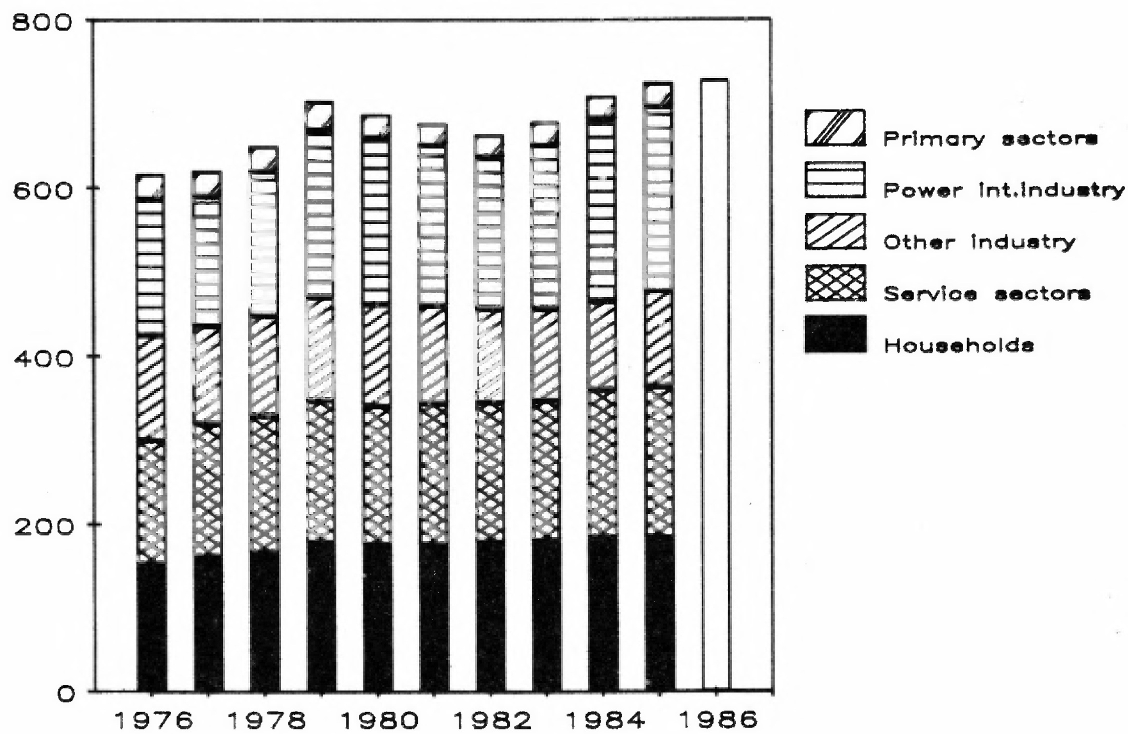


Figure 4.3: Use of energy outside extraction and conversion sectors. By energy commodity. 1976–1986. PJ.

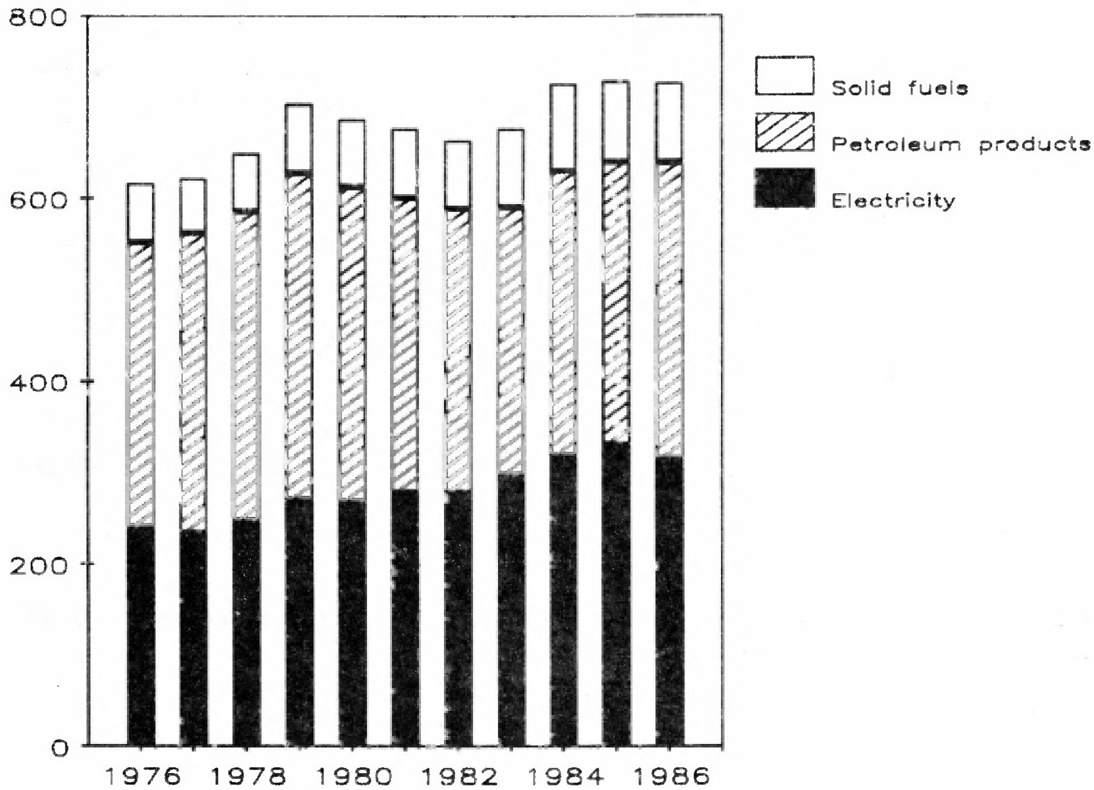


Table 4.4: Energy use exclusive of ocean transport. 1976–1985. PJ.

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Solid fuels	65	60	64	76	74	76	75	86	95	89
Coal, coke	47	41	44	52	49	48	47	56	64	59
Wood, waste etc.	18	19	20	24	25	28	28	30	31	30
Petroleum prod.	311	326	338	357	344	321	309	293	312	308
Electricity	241	236	248	271	269	280	280	298	319	332
Total	617	622	650	704	688	677	664	677	726	729

Table 4.5: Reserve estimates of iron, titanium, copper, zink and lead. Mill. tons pure metal.1980, 1982,1984

		Reserves 1/1	Extraction	Revaluation	Reserves 31/12
Iron	1980	157.3	-2.4	-3.3	151.6
	1982	78.0	-2.1	-0.9	75.0
	1984	72.7	-2.4	-35.6	34.7
Titanium	1980	20.0	-0.4	-0.4	19.2
	1982	18.5	-0.2	-0.1	18.2
	1984	17.9	-0.3	-0.0	17.6
Copper	1980	0.50	-0.03	-0.08	0.39
	1982	0.28	-0.03	-0.00	0.25
	1984	0.23	-0.02	-0.03	0.18
Zink	1980	0.54	-0.03	-0.06	0.45
	1982	0.33	-0.03	-0.00	0.30
	1984	0.27	-0.03	-0.09	0.15
Lead	1980	0.046	-0.002	-0.016	0.028
	1982	0.025	-0.004	-0.001	0.022
	1984	0.018	-0.004	-0.005	0.009

4.2.3 Forest accounts

Although the forest accounts in principle are equal to the energy accounts in describing the resource base, reserves, extraction, trade and use, the emphasis on the various parts of the two accounts are different.

First of all, forest is an input factor in only a few Norwegian production sectors. Thus, the description of the use of forest and forest products includes only some of the sectors appearing in the National Accounts. Also, unlike energy, forest is a biotic resource, and hence conditionally renewable. The main issue in forest management is then to determine the "optimal" extraction rate of the forests. The reserve and extraction parts are therefore paid relatively more attention in the forest accounts than in the energy accounts. The consumption part of the forest accounts is closely connected to the energy accounts, since wood is either transformed to other products or used as energy. Forest accounts have been developed for the years 1970 to 1984.

Table 4.6: The forest balance. Mill. m^3. 1985.

	Total volume 1/1	Harvest	Losses	Growth	Total volume 31/12
Total	616.9	-11.0	-2.3	20.6	624.3
Spruce	282.1	-7.4	-1.2	9.5	283.0
Pine	197.3	-2.1	-0.5	5.4	200.1
Hardwood	137.6	-1.5	-0.6	5.6	141.1

Table 4.7: Forest accounts. Harvesting, conversion and use. 1984.

	Saw-logs	Pulp-wood	Fuel-wood	Wood waste	Sawn wood	Part. board	Fibre board	Mech. pulp	Chem. pulp	Paper, board
			$1000m^3$	—			ktons			
Harvesting	5952	4227	1284	.	.	.	.	.	.	.
Imports	189	1037	73	763	504	42	7	15	105	280
Exports	-215	-295	-8	-191	-459	-31	-36	-221	-353	-1266
Ch. of invent.	141	207	.	86	8	7	8	-2	-1	4
Primary supply	6067	5176	1349	658	53	18	-21	- 208	-249	-982
Industry (Industry production is recorded net. Negative net values are materials input.)										
Sawing and planning	-5658	97	83	2341	2334	.	1	.	.	.
Man. part. boards	-12	-241	.	-373	-1	233	99	.	.	-1
Man. fiber board	-2	-76	.	-202	.	-2	.	.	.	-2
Man. mech. pulp	.	-2858	.	-296	.	.	.	1156	2	.
Man. chem. pulp	.	-2045	3	-1347	.	.	.	.	630	.
Man. paper, board	.	.	.	.	.	.	.	-949	-474	1455
Other supply	39	2	888	271	129	2	.	.	.	159
Losses, stat. errors	271	-40	-132	-537	126	54	92	4	94	-8
Use outside conv. sect.	705	15	2191	515	2651	305	171	3	3	621
Agric., fishing	363	.	.	86	.	.	.	.	.	.
Mining, manuf,	342	15	51	284	976	136	38	3	3	621
Construction	.	.	.	117	1508	169	133	.	.	.
Trade, transp.	.	.	.	.	.	.	.	.	.	.
Households	.	.	2140	28	58	.	.	.	.	.
Unspecified	.	.	.	.	109	.	.	.	.	.

4.2.4 Fish accounts

Fish is an economically important natural resource for Norway. Relatively few sectors use fish as an input factor in their production. Hence, little weight is put on the consumption part of the fish accounts. Fish is a conditionally renewable biotic resource with a reproduction time between 3 and 7 years. This can be compared with the 20 – 80 years it takes for a forest to reproduce itself. Thus, some emphasis is put on describing the age structure of the stocks.

Furthermore, fish is a mobile resource. The resource base and reserve parts of the accounts should therefore contain geographical information in addition to the classification of the reserves by type and age.

Finally, fish is an important export commodity for Norway. The trade of fish is therefore described in more detail than is the case for most other material resources.

Resource accounts for fish have been developed for the years 1977–1985.

4.3 Material resource accounts; a summary

Although the various material resource accounts are built around the same structure, they differ quite considerably in details. The reasons for this can be summerized as in table 4.10.

The table displays various characteristics of the material resources covered in the Norwegian accounts. Thus, while energy is an important input factor in almost all production sectors of the National Accounts, the other resources are used as input in a few sectors only. The number of user sectors therefore varies considerably between different resource accounts.

The reproduction time of conditionally renewable resources determines the details of the age structure necessary in the reserve part of the resource accounts. Similarily, the

Table 4.8: Stock development for fish. 1974–1986. 1000 tons.

Year	North -East Arctic Cod	North -East Arctic Haddock	North -East Arctic Saith	Barents Sea Capelin	North Arctic Herring	North Sea Mackerel	North Sea Cod	North Sea Saith
1974	3070	830	730	2980	120	970	310	790
1975	2740	670	580	4100	120	750	280	710
1976	2520	480	570	6210	260	710	240	700
1977	2150	330	500	4440	380	580	240	500
1978	1800	290	430	3130	440	420	200	430
1979	1400	310	450	3220	550	310	290	390
1980	1250	280	460	3260	640	250	270	390
1981	1110	240	560	4570	650	190	270	430
1982	970	170	500	2460	710	180	290	440
1983	800	130	500	3840	750	200	190	390
1984	920	110	420	1840	670	150	190	420
1985	1380	280	430	1680	670	90	140	410
1986	1880	860	470	..	..	..	160	460

Table 4.9: Quotas and total catch on different fish stocks. 1977–1986. 1000 tons.

	N.E.-Arctic Cod		N.E.-Arctic Haddock		N.E.-Arctic Saith		Barents Sea Capelin	
Year	Quotas	Catch	Quotas	Catch	Quotas	Catch	Quotas	Catch
1977	850	905	120	110	200	183	.	2940
1978	850	699	150	95	160	155	.	1894
1979	700	441	206	104	153	164	1800	1783
1980	390	381	75	88	122	145	1600	1649
1981	300	399	110	77	123	175	1900	1987
1982	300	364	110	47	130	168	1700	1759
1983	300	290	77	22	130	157	2300	2233
1984	220	278	40	17	103	159	1500	1447
1985	220	303	50	41	85	103	1100	851
1986	400	419	100	88	75	70	120	123

Table 4.10: Characteristics of some of the material resource accounts.

	Energy	Minerals	Forest	Fish
Number of user sectors	Many	Few	Few	Few
Renewability	N-R/R	N-R	C-R	C-R
Mobility	Stationary	Stationary	Stationary	Mobile
Trade	High	Low	Low	High

N-R: Non-renewable, C-R: Conditionally renewable, R: Renewable (hydro power)

Figure 4.4: Stock development for fish. 1974–1985. 1000 tons.

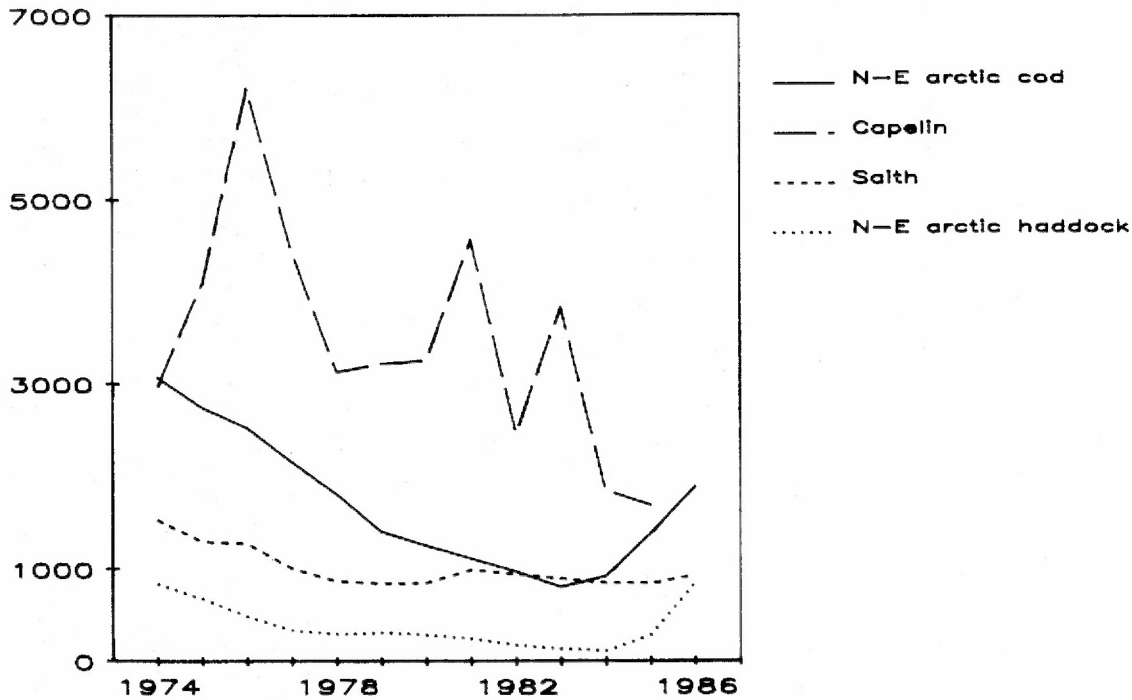
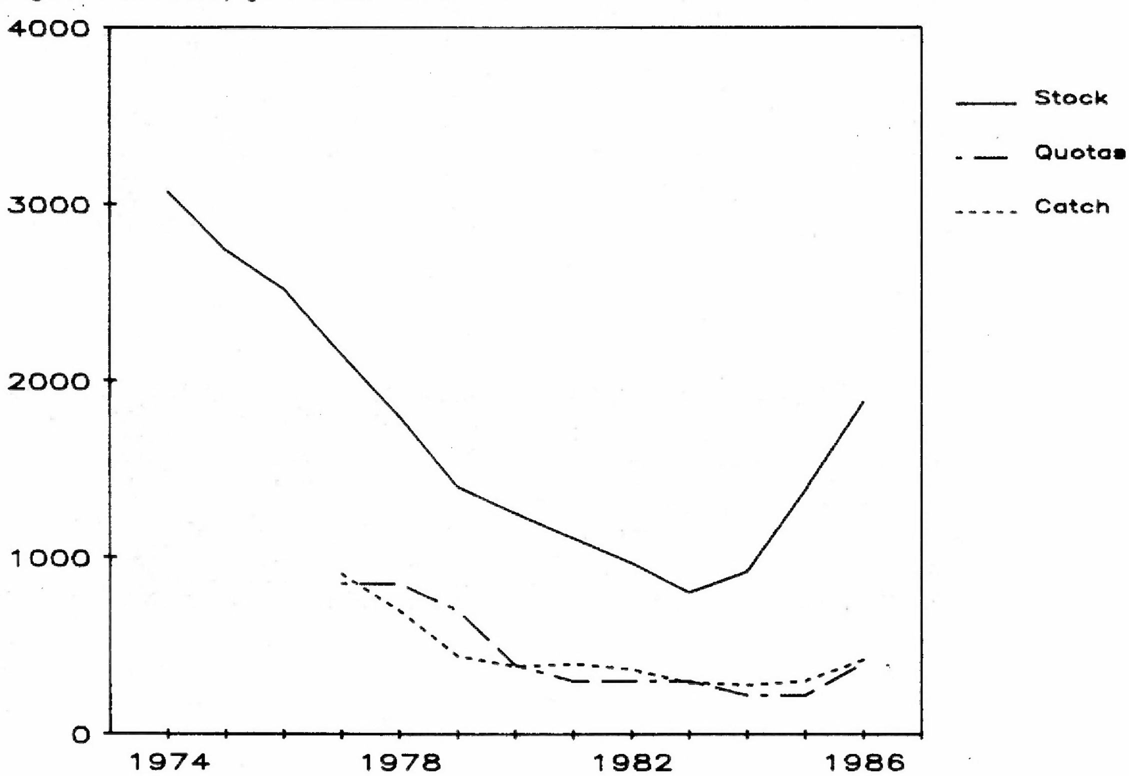


Figure 4.5: Stock, quotas and catch of North-Arctic Cod. 1977–1986. 1000 tons.



mobility of the resource determine whether a spatial dimension has to be included, and the importance for Norwegian export determines the emphasis put on the trade description.

In conclusion, the Norwegian system for material resource accounting is built around a common conceptual framework, but the practical formulation reflects the characteristics of the different resources in order to accommodate the information of interest and importance for each resource.

4.4 Environmental accounts

The main objective of the environmental accounts is to record in a systematic and coherent manner the state of the environmental resources like air, water and soil or land. However, the state of a resource is a very complex concept and difficult to define with any great precision. Another problem associated with the environmental accounts is that the usefulness is often dependent on detailed spatial disaggregation. This is due to the extreme variations often found in the quality of the environment in neighbouring locations. The pollution level in waters is a typical example of this. A good solution to these problems has not been found, although focusing on special problem areas and/or rough indicators of the state of the environment is often acceptable. The Norwegian approach described below is certainly far from perfect.

After a detailed study of the possibility for compiling a fresh water account (Rogstad (1985)) and an evaluation of the usefulness of such an account, it was decided to postpone the development of comprehensive fresh water accounts in Norway. The environmental accounts now comprise accounts for land use and emissions to air at various sectoral and regional levels, in addition to some ad hoc studies of solid and hazardous waste, radiation and noise.

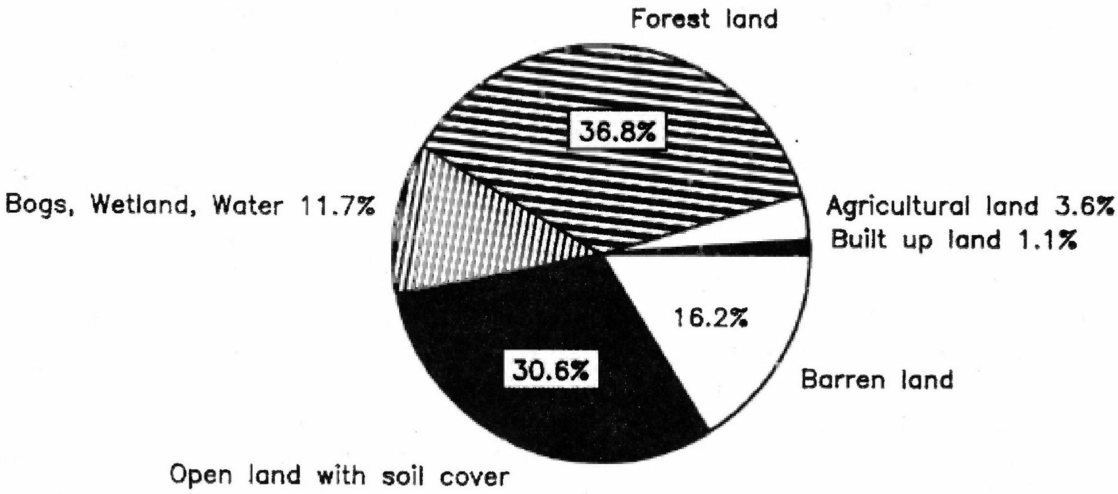
4.4.1 Land use accounts

Through economic growth, the use of land for various purposes changes. A growing manufacturing industry needs more space and land for factories and storages. An increasing population together with a decreasing number of persons per household requires more land for housing and recreational activities. Areas are also needed for the associated infrastructure. The industrial demand for land for various purposes – buildings, infrastructure (e.g. roads) and agriculture – are often in conflict. There are also conflicts between demand for land for productive use and for recreational or aesthetic services.

The main aim of the land use accounts is to provide data on the availability (and changes in availability) of land of various quality classes, suitable for the different purposes of land use. This is essential information if one aims at assessing if and where eventual shortages of suitable areas can be expected.

The work on Norwegian land use accounts has been hampered by the lack of data. This problem has been "solved" by establishing three registers. Two geocoded registers documenting the land use and the quality of land in rural and urban regions. Both were established by the use of a sampling technique on existing economic maps and air photos. The first register consists of data from 6,000 points and is meant to provide data for

Figure 4.6: Land by bedrock and land use. 1970.



rural land use. The second is a register comprising approximately 135,000 sample points from urban areas. This register makes it possible to provide land use information for urban areas with more than 1000 inhabitants. The third register contains information on existing plans for land use in the municipalities of Norway. At present (1987), 12 out of 19 Norwegian counties are included in the register.

The point sampling method for registering land use from maps and photos proved to be a very expensive and time consuming exercise. At present, methods for using remote sensing data (satellite) for classification purposes are under development and testing.

Table 4.11: Land by bedrock and land use. 1970.

		Bedrock (Per cent)					
	Total km^2	Total	Poor in nutrients	Inter-mediate	Rich in nutrients	Very rich in nutrients	Un-distri-buted
Total	323 900	100.0	44.9	15.2	10.4	2.1	27.3
Built up land	3 700	100.0	46.3	15.9	12.6	7.5	17.8
Agric. land	11 500	100.0	43.1	17.9	7.6	5.3	26.0
Forest land	119 000	100.0	48.2	17.0	11.4	2.3	21.1
Bogs, Wetland	20 300	100.0	44.3	12.7	11.2	1.6	30.2
Open with soil	99 100	100.0	47.7	15.6	11.1	1.6	24.0
Barren land	52 500	100.0	43.7	13.4	9.6	1.2	32.1
Fresh water	17 600	100.0	15.0	2.8	5.1	0.4	76.7

Table 4.12: Agricultural land and cultivated land. Suitability for cultivation. Restrictions with respect to climate and choice of crops. km^2.

		Restrictions						
	Total	None	Some	Moderate	More	Strong	Very strong	Non-suitable
Total	19 279	4 174	2 580	2 854	2 203	3 542	2 108	1 819
Cultivated	8 605	3 035	1 430	1 758	987	1 314	81	-
Other agricult.	10 674	1 139	1 150	1 096	1 216	2 228	2 207	1 819

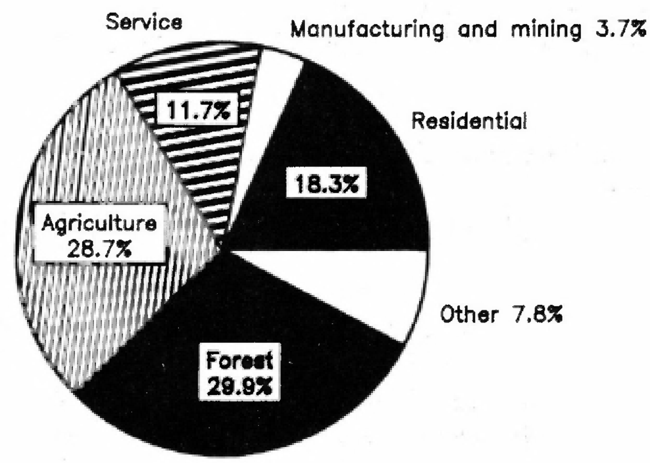
Table 4.13: Land use in urban settlements (with more than 1000 inhabitants). 1955, 1965 and 1975. km^2

Land use	1955	1965	1975
Total	1655	1655	1655
Built-up land	491	661	869
Residential, low buildings	257	357	468
Residential, flats	9	15	26
Manufacturing, storehouses	48	64	87
Mining	7	11	13
Commercial and administration	16	21	26
Institutions	25	34	46
Public parks, cemeteries	11	14	16
Sports installations	12	15	21
Transportations	104	129	163
Technical constructions	2	2	3
Unbuilt land	1164	994	786
Agriculture	419	329	229
Forest	436	379	289
Other use	195	179	167
Lakes	114	108	100

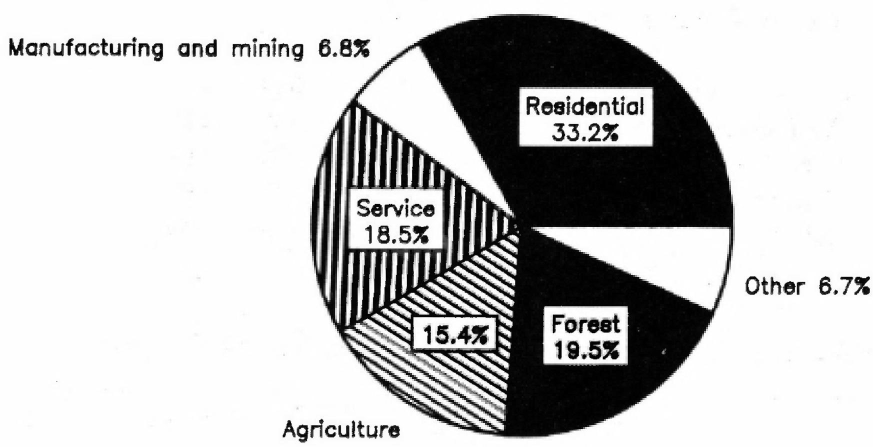
Table 4.14: Plans for land use for building and construction. Rogaland county. 1981–1992. 1000 m^2.

		Purpose					
	Total	Buildings	Manufacturing/ storehouses	Commercial/ adm.	Institutions	Transportation	Other purposes
Total	47 622	28 301	11 521	1 964	4 075	1 697	64
Ready for building	14 770	7 690	3 503	1 037	2 227	313	-
Not ready for building	32 852	20 611	8 018	927	1 848	1 384	64

Figure 4.7: Land use in urban settlements. 1955 and 1975. Per cent.



1955



1975

4.4.2 Emissions to air

There are approximately 30 monitoring stations for air quality in urban areas and 6–8 in rural areas in Norway, see figure 4.8. The environmental accounts for air partly report on indicators for the quality of the air based on this monitoring programme and partly report emission levels of various polluting components based on deduced information from energy use, industrial statistics, etc. The emission components included in the various monitoring surveyes are subject to a continuous evaluation in order to determine whether some of them should be deleted from future surveys or whether new components should be included. In this evaluation the possible or expected impact of a pollutant on the living conditions of human beings and other species are of primary importance.

Emissions to air are closely linked to the use of energy, more specifically, the combustion of fossile fuels. In addition, some industrial processes discharge sizeable amounts of sulphur dioxide and nitrogen oxides into the atmosphere. Although a large fraction of pollutants in the air above Norway is imported from abroad, it is still important to obtain estimates of national emissions since regional air pollution problems are frequently caused by local sources. National emission levels of some pollutants are regulated by international agreements, as the protocol to the 1979 convention on long-range transboundary air pollution on the reduction of sulphur emissions or their transboundary fluxes by at least 30 per cent from 1980 to 1993 (ECE (1985)).

Due to the close link with energy use, the emission accounts are quite similar to the energy accounts with respect to sector description of sources of emissions. The primary source of information for the emission accounts are, in addition to the energy account, technical information on emissions coefficients, cleaning processes of emissions and data on the factor use in the different production sectors. The data are supplemented with actual measurements whenever available, in order to improve the assessments of emissions from specific industrial processes and the effect of cleaning of the emission gases.

Accounts for the emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO) and lead (Pb) exist on a detailed sectoral level for the years from 1976.

In addition to the annual national surveys, overviews of emissions in the municipalities of Norway (approximately 450) have been developed for a few selected years (1982 and 1984). The regional surveyes include additional components such as ammonium (NH_3), hydro carbons (HC), cadmium (Cd) and mercury (Hg).

Table 4.15: Emissions to air excluding emissions associated with production of oil and gas and ocean transport. 1000 tons. 1976–1986.

	1976	1978	1980	1982	1983	1984	1985	1986	Average annual growth rate (%)
SO_2	148	142	140	116	103	95	99	94	-4.4
NO_x	128	131	125	130	133	144	149	162	2.4
CO	578	598	575	551	543	648	688	755	2.7
Pb	.675	.712	.697	.496	.474	.311	.328	.296	-7.9

Figure 4.8: Air pollution monitoring stations in Norway.

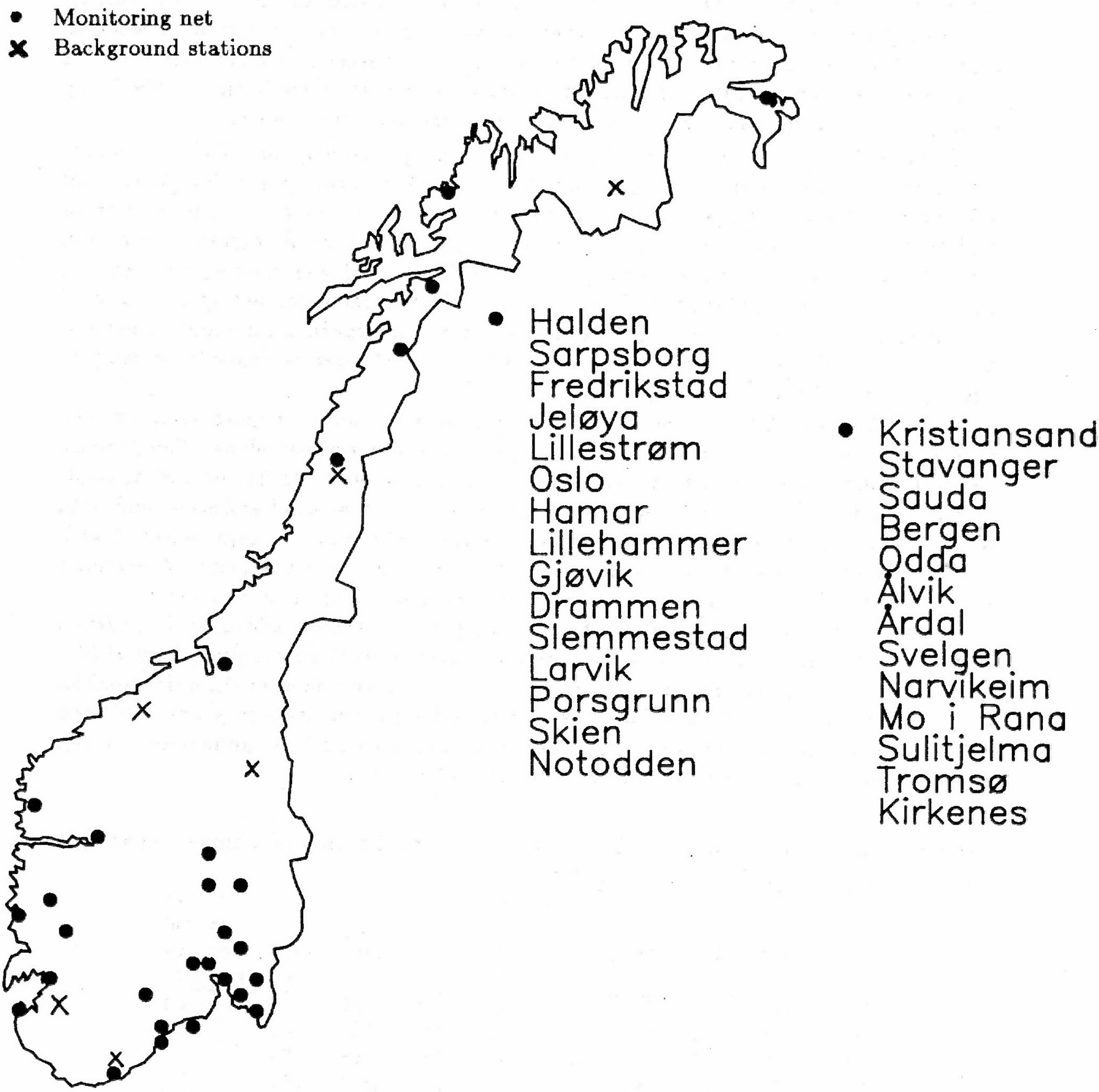
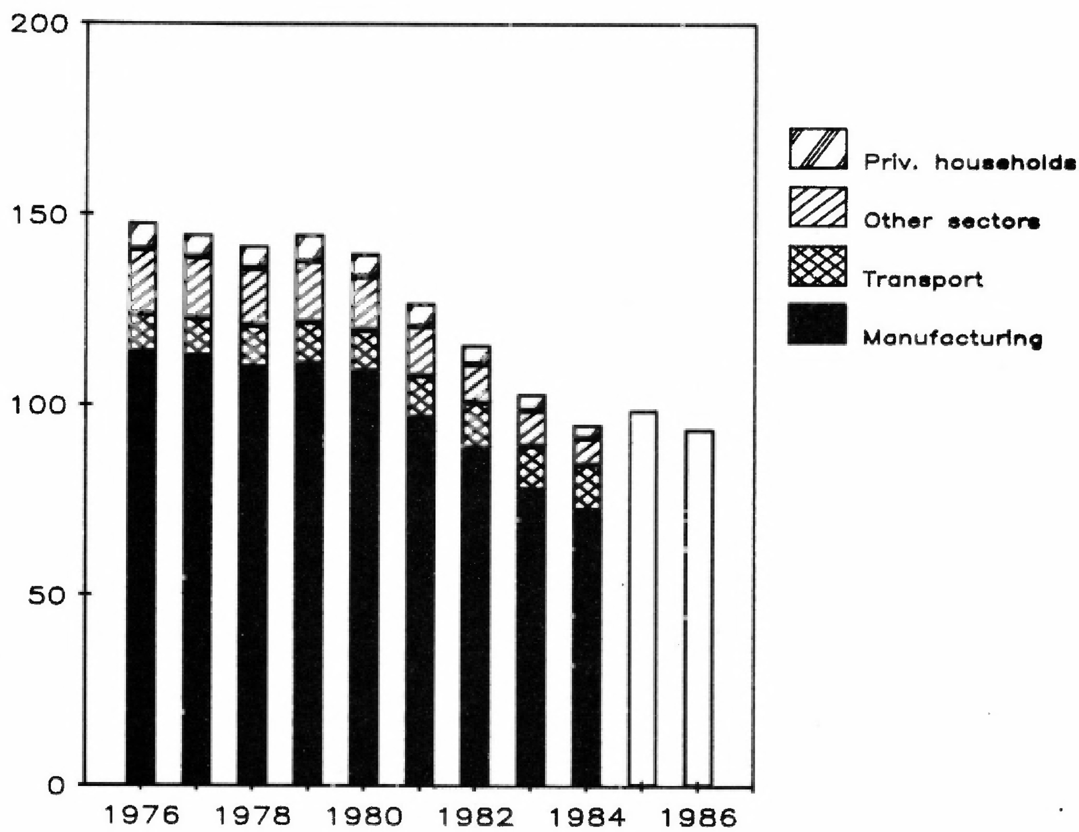


Table 4.16: Emissions of sulphur dioxide. 1984. 1000 tons.

	Mobile combustion	Stationary combustion	Process emissions	Total emissions	Share (Per cent)
Primary sectors	2.5	0.6		3.1	3.3
Pulp and paper		3.2	1.7	4.9	5.1
Power int. ind.		2.9	41.7	44.6	46.9
Other ind.	0.0	17.1	6.2	23.3	24.5
Services	0.7	2.5		3.2	3.4
Transport	11.8	0.1		11.9	12.5
Other sectors	0.5	0.1		0.7	0.7
Households	0.2	3.3		3.5	3.7
Total	15.7	29.9	49.6	95.2	100.0
Share (Per cent)	16.5	31.4	52.1	100.0	

Figure 4.9: Emissions of sulphur dioxide. 1976–1986. 1000 tons.



4.5 Publications on the Norwegian resource accounts

The Central Bureau of Statistics of Norway (CBS) publishes an annual report containing updates on an aggregated level of most operative natural resource accounts together with results from analyses of special issues. The report has been published in the series *RAPPORTER* from CBS for the years 1982 – 1986. The report contains a detailed publication list.

Chapter 5

NATURAL RESOURCE BUDGETING AND ANALYSES

5.1 Budgeting

The political emphasis on resource budgeting has been changing over time. The intention in the beginning and mid-1970s were to present Natural Resource Budgets to the Storting at regular intervals. Specifications of resources to be covered by the Natural Resource Budgets, how often they should be presented etc., were, however, only vaguely described in early official documents (Ministry of Environment (1975), Ministry of Finance (1975)).

In a 1977 White Paper (Ministry of Environment (1977)) the intentions were described more explicitly: energy and land use should serve as pilot budgets, 4 year periods parallel to the Government's Long-Term Programme were suggested as appropriate, and the Minstry of Environment should be responsible for preparing and presenting the budgets as separate reports to the Storting. The enthusiasm peaked in 1981 when new pilot budgets (fish, forest and possibly others) were suggested (Ministry of Environment (1981)). The enthusiasm was quickly punctuated, however, in the new Government's addendum to the 1981 report (Ministry of Environment (1982)). The addendum stated that the Natural Resource Budget should be incorporated as chapter(s) in the quadrennial Long-Term Programme (LTP). The reason given was that including Natural Resource Budgets in the LTPs would make it easier to incorporate resource and environmental concerns into the economic framework. The LTPs normally contain a relatively detailed picture of the economic development in the subsequent 4 years election period and also perspectives in the form of more aggregated forecasts for a 15 to 20 years time period.

When the governments LTP appeared in 1985 (Ministry of Finance (1985)), chapter 4 gave 17 pages devoted to a general presentation of "natural and environmental resources". The only non-historical numbers given in the chapter were key figures concerning land utilization in 1990, key figures concerning water supplies in 1990 and 2000, emission prognoses in connection with energy consumption for 1990 and 2000 and key figures concerning ocean fisheries and fish farming in 1989. None of these short overviews were budgets in the sense of planned or optimal use, and only the emission prognoses had any connection to the economic and energy scenarios presented elsewhere in the programme. A 28 pages appendix to the LTP, worked out by the Ministry of Environment in collaboration with line ministries, gave some additional information and a few additional figures on land use and energy. If the 10–15 years of preceding work should be judged by the results appearing in the LTP the conclusion would be easy: The mountain had given birth to a mouse.

Fortunately, the picture has to be modified. Both energy, minerals, forest, fish, land and water resources have been surveyed and discussed in separate white papers and committee reports – as have air and water quality, waste treatment, protection of areas and species, etc. It would therefore be unfair to judge the preceding work from the original idea of integrating resource budgets in LTPs or presenting plans or budgets in separate revolving white papers. From a policy point of view the MoE has been quite successful in implementing its policy in areas such as protection which has no obvious connections to LTPs – and few conflicts with other policy areas. On the other hand the treatment of energy in official documents and its partial integration in economic planning does not mean that this has been a successful policy area. There are good theoretical reasons to question the present domestic policy on energy use. The point here is that with regard to energy resources data are available, methods for forecasting and planning are available and are well integrated in the national planning process. That was the original idea, which still is theoretically quite appealing.

Table 5.1 – 5.2 give examples of "budgets" (other than energy and air pollution) presented in the LTP 1986 – 1989.

Table 5.1: Land use. km^2.

Type of area	1972	1982	1990
Total	323 900	323 900	323 900
Built-up land	3 700	4 000	4 250
Agricultural land	9 500	9 500	9 700
Productive forest land	66 950	66 450	66 370
Protected area	3 400	12 100	16 500
Cultivable area	8 900	8 400	8 100
Spitzbergen	62 700	62 700	62 700
Protected area	0	34 900	34 900

Source: Ministry of Environment

5.2 Analyses

This section gives four examples of analyses based on resource and environment accounting at the Central Bureau of Statistics of Norway (CBS). The examples are drawn from fairly successful, ongoing or recently completed projects. Earlier projects that are not mentioned are analyses and forecasts of the demand for fish, forest and land. It should be stressed that the work of Norwegian environment monitoring and research institutes such as NIVA,

Table 5.2: Saltwater fisheries. 1000 tons.

	1974	1983	1984	1989
Total	2 579	2 801	2 388	2 668
Cod fisheries	685	623	603	739
Cod	341	282	263	390
Saith	165	226	225	220
Haddock	77	26	22	35
Other cod fishes	64	61	59	63
Flatfish	11	7	7	9
Other fishes for consumption	27	21	27	22
Herring, mackerel, capelin etc.	1 855	2 071	1 685	1 837
Capelin	1 030	1 492	944	960
Herring	117	91	168	376
Mackerel	228	80	141	75
Other fishes for production	420	408	432	426
Shellfish	19	77	84	82
Others	20	30	16	10
Use:				
Bait, grinding, etc.	1 800	1 925	1 528	1 642
Other uses	779	876	860	1 026

Source: Directorate of Fisheries.

Table 5.3: Water supply.

	1974	1983	1984	1990	2000
Water supply (litre/person and day)					
Total withdrawn	600	600	600	575	550
Estimated leakage	300	300	300	275	250
Percentage of population with non-acceptable water quality	20	15–20	15–20	12–18	10–15

Source: Ministry of Environment.

NILU, SFT, SIS, SK are not a subject in this report. (For a list of such institutions, see table 7.1)

The aim of these analyses has been to provide background information for policy decisions. Three of them draw heavily on one of the basic model tools at the CBS's disposal, the macroeconomic model MSG (*M*ulti *S*ectoral *G*rowth model). This model was developed to integrate forecasts of energy demand and economic growth. The model is briefly described in section 5.2.1 below and in more detail in Longva et al. (1985).

5.2.1 Energy economics

The Government's inter-ministerial energy committee continuously elaborates forecasts on indiginous energy consumption. These energy forecasts are based on economic forecasts made by the Ministry of Finance. Normally, the energy forecasts are published every four years, after the Government's Long Term Programmes, in the Energy Programme. The role of CBS in this work has been to provide data (energy accounts), and to develop, maintain and use MSG and other energy models – in addition to act as expert members of the energy committee.

The MSG model traces out the long term growth path of the economy, especially the distribution of labour, capital, energy, and production over 32 industries, changes in the household consumption patterns, and the development in corresponding equilibrium prices. The energy supply in the model is elaborated in some detail for the production of electricity. On the energy demand side, the production model for each of the 32 industries has been developed to allow for substitution between various energy inputs, and between energy, materials, capital and labour. The household consumption model has been developed to include effects on energy demand of changes in stocks of consumer durables and to give proper representation of substitution possibilities between different types of energy. For more detailed specifications of the model, see Longva et al. (1985) and Bjerkholt et al. (1983). Most of the theoretical efforts has aimed at modifying the model and testing alternative specifications, see for instance Bye (1984), Bye and Frenger (1986).

The last energy programme was published in 1987, giving energy forecasts up to year 2000. These forecasts are uncertain both due to uncertainties in the behavioural relations in the model, and due to uncertain exogenous inputs such as future OECD economic growth, technical change etc. The inter-ministerial energy committee published two forecasts that reflect some of the uncertainties and gives a high and a medium growth alternative of future electricity demand. Figure 5.1 and 5.2 depict these long term forecasts for economic growth, domestic energy consumption and electricity consumption in Norway for the period 1985–2003.

In the energy programme special attention is paid to the forecasts of electricity demand. During the last 10–15 years relative prices of oil products to electricity prices based on Norwegian hydro power has fluctuated around an increasing trend. Oil product prices increased sharply through the first and second oil shocks in 1973–1974 and 1979–1980. As a consequence, industries and households substituted from oil to electricity for heating purposes. Since 1980 oil product prices decreased relative to electricity prices mainly due to increased marginal costs of hydro power, and in 1986 the third (reverse) crude oil shock

Figure 5.1: Forecasts of economic growth and domestic energy consumption. 1985–2003. 1985 = 1.0. Medium growth alternative.

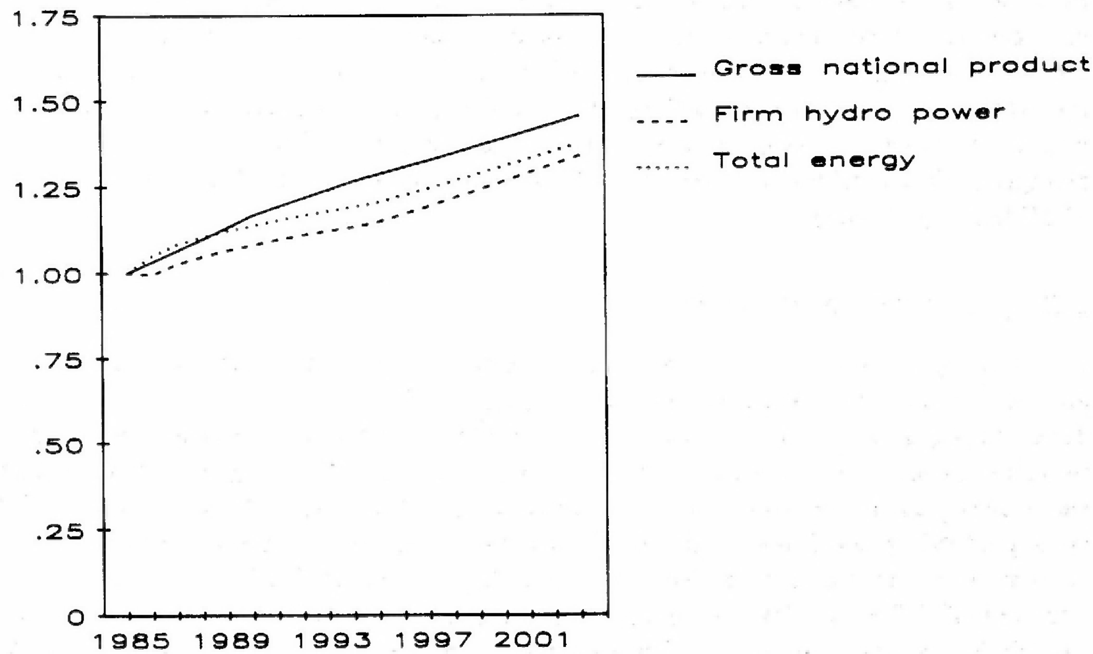
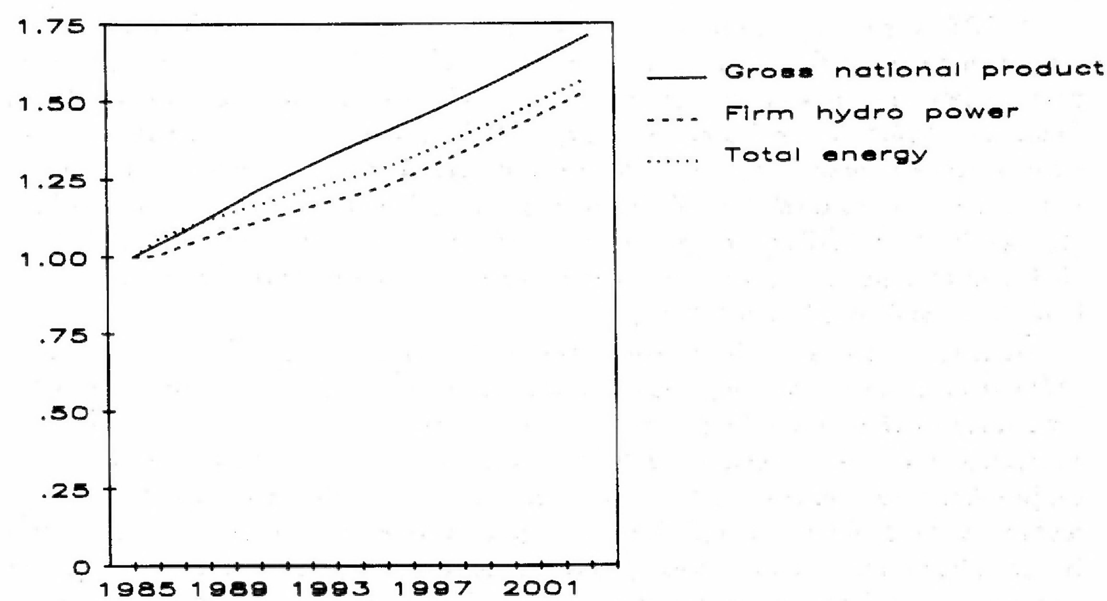


Figure 5.2: Forecasts of economic growth and domestic energy consumption. 1985–2003. 1985 = 1.0. High growth alternative.



came. One important question in energy planning is whether industries and households will react symmetrically to this relative price change, i.e. substitute back to oil at the same relative rate as they substituted from oil to electricity. Some energy economists have, on the basis of observations and empirical testing on static functions, claimed that responses are non-symmetric to relative energy prices. In Bye (1986), however, these seemingly non-symmetric responses are shown to be explained by time lags, non-homotheticity or non-neutral technical change. Demand functions including time lags in the reactions to changing relative prices have been tested and implemented in a medium term model called MODAG (Bye (1984)).

5.2.2 Petroleum economics

The Norwegian petroleum sector is large relative to the size of the economy. In 1984 and 1985, production of oil and gas contributed to 18–20 per cent of GDP. Assessing the direct impacts of this activity through commodity and labour markets and the indirect impacts through spending of oil incomes constitutes a challenging planning problem to the Norwegian authorities. When oil prices came down from 28 to 10–15 US dollars through 1986, gross domestic income in real terms was down by some 10 per cent. The current accounts balance changed from plus 5 per cent of GDP in 1985 to minus 6–7 per cent of GDP in 1986. Although expectations are in favour of higher oil prices in the 1990s the estimates of total Norwegian oil wealth shrunk dramatically overnight and single projects clearly became less attractive to investors than before. To study such and other possible impacts from the petroleum sector, it is necessary to take into consideration the interdependencies between different sectors of the economy and that the economy is simultaneously exposed to other external "shocks" and to policy actions.

A CBS-petroleum project was initiated in 1982 with the aim to develop and use the existing multisectoral macroeconomic planning models (MSG and MODAG), develop support models (oil market, gas market) and provide the planning authorities (Ministry of Finance and Ministry of Oil and Energy) with data, model tools, analyses and forecasts. Central issues have been analysis of different profiles of petroleum investement and production linked to questions of development of industrial structure and "deindustrialization" (Bjerkholt et al. (1982); Berger et al. (1986)), analysis of international markets for oil (Lorentsen and Roland (1986)) and European market for gas (Lorentsen and Roland (1985), Gjelsvik and Roland (1986)).

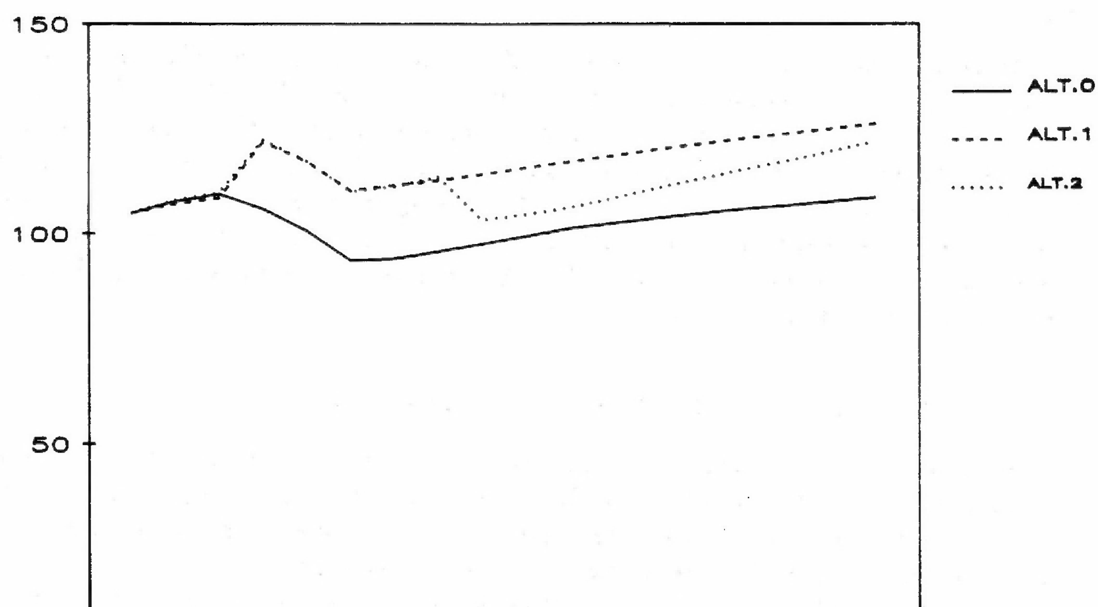
Basic to these analyses have been the evaluation of the resource base and cost structure of Norwegian fields (Aaheim (1983), Lorentsen et al. (1985)), and the analysis of strategies for managing the oil wealth under uncertainty (Aslaksen and Bjerkholt (1985)). For the petroleum resource – which evidently is important to the Norwegian society – the CBS project has thus contributed to data, reserve estimates, theories, model tools, analyses and forecasts. It should be underlined though that for several of the questions approached in the subprojects, economic theory does not provide unambiguous answers. The project has given some information and has clarified choices open to politicians, but especially for planning under uncertainty, both the theoretical foundation and practical planning routines or decision criteria still need improvements.

5.2.3 Environment economics

Environmental problems, *e.g.* air pollution, are linked to economic activity. Making use of existing model tools for energy and economic analysis and the account for energy, the CBS has developed methods for forecasting emissions to air at a national level. The method employed emphasizes the economic forces behind air pollution problems and are, at least in principle, capable of keeping track of all the repercussions felt through the economy when regulations or other control measures are used to combat air pollution. Besides developing emission forecasts based on alternative economic scenarios, the effects and costs of various control policy options have been studied.

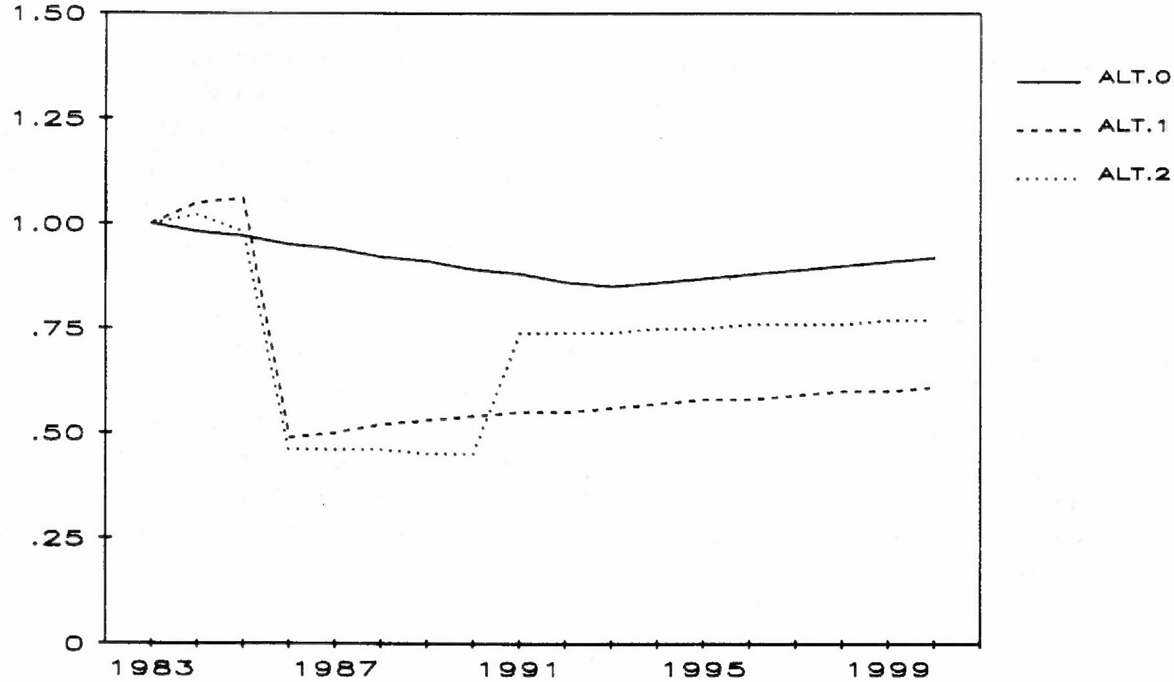
The recent decline in prices of crude oil has renewed the uncertainties associated with forecasts of future oil consumption. Figure 5.3 shows emission forecasts for SO_2 under three different oil price scenarios. The different paths of the oil price are shown in figure 5.4 in the form of price indices. Planned control measures for regulation of emission of SO_2 are incorporated in the forecasts, and are partly responsible for the highly uneven development of the emissions. The underlying economic scenarios incorporate the rather large readjustments of investments and expected export and import volumes for all sectors necessiated by a sharp decline in oil prices.

Figure 5.3: Emissions of sulphur dioxide. 1983–2000. 1000 tons.



Control policies aimed at reducing emissions to air are usually of the direct regulation type in Norway. CBS has, however, made a pilot study of the effects and costs associated with introducing a tax on SO_2 emissions from the manufacturing sectors. The response of the firms was assumed to be a switch of fuel type, from cheap sulphur rich heating oils

Figure 5.4: Assumed development of real oil price. Indices. 1983=1.0. 1983–2000.



to more expensive fuels with a lower specific sulphur content. Special emphasis was put on the economic repercussions in this study. The results showed the effects of the tax to be felt throughout the economy, and not only isolated to the manufacturing sectors directly affected by the emission tax. Furthermore, the total social costs of the control policy, measured by the reduction in GDP, was approximatly two and a half times the direct costs imposed on the manufacturing sectors. Thus, the study points out the importance of including costs associated with reallocation effects in the economy, when assessing environmental control policies.

5.2.4 Environment and health analyses

Damage functions, or more specifically estimates of negative health effects from deteriorated land, water or air quality, are clearly basic information to environment authorities. Unless one to some extent is able to quantify that such effects are, or will be, important, much of the argument for environmental protection smoulders.

The CBS in 1984 took on a project to analyse data on "recreation and health", "noise and health" and "water quality and health". The last subproject has been given the highest priority, and been given considerable publicity. It is briefly reviewed below.

The hypothesis, or possible chain of causes and effects, one wished to study was that acid precipitation dissolves aluminium from lake sediments, the aluminium content of drinking water increases, the released aluminium might be accumulated in the body – more specifically in the brain – and might in turn be a possible cause of early age dementia ("presenility") or increased frequencies of age dementia. People might eventually die from these diseases, in which case the death certificate (according to International Classification of Diseases) should indicate so. The hypothesis was tested by dividing Southern Norway into five geographical zones with different concentration of aluminium in lakes, and checking if age specific mortality rates of dementia were increasing with increasing aluminium concentration. The test was inconclusive in the sense that the hypothesis could not be rejected; zone 5 with the highest aluminium concentration also had the highest mortality rates of demetia (Vogt (1986)). The results from the project received some attention and applaud, but also some heavy critisism. Data were poor, and both from a medical and stastistical point of view the project had many deficiencies. Similar projects with similar weaknesses and conclusions have been carried out in Guam and the U.S. Of course there is some public pressure to find out if there is anything to the hypothesis, both because the disease in question is frightening to any individual and because dementia patients need heavy medical care. The CBS project indicated a potential area of concern both for Norwegian environment and health authorities, and the project is followed up from both sides.

Chapter 6

CRITICAL REVIEW OF THE NORWEGIAN APPROACH

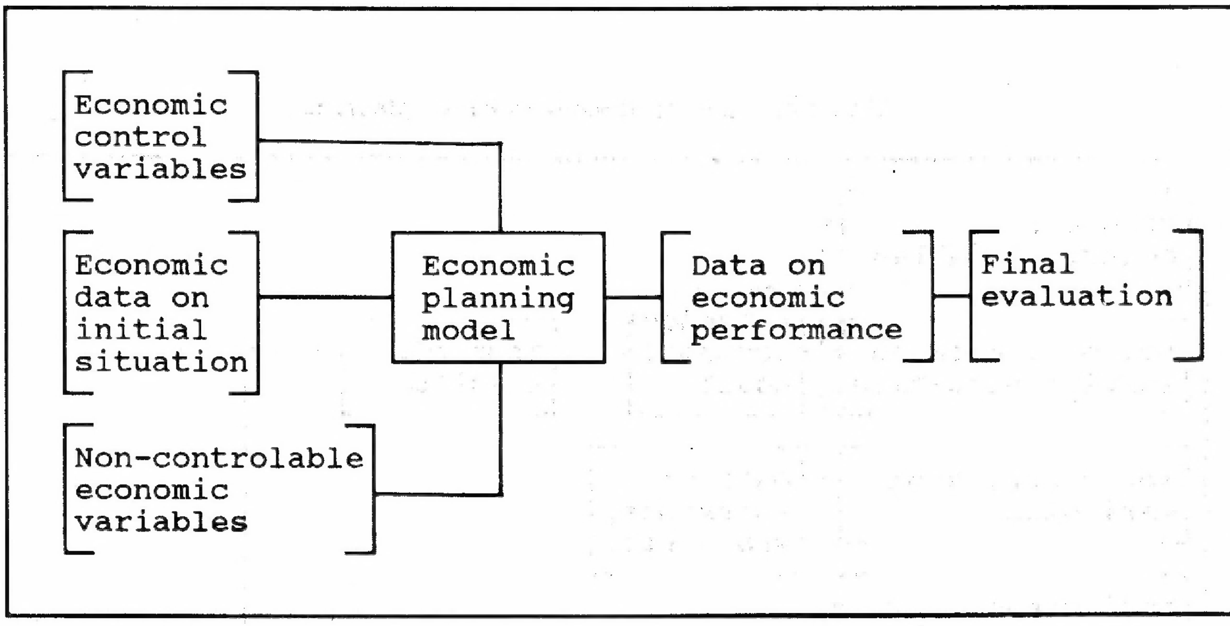
6.1 New dimensions in social planning

The focus on resource and environmental questions in the early seventies explicitly introduced new targets in Norwegian policy making. These targets complicated traditional economic and social planning. For instance: Not only should the government (represented by the Ministry of Finance – MoF) aim at rapid economic growth, full employment, external economic balance, personal and regional equity of income etc. – it should in addition balance these partly conflicting targets against requirements of environmental standards as formulated by the Ministry of Environment (MoE).

Social planning has traditionally focused on economic issues which could be discussed within the (simplified) diagram in figure 6.1. If traditional economic and environmental problems is to be analysed simultaneously, the planning problem becomes much more complicated, and it becomes difficult to arrive at rational decisions, cfr. figure 6.2. It should be underlined that there is no contradiction between economic planning and natural resource and environmental planning. The management of natural resources and internalization of externalities (*e.g.* due to pollution) are both classic issues in economics. The point is that these issues have not been adequately integrated and dealt with in social planning. A very brief criticism of the MoE is that it has so far not been able to establish itself properly within the boundaries of figure 6.2.

Figure 6.2 is one possible illustration of an integrated planning process where the Ministry of Environment and its surrounding research institutes and directorates should try to bring forward the missing data, theories, expertise and organisation. The decision process described in figure 6.2 involves a cooperation between politicians responsible for different policy areas (final evaluation), and bureaucrats and researchers in different institutions and with different backgrounds; economists (economic models), biologist, zoologists (environmental and ecological models), physicians and social scientists (social and health conditions, economic costs of damages).

Figure 6.1: Traditional socio-economic planning.



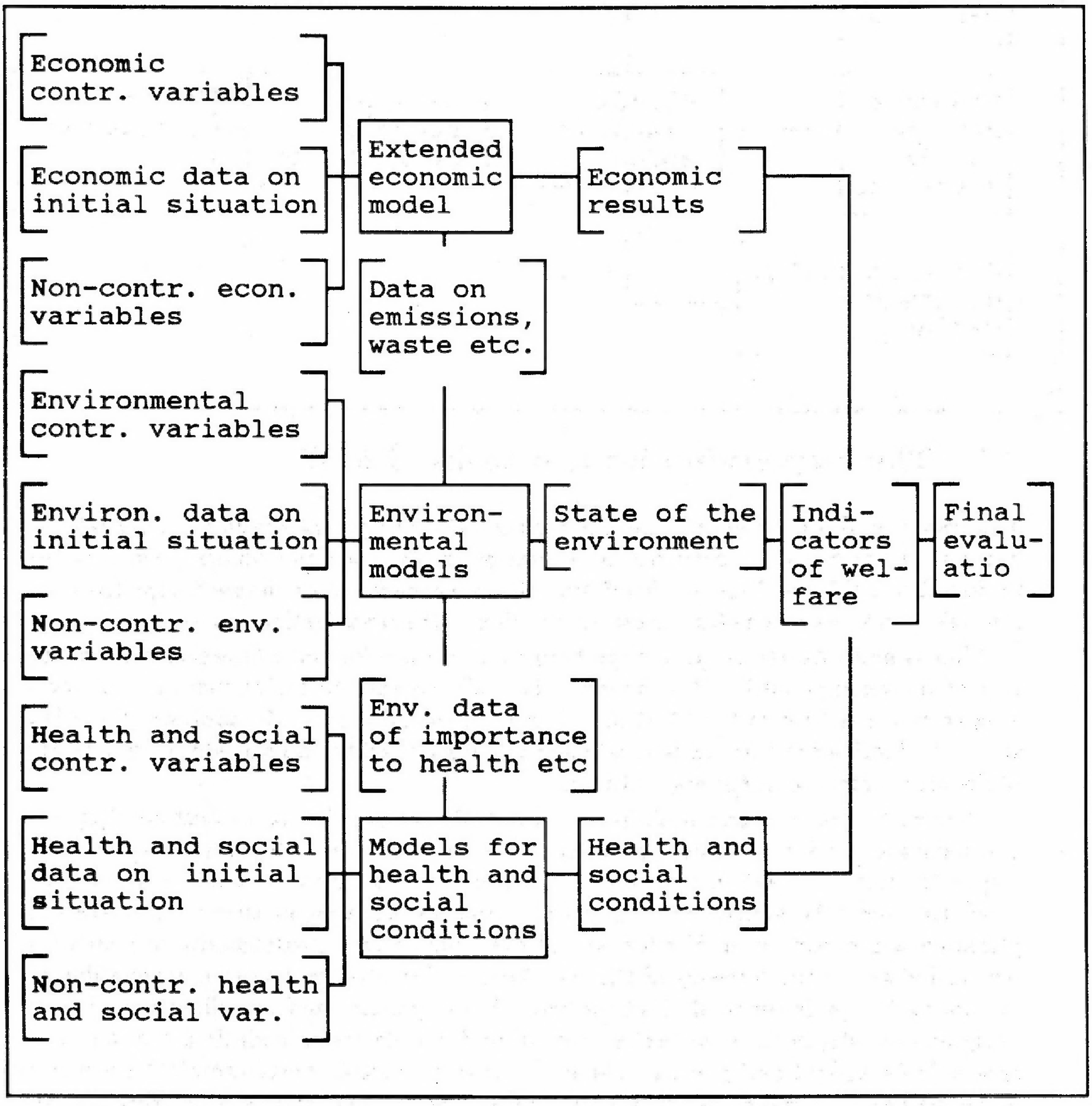
6.2 The responsibilities and tasks of MoE

The responsibilities of the MoE have never been drawn up very precisely in official documents. From broad formulations of objectives, given when the Ministry was first established in 1972, the Ministry itself was left to formulate more detailed objectives and priorities, seek relevant policy measures and design the organizational set-up.

This is understandable. It is often hard to give a precise and comprehensive description of the responsibilities of a ministry. It is all too easy to assign more power and a greater responsibility to the MoE than it can realistically have. In addition, there is a subtle distinction between the ultimate political responsibility and the administrative and professional role a ministry may take on.

Among the obvious responsibilities of the MoE are policies for protection of species and habitats and for abatement of pollution. It is on the other hand not obvious what responsibilitites the MoE should have with respect to management of material resources – oil, fish minerals, forest, etc. For instance the management of energy resources (exploration and depletion profiles for oil and gas, hydro power programmes) is clearly the responsibilities of the Ministry of Oil and Energy. The MoE is, however, responsible for evaluating the environmental effects of hydro power projects and overall national energy programmes. The MoE is indirectly responsible for agricultural pollution, but is not responsible for agricultural policies. There are many grey zones where the MoE might play an active part or confine itself to a more passive role. It is, therefore, somewhat conventional where one draws the lines of responsibility for the MoE. Briefly described, the task of the MoE should be to identify important resource and environmental issues, and to bring forward necessary information to integrate resource and environmental policies into

Figure 6.2: Extended socio-economic planning.



social planning, in order to manage the natural resource capital and the environment in an optimal and efficient manner. The aim should be to balance (mainly long term) resource and environmental concerns against (short term) sectoral economic interests. What one might critisize the MoE of is that instead of defining clear responsibilities – which might of course be changed over time – the MoE has spread its resources over a wide area which *might* be of interest. The areas which have been given priority have been chosen by a mixture of intuition and insight, and quite often by inter-ministerial fights for "territorial rights".

We try to make this general description less abstract in the following sections of chapter 6 and in our recommandations in chapter 7.

6.3 Basic requirements for environmental policies

In our evaluation we try to identify the sources of the 1978–1986 shortcomings; i.e. whether they were due to lack of relevant information, lack of theories to guide the work or lack of economic or ecologic models for policy evaluations. Other relevant questions are whether the organization of the work has been appropriate and whether the Ministry has been professionally strong enough in advocating and implementing its policies. To perform its task the MoE needs:

- Economic and ecologic theories and models on resource and environment management for assessing alternative policies and their effects,
- Data, *i.e.* a monitoring system which gives information on the state of resources and the environment,
- Instruments to implement the goals
- Expertise to develop and use theories and models
- An organization which is able to define objectives, formulate guidelines for action, advocate and implement well founded policies.

The situation with respect to these requirements is discussed in subsequent sections.

6.4 Successes and failures 1978–1986.

The role taken on by the MoE can perhaps be illustrated by listing some of the more successful achievements. Regulations of the sulphur content in heating oils and consentration of lead in gasoline has dramatically reduced the emission levels of these pollutants. The proposed regulation of exhaust gases from private cars will further reduce the emissions of several local air pollutants in the future. The MoE has benn successful in protecting threatend species and their habitats and is establishing national parks and other protected areas. Approximately 4.2 per cent of the area on the main land of Norway is protected area; there is more protected land than agricultural land in Norway. Local environment agencies, subordinate to the MoE, have been established in each county. A plan for the management of the remaining water falls in Norway, i.e. water falls still not utilized for production of hydro power, has been developed by the MoE. Deposit–refund regulations of glass bottles and old cars seem to work very well. There are few discarded bottles and cars to be found along the roadside in Norway. The MoE has been represented and has played an active role both in OECD, ECE and in various Nordic fora.

These are substantial achievements, but it must be noted that all of them, with the exception of the water fall plan, are concerned with topics or are of a size that creates little or no conflict between MoE and powerful sectoral interests. The plan for the development of the remaining water falls in Norway is, on the other hand, closely associated with traditional planning areas of economic and energy planning. The plan has been met by strong opposition from energy intensive industries and political groups, and it remains to be seen to what extent the MoE will be able to defend and implement the plan.

Our main criticism of MoE is that it has so far not been very successful in exercising their influence on traditional economic planning. Rather than being accepted as an important source of new ideas about resource allocation and integrated in economic planning, the MoE attempts of developing resource budgets has been treated as pure addenda in economic planning documents (cfr. the governments Long-Term Programme 1986 – 1989, discussed in chapter 5.1). Environmental and resource issues are still largely neglected or given low priority when important economic policy decisions are taken by the government. Examples are decisions related to acgriculture and power intensive industries – two of the most polluting production sectors in the Norwegian economy. Environmental regulation of the power intensive industry is almost totally disconnected from the question of financial support (mainly as low prices of electricity) to this sector and from the question of the future expansion of the electric power system in Norway. Similarily, subsidies to the agricultural sector are not seen in connection with the large public spendings necessary to clean up inland waters like the lake Mjøsa.

Except for air, water and land use, the MoE has not taken on the responsibility for overall temporal and intertemporal management of resources. The MoE has supported the elaboration of resource accounts for fish, forest, minerals, oil and gas, but the Ministry has not used these accounts for managing purposes. The reasons are in some cases that the Ministry has not been able to follow up its own intentions due to lack of expertise or capacity, that other ministries have taken on the responsibility or simply that expected problem areas have not turned out to be as important as earlier anticipated. Thus, the MoE has been accused of spending more expertise and resources on protective issues like the preservation of threatened ocean-eagles than on the management of vital national resources like oil and gas reserves. The protection of the ocean-eagle has been defined by the MoE as being within the MoE domain, the consequences of depleting the oil and gas reserves have been defined at the edge of this domain.

To be able to allocate scarce human resources to research and policy making in a new area requires information. One excuse for the MoE is that not much information was available in 1972. This made it more difficult to separate vital problem areas from more irrelevant areas. A basket portfolio of potentially important projects is not unreasonable when uncertainty prevails, but the basket should be narrowed as information becomes available. To a great extent, however, this has not happened.

The MoE can also be criticized for being too myopic. There seems to have been only small efforts in the direction of identifying potentially important resource and environmental problems which might occur in the next 20 – 50 years. MoE has taken on the role to detect and repair already existing damages to the environment and the natural resource base, a role which is acceptable in the first 10 – 15 years of work in a new area, but too narrow in the long run. Symbolically speaking, the MoE has been too concerned with what comes out of the pipe and its consequences, and too little concerned with what goes into the pipe and the economic mechanisms behind it. To be able to envisage and prevent new damages, the MoE needs analytical and forecasting tools. The MoE has not, in our opinion, been sufficiently aware of this, and has not systematically aimed at developing this tool kit.

6.4.1 Theories and models

Economic and environmental models have a prominent position within the ideal planning world of figure 6.2. Basically, the models serve three purposes. *First*, they act as manifestations of theories and as such are useful since they bring to light assumptions and limitations that otherwise easily could be hidden. *Second*, models serve as theoretically justified frameworks for collecting and organizing data. Both the type and the amount of data needed for rational decision making often follow indirectly from the data requirements of the various models. And *third*, the models are useful tools for studying "what–if" questions of the future. Thus, specifying and interconnecting the various models as illustrated in figure 6.2 might be of great help in organizing necessary (and avoiding "unnecessary") data.

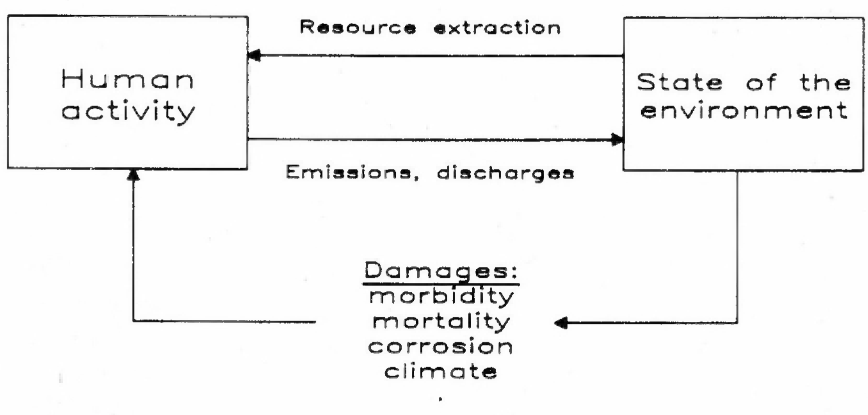
In 1972 there did not exist a set of analytical tools ready and available to evaluate present, and to reveal possible future, environmental and resource problems. There existed though a long term economic model, MSG (Multi-Sectoral Growth model), which was designed for analyzing the allocation of production, labour, capital and other inputs between sectors in an equilibrium growth process. The only place where the linkage between resource and economic issues has been pursued systematically has been in the analysis of energy production and consumption. This work has been based on the CBS/Ministry of Finance model MSG in close contact with the Ministry of Oil and Energy.

At an early stage, however, and at the initiative of the MoE, this model was used to calculate future emissions to air of several polluting components resulting from energy use in the economy (Ministry of Finance (1972)). The calculations forecasted a sinister growth especially in the emissions of sulphur dioxide (SO_2) to air. Partly as a result of these calculations, actions where taken to reduce the sulphur concentration in heavy oils. Although the forecasts were far higher than what has been observed ex post, the forecasts were successful in the sense that they initiated actions which made them wrong. Unfortunately, such valuable studies have not been followed up until recently.

Other important environment economics issues, like methods for assessing the values or benefits of environmental programmes, distributional aspects of environmental policies, intertemporal issues of managing different types of resources, evaluation of different policy intruments with respect to efficiency etc., have until recently been largely neglected or treated in an unsystematic manner.

The picture is perhaps even more disappointing for biological and/or ecological models and theories than for economic models. The reason for pursuing resource and environmental policies is first and foremost the concern over the effects on human living conditions of mismanagement of the environment and the natural resources. (One might separately add concern over damage to animals, plants, capital, climate etc. – but it ultimately expresses the same concern over human survival and quality of life as expressed by humans). One should therefore expect a reasonable research effort along the chain of effects from human activity to emissions and discharges to quality of the environment to human morbidity and mortality, and then back to human activity (cfr. figure 6.3). There has been some efforts to analyse the effects from emissions to quality of the environment and to bring forward information on effects from the physical environment to morbidity and mortality rates, but the efforts have not been systematic and coherent. Given the feedback such analyses can have on natural resource management, this is rather disappointing.

Figure 6.3: Links between human activity and the environment



Analysis and models in the Central Bureau of Statistics

Over the years the CBS has performed a number of analysis and studies of topics related to natural resources and the environment, e.g. within the fields of energy, environmental economics, petroleum economics, land use, fishery, forestry and interconnections between health and the state of the environment. Seperate models have been built on many occassions, and existing economic models have been utilized. The results of the effort can be characterized as a mixed success. Most successful is undoubtedly the work within energy economics. This can be explained by noting that within this field data have been available, model tools have been established, maintained and developed over a relatively long period, and there exist organizational structures within the Ministry of Environment and the Ministry of Oil and Energy capable of using and acting on the information received. Energy analysis has been a continuing effort, thus securing the level of competence in all parts of the process. Briefly stated, energy is an example of a field where it has proved possible to integrate concern for natural resources with more traditional social planning.

The lack of success in other areas, like analysis of fish and forest, can easily be ascribed to shortcomings in one or more of the requirements listed above. Sometimes the lack of professional competence, data and suitable theories have been the stumbling blocks. Perhaps more common is the situation where it proves impossible, for political or other reasons, to use and act upon the information, and where the demand for analysis has been vague, changing or even disappearing. Past experience therefore strongly suggests that natural resource and environmental analysis without an administration and a political body capable of or willing to integrate the effort in traditional sectoral or overall social planning, is a futile effort.

Looking ahead, two new areas look potentially promising. Environmental economics (i.e. economics of externalities) is an area which is closely connected to energy economics, for instance with regard to air pollution. Thus, one should to a certain extent be able to exploit the data, models and organizational structures employed within this field. Also the public awareness of the need to manage pollution, locally, nationally as well as globally, is increasing, cfr. the report of the World Commision on Environment and Development (WCED, 1987).

The other area where at least the data, theories and models is well developed are petroleum economics. Traditionally, this has been the domain of the Ministry of Oil and Energy and the Ministry of Finance, but the long-term development of this resource and the environmental consequences of its use is clearly within the responsibilities of MoE.

In brief, the present concentration of CBS modelling and analysis towards energy and pollution problems seems adequate enough considering the importance of these issues, but the trial and error process has perhaps been unnecessary long.

6.4.2 Data

When the Ministry of Environment (MoE) was established, there existed virtually no systematically organized data on natural resources, environmental quality or discharges of wastes. The exceptions were statistics on economic activity in extractive industries and some limited monitoring data on local air and water quality. The MoE lacked a precise description of its responsibilities and did not have models or theoretical frameworks on resource management at its disposal. It is easy therefore to understand why the signals from the MoE as to which data should be collected over the period 1972 – 1986 has not been very systematic. Rather than selecting information needed from a set of consistent criteria, the collection of information has to some degree been determined by day-to-day political needs. With the advantage of hindsight, our conclusion is that too many projects were launched without a clear formulation of "why" and "for what purpose".

This points to a lack of communication and understanding between the data suppliers and model buildning expertice in CBS and the users in MoE. In particular the CBS may be criticized for beeing too passive and taking too narrow a view on the applicability of existing models to natural resource and environmental problems. The potential benefits from using traditional and revised economic models may for this reason not have been adequately appreciated by the MoE.

Resource accounting in CBS

During the period 1978 to 1986 resource accounts for energy, fish, land use, forest and minerals were devoloped by the CBS as described in chapter 4. Only the accounts for energy could be classified as very useful judged by the intensity of use – both for immediate information and analytical purposes. The reasons are much the same as described in the previous section. The energy accounts are used both by the Ministry of Environment and the Ministry of Oil and Energy for resource and environmental considerations. In addition, analytical methods for analyzing future demand and supply of energy has been developed on the basis of the accounts, and the integration of energy issues into economic planning could to a certain extent be classified as satisfactory.

Lack of primary data have been a problem when establishing some of the other resource account, e.g. accounts for land use. Several line ministries are at present "responsible" for land use for agriculture and forestry, communication, construction and buildings, and other purposes. The MoE has to some extent taken on the role of coordinating policies, i.e. balancing off demands for different kinds of productive use of land (agriculture – infrastructure, hydro power projects – reindeer farming, etc.) and between productive use of land and the use of land for recreational purposes, including the protection of wilderness and habitats of scarce and threatened species. Thus, there is a demand for land use statistics and for analyses of consequences following from alternative uses. In other cases, e.g. accounts for fish and mineral reserves, the accounts themselves were relatively easy to establish, but the user frequency of the accounts have been minimal. This can in some cases be explained by the lack of a suitable modelling framework, which in turn often reflects the fact that the resource in question has not or only sporadically been of interest to the MoE. Another interpretation of the lack of continued support from the MoE and the line ministries, is that the CBS has applied traditional methods in new fields without due thought of the relevance and possible use.

In addition to the material resource accounts, some efforts have gone into establishing environmental accounts. For instance, several man-years over the period 1980 – 1983 were allocated to developing an account for fresh water, defining it both as a material and as an environmental resource. Again with the advantage of hindsight, the project must be evaluated as a failure, mainly because of the size of the task. Water conditions and use vary from place to place on a rather fine spatial level. A national water account would therefore be an enormous collection of local water accounts. These are better developed by local authorities who know the conditions and usually can do much to solve the problems at a local level. A smaller scale project to identify and collect some main indicators on water quality from certain key areas, looks more promising and is a more adequate task for the CBS, who mainly should be concerned with resource management on a national scale. A positive outcome of the project was a catalogue or systematic linkage between geographical units used in traditional (sociodemographic and economic) data collection and precipitation areas. This catalogue might be useful in future local water pollution projects.

The CBS has also carried out a survey on solid waste. The survey shows where the solid wastes are delivered and how wastes are treated by the municipalities. Another survey on hazardous waste is presently undertaken. These surveys will be used by the MoE in their planning of necessary regulations for treatment of wastes.

Through a survey publication every fourth year the CBS publish a review of the state of the environment; the last one was presented in 1983. In this survey, called Environmental Statistics, a lot of information from different institutions are collected and presented. So far this state of the environment publication has turned out to be very popular and useful both for politicians and the general public. Although containing useful background information for the planning process, the book does not contain data that can be utilized in a formal way in the planning process. However, evaluating the small costs in man years against the value for public and general political information this project has been an obvious success.

6.4.3 Instruments

The policy intruments available to environmental authorities can be classified into three categories (see Bohm and Russell (1985) for a detailed and comprehensive discussion):

1. Direct regulations in the form of pollution permits or quotas, or collective arrangements for waste and sewage disposal.

2. Incentives to complete the sets of markets in the form of tradeable pollution permits, deposit–refund systems, etc.

3. Price regulations in the form of subsidies or taxes on input factors, produced goods, emissions, etc.

The various policy instruments must be judged along several dimensions. Among these are:

- Efficiency, i.e. the resource cost of achieving a specific goal by use of a certain instrument.

- The demand for information and ease of monitoring associated with the instrument.

- The flexibility of the instrument in the face of changing economic and environmental conditions.

- The incentives given by the instrument in the longer run.

- Political considerations such as distributional consequences, ethical issues, etc.

No single instrument can be said to be surperior in all situations. Rather, each environmental problem must be analyzed in detail and the final goals clearly stated before the appropriate instrument is chosen.

Like most other countries, Norway relies heavily on the use of direct regulations when trying to solve environmental problems. Efficiency considerations are probably among the main reasons for this, but also historical traditions and the organisational set-up of the Norwegian State Pollution Control Authority plays an important role. While detailed regulations of manufacturing processes allow fine-tuning of local environmental effects, several important draw-backs associated with direct regulations of more general pollutants are usually neglected. A very important draw-back is the lack of long term incentives for developing alternative and cleaner methods of production. Thus, by relying on direct regulations short term efficiency may be chosen at the cost of reduced longer term efficiency.

Another draw-back of direct regulations is the tendency for decisions to be taken isolated from other ministries decisions on for instance economic and energy issues. In many cases it would be far more efficient to integrate the economic and environmental aspects and aims in sectoral plans, relying more on economic incentives.

Perhaps the most successful policy instruments in use today are the deposit–refund systems for used bottles and automobiles. It seems possible and advantageous to expand this system to include objects like batteries, oil residues and other hazardous wastes.

6.4.4 Expertise

Resource and environment analysis and policy formulation are multi-diciplinary activities which require the knowledge of, and the cooperation between, many professions:

- Economists (intertemporal resource management, forecasting resource use and emissions linked to economic activity, evaluation of economic incentives, cost-benefit analysis, etc.),
- Biologists (effects of pollution and resource extraction on the ecological system),
- Engineers (knowledge of physical processes, technical solutions, etc.),
- Meteorologists (diffusion and deposition of air-borne pollutants),
- Physicians (impacts of a deteriorated environment on human morbidity and mortality).

None of these professions – with the possible exception of biologists and economists – have received a basic education in resource or environmental management or implications of mismanagement in their own fields at the universities. The lack of existing multidiciplinary expertise has of course been a problem to the MoE, compensated mostly by staff members post graduate training and learning by doing. The lack of expertise has perhaps been felt even stronger in the research institutes and directorates which have been established or linked to the MoE as support institutes.

The educational system is not easily changed, but resource and environmental questions have slowly been introduced or expanded at several Norwegian university faculties and the subject is put on the agenda at primary school levels. One might criticize the MoE for not leaning harder on educational decision makers, for not having introduced systematic post graduate staff training or utilizing the opportunities of foreign universities and research centres better. But it is unfair to blame the MoE alone for the lack of existing expertise.

Chapter 7

PERSPECTIVES

An evaluation without suggestions of changes or alternative approaches is not very constructive. We therefore in this chapter try to advance from the critical remarks of the preceding chapter to proposals for future priorities and for the organization of future work. Section 7.1 deals with Norwegian natural resource and environmental work in general, and provides a background for the more narrow scope of proposals for the future priority areas in section 7.2. In section 7.3 the future needs for data, information, analyses and models are discussed with special attention paid to the role of the Central Bureau of Statistics. Finally, in section 7.4, we discuss the needs for expertise in resource and environmental research and management.

7.1 General discussion

There are many similarities between the Ministry of Environment (MoE) and the Ministry of Finance (MoF). The MoF has the responsibility of monitoring, policy making and planning of economic activities. Its role is to design and execute policies to achieve politically defined goals (full employment, external economic balance, efficient allocation of economic resources, etc.), taking into account the interdependencies of different sectors and agents in the economy. MoF is a ministry responsible for overall economic planning, not a line ministry advocating sectoral interests.

Similarly, the MoE should have the responsibility for monitoring, policy making and planning of natural resource use. The role of the Ministry should be to design and execute policies to achieve politically defined goals (rational extraction and use of material resources, "optimal" pollution across both media and pollutants), taking into account the interdependencies of different sectors in their use of natural resources. MoE should not be a line ministry advocating sectoral interests, but a ministry responsible for overall resource planning. The MoE should be responsible both for short and long term policies, in the sense that measures taken to remedy short term resource and environmental problems should not be chosen such that they put unnecessary constraints on long term targets. The day-to-day management of material resources should, however, be left to the respective line ministries, whereas the intertemporal aspect should be the joint responsibility of

MoE and MoF – in collaboration with line ministries. Short and long term management of environmental resources should be a clear responsibility area of the MoE.

There is no contradiction between economic planning and resource and environmental planning. The latter deals with rational management of natural resources and with internalizing external effects of pollution. Although these areas have often been neglected in traditional economic planning they are central elements of economic theory. Proper economic management of national wealth includes the management of natural resources and the environment in addition to human capital, real capital and financial assets. There might be a difference of opinion between the MoF and the MoE on priorities and evaluations, but economics provide a common framework for analysis.

Like the MoF, the MoE should aim at an "envisage and prevent" role in its policy making – not a "detect and cure" attitude. The MoF makes economic forecasts to envisage employment problems and to find means to prevent unemployment, rather than awaits high unemployment and then seeks means to cure the problem. The parallel to i.e. the pollution problem and the "envisage and prevent" role of MoE is obvious. But such an active role demands, as was outlined in chapter 6.3, *i)* a monitoring system, *ii)* analytical tools, *iii)* guidelines for actions and *iv)* instruments in addition to expertise and an efficient organizational set-up. Briefly stated:

The first precondition for an envisage and prevent policy, ***monitoring*** requires knowledge about the state of resources and the environment (currently updated resource accounts and environmental data).

The second precondition, ***methods to envisage problems***, requires models to forecast resource use, pollutions and quality of the environment. To enable preventive measures the horizon of the analyses should be relatively long (10–20–50 years). Pollution should be analysed in a multipollutant/multimedia setting and might be part of an early warning system.

The third precondition, ***guidelines for action***, presupposes theories on how resources should be managed, damage functions which show effects of a deteriorated environment on health, capital, species and climate and well founded opinions as to how many and which species/habitats/townscapes etc. should be protected. To establish guidelines for action is perhaps the most difficult precondition to fulfil since it requires that large amounts of scientific and technical information have to be transformed to usable "knowledge" for politicians. Detailed information, often ambiguous and disturbed by noise, have to be conveyed to decision makers in the form of operational benchmarks or rules of thumb.

The fourth precondition, ***instruments***, requires that the MoE seeks to widen its repertoir of economic incentives available for resource and environmental management. The slogan might be "to make environmentally sound decisions profitable", either through a combination of regulations and fees, taxes, deposit-refund systems or otherwise (see section 6.4.3).

One might also add a couple of more speculative preconditions for a preventive policy. The first is ***information*** to the general public and politicians. Unless the general public and the politicians are informed and aware of environmental problems it may be difficult to gain support for preventive measures which will have short term costs, but which may be beneficial only in the longer run. Another speculative precondition is that the researchers and policy makers have to be *imaginative*. They should actively search for possible future problems – not only worry about old and well established problems. (One did not have to be clairvoyant to envisage the Chernobyl disaster, but the Norwegian environment authorities were almost unprepared to meet the sudden demand for monitoring, guidelines for action and public information).

The institutional set-up of the MoE itself (departments, sections) seems to be reasonably well designed. The organizational detail and the choice of professional staffing might be questioned, but it is easy to admit that a relatively small political secretariat as the MoE can not alone meet all the prerequisits. The MoE should be surrounded by a number of support institutions performing the day-to-day monitoring and executive work in addition to resource and environmental research. An illustration of the different tasks of monitoring, research and policy-making and examples of support institutions are given in table 7.1.

7.2 Suggested MoE priority areas

As underlined earlier, the main reason to pursue resource and environmental policies is the concern over quality of human life. Mismanagement might reduce economic living standards (measured by domestic income or consumption) or reduce immaterial standards of life such as health and access to recreational services. National priority areas should thus be of great direct economic importance or otherwise of great political importance, for instance concerns about health effects, possibilities for recreational activities etc. In addition Norway should of course give high priority to the solution of international problems; controlling emmissions of greenhouse gases, acid rain and contribute to the sound management of shared resources. Below, the priority areas are listed under the three headings "Resource management", "Pollution abatement" and "Protection and preservation". It is under each point indicated why the suggested priority area seems important and whether the most urgent concern seems to be monitoring, research or policy formulation.

7.2.1 Resource management

The role of the Ministry of Environment in resource management is unclear since there are line ministries on all resource areas. MoE should leave the day-to-day management to the Ministry of Fishing, the Ministry of Manufacturing and Mining etc. But two resources seem to need continuous and close attention from the MoE: energy and land.

Energy (a research and policy area)

In 1985 almost 20 per cent of Norwegian GDP was income from oil and gas production. At the same time value added in production of electricity and electricity intensive products amounted to 5 per cent of GDP. Misallocation both of oil, gas and hydro power might therefore have significant impacts on the economic performance of the Norwegian economy. Compared to energy's great economic importance, the manpower allotted to research and

Table 7.1: Resource and evironment monitoring, research and policy making.

	Resource/ problem	Monitoring	Research/ Models	Policy
Quantity and	Oil and gas	OD	Intertemporal	
quality of	Hydro	NVE	resource	
material	Minerals	CBS	management:CBS	
resources.	Fish	CBS	Macroeconomic	
Quality of	Forest	CBS	models: CBS	
environmental	Land use	SK/CBS		
resources.	Water	NIVA	Damage functions:	Short-term management:
Flows from	Air	NILU	Health:SIFF	Line ministries, MoE
environment			Corrosion:SFT	Intertemporal management:
to economy			Flora/Fauna:DN	MoE, MoF
(raw materials,			Climate:DN	
environmental				
services, and				
disservices)				
Flows within	Energy, Fish,	CBS	Macroeconomic	
the economy	Forest, Mine-	SK	models, trans-	
(conventional	rals, Land:	NIBR	port models:	
economic	Supply and		CBS, SK, NIBR	
relations)	demand			
Flows from	Air pollution	NILU	Response	
economy to	Water pollution	NIVA	functions,	
environment	Land pollution	SK	transport	
(pollution)	Hazardous waste	SFT	models: NILU,	
	Solid waste	SIS	NIVA, SK, SFT,	
	Noise		SIS, MI	MoE
	Smell			
	Radiation			
Flows	Ecological	NIVA	Ecologic	
within the	response.	NILU	models: NIVA,	
environment	Imported air-	NISK	NILU, NISK, DN	
(ecologic	borne pollution.	DN		
relations)	Self cleaning.			

CBS	: Central Bureau of Statistics
DN	: Directorate for Nature Management
MI	: Institute of Meteorology
MoE	: Ministry of Environment
MoF	: Ministry of Finance
NIBR	: Norwegian Institute of Urban and Regional Research
NILU	: Norwegian Institute of Air Research
NISK	: Norwegian Istitute of Forest Research
NIVA	: Norwegian Institute of Water Research
NVE	: Norwegian Water and Electricity Board
OD	: Petroleum Directorate
SFT	: Norwegian State Pollution Control Authority
SIFF	: National Institute of Public Health
SIS	: Norwegian Institute of Radiation Control
SK	: Norwegian Mapping Authority

policy judgements on energy questions have been astonishingly small. Reallocations might be extremely profitable.

Through a relatively high consumption of fossile fuels per capita, Norway is responsible for large emissions of CO_2, thus contributing negatively to the global greenhouse problem. In addition, choices of national energy programmes are important in determining local and regional air pollution levels and other damages to the environment, for instance wounds in the landscape from energy production facilities. Energy thus seem to be an area which deserves continued and probably increased efforts of research and policy formulation. Information is relatively well covered through energy and economic statistics.

Land use (a monitoring, research and policy area)

Land use seems to be an important area for the MoE since there is no other authority whose responsibility it is to balance the different demands for industrial areas against other demands (agriculture, forestry, housing, infrastructure etc.) or in particular to advocate the public's demand for recreational areas against industrial demand for land. The management of land is at present in a state of flux; there is a lack of information on thr present and potential use of Norwegian land. Monitoring and mapping of land for different purposes employs hundreds of people in Norway, but the work seems badly organized with respect to providing information for national management purposes. There is a lack of knowledge as to costs and benefits of different land allocation. Policies have been based on the protection of farm land or cultivated land. Land is fairly abundant in Norway, but at the moment one can only hope that the combination of the market mechanism together with some control measures result in an allocation of land which is not too sub-optimal.

7.2.2 Pollution abatement

The market mechanism does in general not give correct incentives to reduce emissions or to clean up the environment. Damage to air, water and land might be serious to survival and quality of life. Hence pollution should always be given high priority by MoE. Pollution is a complicated area which can be adequately approached only as a multipollutant – multimedia problem where place, time and form of pollution is important. To avoid an air pollutant in one location one might easily bring about a concentrated, accumulating water pollutant at some other place. For simplicity the problem areas are treated by kind and recipient below.

Air pollution (a monitoring, research and policy area)

There are many sources of air pollution. The most important are transportation, households and some manufacturing industries (in addition to imports of air pollutants from abroad). Air pollution is fairly well monitored, but relatively little has been done to link various pollutants and economic activity, and to evaluate different measures against air pollution. In particular, the measures taken or suggested have been quite narrow in scope, often limited to direct regulations by the authorities. Limits on sulphur contents in fuel oils is of course an effective measure in curbing sulphur emissions, but eventually economic growth will push oil consumption and emissions up, unless new standards are set, oil prices increase, or technology improvements are made. More radical suggestions are to rearrange transportation (private and public) and industry pattern in heavily air polluted areas. Suggestions of this kind of course have to be carefully evaluated before they are advocated and implemented. Most cost-benefit analysis of air pollution control should be based on general equilibrium models to take into account not only the costs and benefits in the sector(s) directly affected, but also the indirect costs and benefits occuring as a result of repercussions through the economy. For instance; taxes on SO_2 emissions from manufacturing industries not only augment costs and prices in the affected sectors. Higher costs are passed on to other producers via increased input prices, inter alia inflation is increased, competitiveness reduced, capital markets affected, sector composition changed, and the amount of emissions of other pollutants affected. These indirect effects can be significant, but are not picked up by partial analyses of the problem.

Air pollution is an international problem. So far international model systems (linking economy, energy, pollution and ecology) have been given low priority. The aggravation of global environmental problems (like the greenhouse effect) might give impetus to such modelling, to seek efficient measures and solutions to conflicting international economic and ecological issues.

Another research area is to establish damage functions; what are the effects, if any, of a deteriorated air quality on human health, corrosion, species and climate. Unless such damage functions are postulated or estimated the guidelines for actions become vague.

Water pollution (a monitoring, research and policy area)

The domestic sources of water pollution in Norway are mainly agriculture, households and some manufacturing industries. In addition comes pollutants imported from abroad via precipitation, which makes water pollution problems more "international" and less local than one might expect. Some action has been taken to cure already existing damages (e.g. limeing of lakes), and as for air pollution some measures has been taken to prevent possible future damages (emission standards in manufacturing industries, pressure on international polluters). But, as for air pollution, some of the main preventive measures makes it necessary to attack policies in other areas than the pure resource and environment policy area – in particular agricultural policies and the support of energy intensive regional cornerstone establishments. This goes to the heart of Norwegian local settlement and incomes policies. In order to achieve a certain dispersion of settlement combined with regional equity of income, one has subsidized energy intensive industries and agriculture. The result is a misallocation of energy, land and human resources. Simultaneously one has created severe environmental problems which in turn needs public action to be remedied. The point is not to criticize political goals on regional settlement and equity of incomes, but to suggest calculations of costs of today's solution and possible alternative solutions. This is an area where the potential benefits of integrating resource, environmental, economic and social planning definitely are large. As for air pollution, data on damage functions are scarce.

Solid waste, hazardous waste, noise, smell and radiation.

The problems mentioned under this heading are probably not areas which deserves huge efforts of monitoring and research, but rather areas where more active use of relevant, existing policy measures are required.

Solid waste treatment is in Norway mainly left to municipal enterprises. Both an economic evaluation of the different technologies used, and their impacts on air and water pollution, seems appropriate areas of priority.

Hazardous wastes have mainly been dealt with by demanding that the producers should deliver waste to special recipients who are then responsible for an appropriate treatment. A more incentive oriented policy on hazardous wastes (e.g. deposit–refund as for used cars and bottles) seems immediately beneficiary.

Noise, smell and radiation might be remedied by probibition, technological solutions or optimal location of the sources. A reasonable approach seems to be national adjustments to international standards – and then in each case find the cost minimizing policy measure.

7.2.3 Protection and preservation

Preservation has always been a high priority area for environmentalists. All types of protection and preservation is based on an envisage and prevent attitude. The arguments put forward are that species are, or might be, of economic, genetic or medical use. Aesthetic natural values should be preserved for recreation and spiritual renewal. It has also been argued that preservation of pluralism or heritage as such is an obligation we have to future generations, or simply that all species have equal rights to avoid extinction. However, most preservations might also be given an economic foundation. Surveys of the willingness to pay for unspoiled nature, aesthetics etc. reflect income elasticities higher than one, i.e. as incomes grow over time, the demand for such services will increase faster than income. Future generations will therefore assign higher real values to these services than we are willing to do today. Hence, an intertemporal optimization of national wealth will leave us with more protected nature than seems immediately appropriate. Protection and preservation decisions are indirectly based on a common set of arguments – although projects are often defended one by one. A more elaborate and clear theoretical foundation for these decisions is possible and perhaps desireable in order to secure a systematic preservation policy towards species, habitats, townscapes, etc.

7.3 Suggested CBS priority areas

Compared to other research institutes, the advantages of the Central Bureau of Statistics (CBS) are mainly socio-economic and statistical expertise and models in addition to easy access to relevant data. The work on various resource accounts and analyses over the last 8 – 10 years, has given the Research Department of CBS competence in a relatively broad field of resource and environmental issues. It seems reasonable that CBS should try to specialize in areas where it has advantages, and not spread expertise too thinly on all resource and environmental issues. There are highly competent research institutes besides

CBS which should be given responsibilities for many of the monitoring and research tasks listed in table 7.1.

Given the number of man-years available today as a constraint on the total CBS-effort, the contributions to solving the priority areas discussed in section 7.2 might be as described in the following subsections.

7.3.1 Accounting

The accounts for energy should be given high priority as before. The accounts for fish, forest and minerals are already brought forward with a minimum of man-years. This seems to be appropriate at the moment. Land use information seems to be relevant to the MoE, but at a more detailed level than the CBS can provide (given the constraint on man-years). A collaboration with the Norwegian Mapping Authority (SK) on primary data catch seems rational, and a future transfer to this institution possible.

CBS, at four year intervals, provides a publication – Environmental Statistics – which is a broad statistical overview of resource and environmental issues, in addition to shorter analysis of special topics. The publication gives information to the general public in addition to the public administration. The CBS has been responsible for this publication since 1979, although the CBS does not collect all primary statistics on resources and the environment. CBS has, however, a broader expertise in compiling and presenting this information than most other research institutions which might be candidates for this editorial task. This work should continue.

The CBS has as background information to projects or on request from MoE, brought forward information on special issues. Emissions to air based on the energy accounts, have been cruical data to some of the analytical projects, and is now established as an emission account. Other examples are data on hazardous waste, on municipal water supply and waste treatment. Such data projects will continuously occur – but it is important that the burden of these ad hoc data projects is kept within reasonable bounds, otherwise they tend to crowd out the research efforts. An approach which seems appealing is that CBS in collaboration with local, national and perhaps international monitoring institutions establish a well framed, but limited national data base on environmental statistics and key indicators.

7.3.2 Models and analyses

CBS is already providing analytical tools (for instance the general equilibrium model MSG) suited to analyse and forecast energy and air pollution. A continuous effort in these two high priority areas will demand most of the available analytical capacity available for natural resource and environmental analysis. Extensions of the model tool kit might on the energy side include the use of the CBS medium term macroeconomic model MODAG, and support models to MSG/MODAG on household energy consumption. On environmental economics, the MSG-model might be supplemented by support models or partial cost-benefit analyses or extended to include feed-back mechanisms from the environmental quality to the economic model through for instance corrosion and health damages. For air pollutants like SO_2 more than 80 per cent of depositions in Norway are imported from abroad. CBS will therefore give some priority to establish international transportation models, which links economic activity, energy consumption and air pollution in various European regions to an international transportation model.

Both in energy and environmental economics the aim is to detect and "correct" mismanagements already existing, and to envisage and prevent future mismanagements by forcing economic forecasts, energy forecasts and environmental forecasts into consistent long term scenarios. Long term programmes and Energy programmes might then include relevant resource and environmental programmes – or this last topic might be covered in a separate (but overlapping) governmental reports. Important topics for research should be policy instruments, and perhaps distributional questions and the valuation of natural resources and environmental qualities.

CBS should provide overviews easily available to politicians of the main theoretical ideas of resource management for exhaustible and renewable resources. Priority should be given to energy resources, air and water (pollution), but also areas like fish, minerals, forest and land use might be given priority if enough research capacity is available.

CBS has presently been engaged in research on health effects of water quality, noise and outdoor activities. Although these are important areas, the epidemiological part of this research seems more appropriate for medical research institutes like SIFF or the Norwegian Cancer Register. The project is a candidate for transfer from CBS to one of these, or similar, institutions.

7.4 MoE and CBS Expertise

The need for expertise in multi-disiplinary fields like natural resource and environmental management, is obvious. Expertise is needed on the research side for development of theories and models, and on the policy making side for evaluation of research results and information and to formulate guidelines for action. Efficient communication between the two sides is also crucial in developing and implementing sound research programmes and policies.

The "iron triangle of natural resource and environmental expertise" should thus consist of the universities with their academic research and education, empirical research institutions and the MoE. To improve the professional quality of researchers and policy makers, the MoE in collaboration with support institutions, should seek to establish better education and more academic research on resource and environmental issues. The MoE has taken initiative to sponsor professorships and Ph.D. scholarships within natural resource and environmental economics. In addition to theoretically dominated research at the universities, more empirically and policy oriented research is needed. The final side in the triangle is of course the MoE, which will have to coordinate the total effort.

To communicate with economic planning bodies, in particular the Ministry of Finance, the MoE probably needs a staff with stronger economic expertise than what has been the case up till now.

Both MoE and its subordinate research institutes have already established a selective portfolio of international research contacts in addition to contacts with policy oriented institutions like OECD, EC and ECE. These contacts should, of course, be well tended, both to enhance the level of knowledge, to increase coordination of research, terminology and standards, and for the sake of influence.

REFERENCES

- Alfsen, K.H. and S. Glomsrød (1986): *Future emissions to air in Norway: Forecasts based on the macroeconomic model MSG-4E.* Paper presented at ECE meeting on General Methodological Problems in Environmental Statistics, Oslo, May 1986. Published in Statistical Journal of the United Nations, no. 4.

- Alfsen, K.H., S. Glomsrød and D.A. Hanson (1986): *Approaches to reductions of SO_2 emissions: Direct and indirect effects.* Discussion Papers no. 20, Central Bureau of Statistics of Norway, Oslo.

- Aslaksen, I. and O. Bjerkholt (1985): *Certainty equivalence procedures in the macroeconomic planning of an oil economy.* Published in Bjerkholt and Offerdal (1985).

- Aukrust, O. (1971): *Forurensning som samfunnsøkonomisk problem.* Unpublished note. Central Bureau of Statistics of Norway, Oslo.

- Berger, K., Å. Cappelen, V. Knutsen and K. Roland (1986): *Effects of a fall in the price of oil on the Norwegian economy.* Forthcoming in the series Social and Economic Studies (SØS), Central Bureau of Statistics of Norway, Oslo.

- Bjerkholt, O. and E. Offerdal (1985): *Macroeconomic prospects for a small oil exporting country,* Martinus Nijhoff Publishers, Dordrecht.

- Bjerkholt, O. and S. Longva (1980): *MODIS IV: A model for economic analysis and national planning.* Social and Economic Studies (SØS) no. 43, Central Bureau of Statistics of Norway, Oslo.

- Bjerkholt, O., S. Longva, Ø. Olsen and S. Strøm (eds.)(1983): *Analysis of supply and demand of electricity in the Norwegian economy.* Social and Economic Studies (SØS) no. 53, Central Bureau of Statistics of Norway, Oslo.

- Bjerkholt, O., L. Lorentsen and S. Strøm (1982): *Using the oil and gas revenues: The Norwegian case.* Articles no. 133, Central Bureau of Statistics of Norway, Oslo.

- Bohm, P., and C. S. Russell (1985): *Comparative analyses of alternative policy instruments.* In *Handbook of Natural Resource and Energy Economics,* vol 1. (eds.: A. V. Kneese and J. L. Sweeney). North-Holland Publishing Company, Amsterdam.

- Bye, T. (1984): ***Energisubstitusjon i næringssektorene i en makromodell.*** Rapporter 84/2, Central Bureau of Statistics of Norway, Oslo.
- Bye, T. (1986): ***Non-symmetric responses in energy demand.*** Forthcoming in the series Rapporter, Central Bureau of Statistics of Norway, Oslo.
- Bye, T. and P. Frenger (1986): ***Factor substitution, non-homotheticity and technical change in the Norwegian production sectors.*** Forthcoming in the series Rapporter, Central Bureau of Statistics of Norway, Oslo.
- Central Bureau of Statistics (1981): ***Ressursregnskap. (Resource Accounts.)*** Statistiske Analyser no. 46. Central Bureau of Statistics of Norway, Oslo.
- ECE (1985): ***Protocol to the 1979 convention on long-range transboundary air pollution on the reduction of sulphur emissions or their transboundary fluxes by at least 30 per cent.*** (ECE/EB.AIR/12), United Nations/Economic Commission for Europe.
- Garnåsjordet, P. A. and H. V. Sæbø (1986): ***A system of natural resource accounts in Norway.*** Published in ***Information and Natural Resources***, OECD, Paris.
- Gjelsvik, E. and K. Roland (1986): ***A dynamic cost of adjustment model of natural gas demand in the Federal Republic of Germany.*** Paper presented at the 8th International IAEE conference, Tokyo.
- Glomsrød, S. and B. Vigerust (1985): ***Luftforurensinger og økonomisk vekst***, Økonomiske Analyser No. 8, Central Bureau of Statistics of Norway, Oslo.
- Jones, P. D., T. M. L. Wigley and P. B. Wright (1986), ***Nature***, vol. 322, pp.430–434.
- Kneese, A. V. and J. L. Sweeney (eds.) (1985): ***Handbook of natural resource and energy economics***, Vol.I,II,III, North-Holland Publishing Company, Amsterdam.
- Longva, S., L. Lorentsen and Ø. Olsen (1985): ***The multi-sectoral growth model MSG-4. Formal structure and empirical characteristics.*** In ***Planning, Multisectoral growth and Production. Essays in memory of Professor Leif Johansen***, North-Holland Publishing Company, Amsterdam.
- Lorentsen, L. and K. Roland (1986): ***The world oil market (WOM) model: An assessment of the crude oil market through 2000.*** Energy Journal, Vol. 7, No. 1.
- Lorentsen, L. and K. Roland (1985): ***Norway's export of natural gas to the European gas market. Policy issues and model tools.*** Published in Bjerkholt and Offerdal (1985).
- Lorentsen, L., K. Roland and A. Aaheim (1985): ***Cost structure and profitability of North-sea oil and gas fields.*** Published in Bjerkholt and Offerdal (1985).
- Ministry of Environment (1975): ***Ressursregnskap – Ressursbudsjettering.*** Forprosjektrapport. Oslo.

- Ministry of Environment (1977): *Om regional planlegging og forvaltning av naturressursene.* Report No. 25 to the Storting (1977–78), Oslo.
- Ministry of Environment (1981): *Om ressursregnskap og ressursbudsjettering.* Report No. 102 to the Storting (1980–81), Oslo.
- Ministry of Environment (1982): *Tilleggsmelding til St.meld. nr. 102 for 1980–81 om ressursregnskap og ressursbudsjettering.* Report No. 35 to the Storting (1982–83), Oslo.
- Ministry of Finance (1972): *Norwegian Long-Term Programme 1974–1977.* Report No. 71 to the Storting (1972–73), Oslo.
- Ministry of Finance (1975): *Naturressurser og økonomisk utvikling.* Report No. 50 to the Storting (1974–75), Oslo.
- Ministry of Finance (1985): *Norwegian Long-Term Programme 1986–1989.* Report No. 83 to the Storting (1984–85), Oslo.
- Ministry of Oil and Energy (1979): *Norges framtidige eneribruk og –produksjon.* Report No. 54 to the Storting (1979–80), Oslo.
- Ministry of Oil and Energy (1985): *Norges framtidige energibruk og –produksjon.* Report No. 71 to the Storting (1984–85), Oslo.
- NOU (1974): *Norges ressurssituasjon i global sammenheng.* Universitetsforlaget, Oslo.
- OECD (1985): *The State of the Environment 1985.* OECD, Paris.
- OECD (1986): *Information and natural resources.* Mimeographed. OECD, Paris.
- Rogstad, L. (1985): *Opplegg for ressursregnskap for vann.* Interne Notater no. 85/8, Central Bureau of Statistics of Norway, Oslo.
- Simon, J. (1981): *The ultimate resource.* Princeton University Press, Princeton, New Jersey.
- Stone, R. (1986): Scandinavian Journal of Economics 88(3), pp. 453–472.
- Strøm, S., and F. Førsund (1980): *Miljø og ressurs økonomi.* Universitetsforlaget, Oslo.
- Thurow, L. (1980): *The zero-sum society.* Basic Books, New York.
- Tickell, C. (1986): *Climatic change and world affairs.* Revised edition. Center for International Affairs, Harvard University/University Press of America.
- Vogt, T. (1986): *Water quality and health. Study of a possible relation between aluminium in drinking water and dementia.* Social and Economic Studies (SØS) no. 61. Central Bureau of Statistics of Norway, Oslo.

- World Commision on Environment and Development (WCED) (1987): ***Our Common Future***. Oxford University Press, Oxford.
- Aaheim A. (1983): ***Norske olje- og gassreserver. Nåverdiberegninger og inndeling i kostnadsklasser***. Rapporter 83/6. Central Bureau of Statistics of Norway, Oslo.

Utkommet i serien Samfunnsøkonomiske studier (SØS)
Issued in the series Social Economic Studies (SES)

* Utsolgt Out of sale

Nr. 1 Det norske skattesystems virkninger på den personlige inntektsfordeling The Effects of the Norwegian Tax System on the Personal Income Distribution 1954 Sidetall 103 Pris kr 3,00

\- 2* Skatt på personleg inntekt og midel Tax on Personal Income and Capital 1954 Sidetall 120 Pris kr 3,00

\- 3 Økonomisk utsyn 1900 - 1950 Economic Survey 1955 Sidetall 217 Pris kr 4,00

\- 4* Nasjonalregnskap. Teoretiske prinsipper National Accounts. Theoretical Principles 1955 Sidetall 123 Pris kr 3,00

\- 5* Avskrivning og skattlegging Depreciation and Taxation 1956 Sidetall 85 Pris kr 3,00

\- 6* Bedriftsskatter i Danmark, Norge og Sverige Corporate Taxes in Denmark, Norway and Sweden 1958 Sidetall 101 Pris kr 4,00

\- 7* Det norske skattesystemet 1958 The Norwegian System of Taxation 1958 Sidetall 159 Pris kr 6,50

\- 8* Produksjonsstruktur, import og sysselsetting Structure of Production, Imports and Employment 1959 Sidetall 129 Pris kr 5,50

\- 9 Kryssløpsanalyse av produksjon og innsats i norske næringer 1954 Input-Output Analysis of Norwegian Industries 1960 Sidetall 614 Pris kr 10,00

\- 10 Dødeligheten og dens årsaker i Norge 1856 - 1955 Trend of Mortality and Causes of Death in Norway 1962 Sidetall 246 Pris kr 8,50

\- 11 Kriminalitet og sosial bakgrunn Crimes and Social Background 1962 Sidetall 194 Pris kr 7,00

\- 12 Norges økonomi etter krigen The Norwegian Post-War Economy 1965 Sidetall 437 Pris kr 15,00

\- 13 Ekteskap, fødsler og vandringer i Norge 1856 - 1960 Marriages, Births and Migrations in Norway 1965 Sidetall 221 Pris kr 9,00

\- 14* Foreign Ownership in Norwegian Enterprises Utenlandske eierinteresser i norske bedrifter 1965 Sidetall 213 Pris kr 12,00

\- 15 Progressiviteten i skattesystemet 1960 Statistical Tax Incidence Investigation 1966 Sidetall 95 Pris kr 7,00

\- 16* Langtidslinjer i norsk økonomi 1955 - 1960 Trends in Norwegian Economy 1966 Sidetall 150 Pris kr 8,00

\- 17 Dødelighet blant spedbarn i Norge 1901 - 1963 Infant Mortality in Norway 1966 Sidetall 74 Pris kr 7,00

\- 18* Storbyutvikling og arbeidsreiser En undersøkelse av pendling, befolkningsutvikling, næringsliv og urbanisering i Osloområdet Metropolitan Growth, Commuting and Urbanization in the Oslo Area 1966 Sidetall 298 Pris kr 12,00

Nr. 19 Det norske kredittmarked siden 1900 The Norwegian Credit Market since 1900 Sidetall 395 Pris kr 11,00

\- 20 Det norske skattesystemet 1967 The Norwegian System of Taxation 1968 Sidetall 146 Pris kr 9,00

\- 21 Estimating Production Functions and Technical Change from Micro Data. An Exploratory Study of Individual Establishment Time-Series from Norwegian Mining and Manufacturing 1959 - 1967 Estimering av produktfunksjoner og tekniske endringer fra mikro data. Analyser på grunnlag av tidsrekker for individuelle bedrifter fra norsk bergverk og industri 1971 Sidetall 226 Pris kr 9,00 ISBN 82-537-0014-8

\- 22 Forsvarets virkninger på norsk økonomi The Impact of the Defence on the Norwegian Economy 1972 Sidetall 141 Pris kr 9,00 ISBN 82-537-0149-7

\- 23 Prisutvikling og prisatferd i 1960-årene En presentasjon og analyse av nasjonalregnskapets prisdata 1961 - 1969 The Development and Behaviour of Prices in the 1960's Presentation and Analysis of the Price-Data of the Norwegian National Accounts 1974 Sidetall 478 Pris kr 15,00 ISBN 82-537-0279-5

\- 24* Det norske skattesystemet I Direkte skatter 1974 The Norwegian System of Taxation I Direct Taxes 1974 Sidetall 139 Pris kr 9,00 ISBN 82-537-0399-6

\- 25* Friluftsliv, idrett og mosjon Outdoor Recreation, Sport and Exercise 1975 Sidetall 114 Pris kr 8,00 ISBN 82-537-0469-0

\- 26 Nasjonalregnskap, modeller og analyse En artikkelsamling til Odd Aukrusts 60-årsdag National Accounts, Models and Analysis to Odd Aukrust in Honour of his Sixtieth Birthday 1975 Sidetall 320 Pris kr 13,00 ISBN 82-537-0530-1

\- 27 Den repræsentative undersøgelsesmethode The Representative Method of Statistical Surveys 1976 Sidetall 64 Pris kr 8,00 ISBN 82-537-0538-7

\- 28 Statistisk Sentralbyrå 100 år 1876 - 1976 Central Bureau of Statistics 100 Years 1976 Sidetall 128 Pris kr 9,00 ISBN 82-537-0557-3

\- 29 Statistisk Sentralbyrås 100-årsjubileum Prolog og taler ved festmøtet i Universitetets aula 11. juni 1976 Central Bureau of Statistics Prologue and Addresses at the Centenary Celebration, University Hall 1976 Sidetall 32 Pris kr 7,00 ISBN 82-537-0637-5

\- 30 Inntekts- og forbruksbeskatning fra et fordelingssynspunkt - En modell for empirisk analyse Taxation of Income and Consumption from a Distributional Point of View - A Model for Empirical Analysis 1976 Sidetall 148 Pris kr 9,00 ISBN 82-537-0647-2

\- 31* Det norske skattesystemet II Indirekte skatter og offentlige trygdeordninger 1976 The Norwegian System of Taxation II Indirect Taxes and Social Security Schemes 1977 Sidetall 124 Pris kr 13,00 ISBN 82-537-0713-4

\- 32 Inntekt og forbruk for funksjonshemma Income and Consumer Expenditure of Disabled Persons 1977 Sidetall 166 Pris kr 13,00 ISBN 82-537-0732-0

Nr. 33 Prinsipper og metoder for Statistisk Sentralbyrås utvalgsundersøkelser Sampling Methods Applied by the Central Bureau of Statistics of Norway 1977 Sidetall 105 Pris kr 11,00 ISBN 82-537-0771-1

- 35 Flyttemotivundersøkelsen 1972 Survey of Migration Motives 1978 Sidetall 233 Pris kr 15,00 ISBN 82-537-0783-5

- 36 Konjunkturbølger fra utlandet i norsk økonomi International Cycles in Norwegian Economy 1979 Sidetall 141 Pris kr 13,00 ISBN 82-537-0910-2

- 37 Norske lytter- og seervaner Radio Listening and Television Viewing in Norway 1979 Sidetall 216 Pris kr 13,00 ISBN 82-537-0931-5

- 38 Analyse av investeringsatferd Problemer, metoder og resultater Analysing Investment Behaviour Problems, Methods and Results 1979 Sidetall 91 Pris kr 13,00 ISBN 82-537-0952-8

- 39 Kvinners yrkesdeltaking i Norge Female Labour Activity in Norway 1979 Sidetall 162 Pris kr 13,00 ISBN 82-537-0961-7

- 40 Framskriving av befolkningens utdanning til år 2000 Projections of the Education Characteristics of the Population to the Year 2000 1979 Sidetall 112 Pris kr 13,00 ISBN 82-537-0998-6

- 41 Nordmenns feriereiser Holiday Trips by Norwegians 1979 Sidetall 222 Pris kr 13,00 ISBN 82-537-0999-4

- 42 Analyse av sammenhengen mellom forbruk, inntekt og formue i norske husholdninger Analysing the Relationship between Consumption, Income and Wealth in Norwegian Households 1980 Sidetall 95 Pris kr 13,00 ISBN 82-537-1012-7

- 43 MODIS IV A Model for Economic Analysis and National Planning MODIS IV Modell for økonomisk analyse og nasjonal planlegging 1980 Sidetall 189 Pris kr 13,00 ISBN 82-537-1014-3

- 44 Holdninger og atferd på arbeidsmarkedet Attitudes and Behaviour in the Labour Market 1980 Sidetall 223 Pris kr 15,00 ISBN 82-537-1186-7 ISSN 0085-4344

- 45 Nasjonalregnskapet i Norge System og beregningsmetoder National Accounts of Norway System and Methods of Estimation 1980 Sidetall 313 Pris kr 18,00 ISBN 82-537-1191-3 ISSN 0085-4344

- 46 Inntektsfordeling og levekår Income Distribution and Level of Living 1980 Sidetall 263 Pris kr 15,00 ISBN 82-537-1195-6 ISSN 0085-4344

- 47 Fruktbarhetsutvikling og fruktbarhetsteorier Norge i et internasjonal perspektiv Trends and Theories in Fertility Norway in an International Context 1981 Sidetall 120 Pris kr 15,00 ISBN 82-537-1236-7 ISSN 0085-4344

- 48 Framskriving av arbeidsstyrken 1979 - 2000 Labour Force Projections 1981 Sidetall 109 Pris kr 15,00 ISBN 82-537-1556-0 ISSN 0085-4344

- 49 Fruktbarhet blant norske kvinner Resultater fra Fruktbarhetsundersøkelsen 1977 Fertility among Norwegian Women Results from the Fertility Survey 1981 Sidetall 349 Pris kr 20,00 ISBN 82-537-1621-4 ISSN 0085-4344

- 50 Flyttemønstre Norge 1971 - 1974 Patterns of Migration Norway 1971 - 1974 1982 Sidetall 238 Pris kr 20,00 ISBN 82-537-1709-1 ISSN 0085-4344

Nr. 51 Utdanning og sosial bakgrunn Education and Social Background 1982 Sidetall 210 Pris kr 15,00 ISBN 82-537-1759-8 ISSN 0085-4344

\- 52 Econometrics of Incomplete Cross-Section/Time-Series Data: Consumer Demand in Norwegian Households 1975 - 1977 Økonometrisk analyse av ufullstendige tverrsnitts/tidsserie data: Konsumetterspørselen i norske husholdninger 1982 Sidetall 307 Pris kr 20,00 ISBN 82-537-1782-2 ISSN 0085-4344

\- 53 Analysis of Supply and Demand of Electricity in the Norwegian Economy Analyse av tilbud og etterspørsel etter elektrisitet i norsk økonomi 1983 Sidetall 334 Pris kr 20,00 ISBN 82-537-1815-2 ISSN 0085-4344

\- 54 Et valg i perspektiv En studie av Stortingsvalget 1981 1983 Sidetall 285 Pris kr 24,00 ISBN 82-537-1932-9 ISSN 0085-4344

\- 55 Endringer i kvinners arbeidsmarkedstilpasninger Changes in Women's Employment Patterns 1984 Sidetall 371 Pris kr 24,00 ISBN 82-537-2039-4 ISSN 0085-4344

\- 56 An Economic Model of Fertility, Sex and Contraception En økonomisk modell for fruktbarhet, seksuell aktivitet og prevensjonsbruk 1984 Sidetall 334 Pris kr 24,00 ISBN 82-537-2094-7 ISSN 0085-4344

\- 57 Uformell omsorg for syke og eldre Informal Care of Sick and Elderly 1984 Sidetall 265 Pris kr 24,00 ISBN 82-537-2101-3 ISSN 0085-4344

\- 58 Individual Labour Supply in Norway Individenes tilbud av arbeidskraft 1984 Sidetall 177 Pris kr 24,00 ISBN 82-537-2114-5 ISSN 0085-4344

\- 59 Økonomi, befolkningsspørsmål og statistikk Utvalgte arbeider av Petter Jakob Bjerve Economy, Population Issues and Statistics Selected works by Petter Jakob Bjerve 1985 Sidetall 431 Pris kr 50,00 ISBN 82-537-2236-2 ISSN 0085-4344

\- 60 Framskriving av befolkningens utdanning Revidert modell Projections of the Educational Characteristics of the Population A Revised Model 1985 Sidetall 95 Pris kr 25,00 ISBN 82-537-2296-6

\- 61 Vannkvalitet og helse Analyse av en mulig sammenheng mellom aluminium i drikkevann og aldersdemens Water Quality and Health Study of a Possible Relation between Aluminium in Drinking Water and Dementia. 1986 Sidetall 77 Pris kr 30,00 ISBN 82-537-2370-9

\- 62 Dødelighet blant yrkesaktive Sosiale ulikheter i 1970-årene Mortality by Occupation Social Differences in the 1970s. 1986 Sidetall 54 Pris kr 40,00 ISBN 82-537-2398-9

\- 63 Levekår blant utenlandske statsborgere 1983 Living Conditions among Foreign Citizens. 1987 Sidetall 299 Pris kr 55,00 ISBN 82-537-2432-2

Pris kr 40,00
Publikasjonen utgis i kommisjon hos H. Aschehoug & Co. og Universitetsforlaget, Oslo, og er til salgs hos alle bokhandlere.

Statistisk Sentralbyrå

ISBN 82-537-2560-4
ISSN 0801-3845