1995-06-27

Nordic Natural Resource and Environmental Accounting

Part I

Physical environmental accounting in a joint Nordic project concerning

Forests
Marine resources
Nutrients
Environmental protection expenditure

Part II

Experiences from Finland, Norway and Sweden in linking physical and monetary accounting and economic valuation studies

Part I

Preface

During 1992-1993, representatives of the statistical offices in Finland, Norway and Sweden carried out a pilot study regarding a system for environmental and natural resource accounting. In the pilot study, it was proposed that further work should concentrate on some specified areas. The pilot study was published in a report from the Nordic Council of Ministers (report 1993:592).

The Nordic Council of Ministers has, thereafter, granted the means required for continuing the work. In 1994, studies have been carried out in the areas which were given priority in the pilot study, i.e. resource accounts for forests, nutrients and statistics on the environmental protection expenditures. In these areas international development work is carried out as well. With Iceland joining the project, the task was extended to include marine resources. The governing group of the Project is the Nordic Group for Natural resource and Environmental statistics.

The project work has been carried out by a working team consisting of a representative from each of the Nordic countries. A lead-country has been appointed for each area, and Sweden is appointed as project leader.

The working team consisted of

Denmark	Eyvind Vesselbo	together with Sweden responsible for the section on environmental protection expenditure
Finland	Leo Kolttola	responsible for the section on forests accounts
Iceland	Àsgeir Danielsson	responsible for the section on marine resources
Norway	Toril Austbø	responsible for the section on account for nutrients
Sweden	Marianne Eriksson	together with Denmark responsible for the section on environmental protection expenditures , also project leader

Contents part I

Summary of part I

This report presents a joint Nordic project aimed at developing environmental and natural resource accounts.

The intention behind environmental accounts is to give a comprehensive presentation of environmental data along with the national accounts.

Internationally, in Agenda 21, the action programme which was adopted at the UN's conference on Environment and Development held in Rio de Janeiro in 1992, it is explicitly stated that environmental accounts should be developed by all member states. In the fifth environmental programme of the EU, which was adopted in 1992, the need for developing environmental accounts is also emphasised. The goal is that environmental accounts should be available in all member states by the year 2000.

UN through its statistical secretariat UNSD, which is responsible for standards of the SNA (System of National Accounts), is developing a satellite system to the SNA, SEEA, (System of integrated Environmental and Economic Accounts). The purpose of SEEA is to, show the impacts of economic activities on the environment. SEEA consists of several different parts, with both physical and monetary accounts. The first step is to link environmental data expressed in physical units with the national account system. The second step will be monetary accounts which are based on the physical accounts to evaluate the impact in economic terms, so as to estimate, for example, the costs of the damage caused by emissions. Furthermore, an accounting system entails that data compilation is made in terms of balanced accounts.

In this joint Nordic project, the objective is in the first place to concentrate on the physical accounts to find common description systems with common concepts and definitions.

The areas which were given priority in the 1st phase of the project were

- *Natural resource accounting,* where such areas as are of great importance to the Nordic countries were chosen, i.e. the forest and marine resources.

- *Nutrients* - Nitrogen and phosphorus, substances which are necessary for biological production but also can lead to substantial environmental problems. The ECE comprises a project for the development of physical accounts, nutrients being one of the areas selected. The Nordic work has been carried out in close co-operation with the ECE.

- *Environmental protection expenditure* - Statistics on environmental protection expenditure are much in demand internationally at the same time as they are much discussed as regards their usefulness and quality. The purpose being to make a summary of the Nordic experience gained by working with statistics on environmental protection expenditure.

In Chapter 1, there is a brief description of the background behind the project, the international development work, as well as the projects in progress in respect of environmental accounting in the Nordic countries.

Chapter 2 presents the natural resource accounting for the forest and the marine resources. The model used builds on a model which has been developed for the Norwegian resource accounts and consists of stock balances describing the stocks and the causes behind changes in the stocks. Stock balances are combined with material flows showing the use of raw material in the economy expressed in physical units. The experiences, from making monetary valuation of forests in Finland and Sweden, is presented, as well as a valuation of the marines resources made in Iceland.

Forest accounts
In the report, the objective has been to extend the traditional quantitative forest accounts or wood material accounts with qualitative variables. The model used builds on the models used in Norway, which comprised three tables: forest balance, sector/product balance (user balance) and mass balance. In the report forest balances and a simplified form of user balance, based on products is shown, whilst a balance according to sector is missing. This simplified balance lessens the use of the accounts for the purpose of analysing and modelling the impacts the forestry industry has on the environment and the interaction between the forestry industry, energy-economizing and the state of the environment.

The forest balance is also shown in the form of a carbon balance, which makes it possible to analyse the binding of carbon dioxide in the forests. As a whole, the carbon cycle in the forest eco-system is a very complex issue and a more extensive analysis of the role played by the forests and the forestry industry in changing the climate is needed before any clear conclusions can be made.

There is an abundance of data on forest area and protected areas, although they are not quite comparable between the Nordic countries. Human impact on the forest, for example through various silvicultural measures, can be described quite well. The report presents information on the quality and state of health of the forests However there are no reliable time series showing the state of health of the forests. The most frequently used indicator is defoliation, which is a comparatively good indicator if acidification has become serious. As regards the situation in the Nordic region, however, defoliation often depends more on the yearly changes in climate and the age of the forests than on acidification.

Biodiversity in the forest can, for example, be measured by estimating the number of forest species that are threatened. So far no attempts have been made to present qualitative information in the form of accounts.

In the report, the monetary valuation studies of forests which have been made in Sweden and Finland are being compared. So far, the monetary accounts only comprise the direct values of the forests and in this aspect, these show that the wood raw material by far plays the most important role in comparison with other uses of the forests. There are some differences between the estimation methods used in Sweden and, Finland, the estimates deviate in terms of relative magnitude of the value items included.

Marine resources

The report presents tables showing the development of some of the fish populations of major economic importance, such as cod and herring. The populations, like the causes behind changes in the same, are shown for different marine areas, such as the areas around Iceland, the North Sea and the Baltic. The statistical problems in estimating the size of the stocks are discussed, as are the problems which follow as a result of the fact that the variation in a population also affects the size of other populations due to different populations competing for food or feeding on each other.

For Iceland, there are a number of tables describing the use of the catches in both physical and monetary terms.

The report also presents how natural resource accounting for marine resources has been used in making economic valuations and forecasts on Iceland. According to economic theory, the value of a biological resource equals that of the maximum present value of the rent which exploitation can generate. One of the advantages with this definition is that it means that utilising the resource in a wasteful way entails a cost. This is especially important when it comes to fishing, as there are examples where the national accounts have shown an increase in the value produced by fishing and the accounts of the companies show profits, but where there in reality are losses and a reduction in the value produced if one considers the cost that accompanies of over exploitation of biological resources - a cost that compared with the conventional methods after some years will manifest itself in reduced value production and losses.

Chapter 3 shows the accounts for nutrients (nitrogen and phosphorus). The objective has been to work out a model for accounts for nutrients using common concepts and definitions and to compile all available data in the form of accounts.

The accounts are intended to describe the links between the flows of nitrogen and phosphorus in the natural environment and in the economy, and should further in a fully developed system also describe such changes in the state of the environment and the environmental quality as are attributable to the use of nutrients.

In the study, the main stress has been laid on those steps in the model which describe the emission/discharges of nitrogen and phosphorus from the economy to the natural environment. The emission/discharges are shown according to the economic sectors causing them. The economic sectors are the same as those used in the national accounts, which makes the data on emissions/discharges consistent with other economic information about each respective sector. Furthermore, data has been compiled in a supplementary table showing balances for nutrients for agricultural land. The transboundary flows of nitrogen and the deposition are presented for country of origin and, respectively, recipient country, as well as the pollution load from nitrogen and phosphorus to the surrounding seas.

The data shown in the report are based on the statistics available in each Nordic country. Considerable attention has been paid to reviewing concepts and definitions thoroughly. Variations in the emission figures between the Nordic countries depend on such factors as regional conditions and differences in agricultural and industrial specialisation. To a certain extent, however, the differences appear to be too sizeable to be explained by insufficient data or regional differences. Different estimation methods and coefficients are other important reasons, especially so when it comes to estimating the net supply of nitrogen and phosphorus to agricultural land. Part of the variations in the supply to agricultural land is also explained by the fact that different definitions of arable land and agricultural land have been used in the estimates.

As previously mentioned, the focus of the study is on the steps showing emissions/discharges from the economy to the natural environment. As far as those parts in the models showing the flows of nitrogen and phosphorus in the economy and in the environment are concerned, the situation today charachterized by lack of the statistical data and lack of scientific knowledge of the ecological relations. In order to proceed and produce a more complete account for nitrogen and phosphorus, more extensive work is needed, for example:

- improving the quality of the existing statistics, by supplementing the economic statistics with data in physical units
- developing methods and estimations based on existing knowledge, information and statistics
- carrying out new statistical surveys and measurements

Chapter 4 deals with statistics on environmental protection expenditure. The Nordic countries (Iceland excluded) have a wide experience of producing statistics on the environmental protection expenditure in respect of both the industry and the public sector. The reports presents an overview of the surveys completed as regards the methods, concept and definitions used. There is, in addition, a review of the most important measuring problems. Internationally, statistics on environmental protection expenditure is very important. Among politicians there is a great need for statistical information. The material is seen as an important tool in comparing the environmental work of different countries. The statistics on environmental protection expenditure is considered to be an important part of the environmental accounting systems which are being built up by international organisations such as the UN and the EU. The EU has developed a system for the accounting of environmental protection expenditure, SERIEE, where the intention is to estimate investments and costs of all environmental protection activities at a rather detailed level. The objective of SERIEE is to follow the flow of money and thereby make it possible us to see who ultimately pays for the environmental protection.

The quality problems in the statistics are substantial. There are numerous delimitation and measuring problems involved when trying to estimate the expenditures in both industry and the public sector. As regards the public sector, the main difficulty is how to define which activities should be classified as environmental protection, especially when environmental protection is an integrated part of other activities. In industry, it is above all the differential costs for environmental protection in investments in processes changes that are difficult to estimate.

The degree of detail in the SERIEE system, combined with the existing extensive measuring problems, contribute to the shared opinions of the Nordic countries that the SERIEE system is far to detailed to be practicable for the time being. As the Nordic countries have used different definitions and delimitations in the surveys on the environmental protection expenditure, it is very difficult to compare the survey results. In spite of this problem, the report shows certain summaries in outline of the environmental protection expenditure in industry and the public sector. Only aggregated results are presented and it has not been possible to distribute the expenditure by activity. As the development work progresses at both the international level and in each respective country, it might in the future be possible to make better comparisons between countries. Above all we should concentrate the comparisons to such areas where the delimitation problems are not quite so difficult and in the long-term try to develop a common Nordic ”hard core” of environmental protection activities.

1. Introduction

1.1 Nordic co-operation environmental and natural resource accounting

In 1991, the Nordic Council recommended the Nordic Council of Ministers to extend the Nordic co-operation in respect of environmental statistics, with the aim of developing a system for estimating the totality of natural resources and changes in the same, as well as to combine this estimation model with estimates of the total costs and revenues in society. Recommendation no. 26/1991.

During 1992-1993, representatives of the statistical offices in Finland, Norway and Sweden carried out a pilot study concerning a system for environmental and natural resource accounting. The objective of the pilot study was to prepare a basis for a decision on how to proceed with the project. The pilot study states that the objective of a joint Nordic project for environmental and natural resource accounting is not to establish a model for the total environmental and natural resource statistics, but to concentrate on specified areas. These should be areas such as are given priority by several Nordic countries and these should, furthermore, have a relationship with the international efforts being made in this area. According to the pilot study, the accounts should primarily be made in physical units, but it also says that an accounting in terms of monetary units could be an element in a future Nordic presentation of environmental and natural resource accounts. The accounts should be a further development of the projects which have been started in the Nordic countries and should further as far as is possible conceptually follow the SNA model, the System of National Accounts, i.e. the UN's system for national accounts.

As proposed in the pilot study, the Nordic Council of Ministers granted means for a joint Nordic project which in 1994 was to concentrate on three areas:

- Forests accounts
- Nutrients
- Environmental protection expenditures

As Iceland joined in as participant in the project, the assignment was extended to included resource accounting for fish or marine resources.

Both Norway and Finland have broad experience of forests accounts. The model used for forest balances and user balances has also been tried out within the framework of OECD, where some 10-odd countries took part in a study. However, both the OECD and the Nordic countries find it necessary to extend the forests accounts to include more variables showing different environmental aspects, such as the appearance of forests damage, protected areas, CO_2 binding, etc. It is also important to make a comparison between the concepts and definitions which have been used by the individual countries.

Within the ECE, there exists a project for the development of physical environmental accounts; work which is organised into two task forces, one for nutrients and one for land use. Finland, Norway and Sweden have participated in the task force dealing with nutrients. The work in the Nordic project has been carried out in close co-operation with the ECE, and the Nordic group has, through the joint Nordic project, been able to contribute to the work of the ECE.

In the Nordic countries, there is a long experience of working with statistics on environmental protection expenditures. For some years there have been discussions within both the OECD, the ECE and the EU on how statistics on the environmental protection expenditures should be set up. Eurostat, which is the statistical body of the EU, is currently developing a system for environmental protection expenditure, SERIEE, (System for the Collection of Economic Information on the Environment). The problems with definitions and delimitations are significant in respect of environmental protection expenditures. The quality of the statistics is much debated and it has proven difficult to make comparisons between different countries. The work in a joint Nordic project aims at collating the surveys that have been made and, in particular, to examine the delimitations and definitions which have been used in the Nordic countries.

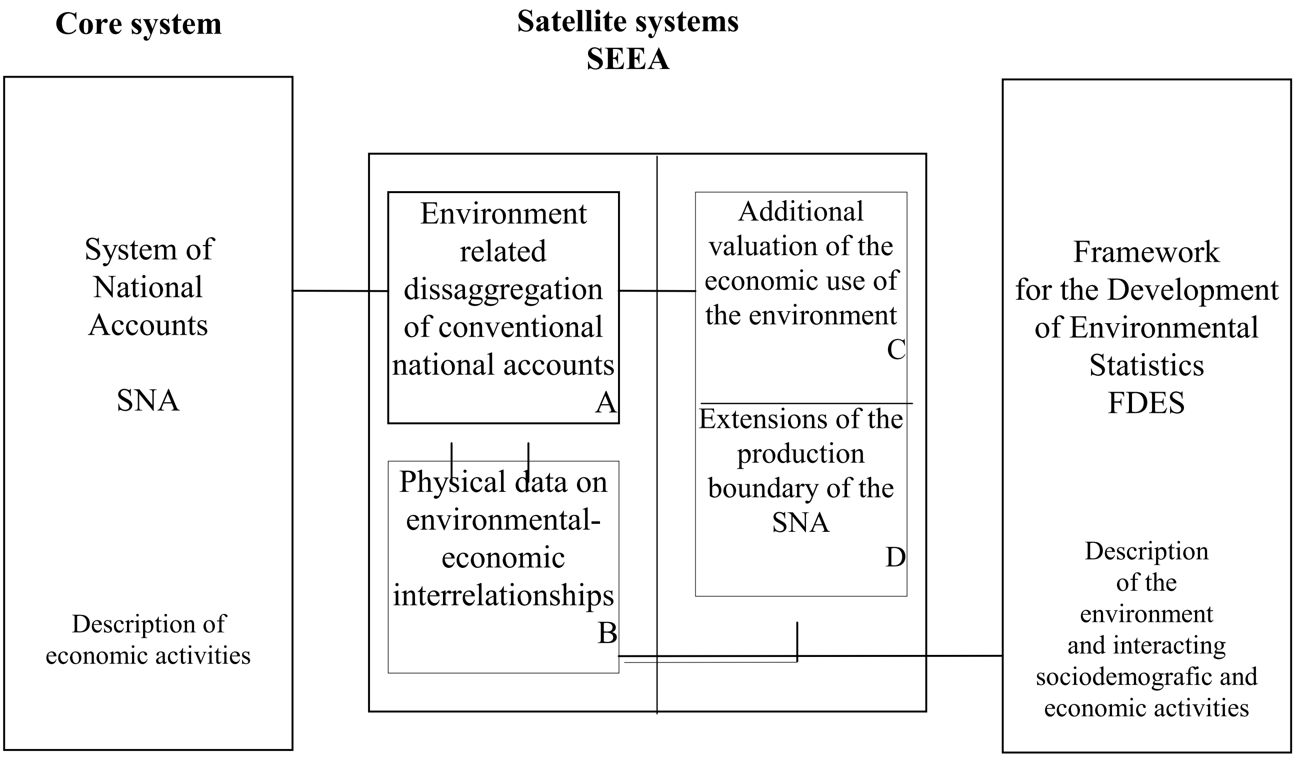
1.2 International work

Internationally, documents such as Agenda 21, the plan of action adopted by the UN's conference on Environment and Development in Rio de Janeiro in 1992, have explicitly mentioned the development of integrated environmental and economic accounts in all member states as a specific objective. The fifth environmental programme of the EU, which was adopted in 1992, also emphasises the necessity of developing environmental accounts, and the goal is that environmental accounts shall be established in the member states before the year 2000.

UN work

One of the most important projects, which further forms the basis of development work taking place in the other organisations, is the system which the UN's statistical secretariat UNSD is developing. UNSD, which answers for the standards that apply to the SNA national accounts, System of National Accounts, is developing a satellite system, SEEA, System of integrated Environmental and Economic Accounts. A preliminary version of the manual was published in 1993, "Integrated Environmental and Economic Accounting".

SEEA
The figure below shows the interrelationship between SNA, SEEA and the environmental statistics.



SEEA comprises four sections which all have parts that can be combined with the traditional national accounts.

A. Disaggregation of the traditional national accounts so as to better illustrate environmental aspects (monetary accounts only).
B. Description of the interrelationships between the environment and the economy in physical units.
C. Estimate of costs for use of natural assets (monetary accounts).
D. Extending SEEA further with, for example, the effects of using environmental services and the activities carried out by the households.

The joint Nordic project primarily embraces areas within section A and B of the SEEA. Below follows a brief description of these sectors..

A. Disaggregation of the traditional national accounts to better illustrate environmental aspects (monetary accounts only)

This section of SEEA includes a detailed accounting in monetary terms for natural assets in the form of a balance sheet showing the stocks and the causes behind changes in those stocks. The total change in the natural assets is thus not estimated on the basis of the balance sheets forming part of the regular national accounts.

Supplementary calculations must be made regarding the degradation and any other possible changes in volumes which are not covered by the national accounts.

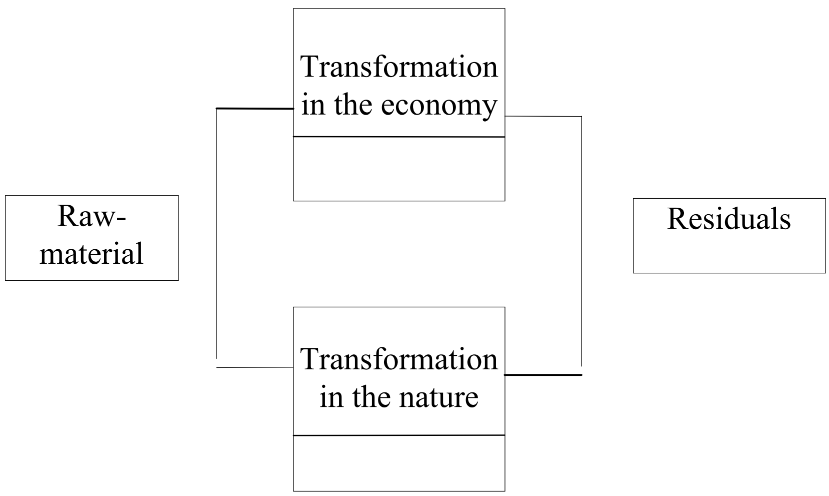
Another important area in section A of SEEA is the separate accounting for environmental protection expenditures. The detailed analysis of economic activities and their environmental impact also necessitates an account for such activities as are meant to prevent degradation of the natural environment. The SEEA system contains an accounting for environmental protection expenditure according to the classification of environmental protection activities as defined by Eurostat and the ECE.

Environmental protection activities in the industry are in the SEEA system shown as three different types of production activities:

- main production activity
  e.g. waste treatment
- secondary activity
  secondary production in the establishment of a product/service which is marketed outside the working site
- internal activity
  internal activities are, in the national accounts, only measured as input material/services, depreciation and payroll, but generate no output in the form of goods or services

B. Description of the interrelation between the environment and the economy expressed in physical units

Physical accounts are shown as natural resource accounts and material/energy balances.



Natural resource accounts and material/energy balances can be considered as being supplementary information systems. Natural resource accounts shows how nature is utilised or affected by the economy, and also shows the changes in natural resources, for example through economic influence. Apart from the flows into and inside the economy, the material flows consist of the flows of residuals leaving the economy and in turn impact the natural environment.

Natural resource accounts
Both physical and monetary data are important to describe stocks of natural resources and changes in the stocks. The physical accounts are quantitative descriptions which, however, can also be supplemented with qualitative information. Natural resource accounts cover biological resources (both produced and wild), sub-soil assets, water, land and air (description of the quality only). Living plants and animals of economic importance are counted as biological resources. Land include not only land, but also the eco systems involved.

SEEA presents the following model for natural resource accounts:

Stock year t
+ Natural growth
+ Discovery of new resources
- decrease due to natural causes
- depletion due to economic causes
+ revaluation
  e.g. technical improvements
  price changes
  improved estimation methods

Stock year t+1

Material/energy balances
The material flows focus on the economy and show the raw material input from the natural environment, the transformation in the economy plus the outflow in the form of residuals back to the environment. The inflow of material into the economy and the outflow from it is shown according to the national accounts system's classification of goods or industrial sector, which makes it possible to directly combine the physical and monetary accounts.

It is important to follow the residuals as they leave the economy and reach the first recipient in the environment. The transformation in the environment, as well as the environmental impact caused by residuals, is shown as changes in the quality of the air, quality of the water, etc., during the accounting period and no attention is paid to any possible time delays between emission/discharge and impact. Other accounts for environmental effects are shown through environmental statistics and indicators, e.g. ecological models showing the transformation in the natural environment or regional accounting for quality changes.

Work within the EU

Within the EU, Eurostat (i.e. the statistical body of the EU) has for a number of years been engaged in the development of a system for statistics on environmental protection expenditure, SERIEE. In 1995, a number of member states have been taking part in evaluating the system.

Eurostat is currently working with a project aimed at developing a so-called "Pressure Index". Furthermore, there are plans afield for producing a European manual for SEEA.

1.2 What projects are in progress in the Nordic region?

Below there is a short presentation of ongoing work with natural resource and environmental accounting in the Nordic countries.

Denmark: In Denmark, there are a number of projects currently in progress in the environmental-economic area. In early 1995, a welfare indicator describing the development of the economic welfare from 1970 until 1990 was presented. The publishing marks the end of a two-year project which was financed by the Rockwool foundation. The welfare indicator was made by adjusting the estimate of the private and public consumption by adding, among other things, the value of household production activities, the value of leisure and the effects on welfare from changes in the environment.

Another two projects showing the interrelation between the environment and the economy are in progress in Denmark. One is through relevant categorisation of input-output tables attempting to give a more exact description of the links between economic activity and emission of pollutants to air and water, as well as waste. This project is financed by the Strategic Environmental Research program.

The other project, financed by the Jubilee Fund of the National Bank, concentrates on valuation of natural and environmental assets, in respect of forest, fish, fossil energy, minerals, water and cultivated and non-cultivated land.

Finland: The Finnish project for natural resource accounting was initiated at the beginning of the 1980s by the Council for Natural Resources, a body subordinated to the Ministry of Agriculture and Forestry. In the middle of the 1980s, the project was transferred to Statistics Finland who now has the responsibility. At the same time, it was decided to initiate a preliminary investigation on the issue. This investigation was completed in 1988, and presented the basic guidelines for the Finnish natural resource accounts.
The first natural resource accounts which were made on the basis of physical units covered flows of wood material in the economy over the period 1980-1990. The accounts include the Finnish forests balance, wood material balance and the mass balance. These accounts will be updated in 1995 and the description area will be extended by taking quality factors in the forests into account.

Statistics Finland started investigating the environmental protection expenditure in the industry in 1992, and the first statistics were completed in the summer 1994. In the future, these statistics will be produced annually. As from 1995, Statistics Finland will also compile statistics for the environmental protection expenditure in the public sector.

Statistics Finland's model for estimating emissions to air was completed towards the end of 1994. Through the model it is possible to estimate emissions of SO_2, NOx, CO_2, CO, CH_4, N_2O and particles in Finland. The Finnish statistics on energy and emissions of SO_2, NOx and CO_2 for the period 1980-1992 were completed at the beginning of 1995. Statistics Finland also compile statistics on waste from the Finnish industry and the recovery of this. Furthermore, Statistics Finland has investigated the possibility of, developing a green GDP and environmental indicators, as well as defining environmentally-related business operations in terms of statistics.

The objective of Statistics Finland’s project for environmental accounts is, to make environmental data useful in the decision making process. The work concentrates on such sectors as are seen as most important in consideration of the environment and the economy. The objective is to show green accounts in accordance with the UN's integrated system for environmental and economic accounts - SEEA - and, ultimately, to measure progress in terms of sustainable development. In Finland, a project aimed at developing accounts according to the SEEA system will start in 1995.
The first steps towards a green GDP was Statistics Finland’s appendix to the budget proposal for 1995 ”Natural Resources and the Environment”. The appendix presented, from the Finnish perspective, the most important guidelines for a sustainable development and the principles for interrelation between the economy and the environment. The appendix also presents an overview of the development in the sectors that are most important according to environmental aspects. These sectors are industry, forests, energy, traffic and agriculture.

Iceland: The Icelandic Ministry of Environment was instituted in 1990. In the same year, The Parliament (Althing), decided to investigate the possibilities of preparing environmental and natural resource accounts, and that a systematic collection of environmental statistics should be organised for this purpose.

In 1992, a committee was set up to lead the work. In the committee there were experts from Hagstofa Island (Statistics Iceland), the Ministry of Environment and the National Economic Institute. The first decision taken by the committee, was that Statistics Iceland should undertake to collect all statistics available in this area and that it should organise a regular production of such statistics. The work was initiated in 1993, and Statistics Iceland has, since then, built up a data base containing environmental statistics.

Various specialised agencies have for a number of years produced statistics on the environment. This work has not been comprehensive and partly sporadic. Some of these statistics have dealt with the emission of substances containing nitrogen and phosphorus, carbon dioxide, etc. The Marine Research Institute in Reykjavik has produced statistics on the marine resources, and other institutes have dealt with other natural resources. Much of these statistics have been compiled by Hagstofa and this material is seen as being the first step towards a systematic production of environmental accounts. In this respect, the work in the Nordic task force for environmental and natural resource accounts has been of great importance to the Icelandic work, as the other Nordic countries have gained far more experience in this field.

The National Economic Institute answers for the development of monetary accounts and for linking the environmental and natural resource accounts to the national accounts.

Norway: The first Norwegian environmental and resource accounts were established in the early 1980s, comprising energy, minerals, fish, forests and agriculture. In the 80s, the public debate and interest transferred from resource management and planning to environmental issues and pollution. Today, regular and complete accounts are only produced for the energy sector. The energy accounts have, however, been supplemented by tables showing the emissions of pollutants to air. The accounts for the energy and emissions to air are integrated in a systematic model and regularly used in the national planning and administration. The last update of a complete forest accounting was made in 1992, but for both fish and the forest the part showing the stock balance is produced on a regular basis (Sæbø 1993). The Norwegian resource accounts are described in more detail in report from the pilot-study. (Nordic Council of Ministers', 1993).

Once again there is a demand for production of physical environmental data in the form of accounts. The "Human N and P cycle" project has been taken up again by identifying and quantifying the flows of nitrogen and phosphorus (Bakken & Bleken, 1994). Statistics Norway has contributed to the project, although the main part of the work is being carried out at the agricultural university of Norway.
In the last few years, Statistics Norway has built up statistics on waste and waste water. The waste statistics comprise physical data on both household waste and recovery. The waste water statistics contain data on municipal sewage systems and waste water treatment plants, as well as discharges. Furthermore, these statistics include the municipalities' expenditures of the treatment of waste and, respectively, waste water. For both these areas it is desirable to achieve a better overall view of the discharge sources and flows and to try to develop an accounting system. In 1995, Statistics Norway has scheduled one man-year for the purpose of working out an accounting for the waste flows.

Literature: Sæbø, H.V.: The Norwegian resource accounting. 1993. Report.

Sweden: In the spring 1992, the government, in accordance with the proposal SOU 1991:37 made by the Environmental Accounts Commission, put forward three assignments

1. Statistics Sweden (SCB) - to develop physical environmental accounts, as well as to improve and supplement the existing environmental statistics.
2. National Institute of Economic Research (NIER) - to report on the most important links between the economy and the environment and have the responsibility of the research and development in the field of monetary accounts.
3. The National Environment Protection Agency - to develop an environmental index system that can give us a comprehensive picture of the condition of the Swedish ecological systems and the changes in the same.

SCB and NIER have worked out a joint model for environmental accounting, called SWEEA, the Swedish Environmental and Economic Accounting. The objective is to point out the links between the environment and the economy. The form of accounting is a satellite system following the national accounts.

Initially, the physical accounts have been concentrated to the flow of environmental pollution. In 1994, data were produced in a form which directly can be linked to economic statistics, the statistics comprise the use of energy, the emission of SO_X, CO_2, NO_X, VOC and AOX, as well as the flows of nitrogen and phosphorus. In addition, SCB has prepared statistics on the environmental protection expenditure in the public sector and the industrial sector. As part of the work with the environmental accounts, data have been compiled in the form of, for example, environmental-economic profiles and key figures shown as links between the different sectors' contribution to the economy and their environmental impact in the form of emissions. The processing of the data has also taken the form of input-output analyses. In continuing its work with physical accounts, SCB will concentrate on improving the quality and disaggregation of industrial sectors, as well as on extending the presentation of emissions/discharges to show the interrelation between economic activities and contributions to different environmental threats. Information on industrial and household waste will be added to the accounts. Furthermore, it has been decided to establish material balances for substances that represent a hazard to the natural environment. The work with input-output analysis will, like the developing of environmental-economic indicators, key figures and profiles, continue. The description of natural resources will be successively extended with regard to stocks and output. SCB's work should also be extended to statistics on eco-industries, above all the recovery sector.

The work of SCB is done in close co-operation with the development of monetary accounts, as assigned to NIER. Most of NIER's work consists of research and method development. In 1994, two approaches were tried out to make valuation studies, namely estimating the cost of damage caused by emissions of a special substance (sulphur) and estimating the production from and different impact on a specific eco-system (the forest). The forest accounts comprise of calculating the forest's total production, which is more extensive than that which forms part of the conventional national accounts. The production concept has been extended to include more types of assets and a quality adjustment is being made when estimating the changes in the state of the environment.

Internationally, the expression "green GDP" has been abandoned in favour of the "greening of GDP" concept, which is an ideal expression for the set objectives when it comes to Sweden's work in the short-term.

Source: Environmental resource accounting, a interim report from the National Institute of Economic Research (NIER) and Statistics Sweden (SCB).

2. Natural resource accounting

The model for the natural resource accounting that has been used in working out a joint Nordic accounting is based on the model that has been developed in Norway. The Norwegian system distinguishes between material resources and environmental resources. Material resources are such resources as can be extracted or harvested from the natural environment. Environmental resources are resources where the quality is of decisive importance for the chances of production and the conditions for life. Environmental resources can also be defined as suppliers of environmental services.

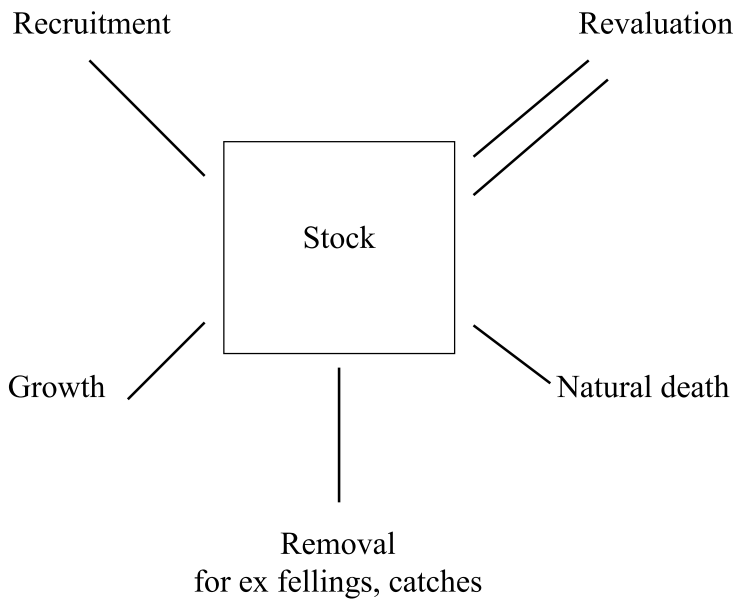
Material resources are divided into:

Mineral resources:	non renewable for example elements, minerals, stone, gravel, sand
Biological resources:	conditionally renewable life in the air, water and on land
Inflow resources:	renewable such as solar energy, the water's circulation, Sea currents

Environmental resources are state resources, such as air, water, soil, land, and are conditionally renewable.

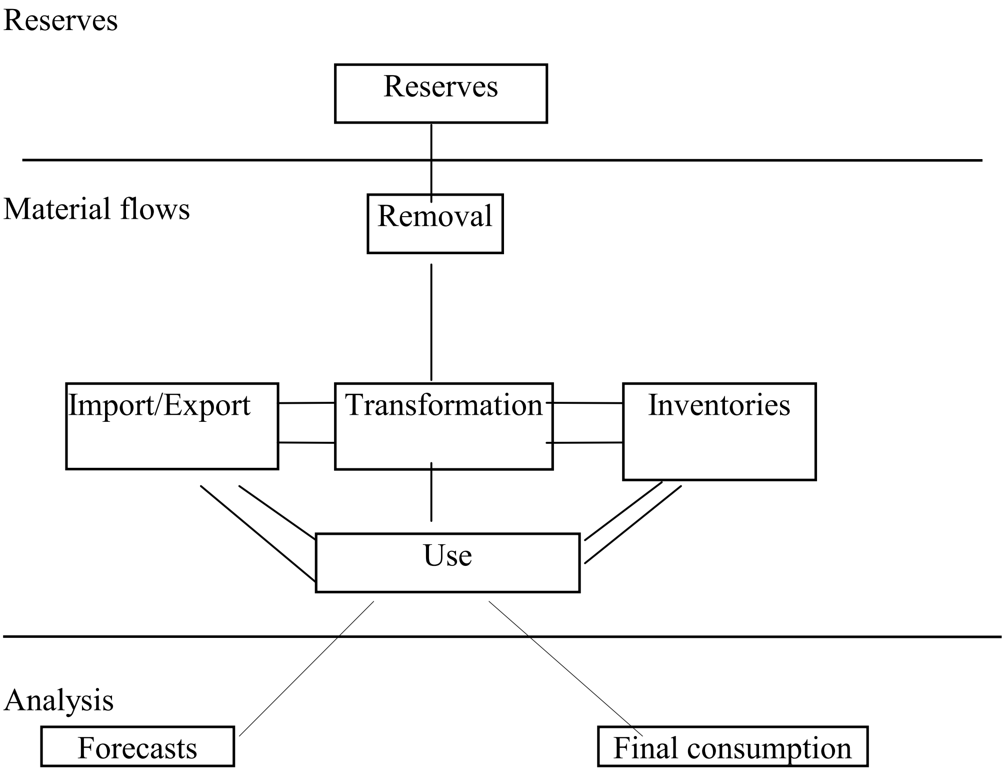
In Norway, the description of material resources is called material accounting and consists of accounts for reserves in the natural environment and material flows of resources from extraction, through the economy to final consumption. In principle, the SEEA system uses the same model, however describing it as two, although connected, parts: natural resource accounting and material flows.

Stock accounts for biological stocks can be described as in **figure 2.1** below



Material flows are described as a balance which is closely connected with the national accounts but is accounted for in physical units.

Figure 2.2 Material flows



The accounts for the biological resources forests and marine resources includes tables showing the stocks and changes in the stocks according to figure 2.1, as well as tables showing the use of the raw material in the first stage. Analyses in the form of forecasts or input-output analysis are not included in the report.

The forestry accounting has been extended with a data on forest area, some qualitative descriptions of the forest and an account in physical terms of some environmental services, for example the CO_2 binding.

For both the forestry and the marine resources economic valuation studies have been carried out, the results from these studies are shortly presented in the report.

2.1 Forest resources

2.1.1 Introduction

The developing of natural resource accounts started in Norway as early as in the 1970:s. Forests accounts were one of the main fields. The Norwegian model for forest accounts comprises three tables: forest balance, sector/product balance and mass balance. The accounts are strictly quantitative and contain no qualitative aspects, such as the forest condition or the recreational value of forests (Statistics Norway 1981). The Norwegian model was used by the OECD in pilot study for forest accounting (OECD 1990). In OECD's pilot project, it was recommended that, firstly, the forest balances should be extended according to the Norwegian model to also show the economic value of the forest resources. These monetary values should furthermore be consistent with the national accounts. Secondly, information about the state of health of the forests should be compiled. This could include, for example, air pollution and damage to forests. A third proposal of extending the accounts was to compile data on other forms of forest usage, such as recreation, stands of species and protected areas, as well as developing indicators showing the material flows and resources on the basis of the forest balance. According to the OECD, it is also important to improve the collection of forest information.

In Finland, forest accounting was the most important area when starting the development projects for a natural resource accounting in the middle of the 1980s. Finland's wood material accounts follow the Norwegian model, the time series for the 1980s being published in 1992 (Puuainestilinpito 1980-1990). In Finland, wood material accounts have been used as input for the macro-economic FMS model at the University of Oulu. A partial model has been developed for the Finnish forestry sector. Using this model, it is possible to analyse different alternative scenarios for the development of the forestry sector and the economy as well as the environmental impacts. Forest balances have also been used for the development of carbon dioxide balances for the forests in Sweden, Norway and Finland. In Finland, the Forestry Research Institute has analysed the carbon dioxide binding in different wood products with the help of wood material accounts (ref.).

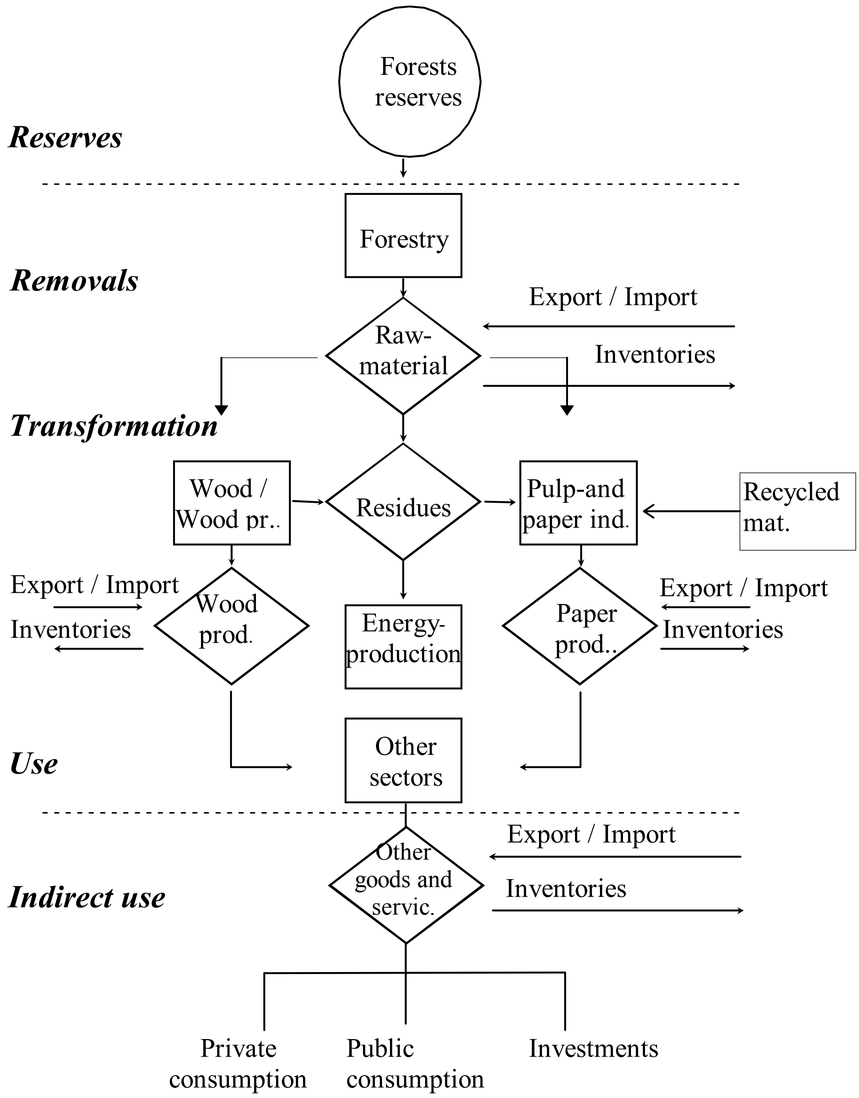
In Norway, forest accounts were given lower priority in the middle of the 1980’s and since then, only simplified accounts have been produced. The reason for this cut-back is that in Norway, where there is no shortage of forest resources and where the forestry sector is considerably smaller than it is in Sweden or Finland, there was little demand for quantitative forest accounts. The Norwegian forest accounts and the Finnish wood material accounts can be criticized for not taking any qualitative aspects into account. The Nordic environmental indicator project has worked towards developing comprehensible, measurable indicators for decision makers.

In Sweden, the Environmental Accounts Commission in 1991 made a proposal for forest accounts for estimating the monetary value of the total production from the forests. In 1994, within the framework of the development of environmental accounting, the study was extended with estimates for another year. The report is published in "Environmentally-adjusted national accounts for the Swedish forest 1987-1991", an appendix to the interim report "Swedish environmental accounts" issued by the National Institute of Economic Research and Statistics Sweden. This report provides an estimate and compares the annual income from Sweden's forest resources according to the principles which conceivably would be applicable to a modified national accounting focusing on the economically sustainable income. In the report are estimated the changes in the size of natural resources and environmental resources in the forest and its eco-systems such as biodiversity, carbon dioxide assimilation and the productivity of the soil. The income items included in the regular national accounts have also been adjusted.

In Sweden the National Environment Protection Agency has, by the Swedish government, been assigned to develop an environmental index system giving a total picture of the condition of the Swedish ecological systems and the changes in the same. The forest was one of the areas which were given priority. SNV has presented a proposal for a number of possible indicators for the forest's production capability, its biodiversity and its recreational and aesthetical values.

In this report, we analyse Nordic data on the forest with the object of attempting to develop a Nordic model for forest accounts which take both wood volumes and forest quality into account. As regards the quantitative information, however, there are shortcomings. Both Denmark, Norway and Sweden are, like Finland capable of filling in the forest balance according to the models of Norway and the OECD. The user balance is applied in a simplified form and only show wood products - not the use of wood by economic sector. For the time being, neither Denmark nor Iceland have the possibility of producing a user balance.

Figure 1. Model for wood material accounts.



2.1.2 Forest area

In Sweden and Finland, the data on forest area are based on National Forest Inventories, whereas in Norway and Denmark they are based on "forest counting". The reference years for the Inventories and, respectively, "stock-counting" vary in the Nordic region. In this report, the information has been adjusted to single years.

As a rule, so-called *forestry area* consists of forest land and other wooded land, scrubland, impediment and roads. In Finland, Norway and Sweden, *productive forestry land* is defined as such forests which have an annual wood production of at least one cubic metre per hectare. In Finland and Norway, the term *scrubland* means areas where the annual growth is between 0.1 and one cubic metre per hectare. *Impediment* is classified as those areas which have an annual production of less than 0.1 forest cubic metre per hectare. In Sweden, all land with an annual growth of less than one cubic metre is counted as impediment.

In total, the forest area has grown in the Nordic region in the last two decades. It has grown in Sweden and Norway, whilst in Finland, it has remained unchanged. Out of the total 195 million hectares of forest in Europe - the former U.S.S.R. excluded - a total of 61 million hectares were found in the Nordic region in 1990. This represents 31 per cent of the European forest area. Table 1 shows the development of the forest acreage in the Nordic region which includes forestry and scrubland land.

Table 2.1.1. Forest area in the Nordic countries.

Forest area million hectare	1970	1980	1985	1990
Sweden	27,64	27,93	28,01	28,02
Finland	22,37	23,32	23,33	23,37
Norway	9,13	9,57	9,57	9,57
Denmark	0,05	0,05	0,05	0,05
Iceland	0,01	NA	NA	0,02
Total Nordic region	59,20	60,88	60,69	61,47

Of the forest in the Nordic region, 45,9 per cent is found in Sweden, 38,3 per cent in Finland, 15,6 per cent in Norway and 0.8 per cent in Denmark. In the Nordic region, the total forest area, impediment included, covers a total of 61,47 hectares. This means than on average, 54 per cent of the land in the Nordic countries is forest. In Finland, 66 per cent of the land is covered by forest, while the corresponding figure for Sweden is 59 per cent. In Norway the share covered by forest is 28 per cent, and in Denmark, the share corresponds to 11 per cent. Of the woodlands in Iceland, 90 per cent of the birch woodland is classified as non-productive. The remaining 10 per cent is productive forests comprising foreign species planted in the last 50 -year period and native birch. The forest area in Iceland is increasing by around 1,5 per cent per year through afforestation. Table 2.1.2 shows the forest area in the Nordic countries and how it is distributed by coniferous and, respectively, broad-leaved forest.

Table 2.1.2. Land use in the Nordic region 1993 (1000 hectare)

	Total land area	Forest area	Coniferous	Broad leaved
Sweden	44 996	23 500	19 729	3 771
Finland	33 815	20 059	18 484	1 575
Norway	32 388	8 697	5 865	2 832
Denmark	4 309	466	308	158
Iceland	10 300	25	NA	NA
Nordic countries	125 808	52 747	44 386	8 336

The total population in the Nordic region amounts to around 23.5 million people, whereof 8.7 million are living in Sweden, 5.2 million in Denmark, 5.0 million in Finland, 4.3 million in Norway and 0.3 million in Iceland. Expressed per capita, this means that there, in the Nordic region, is more forest than anywhere else in Europe. There is, on average, as much as 2.6 hectares of productive forestry land per capita in the Nordic countries, whilst the corresponding figure for the whole of Europe is as low as 0.24 hectares. Measured in this way, most of the productive forestry land is found in Finland, 3.91 hectares per inhabitant, and Sweden. 2.28 hectares per inhabitant.

Table 2.1.3. Forest land ownership in the Nordic region

	Forestry area hectares per capita	Privately owned forests %
Sweden	2,58	71,3
Finland	3,91	73,6
Norway	1,57	88,0
Denmark	0,09	80,0
Iceland	0,10	NA
Nordic countries	2,1	74,1

2.1.3 Protected areas

The first nine national parks in the Nordic region and therewith in the whole of Europe were founded as early as in 1909. There are currently 22 national parks in Sweden, 27 in Finland, 18 in Norway and three in Iceland. Of the total, land area in Norway, Sweden, Finland and Denmark, approximately six per cent are areas protected by law. According to a recommendation issued by IUCN, countries should protect a minimum of 10 per cent of the different eco-system should be protected. In this respect, the forest in the Nordic countries is given just as insufficient protection as in the other industrialized countries.

The protected forest area is often included in the productive forestry land. The area of productive forestry land is also of importance in an ecological context, because the biodiversity will be greater with more forest areas. In spite of this, a sharp delimitation between productive forestry land and so-called scrubland or impediment is not justifiable. The border is often indistinct in forests in the proximity of high mountains.

In Sweden and Finland, around 2.5 per cent, i.e. 12 million hectares, of the productive forestry area is protected. In Sweden, the protected areas are concentrated to the alpine area of the most northern region, where two thirds of the subalpine coniferous woodlands and one third of the surrounding forest have been protected. Of the coniferous forests found outside the alpine areas no more than 0.4 per cent is protected. In Finland as well, the protected areas have been concentrated to the northern parts of the country. Of the Lapland forest, around 15 per cent is protected, while the corresponding figure for southern Finland is a mere 0.3 per cent. In Norway, no more than 0.6 per cent of the productive forestry land is protected, whilst among the stands of alpine birch almost double that amount is protected. In Denmark, around 0.1 per cent of the total forestry area is protected.

2.1.4 Forest balances 1990

The most important source of data in Sweden and Finland for forest balances is the National Forest Inventory, and the "forest countings" in Norway and Denmark. The annual balances are being constructed on the basis of average figures over longer periods. In Finland, however, the Forestry Research Institute has estimated an annual growth for 1990. Silvicultural waste and natural losses have been estimated with the help of fixed coefficients for fellings and the stock.

In principle, the National Forest Inventory and ”stock-countings” include all wooden bio-mass in all trees taller than 1.3 metres. Other parts of the bio-mass, such as smaller trees, tops, twigs, roots, needles and leaves are not included in the forest balance.

The forest resources are abundant in the Nordic region and the annual growth exceeds the removals in all the Nordic countries.

Table 2.1.4. Forest balances for the Nordic countries

Mill. cubic metre solid volume incl.bark

Sweden	Total	Pine	Spruce	Broad-leaved
Stock 1.1.1990	2554,1	978,3	1174,7	401,1
Annual growth	95	31,8	46,1	17,1
Net removal	55,4	16,2	29,7	9,4
Silvicultural waste	3,6	0,6	1	2,1
Natural losses	1,9	0,6	1	0,4
Stock 31.12.1990	2588,2	992,7	1189,1	406,3
Finland	Total	Pine	Spruce	Broad-leaved
Stock 1.1.1990	1896,3	864,8	684,1	347,4
Annual growth	77	36	26	15
Net removal	48,9	19,1	20,5	9,3
Silvicultural waste	4,8	1,4	1,2	2,2
Natural losses	1,3	0,6	0,4	0,3
Stock 31.12.1990	1918,3	879,7	688	350,6
Norway	Total	Pine	Spruce	Broad-leaved
Stock 1.1.1990	655	214,5	307,7	132,8
Annual growth	21,8	5,7	11,3	4,8
Net removal	13,8	2,8	9,5	1,5
Silvicultural waste	0,9	0,2	0,6	0,2
Natural losses	1,5	0,3	0,7	0,5
Stock 31.12.1990	660,6	216,9	308,2	135,4
Denmark	Total	Pine	Spruce	Broad-leaved
Stock 1.1.1990	55,2	3,1	28,1	23,9
Annual growth	3,2	0,2	2	0,9
Net removal	2,02	0,1	1,23	0,69
Silvicultural waste	0,83	0	0,7	0,13
Natural losses	0,1	0	0,04	0,06
Stock 31.12.1990	55,45	3,2	28,13	23,92
Nordic countries	Total	Pine	Spruce	Broad-leaved
Stock 1.1.1990	5160,6	2060,7	2194,6	905,2
Annual growth	197	73,7	85,4	37,8
Net removal	120,12	38,2	60,93	20,89
Silvicultural waste	10,13	2,2	3,5	4,63
Natural losses	4,8	1,5	2,14	1,26
Stock 31.12.1990	5222,55	2092,5	2213,43	916,22

2.1.5 Binding of CO2 in the Nordic region

The carbon balance of the Earth normally comprises carbon dioxide emissions from energy production and industries based on fossil fuels plus the binding of carbon dioxide to the vegetation and Sea. The carbon balance makes it possible to follow the development of the emissions and bonding of carbon dioxide. Gasses which contribute to the greenhouse effect are carbon dioxide plus methane (CH4), Nitrous oxide (N2O) and CFC compounds. Carbon dioxide is the gas which clearly impacts the greenhouse effect the most.

Table 2.1.5: Emissions of CO2 to the air in the Nordic region

	1000 tonnes	Per cent
Denmark (1992)	49 942	25,4
Finland (1993)	51 400	26,2
Iceland (1993)	2 225	1,1
Norway (1992)	34 300	17,5
Sweden (1993)	58 420	29,8
Nordic countries	196 287	100,0

Source: Yearbook of Nordic Statistics 1995, pp 32-33.

The emissions of carbon dioxide in the Nordic countries amounted to 196.3 million tons. According to the OECD, the Nordic part of the global emissions of carbon dioxide was around 16 per cent in 1991. The energy production (traffic included) accounts for 91 per cent of the emissions of carbon dioxide in the Nordic countries.

In the Nordic countries, the forests are important carbon binders which curb the development of the greenhouse effect. Various studies show that it is the young forests that bond most carbon. As they advance in age, the amount of carbon released in the degrading process closes in on the amount being binded through osmosis. Old forests having reached the stage of climax bind just as much carbon as they release. Nature protectionists and the environmental administrations are, however, striving towards protecting old stands on account of the rich variation these represent. With regard to the curbing of the development of the greenhouse effect, the felling of old forests, the production of lasting products of wood material, as well as the planting of new forests means that the total binding of carbon in the forest will increase.

The carbon bonded through the forest growth is stored in the forest eco-system, but also in the different products which are made up of felled trees. The longer the life of this wood and processed wood products, the bigger the carbon reserves they represent. The carbon is preserved best in sawn goods and building material, for which the decomposition cycle is around 80 years. The carbon content in paper products and board is, however, on average released within two years. Certain paper and board products will, however, keep for centuries, amongst other places in libraries and archives.

Carbon balances for the stocks of trees in the Nordic countries have been calculated on the basis of the forest balances with the help of Karjalainen's and Kellomäki's

(1991) coefficients (Seppälä & Siekkinen 1993, p. 20). The dry matter content of the trees has been calculated using the following coefficients: Pine 409 kg/m3, spruce 387 kg/m3 and broad-leaved trees 488 kg dry matter/m3 wood. The carbon content in the dry matter has for spruce and pine been estimated with the coefficient 0,5190039 kg C/kg dry matter. For broad-leaved the coefficient used is 0,504669 kgC/kg dry matter The calculation formula is: the stock of trees expressed in cubic metres fixed measure times the coefficient for the carbon content in the dry matter of each respective type of wood. The carbon balances which have been calculated for the stocks of trees in the Nordic countries are shown in table 2.1.6 shown below.

As can be seen in table 2.1.6, towards the end of 1990, there was a total of 1.1 billion tons of carbon stored in the total forest stock in the Nordic countries. Out of this nearly 40 per cent was stored in pine trees, about the same amount in spruces and just over 20 per cent in broad-leaved trees. During the year, the carbon reserve in the Nordic countries increased by 42.1 million tons through growth.

Table 2.1.6. Carbon balances in 1990 (million tons carbon)

	Mill. tonnes **Total**	**Pine**	**Spruce**	**Broad-leaved**
Sweden				
Stock 1.1.1990	542,4	207,7	236,0	98,8
Annual growth	20,2	6,8	9,3	4,2
Net removal	11,7	3,4	6,0	2,3
Silvicultural waste	0,8	0,1	0,2	0,5
Natural losses	0,4	0,1	0,2	0,1
Stock 31.12.1990	549,7	210,7	238,9	100,1
Finland				
Stock 1.1.1990	406,6	183,6	137,4	85,6
Annual growth	16,6	7,6	5,2	3,7
Net removal	10,5	4,1	4,1	2,3
Silvicultural waste	1,1	0,3	0,2	0,5
Natural losses	0,3	0,1	0,1	0,1
Stock 31.12.1990	411,3	186,7	138,2	86,3
Norway				
Stock 1.1.1990	140,0	45,5	61,8	32,7
Annual growth	4,7	1,2	2,3	1,2
Net removal	2,9	0,6	1,9	0,4
Silvicultural waste	0,2	0,0	0,1	0,0
Natural losses	0,3	0,1	0,1	0,1
Stock 31.12.1990	141,3	46,0	61,9	33,3
Denmark				
Stock 1.1.1990	12,2	0,7	5,6	5,9
Annual growth	0,7	0,0	0,4	0,2
Net removal	0,4	0,0	0,2	0,2
Silvicultural waste	0,2	0,0	0,1	0,0
Natural losses	0,0	0,0	0,0	0,0
Stock 31.12.1990	12,2	0,7	5,7	5,9
Nordic countries				
Stock 1.1.1990	1101,2	437,5	440,8	222,9
Annual growth	42,1	15,6	17,2	9,3
Net removal	25,5	8,1	12,2	5,1
Silvicultural waste	2,3	0,5	0,7	1,1
Natural losses	1,1	0,3	0,4	0,3
Stock 31.12.1990	1114,5	444,2	444,6	225,6

Even though significant amounts of carbon are bonded to the stock of trees, its share, however, according to, among others, Karjalainen's and Kellomäki's study, of the total amount of carbon bonded to the entire forest eco-system in Finland is no more than 15 per cent. The major part, i.e. some 73 per cent of the carbon was bonded to the soil (at a depth from 0 to 30 cm). The carbon's binding to different parts of the forest eco-system is illustrated by figure 2.1.7 below.

Table 2.1 7. Carbon binded in the forest eco-system 1990

	Percent	Mill. tonnes C
Forests	15	1115
Branches	4	297
Needles and leaves	1	74
Roots	6	446
Ground vegetation	1	74
Soil (0-30 cm)	73	5426
Sum	100	7433

It is difficult to make an exact estimation of the annual net carbon binding in the forest eco-systems of the Nordic countries. On the basis of the assessment referred to, one can, however, estimate that there can be as much as up to 7.4 billion tons of carbon stored in the forest eco-systems in the Nordic regions in total. Estimating the extent of changes in this reserve is, however, difficult. It is also difficult to give any reliable estimates of factors which increase the carbon reserve (the mass of wood tied up in forestry products and its life), or of factors which release carbon and consequently reduce the carbon reserve.

Table 2.1.8 below presents the carbon dioxide emissions in the Nordic region in relation to the carbon-binding effect of the growth in the stocks, as well as the percentage of emissions which are binded to the stocks of trees.

Table 2.1.8. CO2 emissions (1992/93) and the binding of these in stemwood

	mill. tonnes C
CO2 emissions	53,5
Annual growth of forests	42,1
Removals of forests	28,9
CO2. binding of forests	13,2
Net emissions	40,3

According to table 2.1.7, the forest growth, measured by the increase in stocks, accounts for around one fifth of the binding of the carbon dioxide emissions in the Nordic countries, and it is clearly that most carbon is binded through the forest growth in Finland and Sweden, where the forests due to efficient forestry and a young age structure are in an intensive state of growth. In the Nordic region, one of the principles for the forestry has been a carbon circulation which in the long-term should be in balance with natural woods and forests which are managed according to the principles of a sustainable forest resource management.

2.1.6 State of health of the forest

It appears that the forest growth in the Nordic region continues almost as vigorously as before. The connection between air pollution and damage to the forest is not as direct as we once had reason to assume. The defoliation is, for example, most accentuated in the high-altitude forests in the Norwegian, Swedish and Finnish alpine areas, and not in southern Scandinavia. The accentuated defoliation in the alpine forests is explained by the interaction of air pollution, the harsh climate and the high average age of the trees. The death of forests which in its true sense is owing to air pollution has in the Nordic region only occurred in the immediate vicinity of certain, very few industrial concentrations.

Table 2.1.9 shows the relative share of coniferous trees in the Nordic countries suffering from defoliation to more than 25 per cent over the years 1987-1993.

Table 2.1.9. Defoliation in the Nordic region over the years 1987-1993

	1987	1988	1989	1990	1991	1992	1993
Denmark	24,0	21,0	24,0	18,8	31,4	28,6	37,0
Finland	13,5	17,0	18,7	18,0	17,2	15,2	15,6
Norway	..	20,8	14,8	17,1	19,0	23,4	20,9
Sweden	5,6	12,3	12,9	16,1	12,3	16,9	10,6

Source: Forest Condition in Europe. ECE 1994.

Although air pollution can have a considerable impact on forest diversity, it is forestry and the forestry methods which represent the most serious threat to the diversity in the Nordic region. As a result of felling activities, the old coniferous and mixed forest have become rare. The many species that need forests in the succession stage have on account of the forestry industry disappeared completely or become very rare. This has had an adverse effect on, amongst others, birds nesting in holes in tree trunks and eagles. Many insects, and particularly beetles also depend on dying and dead trees. The white-backed woodpecker, for example, that lives on beetle eggs which it finds in old deciduous trees is threatened with extinction in Sweden and Finland. In Norway the white-backed woodpecker is also considered a threatened species.

Table 2.1.10 shows the plant and animal species living in the Nordic forests which are threatened with extinction.

Table 2.1.10. Threatened forests species in the Nordic region

	Threatened species	Threatened forest species	Per cent
Denmark	3 176	1 642	52,0
Finland	1 692	727	43,0
Norway	1 839	898	49,0
Sweden	3 397	1 487	44,0

Source: Natural forests in the Nordic region, p. 71

The active fight against forest fires associated with the needs of forestry has resulted in such plants and insects that live in areas ravaged by fire becoming very rare.

Many species of plants have also disappeared as a result of the ditching of swamps and wetland forests for the purpose of improving the soil's production capability from a forestry-economic point of view. Table 2.1.11 show different silvicultural activities taken in the Nordic countries.

Table 2.1.11. Different silvicultural activities taken in the Nordic region in 1990

	Finland (hectares)	Norway (hectares)	Sweden (hectares)
Final felling	144 176	60 000	180 000
Thinning	180 266	10 097	29 000
Cleaning	114 800	62 69	234 700
Scarification	127 400	6 463	172 000
Planting	97 206	3 167	192 000
Sowing	23 942	206	2 200
Fertilizing	47 655	2 557	69 000
Ditching	41 054	2 600	7 000

Source: Natural forests in the Nordic region, p. 21

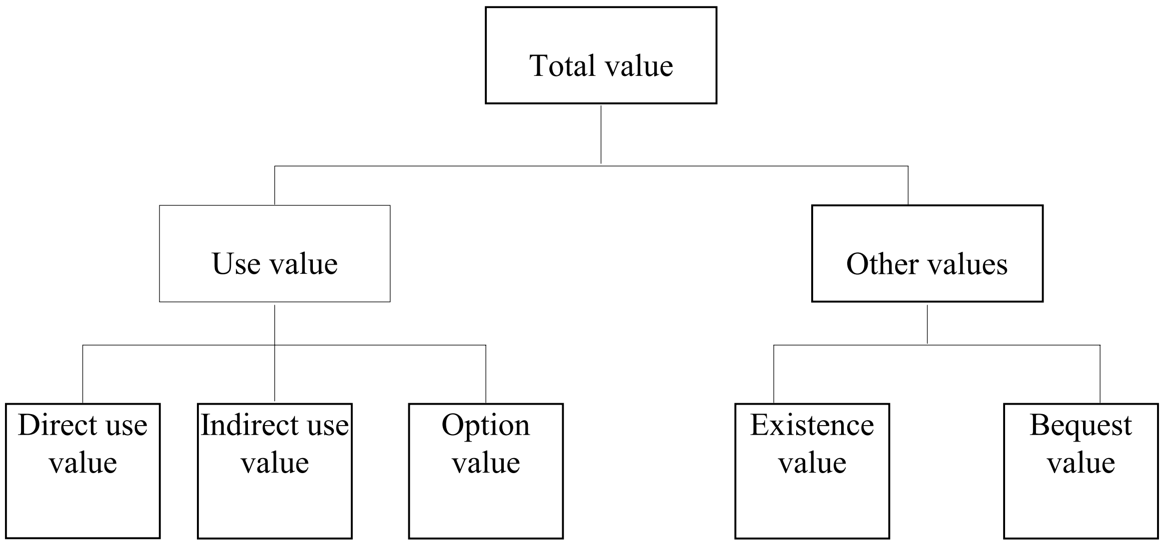
2.1.7 Monetary valuation of the forests and their recreational value

One of the most important development areas in the environmental accounting will, in the next few years, be a more extensive monetary valuation of the forests and the recreational opportunities they offer. We need information about the forests' value, in the first place for SEEA, the UN's Integrated System for Environmental and Economic Accounts. This means that the monetary valuation of the forests should be supported by comprehensive environmental accounts, where the data on quantities and quality are combined. The environmental accounts should in the environmental resource accounting combine such information as is based on physical quantities and the quality data which currently are expressed mainly with the help of indicators. Having completed this work, we can start assessing the different values of the forests in monetary terms in a systematic way.

Different elements in the value of forests

The total economic value of the forest can be said to consist of both use and of other values. The use values as such can be divided into direct and indirect use and option values. Other values are bequest values and existence values. The figure below illustrates how the total economic value of the forest is divided into different elements.

Figure 2. The different values of the forest



The definitions of the different values of the forest are as follows:

1. The direct use value describes the value of the direct well-being afforded humans through the consumption of environmental products

2. The indirect use value shows the value of the indirect benefits humans enjoy through the natural environment. An indirect use value is, for example, the eco-systems' ability to prevent natural disasters, such as the formation of deserts and floods.

3. The option value measures the natural environment's direct and indirect utility values in the future. The optional value shows how much people are prepared to pay for the natural environment in the future.

4. The bequest value shows the value of the natural environment which is handed down to future generations.

5. The existence value shows the value of natural resources or organisms by their sheer existence. The existence value can be defined on the basis of moral and philosophical views, at which the species' right to exist is being measured. The existence value is intimately associated with opinions relating to the preservation of the biodiversity in the natural environment and an ecologically sustainable development.

The barriers between direct utility value, option value and existence value are in some cases relatively low and easy to overbridge.

Methods in pricing the forest

The direct use values for the forest are based on the fact that the different forest elements are physically scarce and that the use values, therefore, often correspond to the market prices. These give no information on the real price level, but should rather be seen as guidelines. In the Nordic region there are, for example, standing timber prices or market prices for different types of timber which are based on physical scarcity. There are also market prices for the game and wild berries that are being traded.

The values for the forest which are not direct use values are related to the quality of the forest. The values which in particular show the quality of the forest - i.e. its future value - are the option, existence and bequest values, and the market mechanisms cannot define prices indicating these values. In pricing these values, we must consequently use artificial prices. There are different methods for estimating these values.

Forests values can be measured on the basis of the different elements' physical scarcity, in which case the prices will not be affected by popular opinions.

This means that the value of the forest can be investigated on the basis of clearing costs, the cost of eliminating hazardous effects, the non-appearance of profits and the loss of social well-fare. Society can also put a price on the forest through political decision, for example with the help of taxes.

Pricing the forest by investigating the public opinion basically means that we find out how much the consumers are willing to pay. In these cases, we measure how much people are prepared to pay for the product the natural environment offers. As determined in this way, the price set on an environmental product will be closely related with the consumers' income level. With the help of liquidity surveys one can extract different use, option and existence values for the forest.

The consumers' willingness to pay can be defined in both *subjective* and *objective* terms. In the subjective method, we ask how much the consumer is prepared to pay for improving the state of the forest. In the objective method, however, we ask how large a compensation the household should be given for letting the condition of the forest deteriorate. In practise, we have found that the *willingness to approve* as is reflected by objective method is greater than the *willingness to pay,* which the subjective method shows. For this reason, the method which measures the willingness to approve in practice has been almost excluded. In using the subjective Contingent Valuation Method, you investigate with the help of interviews how much those interviewed are prepared to pay for improved state of the forest or how much they should get paid for refraining from doing so. In the indirect methods, such as the *hedonistic price method* and the *travel cost method*, the objective is to find such equivalents to market products or other factors as can be measured in monetary terms. The hedonistic method was originally intended for assessing prices of real-estates and takes all factors which affect the price into account. In the travel cost method, the total costs of the consumers' travel to a recreational area indicate the value of the forest.

Forest prices

Over and above the wood as such, there are many other things of forest life which are of economic interest, such as game, edible fungi and wild berries. As far as these are concerned, this is an issue of supply and demand, which means that a market price will form for these products, but in setting a price on the state of the environment, we you must create the prices for environmental damage using methods based on engineering or natural science or with the help of surveys on the willingness to pay. Table 2.1.12 shows an account of monetary values of forests in Sweden and Finland.

Table 2.1.12. The total income of the forest resources in 1991

	Sweden	Finland
	(SEK billion)	
Timber output		
Gross value of output	21,30	17,98
Input goods	-4,30	-2,57
Increase in timber stock	5,67	3,30
Forestry conservation costs	-2,04	-2,36
Total 1	*20,63*	*16,35*
Output of other goods		
Berries	0,41	0,12
Edible fungi	0,30	0,01
Hunting (meat)	0,75	
Lichen	0,74	0,39
Total 2	*2,20*	*0,52*
Change in environmental assets		
Biodiversity	-1,46	-0,54
Carbon dioxide assimilation	3,06	5,33
Loss of exchangeable cations	-0,98	
Loss of lichen production capability	-0,06	
Total 3	*0,56*	*4,79*
Net value output	**23,39**	**21,66**

FIM 1 = SEK 1.58

Sources:: Environmental accounts 1995 Sweden, Statistics Finland - National Accounts ,Yearbook of Forests Statistics 1993-94, Seppälä & Siekkinen 1993.

The prices as shown in table 2.1.12 are mostly based on estimates. The value of the timber production is based on the national accounts. The other value production is based on statistics on the quantities and prices as has appeared on the market. The values relating to the state of the environment have been estimated using methods based on the science of engineering and natural sciences. The use of the forest for recreational needs and the value representing this is missing in the table. In practice, this value can be found with the help of willingness to pay studies.

The recreational value of the forest

According to the information which the UN body ECE and its agricultural organisation FAO collected in 1985, the forests have a high recreational value in the Nordic countries. In Norway, all forests is regarded as being important from the recreational point of view. Of the forests in Denmark, 68.8 per cent is considered to represent a considerable recreational value and in Finland, the corresponding percentage is 55.9 per cent. In Sweden, 71.3 per cent of the protected areas are considered as being important from a recreational point of view. By recreation in this context is meant walks, trekking, camping, hunting and other comparable recreational activities. Defining, for example, the total value of hunting is difficult in as much the value of the catch represents only a part of the total value of the hunting. According to a study made in Sweden the recreational value of the annual elk-hunting is about the same as the value of the meat. According to a study of the willingness to pay which was made in Finland, the recreational content in the grouse-hunting represents as much as 90 per cent of the value of the hunting.

2.1.8 The use of wood in the Nordic region

The simplified user balances in table 2.1.13 show the structure of the forestry industry in Sweden, Finland and Norway. The user balance starts with the removals, which should correspond to the net removals as shown in the forest balance. In this simplified form, the user balance is shown by products only, and not by economic sector, which is necessary when one wishes to relate the data to the input-output accounts and economic data. The existing tables do, however, demonstrate certain differences in the forestry industry's structure. A significant part of the differences could, however, depend on different ways of setting up the industrial statistics, such as the difference in the relative amount of "waste liqueurs" in Sweden and Finland.

There are two lines along which balances can be developed. One is to include economic sectors in order to develop the link between the input-output tables and macroeconomic models, as has been done in Finland, the other is to disaggregate the classification of goods when material flow analyses are of primary interest. This makes it possible to, for example, analyze the flow of various chemicals in the forestry industry.

The most important data bases for the material balances are found in the industrial statistics. The quality of the physical data is, however, by far inferior than is the quality of the monetary data as shown in all of the Nordic countries. The development towards rationalizing the industrial statistics has meant that higher priority has been given to the monetary information. The use of physical data in environmental accounts might turn this trend.

Table 2.1.13. Use of wood in Sweden, Norway and Finland

Sweden				
	Removals	*Import*	*Export*	*Use and I.*
Saw logs	25909	486	393	26002
Pulp wood	28523	3715	409	31829
Fuel wood	3410	0	8	3402
	Production	*Import*	*Export*	*Use and I.*
Sawn wood	11803	243	6516	5530
Plywood, v.	68	176	16	228
Particle board	762	179	194	747
Fibre board	169	90	62	197
Mechanical pulp	3198	18	448	2768
Chemical pulp	6946	167	2276	4837
Paper and board	8426	315	6479	2262
	Recovery	*Import*	*Export*	*Use and I.*
Residues	12248	1013	286	12975
Waste liquers	2284			2284
Recycling paper	909	275	140	1044

Finland				
	Removals	*Import*	*Export*	*Use and I.*
Saw logs	21160	340	280	21220
Pulp wood	24360	5700	350	29710
Fuel wood	3360	30	0	3390
	Production	*Import*	*Export*	*Use and I.*
Sawn wood	7456	58	4173	3341
Plywood, v.	651	18	539	130
Particle board	542	25	184	383
Fibre board	96	24	46	74
Mechanical pulp	3727	21	56	3692
Chemical pulp	5159	26	1405	3780
Paper and board	8958	179	7698	1439
	Recovery	*Import*	*Export*	*Use and I.*
Residues	13789	280	0	14069
Waste liquers	8650			8650
Recycling paper	397	55	50	402

Norway				
	Removals	*Import*	*Export*	*Use and I.*
Saw logs	5367	362	156	5573
Pulp wood	5364	689	470	5583
Fuel wood	1045	2	0	1047
	Production	*Import*	*Export*	*Use and I.*
Sawn wood	2516	535	673	2378
Plywood, v.				0
Particle board	290	32	94	228
Fibre board	86	11	28	69
Mechanical pulp	1449	5	316	1138
Chemical pulp	728	110	343	495
Paper and board	2098	417	1505	1010
	Recovery	*Import*	*Export*	*Use and I.*
Residues	1000	0	0	1000
Waste liquers	42			42
Recycling paper	181	48	69	160

Sources:

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2.2 Marine Resources

2.2.1 Introduction.

This report presents a model for natural resource accounting for marine resources. The report briefly discusses the statistics available covering marine resources and their relevance for the accounting of natural resources. Tables have been compiled showing the size of some fish stocks which the Nordic countries have some rights to exploit. The utilisation of catches is also discussed, and tables, showing the flow of catches through the Icelandic economy, have been compiled. The report comprises a brief description of how natural resource accounting for marine resources has been used in Iceland in valuation studies and forecasts.

It is important to bear in mind that the information on marine resources is rather uncertain; more so than information on most natural resources on land. In most cases, one has to rely on indirect methods to estimate the size of biological populations; methods which are based on data on catches. In addition, quite little is known about the interaction between the different species.

Another important thing to bear in mind when discussing natural resource accounting of marine resources is that nations have not come very far in defining ownership of the marine resources. It is only in very few cases that markets exist for these resources and there are market prices which can be used to estimate the value of the resources. In most cases, it is necessary to estimate the value of the marine resources by estimating their productivity. In these cases, one must compile a great number of data and make extensive calculations so as to obtain, with explicit methods, the information which one normally assumes implicit in the price.

General remarks on data about the Sea and marine resources.

There are many types of data about the Sea, e.g. data showing temperature, salt content, oxygen concentration and other substances in the Sea, discharges, Sea-currents, production of primitive organisms, the size of commercially important biological populations, etc. The information on how these variables affect one another is, however, most inadequate. In the northernmost marine areas, biologists believe that the temperature of the water is all-important. They are quite convinced that even a minor fall in temperature can have a great impact on the fish populations and their productivity. But so far no one has been able to prove these theories in quantitative terms. In most cases, it has not been possible to use information on the temperature of the Sea-water and other similar factors which form the general framework for the biological reproduction in the Sea to make forecasts about biological populations or give advice about the exploitation of these fish stocks[1]. Until now, it has, therefore, in most cases been impossible to include these variables in models which can be used for physical natural resource accounting of commercially important marine populations or to estimate the value of marine resources. This is the reason why this report focuses on the size of the stocks and ignores the general conditions in the Sea.

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[1][1]I. .e. determine catches, quotas (the maximum catches allowable), etc., to regulate the fishing industry.

2.2.2 Data on biological populations in the Sea.

Most of the information forming the basis for forecasts and advice to authorities consists of facts about the size of the populations. The extent and accuracy of this information varies, however, between different species of fish and between different areas. For a commercially important stock, e.g. cod, the information available is usually very extensive. There are estimates of the number of individuals in each year-class from a given age. This age can vary depending on how fast the cod grows. For the Icelandic cod this age is 3, which is the youngest fish caught. The uncertainty concerning these data is greatest for the youngest year-classes. The reason is that the VP (Virtual Population) analysis utilises the catch statistics, which means that the number of observations increases over time for each year-class. This also means that we, over time, are getting better estimates of the total population at a given point in time. So, e.g., today's estimate of the cod stock in 1985 is far more accurate than the estimate we had in 1986 or the one we had in 1990.

Estimates are also being made on the number of fish in younger year-classes in addition to what the catches actually include. The data on catches are of no use for this, as the youngest cods are not being caught. These estimates are very uncertain, which is the reason why biologists usually define a population as cod in the year-classes which show up in the catch statistics. The recruitment to this population will then be the number (or weight) of the 3-year old fish.

For the catch, there are data showing the number of fish in each year-class caught during a certain period of time. Other important data are the weight of the cod according to age and sexual maturity. On the basis of this information it is possible to estimate the weight of the stock.

Four definitions are commonly used:

Total stock: The total number (or total weight) of fish in year-classes which are fished. For Icelandic cod, this means all fish between 3 and 14 years of age.

Spawning stock: The number (or weight) of all sexually mature cod in the age classes included in the catches. If the recruitment depends on the size of the spawning stock, then the spawning stock is a very important variable.

Fishable stock: The total stock less the youngest fish. For Icelandic cod, this means all cod between the age of 4 and 14.

Fishable stock according to catch ability: The number (or weight) of all fish in the total population where the number (weight) in each year-class is weighted with the index for catch ability, i.e. the relative presence of the age group in the catches. There is a direct relationship between this variable and the cost of fishing. It follows that there is a close relationship between this variable and the value of the resource.

Table 2.2.5 in the table appendix shows time series for the Icelandic cod-stock according to the four definitions stated above. Time series showing the total stock, the spawning stock and the fishable stock for some other species of fish in the Nordic region are also shown in the table appendix. Estimates of the size of most of the commercially important fish-stocks in the Nordic region are readily available.

Compiling tables 2.2.6-2.2.17 proved more difficult. These tables show for some important fish-stocks in the Nordic region, catches from the stock, the weight of the fish having died from "natural causes" (natural mortality rate), the weight of the youngest fish at the beginning of the year and gain in weight for the surviving individuals in the older age groups. The tables show in a bookkeeping form what happens to the total stock during each year. Following identity is valid for each year:

	size of the stock in the beginning of year t
-	catches in year t
-	natural mortality during the year
+	recruitment during year (t+1)[2]
+	migration and increase in weight during year t
=	total population at the beginning of year (t+1)

The last item, "migration and increase in weight", is calculated as a residual term. There are some cases where the data available do not allow for such a detailed classification. In those cases changes in the stocks have to be classified in a more aggregate manner.

The VP analysis is used to estimate the size of most of the other populations of ground fish, such as Haddock and Saith. The number of observations, however, is smaller and the uncertainty thus greater than is the case with cod.

For Redfish, which is important to the fishing industry in some of the Nordic countries, the situation is less favourable as it is difficult/expensive to estimate the age of the fish and there are no reliable estimates on the size of the stock.

Shrimp represent an important population where it is difficult to estimate the size of the stock. At the Marine Research Institute in Iceland they have tried to estimate the size of the Shrimp population on the basis of data on the catch per unit effort.

In the case of capelin there is yet another situation. Capelin has a short life-span. For this reason the VP analysis cannot be used to estimate the size of the stock. Nor is it possible use catch ability to measure the stock. The size of the capelin stock must therefore be estimated through direct observations with the help of special instruments (echo integrators) using acoustics. Table 2.2.10 shows time series for the size of the stock, the recruitment to the stock and catches from the stock for the capelin moving in the Sea north of Iceland and which spawns along the south and west coasts of Iceland. It is impossible to distinguish between young capelin, natural mortality and migration/weight increases so by recruitment here is meant estimates of the size of the population at the beginning of the year.

This population of capelin migrates over large ocean areas. It reaches as far north as Jan Mayen and spends part of its life in the economic zone of Greenland. Biologists believe that every year, one should leave at least 400 thousand tons of 2-year old capelin in the Sea for spawning to safeguard recruitment, but as capelin

[2] Recruitment takes place year (t+1) as the biologists assume that the volume of fish x years of age at the beginning of year (t+1) represents the recruitment year (t+1) at the same time as it is part of the total population at the beginning of year (t+1). In this report, we keep to this method.

will die after spawning it should be possible to fish the stock down to 400 thousand tons.
New investigations have shown that capelin is an important source of food for cod. In this way the size of the cod-stock has an impact on the recruitment of capelin.

Uncertainty of the data.

Estimates of the size of biological populations in the Sea at a given point of time are often rather uncertain. Even for a stock such as Iceland cod which we know relatively well, the standard deviation of the estimate for the total stock is as high as 15%. In those cases where the VP analysis is used to estimate the size of a population, the uncertainty in the estimates of a population's size at a given time will gradually decrease. Estimates of recruitment, a most important variable when one is to determine the potential of the population, are often very uncertain. It is thought that the predictions of the recruitment for the Icelandic cod, based on the size of the spawning stock, have a standard deviation of no less than 38%. For other species of fish the degree of uncertainty is even higher.

As mentioned earlier, the methods which use data on catches give gradually more and more reliable estimates of the size of the stock at a given point of time. It is generally believed that the final estimates when all individuals in the population have been caught or died from natural causes are fairly reliable.

Standardisation of the methods.

International co-operation has been used frequently in marine research. One of the reasons for this is that the same resource is often utilised by several countries. Within international organisations for marine research such as ICES (International Council for the Exploitation of the Sea) and NAFO (North Atlantic Fisheries Organisation) researchers from many countries work side by side in estimating the size and the conditions of different biological populations in their area. It should, though, be noted that the reliability of the data which are used for the estimates (e.g. the catch statistics) is different and that availability of other data, which are often difficult/expensive to collect, can be different. Consequently, the reliability of the data on the size of the populations varies considerably even though the accepted methods are similar.

Natural resource accounting for marine resources in physical terms

That biological resources are renewable makes them differ from other natural resources, such as oil or iron ore. This means that a rational utilisation of the resource must duly consider the natural processes which determine the growth of the biological organisms. A fish population can be overexploited so that it yields smaller catches than what would have been the case had the population been larger. At the same time, the costs of the fishing will be higher when the fish in the Sea is sparse. Natural resource accounting of biological resources in the Sea can therefore not just restrict itself to describing the size of the populations, catches, etc. It must also deal with the potential of the resource, i.e. how large the catches could be if the resources were utilised differently.

When estimating the potential of a biological resource in the Sea, e.g. cod, looking at the total stock or the spawning stock at a given point of time is not enough. For these calculations one needs data on the number of individuals in the different year-classes, their weight, and so on. Equally important are data on the recruitment.

The interaction between different biological populations.

Even if most data about the biological populations in the Sea are based on investigations where one studies the individual population in isolation, biologists acknowledge that there is an extensive interaction between different species. They compete for food and they eat each other. In these cases it is necessary to pay attention to this interaction when compiling tables showing such populations. In table 2.2.9, this has been done for the shrimp population in the most important area in the Sea north-west of Iceland. It has been discovered that the size of young cod in the area has a considerable impact on the shrimp population. This has been identified in the compilation of table 2.2.9. In this table the identity which explains the changes in the size of the stock during a year becomes:

	total stock at the beginning of year t
+	growth in year t
+	recruitment year (t+1)
-	the shrimp which was food for young cod year t
-	the catches in year t
=	total population at the beginning of year (t+1)

Some investigations exist showing such interactions between different biological populations in the Sea. In Iceland and Norway the scientists have models which show how cod feeds on shrimp and capelin which means that the value of the stock of shrimp and capelin depends on the size of the cod population and that its gain in weight depends on the availability of capelin and shrimp. For the biological populations in the North Sea and the ones in the Baltic there are models describing the interaction between many biological populations in these areas. Biologists know that whales and seals consume considerable quantities of fish and other organisms in the Sea. An increase in these populations consequently leads to a decrease in the value of other commercially important populations.

Models describing the interaction between populations (multi-species models) are relatively new. Most of the current regulations of fishing are based on models which do not take this interaction into account.

Migration/Divided populations.

Marine resources are not as closely tied to a given area as resources on land usually are. Capelin e.g., a fish which is caught around Iceland, moves around in fishing zones of Norway, Greenland and Iceland and between them. There exists an agreement between Iceland, Norway and Greenland about how to decide the TAC (total allowable catch) for capelin and how it should be divided between these countries and where the fishing vessels from these countries are allowed to fish for capelin. According to this agreement, Iceland has the right to 78% of the TAC, while Norway and Greenland are allotted 11% each. Table 2.2.10 in the appendix shows the total population of capelin and the total catches. Because of the fact that the three countries have not always been able to catch their quota, their shares of the total catches do not correspond to their share of the TAC.

In such cases where an agreement about the utilisation of the population exists it seems natural to make the physical natural resource accounting in terms of the population as a whole and that the individual countries record in their respective national resource account a share of the total resource in accordance with their rights to exploit the resource. As the different countries' possibilities of catching their share from the stock can be very different, it is necessary to consider the special conditions that prevail for harvesting the population from the individual countries when estimating the value of the resource.

For many other biological populations[3] which move between fishing zones of different countries, there exists no agreement. Sometimes the migration follows a regular pattern, as is the case with capelin, but it can also be very sporadic, like the migration of cod between Greenland and Iceland.
Migration does not change the potential or the value of a population, but it causes difficulties in determining in which country's natural resource accounts a given resource should be recorded. The risk of a sub-optimal utilisation is also higher.

2.2.3 Human intervention

Recently people have started to intervene in the biological processes in the Sea. There exists ocean ranching for salmon and extensive research is carried out in the hope that the uncertainty concerning the recruitment to the most important fish-stocks will be decreased. This kind of intervention can be expected to increase in future and will lead to increased productivity of the biological resources of the Sea.

Aqua culture.

The aqua culture which is carried out in the Sea is mostly of the sort where the spawning is controlled, the fish is fed and it is enclosed in small areas so that the cost of harvesting the fish will be minimal in comparison with traditional fishing where the fish has to be tracked before it can be harvested. In the case of aqua culture there usually exists good estimates of the size and value of the resources. Data on aqua culture are much more reliable than data on other resources in the Sea.

Angling and other ways of enjoying the marine environment.

Angling for fish in the Sea is a relatively new phenomenon. The sport is growing, and is foreseen to grow more in the future. Boat-travels, diving and other ways of enjoying the marine environment are on the increase and are expected to continue to grow in the future.

Waste, pollution, etc.

The waste from industries and households contains certain substances which can have adverse effects on the natural resources in the Sea. There are examples of the PCB or mercury content in fish becoming too high for human consumption. The amount of radioactive emissions into the Sea is worrisome, and there are examples where waste from aqua culture has caused environmental imbalances. In all these cases the size and value of the biological populations are affected.

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[3] E.g. shrimp migrating between Greenland and Iceland, and the herring that used to migrate between Norway and Iceland, the Norwegian spring-spawning herring. See table 2.2.12 in the appendix.

2.2.4 Valuation of marine resources.

In the national accounts the value of an asset is usually estimated from its price on the market. This can be done in such cases where there is a market for the type of asset one wishes to valuate. The prerequisite for a market is that there is a right to ownership which allows the owner to buy and sell the asset. There are only a few occasions where the ownership of the resources in the Sea have been defined and among these cases the ownership frequently gives the owner fewer and less clear rights than does the ownership to resources on land.[4] It is e.g. often so where fishing is regulated with the help of catch quotas, which represents a form of right to use the resource, that these rights may neither be bought nor sold.

In the Nordic region, Iceland is the only country where the individual rights to the utilisation of the Sea have been defined and a market exists for these rights. The right to utilise the resource is, however, rather unclear. The law defining these rights comprise e.g. a section saying that "the Icelandic people collectively owns all resources in the Sea surrounding Iceland". The right to use which the law defines is not restricted in time but it is not protected by the constitution like ownership in general. Certain other limitations on the right to use the resource combined with an ongoing debate about how the right to use marine resources should be taxed are factors which certainly affect the price of this right. The price of the right to use the resource should, however, give a certain indication of the value of the resource.

In the summer 1994, the price of a "permanent" quota[5] of cod was around ISK 210, or DKK 19, per kg. On the basis of this price the estimated value of all quotas for catching cod is around ISK 25 billion (DKK 2.2 billion). A valuation according to the same method of the other important biological populations in the Sea around Iceland gives a total value of these resources of around ISK 60 billion (DKK 5.4 billion).

In such cases where there is no market for the right to use a resource the value of the resource has to be assessed through direct estimates of the resource's contribution to the productive process utilising it. When estimating the monetary value of a biological resource in the Sea it does not suffice to describe the actual economic utilisation of the resource. It requires data and a model that makes it possible to analyse the economic potential of the resource. E.g. to estimate the economic potential of the cod stock it is not enough to study the total stock or the spawning stocks at a given time. For these calculations one needs data on the number of individuals in the different year-classes, their weight, catch ability, recruitment, etc.

According to economic theory the value of a biological resource equals the maximum present value of the rent which the exploitation of the resource can generate. One of the advantages of this definition is that utilising the resource in a sub-optimal way, i.e. wastefully, has a cost. This is especially important as far as fishing is concerned, as there are examples where the national accounts show an increase in the value produced by fishing and the company's own financial statements show a profit, but where there in actual fact are losses and a reduction in the value produced if one takes into account the cost that accompanies over

[4] Such as mines, land for agriculture, or the right to fish in rivers and lakes

[5] I.e. the right to catch a certain percentage of the total quota of Cod each year as long as the present system of regulations is in force.

exploitation of biological resources. This cost of over exploitation of the resources is recorded by the usual methods of accounting as a decrease in the value production and losses during future periods of time.

In a recent investigation an attempt was made to estimate the value of the cod stock in the territorial waters around Iceland[6]. According to this investigation, the value of the cod stock is around ISK 170 billion (DKK 15 billion). According to the same investigation, the value of the combined cod, shrimp and capelin stocks is more or less the same, because the profitability of the shrimp and capelin industries is expected to decrease as the cod population grows.

There is quite a difference between ISK 25 billion (DKK 2.2 billion) which is the market's valuation of the "permanent" rights to utilise the Cod population and the ISK 170 billion (DKK 15 billion) which is the model's estimate. As the correct value of the right to utilise the cod population depends on the potential buyers' expectations about the future yield of an investment in this right, the estimates of the correct value through an explicit model trying to evaluate these expectations will never be exact. There are, however, reasons to believe that the price of the quotas gives too low estimate of the value of the resource and that the explicit model gives a better estimate of the future yield of the utilisation of the cod stock than the market price of the currently existing rights. An indication of this is that the price of leasing the right to catch cod during the present year is ISK 50 (DKK 4.50) per kg, whilst the price of "permanent" quotas is ISK 210 (DKK 19) per kg. If one takes into account that the profitability will be higher and the quotas will be bigger when the cod stock approaches it's optimal size, it is difficult to escape the conclusion that the low price set on a "permanent" quota compared to the one-year lease price indicates that the fishermen believe that a lot of political uncertainty is associated with investments in "permanent" quotas.

2.2.5 Utilisation of the catches

The catch statistics and the statistics showing the use of the catches is often considered unreliable. In Iceland, however, it is considered to be fairly reliable. The table below shows the use of catches of certain fish species landed by Icelandic vessels and caught in the Sea around Iceland[7] during 1993. In the table, all figures on the volume of the catch have been converted to the weight of fish in the Sea. Similar tables can be compiled for the past 20 years.

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[6] See Vinnuhópur um nýtingu fiskistofna: Hagkvæm nýting fiskstofna, Reykjavik, May 1994, and Stefansson, Baldurson, Danielsson, Thorarinsson: Utilisation of the Icelandic cod stock in a multispecies context, ICES.C.M. 1994/T:43

[7] E.g. the ocean areas which are found inside Iceland's fishing zone or in its vicinity

Table 2.2.1 Use of catches from Icelandic waters in 1993.
Ton. Value in ISK

	Frozen	Salted	Dried fish	Fishmeal and -oil	Landed abroad	Exported fresh in container	Frozen at sea	Domestic con-sumption	Other	Total	Value
Cod	125954	73990	504	1	3967	10391	35620	661	82	251170	16489
Haddock	22232	0	1	4	5336	7634	7380	4212	133	46932	3721
Saith	34559	18989	640	1	1510	3973	10295	13	2	69982	2322
Herring	25281	17480	0	72691	92	33	996	23	21	116617	819
Capelin	5685	0	0	929946	4717	0	0	1	99	940448	3683
Shrimp	37983	0	0	36	0	0	14821	0	1041	53881	5617
Other	83504	4924	171	92	21526	30120	78334	1572	29	220272	17067
Total	335198	115383	1316	1002771	37148	52151	147446	6482	1407	1699302	49718

Source: Fisheries Association of Iceland (Fiskifélag Íslands),
Útvegur1993..

Production and goods flows

Whereas table 2.2.1 shows the use of the catches from Icelandic waters for some species of fish, table 2.2.2 shows the production and the use of all catches of these species irrespective of whether they were caught by Icelandic vessels in the Icelandic fishing zone, by Icelandic vessels in other waters, by foreign vessels in Icelandic waters, imported as raw material for processing or imported as finished products. In the table, all figures have been converted into a common unit; here the weight of the fish in the Sea. Table 2.2.2 shows the volume in tons, but the value would also be of interest. Disaggregating the table further could also prove interesting, e.g. disaggregating the import in imports for consumption, import for further processing and import for industrial use. The import of fish and other produce from the Sea is fairly small in Iceland. For some other Nordic countries, particularly Denmark, this import is more important. In some Nordic countries, the import of fish for further processing has increased in the last few years and is expected to continue to grow.

Table 2.2.2 Production and use of some fish species in 1993.
Tons

	Caught by Icelandic vessels from:						
	populations present in Iceland's economic Zone	Other populations	Imported	Fished by foreign vessels in Iceland's economic zone	Total	Icelandic export	Domestic consumption
Cod	251170	10000	12000	669	273839	272509	661
Haddock	46932	0	1600	906	49438	44320	4212
Saith	69982	0	0	1640	71622	69969	13
Herring	116617	0	0	0	116617	116594	23
Capelin	940448	0	5000	161600	1107048	945447	1
Shrimps (several stocks) *)	53881	2100	4414	*)	60395	60394	0
Other	220272	0	0	*)	220272	218700	1572
Total	1699302	12100	23014	*)	1734416	1727934	6482

*) The same stock of shrimp is also caught in both Icelandic and Greenland waters.
Source: Fisheries Association of Iceland (Fiskifélag Íslands), Útvegur 1993.

Import and export statistics for fish and other produce from the Sea.

As a rule, the import and export statistics are fairly reliable. These are based on a classification according to the method of production (frozen, salted, blocks, fillets, etc.), and the most important species have special customs codes. Table 2.2.3 shows time series for the export of some important fish products. The table shows the products' value (f.o.b.) at current prices. It is possible to compile similar tables showing the export volume measured in fixed prices and weight in tons.

Table 2.2.3 Export production of some fish products..
Current prices, ISK thousand

	1988	1989	1990	1991	1992	1993
Fresh fish	6082	9200	11988	10370	8391	7619
Frozen	17428	21983	29127	34652	31845	35551
Round fish	13362	16432	22754	27550	24198	25688
Cod, whole	40	118	119	71	31	18
Cod, fillets in blocks	1530	1872	4435	4824	5562	5162
Cod, fillets	4639	5666	6969	7936	6793	8564
Cod, other	58	45	62	100	136	202
Herring	515	610	761	427	382	800
Shrimps	2497	3262	3745	4390	5246	6635
Frozen at sea	5297	6523	7601	10771	10807	13388
Round fish	3939	5280	6562	8887	8950	11137
Cod, whole	88	48	73	128	179	170
Cod, fillets in blocks	556	874	1102	1424	915	991
Cod, fillets	1325	1382	1831	2494	2430	2829
Cod, other	0	0	0	0	0	0
Shrimps	1347	1237	1031	1867	1847	2250
Salted round fish	9822	9891	12398	14409	11663	10171
Dried fish	741	1468	863	931	845	911
Fishmeal and -oil	4973	4506	4609	2359	6035	8198
Fishmeal	3732	3843	3792	1816	4787	5241
Capelin meal	3339	3240	3486	1126	4393	4721
Fishoil	1241	664	817	544	1248	2957
Capelin oil	1229	610	884	415	1114	2613
Salted herring	1234	1640	694	526	436	661
Whale products	135	0	0	0	0	0
Total production	45946	55645	67682	74334	70210	76752
Export	43819	56812	69896	73284	69866	74582

Source: The Statistical Bureau of Iceland, National Economic Institute, Reykjavík.

A table showing the import looks as follows. This table shows the value (c.i.f.) of certain species of fish expressed in ISK thousand. It is possible to compile tables showing the import volume measured in fixed prices and weight in tons.

Table 2.2.4 Import of some fish products.

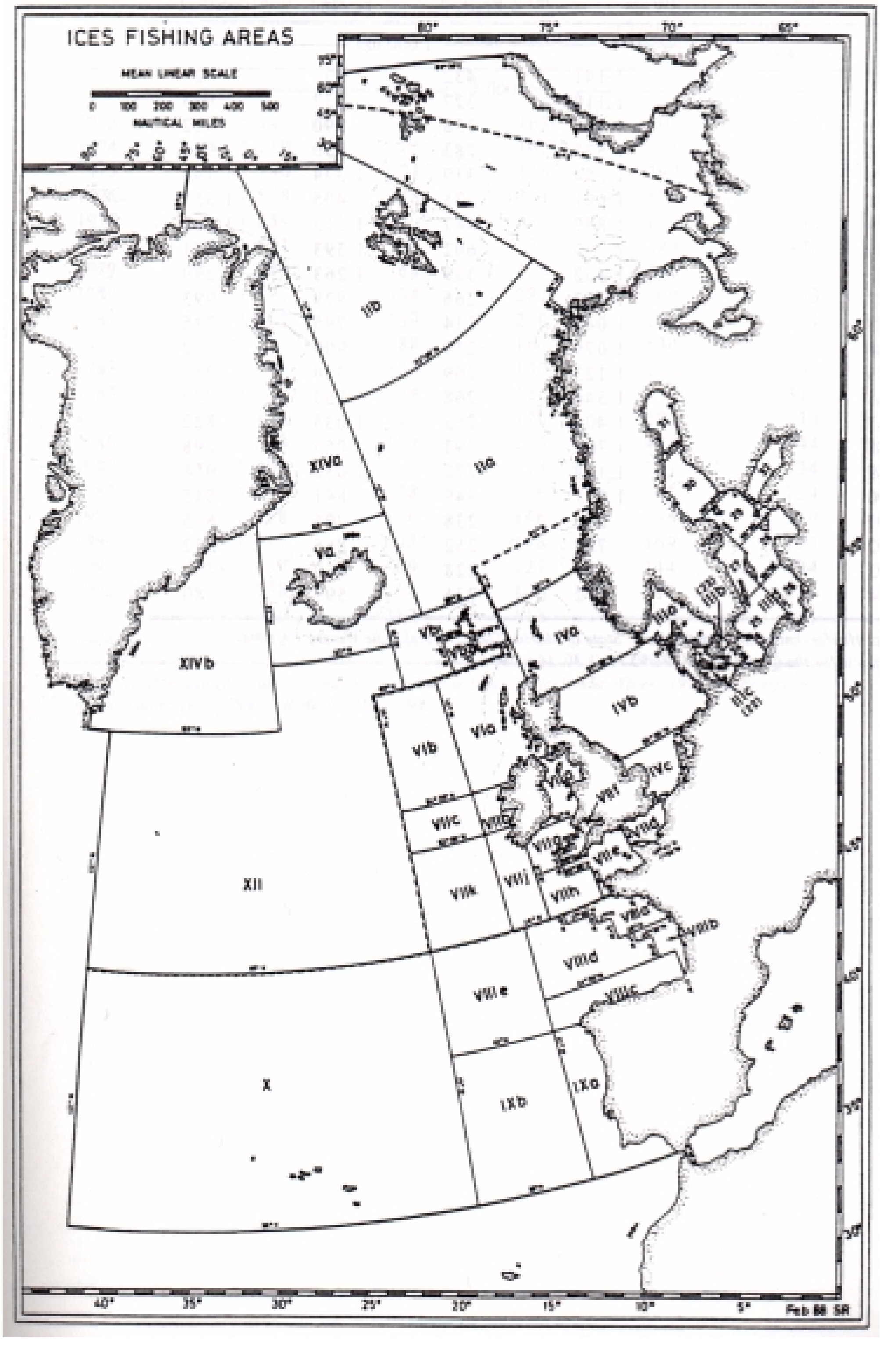
Current prices, thousands of ISK

	1992	1993
Fresh fish	0.5	69.1
Frozen	60.9	68.2
Round fish	13.4	57.1
Cod, whole	0.0	0.0
Cod, fillets in blocks	4.2	42.2
Cod, fillets	0.0	2.0
Cod, other	0.0	0.1
Herring	0.4	0.8
Shrimps	0.0	5.6
Frozen at sea	392.1	902.9
Round fish	130.2	597.5
Cod, whole	116.1	531.1
Cod, fillets in blocks	0.0	0.1
Cod, fillets	0.0	0.5
Cod, other	0.0	0.0
Shrimp	261.8	305.4
Salted roundfish	0.0	28.4
Dried fish	0.0	0.5
Fishmeal and oil	4.3	20.8
Fishmeal	4.2	16.5
Capelin meal	0.0	9.3
Fishoil	0.1	4.3
Capelin oil	0.0	3.9
Salted herring	0.0	0.1
Whale products	0.0	0.0
Total import	697.0	1348.8

Source: The Statistical Bureau of Iceland, National Economic Institute, Reykjavík.

2.2.6 Map of fishing areas

Karta över fiskeområden.



2.2.7 Table appendix

Table 2.2.5 Iceland Cod ,ICES area Va.
Thousand tons.

Year	Total-stock	Spawning stock	Fishable stock	Weighed fishable stock
1973	1141	432	831	920
1974	1110	327	932	933
1975	1180	338	890	922
1976	1528	283	950	956
1977	1554	319	1374	1144
1978	1691	375	1405	1357
1979	1859	447	1513	1502
1980	1793	602	1593	1471
1981	1432	389	1263	1299
1982	1113	266	979	993
1983	1043	214	795	735
1984	1079	219	900	822
1985	1123	269	920	933
1986	1344	268	853	779
1987	1406	253	1035	822
1988	1305	193	1063	898
1989	1128	270	1032	956
1990	1011	349	841	845
1991	850	238	706	645
1992	758	252	565	552
1993	785	228	570	492
1994	672	235	593	480

Source: Marine Research Institute, Iceland State of Marine Stocks in Icelandic Waters 1993/94 - Prospects for the Quota Year 1994/95 R.vík 30. May 1994.

Table 2.2.6 Iceland Cod, ICES area Va.
Thousand tons.

Year	Total stock in the beginning of the year	Catches	Natural mortality	Recruit-ment (3-year old fish)	Migration +increase in weight (=Growth)	Total stock in the end of the year
1973	1141	383	168		210	1109
1974	1110	375	162	309	430	1181
1975	1180	371	176	178	605	1528
1976	1528	348	241	290	36	1553
1977	1554	340	247	578	543	1690
1978	1691	330	273	180	486	1860
1979	1859	368	300	286	256	1793
1980	1793	434	281	346	153	1431
1981	1432	469	210	200	191	1113
1982	1113	388	161	169	345	1043
1983	1043	300	157	134	246	1080
1984	1079	284	166	248	315	1123
1985	1123	325	170	179	514	1345
1986	1344	369	205	203	144	1405
1987	1406	392	214	491	134	1305
1988	1305	378	196	371	154	1128
1989	1128	356	166	243	310	1012
1990	1011	335	148	96	153	850
1991	850	309	121	169	194	758
1992	758	268	109	144	211	785
1993	785	252	118	193	41	672
1994	672			216		

Source: Marine Research Institute Iceland: State of Marine Stocks in Icelandic Waters 1993/94 -
Prospects for the Quota Year 1994/95 R.vík 30. May 1994.

Table 2.2.7 Iceland Saith, ICES area Va
Thousand tons

Year	Total stock at the beginning of the year	Catches	Natural mortality	Recruit-ment (3-year old fish)	Migration +increase in weight (=Growth)	Spawning stock	Total stock at the end of the year
1974	433	98	69	28	90	287	385
1975	385	88	61	29	75	262	346
1976	346	82	54	35	63	227	297
1977	298	62	48	24	62	184	305
1978	305	50	50	55	75	163	342
1979	342	64	55	62	83	160	346
1980	346	58	57	40	65	155	327
1981	327	59	53	31	65	157	314
1982	313	69	50	34	62	168	304
1983	304	58	49	48	73	166	346
1984	346	63	57	76	53	170	335
1985	337	57	56	56	76	152	409
1986	409	65	68	109	54	166	512
1987	513	81	85	182	112	163	533
1988	535	77	89	74	86	158	507
1989	505	82	83	52	109	166	499
1990	499	98	81	50	65	192	424
1991	425	102	67	39	88	203	395
1992	395	80	63	51	90	210	398
1993	397	72	65	56	75	212	387
1994	388			52		205	

Source: Marine Research Institute Iceland: State of Marine Stocks in Icelandic Waters 1993/94 - Prospects for the Quota Year 1994/95 R.vík 30. May 1994.

Table 2.2.8 Icelandic summer-spawning Herring, ICES area Va
Thousands tons

Year	Total stock at the beginning of the year	Catches	Natural mortality	Recruit-ment (2-year old fish)	Migration +increase in weight (=Growth)	Spawning stock	Total stock at the end of the year
1974	121	1	11	11	32	46	163
1975	163	13	15	22	33	117	225
1976	225	17	21	57	34	129	258
1977	258	29	23	37	46	133	266
1978	266	37	23	14	50	176	275
1979	273	45	24	19	45	198	266
1980	267	53	23	17	48	212	292
1981	292	40	26	53	87	186	328
1982	329	57	28	15	59	193	316
1983	316	59	27	13	45	219	298
1984	298	50	26	23	104	232	390
1985	391	49	35	64	120	248	467
1986	467	66	41	40	144	257	526
1987	525	75	46	22	101	360	544
1988	544	93	47	39	72	422	496
1989	496	97	42	20	70	394	513
1990	513	90	43	86	89	357	591
1991	590	78	50	122	150	299	662
1992	662	123	57	50	220	375	805
1993	804	117	71	103	208	571	865
1994	866			41		590	

Source: Marine Research Institute, Iceland: State of Marine Stocks in Icelandic Waters 1993/94 - Prospects for the Quota Year 1994/95 R.vík 30. May 1994.

Table 2.2.9 Shrimp, ICES area Va
Thousand tons

Year	Total stock at the beginning of the year	Growth (net)	Recruit-ment	Food for young Cod	Catch	Total stock at the end of the year
1978	95,6	3,1		11,5	1,4	97,1
1979	97,2	3,2	11,3	12,2	1,1	97,4
1980	97,3	3,2	10,3	11,9	3,1	106,5
1981	106,6	3,5	21	10,3	2,1	111,4
1982	111,4	3,7	13,7	8,1	1,7	114,2
1983	114,1	3,7	8,9	8,4	6,1	121,3
1984	121,4	4	18	8,7	12,2	116,7
1985	116,8	3,8	12,2	8,5	12,2	118,9
1986	118,9	3,9	19	11,2	17,1	118,4
1987	118,4	3,9	23,9	12,6	24,6	105,3
1988	105,3	3,5	20,2	11,5	20,7	95,3
1989	95,2	3,1	18,7	8,5	18,1	95,8
1990	95,8	3,1	24,1	7,2	19,4	109,5
1991	109,6	3,6	37,2	6,2	26,3	119,6
1992	119,5	3,9	38,9	5,1	26,5	122,8
1993	122,8	4	31			

Source: Marine Research Institute, Reykjavik.

Table 2.2.10 Capelin. ICES areas Va,IIa and XIVa.
Thousand tons

Year	Total stock	Recruit-ment	Catch
1978[1)]	2147	2677	1195
1979	1482	1912	980
1980	932	1427	684
1981	743	933	626
1982	307	985	0
1983	985	1843	573
1984	1270	2414	897
1985	1517	3428	1312
1986	2116	2873	1333
1987	1540	2644	1116
1988	1528	2109	1037
1989	1072	1488	808
1990	680	1516	370
1991	1146	2013	677
1992	1336	3093	793
1993	2300	2090	

Source: Marine Research Institute , Reykjavik.

1) Here the year corresponds to the period from 1 st of July in the relevant year up to 30th June the following year

Table 2.2 11 Cod in Barents Sea. ICES-area IIa.
Thousand tons

Year	Total stock at the beginning of the year	Catches	Natural mortality	Recruit-ment (3-year old fish)	Migration + increase in weight (=growth)	Spawning stock	Fishable stock	Total stock at the end of the year
1974	3100	1102	449	345	809	236	2756	2767
1975	2767	829	404	409	604	216	2358	2542
1976	2542	867	371	404	644	234	2139	2176
1977	2176	905	296	228	423	318	1948	1818
1978	1817	699	253	420	409	408	1398	1405
1979	1405	441	211	131	408	232	1275	1253
1980	1254	380	186	92	310	171	1162	1102
1981	1102	399	161	104	307	154	998	952
1982	952	364	136	103	258	378	849	772
1983	772	290	111	62	344	330	711	926
1984	926	278	139	211	281	275	715	1020
1985	1020	308	158	230	466	204	791	1325
1986	1325	430	204	305	408	175	1020	1159
1987	1160	523	169	60	350	152	1100	864
1988	864	435	126	46	616	160	818	967
1989	968	332	149	48	581	178	920	1133
1990	1132	212	189	65	757	375	1067	1662
1991	1662	319	271	174	598	787	1488	1952
1992	1952	508	309	282	964	1047	1670	2345
1993	2344	630	425	246	797	943	2099	2299
1994	2300			213		768	2087	

Source: ICES: Report of the Arctic Fisheries Working Group, Cph, 24.8-2.9 1993

Table 2.2.12 Norwegian spring-spawning Herring, ICES-area IVa
Thousand tons

Year	Total stock at the beginning of the year	Catches	Recriut-ment (3-year old fish)	Migration + increase in weight (=Growth) - Natural mortality	Spawning stock	Total stock at the end of the year
1974	97	8	1	-2	95	92
1975	92	14	5	-3	88	227
1976	227	10	152	34	148	848
1977	848	23	597	275	656	1127
1978	1126	20	27	74	1004	1267
1979	1268	13	87	18	1118	1330
1980	1330	19	57	-171	1209	1213
1981	1213	14	73	-106	1103	1200
1982	1201	17	107	42	1029	1241
1983	1241	23	15	-136	1092	1098
1984	1098	54	16	615	1039	1701
1985	1703	170	42	-1167	1611	1268
1986	1268	225	902	1141	382	2226
1987	2225	127	42	411	750	2568
1988	2568	135	59	305	2200	2746
1989	2746	104	8	228	2630	2945
1990	2945	86	75	-126	2576	3028
1991	3028	85	295	-230	2673	3495
1992	3495	104	782	-133	2397	4204
1993	4203	205	946	12	2360	5749
1994	5750		1739	0	2788	

Source: ICES: Report of the Atlanto-Scandian Herring and Capelin Working Group, CPH, 18-22 Oct. 1993.

Table 2.2.13, Faroe Plateau Cod, ICES area Vb1
Thousand tons

Year	Total stock at the beginning of the year	Catches	Natural mortality	Recruit ment (2-year old fish)	Migration + increase in weight (=Growth)	Spawning stock	Total stock at the end of the year
1984	149	37	23	57	24	115	129
1985	128	39,5	19	16	17	84	97
1986	97	34,6	14	10	16	73	75
1987	75	21,4	12	11	13	61	64
1988	64	23,2	9	9	9	51	54
1989	54	22,1	7	13	5	37	32
1990	32	13,5	4	2	3	26	20
1991	20	8,7	3	2	5	17	17
1992	17	6,5	3	4	6	13	17
1993	17	5,7	3	3	9	13	25
1994	25			8		22	

Source: ICES: Report of the North Western Working Group, Cph, 2.-10.5 1994

Table 2.2.14 Cod in the Baltic. ICES area 22-24
Thousand tons

Year	Total stock at the beginning of the year	Catches	Natural mortality	Recruit-ment (1-year old fish)	Migration +increase in weight (=Growth)	Spawning stock	Total stock at the end of the year
1974	90	47	10	13	46	49	86
1975	86	44	11	7	51	36	88
1976	88	49	10	6	28	48	68
1977	69	45	8	11	49	33	73
1978	74	39	9	8	49	28	79
1979	78	42	10	4	43	40	78
1980	78	38	10	9	47	46	84
1981	84	51	10	7	46	41	76
1982	77	46	10	7	49	39	79
1983	79	47	10	9	48	41	73
1984	73	48	9	3	45	38	65
1985	65	39	8	4	21	40	42
1986	42	25	5	3	32	24	48
1987	47	28	6	4	29	17	43
1988	43	28	5	1	22	24	35
1989	35	18	4	3	11	22	27
1990	27	17	3	3	13	14	24
1991	24	15	3	4	14	11	28
1992	28	15	4	8	23	10	45
1993	44	18	7	13	28	14	58
1994	58	20		11		24	

Source: ICES: Report of the Working Group on Assessment of Demersal Stocks in the Baltic. Cph. 13-21. April, 1994.

Table 2.2.15 Cod in the Baltic, ICES area 25-32
Thousand ton

Year	Total stock at the beginning of the year	Catches	Natural mortality	Recruit-ment (2-year old fish)	Migration +increase in weight (=Growth)	Spawning stock	Total stock at the end of the year
1974	485	148	71	96	236	342	559
1975	559	195	79	57	185	426	527
1976	527	203	72	57	180	424	526
1977	526	165	77	94	252	399	695
1978	695	154	109	159	412	488	959
1979	960	228	147	115	344	727	1011
1980	1010	346	142	82	314	828	969
1981	969	326	137	133	394	780	1032
1982	1032	314	150	132	327	806	983
1983	982	329	144	88	333	783	899
1984	898	395	119	57	285	759	715
1985	716	316	98	46	182	616	534
1986	534	252	68	50	191	451	472
1987	473	217	64	67	212	372	445
1988	445	194	60	41	130	354	344
1989	343	179	42	23	116	284	259
1990	259	154	31	21	89	216	173
1991	174	122	18	10	44	146	94
1992	93	55	11	16	45	72	111
1993	111	40	16	39	84	68	159
1994	159			20		112	

Source: ICES: Report of the Working Group on Assessment of Demersal Stocks in the Baltic. Cph. 13-21. April, 1994.

Table 2.2.16 Cod in the North Sea and the Skagerrak
Thousand tons

Year	Total stock at the beginning of the year	Catches	Natural mortality	Recruit-ment (1-year old fish)	Migration +increase in weight (=Growth)	Spawning stock	Total stock at the end of the year
1974	571	202	142	141	136	213	634
1975	634	185	199	271	172	191	536
1976	536	209	131	114	128	164	729
1977	730	182	263	405	193	144	726
1978	726	263	211	248	215	145	721
1979	721	249	209	254	197	150	910
1980	910	265	309	450	222	164	760
1981	760	301	197	202	158	177	757
1982	757	273	232	337	144	171	571
1983	571	234	152	175	129	138	640
1984	640	205	214	326	135	118	419
1985	419	193	91	63	85	109	561
1986	561	163	202	341	120	98	467
1987	467	175	132	151	93	89	337
1988	336	150	81	84	79	82	357
1989	358	116	117	173	68	76	273
1990	273	105	73	80	61	65	254
1991	253	87	75	98	77	60	405
1992	404			237		64	

Source: ICES: Report of the Working Group on Assessment of Demersal Stocks in the North Sea and Skagerrak. Cph. 7-15. October, 1993.

Table 2.2.17 Herring in the Baltic, ICES area 25-29 and Bay of Riga
Thousand tons

Year	Total stock at the beginning of the year	Catches	Natural mortality	Recruit-ment (1-year old fish)	Migration +increase in weight (=Growth)	Spawning stock	Total stock at the end of the year
1974	3474	310	854	809	259	2142	3258
1975	3258	313	866	689	177	2072	3231
1976	3232	318	923	975	423	1840	3167
1977	3167	314	885	753	420	1916	3215
1978	3216	305	1070	827	433	1859	2886
1979	2885	323	1073	612	448	1728	2817
1980	2818	304	1180	880	382	1494	2892
1981	2892	294	1116	1176	377	1313	2851
1982	2850	311	1119	992	441	1340	2610
1983	2611	302	937	749	338	1349	2489
1984	2488	290	871	779	365	1252	2248
1985	2248	289	739	556	358	1245	1859
1986	1859	268	489	281	291	1168	1844
1987	1843	252	467	451	383	1079	1770
1988	1771	286	420	263	262	1147	1863
1989	1862	290	421	536	237	1019	2061
1990	2062	244	429	673	193	1057	2041
1991	2041	213	397	459	222	1196	1968
1992	1968	210	343	315	29	1327	1753
1993	1753	228	359	309	776	1310	2427
1994	2428	260		485		1592	

Source: ICES: Report of the Working Group on Assessment of Pelagic Stocks in the Baltic. Cph. 13-21. April, 1994.

3. Accounts for nutrients, nitrogen and phosphorus

3.1 Background

By nutrients means elements which are essential for biological production. Of the nutrients it is usually nitrogen or phosphorus which are limiting factors to biological production. Nitrogen and phosphorus are therefore spread on agricultural land to increase the crop production. Emissions of nitrogen and phosphorus compounds can, however, result in serious environmental problems of both global and local character. The nitrogen oxides (NO_X) produced through combustion contribute to acidification and cause damage to fish and the forest. Nitrogen in the form of dinitrogen oxide (N_2O) is an important contributing factor to the greenhouse effect and the degradation of the ozone layer. In lakes and coastal areas the extensive discharges of nitrogen and phosphorus through human activity has led to a strong algae production and eutrophication. The surplus of nitrogen which is spread on agricultural land can also sink into to the groundwater and a high nitrate content in groundwater makes the drinking water hazardous to health.
Through international agreements, the Nordic countries have made commitments to reduce the emission of nutrients to air and water. Under the ECE convention dealing with transboundary pollution, one of the undertakings the countries have made is to, by 1994, stabilize the emission of NO_X at the 1987 level. Together with 7 other countries, the Nordic countries have further signed a declaration of intentions to reduce the emission of NO_X by 30 per cent by 1998, using 1986 as the reference year. The North Sea declarations aim at solving the pollution problems in the North Sea. These are focusing specially on improving the environmental conditions in the coastal areas. According to the declarations, each country will, in relation to 1985 reduce their respective discharges of nitrogen and phosphorus to affected areas by 50 per cent no later than 1995. The countries surrounding the Baltic have through the Helsinki Commission's (HELCOM) resolution set as an objective to, in relation to 1987, reduce the nitrogen and phosphorus discharges to the Baltic by 50% by 1995. In addition, the countries have national objectives in respect of reducing the emission of nitrogen and phosphorus.

An account of the flows of nitrogen and phosphorus linked with economic sectors and transactions in accordance with the national accounting is a useful instrument in working out activities aimed at reducing the emissions. The application and use of environmental and resource accounting have been described in more detail in the report from the pilot study (*Nordic Council of Ministers 1993*).
In 1992, ECE appointed a task force whose aim is to present a proposal on how the ECE should proceed with its environmental accounting over the next few years. The work is carried out in two groups, where one is to develop accounts for nutrients (nitrogen and phosphorus). Three of the Nordic countries, Finland, Norway and Sweden, are represented in this pilot group together with Italy and the Netherlands. The work on nutrients accounting in the Nordic project and, respectively, in the ECE has been carried on in parallel. The Netherlands are widely experienced in developing material accounting. The co-operation within the ECE has therefore also been valuable to the Nordic work.

3.2 Objectives of the Nordic project

The objective of the Nordic project has been:

1) To work out a model for nutrients accounting with uniform concepts and definitions.
2) To compile all data available in the Nordic region concerning of the flows of nitrogen and phosphorus in the environment and the economy into an account.
3) To work out a common Nordic contribution to the work in the ECE.
4) To detect shortcomings in respect of the statistics available and form a basis to decide work priority for future development tasks.

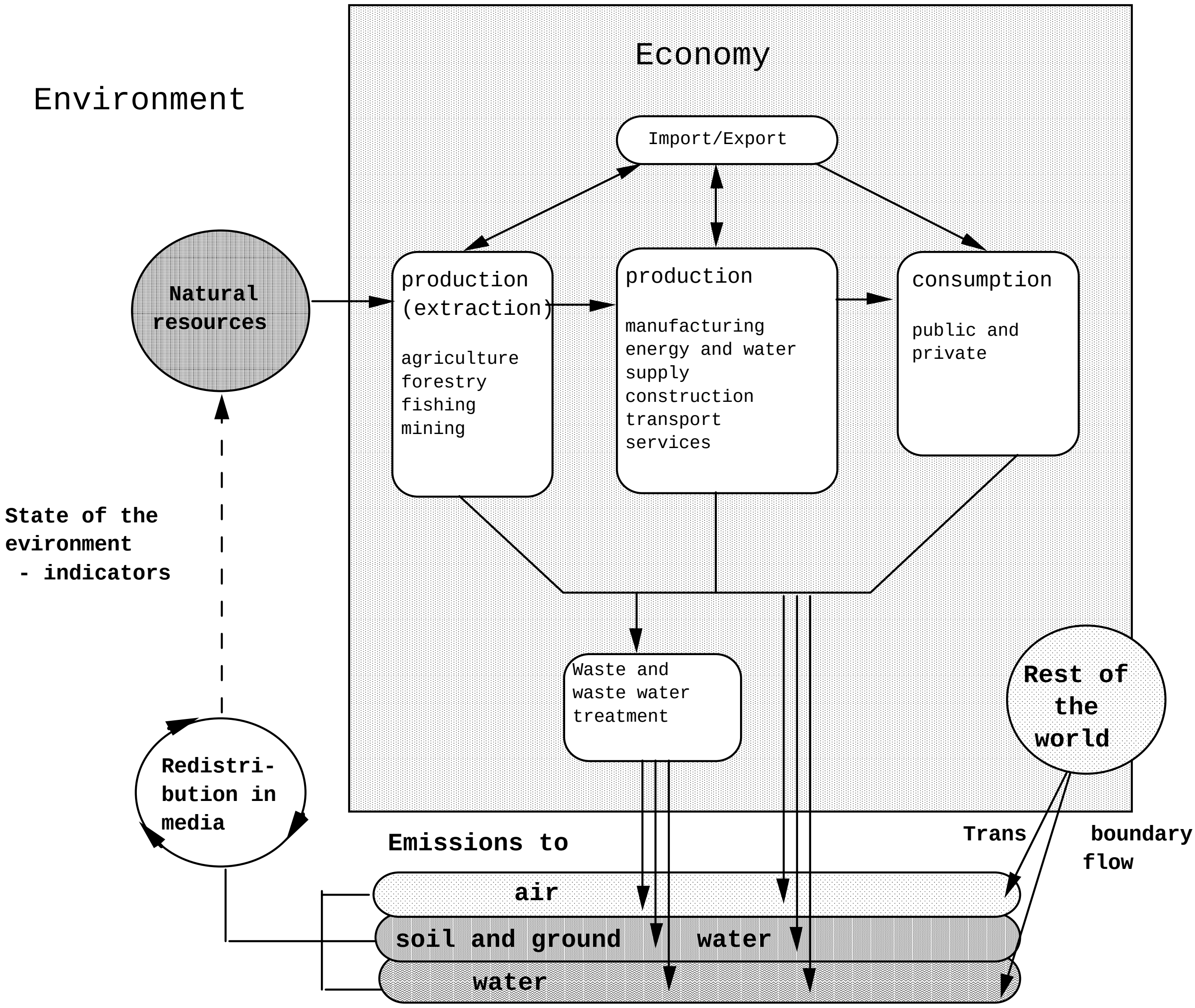
The work of the group was to be based on the existing statistics.

3.3 Model

Natural resource and environmental accounting in its widest extent describe the flow of resources and materials from the extraction from the nature through the economy and back to the environment (figure 4.1):

1)	Extraction of nitrogen and phosphorus	Environment ---> Economy
2)	Imports/exports of goods containing nitrogen and phosphorus	Economy
3)	Use of goods containing nitrogen and phosphorus	Economy
4)	Production of goods containing nitrogen and phosphorus	Economy
5)	Nitrogen and phosphorus in emissions and waste	Economy ---> Environment
6)	Transboundary flows of nitrogen and phosphorus	Environment
7)	Transport of nitrogen and phosphorus between recipients	Environment
8)	Environmental indicators	

Figure 3.1
Model for nitrogen and phosphorus flow

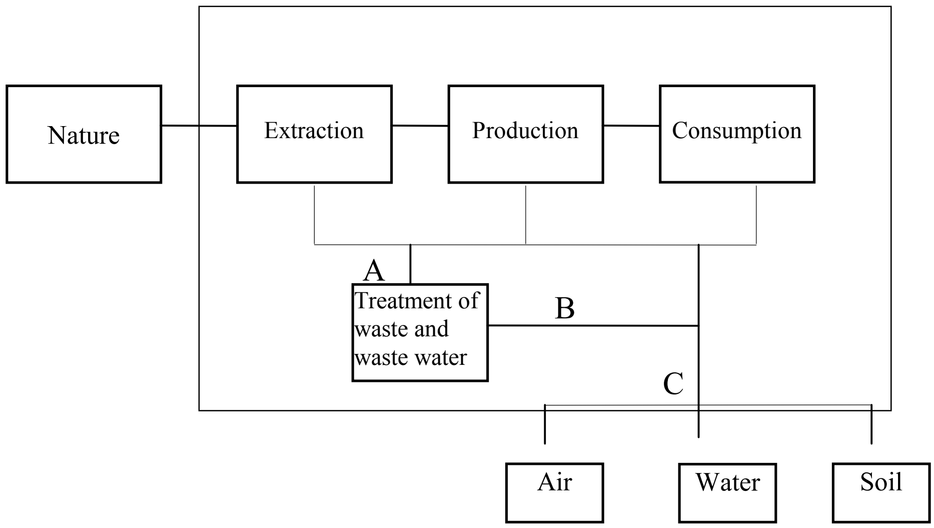


Source: Statistics Sweden

The objective of this accounting, *is not to give* a *complete picture* of what happens with the nitrogen and phosphorus in the environment and in the economy. The accounts should in the first place describe linkages between nature and economy, further the changes in the state of the environment due to the use of resources and substances.

Integrated environmental and economic planning is the main objective in working out the resource accounting. Step 5), which describes the flow from the economy to the environment (figure 3.2).The resource accounting framework has to be based on existing economic standards and sector classification schemes (NACE), thus making it possible to link physical accounts to economic planning in models.

Figure 4.2 Model for the flows of nitrogen and phosphorus from the economy to the environment.



Source: Statistics Norway

3.4 Associated work

3.4.1 Nordic work

Environmental indicators could supplement the accounting system, but the development of environmental indicators is not included in the work presented in this report. A special project group, the Nordic Indicator Group, has been formed for the purpose, and this group will choose and define a number of environmental indicators. This "set of key data" could be used to show the links between the economy and the environmental impacts. The indicators will be presented in an annual report.

The hearing draft from the work of the indicator group shows nitrogen and phosphorus flows as pressure indicators for:

Acidification: Depositing of acidifying substances, including NO_2 and NH_3

Eutrophication: Net inflows of nitrogen and phosphorus through fertilizers and manure from domestic animals. (Nordic Indicator Group 1994.)

3.4.2 Available sources of statistics

Table 4.1 Nitrogen (N) and phosphorus (P) accounting. Available sources of statistics in the Nordic countries.

Statistical area	Denmark	Finland	Norway	Sweden	Iceland
Accounting of N	x, D		D	D	
Accounting of P	D		D	D	
Emission statistics					
Emissions to the air:					
- NO_x	x	x	x	x	x
- N_2O	x	x	x	S,D	x
- NH_3	x	x	x	D	
Discharges to the water:					
- from municipal sewage systems	x	x	x	x	x
- leakage from sewage systems					
- overflowing	x			x	
- households non-connected to sewage syst..	x	x		x	
- industries non-connected to sewage syst.	x	x	x	x	
Agricultural statistics					
- fertilizer consumption	x	x	x	x	x
Aquacultural statistics		x	x	S	x x
International statistics					
Transboundary flows of N (EMEP)	x	x	x	x	x
Discharges to the North Sea (OSPARCOM)	x		x	x	x
Discharges to the Baltic (HELCOM)	x	x		x	
Economic statistics	x	x	x	x	x
Exports/imports statistics	x	x	x	x	x
Industrial statistics	x	x	x	x	x

x: Running statistics
D: Statistics under development
S: Sporadic estimations

Emission statistics

National statistics covering emissions of NO_x, N_2O and NH_3 to the air are compiled in both Denmark, Finland, Norway and Sweden. Iceland keeps statistics for emission of NOX and N2O. There are also statistics on discharges of waste water, while the agricultural statistics and the statistics covering the sale or use of fertilizers give the basis for estimating the emission from the agricultural sector. The statistics and information available do not, however, present a complete picture of the emission of nitrogen and phosphorus from the economy to the environment.

This is particularly true as regards emissions in connection with transporting and handling of waste and waste water.

International statistics

There are international statistics showing transboundary flows of air pollution in Europe and discharges of nutrients to the North Sea and the Baltic (EMEP 1993, North Sea Task Force 1993). "The meteorological Synthesizing Centre - West of EMEP" is on an annual basis estimating airborne acidifying compounds and deposition of air pollution in Europe. Annual estimates have been made ever since 1985 and up to date, 1986 excepted. The Oslo and Paris Commission (OSPARCOM) has established a common supervisory programme for emissions of nutrients and micro-pollution to the north-eastern part of the Atlantic. The programme was started in 1990 and aims at making all countries report their data on an annual basis. The Helsinki Commission has for 1987 and 1992 collected data concerning, amongst other things, the discharge of nutrients from the countries bordering the Baltic.

Economic statistics

The industrial statistics and exports/imports statistics which describe the flow of goods in the economy in economic units also comprise data such as weight and volume. With the help of coefficients for the nitrogen and phosphorus content in different groups of goods one can estimate the nitrogen and phosphorus flows in the economy. With the exception of Denmark, the physical part of the industrial statistics of the Nordic countries has weakened in the past few years; one of the reasons being that it has not been seen as important to revise the physical data. In Finland, only the largest companies which are required to report physical data. The industrial statistics are therefore not an adequate source, and it is necessary to carry out new investigations and contact producers to form a more complete data base. The quality of the physical data in the exports/imports statistics remains good and these statistics therefore form a good source in developing physical accounting. The liberal trading policy of the EU between the member states will, however, affect this statistics. Therefore the future of the statistics showing the exports and imports between countries in the EU is uncertain.

Data on transport between media

The transport of nitrogen and phosphorus in the environment is affected by both natural processes and human activities. The natural processes and the way human activities affect them depend on variables such as climate and soil, and can show considerable variation from place to place and from year to year. For the Nordic region, where there are great differences in terms of geography, temperature and weather, it is particularly difficult to measure or estimate this transport. Research projects aimed at increasing the knowledge of the transport of nitrogen and phosphorus between media are being carried out.

Statistics under development

Until now, Denmark has been the only country to work out a comprehensive nitrogen flow accounting. Now, there are projects in progress in both Denmark, Sweden and Norway aimed at providing more detailed knowledge of the nitrogen and phosphorus flows.

In Norway, there is a project with the purpose of quantifying the nitrogen and phosphorus flows connected to human activity. The project title is "Human N and P cycle". In this work, Norway's agricultural university, which is responsible for the project, co-operates in part with Statistics Norway.

In Sweden, Statistics Sweden is committed to develop physical environmental accounts, which includes nutrients. In co-operation with the National Environment Protection Board work are going on in improving the statistics of the emissions of NH_3 and N_2O. Statistics Sweden is furthermore engaged in developing statistics for balances for nutrients for the agricultural sector.

3.5 Results

Step 5 (section 3.3) has been mentioned as important to the implementation of an integrated planning for natural resources and economic plans. In this project, we have therefore considered it important to compile data for step 5.

A prerequisite for the project was that the group's work should be based on existing statistics and information. Due to the inadequate and uncertain basic data, it has not been possible to work out a complete and coherent account covering nitrogen and phosphorus as the model in section 3.3 illustrated. The uncertainty and lack of data is above all related to the flow of nitrogen and phosphorus *in* the economy, and *in* the environment and we have neither the statistical basis nor the scientific knowledge required.

The work in the ECE project dealing with nutrients concentrates on the same steps as the Nordic work.

7 core and *one supplementary table* have been set up. Tables 1 and 2 correspond to step 5 in section 3.3. The supplementary table a. is a special account for agricultural land, which is more complicated as far as emissions of nitrogen and phosphorus are concerned. This table supplements and adds to the information given in tables 1 and 2. Waste water and waste treatment (O 90) are other sectors for which we are preparing more detailed accounting, but at the moment more detailed information than what is given in tables 1 and 2 is not available for these sectors. No more than a sketchy proposal of more detailed tables for the treatment of waste and waste water has therefore been given.

Core tables:

1 Emissions of nitrogen by economic sector and primary recipient
2 Emissions of phosphorus by economic sector and primary recipient
3 Transboundary flows of , oxidized nitrogen, country to country 1991
4 Transboundary flows of, reduced nitrogen, country to country 1991
5 Transboundary flows of, oxidized nitrogen, 1985-1992
6 Transboundary flows of, reduced nitrogen, 1985-1992
7 Discharges to the North Sea and the Baltic from the Nordic countries. Nitrogen and phosphorus

Supplementary table:

a. Nitrogen and phosphorus balance for agricultural land (infields)

Rough outline of supplementary tables:

b. Inflow of nitrogen and phosphorus to municipal waste water treatment plant and waste treatment

c. Nitrogen and phosphorus balances for municipal waste water treatment plants and waste treatment

Tables 1 and 2 are based on the standard for industrial classification (NACE). Where possible, the sectioning has been made on the first level. For important sectors and where the basic data are adequate, the sectioning is more detailed.

The tables are shown in table appendix.

3.5.1 Emissions/discharges of nitrogen and phosphorus

Tables 1 and 2 show *antropogenic* emissions/discharges of nitrogen and phosphorus (N and P) to air, water, soil and groundwater illustrated by the arrows B and C in figure 3.2. The emissions/discharges are specified under the *industrial sector* emitting the substance in the environment and by the *medium* (primary recipient) receiving the substance.

Emissions to air

There are three main sources of emissions to air: stationary combustion, mobile combustion and process emissions/evaporation. The emissions of NO_X originate from both stationary combustion, mobile combustion and evaporation, whereas the emissions of N_2O and NH_3 mainly originate from processes/evaporation. The combustion in cars with catalytic systems, however, is a source of emission of NH_3, which will probably contribute more to the total emissions in the years to come.

The emission inventories have been calculated on the basis of surveys of energy consumption. Consumption of the different forms of energy is distributed between the different assumed purposes within each economic sector. The consumption is multiplied by emission coefficients connected to source of combustion, form of energy and type of industry. Emissions from evaporation of NH_3 and process emissions are estimated on the basis of information on different activities. Emissions from road traffic are estimated on the basis of fuel consumption, number of motor vehicles in different age classes, technological and weight categories, average distance driven and assumed pattern of driving.

Emissions of NH_3 from the agricultural sector represent the loss of NH_3 from fertilizers, before, during and after up to 2 days after spreading.

Emissions of phosphorus to the air is not considered to be a pollution problem and no national statistics are compiled for this type of emission of phosphorus. It is assumed that only very small quantities are involved. Emissions of phosphorus to the air may, however, result in local air pollution problems.

Discharges to water

Discharges to water include the purified waste water from municipal and private waste water treatment plants, plus direct discharge and leakage. The statistics are based on measurements reported by the municipalities and industry. The estimation of overflowing and discharges from private households which are not connected to the sewage system is based on the knowledge of local and national conditions. Discharges to water from aquacultural plants and from the agricultural sector are discussed in more detail later in two separate sections.

Discharge to soil/groundwater

Discharges to the soil and groundwater include emissions and leakage where the soil/groundwater is the first medium (primary recipient) receiving the pollution. The agricultural sector and leakage from dumps and sewage systems are the most important sources. Emissions to the soil and groundwater from the agricultural sector and treatment of waste and waste water are discussed below in each respective section.

The agricultural sector (A01)

Discharge to soil and groundwater from the agricultural sector are estimated in the balance for nutrients for agricultural land (arable land and permanent meadows and pastures). For agricultural land, the inflows and outflows of nitrogen and phosphorus is caused by both antropogenic and natural processes. Step 5 in the model used focus on the antropogenic outflows and such inflows and outflows as attributable to natural processes are kept out tables 1 and 2. It should be noted that the borderline between "antropogenic" and "natural" discharges can be indistinct. For example, discharges of nitrogen and phosphorus in connection with natural erosion processes might be intensified by fertilizing and other agricultural activities.

Nutrients are also transferred through animals grazing in the woodlands and in the mountains, especially in Finland and Norway. But in comparison with agricultural land the metabolism on outlying land is insignificant and the estimations would be far more complicated if they were to include outlying land. Outlaying land has therefore been ignored.

Surplus of N and P (primary discharge):

Inflows:	= N and P in manure from domestic animals, fertilizers, sludge added to agricultural land, seed for sowing
- Outflows:	= N and P removed from the crops (including straw being removed)

Inflows of manure (M):

M	= A - (B + C + D + E)
A	= Amount of animal manure produced
B	= Change in stocks
C	= Evaporation of NH_3
D	= Animal manure spread on outlaying land and other than agricultural land
E	= Animal manure used for other purposes

A. The amount of manure produced by domestic animals have been estmated by multiplying the number of each type of domestic animal with N and P coefficients for the different types of domestic animals. The coefficients duly consider the time during which the domestic animals are grazing on outlaying land. The N and P content in manure produced during the grazing period is therefore not included in A.

B. The change in stocks has been disregarded. Over time, this will be next to 0.

C. Evaporation of NH_3 from cow-houses, during storing and during up to 2 days after spreading. These NH_3 losses have, together with the loss of NH_3 through animals grazing on outlaying land, been shown as emissions to air.

D. The share of the manure being used in the forests varies considerably from country to country.

E. Manure from domestic animals used for other purposes comprises manure used in, parks, gardens etc. This amount is difficult to quantify and is hardly of mentionable proportions.

In *table a*, the inflows and outflows from agricultural land have been specified. The balance include the flows mentioned under 'Surplus of N and P' in addition to estimates of inflows and outflows which are explained by "natural processes". Outlaying land has not been included.

Inflows

- Manure from domestic animals (manure produced - loss of NH_3)[1]
- Fertilizers[1]
- Sewage sludge spread over agricultural land[1]
- Seed for sowing[1]
- Biological N fixation
- Depositing (dry and wet)

Outflows:

- Crops (including straw being removed)[1]
- Loss of NH_3 from crops during growth
- Denitrification
- Leaching
- Accumulation in soil

[1]Flows included in 'Surplus of N and P' in tables 1 and 2.

Discharge to water from the agricultural sector should comprise discharges from specific sources (sewage systems, silos). The nitrogen and phosphorus content in the run off from agricultural land has been included in the surplus of N and P from agricultural land.

In the ECE project on nutrients, the net inflows of nutrients in the agricultural sector is estmated in the same way as in this Nordic project. The Paris commission's (PARCOM) task force for reducing the discharge of nutrients in the North Sea has used a different model in its guidelines for estimating the balance. Their basis is the agricultural sector as a whole. The inflow, has been estimated as the fodder and fertilizers which have been bought from other economic sectors or from abroad, whilst the outflows has been calculated according to the animal and crop products which have been sold to other economic sectors or internationally (Paris convention for the prevention of the marine pollution 1993). The fact that some countries will estimate the emissions from the agricultural sector based on the PARCOM guidelines, speaks for this method being applied also to this Nordic work. However, PARCOM's method uses the exports/imports statistics, which are prepared on a national level, as input data. The method is thus not suitable when making estimations on regional levels. The method chosen for this Nordic project is, however, suited also for these type of estimations.

Aquacultural plants (B05.02)

The discharges to water from aquacultural plants are calculated on the fodder balance. The discharges mainly consist of fodder spillage and faeces.

Surplus of N and P (fodder balance):
Inflows = N and P in fodder
Outflows = N and P in the harvested fish, gross

Industry (D)

In the joint presentation of the statistics, the distribution of emissions/discharges from different economic sectors can be presented differently for different countries according to the industrial structure. The objective is that 90% of the total emissions should be specified according to the two-digit level of the NACE classification.

Treatment of waste and waste water (O90)

Controlled waste dumps have in this project been defined as a part of the economic system. When waste is left in dumps, their content of materials or gasses can be utilized at a later stage. It is therefore only *leakage and evaporation*, from the dumps to the environment which are treated as discharges/emissions (arrow B in figure 1). The waste being dumped is not treated as emissions to the environment.

The emissions from incineration have been included in sector E, emissions to air.

The discharges of waste water from households and industries being connected to municipal sewage system has been dealt with under treatment of waste water (O90). It is not possible to separate between discharges from households and from industries. Emissions from households and industries which are not connected to municipal sewage systems have been referred to households and, respectively, the industrial sectors.

The N and P content in sludge which is spread over agricultural land is included in the agricultural balance. Sludge which is *not* used for agricultural purposes has been accounted for under "treatment of waste water".

Table b will deal with the nitrogen and phosphorus in waste and waste water which are being delivered to and treated in municipal plants (sector O90), specified after industrial origin. Waste delivered to incineration should also be included. The flows are shown by arrow A in figure 3.2.

Table c is a balance that aims at showing the inflows, leakage and accumulation of nitrogen and phosphorus in municipal waste and waste water treatment plants (sector O90). The flows are demonstrated by arrows A and B in figure 4.2. It should be noted that a part of the nitrogen in emissions of NO_X from incineration, comes from the air and not the actual waste. The amount of air-fixed nitrogen varies from plant to plant depending on the composition of the waste and the incineration process. When the emissions from these plants are purified and the NO_X content in the emissions has been reduced, this problem will be of far less interest.

3.5.2 Transboundary air pollution

The calculations of "The Meteorological Synthesizing Centre - West of EMEP (EMEP 1993) are made on the basis of emission data for substances such as NO_x ($NO_x = NO + NO_2$) and NH_3 and of meteorological data. Both wet and dry deposition is included. The emission data include data from emissions caused by both human activity and natural conditions and are mainly official data from the countries participating in EMEP. For countries where information for a certain year is missing, the figures have been calculated on the basis of information given for other years. Only three countries (Albania, Romania and Turkey) have never reported emission data referring to NO_x. The calculations covering NO_x are therefore considered to be of good quality. For NH_3, however, fewer countries have reported emission data and the calculations are consequently more uncertain. Only very few countries have delivered NH_3 data for grids. All Nordic countries have reported official emission data for NO_x and NH_3 for one or more years. The meteorological data have been taken from the weather forecast model used by the Norwegian meteorological institute and include detailed information of wind and weather conditions.

3.5.3 Discharges to the North Sea and the Baltic

The table contains data from the Oslo and Paris commission's (OSPARCOM) and the Helsinki commission's supervision programmes for discharges of nutrients. OSPARCOM's objective is that the annual data reports should be based on measuring of 90 per cent of the discharges in the North Sea. The Skagerrak and the Kattegat are parts of both the North Sea and the Baltic areas. It should be noted that for Denmark, the discharges to the Skagerrak and the Kattegat have been shown both under discharges to the North Sea and discharges to the Baltic.

The discharge data to the North Sea and the Baltic includes outflowing rivers and direct discharges. The river contributions are polluting substances which are transported to the sea with the main river and tributaries plus the run off from down-stream areas. Direct inflows comprises direct discharges to the sea from municipal waste water plants and waste water from the industry. The pollution which is transported to the sea with the rivers include both antropogenic and "natural" sources. Part of the pollution originates from atmospheric deposition and the share of this deposition is particularly high for the rivers which run through sparsely populated areas such as the northernmost parts of the Nordic region (North Sea Task Force 1993, SCB 1993, SCB 1994).

The atmospheric deposition is also calculated in the monitoring programme for the North Sea, although the figures of the atmospheric deposition in table 7 have been taken from the EMEP programme. The emissions to the North Sea and the Baltic include emissions from the shipping trade. As the estimations are based on the traffic between groups of countries, the emissions from traffic between countries inside the groups are not included. The figures are therefore minimum values (EMEP 1993).

3.6 Comments to the tables

The completed tables show considerable differences in the national emissions from the Nordic countries (table appendix). The differences appear too great to be explained by just regional conditions and different industrial structures. Other important reasons could be differences in estimation methods, the fact that the countries due to differences in available statistics have included different emissions in the tables. It should therefore be observed that certain values have a low comparability.

The differences appear to be particularly great when it comes to agriculture. A simple comparison has been made by calculating the surplus of N and P by hectare (table 3.2). The differences can to a part be explained by variations in regional conditions and different methods in agricultural farming but we assume that they also depend on the application of different estimation methods and different definitions. Agricultural land, for example, as described in section 3.5.1, has not been defined in detail. Furthermore, the choice of coefficients is of decisive importance. It is also important to consider the fact that the crops, and therewith the surplus of nutrients and emissions, can vary a lot from year to year on account of the weather conditions.

Table 3.2 Discharges from the agricultural sector by area 1992. Countries in the Nordic region.

	Denmark	Finland	Iceland	Norway	Sweden
Agricultural area1) (1000 hectare)	2756	2633	140	983[1)]	2790[2)]
Surplus of nutrients					
Kg N/hectare	134,9	35,1	27,9	80,2	19,1
Kg P/hectare	6,9	10,6	1,1	12,0	3,5

1) In Norway, the surplus of nutrients is estimated for all utilized arable land in.
2) In Sweden, the surplus of nutrients is based on all arable land (excl permanent meadows and pastures)

Here follows a written summary of the tables in the table appendix.

Most of the emissions of NOx comes from the transportation sector and from cardriving in the households. Many of the other economic sectors include lines of business where they hire subcontractors for their transportation needs. In these cases, the emissions are accounted for under the transport sector. Other important sources of emission of NO_X are from industries and from the suppliers of electricity-, gas- and water-sector. In Norway, the last mentioned source is negligible, while the extraction of oil and gas are important sources.

Agriculture is the most important contributor to emissions of NH_3, and is furthermore an important source as far as the discharge of nitrogen and phosphorus to the water and soil/groundwater is concerned. The balance for nutrients does not show how much of the surplus of nutrients that ending up in water and groundwater. Some of the surplus will accumulate in the soil and be available for growing crops in later years. This is especially true in respect of phosphorus, which bonds itself thoroughly in soil. The proportion that will accumulate depends on factors such as type of soil, climate, the way of working the land, etc., and is difficult to determine in figures. The agricultural sector also contributes to emissions of NO_x and N_2O.

Discharge to the water (primary recipient) mainly originate from aquacultural plants, the pulp and paper industry and municipal waste water treatment plants. It must be emphasized that the figures showing treatment of waste water are minimum values. Due to lack of data, several of the discharges resulting from the treatment of waste water are not included in the tables in the appendix.

The deposition of nitrogen due to countries' domestic emissions was in 1991 considerable in all of the Nordic countries. However, around 70 per cent of the deposition of NO_x in the Nordic region refers to emissions from European countries other than the Nordic ones. In respect of NH_3, the corresponding figure was 50 per cent. In Denmark, around 75 per cent of the deposition of NH3 was generated domestically. The contribution from the other Nordic countries is minimal in comparison with the total nitrogen deposit in one individual Nordic country.

The agricultural sector is the main source of emission of NH_3, whilst a great part of the NO_x emissions comes from mobile sources. In Norway, the emissions from inland ferries, boat services and offshore operations are relatively significant.

3.7 Conclusion

In this project, we have compiled data showing the emission/discharges of nitrogen and phosphorus from the economy to the environment, transboundary air pollution, discharges to the nearby marine areas and balances for nutrients for agricultural land. The flows from the economy to the environment play a central role in linking natural resources accounting and national accounting. We have thus paid much attention to tables 1 and 2 which describe these flows. The main sources used have been environmental statistics, such as statistics showing emissions/discharges to air and water, and agricultural statistics.

The steps in the model shown in section 3.3, which cover flows of nitrogen and phosphorus *in the economy* and *in the environment* remain blank and data on emissions are also missing for some sectors. This is partly because of lack of statistics reports and, partly, the fact that our scientific knowledge about environmental interaction does not suffice.

The industrial statistics and imports/exports statistics have been seen as an important basis for the quantifying of the flows of nutrients through the economy. However, in collecting these statistics, the main purpose of which is to provide economic information and the physical data are attributed less and less importance. This is particularly the case with the industrial statistics. Because of missing data and errors in the physical data (weight/volume), the industrial statistics are a weak base when compiling physical accounting of material flows. For the time being, it is difficult to tell what will happen to the statistics concerning the imports and exports between the EU countries. To reduce the need for new surveys, which to a certain degree will lead to double work, it should be an important job to improve the physical data in the existing statistics.

The variations in the emission figures between the Nordic countries are partly due to regional conditions, such as variations in agricultural methods, industrial processes, and similar, and partly, depend on the fact that the individual countries to varying degrees lack information. The variations appear too drastic to be attributable to shortcomings and regional conditions alone. Different estimation methods and different coefficients are probably important causes, as well. This is the case especially as regards the estimation for agricultural land of the inflows and outflows of nutrients and the estimation of emissions of N_2O. If we are to arrive at figures that are comparable, it is necessary to coordinate the methods for calculating the data at an earlier stage than has been possible in this project.

In the continued work accounts for nutrients we should in the first place keep working on step 5 in the model section 3.3, (N and P in emissions and waste). On the basis of defined needs we could then extend the accounting to also cover other parts of the model. Stated by priority, this work could consist of:

- Co-ordination of the estimation methods and emission coefficients.

- Improvement of the quality of the physical data concerned in the established statistics which are now mainly used for economic purposes.

- Development of methods and estimations based on the knowledge, the information and statistics being available.

- New surveys and measurements.

3.8 Table appendix

Table a Nitrogen and phosphorus balance for agricultural land ,1992

Table a DENMARK

	Nitrogen	Phosphorus
	1000 kg as N and P	
IN-flows		
Manure	297 000	43792
NH3 evaporation from manure	-110 000	-
Fertilizer	369 300	33072
Sewage sludge	..	2750
Seed	..	..
Biological N-fixation	27 560	..
Deposition	5 512	..
Mineralization	..	..
Total	589 372	79614
OUT-flows		
Crops	184 652	60632
NH3 from crops during growth	..	-
Denitrification	150 000	-
Leaching	220 000	1300
Accumulation in soil	..	..
Total	554 652	61932

..Data missing

Table a FINLAND

	Nitrogen	Phosphorus
	1000 kg as N and P	
IN-flows		
Manure	76 000	13000
NH3 evaporation from manure	-24 600	-
Fertilizer	163 000	35000
Sewage sludge	1 100	900
Seed	..	..
Biological N-fixation	7 000	..
Deposition	17 600	400
Mineralization	..	..
Total	240 100	49300
OUT-flows		
Crops	123 000	21100
NH3 from crops during growth	..	-
Denitrification	26 400	-
Leaching	26 400	1800
Accumulation in soil	..	..
Total	175 800	22900

.. Data missing

Table a NORWAY

	Nitrogen	Phosphorus
	1000 kg as N and P	
IN-flows		
Manure	70 410	11580
NH3 evaporation from manure [1]	-25 220	-
Fertilizer	110 880	14820
Sewage sludge	1 060	740
Seed	..	..
Biological N-fixation and deposition [2])	10 000	..
Mineralization [3])	75 000	..
Total	242 130	27140
OUT-flows		
Crops	78 260	15380
NH3 from crops during growth	..	-
Denitrification [4]	15 000	-
Leaching[5])	30 000	1000
Accumulation in soil	..	..
Total	123 260	16380

1) NH3 evaporation from domestic animals grazing in outlying field are not included
2) Estimate: Biological N-fixation and wet deposition =1 kg/da 3) Estimate. 7,5 kg/da for agricultural land
4) Estimate: 1,5 kg/da for agricultural land 5)Estimate: 3 kg N/da and 0,1 kg P/da for agricultural land

Table a SWEDEN (only arable land)

	Nitrogen	Phosphorus
	1000 kg as N and P	
IN-flows		
Manure [1]	105 700	19100
Manure from grazing animals on arable land [1]	34 200	4500
NH3 evaporation from manure	-40 200	-
Fertilizer	198 000	23100
Sewage sludge [2]	450	320
Seed [2]	5 350	940
Biological N-fixation [2] [4]	28 460	..
Deposition [2] [5]	18 220	820
Mineralization [3])	..	..
Total	350 180	48780
OUT-flows		
Crops [2])	250 300	38300
NH3 from crops during growth [2] [6]	4 100	-
Denitrification	..	-
Leaching [7]	..	820
Accumulation in soil	..	..
Total	350 180	48780
.. Data missing		

1) Total nitrogen, readily available and organically bound 2)only farms with more than 5 hectare arable land
3) estimated to be the same as inflows from organic material 4) Estimated by areas with crops of leguminous plants and clover 5)N estimated from environmental supervision, P estimated 0,3 kg/ hectare arable land
6) estimated 1,5 kg /hectare for arable land 7) estimated 0,3 kg/hectare

Table b
Flows of nitrogen and phosphorus to municipal treatment of waste and waste water

		Waste		Waste water	
Sector	NACE	Total N	Total P	Total N	Total P
Agriculture	A01				
Forestry	A02				
Fishing, of which	B				
fish hatcheries and fish farms	B05.02				
Mining and quarrying of energy prod. mat	CA				
Mining and quarrying exc. energy prod. mat.	CB				
Manufacturing, of which	D				
Wood and wood products, pulp paper and publ.	DD,DE				
Coke and petroleum products	DF				
Chemicals and chemical products	DG				
Non-metallic mineral products	DI				
Basic metals and metal products	DJ				
Electricity, gas and water supply	E				
Construction	F				
Transport and communication	I				
Services, of which	G,H,J-O				
Treatment of waste	O90				
treatment of waste water	O90				
Private households					
Total					

Table c
Balances for municipal waste and waste water

	Total N	Total P
Waste water treatment		
IN-flows		
OUT-flows		
Air (denitrification)		
Water		
Soil/groundwater		
Sewage sludge used in agriculture		
Other		
Accumulation (sludge in dumps)		
Treatment of waste		
IN-flows		
OUT-flows		
Air (NOX from incineration)		
Water (leaching from dumps)		
Soil/groundwater		
Recovery		
Other		
Accumulation (waste in dumps)		

Table 1 Emissions of nitrogen by economic sector and primary recipient

Table 1 DENMARK

		Air					Water	Soil/ ground water
		NOX			N2O	NH3	Total-N	Total-N in manure fertilizer and sludge
Sector	NACE	Stat combust.	Mobil combust	Non-combust.				
		1000kgN						
Agriculture	AO1			100 000		110 000		371 648
Forestry	AO2							
Fishing, of which	B						10 100	
fish hatcheries and fish farms	B05.02						10 100	
Mining and quarrying of energy prod. mat	CA						1 910	
Mining and quarrying exc. energy prod. mat.	CB							
Manufacturing, of which	D							
Electricity, gas and water supply	E	180 000						
Construction	F							
Transport and communication	I		150 000					
Services, of which	G, H, J-O				7 265		13 091	
Treatment of waste	O90							
treatment of waste water	O90				7 265		13 091	
Private households							1 260	
Total		180 000	150 000	100 000	7 265	110 000	26 361	371 648

Table 1 FINLAND

Sector	NACE	Air					Water	Soil/ ground water
		NOX			N2O	NH3	Total-N	Total-N in manure fertilizer and sludge
		Stat combust.	Mobile combust	Non-combust				
		1000 kg N						
Agriculture	AO1	550	4 040		7 600	41 000	1 100	92 500
Forestry	AO2		1 130					
Fishing, of which	B		70				1 640	
fish hatcheries and fish farms	B05.02						1 640	
Mining and quarrying of energy prod. mat	CA		10					
Mining and quarrying exc. energy prod. mat.	CB	14	30				24	
Manufacturing, of which	D	3 790	970	360	2 200	400	5 000	
Wood and wood products, pulp paper and publ.	DD, DE	380	250				3 400	
Coke and petroleum products	DF	810	10				200	
Chemicals and chemical products	DG	210	50			291	390	
Basic metals and metal products	DJ	970	120				800	
Electricity, gas and water supply	E	23 870	30		700			
Construction	F		1 950		600			
Transport and communication	I		18 080		1 000			
Services, of which	G, H, J-O		3450				14 400	2 800
Treatment of waste	O90							
treatment of waste water	O90						14 400	2 800
Private households			24440				4 000	
Total		28 224	54 200	360	12 100	41 400	26 164	95 300

Table 1 ICELAND

Sector	NACE	Air			Water	Soil/ ground water
		NOX	N2O	NH3	Total-N	Total-N in manure fertilizer and sludge
		1 000 kg N				
Agriculture	AO1		500			3 900
Forestry	AO2					
Fishing, of which	B				7	
fish hatcheries and fish farms	B05.02				7	
Mining and quarrying of energy prod. mat	CA					
Mining and quarrying exc. energy prod. mat.	CB					
Manufacturing, of which	D	600			3 000	
Fish and fish products	DA15.2				3 000	
Electricity, gas and water supply	E	100				
Construction	F					
Transport and communication	I	21 500				
Services, of which	G, H, J-O				1 120	
Treatment of waste	O90	100				
treatment of waste water	O90				1 120	
Private households		100				
Total		22 300	500		4 127	3 900

Table 1 NORWAY

Sector	NACE	Air					Water	Soil/ ground water
		NOX			N2O	NH3	Total-N	Total-N in manure fertilizer and sludge
		Stat combust.	Mobile combust.	Non-combust				
		1 000 kg N						
Agriculture	AO1	32	2 458		4 141	28 000		78 870
Forestry	AO2							
Fishing, of which	B		8 423		50		10 100	
fish hatcheries and fish farms	B05.02						10 100	
Mining and quarrying of energy prod. mat	CA	8 535	3 375		59			
Mining and quarrying exc. energy prod. mat.	CB							
Manufacturing, of which	D	2 987	1 735	2 011	3 232	292		
Wood and wood products, pulp paper and publ.	DD, DE	532	171	4	302			
Coke and petroleum products	DF	898	60		90			
Chemicals and chemical products	DG	306	75	303	2 698	291		
Non-metallic mineral products	DI	922	525		35			
Basic metals and metal products	DJ	159	470	1 704	49			
Consumption goods		170	433		59	1		
Electricity, gas and water supply	E	388	78					
Construction	F	20	1 702		31	2		
Transport and communication	I	2	16 338		254	12		
Services, of which	G, H, J-O	185	5 817		164	66	11 410	580
Treatment of waste	O90							
treatment of waste water	O90						11 410	580
Private households		482	12 176		349	270		
Total		12 631	52 102	2 011	8 280	28 642	21 510	79 450

Table 1 SWEDEN

Sector	NACE	Air					Water	Soil/ ground water
		NOX Stat. combust.	Mobile combust.	Non-combust.	N2O	NH3	Total-N	Total-N in manure fertilizer and sludge
		1 000 kg N						
Agriculture	AO1	186	5 677	-	5 000	40 365		53 200
Forestry	AO2	20	4 200	-		123		
Fishing, of which	B	-	1 415	-			900	
fish hatcheries and fish farms	B05.02	-		-			900	
Mining and quarrying	C	218	462	606				
Manufacturing, of which	D	5 668	3 203	6 744	4 500	840	5 270	
food, textile, wood & mineral product	DA- DD, DI	2 857	647	1 583				
pulp, paper, printing	DE	1 726	520	2 749			3 630	
Coke and petroleum products	DF	-	382	1 007				
chemical and plastics (excl. petrol.prod)	DG, DH	330	520	558				
Basic metals and metal products	DJ	436	551	746				
basic machinery and equipment	DK-DM	320	582	102				
Electricity, gas and water supply	E	5 601	230	-	900			
Construction	F	138	2 027	-				
Transport and communication	I	-	34 902	-	450			
Services, of which	G, H, J-O	1 327	18 379	-			29 107	7 800
Treatment of waste	O90							
treatment of waste water	O90				40		29 107	7 800
Private households		2 322	26 593		400	740	5 539	
Total		15 480	97 088	7 350	11 250	42 068	40 816	61 000

Table 2 Emission of phosphorus by type of flow and economic sector

Table 2 DENMARK

Sector	NACE	Water	Soil and ground water
		Total-P	Total-P in manure fertilizer and sludge
		1000 kg P	
Agriculture	AO1	490	18 982
Forestry	AO2		
Fishing, of which	B	290	
fish hatcheries and fish farms	B05.02	178	
Mining and quarrying of energy prod. mat	CA		
Mining and quarrying exc. energy prod. mat.	CB		
Manufacturing	D		
Electricity, gas and water supply	E		
Construction	F		
Transport and communication	I		
Services, of which	G, H, J-O	3 081	
Treatment of waste	O90	171	
treatment of waste water	O90	2 910	
Private households		434	
Total		4 295	18 982

Table 2 FINLAND

Sector	NACE	Water	Soil and ground water
		Total-P	Total-P in manure fertilizer and sludge
		1000 kg P	
Agriculture	AO1	400	27 800
Forestry	AO2		
Fishing, of which	B	219	
fish hatcheries and fish farms	B05.02	219	
Mining and quarrying of energy prod. mat	CA		
Mining and quarrying exc. energy prod. mat.	CB		
Manufacturing	D	500	
Electricity, gas and water supply	E		
Construction	F		
Transport and communication	I		
Services, of which	G, H, J-O	279	2 200
Treatment of waste	O90		
treatment of waste water	O90	279	2 200
Private households		500	
Total		1 898	30 000

Table 2 ICELAND

Sector	NACE	Water	Soil and ground water
		Total-P	Total-P in manure fertilizer and sludge
		1000 kg P	
Agriculture	AO1		160
Forestry	AO2		
Fishing, of which	B	2	
fish hatcheries and fish farms	B05.02	2	
Mining and quarrying of energy prod. mat	CA		
Mining and quarrying exc. energy prod. mat.	CB		
Manufacturing	D	450	
Electricity, gas and water supply	E		
Construction	F		
Transport and communication	I		
Services, of which	G, H, J-O	230	
Treatment of waste	O90		
treatment of waste water	O90	230	
Private households			
Total		682	160

Table 2 NORWAY

Sector	NACE	Water	Soil and ground water
		Total-P	Total-P in manure fertilizer and sludge
		1000 kg P	
Agriculture	AO1		11760
Forestry	AO2		
Fishing, of which	B	1950	
fish hatcheries and fish farms	B05.02	1950	
Mining and quarrying of energy prod. mat	CA		
Mining and quarrying exc. energy prod. mat.	CB		
Manufacturing	D		
Electricity, gas and water supply	E		
Construction	F		
Transport and communication	I		
Services, of which	G, H, J-O,	574	405
Treatment of waste	O90		
treatment of waste water	O90	574	405
Private households			
Total		2524	12165

Table 2 SWEDEN (only agricultural land)

Sector	NACE	Water Total-P	Soil and ground water Total-P in manure fertilizer and sludge
		1000 kg P	
Agriculture	AO1		9660
Forestry	AO2		
Fishing, of which	B	135	
fish hatcheries and fish farms	B05.02	135	
Mining and quarrying	C		
Manufacturing	D	500	
food, textile, wood & mineral product	DE	410	
Electricity, gas and water supply	E		
Construction	F		
Transport and communication	I		
Services, of which	G, H, J-O	484	5800
Treatment of waste	O90		
treatment of waste water	O90	484	5800
Private households		820	
Total		1939	15460

Comments to tables 1-2

Denmark
Emission to air
Source: Statistics Denmark, annual statistics
In the estimations of denitrification in treatment of waste water is provided 35 percent denitrification and an effect of 90 percent (Environmental Protection Board)

Discharge to water
Environmental Protection Board, annual statistics

Finland
Emission to air
Source, Statistics Finland, annual statistics

Discharge to water
Source:Vatten och miljöskyddsstyrelsen
Estimation of discharges from fish hatcheries and fish farms: amount of produced fish per year * emission coefficients.

Norway
Emission to air
Source Statistics Norway, annual statistics
Emission to air from forestry are included in emission to air from agriculture
Emission from electricity, gas and water supply also include emission from incineration
Emission of NH_3 from households are mainly emission from road traffic

Discharge to water
Source: Statistics Norway, The data are partly from reported discharges partly estimations. Discharges due to leaching may be included for some waste water plants.
Discharges from industry not connected to the municipal sewage system are missing.
Basic data for discharges from fish hatcheries and fish farms originate from Akvaforsk, calculations are made by Statistics Norway.

Discharges to soil groundwater
Nitrogen and phosphor content in sewage sludge are estimated to 0,002 kg N and 0,014 kg P per dry kg

Sweden
Emission to air
NOx :Source: Swedish environmental accounting, Statistics Sweden, annual statistics.
N_2O: Source, Swedish Environmental Protection Agency, report for Corinair
NH_3: Source: Statistics Sweden and Swedish Environmental Protection Agency.
NH_3 emissions from forestry due to spreading of fertilizer. Emissions of NH_3 from private household include emissions from pet animals and (410 tonnes) and from private households not connected to municipal sewage system (330 tonnes)

Discharge to water
Data for fish hatcheries and fish farms refer to 1992, HELCOM-report
Manufacturing sector: Discharges from industries not connected to the municipal sewage system. Statistics Sweden collect data for the paper and pulp industry and industries by the Baltic Sea coast. Data for industries in the inland are estimated in the HELCOM report.
Waste water treatment sector: Discharges from municipal waste water treatment plants include industries and private households connected to the municipal sewage system. Due to broadening the numbers for N and P have been increased with 15% and 3% respectively.
Private households: data for households not connected to the municipal sewage system have been estimated by the National Environment Protection Agency to 3,3-4,38 kg N/person and 0,48-0,8 kg P/person according to regional variations.

Discharges to soil/groundwater
N and P in sewage sludge are estimated to 0,034 kg N/kg dry weight and 0,0025 P/kg dry weight.

Table 3 Transboundary flow of oxidised nitrogen in air, country to country 1991
1000 tonnes as N

Destination	Origin Denmark	Finland	Iceland	Norway	Sweden	Baltic Sea	North Sea	Others*	Total
Denmark	1,9	0,1	0	0,3	0,6	0,2	0,6	20,2	23,9
Finland	2,7	12,7	0	1,9	7,7	1,4	0,7	50,2	77,3
Iceland	0,1	0	0,2	0,1	0	0	0,1	7,3	7,8
Norway	3,4	1,1	0	6,6	4,1	0,6	1,6	71,1	88,5
Sweden	7,6	5	0	5,6	15,1	1,6	2,1	82,3	119,3
Baltic Sea	10,1	5,9	0	2,5	13,2	2,9	2,5	116,1	153,2
North Sea	4,8	0,5	0,1	3	2,7	0,7	7,3	253,1	272,2
Others*	36,4	34,9	1,1	19,2	39,1	10,8	30		
Total	67	60,2	1,4	39,2	82,5	18,2	44,9		

* other countries and sea areas in Europe
Source: The Norwegian Meteorological Institute (EMEP)

Table 4 Transboundary flow of reduced nitrogen in air, country to country 1991
1000 tonnes as N

Destination	Origin Denmark	Finland	Iceland	Norway	Sweden	Baltic Sea	North Sea	Others*	Total
Denmark	45,5	0	0	0,1	0,5	0	0	15	61,1
Finland	1,3	19,8	0	0,4	1,3	0	0	36,3	59,1
Iceland	0	0	1,2	0	0	0	0	3,2	4,4
Norway	3,2	0,2	0	15,5	1,3	0	0	36,2	56,4
Sweden	8,4	1,4	0	2,4	23,3	0	0	46,9	82,4
Baltic Sea	16,3	2,5	0	0,7	6,2	0	0	102	127,7
North Sea	11,4	0,1	0	1,7	1,1	0	0	184,3	198,6
Others*	24,4	7,6	0,6	4,4	7,6	0	0		
Total	110,5	31,6	1,8	25,2	41,3	0	0		

* other countries and sea areas in Europe
Source: The Norwegian Meteorological Institute (EMEP)

Table 5 Transboundary flow of oxidised nitrogen in air, Nordic countries 1985-1992
1000 tonnes as N

Country/	Emission								Deposition							
Sea area	1985	1986	1987	1988	1989	1990	1991	1992*	1985	1986	1987	1988	1989	1990	1991	1992*
Denmark	69,7	..	70,1	63,2	61,2	63,5	67	64,1	25	..	25,7	29,5	26,9	28,2	23,9	21,2
Finland	48,5	..	54,4	54,3	53,7	56,3	60,2	58,4	68,4	..	61,8	83	80,1	71,3	77,3	73,6
Iceland	0,9	..	1	1,1	1,2	1,3	1,4	1,4	8,2	..	14,1	7	7	7,5	7,8	4,5
Norway	33,1	..	32,9	34,4	35,8	35,1	39,2	39,8	77,3	..	79,6	97,6	94,9	102,7	88,5	82,8
Sweden	89	..	87,2	80,7	80,4	78,6	82,5	79,3	122	..	121,5	143,7	127,2	139	119,3	116,5
Baltic Sea	18	..	18	16,9	17,5	17,6	18,2	17,7	174,3	..	172,2	177,9	164,6	169,3	153,2	156,8
North Sea	45,1	..	44,1	42,8	44,1	44	44,9	45,9	254,9	..	288	261,5	242,1	253,3	272,2	280,3

* Preliminary results
Source: The Norwegian Meteorological Institute (EMEP)

Table 6 Transboundary flow of reduced nitrogen in air, Nordic countries 1985-1992
1000 tonnes as N

Country/	Emission								Deposition							
Sea area	1985	1986	1987	1988	1989	1990	1991	1992*	1985	1986	1987	1988	1989	1990	1991	1992*
Denmark	119,9	..	126,2	120,3	117,6	114,8	110,5	107,8	68,9	..	71,4	72,4	66,9	66,9	61,1	58,3
Finland	32	..	32,5	32,1	31,2	30,5	31,6	31,4	64,1	..	56,5	69	63,8	53,6	59,1	58,1
Iceland	1,5	..	1,6	1,7	1,8	1,8	1,8	1,8	4,8	..	7,7	4,7	4,1	4,4	4,4	3,3
Norway	25,7	..	24,6	24,7	25,3	25,1	25,2	26,1	59,4	..	52,6	62,9	61,2	65,6	56,4	54,6
Sweden	42,7	..	41,8	40,2	40	40,7	41,3	40,5	96,5	..	90,1	100,3	91,2	95	82,4	82
Baltic Sea	0	..	0	0	0	0	0	0	158,4	..	159,8	148,7	133,6	133,4	127,7	130,2
North Sea	0	..	0	0	0	0	0	0	206,3	..	209,8	194,7	172,2	178,6	198,6	210,6

* Preliminary results
Source: The Norwegian Meteorological Institute (EMEP)

Table 7 Inflows of nitrogen and phosphorus to the North Sea and the Baltic Sea from the Nordic countries
1000 tonnes as N and P

	North Sea*		Baltic Sea*	
Inflows	Nitrogen	Phosphorus	Nitrogen	Phosphorus
Denmark	79,8	2,8	66,8	2,7
Riverine inputs	59	1,9	31,4	1
Direct inputs	4,6	0,9	9	1,7
Deposition	16,2	..	26,4	..
Finland	0,6	..	91,1	4,8
Riverine inputs	-	-	73	4,3
Direct inputs	-	-	9,7	0,5
Deposition	0,6	..	8,4	..
Iceland			0	
Riverine inputs			-	-
Direct inputs			-	-
Deposition	0,1	..	0	..
Norway	62,9	1,9	3,2	..
Riverine inputs	48	1,1	-	-
Direct inputs	10,2	0,8	-	-
Deposition	4,7	..	3,2	..
Sweden	42,8	1,4	114,3	3,5
Riverine inputs	35,3	1,3	81,7	2,9
Direct inputs	3,7	0,1	13,3	0,6
Deposition	3,8	..	19,4	..
Total	186,1	6,1	275,4	11

* For Norway and Sweden the Cattegat and the Skagerrak are included in The North Sea area and not the Baltic Sea. For Denmark the Cattagat and the Skagerrak are included both in the North Sea area and the Baltic Sea.

Source: North Sea task force 1993, EMEP 1993, Statistics Sweden, Statistics Denmark

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4. Environmental protection expenditure

This section presents an overview of statistics on environmental protection expenditure statistics that have been carried out in Denmark, Finland, Norway and Sweden. No work with environmental protection expenditure has, as yet, started in Iceland.

4.1 Introduction

4.1.1 Background

Several of the Nordic countries have a long experience of working with environmental protection expenditure statistics for both industry and the public sector. On the international scene, projects aimed at building up statistical systems for economic data on the environment are currently being carried out. Statistics on environmental protection expenditure are under much discussion, both internationally and in the Nordic countries, including aspects such as intended use, measuring problems, the quality of the surveys, etc. Here, the intention is to give a comprehensive report on the surveys which, so far, have been carried out in the Nordic region with regard to the methods used, the concepts and definitions. Furthermore, it discusses measuring problems in different types of investigations, as well as the experience gained through comparing the results from the surveys made in each respective country. The results from the surveys in each single country are also presented.

An overview of environmental expenditure surveys for the industry in some countries was produced some years ago by Statistics Denmark. The initiative behind this comprehensive study was taken by the Nordic Council of Ministers contact group for environmental economics. The report is published in the Nord series 1990:112. The report covers surveys made up to and including 1990.

4.1.2 Work in the EU

<u>SERIEE</u>

SERIEE, the "European System for Collection of Economic Information on the Environment" was developed by Eurostat, the statistical body of the EU, for the purpose of meeting the demand for data showing the effects of the environmental programme of the EU. The intention is to give the member states a common system for the collection and presentation of economic data on the environment. The SERIEE system has been described in Eurostat's report SERIEE-1994 Version, Theme 8 Series E.

For the time being, the system consists of:

- the Environmental Protection Expenditure Account (EPEA). EPEA should be seen as separate satellite accounts for environmental protection expenditure. In the manual, the importance of the requirement that all descriptions of activities must be consistent with the national accounts in each individual country being emphasised. To define environmental protection activities, the ECE and Eurostat have jointly worked out a classification system, CEPA, single European standard for statistical Classification of Environment Protection Activities. CEPA has been confirmed by the Conference of European Statisticians.

- "intermediary" systems for the collection of basic data and the construction of EPEA, SERIEE contains two intermediary systems, one for the public sector and one for the industry.

- accounting for the use and management of natural resources. This part is included in the planned development work in Eurostat and will comprise accounting for the management of water and other natural resources, such as forests, soil, energy, etc. Also other activities, which are not covered by EPEA, such as energy savings, recovery and recycling activities.

In Eurostat, there is a discussion about which additional areas should possibly be added to the SERIEE system, such as integrating monetary and physical data, input/output tables as well as the development of a system for a comprehensive study of eco- activities. There are also plans for the development of intermediary systems for households and eco- industries.

4.2 Completed and planned surveys in the Nordic region

Below an overview of the surveys on environmental protection expenditure carried out up to and including 1994 is presented.

Chart 4.1 Surveys on environmental protection expenditure

The year stated refers to the year for which the data are collected

	Denmark	Finland	Norway	Sweden
Industry	1972-1981 1993 pilot study. 1994	1973- [1] 1987 [2] 1992- [3]	1974- 1984,1985[4] 1969-1991 [5]	1981, 1985, 1988, 1991
Public sector. Government	1988-	Planned [6]	1989- [7]	Annual [8]
Public sector. Municipalities	1988	1973- [1] Planned [9]	1993 [10]	1991
Public sector. County	1988-			
Other sectors	1995- Semi-public sector		Agriculture [11]	

1) waste water expenditure only
2) waste management expenditure only
3) annual investigations planned
4) same survey
5) surveys by ‘ Main Organisation for Industry and Trade” (Näringslivets Hovedorganisasjon, NHO) 1969-1991, which cover the investments for each year throughout the whole period and the management costs and revenues for the years 1989-1991
6) based on national accounts, inclusive data on the regional administration, by county
7) The ministerial production "The green book", containing data on environmental expenditure in the government budget
8)Governmental grants to environmental protection according to the budget proposals, compiled by the National Environment Protection Agency
9) information taken from the investigation of the economy and operations of the municipalities
10) waste water and waste management alone. In 1994, Statistics Norway (SN) carried out a survey on waste water treatment plants showing both physical and economic data. For waste management, SN will collect physical and economic data using one and the same form. 1994 is the first year to include questions involving economy. In the course of 1994, a sample survey will be made, where the economic aspect is seen as a test survey. The expenditure incurred by the waste water treatment is published for the years 1982-1987, and based on the municipal accounts
11) Subsidies paid out by the government for technical environmental activities plus subsidies in support of changed cultivation methods.

As shown in the table above, the work with environmental protection expenditure statistics has been going on since the 1970s, although the grounds for prioritizing statistics on environmental protection expenditure have varied between the different Nordic countries.

Denmark: From 1972 to 1981, Statistics Denmark collected information on the environmental investments made by the industry. In 1981, however, the collection of data came to a halt as it was no longer possible to find a clear delimitation and definition of environmental investments. In 1993, Statistics Denmark made a pilot study for the EU in respect of environmental protection expenditure in the industry. The pilot study was made up of 25 interviews with industrial establishments and aimed at preparing a questionnaire that could be distributed to a larger group of establishments, which would facilitate random controls on realistic grounds. A questionnaire based on this pilot study was prepared and distributed to approximately 600 establishments in the spring 1994. All establishments with more than 500 employees were included, in total 50 establishments. The remainder of the sample - approximately 550 establishments - were selected among establishments with between 20 and 500 employees and a taxable turnover of more than DKK 20,000,000. The results are not yet published.

As regards the public sector, Denmark has a system which can provide figures showing the government's, the counties' and the municipalities' combined expenditure and revenue in the environmental area. The system has been developed on the basis of standardised charts of accounts for the three sectors. Information is available from 1988 and up to the previous financial year. Budget data can also be extracted.

Finland: Extensive statistics on environmental protection expenditure have, for many years, been prepared as regards waste water treatment and the forestry industry. The Water and Environment Protection Board has been collecting data for waste water treatment in municipalities and industry ever since the early 70s, and the Finnish Association of Forestry industry has collected statistics showing the environmental protection expenditure in its own sector. There are no statistics showing the costs of reducing air pollution or the costs of waste management. In 1992, the lack of comprehensive information about the environmental protection expenditure in industry enticed the environment ministry and Statistics Finland to initiate a project for the purpose of developing an overall statistical system.of environmental expenditures.This account is intended to be one of the major part of the Finnish system on environmental accounts supporting SNA. The first study of the industry's environmental protection expenditure covered 1992 and thereafter it has been made in annual basis.

Statistics Finland is currently working on the accounting of the environmental protection expenditure in the public sector. The statistics are based on material from the financial statistics and no separate collection of data is being made.

Norway: The Statistics Norway (SN) carried out a study in respect of environmental investments in the industry in 1986, covering the years 1974-1984 and 1985. There were several factors of uncertainty in the study, such as the fact that the companies had problems in defining environmental protection activities, in distributing environmental investment by environmental area and in estimating differential investment expenditures concerning the environment when it was a matter of integrated environmental investments. As a result of the unreliable data the results were only presented in an internal report. The only details that have been published are data on the environmental investments' share of the total investments in different sectors. Since then statistics on environmental protection expenditure have, remained a non-prioritised area in SN.

The ‘Main Organisation for Industry and Trade’ (NHO) studied the environmental protection expenditure in the industry for the years 1969-1991 (the same study). The environmental investments were estimated for the total period, whereas the environmental operational costs and the revenue generated by environment protection activities were studied for the years 1989-1991. In the 1980s, a compilation was made of the municipalities' expenditure on waste water management, the information was taken from the municipal accounts.

The Ministry of Environment has, for a number of years, prepared a report on the ministries' environmental protection expenditure based on the budget, which is being published in "Grønn Bok", the Green Book.

For the time being, SN will be concentrating on the municipalities' expenditures in the areas waste water management and waste management. SN has for a couple of years been collecting physical data on the treatment of waste and waste water. Questions on expenditures in these studies were introduced in 1994. Next year, there will be a follow-up of this work. As far as the industry's environmental investments are concerned, there are no plans for new surveys, but SN is following the work that is taking place in Eurostat and standing by for any possible directives.

Sweden: Sweden has since 1981 been making surveys of the industry's environmental investments, the latest dating back to 1991. The National Environment Protection Agency has, for many years, compiled statistics on the government grants to environment protection activities. Given that more and more of the environmental responsibility has been transferred to the municipalities, it was seen as particularly urgent to, in the first place, extend the statistics with a study of the municipalities' environmental protection expenditure.

In June, 1992, the Parliament adopted a proposal aimed at developing environmental accounts. Statistics Sweden (SCB) was then assigned to develop physical environmental accounts. The assignment implies the development of statistics showing the environmental protection expenditure and that it is necessary to extend these to also include the expenditure of other sectors, such as the energy, agricultural and household expenditures.

During 1993/94, SCB concluded two surveys. In working with these studies, the measuring problems which arise in trying to measure the environmental protection expenditure have become increasingly evident. These have been further described in a report by Mats Björsell, "Environmental expenditures in the Swedish manufacturing industries. An inventory of problems."

In the spring 1994, SCB engaged three consultants from the University of Lund, from the Foundation for research in industrial environment economy, for the purpose of making an evaluation of the study on the environmental investments made by industry. It is proposed that a set of key figures should be developed to follow the environmental work of the industry. The key figures compared to the environmental expenditure statistics can follow the operations more and are just as well suited for expressing both requirement and ambition levels. In view of the fact that the EU might decide to put the member states under obligation to report data on the environmental protection expenditure in the industry, it will be necessary for SCB to continue its work towards a simpler way of collecting the data and to investigate how data with acceptable quality can be obtained.

For both the municipal and the governmental environmental protection expenditures, SCB need to continue the work on finding out how to link these data with national accounts. For the time being, the distinction between the public and private sectors in the environmental protection expenditure statistics is not consistent with the distinction in the national accounts.

4.3 Application areas for statistics on environmental protection expenditure

The purpose of making statistics showing the public expenditure and revenue in the environmental area is to provide politicians and planners with a tool that enables them to make economic priorities in the environmental field. In developing the environmental policy and the resulting laws, it is of great importance to know the economic prerequisites and consequences.

For the private sector, it is important to obtain an outline of how much companies invest, amongst other things for the purpose of studying the size of the expenditure that the company will have to pay on account of environmental obligations stipulated by law. At the same time it is important to estimate the cost of changes in the production process, as is the question how much it will cost to clean up damages of the past.

4.4 Environmental protection expenditure in industry

4.4.1 Definitions and survey method

Definition of environmental protection

In the surveys that have been undertaken, the concept environmental protection has been defined in somewhat different ways. In all surveys, environmental protection only stands for activities affecting the natural environment, whilst activities furthering improved internal requirements for hygiene or security are being ignored. The delimitations in the surveys made in the last few years have on the whole been based on the definitions of environmental protection activities as defined in the SERIEE system.

Denmark: Activities taken for the purpose of reducing the discharge of polluted waste water, of reducing the emission to air, (including bad smells), noise abatement and management of waste. Only such expenditure that leads directly to a reduction in the emissions shall be counted. This means that costs for research and development, as well as for control and supervision are not counted as an environmental protection expenditure.

Finland: As from 1992, in the Finnish surveys ,environmental protection is defined as such activities that reduce the harmful effect on the physical environment outside the plant, or measures which significantly contribute to reducing harmful effects of this type. This could, for example, be a question of activities taken towards treating waste and emissions to the air, water or soil or pollution prevention activities, restoration environmental monitoring, management and planning, research and development work. Activities for internal hygiene or security are not included.

Norway: As used in the study made by SN in 1985, the concept environmental investment referred to investments which, in their entirety, were mainly being made so as to meet existing or expected directives from the authorities in order to reduce the emission of pollutants to the environment.

In the studies made by NHO, the central organisation of trade and industry, an investment will be considered as an environmental investment when it is made primarily for the purpose of reducing pollution or improving the environment, internal hygiene and security. The study distinguishes between expenditures for the internal environment and expenditures for the outer environment. Environmental investments leading to lower production costs should be included as well. These studies include such investments as are made according to directives from the authorities and such investments made for other reasons.

Sweden: According to the instructions in the questionnaire, environmental control and protection was defined as such activities aimed at preventing harmful effects on the outer environment, the "natural environment". These could be such activities as are intended to reduce pollution to the air, water and soil, to prevent pollution, monitoring and control, planning and investigative activities, as well as research and development in the environmental protection area. Waste management is also part of the environmental protection, as are noise abatement activities.

Chart 4.2 and 4.3 present an outline of the methods for data collection, the sample size and the domains of study used in the surveys carried out.

Chart 4.2 Methods for data collection, population, sample size and response percentage in the industrial surveys.

	Denmark		Finland		Norway		Sweden
					SSB	NHO	
Survey referring to year	1992	1993	1992	1993	1985	1991	1991
Postal questionnaire		yes	yes	yes	yes	yes	yes
Interview	yes		1)	1)			7)
Accounts		yes					
Population		1957	6889	6444	399	6)	c:a 8000 [8]
Sample	25	577	1475[3]	1496	399[5]	200	1750[9]
Response %		55%	81% total	80% total	67%	6)	67%
			72% usable [4]	73% usuable			
Industrial sectors covered by the survey:							
Mines and minerals quarries	no	no	yes	yes	no	yes	yes
Manufacturing industries	yes	yes	yes	yes	yes	yes	yes
Prod. of electricity, gas etc.	no	no	yes	yes	no	no	no

1) Follow-up by telephone of around 200 working sites in 1992
2) Establishments with a minimum of 5 employees
3) Total investigation of the most important sectors and also of the very largest establishments in each trade
4) About 80% of the total production value
5) Establishments with a minimum of 5 employees
6) The 200 companies answered for 18.5% of the employment in the industry
7) Telephone reminder calling around 200 establishments plus telephone interviews involving around 100 larger establishments for quality control
8) Establishments with a minimum of 20 employees
9 Total investigation of working sites with more than 200 employees

Chart 4.3 Sectors in the manufacturing industry (ISIC 3) for which results are being presented

Sector	Sector ISIC	Denmark 1993	Finland 1992	Norway 1985 SN	Sweden 1991
Manufacturing of food, beverage and tobacco	**31**	**X**	**X**		**X**
Production of fish-oils. fish-meals and vegetable oils	31151-2			X	
Textile, wearing apparel and leather ind.	**32**	**X**	**X**		**X**
Textile industry	321				
wearing apparel, tanneries, shoe ind..	322-323				
Wood and wood products	**33**	**X**	**X**		**X**
Pulp, paper and paper products, printing and publishing	**34**	**X**			**X**
Pulp, paper and paper products	341		X	X	
Pulp industry	34111				X
Paper and paper products	34112				X
Printing and publishing	342		X		
Manufacturing of chemicals, petroleum, coal, rubber and plastic products	**35**	**X**			**X**
Production of chemical-technical products	351-352		X		
Production of chemical raw material	351			X	
Production of chemical-techn. products	352			X	
Chemicals ind.	3511				X
Synthetic fibre & plastic ind.	3513				X
Other chemical ind..	3520				X
Oil and coal products	353-354		X		
Refining of ground oil	353			X	
Production of ground oil and coal products	354			X	
Rubber & plastic article ind.	355-356		X		
Non-metallic mineral products, excp. petrol. coal	**36**	**X**	**X**		**X**
Glass and glass products	362				
Production of bricks, cement and lime	3691-2			X	
Other products of minerals	36999				X
Basic metal industries	**37**	**X**	**X**		**X**
Production of iron, steel and ferro-alloys	371			X	
Iron and steel mills	37101				X
Iron and steel foundries	37103				X
Production of non-ferrous metals	372			X	
Fabricated metal products, machinery and equip.	**38**				**X**
Machinery	382		X		
Electro-ind..	383	X	X		
Transport	384	X	X		
Other manufacturing industries	**39**	**X**	**X**		**X**

The delimitation of environmental protection investments is very difficult to make. A basic philosophy is that the investment primarily should have been made to reduce the burden on the natural environment, such as reduction of pollution, smaller amounts of waste, less hazardous waste, using smaller amounts of hazardous chemicals, etc. Chart 4.4 presents an outline of the delimitation criteria which were used and what type of expenditure the surveys include.

Chart 4.4 Delimitation of environmental expenditure in the industrial surveys

	Denmark 1993	Finland 1992	Norway		Sweden 1991
			SN 1985	NHO	
Investments					
1. Only investments which primarily aim at improving the environment	X	X	X	X[1]	X
2. Directives by the authorities					
2.1 Directive-induced investments			X		
2.2 All environmental investments	X	X		X	X
3. Delimitation of economic reasons					
3.1 Cost criterion		X			X
3.2 Surplus investm. criterion	X			X	
4. Process relation					
4.1 End of pipe (EOP)	X	X	X	X	X
4.2 Modified process (CIP)					
thereof total investment		X			
differential environmental exp.	X	X	X	X	X
5. Waste .	X	X	X	X	X
6. Environmental adapted products					
7. Energy saving	X				
Operational costs	X	X		X	X
1. Process relation					
1.1 End of pipe	X	X			
1.2 Excess cost of CIP	X	X			
1.3 Related to the year's investments.	X				
1.4 Related to prev. investments	X				
1.5 Unrelated to prev. investments		X		X	X
2. Expenditure for waste	X	X		X	X
3. Other expenditure		X		X	X
Capital costs					
1. Specified in the questionnaire					
2. Calculated on the basis of other data					
Revenues	X	(X)	X	X	X
Questions on reduction of pollution	X	X	X		

1) incl. internal hygiene and security

Investments could refer to changes in the process (CIP - Change in process) or activities which do not affect the production process, such as investing in filters, purification plants or measuring equipment (EOP - End of pipe).

According to the SERIEE system, such investments should not be included as are made

- for reasons other than environmental, for example economic or technical
- in order to improve internal hygiene or security
- in order to reduce the utilisation of a resource, for example energy savings activities

These delimitations have to an extent been applied also in the Nordic countries.

Delimitation of economic reasons

The economic reasons, in turn, can be delimited in two ways, according to either the *cost criterion* or the *surplus investment* criterion.

The cost criterion: The investment counts as an environmental investment when the total differential cost in the implementation exceeds the additional revenue. The calculations should then also include capital costs, operative costs, capital income and operative revenue. The investment must be unprofitable in short-term.

Surplus investment: The investments expenditure for an environmental investment must be higher than that of alternative investment made without environmental consideration, where the alternative without environmental consideration is known as reference technology.

Finland: Activities which meet a company's normal profitability requirements should not be counted as an environmental investment. The environmental advantages generated by the investment should be delimited according to the surplus investment criterion.

Denmark: Delimitation according to the surplus investment criterion. Environmental investments are such investments where the company will have a differential cost when investing in an environmentally adapted technology as compared to traditional technology. No delimitation according to profitability is thus being made.

Norway: In the study made by SN in 1985 environmental investments are delimited to comprise investments which were made as a result of directives or expected directives from authorities for the purpose of reducing pollution.

Sweden: Delimitation according to the cost criterion has been used in the latest surveys, which means that none of the investments which the companies have seen as meeting their normal profitability requirements count as environmental investments. Sweden has thus used a narrower delimitation of environmental investments than is the case with Finland and Denmark. The problems which arise in making delimitations according to the two models are discussed more in detail in section 4.4, where measuring problems are dealt with.

Operational costs

Denmark: The Danish survey asks for changes in the operational costs connected with the investments which were specified in the questionnaire and shown by CIP and EOP, as well as any changes in such operational costs as are caused by previous investments. Changes in the operative costs should be specified according to labour cost, raw material and input goods and energy consumption. Charges for waste management should be shown separately, at which the amounts of waste should be specified as well.

Finland: Like the investments, the operational expenditure is shown by EOP and CIP cost. By operational costs for CIP activities are meant differential costs in comparison with conventional technology. Also operational costs incurred on account of previous investments should be included, however without reference to the year when the investment was made. Operational costs should be shown divided into 7 main points

- running and maintenance costs for the plant and equipment, which includes items such as labour costs, the price differences caused by the use of cleaner fuel, raw material and additives, as well as the utilisation of waste products in relation to conventional materials
- waste water
- waste management
- measuring of emissions and discharges
- monitoring
- environmental management, for example permit fees
- remuneration, compensations and other fees

Norway: The survey made by SN did not include operational costs. In NHO's study, there was a question asking for the annual environmental expenditure. Operational costs include in this study, for example, management, maintenance, costs of materials, chemicals, differential costs for purchasing more environmentally friendly raw materials, waste water treatment, sulphur taxes, environmental measuring, recipient controls, consultancy fees.

Sweden: The following items are included in operational costs
- labour costs including personnel expenditure connected with environmental protection and control, for example maintenance and management of plants, environmental accountants
- the cost of materials, chemicals, and energy for purification plants
- differential costs on account of more expensive raw material or input goods being used for environmental reasons
- extra fees to municipal waste water treatment
- compensation paid to external personnel, for example environmental education, environmental accountants
- costs of supervisory activities to authorities
- for waste management, the total operational costs should be reported: the personnel costs involved in the waste management, fees paid to contractors or the municipality for taking care of the waste. This goes for all types of waste, be it specific to an industry, hazardous, from households or offices.

Environmental taxes should not be included.

Capital costs

By capital costs are meant interest expense and depreciation. No surveys deal with the capital costs involved as far as environmental investments made earlier on are concerned. One of the reasons is the difficulty in calculating the capital costs of the environmental content in respect of previous investments, as well as the difficulties in reaching comparability with regard to depreciation methods and interest rates. The SERIEE system states that expenditure for environmental protection includes both running costs and capital costs. A way of estimating the capital costs is to base the calculations on information about the investments made over a number of years back in time and then assess the capital costs. None of the Nordic countries had done this.

Questions concerning the effects in the form of reduced emissions

Denmark: The enquiry asks what reductions in the emission amount the investments have led to. In the evaluation of the test survey, it is pointed out that such questions about emissions expressed in physical units are of limited value. One of the problems is, for example, the fact that it was impossible to add up the results due to different measuring methods.

Finland: A verbal description of the environmental advantage with the investment is requested, but the information cannot be used to present figures for changes in the amount of emissions or waste. The analysis of the results includes some descriptions of the intentions behind the investments.

Norway: The survey made in 1985 included questions about the effects of investments in the form of, for example, reduced emissions to air and reduced discharge to water of, amongst other things, organic substances, phosphate and nitrogen compounds. The experience gained was that it is difficult to draw any conclusions about the reduction in emissions/discharges as many companies not were able to deliver any data.

Sweden: This area was not dealt with in the survey of 1991. It was, however, included in the survey of 1985, but the results were too difficult to interpret to be presented in the report.

Environmentally-adapted products

By "environmentally-adapted products" are meant such products which in the production, use or as waste have less harmful effects on the natural environment than traditional products have. Investments made for the purpose of offering "cleaner products" have so far not been covered by any statistics showing the environmental protection expenditure. Today, more and more of the companies' environmental investments are concentrating on environmentally-adapted products, use of recycled raw material, etc. Now, interest is focusing more and more on eco-industries. The efforts of the eco-industries will in the future be an important factor in measuring the environmental work of countries.

Investments distributed by environmental media

In all Nordic countries, the establishments are asked to distribute the investments by environmental media, i.e. air, water and soil and ground-water, or to specify whether the investments involves waste management or activities aimed at noise abatement.

In Norway, the distribution is shown by media for sectors and type of environmental investment (e.g. purification plant, new process).

In Sweden, this is only shown for establishments with more than 200 employees. The reason for this is that SCB in consultation with the Swedish industry decided not to ask smaller establishments about the distribution of investments by media so as to make the reporting less of a burden for them.

Chart 4.5 Investments by environmental media

	Denmark 1993	Finland 1992[1]	Norway 1985	Sweden 1991[5]
Investments for				
Protecting air	X	X	X	X
Protecting water	X	X	X	X
Protecting soil/ground-water				X
Waste	X	X[2]	X	X
Noise in the outer environment	X			X
Other		X[3]	X[4]	X

1) not for all 23 sectors
2) including soil and ground-water protection
3) including noise in the outer environment
4) including noise and smell
5) only establishments with more than 200 employees

4.4.2 Measuring problems

The statistics on the industry's environmental protection expenditure comprise a number of measuring problems. These have been described by, amongst others, de Boo in "Technological Development and the Costs of Environmental Control", Netherlands Central Bureau of Statistics, and Mats Björsell in "Environmental expenditure in the Swedish manufacturing industries, an inventory of problems", Statistics Sweden, 1993.

The Nordic countries have a shared opinion on both the nature of the worst problems and what the existing measuring problems are. Experts in Sweden and Norway are most doubtful when it comes to the quality of the surveys made. In Finland, the measuring problems are recognised difficult, but not too large to be resolved. The results from the annual surveys since 1992 are regarded as relatively reliable.

Denmark is currently engaged in its first survey, but the results remain to be evaluated. In Norway SN made an investigation in 1985, but the quality of the survey was so uncertain that the results were published in an internal report only. SN has not undertaken any new investigation in this respect. Statistics Sweden has published statistics on environmental protection expenditure in the industry for the years 1981, 1985 and 1988. In the 1991 survey, the quality problems have increased and the results will only be published in a working paper from Statistics Sweden.

The fact that the quality problems have increased depends on factors such as structural changes in industry, where much of today's environmental work takes place by changing the production process and by developing environmentally-adapted products.

Below some of the most important measuring problems are outlined in detail. The analyses are based on the Swedish report. It must be noted that the Finnish experiance of measuring environmental expenditures by annual suveys is somewhat different and the problems are no looed upon as severe as are described here.

Definition of environmental protection

It is difficult to unequivocally define what is meant by environmental protection. Even though all of the Nordic countries, on the whole, follow the definition of environmental protection as has been drawn up by Eurostat/ECE, there are in practice many a difficult delimitation one must make. So, for example, can steps primarily taken for the sake of internal hygiene or security be of great importance even to the outer environment and therefore in many cases be counted as environmental investments. Identifying activities for improving the environment and defining technical development represent an additional difficulty. In the future, these problems will increase as the basic technology that forms our basis of comparison becomes environmentally-adapted as well.

Lack of environmental accounting

In the companies' regular accounting there are no special accounts for environmental expense. The environmental protection expenditure is usually included in other costs, which leads to statistics having to be based on more or less qualified guesses. This also means that a lot of work is required if the companies are to calculate their environmental protection expenditure. Estimates of what should be considered an environmental investment and estimating the cost of this can in many cases be a matter of very biased views and give quite different results depending on who answers the question. In the EU, so-called eco-auditing will be implemented in future, i.e. a compulsory environmental accounting, which should make it easier for the companies to report their information.

Delimitation of economic reasons

According to recommendations issued by Eurostat/EC such activities taken for other reasons than environmental consideration shall not count as environmental protection, even though they may have a positive effect on the environment. These are, above all, such activities as are taken for economic or technical reasons. The point with this delimitation is to see how the environmental protection work burdens the companies' profits. The delimitation can be made according to either the cost criterion or the surplus investment criterion. Applying the cost criterion means that many environmental investments will never be included in the statistics. This is above all the case with the investments made in changing the process. There are researchers specialising in business economics who claim that most of the total investments in one way or another are profitable in the short-term or long-term. But there is also research showing that a major part of the companies' environmental investments will not increase the profitability in the company. If we are to make a correct delimitation according to the cost criterion, we must estimate expense and revenue in the long-term.

A major problem in calculating the differential cost of an environmental investment is to find a reference technology to compare it against. The problem increases as we make comparisons over time, given the fact that no technical development is taking place in the basic technology,i.e. the technology without environmental protection measures. This means that even the existing reference technology to some extent includes environmental activities which result in that the surplus expenditure which the enterprise actually has to pay as a difference between the environmental technology and the former used (conventional) technology is less than the differential expenditure between environmental technology and the so-called basic-technology and probably becomes to zero. Methodological studies are currently being made in this area (see, for example, A.J. de Boo, "Cost of integrated environmental control", Statistical journal of the United Nations, ECE 10, 1993). The problem in finding a suitable reference technology exists irrespective of whether one uses the cost or surplus investment criterion in making the delimitation.

Environmental investments in respect of new establishments or expansion of the production capacity

Today, operations will almost always undergo environmental adaptation when expanding or extending production capacity. The environmental investment would in a case like this be the differential cost as compared to a plant which has not been environmentally-adapted. Here, it is not a case of changing an existing process, but an investment in a completely new process where there is no basis for comparison and is therefore difficult in estimating the excess cost. Using the cost criterion, these investments will not normally be counted given the fact that they are usually made for economic or technical reasons.

Companies creating an environmental image

Environmental adaptation of whole companies for commercial reasons will be more and more common. Companies will create, themselves, an "environmental image" through, for example, the selection of environmentally-adapted raw material, using the least hazardous transport systems for raw material and products, etc. The extra costs and revenues which these activities lead to for the companies are very difficult to measure.

Environmental adaptation of products

Today, the environmental protection expenditure statistics do not include the cost of developing environmentally-adapted products. The industry is now investing considerable resources in the development of such products. The definition and measuring problems are significant - what is meant by an environmentally-adapted product, what is the differential cost of the environmental adaptation when developing new products, when is a product "environmentally-friendly" or approved from an environmental point of view. Internationally, there are several methods for estimating the differential cost of the production of such products, such as calculations based on the difference in the market price between "environmentally-friendly" and traditional products or estimating the investment costs for the acquisition of the production means.

Operational costs

In calculating the operational costs, the measuring problems have not been subject to the same intensive discussions as is the case with investments. Certain operational costs which relate to increased operational costs in connection with changes in the process are probably very difficult to calculate, and this becomes even more pronounced when the investments were made a number of years ago. The same applies also to decreased operational costs on account of an environmental investment. The calculations are, furthermore, very time consuming and presuppose access to very detailed information in the companies.

The costs involved for specific purposes such as waste management, environmental measurement and environmental management are often easier to account for.

4.4.3 Results

Here follows an overview of the environmental protection expenditure in the Nordic countries. It must be emphasised that no direct comparison can be made between the figures shown in the table below for the simple reason that the surveys have been made on different grounds.

Table 4.1 The industry's environmental protection expenditure (gross)

	Sweden	Norway	Finland	Denmark
	1991	1991	1992	-
Investments	2,3 bill. SEK.	1,4 bill. NOK.	1,2 bill. FIM.	-
Operational costs	2,7 bill. SEK.	1,2 bill. NOK.	1,2 bill. FIM.	-
Sum	**5,0 bill. SEK.**	**2,6 bill. NOK.**	**2,4 bill. FIM.**	**-**

Sweden: The information was collected by a postal questionnaire distributed to a sample of establishments in the industry. Investments made for other reasons than environmental, for example investments on technical and economic grounds, or for the purpose of lower resource consumption or internal hygiene or security, do not count as environmental investments.

Defining and measuring the industry's environmental protection expenditure is difficult. The information is therefore very uncertain. Among the information gathered, it is especially difficult to estimate the costs of changed processes.

In addition, the costs involved in adapting products environmentally were excluded completely from the survey, as was the preventive work with the industry's economising in respect of natural resources and energy, as well as recovery of materials. These activities are also profitable in as much as there exists consumer demand for good production methods which cause as little damage as possible to the environment.

In 1991, the investments in environmental protection amounted to SEK 2.3 billion and the operational costs to SEK 2.7 billion.

Norway: The figures shown in the table above have been taken from the study made by NHO. The industry has utilised considerable resources for environmental protection in the past 20 years. According to NHO's findings, the industry invested around NOK 25 billion (rate 1991) in environmental protection over the period 1973-1991. The environmental investments were particularly high in the clean-up programme for the industry in the 1970s. In 1976, the environmental investments represented over 20% of the total industrial investments.

From 1974 up to and including 1985, the environmental investments on average amounted to 7% of the total investments. For the sectors which SN covers in its survey, the corresponding figure was 8%. Over this period, the companies taking part in SN's study invested around NOK 7 billion in environmental activities. NHO has for the same period estimated the environmental investment for the whole industry to NOK 16.6 billion. Therefor there are good reasons why we should believe that SN’s figures are minimal.

In the period 1989-1991, the operational costs relating to the environment represented around 45% of the total environmental protection expenditure. In 1991, the operational costs relating to the environment amounted to nearly NOK 1.2 billion. The investments made in the same year totalled NOK 1.4 billion.

Finland: In Finland, the total investments in environmental protection amounted to FIM 1.2 billion in 1992. The operational costs in the same year amounted to FIM 1.2. In order to make the information comparable with the other Nordic countries, investments and operational costs pertaining to the energy sector have been excluded from the Finnish figures.

The results are shown for 5 main categories within the industry: forestry, energy, the metal industry, the chemical industry and other industries. These 5 categories are subdivided into 23 sectors.

The forestry industry is the sector which invests the most in the environment, i.e. FIM 673 million.

Denmark: The results from the study carried out in 1994 are not available.

4.5 Environmental protection expenditure in the public sector

4.5.1 Delimitation of the public sector

This section accounts for the investigations made in respect of the environmental protection expenditure of the state and municipalities.

As referred to in the national accounts, public production/consumption, to put it very simply, means all operations financed by taxes. The state and the municipalities are in addition responsible for operations which are wholly financed via fees and which are run on businesslike grounds. In addition, a sizeable part of the governmental and municipal activities is run on a corporate basis.

In SEEA, the environmental accounting system of the UN, and in the SERIEE system, a basic prerequisite is that the environmental data, both economic and physical, can be combined with the national accounts systems. In setting up statistics on the public environmental protection expenditure, Denmark and Finland has followed the classification of public operations as specified in the national accounts.

Sweden and Norway, however, have not adapted to the national accounts so far.

4.5.2. Scope, delimitation and basic data

Environmental expenditures of the government

The Nordic countries have for a number of years compiled statistics on the environmental expenditure of the government. All of the statistics are based on data taken from official accounts.

Denmark: Statistics Denmark prepares annual reports on the environmental expenditure and revenue of the public sector. The statistics comprise the government, counties and municipalities, and are published in a joint report.

The information is based entirely on public accounts and the public sector is delimited in the same way as when preparing the national accounts. The basic data for the statistics is stored in a data base the so called ”DIOR" data base for integrated public accounts built by Statistics Denmark,. The environmental fields are selected from this database.

The environmental expenditure and revenue of the public sector are defined as such expenses as are incurred and revenues as are earned by the public sector, the primary purpose of which is to restore, maintain or improve the natural outer environment which is conditional for people's health and recreation, as well as to uphold a diversified animal and plant life".

Environmental protection are divided in five categories
1. Environmental protection
2. Forest and natural environment management
3. Environmental research and investigations
4. Other environmental activities
5. Environmental and resource fees (revenue only) The five categories, in turn, are divided into sub-groups.

Group 1 "Environmental protection" is divided into four areas

1. *Waste*: Does not include municipal waste management on account of its resemblance to businesslike or semi-public operations - the statistics are restricted to public subsidies earmarked for waste management and means allocated to activities aimed at limiting the amounts of waste and activities furthering a cleaner technology

2. *Water and soil*: Mostly consists of municipal waste water treatment plants privately-owned plants are not included

3. *Air:* Comprises the public sector's expenditure relating to the supervision and regulation of pollution in the atmosphere and the reduction of pollution for air-polluting sources which are owned by the public sector. The costs involved in reducing the emission of CO2 are included

4. *Other environmental activities*: Other expenditure relating to pollution. Noise abatement activities, as well as governmental initiatives in the traffic- and -environmental fields, as well as superordinate administrative expenses in the environmental area

As public accounts have been the starting-point for the delimitation of environmental activities, the definition of environmental activities depends on the delimitations used in each respective chart of accounts. Environmental activities in a programme which basically has another direction are therefore not shown in the statistics. Correspondingly, all activities in an environmentally-directed programme will be classified as environmental control, even such parts which do not relate to the environment.

The statistics have so far not included publicly owned operations which fall outside the delimitation of public activities as specified for the national accounts, such as government-owned companies or similar. Denmark is currently working on extending the statistics to include these areas as well.

Finland: No annual statements on the public sector's environmental expenditure have been published so far. In future, the statistics will delimit the public sector in the same way as is done in the national accounts (ESA S60). Data for the public sector's environmental expenditures are based on the government's administrative accounts. Environmental activities cannot be directly identified in the national accounts for the reason that the activity classification that is being applied is not adapted to environmental statistics. The planned statistics will show the government's subsidies to the municipalities and the subsidies from the public sector to the other sectors.

Norway: Ministry of the Environment has ever since 1989 compiled statistics for the environmental protection activities in the budget. The report is compiled in co-operation with the individual ministries and from 1991, the environmental protection activities are divided into the categories

I: "Purely environmental activities"
II: "Activities of considerable environmental concern"
III: "Activities of limited environmental concern"

In category I the activities should include environmental activities to more than 2/3, in category II between 1/3 and 2/3, whereas the requirement for category III is between 1/10 up to 1/3. The advantage of the division into three categories is that the statistics have become more clear-cut and reliable. The disadvantage is that the approximate delimitations are based on knowledge of the operations' content and that changes in the budget items could make comparisons between the years difficult. To be added is that the figures shown are taken from the budget and not the final statements.

Sweden: The National Environmental Protection Agency (SNV) has for many years compiled statistics showing governmental grants to environmental protection activities. SNV has based the work on the budget, selecting such grants which from the name can be judged as pertaining to the environment protection. The level of detail in the grant statement is generally low and it is difficult to specify the grant by activity area, for example emission control, waste management, etc. Another problem is that, in the last few years, it has been impossible to show certain grants which were previously shown in SNV's statements depending on the fact that grants which used to be shown separately are now combined with other, larger grants and that the grant structure has changed over time.

In order to achieve an improved accounting of the governmental environmental expenditure, SCB has engaged a consultant who has worked out a method that uses the annual statements, which the authorities forming part of the governmental accounting organisation, are obliged to present to the government. In total, there are 304 bodies that are obliged to prepare such annual accounts in Sweden, whereof the annual statements of 75 bodies have been examined. The method is described in "The public sector's environmental expenditure", University of Lund, May 1994.

Counties

Denmark: See section dealing with the governmental sector.

Finland: The regional administration's environmental expenditure is included in the government's expenditure.

Norway: No information available.

Sweden: No information available.

Municipalities

Denmark: See section dealing with the governmental sector.

Finland: The information has been taken from the statistics on the municipal economy which is a total investigation of all municipalities. The activity account is not adapted for separate accounting for environmental protection activities, which means that certain environmental expenditure, for example noise abatement, cannot be shown. The environmental expenditure in the "private sector", i.e. municipal companies and business organisations utilised by a municipality, is sizeable in the municipal sector but is not included in the accounting of the public sector. The private sector comprises municipal energy supply, waste water treatment and around 90% of the waste transports. Details on the environmental expenditure for the first two sectors mentioned can be obtained from other statistics available.

Norway: Municipal sewage systems and waste management are important environmental investment areas in Norway and there is a great need for data for the planning and follow-up. It can be very difficult to delimit other environmental activities and therewith identify the expenditure for environmental protection on account of the fact that the environmental activities are integrated with other activities. When it comes to the management of waste and waste water in the municipalities, all activities concentrate on reducing waste water and waste and all costs incurred in these areas therefore represent environmental protection expenditure.
The reports showing the costs for the waste water treatment were previously based on data extracted from the municipal outline accounts. These were not, however, considered adequate and sufficiently detailed to form the basis for statistics on the municipal environmental protection expenditure, for which reason special surveys are being made.
SN has for a number of years collected physical data on waste water and waste, for example facts such as waste amounts, waste treatment, waste water treatment plants, and discharge from waste water treatment plants. Questions about expenditure and revenue are for the first time included in the survey of 1994. As regards waste water, data are collected from all municipalities (435) in Norway. Regarding the waste management, however, it is a sample of 49 municipalities only that is obliged to report economic data, at which the economic content is seen as a pilot survey. Whether this survey is to be undertaken next year is a decision that will be taken once the results and experiences from the 1994 survey have been evaluated.

Sweden: In 1991, Statistics Sweden carried out its first survey of the municipalities' expenditure for environmental protection. The data on environmental protection expenditure that can be extracted from the municipal financial statistics and which are based on municipal accounts, were seen as inadequate for the purpose of estimating the environmental protection expenditure. In the financial statistics, for example, it is impossible to distinguish between water supply and waste water, which is also the case with environment and health. The objective was that the survey should comprise all municipal activities, including municipality-owned companies. The delimitation of environmental protection activities was decided by adapting SERIEE's activity list to the Swedish municipal operations. Environmental protection was divided into 11 main groups, intended to comprise all administrative units and companies.

1. Waste management incl. incineration
2. Reduction of emissions to the air
   in the power production
   in traffic
   in other areas
3. Reduction of discharge to the soil and ground-water
4. Reduction of discharge to the water
5. Noise abatement
6. Restoring the natural environment
7. Nature preservation
8. Supervision, planning and investigation activities
9. Monitoring
10. Education/Information
11. Research and development

As the experience gained from the pilot survey made SCB aware of the fact that the survey would be too comprehensive and that the measuring problems in some areas were serious, it was decided to exclude the following areas from the investigation: environmental activities in the traffic sector, noise abatement activities and nature preservation. Furthermore, it is restricted to comprise municipal enterprises in the areas of waste management and incineration, waste water management and energy only. Other municipal companies, such as housing companies, traffic companies and harbour management companies are not included. In preparing the survey SCB tried as far as possible to use material which had been collected for other purposes, but in spite of this it was necessary to carry out as many as four different enquiries.

Enquiries were sent to 108 out of 284 municipalities. The response percentage was 85% for the main enquiry and 75% for the waste enquiry. Great effort were taken to follow-up and supplement the replies. In the report there is no results for individual municipalities, instead it was decided to divide the material into four categories. The division is based size of the population, population density and industrial structure.

1. Large cities and suburban municipalities
2. Larger and medium-sized cities
3. Average municipalities
4. Sparsely-populated and rural municipalities

4.5.3 Measuring problems

As in the case of investigating the industry's environmental protection expenditure, the measuring problems are great in estimating the environmental protection expenditure in the public sector. The delimitation of the public sector sometimes tends to be difficult to make. How should, for example, public and municipal companies, government-owned business organisations, professional and industrial organisations, colleges, research bodies, etc., be shown? In the public sector, there are areas which clearly belong to the "environmental protection sector", such as waste water treatment and waste management. In other areas, the environmental protection work is integrated in other activities and it is often quite difficult to estimate the cost of the environmental part where the main part of the work involves other areas.

Of the statistical surveys which have been made so far on the public sector's environmental protection expenditure, all except the municipal investigations in Sweden and Norway comprise of data based on public accounts. As no environmental accounting is available, it has been necessary to estimate the content in various budget items and then classify the same as being either environmental or non-environmental activities. In Norway, it was decided to group the budget items into three categories in the accounting for the governmental environmental protection expenditure. The information available did not always suffice to make a distribution of activities by environmental media.

In Sweden, the government's expenditure for environmental protection has been set up in two different ways. Information taken from public annual statements (where no government-owned companies or commercial organisations are included) shows that the environmental protection expenditure has trebled in comparison with the grant survey. An important difference between the two methods is that in using annual statements, we are able to include both grants and charge-financed activities.

In planning the municipal survey in Sweden in 1991, the goal was, as mentioned above, to acquire a comprehensive picture of the cost of the municipalities' total environmental protection work. The survey is based on an enquiry sent to 100 out of 284 municipalities. The enquiry was supplemented with other administrative information and in addition in-depth interviews with around 10 municipalities were made. It proved very difficult, even with regard to the interviews, to estimate the environmental content in areas of work where the environment was an integrated part of other areas. To be added is that the municipalities have deliberately decided to integrate the environmental work in all administration areas.

4.5.4 Results

Here follows an overview of the public sector's environmental expenditure in the Nordic countries. The figures are extremely difficult to compare as both the collection methods, delimitations and definitions differ between the individual countries.

Table 4.2 The environmental expenditure of the public sector

	Denmark	Sweden	Norway	Finland
	1994	1992/93	1994	
The government	3,5 bill.. DKK.	5,8 bill. SEK.	5,8 bill. NOK.	-
	1994			
Counties	0,8 bill.. DKK.			
	1994	1991	1987 (waste water)	-
Municipalities	6,7 bill.. DKK.	9,8 bill.. SEK.	2,5 bill.. NOK.	

Denmark: Denmark can show information about the public sector's environmental expenditure and revenue from 1988 up to and including 1994 (budget figures). The figures are available in the DIOR data base, where all economic information from the government, the counties and the municipalities is concentrated. All three sectors have the same standardised account system. In Denmark, it is therefore possible to give economic environmental information for both the government, counties and municipalities. As the figures show, the heaviest costs are found at the municipal level. This is, amongst other things, attributable to the building and maintenance of waste water treatment. In 1994, the total public expenditure in the environmental area in Denmark was DKK 10.9 billion.

Finland: Finland has not yet published information as regards the environmental protection expenditures in the public sector. This is because of different priorities developing different sectors of EPEA..

Norway: In the budget, the environmental activities are, as mentioned before, being divided into three categories:

- Purely environmental activities
- Activities of considerable environmental concern
- Activities of limited environmental concern

In order to better compare the figures with those from the other Nordic countries, we have in the table above only included the figures for the category Purely environmental activities. In the 1994 budget, these amount to NOK 5.8 billion.

Many ministries have an important role in the implementation of the environmental policy in Norway. In 1994, the ministries in charge of Communications, Agriculture, Environmental protection, Education and Ecclesiastical Affairs will answer for 3/4 of the environmental activities included in the budget, measured in Norwegian crowns. In 1994, the budget of Miljøvernsdepartmentet, the Ministry of Environmental Protection, amounts to 15% of the total environmental protection expenditure and represents around 40% of the purely environmental activities in the budget (categories 1, 2 and 3).

In the period from 1982 to 1987, a report was made on the revenue and expenditure involved in respect of municipal waste water treatment plants. In 1987, the gross expenditure was NOK 2.5 billion.

Sweden: The investigations have shown that the municipalities' environmental protection expenditure (including investments and operational costs) amounts to at least SEK 9.8 billion, whereas the minimum figure for the government is SEK 5.4 billion. The statistics on the municipalities' environmental work do not include expenditure on account of traffic, noise and nature preservation, where the difficulties in defining and estimating the cost of the environmental work have proven too great.

In 1991, the total operational costs for the parts of the environmental expenditure as are covered by the investigation amounted to SEK 7.4 billion. In the municipal administration units, the net costs (which are being charged to the municipal budget) amounted to SEK 700 million, which on average corresponds to SEK 82 per person in Sweden. The operational costs of the management of household waste were SEK 2.9 billion, for waste water management SEK 3.0 billion, while in 1991, the investments in sewage systems and waste water treatment plants amounted to SEK 2.4 billion.

The National Environmental Protection Agency has on an annual basis made a statement of the government's grants which mainly concern environmental protection. Via these grants it is only possible to chart a minor part of the government's total environmental protection expenditure, given the fact that environmental protection today is being practised in some form nearly everywhere in the public sector. SCB has during the spring engaged consultants from the University of Lund for the purpose of testing a new, simplified method which primarily builds on studying the annual statements of authorities. This study shows a result for 1992/93 of SEK 5.8 billion. According to SNV's report, the governmental subsidies amounted to SEK 2.1 billion over the same period.

The first mentioned study includes both grants intended for environmental protection and subsidies which to a part are meant for environmental activities, as well as charge-financed activities for environmental protection. All authorities that could be engaged in environmental control are not, however, included. Most authorities will in the future be included, whilst the environmental expenditure of others, such as the National Road Administration, will probably be impossible to estimate. Government-owned companies and commercial organisation are not included in the study.

4.6 Environmental protection expenditure for the other sectors

Only Denmark have experience in statistics for other sectors. A weakness of basing statistics on environmental expenditure on the national accounting's delimitation of the public sector is thus that the work will not give a representative expression for the activities taking place in the part of the public domain which is found outside the public sector, i.e. publicly-owned corporations.

The Danish studies follows the delimitation of the public sector as per the definitions used in the national accounts, which as a rule means that only non-commercial environmental activities are included. In the environmental area, there are a number of public and semi-public organisations which in form resemble companies, which in the national accounts are referred to the private sector and therefore have not been covered in the Danish statistics.

This is explained by the national accounting's special way of treating public company-resembling (integrated) operations and such public (non-integrated) operations as are organised in the form of companies or similar.

Company-resembling (integrated) public operations are such units which are included in the total public accounting, but operate on a commercial basis and independently. As examples of company-resembling public operations of environmental interest, can be mentioned renovation, certain incineration plants, and the like.

Public operations producing capital goods, by definition primarily enterprises, are always singled out from the public sector as company-resembling operations, irrespective of where the goods are used, unless the operations in question are fairly unimportant.

Public (non-integrated) operations which are organised as companies, or similar, are not directly included in the public accounts. As an example of environmental interest can be mentioned certain incineration plants.

Environmental activities undertaken by the integrated public operations only affect the public sector by their net operational costs (subsidies) and net cost of fixed assets, which are regarded as capital infusion to the proper operation.

Environmental activities carried out by a non-integrated public operation will as a rule not affect the public sector unless being given a direct subsidy. This happens very rarely.

Statistics Denmark is currently preparing statistics on the public corporate sector. This work, which includes both integrated and non-integrated operations, is expected to be completed in the spring 1995. On the basis of these supplementary statistics it will be possible to produce statistics showing the gross expenditure and revenue on the environmental area for the whole of the public sector.

4.7 Conclusions

The reports presents an overview of the surveys in the Nordic countries as regards the methods, concept and definitions used. As the Nordic countries have used different definitions and delimitations in the surveys on the environmental protection expenditure, it is very difficult to compare the survey results.

The quality problems in the statistics are substantial. There are numerous delimitation and measuring problems involved when trying to estimate the expenditures in both industry and the public sector. The Nordic agree on both the nature of the worst problems and what the existing measuring problems are. Experts in Sweden and Norway are most sceptic when it comes to the quality of the surveys made. In Finland, the measuring problems are recognised as difficult, but the results are nevertheless regarded as relatively reliable and there are plans for annual investigations of the industry's environmental investments. In industry, it is above all the differential costs for environmental protection in investments in processes changes that are difficult to estimate. The fact that the quality problems have increased depends on factors such as structural changes in industry, where much of today's environmental work takes place by changing the production process and by developing environmentally-adapted products. As regards the public sector, the main difficulty is how to define the activities to be classified as environmental protection, especially when environmental protection is an integrated part of other activities.

The degree of detail in the SERIEE system, combined with the existing extensive measuring problems, contribute to the shared opinions of the Nordic countries that the SERIEE system is far to detailed to be practicable for the time being. As the development work progresses at both the international level and in each respective country, it might in the future be possible to make better comparisons between countries. Above all we should concentrate the comparisons to such areas where the delimitation problems are not quite so difficult and in the long-term try to develop a common Nordic ”hard core” of environmental protection activities.

Politicians express a demand for statistical information on environmental protection expenditures. The information are need to provide politicians and planners with a tool that enables them to make economic priorities in the environmental field. For the private sector, it is important to obtain an outline of how much companies invest, amongst other things for the purpose of studying the size of the expenditure that the company will have to pay on account of environmental obligations stipulated by law.

The future development of the statistics must be decided from the use of the statistics and the possibilities of obtaining reliable statistics.

Part II

Experiences from Finland, Norway and Sweden in linking physical and monetary accounting and economic valuation studies

Contents part II

Summary of part II

Part II of this report presents for Finland, Norway and Sweden the experiences from different projects in linking physical accounting to monetary accounts and from some valuation studies.

In ***chapter 1*** as an introduction there is a description of different methods for valuing the environment. In monetary environmental accounting one needs to put a value on goods and services that are not sold on any markets and therefore do not have a market price. There are a number of methods that are used by economists to estimate the monetary value of non market assets i.e. damage costs methods, restoration costs and avoidance costs.

Chapter 2 presents an overview of the economic valuation studies carried out in Finland from the late 1960:s until now. Many of the studies are research reports concerning local environmental impacts such as recreational use of lake and forests and existence value of wilderness preservation. These studies are presented according to the valuation method that have been used. So far only a few economic valuation studies have been conducted from the wider macro level perspective. In this report two studies are presented, benefits of global warming and natural resource accounting and valuation. The costs and benefits of global warming to the Finnish economy were analysed for two scenarios, the next 50 years and 200 years. Natural resource accounting for the forest sector and wood material accounting have been developed. New projects are now going on, related to the wood material accounting, where quality indicators for forests are developed and also the multiple uses of forests. Physical data on natural resource accounting have been connected to the national accounts and some experimental calculations on the economic value of forests and forests related resources were made. The valuation of forests has partly been done in the same way as in Sweden. The results from these two studies are also compared in part I chapter X in this report. As the Finnish economy plunged into recession, calculation the green GDP in monetary units was no longer high on the agenda. Even though satellite accounting will be developed further, no decisions have been taken on the extent of the valuation of environmental components in the future.

Chapter 3 presents the work on environmental adjusted national accounts in Sweden by Statistics Sweden and the National Institute of Economic Research (NIER) in close collaboration. Statistics Sweden is developing the physical accounts while NIER is doing research on how to develop monetary environmental accounts. The work has been described in an interim report SWEEA, published dec.-94. The work have concentrated on emissions (flows). Thus natural resources (stocks) has not been treated in this first stage of the project. In this report the two projects on monetarizing the environmental accounts are presented. They represent two different ways of going about this. The ‘sulphur project’ tries to evaluate the impacts of emissions of one pollutant, sulphur, on the environment. The ‘forest project’ extends the accounts of one ecosystem, namely the forest, to en compass production of berries, fungi, hunting game and lichen, as well as environmental services and assets.

The national account division in Statistics Sweden have last year in the framework of traditional accounts been doing calculations of the national wealth and balance sheets for some natural resources. In the report there is also a short overview of this work. A lot of other valuation studies of environmental services and assets have also been done in Sweden. These are mainly focused on local environmental impacts but are not presented here.

The assignment given to the National Institute of Economic Research stresses the long-term nature of this work. On the valuation side, Sweden will continue the work on valuation of emissions to air from the damage cost side. Valuation studies on nitrogen oxides will begin this year. Valuation from the avoidance cost side is important as complementary information to the damage costs, to be able to perform cost-benefit analyses. This is thus also an area which will bee dealt with. Another line of work will be to waste and recycling, which will be performed in close collaboration with the work at Statistics Sweden.

Chapter 4 presents the Norwegian experiences in Statistics Norway with natural resource accounting and linking them to economic planning models. Statistics Norway is responsible for both the national accounting and natural resource accounting as well as development and operation of some of the economic planning models used by the Ministry of Finance. In Statistics Norway the resource accounting framework was naturally based on existing economic standards and sector classifications schemes, thus ensuring general consistency in the sectorial classification of economic and resource related data and statistics, which made it possible to integrate important natural resource variables and relations within already existing macro economic models

In the initial phase of resource accounting, considerable efforts were made to establish resource accounts for energy, fish and land use. In addition, less detailed accounts were made for minerals, forests and sand and gravel. The accounts were kept in physical units. Later, based mainly on the energy accounts, inventories of emissions to air have been established. Because of changing concerns about the scarcity of the above mentioned resources and experience with the governments use of the account, there is at present a stronger focus on a few economically and politically important issues; namely management of energy resources, and important environmental issues like air pollution. The Multi Sectorial Growth (MSG) model used by the Ministry of Finance for medium and log term economic projection have been disaggregated and extended to include energy and air pollution variables and integrated forecasts are now routinely made.

In Norway further work will concentrate on updating and implementing the benefits in the economic models themselves in order to capture the indirect economic benefits of environmental policies.

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5. Methods for valuing the environment

In order to construct monetary environmental accounts, one needs to put a value on goods and services that are not sold on any markets and therefore do not have a market price. There are a number of methods that are used by economists to estimate the monetary value of non-marketed assets. The available methods will be shortly described here.

In the context of national accounts, however, the problems faced are more complicated than in the usual case where one isolated object is being valued. This will be shortly commented in the description of the valuation methods.

5.1 Definition of ENP

The formula for calculating an environmentally adjusted net domestic product (ENP) requires that we first determine in physical terms which environmental assets are affected by human activities during the year and how the natural capital changes as a result of such activities. One must also determine a price (r or v) for the physical quantities thus determined.

Environmental adjusted net domestic product (ENP)

ENP = **NDP** + **r** ∗ (impact of human activity on the flow of environmental services during the year)
+ **v** ∗ (change of natural capital during the year)

r = the estimated (negative) price of noise, impaired air quality, etc.
v = the estimated price of or value per unit volume of natural capital.

Since it is far too difficult to estimate the total benefit we have from nature in the form of recreation, for instance, we must concentrate on the value of anthropogenic *changes* in the quantity and quality of all the environmental services from year to year. One particularly important aspect is to study the stocks of natural capital that are affected by human activity, since it is their quantity and quality that guarantees that we will be able to retain environmental services in the future. It is thus not the total value of the stock of natural capital, but the changes in this stock that are quantified and valued.

We thus need to determine both immediate, temporary effects like noise, and long-term effects on the stock of natural capital, e.g. accumulation of sulphur dioxide which eventually causes acidification of the soil. Most of the impact is of the later kind. Some of these effects are already in the national product in the form of lower productivity etc., though they are not identified. For impacts on assets with a market value, like corrosion of real capital, the valuation is straightforward. For non-marketed goods and services, one or some of the methods described below is needed.

5.2 Valuation methods

Environmental impact means that the number of goods and services provided by nature declines or are of lower quality. The methods available for valuing this decline can be broken down as follows:

i) *damage cost methods* based on the demand side (willingness to pay), i.e. how consumers value what has been damaged or otherwise lost as a result of human activity.

ii) *restoration costs*, i.e. the cost of rectifying damage that has already occurred.

In certain cases, valuation may be based on

iii) *avoidance costs*, i.e. the cost of ensuring that the damage does not arise.

5.2.1 Damage cost valuation

The damage cost method involves determining what has been destroyed or what one believes might be destroyed, and valuing the loss in terms of market prices or the best substitute. One might, for example, wish to determine both the value of impaired forest growth and the impaired recreational value in an area of forest that has been affected by acidifying sulphur emissions.

The national accounting system is largely based on market prices, which are assumed to indicate society‘s willingness to pay for a good or a service. It is therefore quite natural to value environmental impact in terms of market prices in so far as possible. In order to establish the value of impaired timber yield, one can use a market valuation of the timber that could have been sold if there had been no acidification, and thereby determine the loss of income for the owner of the forest. An alternative method is to use the loss of wealth that arises when the land is valued at the present value of everything that the forest will produce in the future, i.e. mainly timber. Other values, such as recreational value, can be found with some of the following methods.

1) Hypothetical markets

Contingent valuation method (CVM): In this method a hypothetical market is created through questionnaire studies on people‘s willingness to pay, i.e. how much they state they are willing to pay to retain an area of forest undamaged, or how much they would wish to be compensated in order to accept changes in the forest and its eco-top as a result of acidification. The big advantage of this method is that it is the only method where you can capture the total value, i.e. also the existence and option values of an environmental asset. On the other hand CV studies are not possible to add up, since there is no budget restriction. Adding up several studies might therefore give a sum larger than the income of the respondents. Extrapolating to the national level also poses several problems. The value of saving hundred lakes is not necessarily 100 times the value of saving one lake. Macro level CV studies can be performed, but many economists feel that results on such an aggregated level are hard to interpret.

It is worth noting that the values in all cases are anthropocentric, i.e. the assets are not related explicitly to their ecological value but to what they are worth to the human society. CV studies is therefore often suggested to be complemented by expert panel questionnaires, where experts on different subjects answer similar questions, rating the environmental problems from the ecological point of view.

2) Derivation from existing markets

Travel cost method: The travel cost method can be used when estimating the value of a recreational site, such as a national park. It involves calculating the amount of money people are paying to enjoy a recreational site. This can also include how much the spend on equipment (such as special clothes, fishing gear etc.). The cost and frequency of their using the site can then be used to impute a value per person and year, which is a lower limit of the value of the "services" that this place gives the people who come there. Together with data on the number of visitors per year, this gives a total per year value. To extrapolate the values from one site to another is not straightforward, though. Adding up different studies also calls for stringency and care, so as to avoid double counting (cost for equipment, frequency of visits etc.).

Hedonic pricing method: A hedonic pricing study compares the prices of economic assets, such as houses, land etc., for example before and after the building of a highway nearby, or of radon-infested houses with radon-free, but otherwise equivalent houses. This gives an idea of how much people are willing to pay for the environmental quality. The difficulty is to separate the variation in prices due to the problem studied from variation due to other causes. In many instances, it is also hard to get a big enough sample that is comparable. Hedonic pricing studies are not well suited for environmental accounts, since they only are applicable on a very disaggregated level, and adding studies or extending to a national level is problematic, as discussed before.

Resource related valuation: This method uses the simplification that natural assets and human beings are valued only as production factors, and that the main objective in a society is to maximise GDP. Existence and option values are not included. Effects of sulphur emissions is thus valued from the production losses in forestry and agriculture due to acidification, and the productivity losses of humans due to health effects of sulphur concentration in the air. This will only give a very limited part of the damage, but in return it is well suited for using at an aggregated level and can give more robust estimates than for example CV methods, which can vary greatly with opinions and expectations. When juxtaposed with the costs of avoiding to cause the damage, this valuation method can give the wrong signals, since the most important part of the damage might well be on values that have no immediate function in production.

3) Political willingness to pay

Political decisions on taxes and charges reflect what our elected representatives believe something is at least worth if their proposal is accepted (e.g. sulphur tax). A valuation is then performed on the volume of emissions times the tax rate. If the tax rate were to be motivated by other considerations, however, this line of reasoning could easily be misleading.

5.2.2 Valuation methods based on the cost of action and avoidance

In order to know, in a decision-making situation, if and where it is most profitable to take action against an environmental problem, one must evaluate the damage, as discussed above, but also determine how much it would cost to repair or avoid such damage.

Cost-based valuation is the method used in the conventional national accounts in the public sector. It corresponds to a sort of minimum value that society places on an activity, since the activity would not be carried out unless it was worth at least as much as it costs. A cost valuation of this sort provides an idea of what it would cost to have production and consumption that are in line with the environmental goals of society.

1) Restoration cost

The cost of repairing the damage, e.g. liming the area of forest so that the original pH value can be restored, may be regarded as a measure of the damage, in monetary terms.
On the national level, it represents the costs that would have to be taken to keep the environment at last years value, which can then be compared with GDP and other macro level indicators, such as total consumption. This methods corresponds to the way capital depreciation is calculated in the national accounts.

2) Avoidance cost

In the avoidance cost method you set the goals in physical terms, based on critical load limits i.e., and then calculate the cost of achieving this.
For example, the avoidance cost of acidification may be the cost of:

- installing purification equipment in the chimneys of the acidifying industry
- replacing a process or an input good in the acidifying industry,
- closing the acidifying industry, i.e. making the cost of action the same as the lost added value resulting from the closure.

This method is robust in several ways: you base the estimates on available knowledge of the environmental impact, and you get the factual costs of achieving different goals.

6. Economic valuation in Finland

6.1 Introduction

This paper goes through the history of economic valuation of environment in Finland. It provides an overview of the studies and surveys carried out in Finland, comments briefly on the valuation methods used, and presents the main results obtained in the studies. The last section of the paper covers the current development of natural resource accounting at Statistics Finland, and highlights its close connection to monetary accounting through economic valuation.

Compared to many other European countries, economic valuation of environmental components is fairly new in Finland: the importance of economic valuation was not recognised before the late 1980s. This is due to a number of reasons. Firstly, Finland is sparsely populated compared to many European countries. Secondly, Finland has few non-renewable natural resources of economic importance. Thirdly, Finland is rich in forest resources and waterways; thus, scarcity of natural resources was never an issue. Fourthly, Finland was industrialised at a fairly late stage, and a large part of the population continues to live in the rural areas. Therefore, Finland has not suffered from pollution to the same extent as many others of its industrialised counterparts. Also, the environmental movement is relatively young in Finland. Thus, it is was not until the late 1980s that the general public and the political decision makers began to demand more information on environmental values.

This paper is organised in seven sections. The studies using the Hedonic Price (HP) approach are reviewed in section 2 below. Section 3 covers the studies where the Contingent Valuation Method (CVM) is applied and section 4 the studies using the Travel Cost Method (TCM). In order to improve the credibility of the value estimates, it is common to apply more than one valuation method in a study. Thus, the results of some studies reviewed here are presented under different headings, when different valuation methods were used in the respective studies. Section 6 covers the Resource Related Valuation studies. Studies on environmental valuation from the macroeconomic point of view are reviewed in section 6. Section 7 provides a brief summary of the topics covered in this paper.

6.2 Review of hedonic price studies

Some of the earliest studies in economic valuation applied a method resembling the Hedonic Price (HP) approach, but most of the analyses were not explicitly based on economic theory. These studies were carried out in the late 1970s and early 1980s. Legislation provided the primary incentive for these studies in economic valuation. They were carried out by people with degrees in technological sciences and not by economists. Consequently, the studies had theoretical weaknesses from an economic point of view. A typical study would evaluate the environmental impacts of a hydroelectric power plant or a pulp and paper mill.

The effect of pollution on property prices has been successfully analysed with the Hedonic Price Method. Application of this method requires a number of assumptions that are often regarded as implicit. One such critical assumption is the existence of a short run equilibrium in the housing market. The Finnish housing market, however, does not meet this requirement fully, because in the recent past housing prices have been very volatile due to major changes in the financial markets. In addition, the tax deductibility of rents of mortgages, as well as thin rental markets, have contributed to the volatility.

No studies on the economic effect of airport noise using the Hedonic Price Method have been carried out in Finland. It is indeed unlikely that airport noise would affect property prices as Finland is sparsely populated and airports are built well outside the cities. Up to now, there have been no studies on the effect of air pollution using the HP approach, or any other method for that matter. Vainio (1995) touched on this topic, but did not obtain significant results. The necessity of these studies, however, has often been expressed (see for example Aaltonen *et al*. (1989) and FinnRA (1991, 1992a)).

One of the first attempts to quantify the value of traffic externalities was by Myhrberg and Väänänen (1980). They assessed the economic effect of daytime (from 7 am. to 10 p.m.) noise above a threshold value of 55 dB(A) in Helsinki and Turku. Their method was not directly based on Hedonic Price theory, and the econometric work was somewhat arbitrary.
Heinonen (1986) studied the effect of traffic noise on house prices in four neighbourhoods along Kehä I ring road (beltway) in Helsinki. He used a linear model according to which an increase of one decibel of noise above 55 dB(A) would cause the prices of properties with detached houses to decrease by 1.06 %. Under similar circumstances, the prices of empty plots would decrease by 1.39 %. The *t*-values were not reported.

Halomo (1992) studied the impact of road traffic on the value of unbuilt property. His study was based on data on individual plot sales adjacent to two main roads - Länsiväylä and Tuusulantie - in the Helsinki metropolitan area. He used the log of the sales price of the plot to estimate the effect of noise above 50 dB(A) on price. Halomo (1992) found that a one decibel increase in noise would reduce plot prices by 0.98 % on average in pooled data. The credibility of his results, however, suffers from the lack of good control variables. For example, he did not measure the distance between the individual plots and the city centre of Helsinki and, thus, this distance measure could not be used as an explanatory variable. Halomo (1992) also estimated the noise coefficient separately for the four towns, and found the absolute value of the noise coefficients to be somewhat higher. Standard errors were not reported.

In the above mentioned Finnish studies, the noise premiums on housing prices have been higher in absolute value than those found in international studies, being about -1 % per a decibel increase in noise. In addition to the general difficulties in the international HP studies, road traffic noise studies in Finland have suffered from arbitrary econometric analysis and lack of appropriate control variables.

Vainio (1995) is the first comprehensive analysis of the value of traffic externalities in Finland, in which the Hedonic Price Method is used. He used data consisting of information on 1522 sales of flats, row houses, and semi-detached houses. The quality of the data is very high. The data include detailed information on the condition of the flats and the buildings, and on the magnitude of road and air traffic externalities. Road traffic externally was measured by the equivalent noise level (L_{eq}), using $L_{eq}55$ as the cut-off point. According to Vainio (1995), an increase of one decibel in noise reduced the price paid for the property by 0.36 %. This corresponds to an average of

FIM 1842 per property. Using a cut-off level of L_{eq} 50, an increase of one decibel changed the property prices by -0.23 %. Using different, partially linear noise specifications, the cut-off level of L_{eq} 55 was supported by data. According to Vainio (1995), the coefficient of traffic externality was remarkably consistent in different model specifications. The estimate obtained in this study is likely to be more accurate than the higher ones obtained in earlier studies carried out in Finland. The results of Vainio (1995) also conformed with those of international studies.

Vehicles are the main source of air pollution in Helsinki. In Vainio (1995) air pollution, measured in total suspended particles (TSP), mostly had an insignificant coefficient. In some model specifications, the coefficient of TSP was unexpectedly positive and significant. This result was implausible, because dust was ranked most harmful (somewhat higher than noise) as a local pollutant by the respondents of the survey. This may be due to unsuccessful extrapolation of TSP levels, based on data from only three measurement stations.

Vainio (1995) also studied the effect of air traffic noise on property prices. He measured it with dummy variables for being within 55 dB(A) contours from either Helsinki-Vantaa or Malmi airports. The effect of air traffic noise on property prices was insignificant. This is not surprising, because air traffic noise levels are low and thus, are not likely to capitalise into the housing prices.

6.3 Review of contingent valuation studies

Contingent Valuation Method (CVM) is widely used in environmental valuation studies, because it is the only valuation method that can capture the total value of an environmental component. The first Finnish CVM study was completed in 1969, after which it took over twenty years for the next CVM studies to appear. In Finland, CVM has been applied in studies ranging from the recreational value of lakes and forests to measuring traffic externalities. CVM has also been used to estimate the direct benefits of managing forests for grouse, and of improving water quality of a lake. Contingent Valuation studies from the early 1990s cover diverse topics, such as theoretical analysis of the existence value of wilderness preservation (Naskali, 1991), and work on option and existence values of the ringed seal of Saimaa (*Phoca hispida saimensis*) (Moisseinen, 1991 &1992).

Aakkula (1991) studied the potential for scenic agriculture in Finland by valuing the agricultural landscape by means of CVM. Scenic agriculture is regarded as one potential alternative for agricultural policy to tackle current excess supply by reducing agricultural production.

6.3.1 Recreational use of a lake

Over the years, leisure has increased significantly in comparison to working time and, consequently, the use of natural resources for recreation has become more important. The first study on recreational value in Finland was carried out by Sarja (1969). She estimated the values for the recreational use of two lakes (Lake Lappajärvi and an artificial lake at Venetjoki). 217 visitors in Nykälä camping site were asked, how much more they would be willing to pay for their stay at Lappajärvi. This additional willingness to pay was FIM 2.38 per day on average (at the time, the cost of overnighting at the camping site was FIM 3 (tent + car)). She interviewed 115 summer cottage owners and asked, how much they were willing to pay for travelling to the lake. She found the recreational value of the lake to the cottage owners to be FIM 365.30 per household per year. According to Sarja (1969), the gross value of recreational use of Lake Lappajärvi was slightly below FIM 27 million and consumer surplus was about FIM 0.4 million annually.

Sarja (1969) asked 331 visitors at the artificial lake at Venetjoki, how far they came to visit the lake, and what would be the maximum distance they would travel to visit the lake. The average distance actually travelled to the lake was 24 km. On average, the maximum distance that the respondents would have been willing to travel was 72 km. Average respondent would thus have been willing to travel 48 km more, which in monetary terms corresponded to a consumer surplus of FIM 2.35 per visit.

After Sarja (1969), new CV studies did not appear until the late 1980s. In one of the first reports, the value of recreational fishing in Central Finland was analysed (Sipponen, 1987). Regretfully, this report did not have strong foundations in economic theory.

6.3.2 Regulation of water level and recreational values

Models for analysing the impact of water regulation on the recreational use of shores were developed already in the 1970s. However, these models did not become popular and were not developed further until the early 1990s. Aittoniemi (1993) studied the effects of water level regulation on the recreational use of shores by Lake Oulujärvi, the fourth largest lake in Finland, as well as five other lakes in the same region. Swimming and boating, as well as the use of summer cottages, camping sites and beaches are examples of recreational activities that are influenced by the position of the shoreline. Conventionally, it is considered to be best for the recreational use of shores during summer to keep the water level as close as possible to its maximum level and to keep the fluctuations in water level to the minimum.

Aittoniemi (1993) analysed the impact of water regulation on recreational values with a model, in which regulation of water level caused the shoreline to shift from the optimum zone to a higher or lower position along the shore. He defined the optimum zone as the preferred position of the water level for using the shore. The analysis of Aittoniemi (1993) concentrates on recreational use of shores when the lakes are free from ice. He used data on the slopes and the usage of the shores, and the water levels in the lake. In the first stage of the assessment, the various effects on recreational use were evaluated separately for uniform shore types, and the distances of the shorelines from the optimum zones were measured. In the second stage, the different adverse factors were made commensurable and were expressed in monetary terms, so that different water levels and regulation alternatives could be compared. The economic effects on shores with houses and summer cottages were based on a shore-induced share of the economic value of the house, the figures for camping sites and beaches were based on the usage and the monetary value set on visiting them. Contingent Valuation data, consisting of 3000 respondents in 120 interviews, was used to estimate the monetary values (Aittoniemi, 1991).

Recreational value is assumed to be highest when the water level is at the optimal zone, and to decrease linearly when the shoreline shifts up or down. The optimal zones were estimated with the model to be the zones that maximised the recreation value of using the shores. Optimal zones were also studied by Partanen (1975). Aittoniemi (1993) found that the shoreline position at current water regulation is close to the optimal zone. Current water regulation is bad from the recreation point of view in May and the beginning of June, but good from July onwards. According to Aittoniemi (1993), the recreational benefits would increase, if water regulation was tighter than at present. For the Lake Oulunjärvi, the decrease to recreation benefits was FIM 2.9 million at a former water regulation level, FIM 1.7 million at present water regulation level, FIM 1.3 million at tighter water regulation level, and FIM 3.9 million with no water regulation at all. The recreation values for the other five lakes evaluated in the study were considerably lower, as these lakes are smaller, and are not used for recreation to the same extent as Lake Oulujärvi.

6.3.3 Measuring the environmental benefits of a lake

Some of the difficulties in measuring the environmental benefits of a lake are caused by extensive everyman's right in Finland. Everyman's right guarantees everyone the right to swim, boat etc. anywhere. People are used to enjoying all these benefits without paying, and thus it may be difficult to obtain reliable results with Contingent Valuation Method. People pay high taxes, in return they expect the government to provide a range of goods and services free of charge or at subsidised cost. Another potential bias may be caused by the polluter pays principle. People are not ready to pay for damages caused by others, as they expect the polluters, such as industries, to pay for their own damages. The Contingent Valuation questions must therefore be formulated carefully, so that people are willing and able to answer correctly.

Mäntymaa (1991) studied the environmental benefits of Lake Oulujärvi. Several major projects, such as a pulp mill and a main road across the lake, were planned; thus it was necessary to analyse the allocation problem between the planned projects and environmental protection. Mäntymaa (1991) evaluated the value of the quality of environment attached to the lake in monetary terms. He used CVM to measure the importance of water quality to actual users, potential users and non-users. The data consisted of 350 interviews of people living around Lake Oulujärvi.

Water quality was described by a five grade scale ranging from "excellent" to "unsuitable". First the respondents were asked to state their own estimates of current water quality. If a respondent considered the current water quality to be, for instance, "good", he was then asked two questions. The first question was how much his household would be willing to pay each year to improve the water quality by one step, i.e. from "good" to "excellent". In the second question the respondent was asked how much his household would be willing to pay each year to keep the water quality from decreasing by one step, i.e. from "good" to "satisfactory". The answers gave two marginal willingness to pay bids for each respondent (one step up and one step down from the reference level). The average willingness to pay to avoid deterioration of water quality by one step in 1990 was FIM 930 for the actual users, FIM 763 for the general public (non-users), and FIM 464 for forest owners. These results are consistent with the theory that the users of an environmental commodity are willing to pay more for high quality of the commodity than non-users and those who actually lose from the protection of the commodity.

6.3.4 Valuation of outdoor recreation

Forest recreation is important in Finland; yet it is difficult to estimate its value. Because of the everyman's right, people can walk, ski, pluck berries, mushrooms etc. in forests, regardless of ownership, and, therefore, are not used to paying for outdoor recreation. Thus it may be difficult to obtain reliable results with Contingent Valuation Method.

The first studies on the value of forest recreation measured by CVM were Pouta (1990) and Sievänen *et al*. (1991). The data consisted of 406 interviews of people at a regional recreation area close to Helsinki. Three different kinds of CVM questions were asked. The main tool of measurement was a question on the willingness to pay (WTP) for entrance to the recreation area. The two other questions were on the WTP for travelling to the recreation site and on the value of a recreation visit in comparison to values of other leisure activities. The average willingness to pay in entrance fees was FIM 10 and in travel costs was FIM 16.

6.3.5 Benefits of managing forests for grouse habitats

Savolainen (1990) and Ovaskainen *et al*. (1991) focused on hunting values in their studies of the multiple uses of forests. The studies aimed at estimating the benefits of managing forests for grouse habitats. Some features are common to all types of hunting: the prices of hunting permits account for only a small part of hunting costs, and the value of meat obtained is only a minor part of the total value of hunting. Therefore, in order to find the socially optimal price of hunting, the recreational value of hunting must be estimated.

Savolainen (1990) and Ovaskainen *et al*. (1991) measured the total value of grouse using the Contingent Valuation Method (CVM). They used a survey on the hunting value of three common grouse species. They measured the benefits of managing forests in special ways to improve grouse habitats, and their ultimate interest was to calculate the incremental hunting value attributable to the resulting change in the stock of grouse. Hunters answered to a number of questions, such as their maximum willingness to pay for hunting in the area with different sizes of grouse populations, when all other factors were kept unchanged. They were also asked about their actual hunting costs (travel costs, hunting permits, etc.). At one site, Lammi, average willingness to pay for hunting at current grouse stock level was FIM 604. This exceeded barely the mean actual hunting costs, which were FIM 600 in 1988. This suggests that there was no consumer surplus. The questions were also presented to potential hunters, whose WTP was nearly 75 % of the WTP of the actual hunters in 1988. The survey was repeated at another site, Keski-Pohja, where the mean WTP for hunting at current stock level was FIM 1370 for local hunters and FIM 1650 for "tourist" hunters, that is, people who lived more than 100 km from the hunting area. The actual hunting costs were also higher at Keski-Pohja, the costs were FIM 930 for local hunters and FIM 1217 for others. The consumer surplus or the net hunting values would, therefore, remain positive at Keski-Pohja even if the grouse stock would decline.

Savolainen (1990) and Ovaskainen *et al*. (1991) found the recreational value of hunting to be nearly 90 % of the total value of hunting, while the value of meat accounted for roughly 10 % of the total value. The results of the CV study were applied in a subsequent cost-benefit analysis. Adjusting forest management to be more favourable to wildlife habitats will incur costs in terms of reduced timber revenues. In order to analyse the economic justification of the adjusted management schedules, opportunity costs of such adjustments were compared to the benefits of improved grouse habitats. The undiscounted net revenues per hectare were equal or slightly above the revenues from conventional schedules.

6.3.6 Measuring traffic externalities

In addition to the Hedonic Price approach discussed earlier, Vainio (1995) studied the effect of traffic externalities with CVM. The data used by Vainio (1995) was influenced by location specific group effects and thus application of OLS-method would have given erroneous results. The models taking into consideration group effects in the hedonic price model were appropriate. According to Vainio (1995), omitting the collinear variables did not affect the important coefficients in his study. Systematic deletion of collinear variables guaranteed that results could be trusted to be robust.

The mean annual willingness to pay was FIM 341, or 0.32 %, if measured as a percentage of household income. In the CVM survey, WTP for a reduction of traffic externally gave expected results. The sample was 699 households and the response rate was 60 %. The average willingness to pay to reduce traffic externalities was FIM 341 per annum. For the households living in areas where noise levels were higher than 55 decibels, the mean was FIM 605 per annum.

6.4 Review of travel cost studies

Compared to the CVM, the applicability of Travel Cost Method (TCM) is much narrower. Sarja (1969) was the first to apply TCM in Finland, as she asked all the respondents in her CVM study about their actual travel costs to Lake Lappajärvi and the artificial lake at Venetjoki. It is probable that the significance of the TCM results was not understood at the time, as Sarja (1969) reports the actual distances travelled to the recreation site, but does not emphasise the accompanied costs. Based on her calculations on consumer surplus, the average actual travel cost of the respondents was FIM 1.17 per visit.

In their studies on the value of forest recreation, Pouta (1990) and Sievänen *et al*. (1991) used TCM in addition to CVM. With the Travel Cost Method the value of one visit to the recreational area was calculated from the direct travel costs of the actual visit. Travel costs could be calculated, as the means of transportation and the distance between the visitor's residence and the recreational area were known. The distance was treated as a continuous variable, and the demand curve was estimated on the basis of travel costs of individuals having travelled the same distance. In the study, the average person visited the site eight times per year. He paid on average FIM 24 in actual travel costs per visit.

6.5 Resource related valuation

The Resource Related Valuation approach is based on two principles. Firstly, it assumes that the main objective in a society is to maximise GDP. Secondly, natural resources and people are valued only as factors of production and, thus, they do not have existence or option values. For example, the value of health effects of air pollution are calculated from the increases in the cost of medical care and from the decreases in income caused by production losses. This method has its limitations as it requires, that the stress-response relations between emissions and environmental damages can be quantified and valued. Ahonen and Leiviskä (1993) used the Resource Related Valuation approach to estimate the environmental effects of the fuel-peat chain.

In their study, Ahonen and Leiviskä (1993) evaluate the environmental effects of the fuel-peat chain in terms of monetary costs to society. The fuel-peat chain is based on a 60/120 MW peat-power plant. The plant generates 1080 GWh of heat and electricity per year and uses 1.367 million m^3 of peat and 2227 tons of oil annually.

The economic parameters used in the study of Ahonen and Leiviskä (1993) range from the cost of peat, FIM 0.7/m^3, to the value of a human life, FIM 15 million. Ahonen and Leiviskä (1993) found the environmental costs to be about FIM 8.8 million per year, which is equivalent to FIM 8/MWh. Greenhouse gases accounted for 70 % of environmental costs. Estimated environmental costs account for 15 % of fuel costs. The cost estimates do not include all environmental effects of the fuel-peat chain. In particular, some characteristic effects of fuel-peat, such as the effects of peat-dust and noise, aesthetic impact of peat production sites and adverse effects to reindeer management, were not evaluated in their study.

6.6 Review of macro level studies

The scope of many economic valuation studies carried out in Finland is fairly limited. In a representative study, CVM would be used to estimate the economic value of a recreational site. The results obtained in a particular CVM study cannot be extended to cover other recreational sites without considerable difficulties. In addition, value estimates from different studies using different methods cannot be aggregated. There is no straightforward method for getting macro level results from micro level studies. In fact, macro level studies tend to require their own methodology. These macro level studies are often difficult to carry out, they have huge data requirements, and they are very time consuming. Therefore, it is not surprising that only a few studies have been conducted from this wider perspective so far.

6.6.1 Benefits of global warming

Kinnunen (1992) analyses the costs and benefits of global warming to the Finnish economy. He used a number of earlier studies carried out on the economic consequences of climate change to estimate the long term economic effects of global warming to Finland. These earlier studies were based on different conceptual frameworks and thus gave different predictions. Due to the uncertainty inherent to the global warming, he studied three different scenarios: pessimistic, neutral and optimistic. According to the neutral scenario, which is regarded as the most probable, Finland would benefit from global warming during 2030-2050 by as much as 0.9 % of the 1990 GDP. However, the indirect consequences of the climate change can be strongly negative. For instance, Finland may have to increase its development aid, or give support as a member of the European Union to the Member States that suffer from the global warming.

The time period for which Kinnunen (1992) calculated the economic effects of global warming was 50 years. This period, however, is not long enough as climate change is a slow process and the benefits of limiting the emissions of greenhouse gases will not be evident in 50 years. Kinnunen (1992), therefore, used a planning period of 200 years to compare two scenarios. In the first scenario, he assumed that the emissions would continue to grow at the present pace for the next 50 years after which the growth would stop. Consequently after 200 years, the greenhouse gas emissions would be the same as the emissions after 50 years. In the second scenario, he assumed that there would be no reductions in greenhouse gases in the next 200 years. He thus was able to calculate the benefits of emission reductions in the long run. With a discount rate of 1 (or 0) per cent, the benefits to Finland would be FIM 100 (or 450) million. The benefits would be insignificantly small, if a higher discount rate was used.

6.6.2 Natural resource accounting and valuation

Development of natural resource accounting began in Statistics Finland in 1985 after the completion of a preliminary study on the subject (Kolttola *et al*. 1985). The system of natural resource accounting is based on the Norwegian model. The primary objective of the development work was to develop physical accounting for the most important natural resources in Finland. Natural resource accounting for the forest sector was developed first and wood material accounting for the period 1980-1990 was published in 1992 (Statistics Finland, 1992). Closely related to the wood material accounting is a new project, where quality indicators for forests are developed and information on the multiple uses of forests is collected.

The development of energy and emission accounting was completed in 1995. The energy and emission accounts contain detailed information on the various energy sources used by the different sectors of the economy as well as data on the energy related emissions of CO_2, NO_X, SO_2 and particles. At present, energy and emission accounting cover the period 1980-1993. Statistics Finland is also collecting data on the environmental expenditure of manufacturing and related industries and the public sector (Statistics Finland, 1994).

All physical data on natural resource accounting can be integrated to the system of national accounts as the definitions and classifications are compatible. Examples of the integration of physical and monetary accounts are the successful application of the wood material accounting in a research project studying the use of wood and the carbon cycle as well as in another project analysing sustainable development and the Finnish economy (Seppälä and Siekkinen, 1993; Mäenpää and Männistö, 1993). Use of natural resources has also been studied by Laine (1994). He evaluated the use of natural resources from 1960 to 1991, and forecasted the use of natural resources as raw materials in the year 2005.

At present is it not regarded feasible to develop green accounting that would include all environmental components and their monetary values. But, with the help of satellite accounting, the current system of national accounts can be expanded to include the most important natural resources. Some experimental calculations on the economic value of forests and forest related resources at macro level were presented by Arjopalo (1994). The value estimates for forest stock were based on the wood material accounts and data on the market price of standing timber (stumpage price). In 1992, for example, the value of forest stock was estimated to be slightly above FIM 220 billion, and the value of annual growth, FIM 9 billion. Stumpage prices decreased in the 1990s, when the Finnish economy was hit hard by the recession. Consequently the value of forest stock and annual growth increased throughout the 1980s and decreased in the 1990s. For instance, the value of forest stock in 1980 was about FIM 149 billion, reaching its peak in 1990, when the value was about FIM 296 billion. The value of annual growth followed a similar pattern: it was FIM 6.4 billion in 1980, peaking at FIM 11.9 billion in 1990.

Arjopalo (1994) also estimated the economic value of hunting and collecting, which included the picking of berries, mushroom etc. for own consumption as well as for commercial purposes. The figures for hunting and collecting for own consumption were based on the Finnish household consumption expenditure survey of Statistics Finland. Sellers' prices were used in the calculations, and no attempt was made to estimate the recreational values of hunting. The value of hunting of elk (*Alces alces*) and other members of the deer family dominated the total value of hunting. In 1990, for instance, the value of hunting of deer animals was FIM 141 million, while the figure for grouse was FIM 32 million, for hare FIM 20 million, and for fur animals FIM 16 million. The total value of collecting in 1990 was FIM 249 million. These figures do not include the production of peat nor reindeer farming and are, therefore, lower than the figures presented by Seppälä and Siekkinen (1993). When compared to the value of forest stock, the economic value of other forest related resources is fairly small.

The Finnish household consumption expenditure survey is carried out every five years by Statistics Finland. This survey provides valuable information on a number of topics related to environment, such as on the value of recreational fishing and picking of berries, mushrooms etc. Only direct use values are captured by the survey; the figures do not, therefore, include existence or option values for instance. These direct use values of environmental components are then included in the standard GDP calculations. Thus, estimates on the values of some environmental goods are already included in the GDP. This is a fact that is often forgotten by people who claim that environmental aspects are not considered at all in the current practice of national accounting.

6.7 Conclusions

This paper has provided an overview of the economic valuation studies carried out in Finland from the late 1960s to the present. The valuation studies have covered many important aspects of the Finnish way of life, such as recreational use of lakes and forests. These studies on recreational values outnumber the studies on the economic effects of pollution, which can be interpreted to mean that pollution has not yet caused serious environmental damages in Finland. However, it may also mean that the seriousness of pollution damage is not widely understood at present.

Hedonic Price approach has been used to estimate the effect of traffic externalities on property prices. When appropriate control variables have been used in the HP studies in Finland, the noise premiums obtained conform with those of international studies, being about -1 % per a decibel increase in noise.

The first Contingent Valuation study in Finland was carried out in 1969, after which over twenty years lapsed before next CVM studies appeared. CVM studies cover various topics such as the recreational value of forests and lakes, the existence value of wilderness preservation and the option and existence values of the ringed seal of Saimaa (*Phoca hispida saimensis*).

The Travel Cost Method has been used in conjunction with the Contingent Valuation Method, because the scope of application of the TCM is fairly narrow. The Travel Cost approach has been used to estimate the recreational value of lakes and forests.

In the Resource Related Valuation approach natural resources and people are valued only as factors of production. This method has been used to estimate the environmental effects of the fuel-peat chain.

So far, only a few economic valuation studies have been conducted from the wider macro level perspective, despite the obvious need for this kind of studies. In the late 1980s there was a public outcry for the calculation of the green GDP. As the Finnish economy plunged into recession (and researchers learnt about the practical problems in economic valuation the hard way), calculating the green GDP in monetary units was no longer so high on the agenda. Even though satellite accounting will be developed further, no decisions have been taken on the extent of the valuation of environmental components in the future.

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7. Studies on monetary environmental accounts in Sweden

7.1 Introduction

The work on environmentally adjusted national accounts in Sweden is done by Statistics Sweden and the National Institute of Economic Research in close collaboration. Statistics Sweden is developing the physical accounts while NIER is doing research on how to develop monetary environmental accounts. The work has been described in an interim report, "SWEEA - Swedish Environmental and Economic Accounts" which was published in December 1994. The work have concentrated on emissions (flows). Thus natural resources (stocks) has not been treated in this first stage. This is because pollution is the main concern in Sweden, while depletion of natural resources is a lesser problem.

In this paper the two projects on monetarizing the environmental accounts are presented. They represent two different ways of going about this. The "sulphur project", carried out by the NIER, tries to evaluate the impacts of emissions of one pollutant, sulphur, on the environment. The "forest project", which was done by University of Umeå, extends the accounts of one ecosystem, namely the forest, to encompass production of berries, fungi, hunting game and lichen, as well as environmental services and assets.

A lot of valuation studies of environmental services and assets have been done in Sweden. These are mainly focused on local environmental impacts, which is what the methods of contingent valuation and willingness-to-pay studies are best suited for. The problems when doing estimates on a national level are quite different, which has been discussed in the description of the valuation methods. The studies undertaken have therefore mainly concentrated on effects on goods and services which have a market price or to which prices from closely related assets can be ascribed. The path chosen comes close to what is called "resource related valuation", where only production related values of natural resources and people are considered, not existence or option values. This gives a limited but maybe more robust valuation than if one includes other valuation methods.

7.2 The Sulphur Project

The sulphur project was initiated as a result of the co-operation with Statistics Sweden. We wanted to explore the possibilities of putting a monetary value on the emission data they provided. We choose sulphur because it is a major pollutant, has local impact (unlike CO2 etc.) and its effects is relatively well-known. Also, Sweden has a large net import of sulphur. Our soils are very sensitive to acidification, much more than most soils in the rest of Europe, so this is an interesting issue from a Swedish point of view.

We wanted to see if it was possible to make a valuation from the damage cost side, since it is the most adequate measure, though the most difficult to measure. It is desirable to have a benefit side to compare with the costs of cutting the emissions. The basic rule we have followed is to estimate the effects of activities that have an environmental impact and to value these effects at present market prices. This may include, for example, loss of production and the cost of combating the effects of an environmentally hazardous substance. This provides us with a measure that may only include a subset of the values affected, but with the advantage that it is directly related to the actual economic impact of the damage.

With a few exceptions, we make no attempt to estimate recreational values, existence values and the like, but limit ourselves to valuing the way economic activities are affected. Existence values are difficult to establish other than through studies of willingness to pay, and these can only be performed locally - only in special cases at a national level. Recreational values and option values can be calculated, but the results are uncertain and it is doubtful whether they can be presented in the form of accounts. In cases where monetary values are considered unreliable, the damage aspects will be presented in purely physical terms, so that the reader can draw his or her own conclusions.

In order to be able to perform a valuation of the effects of sulphur emissions, we must have information about the cause-effect relationships between emission and environmental impact. The real difficulty was to identify these relationships. Emission data provide us with the cause, but not the effect, while the environmental indices provided by the Environmental Protection Agency to describe the state of the environment tell us about the effect, but not the cause. The purpose of the monetary environmental accounts is to provide an idea of the external costs incurred by the environmental impact of our economic activities during the course of one year, preferably broken down according to sector. The monetary valuation of a measured negative change in the different environmental indices during the course of one year would provide us with an "environmental debt", since the present state is the result of activities in earlier years. It may be difficult to determine which of the activities have caused the environmental state reflected in a given environmental index figure.

However, the main point of interest is the stress indicators that may be developed in the longer term, where the chain of causes — *economic activity-impact-change in the environment* — is to be highlighted. Pending such indicators, we have used the findings of various research teams to put together a cause-effect chain to the best of our ability on the basis of the material available.

The work thus largely consisted of assembling available knowledge from experts in universities and institutions all over Sweden. As important as the things we did find is what we could not find; it is a mapping of what is possible to find in this area. Some costs have been included, others will take more time and expertise to quantify, others are not possible to find in the foreseeable future. The largest problem is to quantify physical effects. This will hopefully be the scope of interdisciplinary work in the future.

When we chose what to value, we used the Environmental Protection Agency's division into types of natural asset and the different values that may be lost in each type of natural asset.

Table 7.1 Endangered value/type of natural asset

	Health	Biodiversity	Resource management[2]	Natural and cultural landscape
Forest	-	..	*	-
Cultivated landscape	-	..	*	-
Freshwater	..	..	*	-
Built-up areas	-	..	*	*
Natural land[2]	-	..	..	-

[1]Coast, Sea, wetlands and mountains
[2]Keep or restore the long term production ability of the ecosystems, economize with resources
- : probably minor effects and therefore not included
..: effects exist, but we are in no position to attempt a valuation
*: valuation performed

Certain of the environmental indicators developed by the Environmental Protection Agency use sulphur as a direct (sulphur concentrations in the air in built-up areas) and indirect (pH value of freshwater) measurement. The Environmental Protection Agency approach is related to different environmental threats — emission figures can be compiled to provide an account of acidification, eutrophication, ozone depletion and the greenhouse effect. Our purpose is to evaluate the impact that human activities have had on these environmental problems during the year in question. When several substances are being considered, e.g. all those that contribute to acidification, it can be done in a more comprehensive manner. The combined effects of different substances can be taken into consideration. In this study, however, we only analyse the impact of sulphur, mostly on the basis of its acidifying properties.

7.2.1 Sulphur concentrations and impact

Sulphur is an element that is mainly found in the soil and marine sediment and which also circulates in ecosystems for natural reasons. Certain of these natural flows of sulphur are essential to life on earth. In the wrong form, in the wrong place and in excessive concentrations, however, sulphur can be harmful. Volcanic eruptions give rise to a net surplus of sulphur pollution, but otherwise the world increase in the flow of sulphur is due to human activity. Apart from the lime-rich soils of Skåne, Öland and Gotland, Swedish soil types possess a poor buffer capacity (their capacity to neutralise sulphur). High levels of sulphur in acid deposition can therefore have relatively rapid impact on soil chemistry — impact which may affect ecosystems in the long term, including forest productivity. It is therefore important to establish the amounts of sulphur being deposited over different areas of Sweden and to know which ecosystems may be affected.

Globally, half of the sulphur circulating in ecosystems is anthropogenic in nature, but in the industrialised areas of the northern hemisphere, the figure is over 90%. Three main factors are involved:

i) the use of fossil fuels (sulphur is bound up in organic material such as oil, coal and natural gas)
ii) the extraction of ore and production of metals, which means that the sulphur bound up in the ground can be released,
iii) the use of chemicals containing sulphur in industrial processes.

In the environmental economic matrix METRIS (presented in the report SWEEA), one can see which Swedish sectors generate sulphur emissions, how much of this sulphur is exported and how much sulphur we import from neighbouring countries. Swedish deposition in different parts of the country is measured on an ongoing basis by the Environmental Research Institute. By studying the resistance of ecosystems to sulphur deposition and acidification, it is possible to establish critical loads for different types of ecosystem in different parts of the country. The areas where the critical loads are being exceeded require special study so that any damage and risks can be analysed. It is in these special areas that we have used the finding of different research teams.

7.2.2 Valuation of sulphur impact in Sweden

In this study, the total cost incurred by sulphur deposition in Sweden in 1991 was valued at least SEK 2,500 million. Corrosion represents by far the largest part of this sum. This is hardly surprising, since corrosion is the item for which we have the best data and which involves real capital, so that the item impaired has a high market value. The other items are more uncertain and have been computed with caution.

Table 7.2 Valuation of sulphur-related damage. MSEK

Forest	550
Agricultural land	5
Freshwater	130
Corrosion	1885
Biodiversity	?
Total	2 570

Forest

Acidification damage to forest is valued in accordance with the loss of income incurred by forest-owners as a result of the long-term decline in timber output . The calculations are based on a scientific study by Sverdrup and Warfvinge (1993). Their method was to measure the chemical ratios (between base cations and aluminium) in the soil and use them as a basis for determining the decline in forest growth. The method is not undebatable (see discussion in section 5.2), but has gained some legitimacy as a result of its use in a number of countries to provide material for the sulphur negotiations in Geneva. The advantages of the method largely lie in the fact that it permits calculation of how future forest growth will be affected by acidification. It is, however, important to distinguish and separate the contribution of nitrogen and forestry methods to soil acidification, since the acidification process is not governed by sulphur deposition alone. For the sake of simplicity, we have made the somewhat optimistic assumption that nitrogen deposits and the acidifying impact of forestry methods will be reduced at the same rate as sulphur deposition declines.

Since it is the accumulated deposition of acidifying substances that has a negative impact on forest growth, future emissions will also have a bearing on the long-term impact of present emissions. This means that we must draw assumptions concerning future emissions.

Table 7.3 Initial assumptions

Emission reductions	1.5 %/year
Effect on growth	25 %
Discount rate	2 %
Timber prices	160 SEK/m^3

We assume that the latest international sulphur agreements regarding reductions in emission levels up to the year 2000 will be implemented and that reductions will then continue at the same rate, i.e. by 1.5% per annum. We also assume that forestry output will decline by 25% *if and when* the available store of base cations in the forest soil is depleted by acidification. The discount rate is set according to the GDP trend, i.e. 2%. The reduction in growth occurs as different areas of the country reach the critical ratios in terms of soil chemistry. The Swedish decline in timber output is not assumed to affect the actual timber price as a result of the size of the world timber market. The stumpage value of timber has been drawn from the 1991 forest statistics. Since major uncertainties are associated with these assumptions, we have performed a sensitivity analysis (see appendix). For reasons of space, we present only best-guess results here.

Deposition is buffered through erosion of alkaline compounds in the soil. The actual extent depends on the soil type. Forest growth also differs in different parts of the country. Data is being gathered for many different places in the country and can be presented in a grid map of Sweden (EMEP grid, 150x150 km). Data is also available for the forested land in each square. The present value of the total loss of timber caused by the growth-inhibiting effect of acidification is computed to be in the region of SEK 100,000 million over the coming 100-200 years, which is a relevant time scale for the impact of sulphur acidification on the forest ecosystem. From 1900 to the year 2200, over two thirds of the acidification problem may be said to originate from sulphur deposition, which means that SEK 70,000 million of the future loss of income can be said to have been caused by sulphur emissions.

If the burden of debt for the acidifying impact of sulphur over the years is distributed evenly over all emissions that exceed the critical load, the effect would be that four-fifths (almost SEK 60,000 million) would be attributable to emissions prior to 1991. Although the decline in forest growth has in many cases not yet appeared but will only do so in a decade or so and then continue over perhaps more than a century, future loss of income must be seen as a form of environmental debt for which the forest owners must take the economic consequences. The final fifth of the total sum (over SEK 10,000 million) is, however, attributable to the present and future sulphur emissions. According to this computation method, sulphur deposition over Sweden in 1991 (the base year for the model) are responsible for SEK 550 million in terms of timber-related damage alone.

The total cost of forest acidification in 1991, including the contribution from nitrogen and forestry methods, amounts to SEK 800 million. It should, however, be pointed out that even if the majority of undesirable changes in soil chemistry are attributable to past emissions, we could avoid greater damage — and cost — to the Swedish forest by implementing a vigorous programme of measures against acidifying activities in Sweden and neighbouring countries. A large part of the forested land in Sweden is very close, in terms of soil chemistry, to the critical value at which forest growth can be impaired. The marginal effect of what we do today is therefore very great, since it is the stock of acidifying substances, not the annual flow, that determines what happens in the Swedish forests.

Forest acidification also means that the competitive situation between species living in the forest changes, which may have a long-term impact on biodiversity. This is perhaps most evident in the decline of lingonberries, blueberries and certain types of fungi. As time goes on, there will also be changes among other flora and fauna, which will affect our idea of the forest and also perhaps the recreational values it provides. The decline in production of berries and edible fungi, like the decline in the ability of the forest ecosystem to provide recreation, may possibly be quantified and valued in a few years time, since researchers have been devoting much interest to the subject in recent years.

The cultivated landscape

Acidification of agricultural land is valued according to the cost of the liming required to maintain the pH value of the soil. The level of liming in agriculture today is not enough to combat acidification, however. Today, doses of 25 kg lime per hectare are used, while about 175 kg/hectare would be required to fully buffer acidification. In the long term, this involves a gradual deterioration in the soil and in its production capacity. This is very difficult to measure, however, since cultivated land is subjected to so many different forms of agricultural impact. There is also a lack of information about growth decline of the sort that is available for the forest. If the pH value of the soil reaches low levels, it will perhaps be necessary to switch to less acid-sensitive crops — from wheat to oats, for example. Liming will probably have been stepped up to an appropriate level before this happens, however.

The main cause of acidification in agricultural land is not airborne deposition, however, but modern agricultural methods. 15% of the cost of acidification can be attributed to sulphur dioxide, according to the Swedish University of Agricultural Sciences. Using a model similar to that developed for the forest, in which sulphur deposition in different EMEP squares is computed together with the cultivated land in the corresponding squares, we can work out how much extra revitalisation fertilisation is required in different parts of the country as a result of sulphur deposition. The cost involved in purchasing and dispersing lime is estimated at SEK 0.30/kg. The real extra cost to farmers of liming as a result of sulphur deposition was SEK 5 million in 1991, and it is these costs that we have decided to use in this report. If we looked at the amount of liming that the Swedish University of Agricultural Sciences considers necessary in order to maintain the long-term quality of the soil (175 kg/ha/year) instead, the figure obtained for the cost would have been about five times greater.

Freshwaters

Freshwater acidification is largely remedied by liming. We assume that the cost of the damage is at least equal to the cost of liming, since it is considered worthwhile. The remaining acidification ought to be valued according to the damage it causes. This is mainly a matter of declining production among fish and aquatic flora, which in certain cases may lead to local or even regional depletion of biodiversity. The direct economic values lost when a lake is acidified are primarily attributable to tourism. Angling is a very important source of income in the tourist industry in large parts of the country, and a number of studies have been performed showing how anglers value their pastime. A large number of lakes and rivers are involved, however, which means that it is difficult to value a loss corresponding to tens or hundreds of fishing sites out of the thousands of sites that angles have to choose among.

It is not the deposition on the water surface that causes the acidification in a watercourse, but the degree of acidification in the surrounding soil (usually forested land). With the help of material from the forest computations described above, it is possible to estimate how many lakes will be affected by acidification at different times in the context of different sulphur emission reduction scenarios. Most of the larger freshwaters under threat from acidification are now being limed under the auspices of the Environmental Protection Agency. About 7,000 lakes are involved, which represents about 80% of the threatened surface area. The Environmental Protection Agency has estimated that the SEK 200 million invested in freshwater liming every year are justified in socio-economic terms since it is an effective method of protecting large areas. If the burden of debt is allocated in the same way as in the forest case, sulphur must shoulder SEK 130 million of the liming costs each year. The extra sulphur-related liming that would be required for the remaining 10,000 lakes that are threatened with acidification would cost about SEK 70 million.

Corrosion

In order to study the cost of corrosion caused by sulphur, the objects affected in society are divided into a number of categories: buildings, infrastructure, vehicles, electrical contact materials, and items of cultural or historical value. The cost of corrosion in water pipe systems and ground installations have also been studied. The cost items represent the actual additional costs involved in accelerated wear and tear. Over SEK 1 billion of these costs are attributable to real capital and over SEK 700 million to household assets such as dwellings and vehicles. It has not been possible to estimate the additional costs in the form of the development and use of materials and protective paints with greater corrosion resistance.

For buildings and infrastructure, computations could be performed on the basis of estimated relationships between shorter maintenance intervals and the amount of sulphur deposition, as drawn up by the Swedish Corrosion Institute, among others. The level of sulphur dioxide in the air has been established with the help of measurements by the Environmental Research Institute. The estimates of materials for buildings have been drawn from the national property register and the former National Institute for Building Research. The corresponding procedure was followed for infrastructure in the form of galvanised steel constructions such as crash barriers on roads and railings on bridges, pylons and household aerials.

Table 7.4 Corrosion costs 1991. SEKM

Buildings	1 700
Infrastructure	25
Vehicles	50
Cultural and historical values	10
Water pipes	100
Total	**1 885**

Corrosion in water pipes is mainly a problem in private wells. In local authority water works, the pH value is raised for other reasons, which means that no real extra cost is attributable to sulphur deposition. The proportion of the cost of installing filters in private wells attributable to sulphur is approximately SEK 100 million, calculated according to a depreciation period of 15 years. For cars and trucks, the cost of shorter service lives and repairs resulting from corrosion during one year have been estimated at SEK 5 billion. Between 1 and 10% of this is considered to be attributable to sulphur. Assuming 1%, this gives SEK 40 million per annum for cars and SEK 10 million for trucks. Endangered historical and cultural values have also been valued according to the cost of measures to safeguard them. The annual cost of conserving the stock of sculptural stone has been stated to be about SEK 10 million if 50% of the damage is estimated to be attributable to sulphur. It has not been possible to estimate the cost of conserving rock carvings. Other large potential items that it has not been possible to determine with adequate precision include ground installations and electrical contact material.

Biodiversity

The concrete loss of ecosystems, species and/or genetic diversity, locally, nationally and/or globally is linked with the quasi-option value (globally), existence value (locally and globally) and recreational value (mostly locally). The difficulty in establishing a value for what is lost or is in danger of being lost is almost insurmountable. When facing the biodiversity issue, it is impossible to avoid difficult ethical issues. It is hardly possible to put a price on phenomena that, according to certain researchers, may be crucial to human life on earth. The main threat to biodiversity is presented by society‘s use of land. Mankind uses methods of land use that clearly favour a few species and are greatly to the detriment of others. The fragmenting of ecosystems that the construction of infrastructures involves, moreover, jeopardises the dynamics of certain populations of species by limiting their chances of spreading.

Acidification has a direct and demonstrable impact on a few species, particularly in the freshwater ecosystem. Some of the more susceptible species that live in the forests are also being driven further north from the increasingly acidified land in the south. However, it is mostly in small refuge environments such as screes, where there is no human activity for practical reasons, that airborne deposition alone can be said to cause the eradication of species. Many of these environments are, however, relatively diverse and represent a last refuge for many species.

In order to be able to determine the impact of sulphur on biodiversity, therefore, one must first agree on the safeguards necessary and determine the cost involved. One possible measure could be to reserve areas of forest, and this is discussed in the following study. The cost of reserved forest amounts to lost income of one or two billion SEK per year. In agriculture, special subsidies are available for conservation in the cultivated landscape, and other forms of subsidy for alternative agriculture or ecological measures can act as indicators of what it costs to safeguard local biodiversity. Annual subsidies paid out must then be revised upwards if there is reason to believe that not enough agricultural enterprises are participating in the system for safeguarding biodiversity. Here too, the final sum would probably be between one and two billion SEK.

Safeguards in freshwater systems might include restricting human impact in one or more catchment areas, by prohibiting fish-farming, stricter emission requirements for local industries, restrictions on the use of fertilisers in nearby agricultural enterprises, and restrictions on felling in the area, in addition to the types of liming and restoration activity that are already conducted today. The cost would probably not need to be any higher than a couple of hundred million SEK each year. For agricultural and forestry, the burden of debt attributable to sulphur is low, less than 10%, while for freshwater it can be said to be around one-third. We are in no position to determine the cost of the impact of sulphur on biodiversity at this stage.

7.2.4 Allocation of sulphur costs by sector

The total cost of SEK 2,570 million can be allocated according to the agents generating it. Since total sulphur dioxide[8] deposition in 1991 amounted to 379,000 tonnes, the cost of emitting one tonne of SO_2 is SEK 6,425. Sulphur emissions from the different sectors are shown in SEK in Table 1.5. We have assumed that Swedish emissions that are exported have the same impact abroad as imported emissions have in Sweden, which allows us to value our “trade balance“ in sulphur. The vast majority of the sulphur deposition, 75%, comes from abroad. The domestic share of the SEK 2.5 billion is therefore fairly small, and the totals are small in relation to the added value. The sectors that emit most sulphur in relation to value added are mining and iron & steel. Traffic, pulp & paper, and electricity, gas & heat represent the main sources of sulphur emissions, but since they also represent high value added, the cost of emission per Swedish krona is less in relative terms.

Some re-allocation takes place since enterprises are not compelled to bear their own costs. A discussion of this aspect would require detailed analysis, however. It would, for example, appear that forestry only gives rise to a cost of SEK 1 million, but bears SEK 550 million of the cost of damage. This is correct as long as they do not transfer any of their costs to the pulp and paper enterprises, which are major sulphur emitters. The fishing industry is charged with emissions from transport, but only a small proportion of transport costs is included for other sectors since they do not own their transportation facilities to the same extent. This means that fisheries bear an unfair share of the burden of debt. Such conclusions should be reached with

[8] 379,000 tonnes of sulphur dioxide corresponds to 189,500 tonnes of “pure“ sulphur. Domestic emissions amount to 116,000 tonnes of sulphur dioxide, whereof 84,000 tonnes are exported. 348,000 tonnes are imported.

caution, however, and the valuation method, what it includes, and similar factors must be borne in mind.

Table 7.5 Sulphur-related costs per emission source. MSEK. 1991 prices.

	Agri-	Fishery	Fore-stry	Min	Foods	Pulp&	Chemi-	Steel	Enginee	El,gas,	Water,
Goods& services	16223	4304	405	5951	129083	77968	44908	16465	35124	199172	17776
Wages	4551	4852	131	2694	38649	29765	16401	742	9563	101633	7051
Operating surplus	1994	11770	477	-473	13239	2245	7262	4820	-2119	-2446	17662
Capital depreciation	6016	1284	138	1301	8170	7994	4307	425	3026	14943	10483
Sulphur emissions,	1.4	0.3	0.2	3.1	13.0	18.1	4.4	4.9	11.2	0.9	17.7
Sulphur, mill kr	9	1	2	21	88	123	30	33	76	6	120
% of net value added	0,14	0,01	0,31	0,93	0,17	0,38	0,12	0,60	1,02	0,01	0,48
% of gross v.a.[2]	0,07	0,01	0,27	0,60	0,15	0,31	0,11	0,55	0,73	0,01	0,34

	Refine-	Cons-	Trans-	Serv-	Dwell.,	Gov.	Sum	Cons-	RoW	Total
Goods& services	3634	88518	5683	214531	70623	134193	1134561	771310		1905871
Wages	1003	78637	42787	245701	12359	274207	870726			
Operating surplus	1554	14254	-1050	69503	81660	8148	228500			
Capital depreciation	2730	5645	16410	37666	53403	17603				
Sulphur emissions, Ktonnes	0.0	0.8	26.1	2.4	1.3	2.2	108	7.3	348-84	400
Sulphur, mill kr	0	5	176	16	9	15	730	49	1791	2570
% of net value added	0,00	0,01	0,42	0,01	0,01	0,01	0,07			
% of gross v.a.[2]	0,00	0,01	0,30	0,00	0,01	0,01	0,06			

[1]Net value added = wages + operating surplus

[2]Gross value added = wages + operating surplus + capital depreciation. The gross VA is used in the calculations in chapter 3.

7.3 The forestry study[9]

A draft for “forestry accounts“ was presented by the Environmental Accounts Commission in 1991 and was based on 1987 data. The following has been updated with 1991 figures for the sake of comparison. The approach here is different from the one adopted in the sulphur study. Instead of a specific pollutant, an ecosystem is discussed, which means that measurements are performed in a different manner — instead of simply measuring the environmental impact of harmful substances, one computes the total output of the forest, which is more comprehensive than what is included in the conventional national accounts. In this case, the production boundary is extended to cover several types of asset, and a quality adjustment is performed since the state of the environment is taken into consideration.

Changes in environmental assets are measured by looking at certain factors, i.e. by looking at a type of indicator. An extension of this study would be to draw up accounts for the other types of natural asset included in the Environmental Protection Agency environmental indices, where applicable. For the forest as an ecosystem, the total output is calculated as in the national accounts, plus unmarketed goods and services, plus adjustments for changes in the state of the environment. The results are shown in Table 2.1 on the next page. As can be seen, the value declined between 1987 and 1991. This is primarily attributable to the fact that timber output has fallen. This fall is compensated to some extent by rises in other items (e.g. the increased assimilation of carbon dioxide that is attributable to a somewhat higher estimate of the timber stock).

7.3.1 Extended implications of forest capital

Timber output

Gross output value

The gross output value calculated by Statistics Sweden every year consists of pulp wood, saw timber, firewood, other timber and Christmas trees. The method used for computation in the national accounts has been discussed in Hultcrantz, SOU 1991:38. The value is estimated by standardising the saw timber and pulp wood transactions with the help of output figures from the pulp and paper industry, listed prices and average prices. In the national accounts, firewood refers to the wood traded on the open market. In order to estimate total output, however, the firewood that is not sold on the market should also be included. The marginal alternative use for this wood is pulp wood, which means that its value is based on the price of pulp wood. On the basis of estimates by the National Board of Forestry of the consumption of forest fuels, this provides an additional SEK 600 million per year.

Increases in timber stock

Changes in the volume of the timber stock are valued according to the three-year mean of the average net value of raw timber published in the 1990 Swedish forestry statistics year book (SSÅ). Growth volumes may fluctuate considerably from year to

[9] *Performed by Peter Eliasson and Lars Hultkrantz at the University of Umeå (see list of annexes). This summary has been written by the National Institute of Economic Research.*

year, but the timber stock in Sweden is increasing steadily, since the annual growth in recent years has always exceeded total felling. The cost of *input goods* and *forestry conservation costs* is drawn from SSÅ 1992.

Table 7.6 Total income from forest assets. Bn SEK. 1991 prices

Income category	1987[1]	1991
Timber output		
Gross value of output	25.29	21.30
Input goods	-4.27	-4.30
Increase in timber stock	5.63	5.67
Forestry conservation costs	-2.11	-2.04
Total 1	*24.54*	*20.63*
Output of other goods		
Berries	0.68	0.41
Edible fungi	0.34	0.30
Hunting (meat)	0.64	0.75
Lichen	0.73	0.74
Total 2	*2.39*	*2.20*
Change in environmental assets		
Biodiversity	-1.69	-1.46
Carbon dioxide assimilation	2.84	3.06
Loss of exchangeable cations	-0.98	-0.98
Loss of lichen production capability	-0.03	-0.06
Total 3	*0.14*	*0.56*
Net value of output	**27.07**	**23.39**

[1]*Prices adjusted to consumer price index*

Other output

Berries and edible fungi

Little information is available about the availability and harvesting of berries and edible fungi. No nationwide studies have been performed since the late 1970s. The berry study covered output of blueberries, lingonberries, raspberries, cloudberries and cranberries. It was estimated that 5-7% of the annual availability of blueberries and lingonberries (350-450 million kg/year) was harvested. This corresponds to about 13 litres per person per annum. Higher figures have been found in more recent studies, however. Because of lack of data, the same volumes have been used for berries in 1991 as in 1987. The prices used are those paid by one of the biggest berry purchasers in the country.

Several questionnaire surveys have been used to study the harvesting of edible fungi and most of them have reached a figure of around 4-6 litres per person per annum. For volumes of edible fungi picked, the study is based on an assumption of 4 litres per person per annum for both 1987 and 1991. The price — SEK 30/hg — has been weighted downwards from the consumer prices of the better-quality edible fungi such as chantarelle and cep. This is necessary because most fungus harvests do not contain only these exclusive species. No attempt has been made to value changes in stock.

Hunting
The value of hunting in the Swedish forest has been studied by the Institute for Forest Economy at the Swedish University of Agricultural Sciences. Meat value, recreational value and the cost of hunting were estimated on the basis of a questionnaire survey in 1987[10]. In order to determine 1991 values for this report, the 1987 figures were recalculated according to the number of animals shot and the meat prices in 1991. An estimate of the value of the meat has also been performed on the basis of consumer prices for meat and hides in 1991. The price of the meat represents the hunters' own view of its value. This may vary considerably depending on the meat allocation. Those who receive a small allocation value it close to the over-the-counter price, which may be very high, while those who receive more may set a much lower value (this applies to moose). Other game, such as grouse, often costs much more over the counter than in the estimate of the hunter. The lack of a proper market for game thus makes it difficult to determine a consistent meat price, which means that we have used an average of hunters' estimates.

The recreational value of moose and deer hunting has been stated by Swedish hunters to represent two-thirds of the entire value of hunting, while the meat represents one-third. One may assume that the marginal benefit of each additional moose declines with increasing availability. Since there has been no significant increase in numbers since 1987, however, the value of hunting has only been recalculated in line with price increases. The recreational value for small game exceeds the value of the meat. The 1987 figures have therefore only been revised in line with increases in the consumer price index, without taking the number of animals shot into account.

Lichen
The value of lichen, in terms of the amount that the reindeer stock graze upon in the course of one year, is estimated according to the size of the reindeer stock and the alternative cost, i.e. the cost of distributing extra fodder. In the long term, the possible "harvest" of lichen is affected by the total stock of lichen (cf. timber output — timber stock growth). Any impairment of the output capability will lead to a reduction in stock. This is shown under the item *changes in environmental assets*.

7.3.2 Changes in environmental assets — qualitative changes in the forest capital

Species depletion

The Swedish cultivated forest still contains many exclusive species, but these are often isolated in small areas. Many of these species are probably living under conditions that do not meet the criteria for their long-term survival. The reason that they still exist is that the ecological processes that lead to the extinction of populations are very slow.

[10] *That part of the value that represents the recreational value should not be included in any adjustment of the net domestic product, since recreational values have not yet been computed for other items.*

The Forestry Policy Commission of 1991 called for criteria to be drawn up for adequate safety margins for preservation of biodiversity. One essential measure was considered to be the introduction of provincial ecological planning in which core areas for biodiversity could be identified, secured and linked up with corridors to allow species to spread. If these criteria are to be met, about 15% of the productive forested land must be exempted from forestry. One simple, but far from complete, method for estimating the safeguarding and conservation of biodiversity is quite simply to count the amount of protected forested land in the country. Forestry output assumes impact on forest ecosystems that may affect the survival of certain species. It is therefore clear that income from timber has been achieved at the expense of some increase in the threat to the continued existence of certain species.

The proportion of completely protected land area in the form of nature reserves, forestry reserves and national parks increased, according to The National Board of Forestry, from 1.9% in 1987 to 2.7% in 1992. One may add to this the forested land where technical or economic obstacles or competing land utilisation impedes full timber output (although the purpose of this may not be to protect biodiversity, nor is the land in any way safeguarded from future exploitation). The total area of protected land can thus be estimated at 5.08% of the total area of productive forest in 1987, and 5.03% in 1991. For the purposes of this study, the cost of depletion of the stock of “species capital“ has been estimated to correspond to the income that forest owners would have to refrain from if 15% of all productive forested land were actually to be reserved. Protection would have to be extended to correspond to 10% of the area of forested land[11] for the two years in the study. On the assumption that the average income from timber from the reserved land coincides with the average income from the total area, the cost of not having any protection was about SEK 1.65 billion in 1987 and SEK 1.13 billion in 1991. The higher figure for 1987 despite the fact that the proportion of protected forest was actually greater, is because the total forest yield for that year was much higher than in 1991.

Carbon sinks

The increased levels of carbon dioxide are considered to be the main cause of the rising average temperature in the earth‘s atmosphere. Other greenhouse gases include CFCs, methane, nitrous oxide, and ozone. An increase in average temperature increases the risk of global climate change, with floods, changing crop conditions and far-reaching impact on ecosystems. It is the burning of coal, oil and natural gas that has resulted in a net surplus of carbon dioxide in the atmosphere. Today, the concentration of carbon dioxide is 25% higher than it was in the mid-19th Century, before the industrial revolution.

It is difficult to estimate the value of the forests as a carbon dioxide sink in order to cushion the green house effect. Such an estimate would assume that the effects of a rise in temperature are known, and that a cost can be attributed to them. A comparison of three such cost computations has been performed by Nordhaus (1993). Should the carbon dioxide concentration double (which it will around the year 2030 unless today‘s rate of increase slows) the average temperature on Earth is expected to rise 1-3°C above today‘s levels, which according to some studies will

[11] *On the assumption that there were so few corridors for the spread of species in 1991 that they entailed nothing more than marginal value for biodiversity at a national level.*

give rise to costs corresponding to 1.0-1.3% of GDP annually. This corresponds to SEK 0.02/kg CO_2 if USD 1 = SEK 6. An alternative method that we have used in this study is to examine the willingness to pay as expressed politically in the form of environmental charges. The Swedish environmental charge on CO_2 for industry is currently SEK 0.08/kg. The value of the forest‘s ability to bind up CO_2 can thus be estimated at SEK 2.84 billion in 1987 and SEK 3.06 billion in 1991. These figures are directly proportional to the increase in timber stock and might well be merged with this in the tables. They are shown separately solely in order to show the two functions of the timber stock. The timber is valued both as a resource stock which has a value in its future use, and as a carbon buffer — which implies that it should preferably not be used in the future, since the environmental service it provides would thereby be lost.

Loss of exchangeable cations

Air pollution represents an increasing threat to the long-term production capacity of forested land. Few would doubt that acidification may become a significant threat. There is, however, considerable disagreement among researchers about the causes and consequences of changes. One standpoint is that acidification of water in the soil inhibits the uptake of nutrients, and that the effects of changes in soil chemistry on the health of the forest can be monitored by studying the ratio between easily-available mineral nutrients such as calcium, magnesium and potassium to aluminium (BC/Al ratio). At the same time as the store of nutrients in the soil is depleted, the danger increases that aluminium will be released, which in turn inhibits the uptake of nutrients. According to this view, no time should be wasted in taking action in the form of liming and revitalisation fertilisation.

Other researchers claim that there are more causes of damage, and that liming on land where there is a nitrogen load could have serious adverse effects. One such effect could be that nitrogen leaches out in the form of nitrates, which would result in eutrophication of watercourses. There are also suspicions that liming increases the risk of drought damage since the fine roots of trees are affected. forest damage is thought to depend on a combination of unfortunate, but natural, local variations in climate, high levels of air pollution and unsuitable choices of tree species in certain areas.

Despite disagreement among researchers and the risks of liming described above, we have calculated a minimum cost for forest damage on the basis of the cost of restoring the pH value to the level at which the loss of base cations is reduced, with the help of liming and revitalisation fertilisation. The National Board of Forestry has performed some practical experiments over four years to show that liming, in well balanced doses, can yield good results as long as land where there is a risk of negative consequences is not included. Their study resulted in a calculation of the cost of dispersing a total of 2.4 million tonnes of lime and 0.6 million tonnes of revitalisation fertiliser in the form of wood ash. This corresponds to the approximate average need estimated by Sverdrup *et al* in order to compensate for deposition during the course of one year. The costs include lime and revitalisation fertiliser, administration, planning and dispersal (by land and by helicopter). According to this method of calculation, the annual cost of damage in terms of acidified soil can be estimated at SEK 980 million. It should be pointed out that this is a very cautious estimate, which indicates the lower limit for the damage costs associated with acidification.

Loss of lichen production capability

The stock and growth of lichen is affected by several factors. The growth of lichen is affected by the growth conditions of the trees and the age of the tree stock. On the basis of this assumption, Erik Wilhelmsson at the Institution for Forestry Taxation has forecast the effect of timber output on lichen pasture in the provinces of Norrbotten and Västerbotten. One important factor, apart from site conditions and the age of the tree stock is the amount of grazing. From 1987 to 1991, the reindeer population increased by about 100,000 individuals. Lichen is also assumed to be a scarce resource, whose alternative cost consists of the cost of distributing extra fodder. Wilhelmsson has calculated that the production of ground lichen will decline by 13.5% and that tree lichen will increase by 1.5% from 1900-2000. On the basis of the 1987 valuation, Wilhelmsson‘s model and 1991 prices, the value of the change in the long-term production ability can be estimated at SEK -31 million for ground lichen and -26 million for tree lichen. The total cost of reduced lichen output can thus be estimated at SEK 57 million in 1991.

Omitted items

In addition to the areas discussed above, the value of the forest as a nitrogen sink should be taken into account. The recreational value is very difficult to estimate and requires more detailed studies than has been possible with the resources at our disposal for this project.

7.4 Natural resources in the Swedish national accounts

In 1992 the National Accounts Division at Statistics Sweden published the first set of Balance Sheets covering the period 1981-1990 The intention was to cover as great a part of the assets given by the provisional UN guidelines (M60) as possible. The M60 classification of non-reproducible tangible assets (mainly natural resources) includes the following assets: land, timber tracts and forests, subsoil assets and extraction sites, fisheries and historical monuments. Given problems of valuation we decided to exclude fisheries and historical monuments from our compilation. In SNA-93 historical monuments have been removed to another category due to a new principle of classification and non-cultivated biological resources (except fisheries) and water resources have been added to the list.

Below is a short description the sources and methods of calculation used at the National Accounts Division at Statistics Sweden for valuation of land, timber tracts and forests and subsoil assets.

Land

The estimates for agricultural and other land have been based on annual information given in the statistics on assessment of real estate. In General Assessments each unit of real estate has been assessed and given a value corresponding to 75% of the market value observed for transactions in similar units. Land values are separated from building and construction values. There is also a system of price statistics covering units that have been traded. For each of these units is given a ratio between the transaction price and the assessed value. Using the weighted averages of these ratios it has been possible to derive current prices as well as prices of a specific base year. Furthermore, the data is given with a rather detailed breakdown into activities making it possible to obtain a subdivision into institutional sectors. The assessments do not cover real estate in non-commercial use, most of which are in the central and local government sector. For both assessed and non-assessed units there exists information on land areas. It has therefore been possible to calculate prices per m^2 land in assessed units and use these prices to estimate non-assessed land areas in similar types of use.

Timber tracts and forests

The value of forests can in principle be derived in the same way as for land. The general assessment also cover forest land including timber tracts. Data at current prices can be calculated in the same manner as land. It is not possible to obtain any volume figures with this method because the assessments do not properly reflect changes due to natural growth and fellings. In the National Forest Inventories data is given on the levels and changes in the growing stock in terms of standing volume. Balances can also be compiled showing the natural growth and annual fellings. It is possible to have a breakdown into institutional sectors. Using an assumption of negligible land value, implicit prices have been calculated for 1985 (base year) by comparing values on the growing stock obtained from SA reflated by use of the price statistics for the same year. A set of annual balances in 1985 prices showing opening stocks, natural growth, fellings and closing stock is thereby available. Current Balance data at current prices have been obtained by using prices implicitly calculated by comparing growing stock in current prices based on general assessment.

In the Swedish Economic and Environmental Accounts (SWEEA) a different method is used. To estimate the valuation of net growth of timber SWEEA use stumpage value,net. In SWEEA the interest is primarily in the annual income from different uses of forests. This method can, together with information on age distribution of all timber, be expanded to value the total stock.

Subsoil assets

In the case of subsoil assets the use causes a reduction in volume. A subsoil asset is much like inventories or other funds of resources for instance services stored in fixed capital. Extraction of subsoil assets means both reduction of reserves and realisation of rent to capital attached to the extraction. The calculations of subsoil assets are first set up in the form of quantitative balances in metric tons. Data on iron ore and non-ferrous ore is provided by the Geological Survey of Sweden (GSS). The starting point is the proven reserves at 1990. The period 1981-1989 is traced back using information of depletion. Going backward the annual depletion is added to the reserves. Quantitative data on depletion is also provided by GSS. This method is reasonable because of the negligible amount of new findings.

The valuation methods used in the Swedish National Accounts are, in lack of observable market values for transactions, discounted present values. That goes for iron ore and non ferrous metal ore. In the case of subsoil assets we derive both a natural resource rent and a wealth value of the reserves. The natural resource rent is defined as the (market) value of the resource before any costs for the extraction is taken into account, like mineral exploration, construction of mine shafts and wells and other costs. This rent can be calculated using the market value of the annually produced ore and from that value subtract all production costs. Production costs includes not only intermediate consumption, wages and salaries and associated costs, consumption of fixed capital but also normal return to fixed capital.

7.5 Future work

The assignment given to the National Institute of Economic Research stresses the long-term nature of this work and the fact that a great deal of research and methodological development will be required, particularly in the initial phases. Close co-operation will be required, particularly with centres of environmental and economic research, and we have established a contact network with different research teams and university departments. The economic part of the environmental accounts will by nature follow the work of Statistics Sweden on the physical accounts closely. The work at the NIER consists of two parts: valuation studies of the physical accounts, and use of the data in modelling and economic analysis. The modelling part will include simulations for official reports. During 1995 we will do analyses for the Swedish Energy Commission, on the structural and environmental effects of closing down the nuclear power plants, and for the "Green tax shift committee" on the effects of a tax shift from labour taxes to environmental taxes.

On the valuation side, we will continue the work on valuation of emissions to air from the damage cost side. Valuation studies on nitrogen oxides will begin this year. Valuation from the avoidance cost side is important as complementary information to the damage costs, to be able to perform cost-benefit analyses. This is thus also an area which we will deal with. Another line of work will be to waste and recycling, which will be performed in close collaboration with the work at Statistics Sweden.

The implementation of SNA-93 is planned by Statistics Sweden to be completed in 1997. From a natural resource point of view SNA-93 has some extensions, e.g. waterresources, which have great importance in the Swedish economy. But implementing SNA-93 also means revision of sources and methods and last but not least co-ordination with other producers of natural resource statistics both at Statistics Sweden and outside

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Appendix:

Andersson, Björn	Cost of corrosion caused by sulphur
Eliasson, Peter	Forestry accounts 1987 and 1991
Pettersson, Bengt	Natural resource accounts in monetary terms
	Classification of Natural assets and Environmental services
Skånberg, Kristian	Acidifiation damage to forests
Michael Wolf	Estimations of the National Welth

8. Use of resource accounting in Norway

8.1. Introduction[12]

This section presents resource accounting and monetary valuation studies carried out by Statistics Norway (SN).

Due to increased concern for the management of natural resources the Ministry of Environment in Norway initiated work on natural resource accounting in the early 1970s, with the aim to ensure a better long term resource management. This would be accomplished by providing new and better suited data in a form compatible with traditional economic statistics, for monitoring resource use, for long term management purposes, and to facilitate integrated analyses of natural resource and economic issues.

In 1978 the responsibility for operating and further development of the system was transferred to Statistics Norway (SN). Since SN also is responsible for national accounting and development and operation of some of the economic planning models employed by the Ministry of Finance, this enabled a better co-ordinating of the work on the natural resource accounting with ongoing work on tools for economic planning. This co-ordinating has been useful for a number of reasons:

- Locating the work to SN has assured access to statistical expertise and closeness to primary statistics.
- In SN, the resource accounting framework was naturally based on existing economic standards and sector classification schemes, thus ensuring general consistency in the sectoral classification of economic and resource related data and statistics. In particular, the linkage to the UN Standard of National Accounts (SNA) has made it possible to integrate important natural resource variables and relations within already existing macroeconomic models.
- Use of a common set of economic standards and models in the analysis of resource issues has facilitated the communication between the ministries responsible for the management of the economy and the ministries responsible for the management of the natural resources; e.g. the Ministry of Finance and the Ministry of Environment.

In the initial phase of resource accounting, considerable efforts were made to establish resource accounts for *energy*, *fish* and *land use*. In addition, less detailed accounts were made for *minerals*, *forests* and *sand and gravel*. The accounts were kept in *physical units*. In all parts of the accounts emphasis was put on consistency with the classifications and definitions of the national accounts. Later, based mainly on the energy accounts, *inventories of emissions to air* have been established.

Because of changing concerns about the scarcity of the above mentioned resources and experience with the governments use of the account, there is at present *a stronger focus on a few economically and politically important issues*; namely management of Norway's considerable *energy resources*, and important environmental issues like *air pollution*, where several international protocols regulate national emission levels.

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[12] Chapter 1-2 is taken more or less directly from Alfsen (1994).

There is a continuing effort to integrate resource and environmental issues into the *existing* economic planning procedures in Norway. This is seen as a more useful approach than striving for establishment of parallel and more or less separate resource and environmental planning procedures. The integration is attempted carried out by linking data in physical units on exploitation and use of natural resources and the environment with economic data (e.g. the national account) and traditional economic models. Thus, over the years, the sectoral macroeconomic models employed by the Ministry of Finance for medium and long term economic projections have been disaggregated and extended to include energy and air pollution variables. Integrated forecasts are now routinely made of economic development, demand for energy and the consequences for emissions to air of several important polluting compounds.

8.2 The natural resource account

Natural resource accounting in Norway is not considered as a goal in itself, but rather as a way of providing systematised data for analytical purposes. Thus, information based on the energy accounts and the associated emission inventories have been integrated into more comprehensive analytical tools by expanding the macroeconomic planning models. These extended macroeconomic models are now used by the government and other administrative bodies on a routine basis. Some recent examples of their use are reported by the Green Tax Commission (NOU, 1992) and the government's Long Term Programme 1994-1997 (Ministry of Finance, 1993).

By integrating the resource and environmental data with economic models, several aims are achieved. *First,* consistency between economic planning, expected growth in energy use and the resulting emission to air is secured. *Second*, by providing output tables covering both economic, energy and environmental variables, the linkage between these policy areas is brought to the attention of the policy makers. *Finally*, by making a single modelling tool available to both the Ministry of Finance and the Ministry of the Environment (among others), communication among the different branches of the government is enhanced.

Types of questions addressed by the integrated model are: What are the likely future developments with regard to economic growth, demand for energy and emissions to air? How will a change of policy affect the projected development, both with respect to the economy and the environment? How will future development in the state of the environment and availability of energy resource affect the economic development?

8.2.1. The structure of the Norwegian resource accounts

The Norwegian resource accounts are kept in *physical units* and comprise the following three sub-accounts: 1) Reserve accounts, 2) Extraction, conversion and trade accounts, 3) End use accounts. By reserves is meant discovered resources that are economically extractable with today's technology, and they will vary from year to year due to extraction, price fluctuations, technological development and new discoveries.

A couple of points is worth noting with regard to the structure of the account. *First*, the end use account is essential when the resource accounts is used for management purposes, where it is important to know *who* are going to be affected by a change of policy. *Second*, although the accounts are kept in physical units, they are complemented with price information whenever *market prices* are available, allowing tables in monetary terms to be generated. *Third*, the sectoral structure of the extraction, conversion and trade accounts and the end use accounts follow the classification in SNA. This facilitates the inter linkage between the resource accounts and the national accounts. *Finally*, the accounts for the different resources differ with respect to details in the various parts of the accounts. In addition to accounts for material resources like fish, forest and energy, related statistical information is collected for environmental resources. In particular, the energy account (end use account) is an important and necessary foundation for the *emission inventories*, which at present cover emissions of sulphur dioxide, nitrogen oxides, carbon monoxide and carbon dioxide, particulate matter, non-methane volatile organic compounds, lead, methane and nitrous oxide.

8.2.2. MSG, the economic core model

The Multi-Sectoral Growth (MSG) model was originally constructed to study the overall long-term prospects of the Norwegian economy with emphasis on the sectoral composition of economic growth. Later on, the interest widened to cover the long-term interactions between economic growth and energy supply and demand. The dimensions of the model, some *30 production sectors* and *40 commodities* (depending on model version), reflect a compromise between the ambition of applying detailed sector information and the Ministries' need for a manageable model.

Over the years several variants of the basic MSG-model have been developed. Some of the variants differ only as to which variables are treated as exogenous and endogenous. There are also variations on how external trade and private consumers are treated. A version of MSG called MSG-EE (EE for Energy and Environment) has been developed where transport activities and power production are modelled in more detail. In MSG-EE, production of commercial transport services has been disaggregated into five production sectors covering transport by road, air, rail and Sea in addition to post and telecommunication. Transport (both own produced and commercially purchased) has also been introduced as a separate input factor in all production sectors, complementing the usual quartet of capital, labour, energy and materials. Power production in MSG-EE covers both production by hydro power and natural gas. Production and transmission/distribution of power are also treated as separate production activities.

8.2.3. The emission sub-model

Sectoral emissions of nine pollutants from four types of sources are presently calculated in post models to the economic core models. The compounds are SO_2, No_x, NMVOC, O_3, CO, particulate matter, CO_2, CH_4 and N_2O. The sources are stationary combustion, mobile combustion, process emissions and evaporation.

Emissions from industries and private households due to stationary combustion are associated with the demand for fuel oils, emissions from mobile combustion are associated with the demand for gasoline and diesel, non-energy related process emissions are associated with demand for intermediate materials other than energy commodities, while evaporation is associated with both industry specific use of materials, total demand for transport fuels and private consumption. Waste generation in private households is assumed to follow private consumption of food. Emissions from waste dumps (mainly methane) and incineration of waste are determined by exogenously given factors determining the relative amount of waste generated going to dumps and incineration, respectively.

The generic procedure for calculating emissions

Emission coefficients are calibrated in a base year, and are projected over the forecasting period by taking into account the effects of planned and implemented environmental control policies such as emission standards for new vehicles, limits on sulphur content of heating oils, direct regulation of emissions from specified firms, etc. The emission level in year *t* is calculated as the product of a fixed emission coefficient, an activity variable for the type of source and a time dependent parameter. The last parameter is meant to take care of expected changes in emission intensities that are not taken into account by the economic model. For instance, stringent regulation of emissions from gasoline powered light vehicles in Norway imply that new cars must be fitted with catalytic converters. As the stock of cars is renewed, the emission intensity declines and this is reflected in a reduction in this parameter. It can also be used to take account of technological change affecting emissions in excess of the energy savings, etc. already captured by the economic model.

It is worth noting that the sectoral emissions are projected by using *input factors* (heating oil, transport oils, intermediate deliveries) as activity variables. This implies that any technical change (factor specific or factor neutral) included in the modelling of the economic behaviour is also reflected in the calculation of the emissions. Thus, if technological progress reduces the need for input factors by, say, 10 per cent over a specific time period in a sector, the emission intensities, measured as emissions per unit real output, are also reduced correspondingly.

Exceptions to the generic rule of emission projections

There are several exceptions to the generic projection rule described above. Some of the exceptions are of a permanent character, while others are only introduced occasionally in particular studies.

The way fishing is treated is an example of a permanent exceptions to the generic rule. The sector is treated as a single economic activity in the model, but in reality it consists of at least to different activities; ocean fishing and rearing, with very different emission characteristics. Usually there are no reasons to believe that these activities will grow at the same rate. While the fishing fleet is a major emission source in Norway, in particular of NO_X emissions, breeding and rearing of fish have few if any air pollutants directly associated with it. A third source of emissions classified as coming from the fishing sector, is the liming of fresh water lakes (approximately 10 000 tonnes CO_2 per year). The emission generating activities within the fishing sector are all characterised by being very difficult to model in economic terms. Thus, usually the emissions from all types of sources in this sector are treated exogenously, typically by keeping them equal to emission levels in the base year.

Another example of a permanent exception is the burning of wood for heating in the private households, which is a major source of emissions of particulate matter in Norway. However, the fuel wood is only seldom bought on the market. More often, it is harvested directly in forests, either owned by the household or freely available to the household. It is thus difficult to stipulate a price on this fuel, and correspondingly difficult to model the demand for fuel wood in economic terms. For this reason, emissions from burning of wood in the households are usually treated exogenously, either assuming a growth proportional with the population or keeping the emission levels at the base year level.

A non-permanent exceptions to the generic rule are concern burning and storage of non-hazardous waste, which generate emissions to air. Methane generated by the decomposition of organic materials is sometimes collected and used as fuel. This combustion also generate emissions to air. Sometimes the amount of waste generated is modelled as a function of private consumption of food and other non-durable goods and the activity levels in some waste intensive production activities. In other cases the amount of waste is given exogenously. In almost all cases the division of the waste among incinerators and waste dumps is given exogenously.

Benefits of environmental control policies

In this subsection we describe the way benefits of reducing *local* air pollution and road traffic due to tax on fossil fuels are calculated in Norway.

Two different types of benefits associated with a reduction in fossil fuel use are calculated. The first (denoted environmental benefits) is related to changes in emission levels of sulphur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO) and particulate matter. These are pollutants harming human health, forests, fresh water lakes and certain types of capital equipment. In addition, the presence of these compounds reduces the welfare of the population by inflicting aesthetical damage to the natural environment. The second type of benefit is related to reduction in road traffic, and cover aspects such as congestion, accidents, damage to roads and noise from road traffic.

Environmental benefits

The economic cost of damage to fresh water lakes from deposition of sulphur and nitrogen in Norway is estimated on the basis of willingness-to-pay surveys carried out in the 1970s. Damage to Norwegian forests from sulphur deposition has been assessed by an governmental commission. Given this estimate of physical damage, the economic loss due to reduced timber production has been assessed. The estimation of loss in recreational value from damage to forests is roughly assessed in proportion to recreational loss from damage of fresh water lakes.

Damage due to corrosion of some building materials and machinery equipment has been estimated on the basis of data on capital exposure to atmospheric sulphur, cost of maintenance and replacement, and detailed physical damage functions (e.g. amount of material corroded under different atmospheric conditions).

Estimates of health damage due to air pollution are based on two official Norwegian reports on air pollution induced health damages and their costs in some Norwegian cities. These, in turn, are built on international dose-response studies adjusted to correspond to Norwegian conditions.

Traffic related benefits

In the same reports marginal external costs of road traffic due to congestion, traffic accidents, damage to roads and noise are estimated. In the sub model we assume future road traffic to be proportional to the demand for transport fuels.

Multiplying the marginal cost of the various damage components with changes in emission to air of the relevant compounds and with the change in demand for transport fuels, yields a rough estimate of some of the direct benefits of environmental control policy compared to a baseline scenario. It is difficult to measure the economic cost of introducing a control policy correctly, but a rough indicator is the calculated reduction in GDP.

8.3. Current projects

One of the main activities at the Research Department at SN is further development and use of the models to study economic and environmental consequences of different changes in politics. Use of new theories and development of new models are also an important part of the research. At the same time are continuing improvements of the models, both concerning the representation of the economy and which environmental indicators should be incorporated.

In this chapter we are going to refer to some of the projects that are in progress during 1995 at the Natural Resource Division of the Research Department. This projects concern rent from Norwegian natural resources, health damages due to emissions to air and predictions of waste amounts.

8.3.1. Rent from Norwegian natural resources[13]

Rent from resource-based sectors gives us an indication of the additional return earned by factor inputs compared with other economic activities. Calculations based on National Accounts statistics show that rent from Norwegian natural resources amounted to NOK 43 billion in 1991, equivalent to 6 per cent of GDP. The rent is calculated on the basis of the following accounting relationship:

Rent = Factor income + Indirect taxes - Subsidies - Wages - Normal return to capital

This is the same as defining rent as the share of income from resource based activities which cannot be attributed to the production factors labour and capital. Natural resources wealth is the present value of future rent, and therefore estimates of all future rents are needed to calculate this wealth. The calculations in this project are all based on the assumption that all future rent will be equal to rent in the base year. Especially for petroleum and fishery sectors this may seem like a very unrealistic assumption, whereas it for other natural resources is more reasonable.

Calculations are made of rent for the non-renewable resources oil/gas and mining, for permanent resources (hydro-power) and from fisheries and forests (biological renewable resources). Only resources that are sold on the market are included, in other words no attempt is made to put a value on services provided by nature beyond those which are purely commercial.

This project is part of a larger one, called the Methodology Project, that has been running since 1991 and are planned to end during this year. The Methodology project is part of a programme called “Economy and ecology - management tools for sustainable development” supervised by the Norwegian council for research (NFR, Norges Forskningsråd). Other parts of the methodology project concerns methods for valuation of the environment, “green” GDP and intertemporal growth models

8.3.2. Calculation of health damages due to emissions to air

The Norwegian Pollution Control Authority (SFT, Statens Forurensningstilsyn) has initiated a project called “Valuation of noise and air pollution from different sources”, where the research department at SN is participating. The work SN are doing includes estimation of health damage functions and calculation of the costs they give rise to.

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[13] This section is an abstract of Lurås (1995).

The methodical approach can be described by a chain of consequences, where economic activity leads to emissions, which in turn spread and causes deposition/concentration in the environment, and this gives a response resulting in costs to the society. The repercussion in the total model is that these costs affect the economic activity negatively. The first stage (economic activity causing emissions) is the one best known today, while there is a need for more knowledge about the processes concerning deposition and concentration and the damages and costs they causes.

SN is involved in studies of all stages, with special attention paid to the last (costs to society) and the repercussion on the economic activity. The project is an extension of former model assessment, including further work with quantification of the repercussion from the environment, in a simultaneous framework.

Concerning damages to health the aim is to map the economic aspects of local environmental problems relating to the use of fossil fuels, in particular No_X and particulate. It is of special interest to find the effects on the supply of labour, and the costs to public health care.

Apart from health costs, there are other types of environmental costs dealt with in the MSG-EE model framework. The impact of traffic injuries on labour supply and public expenditures is treated simultaneously with health costs. The analysis will be updated this year to cover road deterioration, noise and cost of traffic congestion.

8.3.3. Predicting waste generation on the basis of macroeconomic models

This project was started in 1994 and aims at finding reasonable predictions of waste generation for the period from 1995 to 2010. The first stage is to make simple predictions of different types of wastes based on production and consumption in a "normal" model forecast, using fixed coefficients between output and waste and the macroeconomic model MSG-EE. The stage is completed, see Bruvoll and Spurkland (1995).

The advantages connected to the choice of economic models as a basis of waste projections are many. The generation of waste is clearly dependent upon basic economic variables such as production structure, consumption pattern and economic growth. The information in the economic model already explains several basic causes of future waste generation. Waste problems are multi-sectoral, so is the economic model used. To estimate the costs associated with waste generation it is essential to use a general economic model, which can reflect the way an extra cost in one sector spills over to other sectors in the economy. Using models that are well known to the bureaucracy may make the analysis more accessible to the users of the analysis.

The waste are being predicted for the following categories: waste delivered to municipal refuse disposal service (including waste from households and commercial waste), hazardous waste (both generated and delivered) and waste generated in industrial production activities. The predictions can be decomposed in different types of waste (for instance paper, glass and organic waste) and for different production, consumption and delivering sectors.

The main activities during 1995 are:

- Making the predictions more realistic by implementing more specific political, structural and technological assumptions. To find the effects of technological changes the predictions will be based on the use of material input, under the assumption that it is this input factor that ultimately generates waste. A consequence of this is that predictions that take care of changing technology only affects waste generated in production activities. Another reason for the choice of material input as the independent variable is that it is at this stage it is possible to assess technological development that affects the use of input factors when one is using MSG.
  The predictions will also be adjusted according to decided, planned or possible political measures concerning the generation and treatment of waste.
- Studies of environmental and economic consequences of different ways to treat waste, for example use of landfills and incineration. Consequences of decided, planned and possible political measures to deal with the waste problem will also be considered.
- Updating all predictions with new data.

The project for 1994 was financed by the Norwegian Research Council (Norsk forskningsråd), and for 1995 it is financed by the ministry of Environment. Data are being collected from Norsas AS (Norwegian competence centre for waste and recycling) and SN.

8.4 Conclusions

We have briefly outlined the structure of the Norwegian resource accounts and their historical development from the 1970s until today.

Over the years a pragmatic approach has been followed with emphasis on the use of the resource accounts for analytical purposes. The tools used are all based on slightly extended versions of disaggregated macroeconomic planning models already in use by governmental bodies. This has facilitated the introduction of environmental concern in the planning process in Norway. Furthermore, by using the same modelling framework for analyses of both economic and environmental policies, consistency in behavioural and other key assumptions are secured. Finally, linking physical resource accounts and environmental statistics to economy wide models provides for better and more comprehensive information on the value of natural resources and environmental services than available through more partial studies. For these reasons, we strongly recommend a strategy where resource and environmental issues through their physical characteristics are integrated into already operational economic planning tools. This in opposition to a strategy where new and separate models for resource and environmental analysis are developed in addition to existing models.

In Norway, future work will concentrate on updating and implementing the benefits relations in the economic models themselves, in order to capture the indirect economic benefits of environmental policies.

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