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Uses of Environmental Accounts in Sweden

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The views expressed in this document are the author's and do not necessarily reflect the opinion of the European Commission

Preface

This report has been prepared on commission from Eurostat, which supports and coordinates the development of environmental accounting in the EU Member States. The European Commission DG Environment has contributed financially to the project. Viveka Palm has written the report, based on contributions from many of those who have participated and developed the Swedish Physical Environmental Accounts so far.

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1 Introduction

In 1993, Statistics Sweden, the National Institute of Economic Research and the Swedish Environmental Protection Agency were instructed by the Government to prepare a study covering the physical links between the economy, the environment and natural resources, the monetary reflection of these relations, and the state of the environment. The aim of the work on environmental accounts at Statistics Sweden is to develop a system of physical accounts that are linked to the economic activities described in the national accounts. In practice this means developing a system of environmental and natural resource statistics that can be linked to the industry, product and sector categories used in the national accounts, thus forming a satellite system of accounts around the national accounts.

According to the UN, a system of environmental accounts should in principle cover:

- **Flows of materials** through the economy, e.g. energy and chemicals, together with the **emissions** and **waste** to which these flows give rise. Data on emissions, above all to the air, have been published for many countries, but there are often differences between traditional emissions statistics and emissions in environmental accounts, e.g. where bunkering is concerned. Within the EU, many countries have opted to use the NAMEA system¹ to describe these flows.
- **Economic variables** that are already included in the national accounts but are of obvious **environmental interest**, such as investments and expenditure in the area of environmental protection, environment-related taxes and subsidies, and environmental classification of activities and the employment associated with them, etc. In principle, environmental taxes and environmental protection costs can be regarded as two sides of the same coin. Both entail costs involved in production processes that are related to the exploitation of the environment in different ways. On the one hand, environmental protection costs record investments in measures aimed at improving the environment, while on the other, taxes record the costs set by the central government for exploitation of the environment. Within the framework of economic theory, this could be interpreted as clean-up costs versus emissions charges. Thus, in the total cost of production, the environmental taxes paid can be added to expenditure on environmental protection to give the total cost of using the production factor nature.
- **Natural resources.** Environmental accounts should make it possible to describe stocks and changes in **stocks** of selected finite or renewable resources. They should deal both with questions related to the **monetary** valuation of this natural capital and **qualitative** aspects that do not have any market or other defined monetary value, e.g. the value of outdoor life and biodiversity.

¹ NAMEA stands for National Accounting Matrix including Environmental Accounts. In principle this is a Social Accounting Matrix (SAM) supplemented by environmental accounts data on, e.g., emissions to air and waste, linked to the Use and Supply Matrices that a SAM is constructed around. Just as a SAM is a way of presenting national accounts data, NAMEA is a way of presenting environmental accounts data.

The tools the central government has at its disposal for influencing the actors in the economy are information, and administrative and economic instruments. The administrative instruments include laws, standards and ordinances. The economic instruments consist primarily of charges, taxes and subsidies. The use of taxes and subsidies as instruments of environmental policy has grown in significance in recent years. Where environmental taxes and other excise duties are concerned, the emphasis is generally on the desired allocation effects. Subsidies, in turn, also have allocation effects, but are perhaps used principally for reasons of redistribution policy. The non-explicit allocation effects of subsidies are probably important not least in the environmental sphere.

It has become clear in recent decades that the environment imposes limits on economic development. Problems have become apparent in terms both of the depletion of natural resources and of the environmental impact of emissions from the production of goods, heating and transport. Awareness of these problems has been formulated in, *inter alia*, the principle of sustainable development, which was expressed in the Brundtland Report in 1987 and received widespread international support at the UN Conference on Environment and Development in Rio de Janeiro in 1992. In Agenda 21, as adopted by the Rio conference, special emphasis is placed on the importance of all countries integrating “sustainability into economic management“ and establishing “better measurement of the crucial role of the environment as a source of natural capital and as a sink for by-products generated during the production of man-made capital and other human activities“.

If these principles are to provide guidance in the political decision-making process, the environmental issues must be integrated in the information systems upon which decisions are based. There is a particular need of a national accounting system that provides comprehensive information on the environment and the economy. This was the fundamental idea behind the Swedish Environmental Accounts Commission, which submitted its final report in 1991.

As a result of the Commission Report three Government commissions were given to Statistics Sweden, to the National Institute of Economic Research and to the National Environmental Protection Agency, respectively.

1. Statistics Sweden was to develop *physical environmental accounts*.
2. The National Institute of Economic Research was to investigate the feasibility to develop *monetary environmental accounts*.
3. The National Environmental Protection Agency was to design a *system of environmental indexes*, with the purpose to give an overview of the state of the Swedish ecosystems. This task is since then reoriented towards economic assessments of environmental policy.

The work on physical environmental accounting at Statistics Sweden is carried out by the Programme of Environment Statistics, in collaboration with the Programme of National Accounts.

The general view of the building blocks of an accounting system is illustrated in figure 1. To describe the links between the economy and the environment in a complete environmental economic system statistics must be developed for all parts in the chain of cause and effect: *natural resources, economic activities, emissions, deposition, load on different ecosystems and impact*. The physical environmental accounts have its focus on the first three components in this chain.

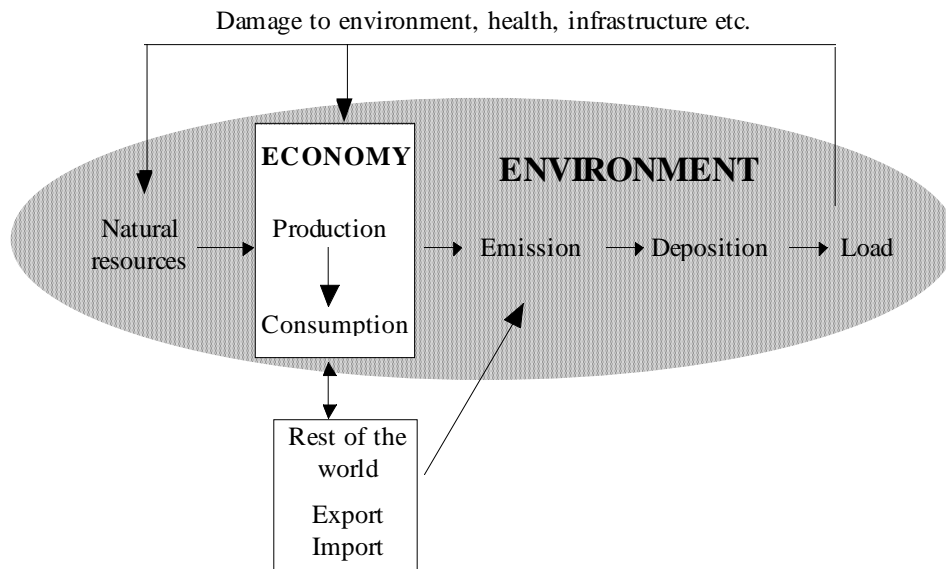


Figure 1. National and regional economic activities consume and transform natural resources into goods and services, and give rise to emissions and waste in the process. The physical environmental accounts record the physical flows and the economic flows from the Swedish actors. The valuation of damage on the environment is performed by the National Institute of Economic Research.

The environmental accounts describe the environmental pressures from a nations economic activities through its producers and consumers. The producers purchase energy, materials, labour and capital to produce goods and services. This production process also produces waste, air emissions and water emissions (Figure 2).

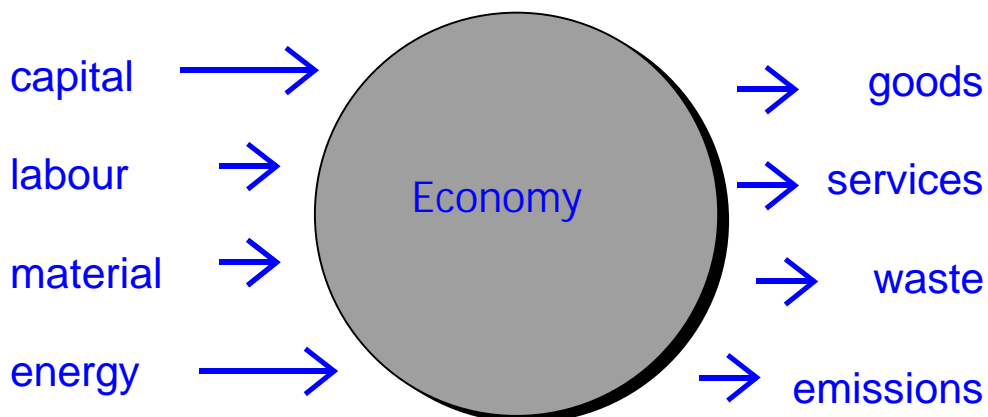


Figure 2. Input to and output from the economy

The environmental accounts aim at quantifying these resource flows and the relationships between them. From a sustainable development point of view, the economic system should produce the desired goods and services with a minimum of environmental impacts. This can only partly be achieved by reducing emissions from specific processes by end-of-pipe solutions, and reducing waste by recycling.

The size and composition of the inputs in the production process is of great importance for the resulting environmental pressure. This is particularly clear for carbon dioxide emissions from fossil fuel input, as well as for the use and spreading of chemicals. As the economy grows, so do the inputs of materials into the system. However, a counterbalancing factor is the energy and material efficiency gains that occur in the development of new products and new equipment.

If, for example, these effects balance each other, we are facing a development with constant environmental pressures. This is not a satisfactory situation, as the recently defined Swedish environmental quality objectives will only be met if the environmental pressures are reduced.

2 The Data

2.1 Overview

The different data sets can be presented under the headings resource use, residuals, employment, economic variables, resource accounts and various analyses (Table 1). In general, the system presents data on a national scale, concerning activities made by Swedish citizens, according to the same definition that the national accounts are using.

Table 1. The data presented to date in the Swedish Environmental Accounts

	Description	Years	Comments
Resource use			
energy	fuels and electricity, PJ	1993-1996	
material flows	direct material input (tonnes)	1987-1998	Sum
chemicals	indicators for hazardous substances	1996	
water	use	1995	
Residuals			
air emissions	CO ₂ , SO ₂ , NO _x CO, CH ₄ , N ₂ O, (NH ₃)	1993-1996 1995 (1993)	
water emissions	BOD, COD, nitrogen, phosphorous, metals	(1985-1998) 1995	Sum by industry
waste		1993, 1998	
Employment			
employment	hours worked	1993-1998	
environment industry	number of employees, turnover, export, value added, operating profits, gross investments	1998, 1999, (1995-1999)	
Economic variables			
value added	current and fixed prices	1993-1998	
green taxes		1995 1993-1998 sum	by industry
environmental costs	industry state municipalities	1997 (1985, 1988) 92/93 1995-1998	
env. harmful subsidies		1993-1995	
Resource accounts			
water accounts	use, emissions and costs	1995	
forest accounts	quantity, quality	1990-1994	
Specific analyses			
regional analysis	Stockholm County	1993	
input-output tables		1991, 1995	
physical input- output table	The use of wood	1993	
households	air emissions	1995 (1991)	
trade	air emissions due to import and export of goods and services	1995 (1991)	
Env. Reporting for firms	Benchmark indicators for industries, in environmental reports	1995	
Internat. Comp.		Various years	

Most variables can be shown for 1995. For some areas, time series are available. The common level of aggregation enables about 40 industries, the public sector and private consumption to be singled out. The parenthesis in the table indicate that data are more aggregated.

2.2 Resource use

2.2.1 Energy

The energy accounts represent a system in which energy data, in both monetary and physical terms, have been incorporated in the national accounting system. The input-output tables of the national accounts provide the natural platform for the energy accounts in values and quantities. The energy accounts can be used, either directly or via computations based on economic models, to analyse energy use in relation to different economic activities in society.

The figures have mainly been computed on the basis of the “energy balances“, which provide comprehensive data on the total energy supply and use for the country. The energy balances are a part of the annual energy statistics produced by Statistics Sweden. The energy accounts are used as a basis for computations of energy-related emissions (see below). Since the calculations of emissions of sulphur dioxide, nitrogen oxides, carbon dioxide and volatile organic compounds are partly based on the energy accounts, a consistent system has been obtained that describes economic activities, energy use in monetary terms, energy use in physical terms as well as environmental impact through emissions. However, there are problems getting data ‘on time’. In order to overcome the time lag that is inherent in today’s system, new ways of making energy accounts based on quarterly statistics are planned (see below).

2.2.2 Material flows

Many environmental problems are connected to production and use of materials and energy. It would therefore be desirable to have an information system that gives consistent and complete information on material and energy flows. Such a system would even be more useful if it could be connected to economic data. The environmental accounts provide such a framework, but comprehensive statistics on material flows have not earlier been available. Statistics Sweden is now in the process of developing material flow statistics for Sweden. One part of this work focuses on an aggregate description of the total material throughput for the society, with a methodology similar to what has been suggested internationally (WRI, 1997). This knowledge can be used to work towards eco-efficiency by improving the resource productivity. The results contribute to the work with environmental accounts and provide a link between society’s use of materials and natural resource accounting.

The size of the Swedish consumption of natural resources has been estimated from 1987 to 1997. An attempt is made to couple this information to environmental pressure as recorded in the environmental accounting system, through a monetary input-output analysis. The study includes main primary categories of direct material inputs (DMI) in the society such as inputs from foreign trade, agriculture, forestry, mining and fuels, and outputs such as exports, waste, and air emissions. In the future, results from similar studies may show the increase of stocks in society. However, due to incomplete solid waste data, no such estimates are included now. The time series have their main focus

on the input side, as the output statistics have not been produced with the same frequency. Until now, there has been no coherent statistics on material flows to follow the development of material inputs. By establishing material flow statistics, policies on materials and eco-efficiency will have a firmer point of reference.

2.2.3 Chemicals

Information about the use of chemicals is a deeply needed prerequisite for political action on decreasing environmental and health risks. The Product Register, kept by the Chemicals Inspectorate, plays an important role in Swedish control of chemicals. The Chemicals Inspectorate was formed in 1986, as an authority responsible for minimising risks to humans and environment from the use of chemicals. Sweden has since 1992 registered components of chemical products in the Product Register. The register was constructed mainly as a tool for the superintendence of importing and manufacturing companies but it also contains chemical information on the registered products as well as quantities used.

The number of substances and chemical products is too large to allow a presentation of each separate chemical in a NAMEA framework. There are however different health classifications available, which can provide a means to present weighted chemicals in a more comprehensive manner. Until now the register has only been possible to use for one year at a time. From the year 2000 it will be possible to go back and look at historical data.

2.2.4 Water use

See 2.6.1 water accounts below.

2.3 Residuals

2.3.1 Air emissions

Emissions of carbon dioxide (CO₂), sulphur dioxide (SO₂) and nitrogen oxides (NO_x)

Emissions of carbon dioxide, sulphur dioxide, and nitrogen oxides originate from three main sources:

- combustion in the generation of energy and heat
- transportation (road, air, rail, sea, off-road vehicles, motorised equipment)
- industrial processes (manufacture of various goods)

Emissions of *carbon dioxide* largely come from combustion and are proportional to the carbon content of the fuel. Emissions of *sulphur dioxide* mainly come from the combustion of oil products and from industrial processes. Emissions from combustion depend both on the sulphur content of the fuel and on any purification measures involved. For *nitrogen oxides*, the main source of emissions is transportation. These emissions depend not only on the amount of fuel consumed, but also on the combustion conditions, i.e. the oxygen availability, temperature and purification. This is taken into account in the emission factors and computation methods employed.

Emissions of carbon monoxide (CO), nitrous oxide (N₂O), methane (CH₃), and ammonia (NH₃)

Emissions of carbon monoxide come from manufacturing industry and trade among others. Mobile sources contribute most. Carbon monoxide contributes to global warming and to photo-oxidant formation.

Nitrous oxide is a greenhouse gas. The most important sources from society are from manufacturing industry and chemical industry.

Methane is a gas with global warming potential and stands for around 15% of the yearly Swedish greenhouse gases, expressed as carbon dioxide equivalents. The emissions of methane are largely due to agriculture (70%). Waste deposits also contribute with about 20% of the Swedish emissions of methane.

Ammonia emissions contribute to eutrophication and acidification. The main source for emission of ammonia is agriculture and the emissions are related to production, storing and spreading of manure. The model for calculating emissions from agriculture is very detailed. The main users in Sweden have agreed on the model and the data used in it. The emission factors are probably the weakest part since they vary depending on the circumstances. Emissions from power plants, industries and manure from pets cause only about four percent of the total, and are based on rather rough estimations.

2.3.2 Water emissions

Water emissions have been estimated for 1995, within the water accounts (see below). Metal contributions are found for the mining and steel industries. However, some contribution also comes from the pulp and paper industry, due to their large volumes of process water. Mining leakage from mining deposits in northern Sweden also contributes to some extent.

The emissions of oxygen demanding substances, measured by BOD or COD, is dominated by the pulp and paper industry, whose emissions exceed those of the municipal waste water treatment plants. These two sources are totally dominating with regard to this type of pollution.

Concerning phosphorus and nitrogen, the municipal waste water treatment plants account for 80% of the nitrogen and 50% of the phosphorous. Contributions are also found for a few other industries. Nitrogen emissions stem from the mining and steel industries as well as some chemical industries, especially plants for production of nitrogen fertilisers.

A few other industries discharge large quantities of water. Some chemical industries use huge amounts of cooling water which is discharged at a higher temperature than the incoming water but which is not believed to differ significantly in chemical composition. In addition to this, much smaller amounts of process water are produced, which may be polluted in various ways. The contents of standard pollution parameters are however very small compared to the pulp and paper industry.

2.3.3 Waste

Waste is like emissions to air and water a form of pollution resulting from economic activities. Waste statistics for the extraction and manufacturing industries in 1993 and 1998 are included in the environmental accounts. Waste surveys were conducted in 1994 and 1999, and the statistics was collected directly according to economic classifications. The data is classified into types of waste and into treatment methods applied. The definition of waste has changed between the surveys, so that more waste is recorded in 1998.

The extraction industry dominates the total waste amounts for the studied industries. The waste from this industry is about three times as much as that from all manufacturing industries together.

2.4 Employment

2.4.1 Employment

Employment and unemployment are major concerns for policy making. The threat that harder restrictions on pollution will cause unemployment is one reason why the Polluter Pay Principle is so hard to establish in practice. Employment can be measured in several ways. Until now it has been presented as hours worked in different industries and sectors. Hours worked shows how labour intensive each industry is and it also shows the activity within the economy. Since employment is such an important social variable it would be of great importance to also present the actual number of employees in the future. After the recession in Sweden in the early nineties, the hours worked increased when the economy began to regain pace, but the unemployment rates only decreased moderately. The companies chose to make people work overtime, rather than to hire new labour.

2.4.2 Environment industry

Interest in the Environment Industry has grown in recent years, with attention often focusing on the relationship between the environment, industry and employment. There are hopes that the development of the environment industry will make it possible both to reduce environmental pressures and at the same time to increase employment and exports.

Data is now available about the *employees* at environment industry establishments. Besides information on *environment activity and industry*, data is also available about *geographical distribution, age, sex, level and line of education, income and former unemployment*. A detailed economic description of the enterprises is available for 1999. Data is presented about *number of enterprises* in the different environmental activities and industries, *private and public ownership, turnover and export*. New sources of information have been used, in order to e.g. produce information on what kind of products and services are exported and to which countries. Indicators on how solid the enterprises are financially and how much profit and value added they generate are also presented. A new breakdown of the information has been introduced in order to show the importance of *small and medium sized enterprises*, in different environmental activities and industries, and for different economic variables.

The work on environment industry at Statistics Sweden started in 1997. The methodological approach chosen is to build up a database of individual establishments and enterprises producing environmental goods and services, and combine this with a number of existing registers and surveys to provide detailed data not only for the core industries, but also for the environment industry as a whole. The first stage of the work focused on identifying enterprises involved in environmental production, analysis of the existing registers and surveys, and presentation of a first set of data. In the second stage the focus was mainly to get the environment industry database as complete as possible. Although the coverage, completeness and quality of the database have improved substantially, this is a long-term project, with continuous improvements.

2.5 Economic variables

2.5.1 Value added

Value added is one of the key variables in judging the economic importance of different industries in terms of their share of GDP. It is therefore the most relevant counterpart to different measures of the shares of total environmental pressure of different industries.

The value added data used in the NAMEA-type of environmental accounts are based on the published Use-tables of the national accounts. This means that they are part of a consistent framework of production costs, imports, taxes, wages, etc. As the emissions to air are dependent on the same detailed yearly national account tables value added measures are available when the emissions are calculated. When all systems are implemented, this means that value added figures, together with other variables by industry, e.g. employment, exports, taxes etc., will be available 18 months after the year in question. The same applies to emissions to air. Sometimes more preliminary measures are used for specific purposes, e.g. when there is a need for more recent data than what is available in yearly detailed national accounts.

2.5.2 Green taxes

In Sweden, the issue of environmental taxes has been much debated in the 1990s, above all in connection with green "tax shifts". In themselves, environmental taxes are considered to be an important means of influencing resource management so as to promote a sustainable society, and the link to a "tax shift" is thought to have a potential double dividend. This double dividend essentially consists in the idea that the efficiency of the economy can be enhanced by correcting the price of activities that impose a burden on the environment (i.e. by reducing an implicit subsidy), while at the same time reducing taxes (e.g. on labour) where the tax entails an inefficient use of resources. One further element in the discussions about shifting taxes from labour to the environment has been the hope of achieving a positive impact on both the demand for and supply of labour.

In the international arena, the use of environmental policy instruments has increased and organisations such as Eurostat (the Statistical Office of the European Communities), the OECD (the Organisation of Economic Co-operation and Development) and the IEA (the

International Energy Association) are attempting to ascertain how environmental taxes are used in different countries. The increased interest on the part of these organisations is due primarily to a strong political interest in fiscal policy instruments in the environmental sphere together with the potential for transferring taxes from areas where they are thought to impede efficiency to the natural resources/environmental sphere.

Within the framework of the environmental accounts environmental taxes are allocated by industry and to private consumption. This means, that it is possible to link the taxes paid to the emissions caused. It is also interesting to compare the actual taxes paid, by different industries and private consumption, to different calculated environmental shadow prices. Detailed data on environmental tax by industry will be added to the environmental accounts in parallel with the emissions calculations, i.e. at best 18 months after the year in question.

2.5.3 Environmental costs

Statistics Sweden has compiled statistics on environmental protection expenditure in the manufacturing industry for 1981, 1985, 1988 and 1997, on local authority environmental protection expenditure for 1991-1998, and on the cost to the state for the 1992/93 budget year and onwards. For many years, the Environmental Protection Agency has been compiling data on state grants for environmental protection.

Studies for the year 1997 show that local authority environmental protection expenditure (investments and running costs) amount to at least SEK 10 billion, state costs are at least SEK 5 billion and those borne by manufacturing industry are at least SEK 8 billion, i.e. a total of around SEK 23 billion (corresponding to 1.5% of GDP). Environmental protection expenditures are difficult to define, measure and distinguish, and the precision of the estimates may therefore be poor.

2.5.4 Environmentally harmful subsidies

Whether and to what extent a subsidy contributes to negative impacts on the environment is far from self-evident. In 1997, the Swedish Environmental Protection Agency published a report commissioned by the Ministry of the Environment, showing the subsidies that have the greatest impact on the environment.² The subsidies investigated are based on the list of environmentally damaging subsidies compiled by the Swedish Environmental Protection Agency. In assessing whether a subsidy is damaging to the environment or not, the Government's three criteria for ecologically sustainable development³ were used:

- Protection of the environment
- Efficient use (of energy and other natural resources)
- Sustainable supply (closed cycles).

² Naturvårdsverket [1997], *Ett urval av statliga subventioner som kan motverka en ekologiskt hållbar utveckling* (Swedish Environmental Protection Agency, Selected state subsidies that may be inconsistent with ecologically sustainable development).

³ Proposition (Government Bill) 1996/97: 150, appendix 5.

The subsidies that have been identified come into conflict with one or more of these criteria. These selection criteria mean that the subsidies identified include not only subsidies that can be assumed to have a direct impact on the environment (e.g. in the form of increased emissions), but also subsidies that work against the efficient use of resources or undermine the principle of a sustainable long-term supply.

There are certain subsidies, mainly introduced for distributional purposes, which have a potentially harmful influence on the environment. Implicit subsidies may for example be introduced through exemptions in environmental taxes. There are other examples of subsidies that are more direct, e.g. subsidies on housing, transports or agriculture. They can all be linked to potential increases in environmental pressures. Some of the environmentally harmful subsidies that have been identified by the Swedish EPA are calculated and published in tandem with the environmental taxes.

2.6. Resource accounts

2.6.1 Water accounts

In a NAMEA framework accounts are presented for water abstraction, use and discharge of water. Available physical and monetary data referring to 1995 are recalculated and adjusted to the environmental accounts.

2.6.2 Forests accounts

Yearly forest balances will be compiled in the NA framework. For the moment the method is under development. One of the problems to be resolved is how to handle statistical errors in the Forest Inventory data. The preliminary suggestion is to use five year averages for opening stock, closing stock and gross growth in combination with yearly additional information of other changes. It is also an open question how to relate NA values to official physical data, because NA may use different data sources from year to year. In the Forests accounts physical data on the non-NA functions of forests e.g carbon assimilation, recreation and biodiversity are also included.

2.7 Specific analyses

2.7.1 Regional Environmental analysis

Environmental accounts can be developed into regional accounts in the same way as the national accounts. A growing interest in regional economic data stimulates an interest in regionalized environmental accounts data. There is a need to follow up on regional commitments to sustainability. There is also a distributional aspect to creating regional economic and environmental accounts. This development is a long-term process, proceeding in unison with the development of the regional financial accounts. Financial data, Energy consumption, some emissions and waste have been calculated for Stockholm county. The project was financed by the Office of Regional Planning and Urban transportation in Stockholm.

The pilot study was made in the Stockholm region to set up parts of a regional environmental account. Regional accounts can mainly be done in two ways

- a) top-down, to use the national environmental accounts data and allocate these to the region with the use of data from the regional economic accounts, i.e. take the emission coefficients and apply these to the production values of the regional industries.
- b) bottom-up, to make calculations of for e.g. use of energy, emissions or waste for different industries located in the region

For this project we choose to use the bottom-up method with the idea to get a better true picture of the situation in the region, since the national environmental account at that time was very aggregated and the heterogeneity of the industries was too severe in many cases. As there is a great lack of regional environmental statistics most of the regional environmental accounts data had to be compiled more or less from scratch using a variety of sources.

With the recent, more disaggregated, environmental accounts data as well as the presence of a regionalized input-output model for Sweden, the situation is changed. A second round on environmental accounts for the Stockholm region will be used as a vehicle to evaluate the possibilities in using national environmental accounts data and fairly straightforward allocation methods to set up regional accounts. There will still be a need for further analysis and data compilation for certain industries or sectors as well as for certain components of the environmental accounts, e.g. mobile emissions.

2.7.2 Input-output analysis

For the moment ESA95 is being implemented in the Swedish National Accounts (NA). This means, that the system has not reached its final structure and therefore the description below is tentative in relation to the final outcome.

As the environmental accounts are largely based on the use- and supply tables of the national accounts, IO analysis can be a powerful tool for different kinds of analysis. IO analysis can be used to link the industries with the products and services. For example, the environmental pressures can be allocated to final demand, so that a nation's consumption and export of products and services can be linked to the environmental pressure. Input-output analysis has been used e.g. in the pilot study on the environmental importance of trade.

Proper input-output tables have not been published in Sweden since 1985. The environmental accounts have had access to preliminary tables for 1991 and 1995. These are not very disaggregated (~45 commodity groups) and are therefore not appropriate for analysis that requires greater detail, for instance some types of material flow analysis.

All member states are required to publish input-output tables every 5 years, starting with 1995 that will be available in 2002. As the environmental accounts would ideally need yearly tables as well as more disaggregated tables than the 60 by 60 tables that are required, development work has been initiated to explore the possibility of having

yearly tables produced. This would facilitate decomposition of the changes in environmental pressures as well as provide a better foundation for forecasting and modeling efforts.

A physical input-output table was established (in units of carbon content) for 1993. This was done in order to check for possible uses of the results and to test the data availability in a field where physical data was relatively detailed (MIR 1998:3).

2.7.3 Households

So far, the environmental accounts have treated households or consumers as a component of final demand – namely private consumption. This has made it possible to calculate the direct emissions caused by the actions of consumers (they consume energy which causes emissions) as well as indirect emissions (emissions caused in the production of the goods and services consumed). These calculations have been made for private consumption in total and disaggregations have been restricted to straight per capita measures. The households contributes to the environmental pressure, but can also in many ways contribute to a sustainable development by e.g. changes in consumption patterns, changes in travel habits and changes in energy consumption. Some of these changes will probably be voluntary while others will be in response to changes in taxes, subsidies, regulations or institutions.

The household sector is not homogenous. It consists of individuals and households that are very different in their environmental impact. They will also adopt different strategies for the changes ahead according to tastes, beliefs, culture, financial means etc. It is important that the environmental accounts capture these differences to some extent, as they are primary factors for a development towards a sustainable future.

Environmental accounts are mainly production oriented in that the environmental pressures are allocated to industries. As the accounts are linked to the Use, Supply or symmetric Input-Output tables of the national accounts, the environmental pressures of the demand side is also calculated, e.g. the direct emissions from the private consumption of energy for heating and transportation. The role of the consumer has been highlighted in the discussion of sustainable development in recent years, with the introduction of environmental labelling schemes and a general interest in a more environmentally friendly life style.

This has a macro as well as a micro perspective. The macro perspective deals with the volume and composition of private consumption. This can be done with input-output analysis of the environmental accounts. The micro perspective involves tracking the volume and composition of different types of households. In order to use environmental accounts data to analyse the environmental pressures caused by different groups or types of consumers, the final demand side of the accounts has to be linked to other kinds of data, e.g. household expenditure surveys.

A pilot study has been done on air emissions using Environmental accounts data for 1991 and 1995, together with input-output analysis for the same years. These were then linked to Household budget surveys for 1992 and 1995 as well as a time use survey covering 1990-1991. As this analysis of private consumption and households is

dependent on input-output tables and reasonably stable household budget surveys, it will be updated when possible.

2.7.4 Trade

Until now, the environmental accounts have principally described events inside Sweden. Estimates of emissions to air, for example, are produced on the basis of the emissions in Sweden due to Swedish consumption and production⁴, but Swedish consumption also affects the environment in other countries where the goods we import are produced. In the same way, part of the impact on our national environment is linked to the goods Sweden exports. Sweden is a small open economy with extensive trade with the world around. A large part of what is consumed in Sweden – equal to 34 per cent of GNP – is produced elsewhere in the world. Similarly, what is produced is consumed in other parts of the world (40 per cent of GNP). The goal is a system of environmental accounts that reflects all impact on the environment caused by Swedish final use⁵. In a pilot study, the emissions of carbon dioxide, sulphur dioxide and nitrogen oxides that Swedish imports and exports give rise to have been calculated.

Most, if not all, environmental accounts focus on the environmental pressures caused by national economic activities. However, all countries are more or less dependent on trade. The economic activities in one country are dependent on production and consumption in other countries. Therefore, environmental accounts should, at least, give an idea of the kind of environmental pressures the domestic production and consumption patterns create in other countries. Ideally, this would be a kind of environmental balance of trade estimate to complement the national data.

Data, for calculating the global environmental pressures due to imports into any one country, are hard to get by. There is a need for trade data as such, e.g. allocating imported goods and services to producing trading partner from the countries involved in the trade. On top of that, environmental data and economic data are needed, e.g. the emissions from exports by industry and trading partner. A pilot study for Sweden, covering 1991 and 1995, illustrated the different possible approaches to establishing an environmental trade balance. As with most calculations made in this area, this study was made using Swedish input-output relationships as a proxy for production techniques in all other countries. Continued development of the, more or less, harmonized European NAMEA-systems, especially input-output tables, will address some of the data issues. As the trade within the EU accounts for the major part of the trade volume for Sweden, this will make it easier to go some way towards including traded environmental pressures in the environmental accounts. In the long run, data on production conditions outside the EU will be needed to account for the global impact of Swedish and European trade.

2.7.5 Benchmarking indicator for environmental reporting of companies

The interest for environmental reporting on a company level is growing, and no standards have yet been established. We have cooperated with some companies

⁴ Figures for Swedish water, air and road goods transport include emissions in other countries.

⁵ Swedish final use includes private and public consumption and investments.

interested in using the environmental accounts data as a benchmarking or norm for trends. They request help with defining appropriate and common definitions.

2.7.6 International comparisons

Most effort has been put down on establishing a system to describe the national activities as such. However, it is of course important that the data collected can be compared with and linked to data in other nations' environmental accounts. Some studies have been performed on a Nordic level in order to explore differences and similarities in the respective systems. These studies have shown that standardisation work is still needed in many areas. In particular, the waste statistics are not yet comparable between countries. The value of an environmental accounting system increases when similar analyses can be made not only on national levels, but also for larger regions, as we are depending on each other through trade, through global environmental problems and through policy issues that are decided on an international basis.

3 The main Users and Uses

The National Institute of Economic Research (KI) KI is a public organization that does analytical work for the parliament and other government bodies. Their Division for Environmental and Resource Economics has been a major user of the accounting data from the beginning of the work, and they have served on the steering committees that set up and managed the accounting work. (Publications in their Working Paper series can be ordered at www.konj.se)

KI have mainly used economic data, energy data and air emission data so far. For evaluation studies the forest account data has been used. A medium-term economic forecast model has been developed, which takes environmental aspects into account. The model uses environmental accounting data to link air emissions to productive sectors and assess the economic impacts of different environmental goals. It also is linked to transportation models, since transport is a major source of pollutant emissions and a key input into production. KI have used this to assess the implications of Kyoto Protocol targets for economic activity. Their wish is to include more types of data, e.g. environmental taxes in future work.

The Ministry of Finance routinely undertakes medium-term economic forecasts based on a general equilibrium model developed at KI, which includes some environmental aspects as described above.

The Swedish Environmental Protection Agency (NV) is using information from the environmental accounts in many different ways. We made a small email-survey asking its personnel who uses the environmental accounts and for what purpose. Many noted that they used it for general information on economic issues, and when preparing reports or speeches.

The Swedish Government has called for a number of studies based on the accounting data. They have created national commissions on climate change, the Committee on Environmental Objectives, the committee for growth and environment, and green taxes, all of which have commissioned analytical work relating the economy and the environment. These commissions are central to the Swedish process for identifying key policy issues and analysing strategies to resolve them. Thus the accounting data are feeding into high-visibility public debates about tax policy, climate change, environmental policy and economic growth.

The Environmental Advisory Council has used the material flow data for one of Sweden's green headline indicators.

The Swedish Environmental Research Institute (IVL). Swedish accounting data are being used by consulting firms that advise businesses on their environmental performance. One firm, IVL, has used the accounting data to produce indicators on energy use and pollutant emissions per unit of output for different industrial sectors. These are aggregated to produce indicators of the industries' impacts on the greenhouse effect, acidification, and eutrophication. IVL uses a system for weighting the contributions of the different pollutants to the indicators that was adopted by the International Standards Organisation (ISO) and has been used in many countries. They

are using these indicators to help individual firms assess their own performance relative to the norm for their industry, and to help them develop priorities for monitoring their environmental impacts.

International organisations such as the **Nordic Council of Ministers**, has commissioned studies on the comparability of data between the Nordic countries. Dr. Joy E. Hecht, Green Accounting Initiative, **IUCN/The World Conservation Union** has performed a study comparing Environmental accounts in different countries. Sweden was chosen a European Union (EU) country that has actively worked with Eurostat (the statistical office of the EU) in helping to design, test, and implement accounting methods intended for all EU countries.

The Swedish delegation for sustainable technology (miljöteknikdelegationen), has used data on environment industry and has financed parts of the establishment of the data base. They are also actively spreading these data into regional work being done in this field. For example, the information is being published on regional web-sites (Figure 3).

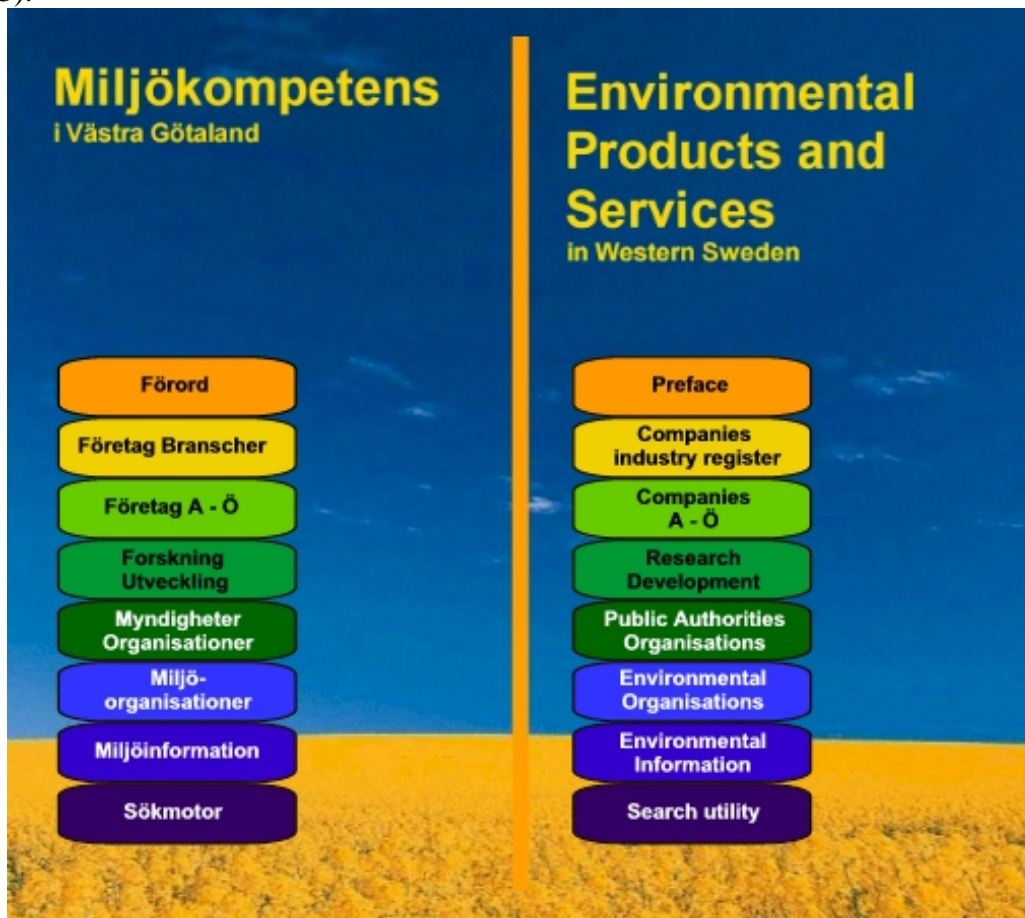


Figure 3. A web-site describing environmental products and services in Western Sweden.

The Swedish National Labour Market Administration (AMS), has used the estimations on the size of environmental industry in their analyses on employment potential and policy.

The Swedish Trade Union Confederation (LO), has been interested in the linkages between industries and environmental pressure on a seminar on environment and unions, which was held together with **The Swedish Society for Nature Conservation**.

The Office of Regional Planning and Urban transportation in Stockholm (RTK), has commissioned work on regional accounting, as a basis for their analyses.

The data is also requested by **journalists, universities, political parties, and writers**.

The data is published in **official statistical publications** that give a general overview of Swedish society.

Eurostat is using the environmental accounts to e.g. test which methods can be recommended, and to be able to assess comparable data over Europe.

The London Group on Environmental Accounting was created in 1993 to provide a forum for practitioners developing and implementing environmental satellite accounts. It convened its first meeting in March 1994 in London, England. Participation includes representatives from statistical offices and international organizations. The meetings are hosted voluntarily by participants one at a time. So far, the United Kingdom, the United States, Sweden, Canada, France and Australia have each provided facilities and secretarial functions for one of the meetings. A Papers and Proceedings volume has been compiled after each meeting. The London Group is a forum where some results and experiences from Sweden's work has been published and discussed. (See for example SWEEA, Swedish Economic and Environmental Accounts in Structural Change and Economic Dynamics no 10, 1999, pp 39-72.)

4 Published reports

English reports and Swedish reports have been put on the web of Statistics Sweden, in order to enhance the availability (see <http://www.scb.se/publkat/miljo/eu/eu.asp> for the English reports and <http://www.scb.se/landmiljo/annan/raken/raken.asp> for the Swedish reports).

The results are published in three main publication series. The first two are possible to subscribe to. Time series are presented in the ordinary publications for official statistics, with only some comments to the tables. These are in Swedish with a very short English summary, and English names on the tables. In the future, these types of publications will be designed to be put on the web.

The more reader-friendly analysis of different areas in the environmental accounts are published in the series 'Miljöräkenskaper', mostly in Swedish, but also in English. There are English summaries available for most Swedish reports. Other English reports, dealing mostly with methodological issues, are published in Eurostat working papers. (The work with these reports have partly been financed by the European Commission.)

Statistical Reports

Na 53 SM 9601	Miljöräkenskaper, Fysiska räkenskaper för energi och utsläpp till luft 1989, 1991 och 1993 (Physical accounts for energy and air emissions 1989, 1991 and 1993.)
MI 53 SM 9901	Miljöräkenskaper, Fysiska räkenskaper för energi och utsläpp till luft 1993 och 1995. (Physical accounts for energy and air emissions 1993 and 1995.)
MI 23 SM 0001	Miljöskyddskostnader i industrin 1997. (Environmental Protection Expenditure in the industry 1997)

Reports in the series Miljöräkenskaper

1998:1	SWEEA, Swedish Economic and Environmental Accounts Svenska miljöräkenskaper, En lägesrapport från Konjunkturinstitutet och Statistiska Centralbyrån 1994	KI, SCB
1998:2	SWEEA, Swedish Economic and Environmental Accounts English version 1994	KI, SCB
1998:3	Materialflöden och kretslopp i de svenska miljöräkenskaperna - en förstudie 1995 (Material flows, bio-carbon PIOT)	SCB
1998:4	Industrins miljöskyddskostnader 1991 (Env. Prot. Exp. industry)	SCB
1998:5	Aggregering av miljödata till miljöhot – en förstudie 1996 (Aggregating data to environmental threats)	SCB
1998:6	Samband mellan miljö och ekonomi, en rapport om fysiska miljöräkenskaper i Sverige (Overview)	SCB

1998:7	Kostnader för att minska utsläpp av kväveoxider och flyktiga organiska ämnen (Costs to reduce emissions of nitrogen oxides and volatile organic substances)	NV
1998:8	Avfall 1993 (Waste)	SCB
1998:9	Svenska miljöräkenskaper för svavel och kväve samt Sveriges kostnader för kväveutsläpp (Swedish Env. Acc. For sulphur and nitrogen, and Swedish costs for nitrogen emissions)	KI
1998:10	Miljöräkenskapsprojektet vid Konjunkturinstitutet 1992-1997 med bilagorna Gröna nationalräkenskaper och Att konstruera ett miljöräkenskapssystem (Overview of KIs work)	KI
1998:11	Indikatorer för hållbar utveckling – en pilotstudie (Indicators for sustainable development- a pilot study)	SCB
1999:1	Minskade koldioxidutsläpp genom förändrad materialanvändning- en förstudie (reduced carbon dioxide emissions through changes in material use – a pilot study)	SCB
1999:2	Miljöföretag och gröna jobb i Sverige (Environment industry)	SCB
1999:3	Skogsräkenskaper - en delstudie avseende fysiska räkenskaper (Forest accounts)	SCB
2000:1	The environment industry in Sweden 1999	SCB
2000:2	Industrins miljökostnader 1997 - resultat från en svensk pilotstudie (Environmental costs for industry 1997- results from a Swedish pilot study)	SCB
2000:3	Miljöskatter och miljöskadliga subventioner (Environmental taxes and environmentally harmful subsidies)	SCB
2000:4	En framtida nationell materialflödesstatistik – användning av naturresurser, substanser och kemikalier i produktion och konsumtion. (Material flow statistics- uses of natural resources, substances and chemicals in production and consumption))	SCB
2000:5	Miljöpåverkan av svensk handel - resultat från en pilotstudie (Environmental pressure from trade – results from a pilot study)	SCB
2000:6	Vattenräkenskaper – en pilotstudie om uttag, användning samt utsläpp, fysiska och monetära data (Water accounts)	SCB

English reports on the web-site

1	Nordic Natural Resource and Environmental Accounting	Natural resources	1995
2a	Testing SERIEE's Environmental Protection Expenditure Account in Sweden	Environmental protection expenditure	1996
2b	The recycling industry in Sweden 1995	Environment industry	1996
3a	Disaggregation and Improvement of the Swedish NAMEA	Air emission	1997
3b	Forest economic environmental accounting: a pilot study of a first implementation	Natural resources (Forest accounts)	1997
3c	Disaggregation and Incorporation of Environmental Protection Expenditure in the NAMEA-framework	Environmental protection expenditure	1997
4	Adaptation of Swedish data on environmental protection in the public sector to the SERIEE-system	Environmental protection expenditure	1997
5	Environmental Protection Expenditure in Industry in 1997: Results of the Swedish Pilot Study	Environmental protection expenditure	1999
6a	Extended Time Series in the Swedish Environmental Accounts	Air emission	1999
6b	The Environment Industry in Sweden	Environmental industry	1998
6c	Environmental Accounts Households	General	1999
6d	Material flow study of sand and gravel in Sweden	Material flow	1999
7	Producers of Environmental Services	Environmental protection expenditure, Environment industry	1999
8a	Water Accounts: Physical and Monetary Data connected to abstraction, use and discharge of water in the Swedish NAMEA	Natural resources (Water accounts)	1999
8b	Direct Material Input (DMI) for Sweden 1987-1997	Material flows	1999
9	The Environment Industry in Sweden 1999	Environment industry	1999
	Forthcoming reports		
10a	Environmental employment	Environment industry	2000
10b	Environmental Taxes	Environmental taxes	2000
11a	Chemicals	Chemicals	2001
11b	Forest accounts	Natural resources (Forest accounts)	2001

Other reports in English with a regional or local perspective

Regional Environmental Accounts for the Greater Stockholm Region - a first step. RTK 1999

Tema Nord 1996:563 Nordic Natural resources and environmental accounting - sub-report I

(The report focuses on Forest accounts, Fishery accounts, accounts for nutrients and Environmental protection expenditures, and was translated to English with financial aid from Eurostat)

Tema Nord 1997:598 Nordic Natural resources and environmental accounting- sub-report II.

(The report focuses on Energy and emission accounts, Material flows and Eco-industries)

Tema Nord 2000:515 Nordic Natural resources and environmental accounting sub-report III. Nordic Environment-Economic Indicators

In the report there is a comparison of the NAMEA information concerning economic data, use of energy and emission to air

5 Plan for regular statistics from the Environmental Accounts

Data that will be published every year

- Energy statistics
- Air emission statistics
- Economic statistics
- Employment statistics

Data that is collected and presented regularly with approximately 3-5 years interval:

- Natural Resource Accounting Statistics
- Water emissions
- Waste statistics

Data which would preferably be presented each year, but which awaits funding or better data

- Material flow statistics
- Chemicals
- Input-output tables
- Environmental pressure from trade
- Environment industry

The data collection needs to be complemented by special analyses, such as the underlying factors of trends, production of quarterly statistics, analyses of different aggregates of the data and of different regional analyses.

6 Experiences in short

The data have found many different uses and the reports are read by a number of people who use them to keep themselves updated on environmental accounting in Sweden. The environmental accounts were from the start divided between three institutions and this is likely to have contributed to the spreading of data to different actors in Sweden.

The environmental economic profiles (see e.g. Figure 4) have shown to be an illustrative tool to present environmental accounting data to new users. In order to spread the use of the data, it is regarded as vital to make specific analyses and combine the data to get information that can be used in policy making. The Swedish report on sustainability indicators has been a good way of presenting data in an overview form. We plan to be publishing more data in similar indicator form, as soon as the regular reporting is working properly.

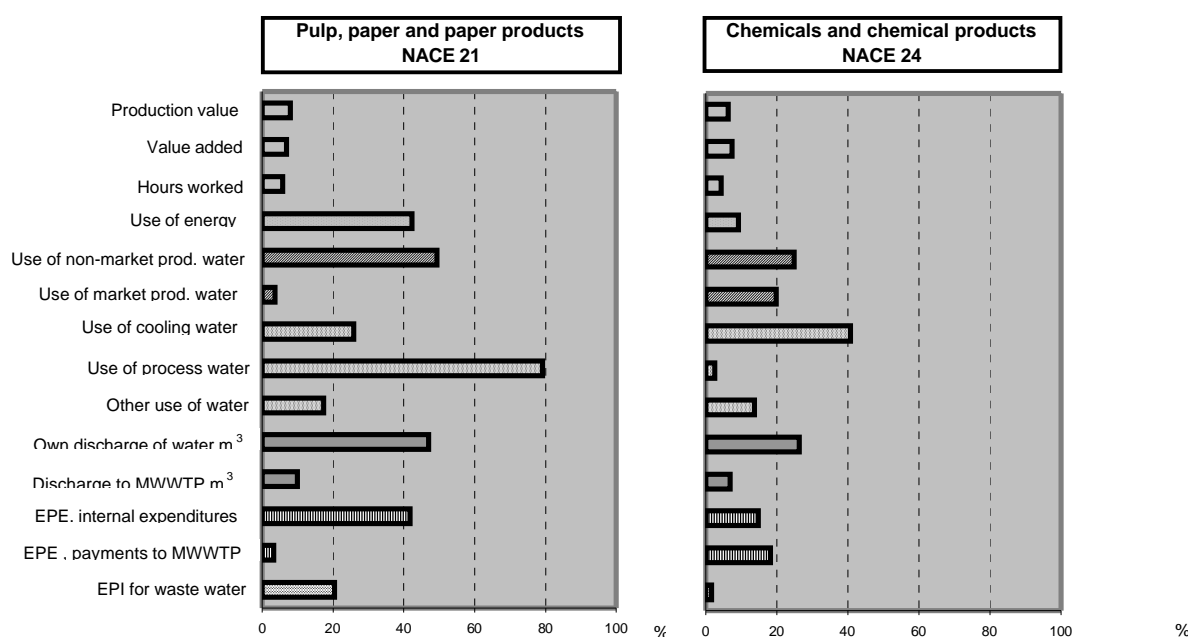


Figure 4. An example of an environmental economic profile, showing various parameters for different industries as a percentage of the national contribution.

The use of press releases is a good way to spread the main results of the development work to the Swedish media. Whenever a report is released from the environmental accounts, a press release is sent out, and is usually cited in many newspapers.

The fact that many data sets are depending on the production of statistics from the national accounts has caused problems with the timeliness of the information. Due to extensive revisions and restructuring of the national accounts, the latest time series for air emission accounting data is e.g. from 1996. This problem will have to be dealt with, in order to make the information as useful as possible for policy work.

In order to present some figures on the level of economic activity and its environmental pressure, a national environmental economic profile was made for this project (Table 2). These figures should of course become even more interesting if coupled to e.g. national goals, but that work lies outside the scope of this report.

Table 2. A national environmental profile, data from 1995 and various years. (8,8 million inhabitants, GDP for 1995 1713 billion SEK). Emissions from 1998, including bunker fuels.

Area	Total	per capita	per GDP (1000 SEK)
Energy use	1091 PJ	124 MJ	0,64 MJ
Material input DMI	238 Mtonnes	27 tonnes	0,14 tonnes
Water use	2700 Mm ³	310 m ³	0,002 m ³
CO ₂ -emissions	62 000 ktonnes	7 tonnes	0,04 tonnes
SO ₂ -emissions	65 ktonnes	7 kg	0,04 kg
NO _x -emissions	297 ktonnes	34 kg	0,2 kg
N to water	32 ktonnes	4 kg	0,02 kg
Employment	6600 Mhours	750 hr	0,004 hr
Employment, no of people	3 986 000	0,45	2 . 10 ⁻⁵
Unemployment, no of people	333 000	0,04	2 . 10 ⁻⁶
Environment Industry, no of people	95 000	0,01	6 . 10 ⁻⁷
GDP, market price ('95)	1713 GSEK	195 000 SEK	1
Env. Taxes	51 GSEK	5 750 SEK	0,03
Env. Costs	20 GSEK	2 300 SEK	0,01
Trade import	576 GSEK	65 000 SEK	0,34
export	686 GSEK	78 000 SEK	0,40
Household direct CO ₂ emissions	15 Mtonnes	2 tonnes	0,01 tonnes
Protected forest	768 000 ha (3,3 % of productive forest area)	0,09 ha	4,5 . 10 ⁻⁹

Possibilities of cost-effective production

The environmental accounts are largely based on data that are already collected for other purposes. The data on economy and energy have been collected for many years. It is rather the connecting of data into an information system that makes other analyses possible.

In some areas, the data are collected specifically for the environmental accounts, such as the environmental costs. In other areas, the classification by industry has been included in the 'ordinary' environmental survey, as for the waste surveys.

For the area of environmental industry, Sweden has chosen an approach to use existing data registers rather than questionnaires. It is also possible to combine these methods, by sending questionnaires to a more well-defined population that is collected from the now established data base of environment industry companies.

The production of data in all the described areas is regarded as important for environmental policy. For some areas the data is needed on a yearly basis, for some a three or five year interval may be sufficient. This is a function of e.g. the variation between years, and if there are special policies regarding the area.

7 Future work

In order to get data as early as possible, we are currently investigating the possibilities of making quarterly energy accounts. If the preliminary data on energy consumption is complete enough for a conversion to air emissions, quarterly indicators for e.g. carbon dioxide emissions for large aggregates of industry would be available at the same time as the quarterly economic assessments were published. This would enhance the usefulness of the data and also make data more suitable for use in yearly environmental reports from companies.

In the future, with regular production of data into time series, it becomes increasingly important to make the data available to the users by the means of databases. We have recently put out the publications, which often contain the data that is available until now, on the SCB homepage. This increases availability, and is appreciated by our users.

I/O-analyses on a regular basis are highly prioritised, but awaits regular production of official IO-tables. Today, it is the possibilities to analyse environmental pressure for different sectors and for different products that are most asked for. The new policy instrument 'IPP' Integrated Product Policy, could probably benefit from this type of analysis.

Modelling work is deeply needed, in order to understand the couplings between the different areas that are part of the environmental accounts. One major topic will be to investigate the properties of different policy instruments. Other types of analyses will be necessary to understand how economic cycles, structural changes, technological changes and behavioural changes affect the outcome of the system.

Further development of the data collection will be necessary for many areas. Newly established areas such as subsidies, chemicals, water emissions, sustainable development indicators and environment industry are still being formed. In some cases, the areas will have to get financial aid from the government in order to become part of the official statistics. Pilot projects have been financially supported by Eurostat, but regular reporting is of course something that needs further funding.

The possibilities for different types of resource accounts will be further explored. For example, a pilot study on land accounts would be of interest.

International co-operation is a necessary component in the work for several reasons. Partly, because the data needs to be internationally comparable. Partly, because the environmental accounts is well suited for analyses of factors that do not only work on a national level. In the future, we hope to be able to link the Swedish environmental accounts to our trading partners and thus give a more full perspective on the links between environment and economy.

8 Conclusions

Some information is available in most relevant areas (see table below), and can be used to give a picture of the size of environmental pressure and economic flows.

The data presented to date in the Swedish Environmental Accounts

	Description	Years
Resource use		
energy	fuels and electricity, PJ	1993-1996
material flows	direct material input (tonnes)	1987-1998
chemicals	indicators for hazardous substances	1996
water	use	1995
Residuals		
air emissions	CO ₂ , SO ₂ , NO _x	1993-1996
	CO, CH ₄ , N ₂ O, NH ₃	1995 (1993)
water emissions	BOD, COD, nitrogen, phosphorous, metals	(1985-1998) 1995
waste		1993, 1998
Employment		
employment	hours worked	1993-1998
environment industry	number of employees, turnover, export, value added, operating profits, gross investments	1998, 1999, (1995-1999)
Economic variables		
value added	current and fixed prices	1993-1998
green taxes		1995 by industry 1993-1998 sum
environmental costs	industry	1997 (1985, 1988)
	state municipalities	92/93 1995-1998
env. harmful subsidies		1993-1995
Resource accounts		
water accounts	use, emissions and costs	1995
forest accounts	quantity, quality	1990-1994
Specific analyses		
regional analysis	Stockholm County	1993
input-output tables		1991, 1995
physical input-output table	wood	1993
households	air emissions	1995 (1991)
trade	air emissions due to import and export of goods and services	1995 (1991)
env. reporting for firms	benchmark indicators for industries, in environmental reports	1995
Internat. Comp.		Various years

Most variables can be shown for 1995. For some areas, time series are available. The common level of aggregation enables about 40 industries, the public sector and private consumption to be singled out.

However, time series are not available in all areas, and the time lag with which data is reported is not satisfying for some uses. A time lag of approximately one year for energy, emission and economic data would be more acceptable.

The data have been used by a variety of actors in Swedish society and has made new analyses possible, which could not be performed with earlier statistics.

Future work will, together with refining of the methods to produce the data that is now in the system, be concentrated on getting more timely data and on refining the underlying factors behind the changes in environmental performance.