Using the right environmental indicators: Tracking progress, raising awareness and supporting analysis

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Nordic perspectives on indicators, statistics and accounts for managing the environment and the pressures from economic activities

Julie L. Hass, Statistics Norway and Viveka Palm, Statistics Sweden

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Content

Preface

The challenge of developing appropriate indicators and accounting systems for environmental issues and policy targets, perhaps particularly in relation to national accounting, and for linking and integrating environmental policies and economic policy-making, has long been a focus of attention for environmental policy, internationally, in the Nordic countries and in the Nordic Council of Ministers.

In recent years, several major initiatives have been taken internationally, including the report of the Stiglitz-Sen-Fitoussi commission, the European Union's work on "GDP and beyond", and the international collaborative work led by the OECD on "Measuring the Progress of Societies". The United Nations' handbook on a System of Environmental-Economic Accounts (SEEA) has also recently been revised. These efforts all support the development of alternative measures and improved data on critical dimensions of both human well-being and better accounting for the sustainability of the earth's natural resource base, ecological systems and biological diversity.

A common recommendation from EU work and OECD-led work, and from the Stiglitz-Sen-Fitoussi commission, is that there is a need for a range of measures and indicators: No single index or indicator can reply to very different needs and purposes.

In the Nordic countries, Denmark, Finland, Iceland, Norway and Sweden, we have seen the need for an updated overview of how different types of environmental indicators and accounting systems can best be applied to such diverse uses and purposes. The Working Group on Environment and Economics (MEG) under the Nordic Council of Ministers commissioned the national statistical agencies in the Nordic countries, led by Statistics Norway and Statistics Sweden, to prepare a report on these questions, and to discuss and recommend how the Nordic countries could contribute to developing such indicators and accounts further.

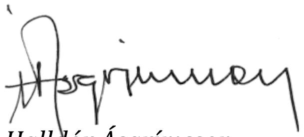
Some important and particularly interesting conclusions and recommendations in the report include:

- Indicators need to be used appropriately. For example, indicators which are best used for awareness-raising cannot be appropriately used for monitoring policies

- Statistics used for monitoring need to be constructed specifically to address and keep track of policy goals
- Complex, aggregated indicators are typically only appropriate for awareness-raising, and data quality and international comparability are often questionable
- Attempts to develop "Green GDP" figures encounter a range of problems, above all that all valuation methods proposed for assigning prices to environmental goods and services yield prices that are not consistent with and cannot be added to the market-based prices in the present system of national accounts
- These problems also arise for attempts to integrate the value of ecosystem services in national accounting. While much useful work has been done and can be further developed on identifying and describing physical ecosystem services, in measuring the amounts and the importance of such services to human users and stakeholders, and in analysis and evaluation of the different types of "value" of these services, the fundamental problem of incompatible types of prices remains a stumbling block to full integration in national accounting
- The statistical offices of the Nordic countries have a long history of working with "satellite accounts" for the environment, in combining national accounts with environmental information (e.g. the NAMEA system, National Accounting Matrix including Environmental Accounts), and in modelling and analysis of a range of environmental issues, based on linking such national accounting and environmental data. These systems and methods may be the best approach to respond to the needs and demands of policy-making that "Green GDP"-efforts are sometimes put forward as an answer to
- On proposed new modules in the European Union legal framework on environmental-economic accounts, the report supports a module on energy use by economic actor, with some modifications, sees the detail required for a module on Environmental Goods and Services as a determining factor in its acceptance, and suggests that data needs for a new module on environmental protection expenditure could be met by current required reporting
- In relation to further development of existing modules, the report strongly recommends that priority on material flow accounting move from overall economy-wide figures to substances with less mass but higher environmental impacts, such as hazardous chemicals

These conclusions and recommendations might form part of the basis for Nordic contributions to further work in the OECD (e.g green growth indicators) and in EU/Eurostat (indicators for resource efficiency, environmental-economic accounts).

The report has been written by Julie Hass of Statistics Norway and Viveka Palm of Statistics Sweden, with contributions and comments from the statistical agencies in all five Nordic countries, and has also received valuable input from members of the MEG on draft versions.



Halldór Ásgrímsson
Secretary General
Nordic Council of Ministers

Summary

The production of environmental information is often the responsibility of various ministries, agencies and institutions. Putting different parts of environmental information together to make a coherent picture can be a complex task. Making sense out of this variety of information and knowing which indicators are developed is also challenging.

The main focus of this report is on indicators related to the environment and some sustainable development indicators since these indicators include an environmental perspective. This report does not attempt to be exhaustive but tries to include many of the most commonly encountered indicators by environmental policy makers. In addition to describing the different types of indicators, some evaluation and guidance regarding the use of indicators is given.

This report has two major parts. The first part of this report attempts to evaluate different types of information/indicators and their major uses. The second half looks at the work of the Nordic countries in light of the System of Environmental-Economic Accounting (SEEA), the related 2011 EU regulation requiring reporting of environmental accounts and the proposed new reporting areas that are under discussion with the European Commission (Eurostat).

In Part 1, it is noted that different types of information and indicators are needed for tracking progress, raising awareness and for analysis. Policymakers need to have a variety of tools available in their toolboxes. The right tool needs to be used for the right purpose. In the same manner, indicators need to be used appropriately. Indicators which are best used for awareness-raising cannot be appropriately used for monitoring policies.

Indicators that can be used for monitoring policies or goals need to be constructed to specifically address and keep track of that policy or goal. Typically these types of indicators track a single area and can often be rather simple in their presentation, although not always so simple in their interpretation. Complex, aggregated indicators, which typically put a variety of different things together into a single indicator, are typically only appropriate for awareness-raising. Often, the amount of data needed for constructing these types of indicators is substantial and can be of questionable quality if the data is being developed for all countries. Typically the quality of the data means that only very rough groupings of

countries should be made and any type of ranking of individual countries can be of questionable quality. Statisticians can often provide advice and insights in the development and evaluation of indicators.

Part 2 focuses on the environmental accounts work in the Nordic countries. The well established statistical systems in the Nordic countries is a resource especially when it comes to data availability, establishing new data from existing information systems including administrative records and in using the data for analysis purposes. The new EU regulation 691/2011 will provide country data from European countries that can be used for comparison and analysis.

The Nordic countries have been active in the development of environmental accounts. They have contributed in a variety of ways, but the Nordic countries have been particularly good at experimenting and trying to figure out how different types of accounts could be developed. This work has been particularly helpful to the wider statistical community.

The European Regulation (691/2011) will provide the structure and impetus to establish the three environmental accounts modules, air emissions, environmentally-related taxes and material flows as official statistics. This process will most likely contribute to improving the quality of these statistics.

As additional modules are considered, the issues of quality and cost need to be seriously evaluated with respect to the type of information that is being developed. The methodology for data collection and the approach to developing the accounts needs to have a focus as well. Identifying the types of policy questions that need to be answered are also important since these new modules need to be fit for purpose.

Introduction

The production of environmental information in countries is often a puzzle with many different pieces found in various Ministries, agencies and institutions involved in the development and publication of data, statistics and indicators. Making sense of this information and keeping track of who is doing what can be a complex task. Figuring out what information is needed and when to use which type of indicator can also be a challenge. The main focus of this report is on indicators related to the environment and some sustainable development indicators since these indicators include an environmental perspective. This report does not attempt to be exhaustive but tries to include many of the most commonly encountered indicators by environmental policy makers. In addition to describing the different types of indicators, some evaluation and guidance regarding the use of indicators will be given.

This report has two major parts. The first part of this report attempts to evaluate different types of information/indicators and what are their major uses. The second half looks at the work of the Nordic countries in light of the System of Environmental-Economic Accounting (SEEA), the related 2011 EU regulation requiring reporting of environmental accounts and the proposed new reporting areas that are under discussion with the European Commission (Eurostat).

In Part 1, an evaluation of existing types of statistics and indicators related to the environmental dimension of sustainable development will be made. The goal is to develop an overview of the types of indicators that are appropriate for certain types of analyses or uses and a general explanation over what they cannot be used for. Some reflections on the path that has been taken to today's situation and some suggestions for the future will be developed. With the upcoming Rio+20 summit meeting in the summer 2012, new indicator initiatives may be proposed and knowing how to evaluate these proposals could be of help to policy makers. In Part 2, a description of what is currently being published and developed by the Nordic statistical institutes regarding environmental accounts is presented and a discussion of the new modules Eurostat is proposing for inclusion in the environmental accounts statistics regulation. Common Nordic positions will be identified and differences will be described. As part of this evaluation, the types of information and indicators arising from the proposed modules will be identified and as well as the policy usefulness of these new modules.

Part 1.
Policy and indicators

1. Major policy initiatives and resultant indicator sets

There are such a large number and variety of policy initiatives at regional, national, multi-national and international levels that it is not possible to make a definitive list. When some of the larger international environmental and sustainable development related initiatives are examined, there seems to be roughly a ten year cycle for policy initiatives and their related metrics. The impetus seems to begin with the United Nations Conference on Environment and Development (informal name: Earth Summit) held in 1992 in Rio, continues with the follow-up conferences Rio+10 held in Johannesburg in 2002, and the upcoming Rio+20 to be held in Rio in summer 2012.

At the 1992 Rio Earth Summit there was a call for countries to develop indicators for sustainable development (SDIs). This call led to a large number of sustainable development indicator initiatives at all levels of government – Agenda 21 initiatives at the local level and SDI Task Forces and committees at regional, national and multinational levels. At the World Summit on Sustainable Development in Johannesburg in 2002, countries and multi-national organisations presented their sustainable development indicator sets (Hass, Brunvoll and Høie 2002).

At the European Union level, in addition to the Sustainable Development Strategy, the European Council at its meeting in Lisbon in 2000 resolved to make the European Union the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion. The action plan that resulted from this decision was known as the Lisbon Strategy (also called the Lisbon Agenda or Lisbon Process). An indicator set for monitoring this strategy was established and a large set of sustainable development indicators (SDIs) were established via a Task Force led by Eurostat.

When the Lisbon Strategy time period ended in 2010, it was replaced by Europe 2020, a 10-year strategy proposed by the European Commission in March 2010 for reviving the European economy. The strategy aims at smart, sustainable, inclusive growth with greater coordination of national and European policy. Specific targets for employment rates, R&D investment, reducing greenhouse gas emissions, energy consumption, energy efficiency, early school leavers and numbers of persons living below national poverty lines were established and specific indicators for monitoring progress were also identified. Again an indicator set was established in the statistical system (http://epp.eurostat.ec.europa.eu/portal/page/portal/europe_2020_indicators/headline_indicators).

The statistical systems have typically been heavily involved in the identification, establishment, monitoring and publishing of these different indicator sets. The SDI, Lisbon and Europe 2020 indicator sets consist of a large number of indicators from which it can be difficult to discern a consistent message. One way of aiding in the communication of these indicators is through the use of symbols (such as "smileys", traffic lights, or weather symbols). These indicator systems typically aim at being comprehensive but often this has not contributed to clarity but rather to confusion due to the size and complexity of the indicator systems. It is difficult to understand the messages about sustainability that are obtained from a long list of indicators.

One reaction or response to these sometimes large and complex measuring/indicator systems was the Beyond GDP initiative. The Beyond GDP website states that, "the Beyond GDP initiative is about developing indicators that are as clear and appealing as GDP, but more inclusive of environmental and social aspects of progress. Economic indicators such as GDP were never designed to be comprehensive measures of prosperity and well-being. We need adequate indicators to address global challenges of the 21st century such as climate change, poverty, resource depletion, health and quality of life" (http://www.beyond-gdp.eu/background.html).

The International Commission on Measurement of Economic Performance and Social Progress (also known as the *Stiglitz-Sen-Fitoussi* Commission) also looked critically at the adequacy and relevance of current measures of economic performance (specifically GDP) as measures of societal well-being and as measures of economic, environmental and social sustainability. The aim of the Commission was to identify the limits of GDP as an indicator of economic performance and social progress, to consider additional information required for the production of a more relevant picture, to discuss how to present this information in the most appropriate way, and to check the feasibility of measurement tools proposed by the Commission (http://www.stiglitz-sen-fitoussi.fr/en/index.htm).

The Beyond GDP initiative and the Stiglitz-Sen-Fitoussi Commission have spurred development in the statistical system but it is too early to conclude whether the recommendations will eventually lead to better information for policy makers.

Another approach to reducing the large, complex measuring/indicator systems has been the development of "dashboards" or composite indicators or indices. These types of indices are typically skewed in certain ways due to how the calculations are devised. Often those who have devised these indices are unaware of how these indices are influenced by the methods chosen to aggregate the data (OECD and European Commission (JRC) 2008).

After the economic crisis of 2007/2008 and leading up to the United Nations Conference on Sustainable Development (also called "Rio+20") a number of "green" policy initiatives have appeared both nationally and internationally. A number of initiatives worth mentioning include the OECD's Green Growth Strategy and the associated indicators to monitor progress (http://www.oecd.org/document/56/0,3746,en_2649_37465_48033720_1_1_1_37465,00.html), the European Commission's (DG Environment) Roadmap for a Resource Efficient Europe (http://ec.europa.eu/resource-efficient-europe/), and the Nordic "Towards a Green Economy" initiative (http://www.norden.org/en/nordic-council-of-ministers/ministers-for-co-operation-mr-sam/sustainable-development/the-united-nations-commission-on-sustainable-development-csd/sustainable-development-up-close-the-nordic-events-at-csd-19/towards-a-green-economy).

These are all policy initiatives that will need metrics for measuring progress. Some indicators have been established, such as those of the OECD Green Growth Strategy and for Europe 2020, but other policies do not have well defined goals that can be easily measured.

There seems to be a tension between defining policy and finding ways to measure or evaluate the effectiveness of the policy and its implementation. Finding a good match between policy and ways to measure the progress related to that policy is not easy. And before we look more closely at different types of indicators and metrics we need to remind ourselves that the mind-set or narrative that is assumed here is that policy is fact-based and that progress of a specific policy is something that can be measured. This may or may not be the case in actual fact but this is the modus operandi that is assumed in this analysis.

Sometimes environmental policy makers yearn for just one number, like GDP, which is readily available at only a 3 month time-lag. Having to manage and understand a multifaceted area such as the environment, which does not lead easily to the development of a single indicator that can be used for management purposes, makes the management and policy making more complex. Having to interpret a large set of indicators is very challenging and often overwhelming since it is difficult to even figure out where to start, much less know what to do with all of the information in order to figure out the story line.

Given that users are often confronted by a large variety of different types of information, the next section of this report will look at different types of indicators/information that is found in the field of the environment. We will try to make some sense out of this variety of information and attempt to make some general comments regarding appropriate uses and typical abuses when using different types of indicators/data/information.

2. Different types of indicators often used in relation to the environment

When evaluating appropriate indicators, it can be helpful to figure out what perspective is represented in the policy and in the metric being considered. Often it is helpful to have a match between these two. One useful categorization is the Driving forces – Pressure – State – Impacts – Response (DPSIR) model (see Figure 9). Figuring out the different aspects of a policy in these terms can often help lead to the matching or development of appropriate types of metrics for measuring progress.

For example if a policy is directed at maintaining the state of some area, such as there will not be a loss of biodiversity in a certain area, then appropriate metrics would perhaps describe the current situation (state) and then could also consider tracking factors that might be the biggest threats or pressures. At a later time the situation or state would need to be re-evaluated and a measurement of change could then be devised. In this way a type of measuring system could be developed. Matching the policy focus and the ways of tracking progress – with existing information/indicators or by developing new information sets – can lead to sensible monitoring systems.

Another approach is often to identify different existing information or indicators and to figure out what these can be used for – sometimes this can lead to inappropriate uses of these indicators. One should be careful when taking information developed for one purpose and using it in another context or for another purpose. Using information that is fit for purpose is the best.

There are many different sets of data, indicators and information and taking a look at different groups of these indicators can be helpful when encountering different indicators and information in the course of policy making and monitoring.

2.1 Indicator/information types

There are many different ways to group and discuss sets of information or indicators. The following discussion tries to provide some useful insights and is not meant as a definitive classification or exhaustive list of indicators but most types or approaches have tried to be included in the discussion.

Many of the statistics and resultant indicators developed from environmental statistics and accounts have been pressure indicators from a production perspective. Examples of these are different types of emissions to air or to water or amounts of different types of waste by industry. This type of information has helped to identify, for example, which industries or specific plants in a country are contributing to a problem and to monitor progress of these industries or plants. Sector or industry-based policy has needed this type of production perspective information. Examples of these types of data would be solid waste and emissions to air and water from the industries that are releasing these different types of pollution.

With a production perspective, the focus has typically been on what has been produced and are assigned to those producing the products. But this can also look at what goes into a production system using an efficiency or productivity view. Measuring or monitoring from this perspective needs efficiency or productivity measures which often mean that two different types of data need to be combined to make ratio indicators (typically environmental and economic or physical production data are combined).

But as the focus in environmental policy making changes from a production to a consumption perspective and from a primarily national production focus to a global production focus then more consumption-based information is needed. In this case, the demand for information including embedded emissions or embedded carbon increases. If a consumption perspective is taken, then for example the emissions related to oil extraction are not assigned to the country extracting the oil but to the country which uses the oil – in intermediate or final consumption.

These types of production, consumption and efficiency/productivity metrics are measuring flows. Another way of looking at developments is to measure the status or state of different assets between two or more points in time and identify/describe differences. The Nature Index in Norway is one example of a status or state indicator (see Figures 4 and 5).

Sometimes an indicator is constructed by taking flows and converting them into stocks or area – for example the Ecological Footprint takes consumption and converts it into land area. Any time there is some type of conversion from one type of information into another (flows into area, physical units into monetary units, physical units into "impacts", etc.) the process of conversion typically adds another layer of uncertainty and approximation into the calculations. This increases the uncertainty of the figures and typically reduces the precision of using these indicators for monitoring purposes.

Including aspects beyond the physical environment, as is the case with sustainable development for example, means that information about economic and social topics are also included in the data set or composite indicator. These additional dimensions add another level of complexity to the indicator and to the use and interpretation of these types of indicators.

Combining things that are measured in different units also requires some type of scaling, normalization or conversion into units that can be appropriately combined.

The common elements in producing an aggregated type of index or indicator involve a number of steps. This process has been described as including four steps (OECD 2002b), the selection of variables, transformation into the same dimension, weighting the constituent variables before combining them and the evaluation of the index scores ("good", "poor", or in relation to a goal).

The development of indices is actually a rather complex process. The Econometrics and Applied Statistics Unit at the Joint Research Center (JRC) of the European Commission have evaluated many of the most popular composite indices and have identified serious flaws inherent in their construction. Since there are so many technically incorrect aggregation methodologies used in these popular indicators, the JRC and the OECD have developed a manual describing a 10 step process for constructing composite indicators (OECD 2008), see table 1 below.

If these steps are followed during the construction of a composite indicator/index, then the most common construction pit falls can be avoided.

Table 1. 10 Steps for Constructing Composite Indicators

Step	Why it is needed
Developing a theoretical framework	Establish a clear understanding of the multidimensional phenomenon to be measured. Structure various sub-groups of the phenomenon if needed.
Selecting variables	Need to be relevant to phenomenon of interest, data availability and quality.
Imputation of missing data	A complete data set is needed – so this step gap-fills available data sets.
Multivariate analysis	Check the underlying structure of the data (principal components analysis, cluster analysis) to identify groupings in the data. Compare the statistically-determined structure inherent in the data with the theoretical framework. Identify and discuss differences.
Normalisation of data	Variables need to be made comparable.
Weighting and aggregation	Weighting and aggregation procedures should be done in accordance with the theoretical framework. Determine whether correlation issues among indicators should be accounted for. Discuss whether compensability among indicators should be allowed.
Robustness and sensitivity	Conduct sensitivity analysis of the assumptions (inference) and determine what sources of uncertainty are more influential in the scores and/or ranks of the composite indicator results.
Back to the details	Try to identify the main drivers of the movement of the indicator. Identify if the results are overly dominated by a few of the component parts of the index.
Links to other variables	Develop data-driven narratives based on the results.
Presentation and dissemination	Present the composite indicator results in a clear and accurate manner. Develop a coherent set of presentational tools and select the visualization technique which communicates the most information.

Source: (OECD 2008, table adapted from Table 1, 20-21)

There are a variety of different approaches that can be taken when making groupings of indicators. The categories of sustainable development (economic, social and environmental) was used in the Naturvårdsverket report (2011) and the OECD (2002b) report uses the following 4 groups: (1) Indices solely based on natural sciences; (2) Policy performance indices; (3) Indices based on an accounting framework; (4) Synoptic (aggregated) indices.

In this report a number of different types of information/indicator types are presented which are grouped according to their main uses or relevance to policy. Please note that the main focus is on indicators related to the environment and some sustainable development indicators since these indicators include an environmental perspective and not on all possible types of indicators. This list does not attempt to be exhaustive but tries to include many of the most commonly encountered indicators by environmental policy makers (see Table 2).

Table 2. Indicators and their major uses / policy applications

Major uses/ Policy Applications	Information Type		Indicator/Information description or example
Monitoring progress or goals	"Simple" / one component indicators		Physical emissions (to air, to water, to land), waste amounts (production perspective) Energy, water use (use or "consumption" perspective)
	Ratio	Productivity / Efficiency / Intensity	- Ratio calculation (Tonnes steel produced/CO_2 emissions; CO_2 emissions/production value)
		Comparison / Decoupling	- Components are shown separately (emissions and production value) - Shows if two components moving together or in separate directions
Awareness raising for Environment	Environmental Indices		Ecological Footprint[2] Specific types of so-called "footprints" - Carbon/carbon emissions "footprint" - Water "footprint" (These are typically expressed in mass or volume units rather than area units so are technically not really "footprints" which imply area) EMC (Environmentally-weighted Material Consumption[2]) DMC (Domestic Material Consumption) HANPP[2] (Human Appropriation of Net Primary Production) NI – Nature Index (Norway, NL and under development in Australia)
Adjusting the national accounts (flows and assets)	Monetarised Flow accounts		Depletion adjusted national accounts aggregates (SEEA) Production Account: - Depletion adjusted GDP - Depletion adjusted Value added Distribution and Use Accounts: - Depletion adjusted Operating surplus - Depletion adjusted saving Green/Environmentally adjusted Net National Product (Green NNP) Measure of Economic Welfare (MEW) [1]
	Monetarised Asset Accounts		Genuine savings (GS) National wealth
Awareness raising – about social, economic and environmental topics, sustainable development. Often used to "rank" countries	Composite indicators including more than an environmental dimension		Genuine Progress Indicator (GPI) [1] Human Development Index (HDI) [1] Happy Planet Index (HPI)[1] Index of Sustainable Economic Welfare (ISEW) [1] Sustainable Net Benefit Index (SNBI) [1] Weighted Index of Social Progress (WISP) [1] Sustainable Society Index (SSI) [3] FEEM Sustainability Index (FEEM SI) [4]

Major uses/ Policy Applications	Information Type	Indicator/Information description or example
Analysis	Decomposition	Can quantify some of the factors that are influencing the changes in the data – typically including structure of the economy and factor inputs (such as energy/fuel types, industries (NACE/ISIC), economic growth)
	Environmentally Extended Modeling – includes environmental variables	Input-Output Based on the Leontif I-O methodology used with national accounts. General Equilibrium and other types of econometric models Used for scenario building and prediction of future trends Budgetary modeling – income and transfers Including environmentally related transactions (taxes/subsidies)

For more detailed descriptions of these indicators please see:

[1]Indikatorer för Välfärd och Hållbar Utveckling: En översikt (2011). Naturvårdsverket Rapport 6453.

[2]Potential of the Ecological Footprint for monitoring environmental impacts from natural resource use: Analysis of the potential of the Ecological Footprint and related assessment tools for use in the EU's Thematic Strategy on the Sustainable Use of Natural Resources. (2008). Report to the European Commission, DG Environment.

[3]NI = Nature Index. Norwegian Directorate for Nature Management (2011). The Norwegian Nature Index 2010. DN-Report 1-2011.

[4]SSI = Sustainable Society Index (http://www.ssfindex.com/ssi/)

[5]FEEM SI = Fondazione Eni Enrico Mattei Sustainability Index (http://feemsi.org/)

Each of these groupings will now be described in more detail with a focus on their strengths and weaknesses. Typical uses or misuses of the indicators will also be covered.

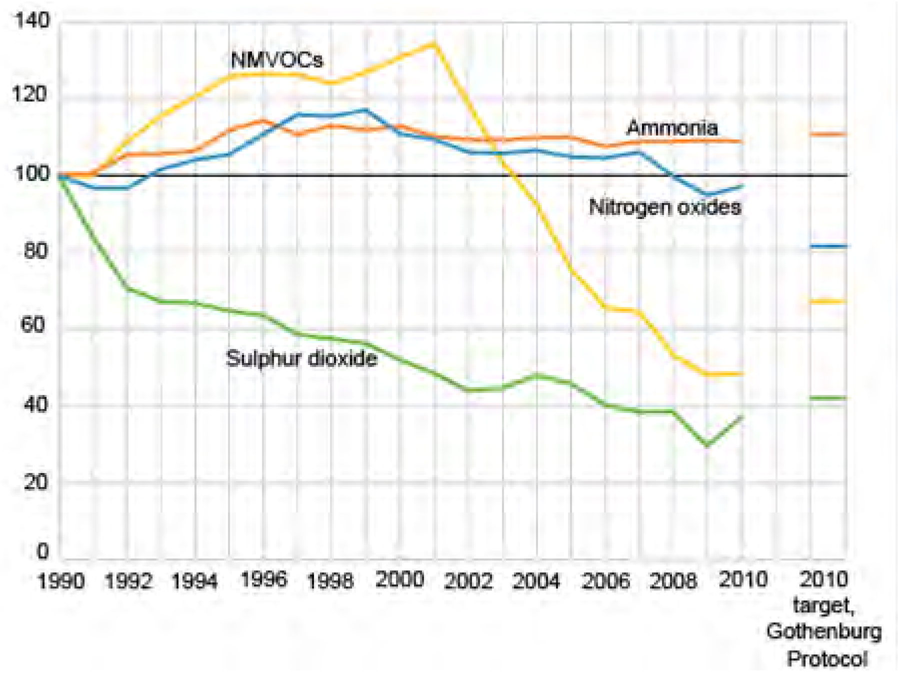
2.2 Monitoring Progress or evaluating developments towards goals

Major uses/ Policy Applications	Information Type	Indicator/Information description or example
Monitoring progress or goals	"Simple" / one component indicators	Physical emissions (to air, to water, to land), Waste amounts (production perspective) Energy, water use (use or "consumption" perspective)

When goals are specified in a policy, for example a certain amount of reduction (per cent or amount) within a certain time period or end point, often monitoring the progress towards achieving these goals is desirable. If the goal set is something that is already measured, then the statistical system or another monitoring system's data can contribute fairly easily to this type of monitoring.

One example of measuring towards targets are the Norwegian emissions of acidifying and polluting gases included in the Gothenburg Protocol and the 2010 targets set in that Protocol. The following figure shows the Norwegian emissions to air with the 2010 target clearly identified on the right-hand side. Norway has met the targets for nitrogen oxides, sulfur dioxide and non-methane volatile organic compounds (NMVOC) but not for ammonia.

Figure 1. Emissions to of nitrogen oxides, sulfur dioxide, ammonia and NMVOC. 1990-2010. Norway. 1 000 tonnes. 2010 target, Gothenburg Protocol. Index 1990 = 100



Sourse: Emission inventory from Statistics Norway and the climate and Pollution Agency http://www.ssb.no/english/subjects/01/04/10/agassn_en/

Not infrequently, however, the goals being set by policy makers are not very easy to define what should be included or excluded, by which breakdowns or how changes should be measured. This type of situation often results in the use of proxies rather than indicators which directly measure progress towards a goal. Typically the industry breakdown or the types of emission or waste or the specific energy carrier (biofuels) are slightly different between the statistics and the policy.

For example, voluntary agreements for pollution reduction are sometimes made between government authorities and industry organizations. Monitoring this type of agreement using existing statistics can often be challenging since it is very seldom that the members of an industry organization are the same as in the industry groups used in the statistical system (NACE/ISIC). Or perhaps an agreement regarding packaging waste has been made – but the waste categories are material-based (paper, metal, wood) and not use or purpose-based, i.e. used for packaging. These types of differences in definitions of the populations or categories make it difficult to sometimes use the existing statistics.

Evaluating whether the goal is being reached can also be challenging. Linear relationships seldom occur but are often assumed when making predictions in the future. These types of assumptions often have implicit increasing growth (or reduction) rates which become more unlikely with increasing time. Considering the annual (or periodic) growth or reduction rates needed to reach the goals may be a better way to understand the magnitude of change that is required. Often reducing rates of improvement can be encountered when incremental change is expected. Distance to target can also be measured in different ways and is not always as simple as it seems.

These types of indicators clearly show the development over time and are generally sensitive to changes (if measured at an appropriate level of sensitivity). Typically the information can be expressed in a fairly simple, understandable and clear manner that even non-experts can readily understand. The difficulty with this type of indicator is trying to figure out what factors are influencing its development over time. Identifying these factors often require different types of analyses.

2.3 Ratio Relationships

Major uses/ Policy Applications	**Information Type**	**Indicator/Information description or example**
Ratio Relationships – typically between two types of pressure often one economic and one environmental	Productivity / Efficiency / Intensity Decoupling	- Ratio calculation (Tonnes steel produced/CO2 emissions; CO2 emissions/production value) - components are shown separately (emissions and production value) - shows if two components moving together or in separate directions

Ratios of two variables are typically constructed when these two activities are considered to be closely related. Depending on what is placed in the numerator and denominator, productivity, efficiency or intensity ratios can be developed. Producing more for less is a typical type of goal. Labor productivity, resource efficiency, pollution intensities are all ratio indicators. Whether the indicator should be increasing or decreasing depends on how the indicator is constructed; productivity and efficiency often should increase whereas intensities typically should decrease if an improvement is seen.

One problem with these types of ratio indicators is that one part of the ratio could be the dominant factor in changing the direction of the indicator. To show the trends in both of the components of the ratio, decoupling indicators (OECD 2002) can be developed where both the trend in the numerator and the denominator are shown separately from the ratio trend. Typically these indicators are shown indexed to the first year in the time series. With this type of depiction it can be fairly easy to see if one factor is influencing the trend in the ratio indicator more than the other. If decoupling is the goal, then the two factors being tracked should be going in separate directions and not moving together in the same direction.

Often the problem with ratio and decoupling types of indicators is that what is included in the numerator is different from what is included in the denominator. In other words, you have apples divided by oranges rather than apples divided by apples.

For example, greenhouse gas emissions (as defined by the Kyoto Protocol) vs. GDP – here the emissions of international shipping (ocean transport) and international air transport are excluded from the GHG-emissions calculations but the economic activities of the shipping and airlines are included in the GDP. So here you have the case of apples and oranges.

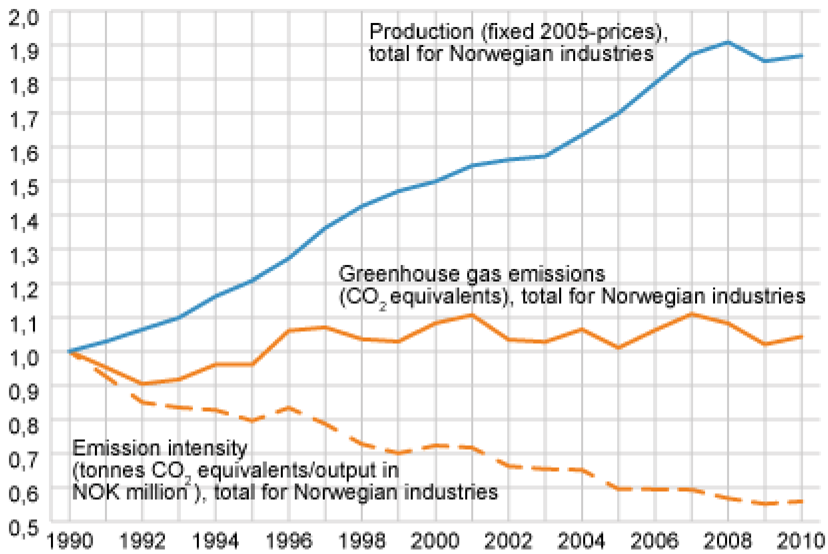
When setting up ratio or decoupling/comparison type of indicators it is important to be sure that the system boundaries are the same regarding what is included and excluded in the numerator and denominator and that it makes sense to compare the two factors. These types of indicators, when so graphically placed together, strongly imply mutual casualty. If there is doubt whether these two things are linked, then it may be wiser to avoid constructing these types of combined indicators.

There can be many different types of comparison or decoupling indicators. Two which are relevant to the field of environment are called "resource decoupling" and "impact decoupling." In the case of resource decoupling, economic activity is compared with the associated natural resource use. In the case of impact decoupling, environmental impacts are compared with economic growth. From the national accounts we have measurements for economic activity such as GDP. Measurements for resource use have also been developed but very often they do not encompass all of the resources needed for the economic activity. Even more problematic are measurements for identifying and measuring environmental impacts.

The goal is often expressed as decoupling one activity from another. Statistically we would describe this as various measures of correlation. Relative decoupling would exhibit weak correlation between variables and absolute decoupling would show negative correlation between variables.

In the following example, greenhouse gas emissions (in tonnes CO_2 – equivalents) from Norwegian industry are combined with their output in economic terms. Emissions from households are excluded since households are consumers and do not contribute in terms of industrial production. Emissions from international transportation (ocean and air transport) are included. In these ways the emissions inventory data used for reporting to the Kyoto Protocol are adjusted to the same system boundaries as the economic data used for comparison.

Figure 2. Total Greenhouse gas emissions (CO_2 equivalents), output (constant 2005-prices) and emission intensity for Norwegian economic activity (excluding households, including international air and ocean transport). 1990-2010*. Index 1990 = 1.0



Source: Statistics Norway http://www.ssb.no/english/subjects/09/01/nrmiljo_en

2.4 Awareness-raising for the Environment: Environmental composite indices

Major uses/ Policy Applications	Information Type	Indicator/Information description or example
Awareness raising for Environment	Environmental Indices	Ecological Footprint[2] Specific types of so-called "footprints" - Carbon/carbon emissions "footprint" - Water "footprint" (These are typically expressed in mass or volume units rather than area units so are technically not really "foot-prints" which imply area) EMC (Environmentally-weighted Material Consumption[2]) DMC (Domestic Material Consumption) HANPP[2] (Human Appropriation of Net Primary Production) NI – Nature Index (Norway, NL and under development in Australia)

When wanting to increase awareness about the environment and how humans are impacting the environment, indicators that are both intuitive and can make a visual impact are often very effective communication tools. By taking a consumption focus rather than a production focus, the indicators often become easier to understand for the general public. The attraction is that they include everything into just one number.

To make these types of indicators you have to add together many different things – and this is where the inherent complexity and uncertainty enter. In addition, when so many different things are combined, the indicator becomes insensitive to change. This also means that these overall composite indicators are not useful for monitoring goals or evaluating policies.

There are different approaches taken to this process of aggregation. The Ecological Footprint converts economic consumption and the resultant emissions into a measure of productive land, called a global hectare. The Ecological Footprint (EF) measures the extent to which humanity is using nature's resources relative to an estimated regeneration rate for nature. EFs are usually presented together with biocapacities (BCs) which measure the bioproductive supply. If an EF is larger than the available BC for a selected time period the EF/BC resource accounting results in a deficit or overshoot. Overshoot occurs in case of human resource extraction and waste generation exceed an ecosystem's ability to regenerate the extracted resources and to absorb the generated waste. Global overshoot (at the planet level) leads to a depletion of the earth's life supporting natural capital and a build-up of waste.

This is done for each country and then the sum of all countries gives a measure of how many "earths" are needed for this type of consumption. By taking a consumption approach, rather than a production approach, this indicator feels very intuitive for many people. There are a number of inherent challenges with the Ecological Footprint – the largest is perhaps the conversion of consumption into a measurement of area. Defining the "global hectare" is not an easy task and providing the conversion factors for each product consumed in each of the different countries to this unit of measure is also an art and a science. The approaches used to present the Ecological Footprint typically embed a normative evaluation of fairness.

In addition, resources without a significant regenerative capacity do not fit in the concept of biologically productive area. For example, the biocapacity needed to sequester CO_2 emissions is included but not the regeneration of the "burnt" fuel stocks. Moreover, nature has no significant absorptive capacity for several important environmental problems: pollution from heavy metals, radioactive materials or persistent organic pollutants. This means that the reductions of these environmentally active substances which do not have a significant absorption or regenerative capacity are not covered by the EF/BC accounts (Eurostat 2006).

Even with these significant shortcomings, the ecological footprint is a widely used indicator even though it can be misleading. The European statistical system has not endorsed its use in official statistics.

But the idea of the "footprint" is so appealing that two more limited "footprint"–like indicators have emerged; the carbon /carbon emissions footprint and the water footprint. In contrast to the Ecological Footprint, these other two "footprints" are typically expressed in mass or volume units rather than area units so are technically not really "footprints" which imply area. But all the "footprints" are consumption rather than production indicators.

The Carbon footprint calculation methodology is more highly developed than for water. Carbon footprint can be calculated at any level – local, regional, or country – whereas the Water footprint is typically calculated at a local or only regional level but can be calculated at the country level. There can be rather high levels of uncertainties in the calculations so that revisions in the factors used can have large consequences and influence the results. Also what is included in the calculations can be rather questionable. For example, how much of the evapotranspiration occurring in the land of origin for imported products can greatly influence the water footprint of imported products.

The indicators, EMC (Environmentally-weighted Material Consumption) and DMC (Domestic Material Consumption) are based on material flows in the economy. EMC uses LCA (life cycle analysis) data for creating impact coefficients to develop an aggregated impact indicator. This indicator has been developed by researchers and is not easily replicable by others. DMC and DMC_{RME} (Domestic Material Consumption in Raw Material Equivalents) is being further developed by Eurostat and uses both LCA information as well as environmentally extended input-output modeling for developing coefficients for transforming imported products (and exported products) into raw material equivalents.

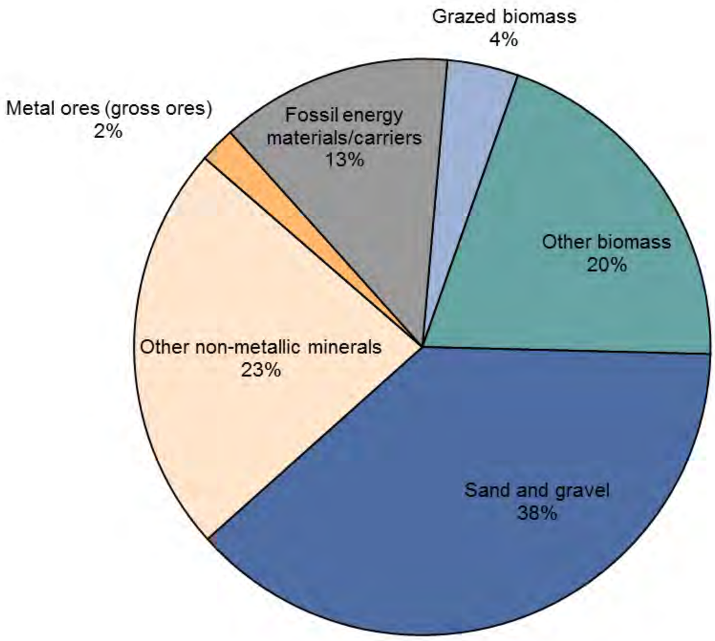
To determine the amount of material inputs needed for the economic activity of a country, the following calculation is made:

Extraction from the national environment =
+ Imported products converted into raw material equivalents
- Exported products converted into raw material equivalents

By converting the imports and exports into their raw material equivalents, the calculation gives a fuller picture than the calculation of Domestic Material Consumption (DMC) which combines the national extraction of raw materials with products that are imported and exported.

In the case of DMC (domestic material consumption) as it is currently being reported, raw materials are combined with products. This means that there is an inherent asymmetry in this indicator when raw materials (minerals, grazed biomass, harvested crops, etc) are combined with finished and semi-finished products. DMC already selectively leaves out oxygen and water but it is still dominated by relatively inert materials – biomass, sand and gravel – which make this a very questionable indicator. The following figure shows the domestic material used (domestic extraction + imports) by materials for EU27. Sixty-two percent of the total is biomass, sand and gravel.

Figure 3. Domestic Extraction Used EU-27 (extraction + imports), 2007



Source: Eurostat (2010) (data: env_ac_mfa)

Combining these very different things does not really provide much useful information about the environment or the economy, especially as DMC is dominated by biomass, sand and gravel. It is also important to note that comparing DMC to economic variables, such as GDP, is inappropriate since the system boundaries are different. Since water is excluded in the physical flows covered by DMC this would mean that the economic activity related to water should also be excluded – such as electricity generation from hydropower plants, drinking water, etc. – which is not possible. When making indicators that combine two different units (such as mass and production value) the system boundaries – i.e. what is included in the different systems – need to be the same.

The OECD has developed a database for material flow accounts for its member countries which exclude not only oxygen and water but also sand and gravel. By also excluding sand and gravel, which are a major portion of the material flows in most countries, allows for other material flows which have potentially greater environmental impacts to be identified in the data sets. This approach does not however address the problem of the asymmetry between extracted raw materials and finished and semi-finished products when added together.

In addition, the data used for imports and exports is typically from trade statistics. The trade in certain large items, such as ships and oil platforms, are only given in non-mass units. Converting either volume or number of units to mass can only be done with conversion factors which have a high level of uncertainty. This brings even more uncertainty into the figures. For these reasons, DMC can not be used for monitoring or goal-setting purposes.

Human Appropriation of Net Primary Production (HANPP) is a measure of human use of ecosystems and can be defined as the amount of terrestrial net primary production required to derive food and fibre products consumed by humans, including the organic matter that is lost during the harvesting and processing of whole plants into end products (Best, et al. 2008). HANPP identifies the intensity with which humans use land areas and is related to landscape structure and diversity. According to Haberl (1997, Haberl, et al. 2007) HANPP refers to areas of land and not to the biomass consumed by the defined population and is considered as a measure of the physical size of an economy relative to the ecosystem in which it is embedded.

Typically HANPP is shown using color coding in maps (see for example: http://sedac.ciesin.columbia.edu/es/hanpp.html). Again, there is the challenge of changing consumption into measures of area, the same challenge encountered with the Ecological Footprint. High levels of HANPP are found primarily in urban areas and this pattern is easily seen in maps typically used to illustrate HANPP.

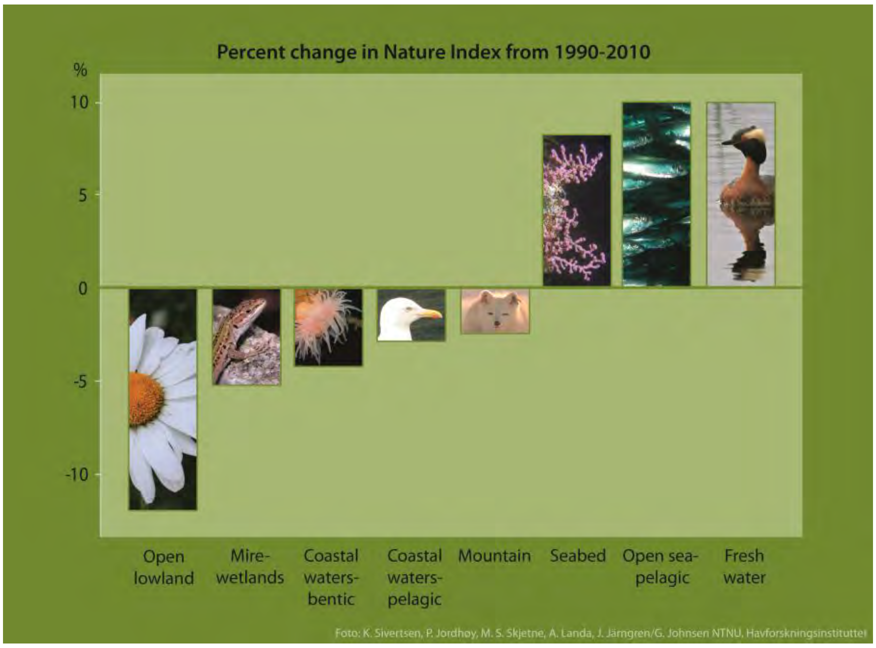
These indicators are typically easier for individuals to relate to since their focus is consumption and the visual representation of the indicators can be appealing and easy to communicate. But these indicators combine so many different things through the use of conversion coefficients which are not that well grounded or tested. For these reasons these indicators cannot be used to monitor specific goals but are useful as awareness raising information at a macro-level. These indicators are not developed or published by the statistical system and are usually the products of research institutes or consultancy projects.

A different type of environmental composite indicator is the newly developed Norwegian Nature Index (Nybo, et al. 2011). This indicator is markedly different from the other composite indicators for the environment since it evaluates the current state of an area with respect to a defined reference state. The reference state is not defined as a pristine ecosystem but rather as an ecologically sustainable state. A scaling methodology was used to facilitate the combining of various indicators. It is not essential that the reference value be completely correct as long as it is set at a level that would describe a very good state of the indicator. The advantage of using reference values is that these enable evaluations between different ecosystems, allows for measurement over time and facilitates aggregation across a variety of dimensions. The methodology for the Norwegian Nature Index is described in more detail by Certain, et al. (2011) (http://www.plosone.org /article/info%3Adoi%2F10.1371%2Fjournal.pone.0018930).

The following nine major ecosystems are evaluated in Norway's Nature Index:

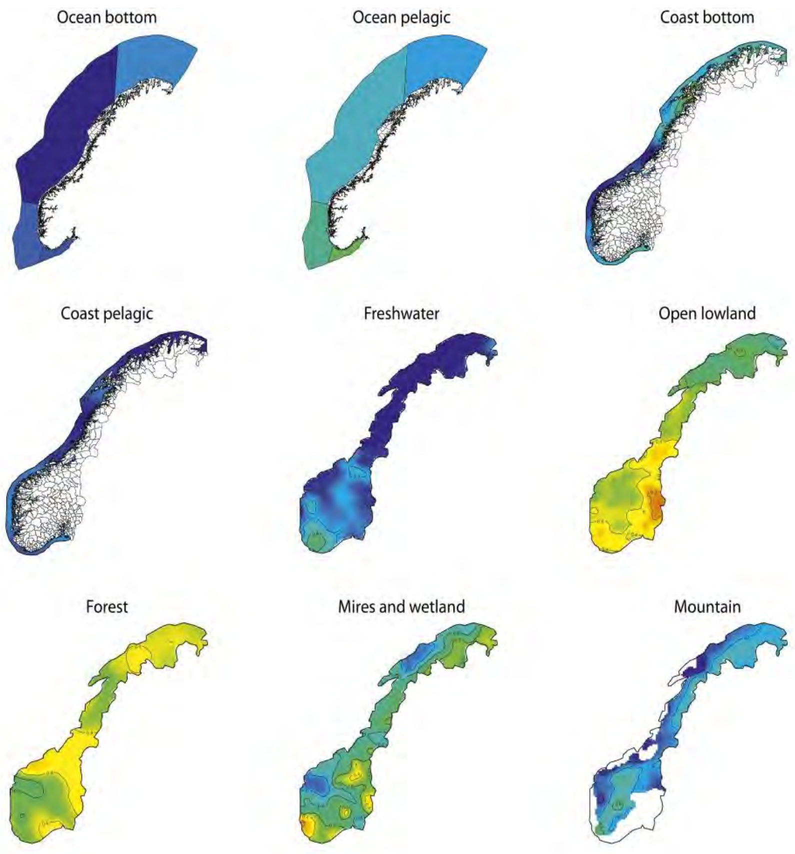
(1) seabed; (2) open sea – pelagic; (3) coastal waters – benthic (bottom dwelling species); (4) coastal waters – pelagic; (5) fresh water; (6) open lowland; (7) forest; (8) mire–wetlands; (9) mountain.

Figure 4 Trends in Nature Index values per major ecosystem, averaged over the whole of Norway



Source: Norwegian Institute for Nature Research, Nybo, Certain and Skarpaas (2011) (http://www.dirnat.no/content/500042044/The-Norwegian-Nature-Index-2010)

Figure 5. Nature Index values for each major Norwegian habitat in 2010



Source: Norwegian Institute for Nature Research, Nybo, Certain and Skarpaas (2011) (http://www.dirnat.no/content/500042044/The-Norwegian-Nature-Index-2010)

The Nature Index is a compilation of the knowledge of the experts and an evaluation of the state of biodiversity and its vitality. The Nature Index is first and foremost a measure of the state and development of biological diversity on an overall level (Nybo et al.2011). The Nature Index is developed at the national level or for different areas of the country and for different ecosystems. Figures 4 and 5 present the developments in each of the ecosystems between 1990 and 2010 in the first figure and the state of the different ecosystems in 2010 for different areas (municipalities) in Norway.

The development of the Nature Index has helped to bring the scattered information about biodiversity together in a coherent way. There are a number of areas that need improvement but the value of bringing together such divergent sources of information and expertise into creating a whole picture of the Norwegian biodiversity should not be underestimated.

In the long run, the Nature Index is wanted to be used for monitoring purposes. Since it is possible to systematically disaggregate the data it may be possible that the data used to create the Nature Index can also be used for monitoring purposes. The Index at the national level, however, is mostly useful for awareness raising purposes.

2.5 Adjusting the national accounts – flows and assets

Major uses/ Policy Applications	**Information Type**	**Indicator/Information description or example**
Adjusting the national accounts (flows and assets)	National income measures adjusted for natural resource depletion and degradation	Depletion adjusted national accounts aggregates *Production Account:* - Depletion adjusted GDP - Depletion adjusted Value added *Distribution and Use Accounts:* - Depletion adjusted Operating surplus - Depletion adjusted saving Green/Environmentally adjusted Net National Product (Green NNP) Measure of Economic Welfare (MEW)
	Asset Accounts – valuing the net change in a range of assets (including human and environmental capital)	Genuine savings (GS) National wealth / The Wealth of Nations

In the System of National Accounts (SNA) there are two types of accounts. The flow accounts follow different transactions in the economy over a certain time period. The asset accounts, which are estimates of stocks, have an opening value at the beginning of the time period and a closing balance at the end of the time period and describe the changes between these two valuations.

Monetarised flow accounts include the depletion adjusted national accounts aggregates as described in the newly revised SEEA manual (System of Environmental-Economic Accounting) and indicators such as Green Net National Product (Green NNP) and Measure of Economic Welfare (MEW). These indicators adjust the existing SNA aggregates with estimates for natural resource depletion (SEEA), environmental degradation (included in Green NNP) and consumption of non-market goods and services (MEW).

When using the national accounts as the frame of reference, the valuation techniques applied need to be of the same character as those found in the national accounts (as defined in SNA-2008). This means that only assets that are recognized by the national accounts and have market prices can be included and only monetary flows that have transactions can be included.

Other methods for valuation (http://www.communities.gov.uk/documents/corporate/pdf/146871.pdf), such as willingness to pay, stated preference (Contingent valuation or choice modeling), revealed preference (choice models, travel cost, Hedonic pricing, averting behavior) or benefits transfer are not considered consistent with the valuations used in the national accounts. The national accounts require substantive additivity which means that the methods of valuation are economically uniform for all types of assets. Valuation at current market prices, or the nearest feasible approximation to them, is the only method that meets the requirements for both formal and substantive additivity. This is one of the main problems with combining the national accounts with other types of non-market valuations.

The System of Environmental-Economic Accounting (SEEA-2012 UNSC draft) provides information for the calculation of depletion of national resources for which market prices can be determined. These include resources such as minerals, crude oil and natural gas, timber, land and fish.

It is thought that by including depletion in the calculations of the main national accounts aggregates, the using up (technically called "depletion") of natural resources could be more appropriately included in the national accounts than is currently recommended in the SNA-2008.

In the SEEA (2012 White Cover draft) the following national accounts aggregates are adjusted for depletion:

- Production Account:
  a) Depletion adjusted GDP
  b) Depletion adjusted Value added
- Distribution and Use Accounts:
  a) Depletion adjusted Operating surplus
  b) Depletion adjusted saving

Calculations for depletion should use the Net Present Value (NPV) approach. Assumptions regarding future prices, extraction rates and costs, and discount rates are also necessary for these calculations. Other approaches to depletion valuation such as net price method or El Serafy method (also called the user cost method) are not endorsed in the revised SEEA (2012-draft). Valuing degradation is also not currently included as part of the revised SEEA (2012-draft). Therefore only depletion adjustments can be made to the national account aggregates.

Green/Environmentally adjusted Net National Product (Green NNP) requires that both natural resource depletion and environmental degradation be valued and included with the standard national accounts to adjust these accounts for the using up (depletion) of natural resources and damage (degradation) to the environment. Although this is proposed by economists, this approach is not acceptable under the guidelines established for the System of National Accounts (SNA).

These types of depletion and degradation adjustments require extensive information about the natural resources being used in the economy and about the condition of the environment. Information about the state of the natural resources/environment at the beginning of the time period and at the end of the time period – identifying the changes and then valuing these changes is needed.

Typically this type of information used for asset accounting is not available at the time intervals or frequencies needed. In addition and more importantly, the valuation methodologies used for environmental degradation are not compatible with the market values used in the national accounts. Although the units of measurement are both monetary, the types of values that are represented in the national accounts (market) are totally different from the degradation valuations and technically speaking should not be combined.

Other issues such as the large uncertainty and the high levels of variation in the asset accounts for some natural resources – such as oil and natural gas due to annual reappraisals of the reserves – means that these factors will obscure other more subtle changes which will make the figures less useful for management purposes. In addition, which natural resources that are included can depend on whether only those with market prices (timber, fish, oil, natural gas, different minerals) are included or whether there is an attempt to include other resources (for example, non-timber resources from forests) or entire ecosystems (such as "a well functioning climate" or "biodiversity"). The scope of what is included in the calculations can vary.

In addition to the scope (what is included and excluded) and the technical issues of implementation (especially valuation), changing very well known economic indicators (i.e., GDP or GNP) by making unconventional adjustments can lead to confusion. On the other hand, for countries where natural resource extraction plays an important role in the economy, good information about the stocks and flows of these resources in physical terms is important for their management.

Genuine Savings

In standard national accounting, only the formation of fixed, produced capital is counted as investments. Likewise, in the standard calculation of net saving rates only depreciation in the value of human-made capital is included as a decrease in the value of a nation's assets. In the World Bank's adjusted net savings framework (also called "genuine savings") a broader view of natural and human capital are taken.

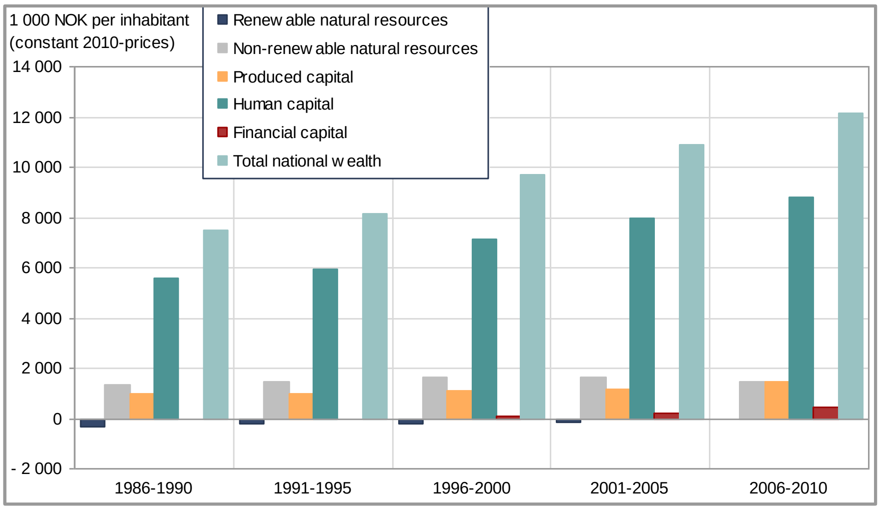
Using this broader view of capital, depletion of a non-renewable resource (or over-exploitation of a renewable one) is seen as decreasing the value of that resource stock as an asset and represents a disinvestment in future productivity and well-being. In the same way, the creation of an educated populace and a skilled workforce—a nation's human capital—increase the value of that resource and might better be seen as an investment. In addition to valuing the depletion of natural resources (energy, mineral and forests) and treating most outlays for education as investments rather than current expenditures, the damages from carbon dioxide emissions are subtracted (depletion of soils, fish, water resources and the damages from water pollutants and other air pollutants besides CO_2 were not included in the empirical calculations but they could have been included if data were available).

National Wealth calculations are primarily based on the national accounts data and would be taken from the balance sheets of countries, if countries have balance sheets. Most countries' national accounts units do not publish national balance sheets or national wealth calculations. Typically these types of calculations are made by research institutes, often using national accounts data. This may be changing slightly in the future since European countries will need to report the value of land to Eurostat as part of their periodic national accounts reporting. Connected to the value of land includes not only buildings but also assets connected to the land such as minerals, oil and natural gas (subsoil assets). These calculations will only include resources that have market prices.

National wealth consists of the assets remaining in the consolidated balance sheets of all resident economic units. Basically, this includes non-reproducible tangible assets, such as land and subsoil assets; reproducible fixed and movable tangible assets, such as buildings and other structures, machinery and equipment, vehicles, and consumer durables; inventories of monetary metals, raw materials, work-in-progress and finished goods; and the excess of foreign assets over foreigners' holdings of domestic claims, equities and tangible assets.

In the calculations for national wealth, a total value is calculated which is then broken down by the different types of capital. One of the sustainable development indicators for Norway is the net national income per inhabitant and as part of the work of calculating this indicator, national wealth is also calculated and broken down by different types of capital. The following figure shows the different types of capital per capita for Norway over 5-year periods since 1986. As the figure shows, the calculation is made in such a way that the total is comprised of a number of items that can be determined, and the rest (or residual) is called "human capital" in this illustration.

Figure 6 National Wealth, type of capital, Norway. 1986–2010. 1000 per inhabitant. Constant 2010 prices



Source: Statistics Norway (adapted to English)
http://www.ssb.no/emner/01/rapp_indikator_utvikling/sa_123/sa_123.pdf

The World Bank has made estimates of countries' wealth (The World Bank 2006) and has concluded that "intangible capital" makes up the largest share of a country's wealth and that natural capital has a larger share than produced capital in the lesser developed countries. Agricultural land is the largest portion of natural wealth in low income countries. The World Bank describes the following three types of capital and gives a few examples of what is included in each capital type:

- Produced capital – buildings, machines and infrastructure
- Natural capital – cropland, pastureland, forests, minerals and energy
- "Intangible capital" – human capital and quality of institutions

Taking this type of view leads The World Bank to conclude that the following should be the main focus for how countries should prioritize their development:

- Strengthen natural resource management in low income countries
- Pay particular attention to soil degradation
- Reduce incentives to over-exploit resources, especially living resources
- Re-invest resource revenues in other assets
- Invest in human capital and stronger institutions

There are a number of calculation challenges including the choice of discount rates. Governments often prefer using social discount rates since in their quest for sustainable development they would prefer to allocate resources across generations.

Natural resources are an important share of the wealth of nations and the management of these resources is an important part of the development process for countries endowed with national resources. However, human resources are by far the largest component of national wealth.

2.6 Awareness-raising about social, economic, environmental topics, sustainable development

Major uses/ Policy Applications	Information Type	Indicator/Information description or example
Awareness raising – about social, economic and environmental topics, sustainable development. Often used to "rank" countries	Composite indicators including more than an environmental dimension	Genuine Progress Indicator (GPI) Human Development Index (HDI) Happy Planet Index (HPI) Index of Sustainable Economic Welfare (ISEW) Measure of Economic Welfare (MEW) Sustainable Net Benefit Index (SNBI) Weighted Index of Social Progress (WISP) Sustainable Society Index (SSI) FEEM Sustainability Index (FEEM SI)

This group of indicators includes composites of all sorts of different types of information that are combined into a single number. There is a great deal of creativity exhibited in the development and calculations of these indicators. They are not bounded by valuation issues imposed by the system of national accounts (SNA) or by only including environmental components. Many include not only economic and environmental aspects but also human and social dimensions.

Indices with a strong economic focus – but go beyond "adjusting" national accounts aggregates

In an effort to bring more externalities into the national accounts, a number of indices have been developed, for example, the Index of Sustainable Economic Welfare (ISEW) (Daley and Cobb 1990, Cobb and Cobb 1994), the Genuine Progress Indicator (GPI) (Cobb, Halstaed and Rowe 1995, Hamilton 1999, 2008) and Sustainable Net Benefit Indes (SNBI) (Lawn and Sanders 1999, Lawn 2000). Typically these indices start with the economic activities as defined in the national accounts and then bring in different variations of non-market consumption of goods and services of various types, estimates of a variety of different types of damage costs, differences in income levels and changes in capital (typically assuming complete substitution of one type of capital for another type). After all of these different adjustments, it is typically assumed that an increase in an individual's level of consumption is considered an increase in welfare.

There are a number of strengths and weaknesses of these different indices but one common criticism is that they do not include any concept of "thresholds" or "tipping points" since all types of capital are considered substitutable for each other. For a further discussion of these indices, see Naturvårdsverket Report 6453 (2011: 23-26).

Indices with a strong social focus

The Human Development Index (HDI) was introduced by the United Nations Development Program's Human Development Report in 1990 as a new way to measure development. An index that includes GDP per capita, life expectancy (used as a proxy for health and living conditions) and number of years attending school are scaled and combined to provide a value between 0 (lowest) and 1 (highest) for each country. This approach has been criticized also for the substitution between the three factors, for example a decrease in life expectancy can be offset by an increase in GDP per capita.

An alternative to HDI is the Weighted Index of Social Progress (WISP) (Estes 1976). WISP includes 45 different indicators that comprise 10 subindices which are aggregated together to WISP. The amount of information included in the index is substantially more than in HDI but this also adds to the difficulty in understanding exactly what it measures.

The Happy Planet Index (HPI) has been developed by the New Economics Foundation and it claims the index shows "the relative efficiency with which nations convert the planet's natural resources into long and happy lives for their citizens" (http://www.happyplanetindex.org/). The calculations of the index include data for life expectancy at birth, the ecological footprint and the answer to the question, "All things considered, how satisfied are you with your life as a whole these days?" (http://www.happyplanetindex.org/learn/calculating/global.html).

Indices with human, economic and environment (sustainable development) included

There are a number of indices that are developed based on the three main groupings of sustainable development, economic, environment and social. Two indices will be described in more detail, SSI and SI.

The Sustainable Society Index was launched by the Sustainable Society Foundation in 2006 and has been updated in 2008 and revised in 2010 (http://www.ssfindex.com/). The 2010 approach is calculated using 24 different indicators that are grouped into 8 sub-themes (3 indicators in each sub-theme) which are then further grouped into economic well-being, environmental well-being and human well-being. Each of the indicators is scaled between 0 and 10 and is shown as a web or wheel diagram with 24 spokes of the wheel – one spoke for each indicator. All of the indicators are then aggregated to a single figure. The SSI for 151 countries is calculated and countries are ranked against each other.

This approach assumes substitutability between all dimensions – meaning that a decrease in one indicator can be compensated by an increase in another regardless of whether this actually makes any sense or not. Countries are ranked based on very small differences in the aggregated value which assumes that there is a high degree of precision in the underlying data being used. The data for many of the countries included in the rankings are of variable quality and certainly do not merit being used in such a fine level calculation. At best, groupings of countries could be made using the data available not rankings.

The Fondazione Eni Enrico Mattei (FEEM) Sustainability Index (SI) is a project that aims at creating an aggregate index for a country. In contrast to all of the other indices that are simply aggregating existing data, the FEEM SI is built on indicators obtained from a computable general equilibrium model. Thus the index can be calculated for different countries, in different years and under different policy assumptions (http://www.feemsi.org/pag/results.php). The FEEM SI presents results from the modeling rather than simply aggregating indicators.

Data requirements and methodology used to combine the data into an index

The challenge with most of these composite indicators/indices is that the method of combining the different data sets into the calculation of one indicator typically determines the result. The weighting chosen (whether implicit or explicit) is often very critical and influential. Movement in the indicators over time is typically explained by changes in the calculation methodologies rather than by the changes in the data sets themselves although recalculations of time series is becoming more common as these problems become known to the developers. These challenges make these types of indicators rather problematic.

Typically the precision in the calculations is much greater than the accuracy of the data so that single country rankings are not warranted – at best groupings of countries with similar characteristics could be made but often this type of information is already known and has little media appeal; it is the ranking of individual countries that is so appealing. At the same time it is often difficult to grasp what the rankings actually mean – even though there is an accompanying narrative in the media, often this is very simplistic presentation of what is being measured or described by the indicator.

The attraction of these indicators is that they appear very intuitive and simple since they provide one number. They are often used to rank countries by the media – so their appeal is undeniable – but their usefulness is basically limited to awareness-raising. There are typically too many things included in the calculations of the composite to be able to use the indicator to point to any one area of importance.

Another problem is that everything is blended together so that changes in the indicator are difficult to understand. Only by looking at the individual parts can the changes in the aggregate be understood – so any advantages of aggregating are lost. The other problem is that an aggregate seldom changes to any large degree since changes is a diverse data set typically counter act each other.

2.7 Analysis

Major uses/ Policy Applications	Information Type	Indicator/Information description or example
Analysis	Decomposition	Can quantify some of the factors that are influencing the changes in the data – typically including structure of the economy and factor inputs (such as energy/fuel types, industries (NACE/ISIC), economic growth)
	Environmentally Extended Modeling – includes environmental variables	Input-Output Based on the Leontif I-O methodology used with national accounts General Equilibrium and other types of econometric models Typically used for scenario analysis and prediction of future trends Budgetary modeling – income and transfers Including environmentally related transactions (taxes/subsidies)

There are a variety of different types of analyses or modelling approaches that could be described. The key to being able to do these types of analyses is having data that are appropriately matched together – typically found in environmental-economic accounts. The data that will be used in the analysis or modelling exercise need to have the same system boundaries determining what is included or excluded, be classified the same way and typically according to standard industry classifications (NACE or ISIC) and often organised using a supply and use approach as defined by the System of National Accounts. When the data are organised in this way and can be matched up to the national accounts, then the analytical methods developed based on the national accounts can be extended to include environmental dimensions. Work related to data improvement and the establishment of environmental-economic types of accounts has been called "NAMEA-accounts" in Europe – which stands for National Accounts Matrices including Environmental Accounts.

These data requirements are the key to making high quality analyses. If the data used for analysis are not matched in a good way the relationships uncovered in the analysis may not be as sound as the analysis would indicate. Avoiding a "garbage in, garbage out" analysis requires a focus on data quality. Improving data quality is one area the statistical system has as their core competencies. Some national statistical offices also can make different types of analyses – such as the ones that will be described below.

Often these approaches assume that the relationships within the environmental dimensions are in the same proportion or relation as the economic dimensions. This may or may not be a good assumption but it is often the best available assumption if other more technical information is not available for connecting the environmental data to the economic activity.

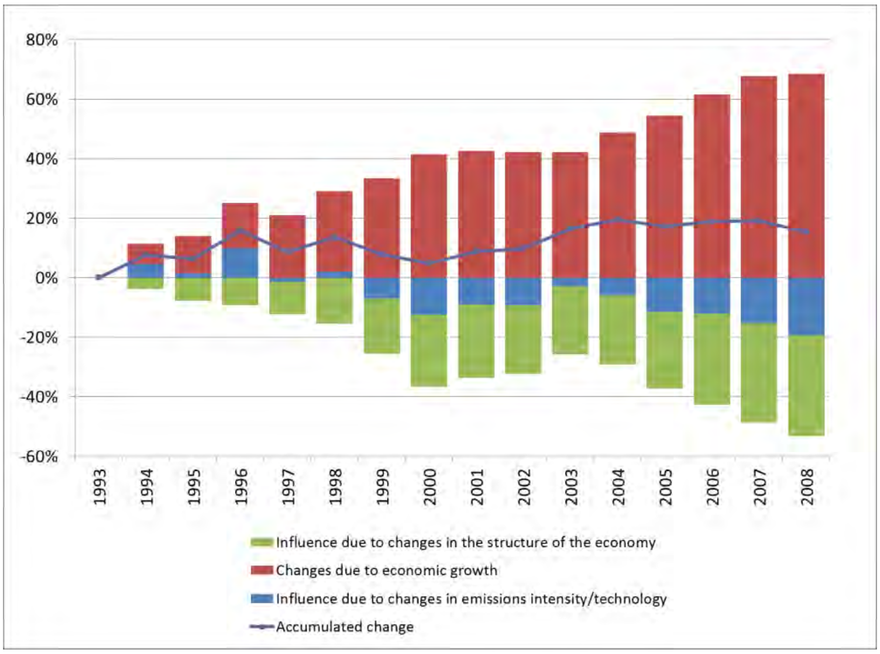
Decomposition

Decomposition analysis is a way to isolate the different factors that add up to a change in emissions, energy use, or some other variable between two periods. It can be done in different ways and for different sets of factors (Wadeskog and Palm, 2003). A change in emission level can, for example, depend on changes in the type of fuel used, changes in levels of consumption, changes in the composition of the economic activity, changes in production including technology improvements or changed types of consumption (other products), etc.

There are a number of different types of decomposition analysis techniques. Which decomposition methodology to use is often determined by the type and structure of data available. The main idea with this type of analysis is to try to discover the strengths that different factors have in influencing the changes observed in the data. The analysis is always done between two (or more) time periods since it is a change over time that is being analysed.

This approach is appropriate to use when there are problems with autocorrelation of the data. Certain regression analysis methodologies can be used but autocorrelation between the variables needs to be specifically treated if regression methods are used.

Figure 7. Decomposition of the change in CO_2 emissions in Sweden into 3 factors (structural, economic growth, intensity/technology). 1993-2008. Percent



Source: Statistics Sweden (Personal communication Wadeskog)

The data requirements for this type of analysis are a matched set of data where variables being included in the analysis have the same detail level. For example, if changes in the air emissions of CO_2 are going to be analysed in relation to the changes in economic activity between two time periods, then the production value and CO_2 emissions for each industry in the economy needs to be included at the same level of aggregation – there can be no missing values in the dataset. If there are missing values, these would need to be estimated or dealt with using an appropriate statistical method.

The results from this type of analysis produces a "residual" or factor that includes all other influences and cannot be separated and specifically identified. In other words, the strength of the factors included in the analysis are quantified and then there is a factor that includes all of the other effects that have not been separated out. In addition, this residual is very often called "technology changes." This label can be very misleading since this factor not only includes the effects of technology but also the effects of policy changes, changes in tax levels, prices and a myriad of other things. By labelling this "residual factor" as "technology changes," the belief that "technology will fix the world's problems" is propagated. This is a misuse of this type of analysis.

Another problem with this type of analysis is that the level of aggregation used in the analysis typically influences the results. For example, if higher levels of aggregation are used for industries, then the lower is the factor for structural changes in the economy and the higher the residual. Whereas using more detailed industry break-downs results in stronger structural effects and lower residuals (or "technology" effects if the residual is called this).

Environmentally extended Input-Output Analyses

The environmental accounts are a satellite accounting system to the national accounts. This means that the economic output of all industries is linked to physical statistics, such as fuel use in TJ or CO_2 emissions in KTonnes. The environmental accounts are set up so that the same relationship exists between the (symmetric) input-output tables of the national accounts and the environmental accounts.

The environmental data is typically connected to industries. This makes it fairly easy to put the environmental data together with the industry x industry national accounts table. To perform analyses, it is necessary to convert the industry x industry tables into product based estimates. This is commonly done using the same technique used to transform a domestic monetary Supply-Use Table (Product x Industry) to an IO-table (Product x Product).

Once these transformations are done all the usual types of IO analysis can be performed with environmental variables. Commonly this means looking at environmental pressures along upstream production chains from a particular product or component of final demand.

In recent years the calculation of emissions induced in other countries through imports, of intermediary products or for direct consumption, has received a lot of attention. This is something that is relatively straightforward in the IO framework, although the lack of data from the producing country often means having to make different kinds of assumptions to arrive at the estimates. This is one of the best approaches available for making calculations that estimate embedded pollution in imports or for obtaining a consumption perspective rather than the current production perspective.

General equilibrium and other econometric models – including environmental dimensions/variables

General equilibrium models use econometrics techniques to analyse economic data. Typically data from the national accounts is used. Initially only economic data were included in the models and were used for policy analysis for different economic conditions, such as taxes, subsidies or investment grants, were changed. As the importance of energy and certain type of environmental issues (such as CO_2 emissions and waste) have increased, variables for these topics have been added to the models.

The data sets again, need to be matched, i.e. the physical data (energy, waste, emissions) need to be at the same industry detail as the economic data. Typically the econometric models including environmental dimensions have less detail than the I-O tables of the national accounts. The general assumption in the models is that the changes and relationships that occurred in the past will continue in the future. This general assumption can be a good one when incremental change is expected. If major crises or discontinuous change occurs then the models are not very good predictors.

When questions about the future need to be answered, modelling is an appropriate approach. Simple extensions of current time series are appropriate in some cases and are often shown when evaluating distance to goals. But when a complex situation is going to be considered and policy scenarios developed, then relevant types of modelling would be the best approach for trying to develop rational or so called "fact based" policy making. Deciding on the relevant type of model is key.

Other types of models

Some models are developed to perform simulations of a more specific type. The model developed and maintained by SCB called FASIT is used for modelling income and transfers. It is also used to assess distributional effects of changes in taxation on different household types. The Swedish national audit office has used FASIT to model the costs for six different types of households related to energy, carbon dioxide and transportation taxes (Riksrevisionen, 2012). In Norway, the MSG and MODAG models are used.

Part 2.
Environmental statistics and environmental accounts

3. The building stones for environmental policy indicators: Environmental statistics and environmental accounts

Statistics are vital to be able to analyze the environmental situation and developing trends. The users of statistics are the public, ministries, policy makers, industry and research, which make it important to give access to data for many different types of uses. It is also important to make sure that the data is being treated appropriately so that it conveys information also to the non-expert. Providing specialized, technical information to non-experts can be challenging. In addition, data confidentiality also puts restrictions on how data can be presented.

Comparing environmental statistics with other types of statistics, such as trade, labour market and manufacturing statistics, it can be noted that the time lag is generally longer. This becomes particularly apparent when the environmental data is used in indicators that combine statistics from different areas – such as air emissions and economic data such as value added or production values. In some instances this time lag is not as important since some environmental areas do not change that rapidly, on the other hand, more timely estimates of CO_2 emissions and other greenhouse gases are perhaps desirable from the policy maker's perspective.

Another observation is the increased focus on consumption and international trade for several environmental policy areas, such as climate change, chemical use and biodiversity. Here, the environmental accounts can be further developed to better reflect these issues in policy debates and in general awareness-raising. Data from the environmental accounts are typically used to reliably include the aspect of international trade using input-output analysis techniques. These approaches tend to include a wider economic perspective than Life Cycle Analysis which typically focuses on a single product or production of a specific product.

3.1 Environmental Statistics

The demand for environmental statistics is largely national, regional as well as international. For users it is not easy to get an overview of available data and sometimes the data is not easy to access. Ordinances, directives, conventions and research are among the driving forces for establishing environmental statistics. This has given rise to statistics on air emissions, water emissions, waste, state of the environment statistics, as well as, biodiversity statistics. Clearly there is a need for cooperation of institutions to make sure that the data is accessible, reasonably harmonised and coordinated.

The UN is currently updating the framework for environmental statistics called the FDES, and the work is planned to be completed in 2013. The current version is arranged according to the Driving forces – Pressure – State – Impacts – Response (DPSIR) model, see figure below.

The environmental statistics area is diversified, both with regards to the number of areas and the number of statistical producers. A Swedish inventory of environmental statistics has been made in two separate projects (Steinbach, 2008 a and 2008 b). The aim of these two projects was to summarise environmental statistics in Sweden, who is producing information and what is the content. The first report covers the official environmental statistics. The second report also describes the data/statistics foundation upon which much of the environmental statistics depends on, such as energy statistics, agricultural statistics and transport statistics.

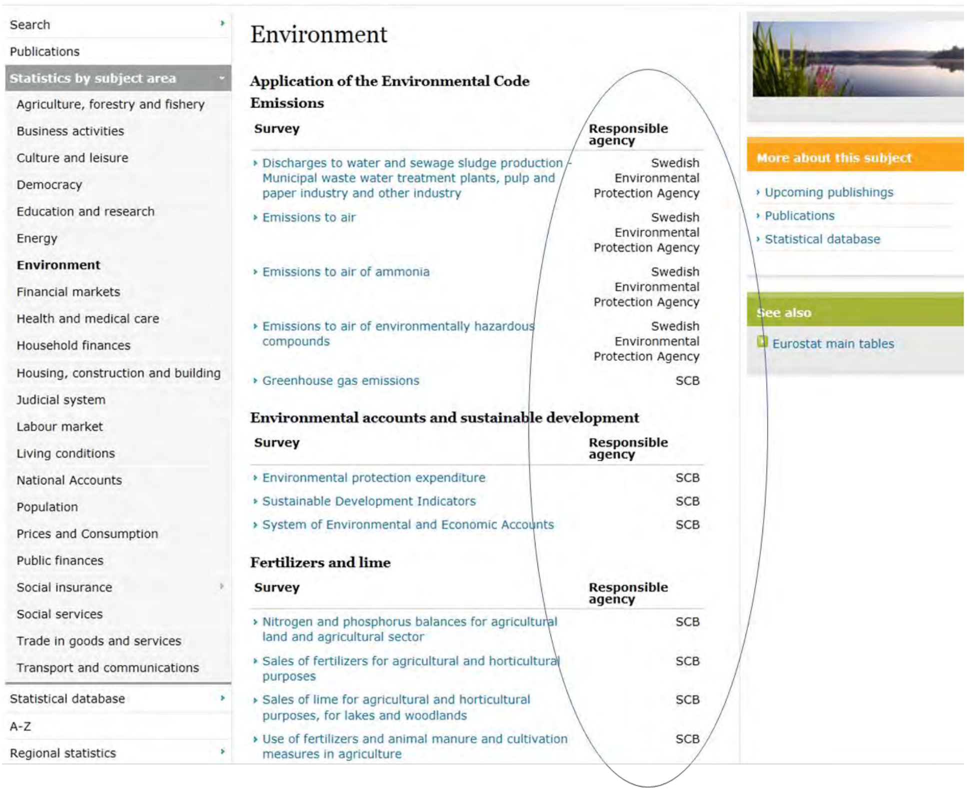
The areas of official environmental statistics covered the following topics:

1. Emissions	Swedish Environmental Protection Agency (SEPA)	6. Environmental Accounts	Statistics Sweden (SCB)
2. Waste	SEPA	7. Sustainable development	SCB
3. State of the environment	SEPA	8. Fertilizers and lime	SCB
4. Adaptation of environmental law	SEPA	9. Land use	SCB
5. Chemicals, sales and use	Chemical Inspectorate (KemI)	10. Water use	SCB

Since this inventory was taken, a new authority that is responsible for marine environmental statistics has been established in Sweden, so that some of the responsibilities of SEPA have been transferred to this new marine authority.

On the SCB website it is very clear who has responsibility for the information being published since this is shown next to the different statistical areas (labelled “Responsible agency”) and circled in the figure below:

Figure 8. Statistics Sweden Website showing the agency responsible for data areas



Source: Statistics Sweden

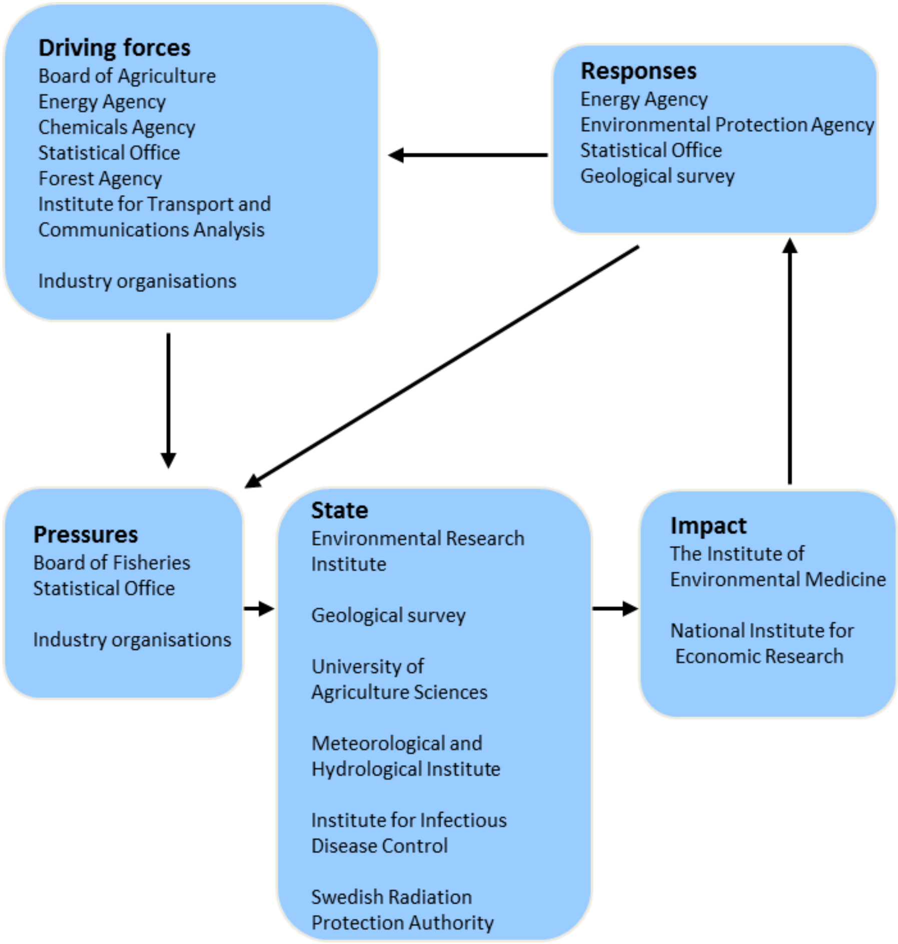
In Norway, the environmental statistics on natural resources, emissions, waste and environmental expenditure is being presented yearly in the brochure Guide to Environment Statistics (http://www.ssb.no/english/subjects/01/milfakt_en/) by Statistics Norway. The Climate and Pollution Agency (KLIF) in Norway also presents a range of environmental topics on a dedicated web-site called Miljøstatus that brings together statistics from different institutions to make the various data sets more accessible for users. The address to the web-site is http://www.environment.no/ and it covers thirteen different areas, including radiation, noise and the polar regions. The Swedish EPA is discussing setting up a similar web-site in order to make it easier for users to find Swedish data.

Coordinating so many different actors responsible for producing environmentally related data is challenging. In addition, harmonising classifications between the environmental statistics and the statistics describing the activities of society (such as the economy, education, health, poverty, etc.) increases the challenge. That is where the environmental accounting system has a role to play, to make a bridge between environmental and economic statistics. This connection is made through the production and consumption activities of the economy and the actors of the economy in the form of industries, government and households.

In the DPSIR-model, the connections between economic actors and environment can typically be found for driving forces, pressure and response indicators.

For the state and impact statistics in the DPSIR-model, such as concentrations of pollutants in air or water or number of species, a geographical or environmental domain classification of the information is needed. Here the connections to the economic actors are not as easily made as for driving forces, pressure and response data. It is likely that environmental statistics for the state of the environment is better show in maps in GIS-frameworks.

Figure 9 Driving forces – Pressures – State – Impacts – Responses (DPSIR) Model and Environmental data producers in Sweden



Source: Statistics Sweden, Adapted from Steinbach 2008b, Figure 2.

3.2 Environmental Accounts

The current system of integrated environmental and economic accounting (SEEA), often called environmental accounts for short, has been under development since the beginning of the 1990s but has its roots in earlier work from the 1970s and 1980s. Starting off by including environmental and resource statistics in a form compatible with the system of national accounts it has then gradually added more environmental economic transactions from within the national accounts system. It has proven to be a comparatively effective way of retrieving or isolating environmentally related information out of already existing statistics. The economic statistics are a rich source of information that can be used to single out transactions that are of particular relevance for the environmental performance of an economy.

Among the Nordic countries, Denmark, Norway, Sweden and Finland have been very active both nationally and internationally in building the system of environmental accounts. The Nordic Council of Ministries has also been involved in the development through commissioning several studies over the years. The statistical office in Iceland has not been participating actively in the environmental accounts development but the central bank of Iceland has models that include environmental aspects.

In 2011, the European Parliament approved a regulation (EU-regulation 691/2011 European environmental economic accounts) for the annual reporting of environmental accounts data, starting with three modules: (1) air emissions by industry and households, (2) environmentally related taxes by industry and households and (3) economy-wide material flows by material categories. The reporting is obligatory from 2013, starting with data from 2008 onwards. Annual reporting of data to all three modules will be required. The regulation will lead to the development of EU aggregates in these three areas. The earlier system, where countries reported on a Gentleman's agreement basis, was not sufficient to recover data from the countries in the European Statistical System.

The regulation was developed in such a way that new modules could be added in the future. Work has now begun regarding several other modules planned for future reporting. The European Commission (Eurostat) has developed modules on (1) energy use accounts by industry and households, (2) environmental protection expenditure accounts (EPEA) and (3) environmental goods and services statistics (EGSS). These modules are being finalized by Eurostat (DIMESA 2012) and the next step is to send them to the European Council Parliament for the legislative process.

In addition, Article 10 of the Regulation 691/2011 on European environmental economic accounts, requires that Eurostat submit a report to the European Parliament and the Council regarding the progress in the development of new modules. These modules include (1) environmentally-related transfers (subsidies), (2) resource use and management expenditure accounts (RUMEA), (3) water accounts (quantitative and qualitative), (4) waste accounts, (5) forest accounts and (6) ecosystem services accounts, the economy-wide material stock accounts and the measurement of unused excavated earth and materials (including soil) (Eurostat ENV/DIMESA/4.1/2012 and EU Regulation 691/2011).

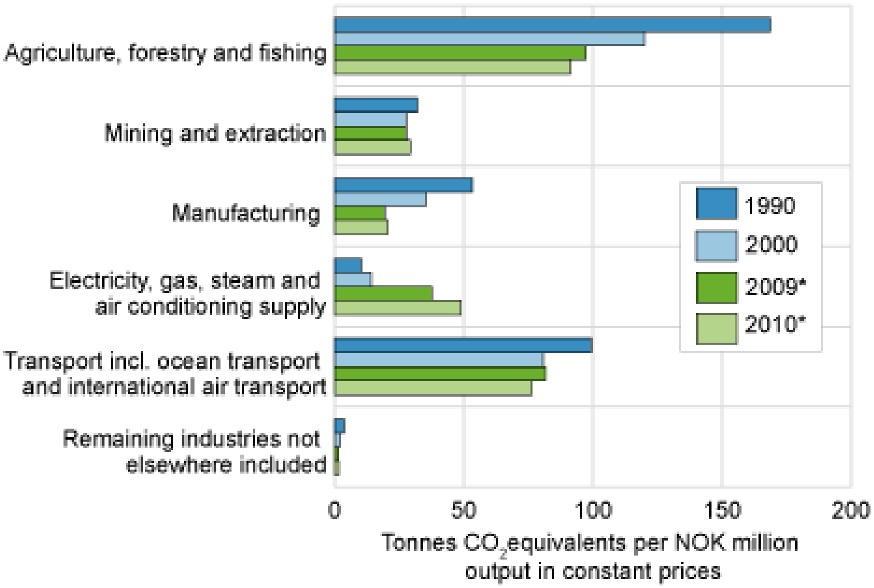
Most of these topics are described in the SEEA central framework statistical standard, which is being finalized and has been adopted at the UN Statistical Commission in March 2012. It is worth noting, however, that resource use accounts are specifically excluded from the SEEA-central framework and ecosystem services accounts are considered experimental at the current time.

In this next part of the report we will consider how the data reported can be used in a Nordic environmental policy perspective. We will also make some observations regarding the proposed modules that the European Commission (Eurostat) is considering to include in the legal base for environmental accounts. During the last 20 years the development of the system has taught us several lessons about the environmental pressure connected to production and consumption activities.

3.3 Some lessons learned in Nordic countries from the development of environmental accounts.

Lesson 1. The environmental economic profiles of industries show general differences for the environmental pressure and economic data between basic industry and construction and service industry. In general, the primary industries including agriculture, fishing, mining and extraction, will have a larger environmental pressure as compared to the economic results. However, the manufacturing industry is of course depending on these primary industries, so that the need to also regard the environmental for the final products is needed as complimentary statistics.

Figure 10. Greenhouse gas emission intensity by industry. 1990, 2000, 2009 and 2010*. Tonnes CO_2 equivalents per NOK million output in constant prices*



Source: Statistics Norway, http://www.ssb.no/nrmiljo_en/ Figure: http://www.ssb.no/nrmiljo_en

Lesson 2. The environmentally related economic instruments are typically geared towards specific activities and are not uniformly applied to all actors. There are a variety of reasons why the instruments are applied differently to different actors but actors with a great deal of international activity or exposure (such as international transportation) are often exempted from certain type of charges or taxes.

Lesson 3. Countries differ widely in their environmental pressure and the economy, natural resources, the energy system. The environmental legislation and economic instruments are keys to understand these differences.

Lesson 4. The environmental pressure from consumption is possible to derive from the accounts as long as there are internationally harmonized environmental data to use as input. Monetary input-output tables are also needed for this type of analysis. The use of accounts may lead to other insights/conclusions than the use of environmental statistics, e.g. air emissions accounts in Denmark show that no overall decoupling of emissions/GDP due to the shipping abroad (Gravgård et al., 2009; Statistics Denmark, 2009).

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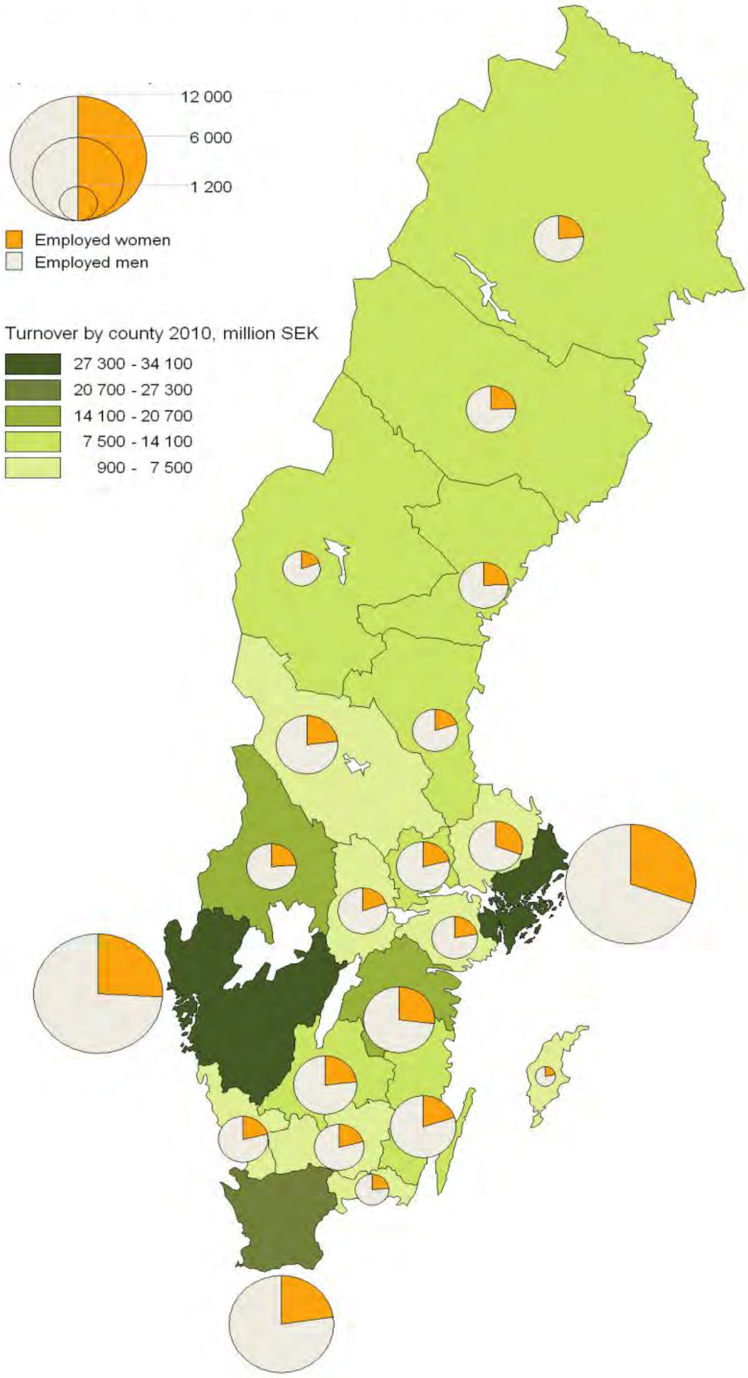
Lesson 5. In order to encompass sustainable development more adequately, social data like employment, population, geo-referenced information, health data, etc., would need to be integrated as well. From these matched set of data, indicators such as emissions per capita or per employee can be calculated. Statistics Sweden has established statistics showing the part of employment that is connected to the environmental goods and services sector by geographic area (counties).

Lesson 6. Environmental accounts and analyses using the accounting data cannot solely focus on the environment and the instruments that are devised for specifically environmental purposes. Other instruments which are established for other policy reasons or to simply raise revenue can also influence what happens in the environment. In addition, prices of resources and the trends of investments and consumption can also have an influence on the enterprises and in turn the environment. For example, the subsidies that some countries give to fossil fuel production and consumption are not part of environmental policy, but are given for economic or social purposes, but will lower the price for fossil fuels and thus contribute in all likelihood to increased consumption and to the overall driving forces for increasing air emissions. Agricultural and fishing subsidies, which can initially be established to support rural communities, can also have environmental aspects or side-effects.

Lesson 7. The development of accounts can be less costly when the accounts build on existing statistics. However, converting existing statistics to accounts can still require substantial investments.

Figure 11. Share of employment within the environmental sector by sex and country 2009



Source: Statistics Sweden, http://www.scb.se/Pages/TableAndChart____257464.aspx

3.4 New areas to be considered for future development

Some areas have yet to be integrated properly in the accounts. Biodiversity is still an area that needs to be connected to the activities of society. Here, Norway has developed a biodiversity index, which is a first step that uses expert opinion to assess the state of biodiversity in the country. (http://www.environment.no/no/Tema/Naturmangfold/Naturindeks-for-Norge/).

That would need to be followed by statistics to show more of the environmental pressure on the biodiversity and preferably also the possible societal responses.

Chemicals with health and environmentally hazardous properties are still not included in an adequate way within the environmental statistics system. Sweden and Norway use national product registers to produce yearly statistics, and Eurostat makes a similar EU-27 indicator for the EU Sustainable Development Indicators. Still, these chemical indicators have not attracted much interest in other countries – some problems with data confidentiality can be the reason. Eurostat is only able to publish EU-27 aggregate and not country-level indicators because of confidential data problems.

Another area that is often discussed and anticipated in a green accounts context is the valuation of ecosystems services or environmental damages. The work to evaluate the damages of environmental pressures in monetary terms have only been possible in a research setting, for specific policy questions, and is not recommended to be included in the statistical system at the current time. Further experimentation is needed before this can be encompassed by statistics.

3.5 How much user involvement can you expect?

In some countries the development has mainly been supply driven, meaning that it is the available statistics that has been the main driving force in developing the accounts (Cervigni et al. 2005). In Sweden, on the other hand, the demand side has been quite prominent. The environmental accounts unit has regular contact with policy makers and other users. In addition, the institutional setting in Sweden includes reference groups and a division of labor between three different authorities which provides demand for the development of certain environmental accounts and analyses.

In Sweden for example, the environmental protection expenditure in the manufacturing industry is a survey that was not available before the development of the environmental accounts were started, and that was initiated by the users. The data from the survey is regularly used by researchers, and they are asking for more details. Also, the work to define the environment sector and turn that into a database has been driven by user needs, national, regional and European. The water accounts were developed as a pilot study with financing from Eurostat and were then used by the water authorities to report to the water directive, and are now used by the new authority in charge of the Marine directive.

The environmental accounts can be difficult to understand for users. Since the users can have a variety of backgrounds, explaining the results is a necessary and sometimes overlooked task. The users often have a background either in economics or in various environmental sciences. The producers are often national accountants and have a terminology that takes times to convey to the non-accountant. One user group is the environmental economists that are already used to the vocabulary and reasoning. The accounts are useful for modeling, can more or less "directly" be used in economic models because the same classification is used. Also these modelers are fairly easy to communicate the numbers to.

We recommend that when the countries allocate resources for developing environmental accounts, that also some of these are used for discussing the results and engaging with users.

3.6 Data situation concerning environmental accounts in the Nordic countries

The Nordic countries have a fair amount experience in developing and compiling environmental accounts data that can be used to understand the linkages between the economy and the environment. Especially if you not only consider the regular publishing of data, but also the pilot studies that have been made over the years. Table 3 is an overview of the regularly published statistics as well as the pilot studies that have been made.

Table 3. Environmental accounts components in the Nordic countries, status January 2012

	DK	FI	IS	NO	SE
Physical Flow Accounts / Statistics					
Air emissions by economic activities (NACE) (CO2, SO2, NOx, CO, CH4, NH3, N2O, NMVOC, PM10, PM2.5, HFCs, PFCs, SF6)	R	Pilot		R	R
Air emissions from consumption by product group	R	Pilot			R
Energy use by economic activities ("Energy Accounts")	R	Pilot		R	R
Energy use from consumption by product group	R				
Material flow (Economy-wide) indicators	R	R		Pilot	R
Health or environmentally hazardous chemicals				R	R
Emissions to water, water use by economic activities	D	R		R	R
MONETARY ACCOUNTS					
Environmental protection expenditure and investments, government (COFOG 05, from the system of national accounts)	D	R	R	R	R
Environmental protection expenditure and investments, Extraction and Manufacturing Industries(Structural Business Statistics, investment and current expenditures)	R	R		R	R
Environmental taxes	R	R		Pilot	R
Environmentally motivated subsidies	D			Pilot	R
Potentially Environmentally Damaging subsidies				Pilot	P
Value added, employment and exports from eco-industries (EGSS)		R			R
CO2-emissions permit	Pilot			R	Pilot
ASSET ACCOUNTS					
Forest accounts	Pilot	R		D	Pilot
Balance sheets for oil and gas reserves in physical and monetary values	D			R	
Fish stocks, marine issues				D	

R: regular publishing, Pilot: pilot studies made, D: discontinued

3.7 Data quality and official statistics

As we gain more experience with the development of environmental accounts and establish certain accounts as official statistics, the requirements around quality become important. Studies and projects can produce interesting results but the quality requirements for official statistics from within the statistical system make it necessary to evaluate if the figures are reliable, coherent and comparable. Estimates of error and descriptions and measurements of quality need to be made.

As part of Regulation 691/2011, quality reports will need to be provided to Eurostat at regular intervals. Exactly how to evaluate the quality of accounts, where figures are collected from others and put together into a system, is not well defined at the current time. Defining quality measures are much easier for specific surveys than for accounts. Typically, confidence intervals or other statistical measures are provided as measures of the uncertainty or error in the figures.

A focus on improving the quality of environmental accounts data without increasing the cost and reporting burden will be important for the established areas of environmental accounts and for any future developments. The quality of statistics, such as the national accounts, has improved over the years. Environmental accounts will also require the same type of development with incremental improvement in statistical quality. Although the current quality is perhaps not as high as desired, improvement over time can occur.

4. Nordic approach: future work

The development of environmental statistics and environmental accounts that serve as the building blocks for indicators will likely continue in the coming years. The need for this type of information is communicated from a variety of users. With the existing environmental accounts, the Nordic countries would be able to do more analyses of the environmental aspects of the economy than is currently being done.

For the environmental statistics, the national needs and the signing of various international conventions have been important drivers. For the development of the accounts, the European Union is identifying additional areas that are being proposed for inclusion in a legal framework. But the skepticism regarding the quality of the data and the reporting burden is also part of the discussion.

4.1 European Commission (Eurostat) proposes new modules to be included in the EU legal framework for environmental accounts

Proposed new EU modules:

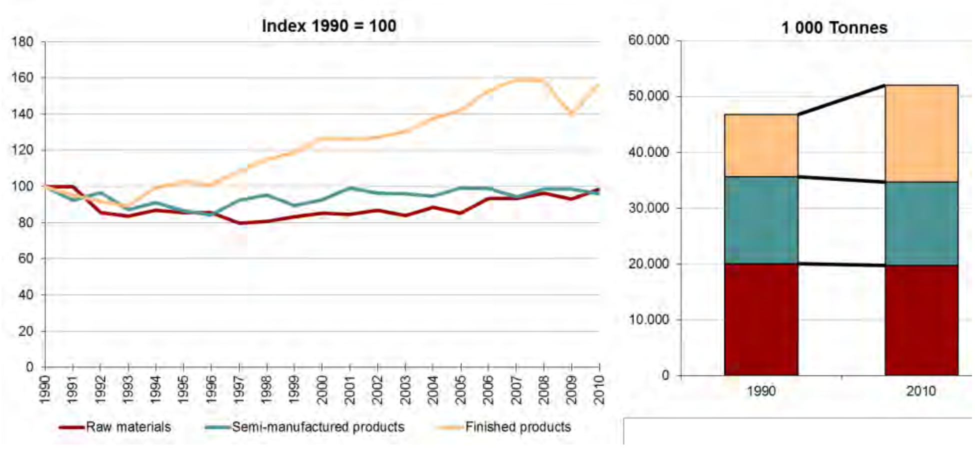
- *Energy use by economic actor*
  Denmark, Norway and Sweden already publish national versions of these accounts. Finland has started a pilot project on this. This module is supported by all Nordic countries, but the current proposal is too complicated and will need modification in order for countries to be able to report. National versions will need to be modified to comply with the Eurostat specifications
- *Environmental Goods and Services Sector*
  Sweden has regular reporting since 2003 but at less detail than proposed. Denmark does not have this as established statistics. Norway has done pilot studies of a limited type. Finland have figures from 2006–2009. http://www.stat.fi/til/ylt/2009/ylt_2009_2010-12-21_tie_001_en.html. The detail required by Eurostat can be a determining factor regarding the acceptance from the countries on this module

- *Environmental protection expenditure accounts*
  There are a number of different ways that the Nordic countries have approached this statistical area. None of the countries has a fully established accounting system where current expenditures, revenues and investments are available for all industries. Typically information is available for the extraction industries and manufacturing industries (collected under the Structural Business Statistics (SBS) Regulation) for three environmental variables (end of pipe investment, integrated technology investments and current expenditures by 5 environmental domains); EPEA data for NACE 37 and 38/39 is available from the national accounts; for the specialized producers in the waste and waste water industries (all SBS variables); and the Government sector (using the purpose based classification called COFOG – Classification of Functions of Government). Countries are complying with these different required reporting regulations from the EU. For the manufacturing industry (according to the SBS-regulation), Sweden has time series since 2000, Finland since 1992, Norway since 2003 and Denmark has recently collected the expenditure for the industry for the first time, after having a derogation. The Danish data for 2009 have been reported to Eurostat, but have been flagged due to possible quality problems. All countries are reporting government data to COFOG 05 and Eurostat is now requesting that the more detailed 4-digit COFOG be reported as well. Eurostat needs to show that the current required reporting under the national accounts government finance reporting (COFOG) and the structural business statistics regulation (SBS) are not providing the information that is needed by EU policy makers BEFORE any additional reporting should be considered

4.2 General recommendations for the statistical institutes – which do not potentially cost much more than the current regulations or are of national interest

- For EW-MFA without too much extra work the trade statistics can be grouped into 3 stages of manufacturing, raw, semi-finished and finished, using the Eurostat conversion tables. This gives some type of useful information regarding imports that do not require full physical supply and use tables or input-output analyses – see figure below from Statistics Switzerland

Figure 12. Imports by raw materials, semi-manufactured products, and finished products. Switzerland (index 1990 = 100)



Source: Swiss Statistics (STAT-TAB Table: Materialflusskonten – Direkte Inputflüsse und wie sich diese zusammensetzen)

- SSB and SCB: carbon trading emission permits – in physical units (See for example SSBs article: http://www.ssb.no/vis/magasinet/miljo/art-2011-06-01-01.html). Denmark has been involved in the Task Force and London Group regarding this topic and has made contributions with discussion papers on how the statistics could be reported

Potential ideas where some work has been done in at least one of the Nordic countries

The environmental accounts in the Nordic countries can be developed in many ways. One way to go is to further integrate the analyses that can be done with the energy, emissions and economic instruments parts of the system. Other potential areas for development are to move into new areas and integrate more information about chemicals, biodiversity, potentially damaging subsidies and noise.

When developing a new area of statistics some experimentation needs to be made. In the past 10 years a number of studies have been made by Nordic countries or in connection with joint projects in the statistical system. Some ideas about potential future developments have arisen. The following is a short description of some of these ideas.

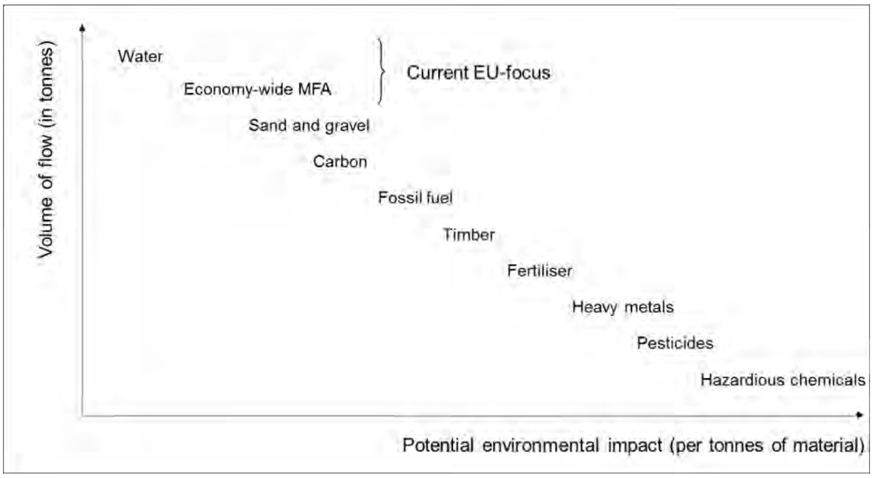
A Nordic environmental account system

- Harmonize consumption calculations and decomposition analysis approaches/calculations among the Nordic countries so these can be compared with confidence. Potentially these could be integrated in a common database or webtool, such as the Swedish environmental accounts webtool (www.mirdata.scb.se)
- Quarterly physical CO_2 emissions (based on energy statistics) – time lag better than the current Kyoto reporting at 18 months (SCB) or early annual CO_2 emissions as is being developed by Eurostat's unit for energy statistics. Policy makers are anxious to have more current data than is currently available from the Kyoto Protocol reporting and this is a project to try to see if more timely information can be provided

Chemicals

- Move from focusing only on Economy-wide MFA to chemicals. Move from top-left in Figure 13, below – which is the current focus of the Eurostat reporting on economy-wide MFA – to bottom right – where there is more focus on substances with less mass but higher environmental impact. Toxic and carcinogenic chemicals, dioxins and endocrine disruptors would be found in this group of relatively small amounts (compared with sand and gravel) with higher levels of environmental impacts

Figure 13. Schematic representation of material flows, environmental impacts and policy uses



Source: Simplified and adapted from OECD (2011)

Sweden and Norway have established statistics in the areas of Chemical use (SCB, SSB) and Chemical emission statistics (SCB). Table 4 shows the Swedish data for hazardous chemicals available to consumers.

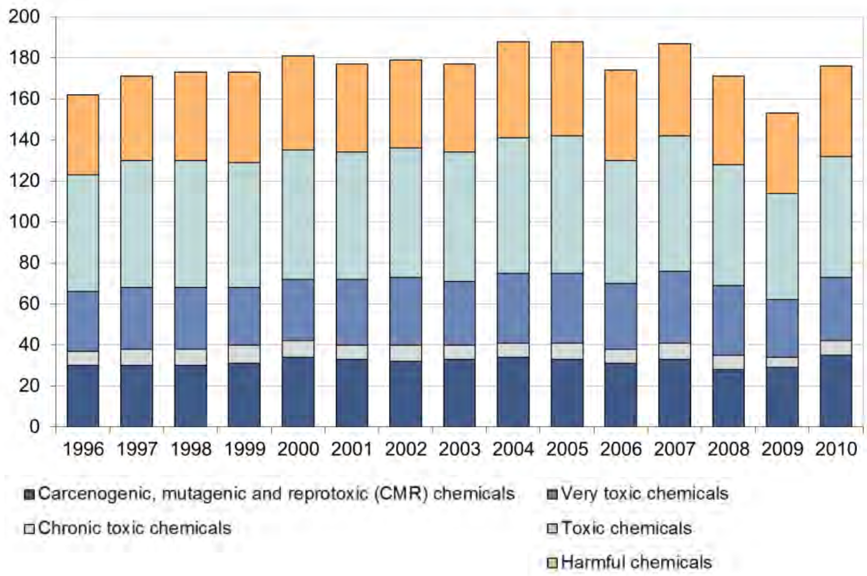
Table 4. The 15 largest product types, hazardous to health and available to consumers. 2010

Product type	Quantity, tonnes	Number of products
Fuels	16 800 000	100
Fuels, other	3 700 000	102
Mortar and similar products	2 460 000	309
Heating fuels	1 660 000	9
Flooring materials	153 000	45
Sound insulating materials	..	2
Insulation materials, other	..	3
pH regulating agents	45 200	54
Filling	36 500	165
Process regulators	36 200	3
Washing powder	20 900	164
Dish soap	14 900	61
Cooling agents	11 600	93
Preservatives for food or feedstock	9 840	3
Sealants	9 130	77

Source: Swedish Chemical Agency, Last updated 2012-05-03 http://www.scb.se/Pages/TableAndChart____20882.aspx
Note: (PRIVATE "TYPE=PICT; AKT=SOS symbol") Each product in the table can be registered in several categories (a maximum of four categories). Therefore, a certain amount of double-counting exists. Quantities are reported to the Swedish Chemical Agency. Unless specifically requested by the Swedish Chemical Agency, quantities less than 100 kg need not be reported.

- The Nordic Product registers could potentially be used to produce national level chemical index using the Eurostat approach which is based on PRODCOM statistics – see figure below. There may be some problems with data confidentiality. One way to perhaps avoid problems with confidentiality would be to develop this indicator for the Nordic countries combined

Figure 14. Indicator on the production in physical amounts of environmentally harmful chemicals (million tonnes)



Source: Eurostat (Data source: tsdph320)

Biodiversity on land and in the sea

The statistical system has not been actively involved in work related to biodiversity and the role that the statistical system plays is not extremely well defined. The following is a list of areas where the statistical system may have a role:

- Biodiversity issues – the bird index that is a common biodiversity indicator for the EU needs to be complemented with other data. Norway has developed reference states for the establishment of a nature index. Could the Nordic countries benefit from a common understanding or approach to defining reference states and establish their own Nature Indices
- Marine directive – interface between economy and marine eco-systems. The marine issues are not yet dealt with in an environ-mental economic way, and this would probably be an area for cooperation between the Nordic countries
- Eco-systems – need to see what comes of World Bank's WAVES and SEEA Ecosystems work
- Potentially environmentally damaging subsidies (SCB) – defining these is particularly challenging

Other

- Noise index and mapping – Statistics Norway has an established noise index and mapping but the quality of the information is limited at very detailed levels

5. Conclusion

Policymakers need to have a variety of tools available in their toolboxes. The right tool needs to be used for the right purpose. For example, a hammer would be a much more effective tool than a wrench if a nail needs to be pounded into the wall. In the same manner, indicators need to be used appropriately. Indicators which are best used for awareness-raising cannot be appropriately used for monitoring policies.

Statistics that can be used for monitoring policies or goals need to be constructed in a way that can specifically address and keep track of that policy or goal. Typically these types of indicators track a single area and can often be rather simple in their presentation. This does not mean that the data collection or the interpretation of the indicator is always simple.

Complex, aggregated indicators, which typically put a variety of different things together into a single indicator, are typically only appropriate for awareness-raising. Often the amount of data needed for constructing these types of indicators is substantial and can often be of questionable quality if the data is being developed for all countries. Typically the quality of the data means that only very rough groupings of countries should be made and any type of ranking of individual countries is suspect. The type of data needed for many indicators are only really available from well established statistical systems. Estimates that are developed for countries are exactly just that, estimates. Whether the data are comparable internationally is questionable.

Caution needs to be used when proposing indicators. Statisticians can often provide helpful advice and insights in the development and evaluation of indicators. Fit for purpose is important in this case.

In the Nordic countries, the well established statistical systems can be a resource especially when it comes to data availability, establishing new data from existing information systems and administrative records and in using the data for analysis purposes. The new EU regulation 691/2011 will provide country data from European countries that can be used for comparison and analysis.

The Nordic countries have been active in the development of environmental accounts. They have contributed in a variety of ways, but the Nordic countries have been particularly good at experimenting and trying to figure out how different types of accounts could be developed. This work has been particularly helpful to the wider statistical community.

The European Regulation (691/2011) will provide the structure and impetus to establish the three environmental accounts modules, air emissions, environmentally-related taxes and EW-MFA, as official statistics. This process will most likely contribute to improving the quality of these statistics.

As additional modules are considered, the issues of quality, the reply burden costs and other costs need to be seriously evaluated with respect to the type of information that is being developed. The methodology for data collection and the approach to developing the accounts needs to have a focus as well. Identifying the types of policy questions that need to be answered are also important since these new modules need to be fit for purpose. These topics can greatly influence the quality of the figures and should not be overlooked in the decision making process.

There is currently a great deal of interest in ecosystems, ecosystem services and the valuation of ecosystem services after the Nagoya Protocol was established. In the context of the Convention of Biological Diversity, Target 2 of the Aichi Biodiversity Targets in the implementation plan states that, "By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems." (http://www.cbd.int/sp/targets/rationale/target-2/).

With this as an impetus, a number of initiatives, both nationally and internationally, are being established with regards to the valuation of ecosystem services. If the phrase, "incorporated into national accounting" means that the value of ecosystem services will be calculated and then added to the production accounts in the national accounts in monetary terms, the same problems that have been encountered in the development of "Green GDP" will arise (see discussion in section 2.5).

First of all, some type of identification and description of the physical ecosystem services will need to be described. Then the physical amounts of these services will need to be measured. And the finally, these services will need to be valued.

Most of the ecosystem services humans receive have no market prices or prices that approach the definition of market prices. And this is one of the main problems with adding this type of information to the national accounts. The national accounts require substantive additivity which means that the methods of valuation are economically uniform for all types of assets. Valuation at current market prices, or the nearest feasible approximation to them, is the only method that meets the requirements for both formal and substantive additivity.

Any of the methods currently being proposed for valuation, such as willingness to pay, stated preference (Contingent valuation or choice modeling), revealed preference (choice models, travel cost, Hedonic pricing, averting behavior) or benefits transfer are not considered consistent with the valuations used in the national accounts. These types of prices are not the same as the prices used in the national accounts and cannot simply be added together.

Although it is not possible to incorporate monetary valuation of ecosystem services into the national accounts, it may be fruitful to pursue a separate physical accounting system to keep track of the physical characteristics and functioning of different ecosystems. This type of system would only be done in physical units such as tonnes, hectares, number of animals. Whether some type of valuation of these systems might be useful, for example to determine the restoration costs or maintenance costs related to the ecosystems may be helpful for certain purposes.

The statistical offices of the Nordic countries have a long history of working with satellite accounts for the environment and with combining the national accounts with environmental information. So as developments regarding ecosystems begin to take shape, the work will benefit by the participation of statisticians that have worked with environmental accounts.

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7. Sammanfattning

Ansvaret för att producera miljöinformation är ofta uppdelat mellan olika departement, myndigheter och organisationer. Att samla olika delar av miljöinformation, om t.ex. utsläpp, avfall, naturtillstånd och artrikedom till en sammanhängande bild kan vara en komplicerad uppgift. Att tolka denna mängd information och veta vilka indikatorer som utvecklas är också utmanande, liksom att känna till vilka som har ansvar för dess olika delar.

Tyngdpunkten i rapporten är indikatorer relaterade till miljö och vissa indikatorer för hållbar utveckling, eftersom dessa indikatorer inbegriper ett miljöperspektiv. Rapporten är inte avsedd att vara uttömmande men tar upp många av de vanligast förekommande indikatorerna som miljöpolitiska beslutsfattare möter. Förutom att beskriva olika typer av indikatorer görs en utvärdering av användningsområden för indikatorer.

Denna rapport har två huvuddelar. Den första delen av rapporten är ett försök att utvärdera olika typer av information/indikatorer och deras huvudsakliga användningsområden. Den andra halvan ser på arbetet med miljöräkenskaper i de nordiska länderna. Efter en period av utvecklingsarbete så har en EU-förordning tagits 2011, vilken kräver rapportering av tre områden inom miljöräkenskaperna, luftutsläpp, miljörelaterade skatter och materialflöden. Nu föreslås nya områden för rapportering som är under diskussion med Europeiska kommissionen (Eurostat), rörande energiräkenskaper, miljöföretag och miljöskyddskostnader.

I del 1 är det noteras att olika typer av information och indikatorer behövs för att följa upp miljömålen, för att öka medvetenheten och för analys. Beslutsfattare måste ha en mängd olika verktyg. Indikatorer måste användas på rätt sätt. Indikatorer som bäst används för att öka medvetenheten om miljöfrågorna på ett generellt plan, behöver inte vara lämpliga för uppföljning av politiken.

Indikatorer som ska användas för uppföljning av politik eller mål bör konstrueras för detta ändamål i möjligaste mån. Typiskt för dessa typer av indikatorer är att de avgränsar sig till ett enda område. De kan vara enkla i sin presentation, men är inte alltid så enkla i sin tolkning. Komplexa och aggregerade indikatorer, som lägger samman en mängd olika saker i en enda indikator, är vanligtvis mer lämpliga för att öka medvetenheten. Ofta är den mängd data som behövs för att bygga dessa indikatorer betydande och det kan vara svårt att få fram data som är jämförbar från många länder. Det kan innebära att endast mycket grova grupperingar av länder bör göras och att rangordningar av enskilda länder kan vara av tvivelaktig kvalitet. Statistiker kan ofta ge råd och ha insikter om fallgropar vid utveckling och utvärdering av indikatorer.

Del 2 fokuserar på arbetet med miljöräkenskaper i de nordiska länderna. Miljöräkenskaperna skapas till stora delar genom att samutnyttja befintlig data på nya sätt. De nordiska statistiksystemen är användbara för att samutnyttja, och har kunnat användas för att ta fram statistik som belyser hur ekonomi och miljö kan kopplas samman. Den nya EU-förordningen 691/2011 kommer att ge nationella data från europeiska länder som kan användas för jämförelse och analys.

De nordiska länderna har varit aktiva i utvecklingen av miljöräkenskaper. De har bidragit på olika sätt, men de nordiska länderna har varit särskilt bra på att experimentera och försöka lista ut hur olika delar av räkenskapssystemet kan utvecklas. Detta arbete har varit till god hjälp för att utveckla systemet i det europeiska statistiksamarbetet och även i framtagandet av en internationell standard.

EU-förordningen (691/2011) kommer att ge struktur och drivkraft att fastställa tre miljöredovisningsmoduler, utsläpp till luft och miljörelaterade skatter och materialflöden som officiell statistik. Denna process kommer sannolikt att bidra till att förbättra kvaliteten på denna statistik.

När nu ytterligare moduler beaktas, bör frågor om kvalitet och kostnader utvärderas mot behovet av data på olika områden. Metoder för insamling är också av stor vikt att diskutera liksom strategin att utveckla redovisningen så att den är anpassad till de frågor som behöver belysas.

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Using the right environmental indicators: Tracking progress, raising awareness and supporting analysis

Finding and using indicators that are most suited for tracking progress, raising awareness and supporting analysis is a challenge. Indicators need to be used in appropriate contexts and should ideally be fit-for-purpose. For example, indicators which are best used for awareness-raising cannot be used for monitoring policy goals.

This report presents a short review of different indicators typically encountered by environmental policy makers. General advice is provided regarding their uses. In the second part of the report, an overview of the environmental-economic accounting work of the Nordic statistical institutes is presented. Lessons learned from the development of these accounts as well as ideas for future work are described. These types of environmental accounts provide a framework for developing information about the connections between the economy and the environment.

The study was commissioned by the Nordic Council of Ministers and conducted by the national statistical agencies in the Nordic countries, led by Statistics Norway and Statistics Sweden.

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