Knut H. Alfsen, Julie L. Hass, Hu Tao and Wu You

International experiences with "green GDP"

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Brudd i den loddrette serien	Break in the homogeneity of a vertical series	—
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Abstract

Knut H. Alfsen, Julie L. Hass, Hu Tao and Wu You

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There are currently debates in many countries on whether or not to adjust or correct the measure of gross domestic product (GDP) for deterioration of the state of the environment and depletion of natural resources. The surge in interest for developing such a "green GDP" can perhaps be traced back to the World Commission on Economy and Development's report "Our common future" (WCED, 1987) and the follow-up conference in Rio de Janeiro in 1992, (UNCED). Also the process of revising the system of national accounts (SNA) and the emergence of a "blue book" on System for Economic and Environmental Accounting (SEEA) (UN, 2003) have played an important role in motivating these debates.

This report is an effort to summarise international experiences and current status with regard to the development of a "green GDP". The context is an ongoing debate in China on how to measure performance at the national and local level in a way that not only gives incentives for economic development, but also take due notice and care of the impact on the environment and the natural resources of the unprecedented economic development taking place in parts of China.

The report is a joint product from three institutions: The National Bureau of Statistics of China (NBS), the State Environmental Protection Administration of China (SEPA) and Statistics Norway, and has been made possible by financial support from the Royal Norwegian Embassy in Beijing. During a six month period, the institutions have developed their respective parts of this report, with Statistics Norway being responsible for chapters 1-4 describing some background, Norwegian and international experiences and status with regard to green accounting and the development of a "green GDP", NBS being responsible for chapter 5 on experiences in China, and SEPA being responsible for chapter 6 on Policy recommendations. NBS and SEPA jointly hosted a successful international seminar on green accounting and green GDP followed by a two-day training course on SEEA in Beijing in February 2006.

The main conclusion of the report is that the notion of green GDP as a single, corrected measure of the value added in an economy, while attractive as a theoretical concept, is too complex and uncertain in practice to be able to guide policy making. International experience indicates instead that natural resource and environmental accounting along the lines of the SEEA is the norm and represents best practice today.

This still leaves the question unanswered: How do you construct performance measures at the local, regional and national level that encourage economic development, while at the same time takes due account of natural resource and environmental degradation? Tentative answers from Norway and some other countries points to sustainable development indicators (SDI) based on the concept of comprehensive national wealth as a possible solution. An indicator set for sustainable development should ideally reflect the status and development over time of the total resource base of the economy, encompassing real (produced) capital, natural and environmental resources as well as human capital. A small indicator set (less than e.g. 20 indicators) should be developed both at regional as well as the national level. Time series of such indicators should show how the resource base is managed, i.e. whether short-term economic gains are had at the expense of the human, natural resource or environmental capital of the region.

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Contents

Contents of Figures

Contents of Tables

1 Introduction

"Therefore, those of us who have authored and promulgated our own approaches should be careful with our missionary zeal. What we are doing may be the correct course in the countries for which we have gained our experience. They may be totally inappropriate elsewhere."
(H. Peskin, 1996, 1999)

Currently there is a great deal of activity in many countries to establish “green national accounts” of various kinds. The surge in interest for this endeavour can be traced back some thirty years to the UN conference on the Human Environment, which took place in Stockholm in 1972. At this conference, environmental issues were, perhaps for the first time, brought to the forefront at the international policy scene. The event was followed by the World Commission on Economy and Development's report "Our common future" (WCED, 1987) 15 years later, and a further follow-up United Nation Conference on Environment and Development in Rio de Janeiro in 1992, (UNCED).

These events, driven by a growing recognition of the economic and ecological importance of a proper management of the natural resources and the environment, have led to a number of initiatives to establish “green national accounts” and various indicators based on the accounts to complement and correct more traditional measures of economic growth and development. Norway started development of natural resources and environmental accounts already in the 1970s, and was thus one of the early movers in the efforts to establish "greener accounts" at the national level. Over time, an international process of revising the system of national accounts (SNA) (Commission of the European Communities, et al., 1993), led by the so called London group (a forum for statistical agencies in the OECD countries), has resulted in the development of a handbook on Integrated environmental and economic accounting, first in draft form in 1993, and then as a final version in 2003 (United Nations, 2003). The handbook goes under the acronym SEEA, meaning System for Economic and Environmental Accounting. SEEA has played an important role in promoting "greener" accounts in several other countries. At the same time there has been parallel movements trying to develop environmental indicators and indicators for sustainable development. The aim again has been to provide timely signals to secure that environmental and other concerns are properly taken into account when development policies are formulated and management strategies decided. Nevertheless, more than thirty years with natural resource accounting and experiments with green accounting and indicators like green GDP, we still do not see any form of international consensus, and has little empirical evidence for their usefulness in formulating practical policies. Why is this? And what recommendations can be given based on national and international experiences with green accounts and green GDP?

Given the cost of establishing even rudimentary green accounts, it may be worthwhile to spend some time thinking about why we need these accounts and indicators, and in what form they are likely to be most useful. To this end the Norwegian Embassy in Beijing has provided support for writing this report, which will summarise Norwegian and international experiences with green accounting and the development of indicators for sustainable development over the last 20-30 years and try to extract some lessons and policy advice from our experiences. The report is the result of a joint effort by the National Bureau of Statistics of China (NBS), the State Environmental Protection Administration of China (SEPA) and Statistics Norway.

Although one should recognize the warning from Peskin (a veteran in this field) quoted above, and despite the fact that Norway is a small and peripherally placed country with its own particular resource and environmental concerns, it is our belief that the lessons presented here are of more general interest and applicability.

The report is organized as follows. Chapter 2 briefly mention and discusses some terms often associated with the concept of “green GDP”, greening the accounts, environmental statistics, natural resource accounts, indicators for sustainable development, index for sustainable development, etc. Chapter 3 goes on to describe and discuss Norwegian experiences with “green GDP”. Chapter 4 reports on international experiences with green GDP and summarises recommendations from international organisations including SEEA and a selected number of country experiences. A discussion is provided of why “green GDP” is not commonly used in other countries. In chapter 5 the Chinese experiences with green accounts and green GDP is summarised. This includes national as well as regional experiments and experiences with natural resource accounting, environmental statistics, and environmental indices. Barriers, problems and challenges for the future, including the role of international collaboration are described. Chapter 6 then goes on to synthesise this into policy recommendations for China. Alternatives to the use of “green GDP” are discussed, such as environmental labelling, green accounting (NAMEA), indicators of sustainable development, index of sustainable development, analytical studies of environmental costs, and state of the environment reporting. Conclusions and a summary of the main recommendations are given. Suggestions for further work are also outlined.

2. A brief clarifications of terms

GDP, or gross domestic product, is a national accounting term designating the domestic economic output measured in value terms minus costs associated with input of goods and services. Thus, GDP is measuring the value added of production and rents to owners of natural resources, values that are available for payment of use of capital and labour.

"Green GDP" on the other hand, is a term much used, but only seldom precisely defined. Most commonly, and perhaps most correctly, it has been used to designate a "corrected" GDP number, or sometimes a "corrected" GDP growth rate, where the correction seeks to take into account the depletion of non-renewable resources, as well as various damages to the environment due to pollution to air, water and soil, and also sometimes loss of ecosystem services as a consequence of pollution from economic activities. To find the true net benefits of economic activities, these activities should obviously be corrected for *all* costs that are associated with the economic activities. Hence, these costs should be deducted from the traditional GDP to obtain a greener GDP.

Unfortunately, and as will be discussed later in this report, there are uncertainties of both precisely which cost items to deduct from GDP and also of how to value those items. This tends to make the green GDP figure ill defined, and it will generally be difficult to ascertain what types of corrections are included and which methodologies that have been used in obtaining a specific green GDP number. Thus, as we will argue in this report, green GDP is an attractive concept from a theoretical point of view, but quite difficult, and perhaps impossible to handle in practise.

There are, however, also other interpretations of green GDP in use. Some go in the direction of providing sustainable development indicators (SDI). In this interpretation, green GDP denotes a set of indicators that should give a better signal than uncorrected GDP alone of whether the development is sustainable or not. In some cases the indicator set is based on a so-called national wealth approach, where the status of the real, financial, natural resource, environmental and human capital is measured by a set of indicators often given in physical units. In this way the problem of quantifying and aggregating the value of the different wealth components are eased, but at the cost of not ending up with a single number. Rather the indicator set in total is meant to reflect important dimensions of the total national wealth. A time series of the indicators may then indicate whether this national wealth is growing or not. If total national wealth is growing, the green GDP is positive and the development can be said to be sustainable. Opposite, a declining total national wealth is a sign that the green GDP is negative and the development is unsustainable. However, as long as the various indicators are not aggregated to a single index (a difficult task), the development of the total national wealth will be open to subjective, and perhaps expert, judgements.

In contrast to the national wealth approach, there are also a large literature on indicators for sustainable development that mainly provide relatively large ad hoc sets of indicators. These are sometimes weighted together to form a single index similar to the green GDP index. A good summary of these and similar sets can be found in Hass et al. (2002), and a partial survey is provided in World Bank (2003). In this tradition the World Bank has developed and published an indicator called "genuine savings", where a country's net national product, the value created after subtraction of the maintenance of the capital stock, is adjusted for the use of non-renewable resources and depreciation of certain aspects of the environment. See Hamilton (2000).

Other indices that in various ways adjust net national product for loss of welfare related to environmental and social conditions are "The Genuine Progress Indicator" (Redefining Progress, 1999, 2001) and "Index of sustainable economic welfare" (Daly and Cobb 1989, Cobb and Cobb 1944). These are all very much based on earlier work by Mishan (Mishan, 1967) and Nordhaus and Tobin (Nordhaus and Tobin, 1972). "Environmental pressure index" (Jesinghaus, 1999), "Environmental sustainability index" (World Economic Forum 2002) and "Well-being of nations" (Prescott-

Allen 2001) are still other approaches where a number of factors related to the environment and social conditions have been measured by separate indicators, and where an overall index is calculated using weights and by aggregating the various indicators. We argue that these are not indicators of sustainable development, but useful for guiding more detailed (usually shorter term) environmental and social polices.

Among mainly biophysically based indicators we find "Ecological footprint", published by the World Nature Fund (WWF) (Rees and Wackernagel 1994, WWF 2004), which measures the amount of productive land needed to supply the world with food and fibre, as well as energy in renewable form. "Living planet index", tries to summarise the development of biodiversity in terrestrial, marine and fresh water based ecosystems (WWF 2004). Such indicators may be useful to highlight important environmental aspects of sustainable development, but ignores (the interaction between) the economic and social pillars of sustainable development. We also draw attention to environmental efficiency indicators seeking to indicate a society's overall consumption of materials (Bringezu and Schütz 2001a,b, Eurostat 2001, 2002). These may be useful for environmental policies but say little about sustainable development. An overview of early efforts can be found in Alfsen et al. (1992) and Alfsen and Sæbø (1993).

Finally, some are using the label “green GDP” for the exercise or practice of greening the national accounts. This may take many forms, but typically starts by constructing natural resource accounts and environmental statistics measured in physical terms organised in a way that are congruent with the standard national accounts. These physical accounts and statistics may sometimes be supplemented by information about relevant prices, and further adjusted or “corrected” accounts (capital accounts as well as end use accounts) may be formed. Most prominently, the United Nation has published standards for the compilation of so-called satellite accounts to the national accounts called System for Environmental and Economic Accounts - SEEA (United Nations et al. 2003). In this tradition, the Netherlands at an early stage developed methods for grouping together economic- and environment-related variables in its so-called NAMEA-system (also called hybrid accounts in the SEEA). Work aimed at expanding and supplementing traditional national accounts also have long traditions in Norway through the development of national resource and environmental accounts from the end of the 1970s, see inter alia Alfsen et al. (1987) for a survey and evaluation.

All of these types of accounts involve large sets of numbers, and it is usually a demanding task to extract easily understandable and politically relevant information from the systems. This accounting approach therefore provides information more suitable as a basis for detailed (environmental) analysis than as core indicators of sustainable development.

In this report we will strictly reserve the term “green GDP” for a single index, which seeks to correct either GDP or net national product - NNP - for extraction of non-renewable natural resources, depletion of renewable resources and costs associated with environmental degradation and pollution damages. By natural resources and environmental accounting we will understand accounts kept in physical units and covering reserves, conversion and trade as well as end use according to a sectoral approach similar to that found in the national accounts. By green accounts we will understand the national accounts supplemented and extended by monetised versions of the natural resources and environmental accounts along the line of the NAMEA approach.

3. Norwegian experiences with "green GDP"

3.1. The institutional history of natural resource accounting in Norway

Norway is among the fortunate countries that are richly endowed with natural and environmental resources. Historically, exploitation of forests and fish has been important sources of income. Around the beginning of the 20th century energy resources like hydro power and, more recently, petroleum resources have contributed significantly to the industrialization of Norway. It is worthwhile to note that most of Norway's natural resources are exploited for export purposes. Except for hydro power, only a minor share of the natural resources have been utilised in the domestic market. This is in sharp contrast to the situation in larger countries, where local natural resources more often meets the demand from the domestic markets. Being a sparsely populated country with only 4.6 million people distributed over 304 280 km^2 of land (resulting in only approximately 15 people per km^2) Norway is also well endowed with environmental resources like clean air and water and unspoiled nature.

After a period of rapid economic development following the Second World War, voices of concern were beginning to be heard on behalf of the environment in the late 1960s. Pollution levels in the air, water and soil became steadily more noticeable, and ever more of the inherited pristine environment succumbed to economic development and deteriorated. At the same time, several important books from Resources for the Future, together with more popular titles like The Silent Spring (Carson, 1962) and Limits to Growth (Meadows et al., 1972) provided an international background for this concern.

The UN Conference on the Human Environment, which took place in Stockholm in 1972, was in many ways a forceful manifestation that these concerns were having an impact also on the arena of international politics. In Norway, one of the world's first Ministries of Environment was established in 1972, thus marking the growing concern and a will to act in the same year.

At the outset the level of ambition for the new ministry was high, i.e. it was envisaged to be more or less on par with the Ministry of Finance. Thus, while the Ministry of Finance manages and controls the fiscal resources of the country, the Ministry of Environment should in a similar manner manage and control the physical resources of the country. Consequently, a search for suitable management tools for natural resources and the environment was initiated. Natural resource accounting (NRA) was seen as a potentially important part of the necessary tool kit, and from 1978 Statistics Norway was given the task of developing such accounts for Norway. The aim was to ensure a better long-term natural resource management by:

- Providing new and better-suited data for monitoring natural resource use for long-term management purposes.
- Providing data in a form compatible with traditional economic accounts to facilitate integrated analyses of natural resource and economic issues.
- Avoiding double efforts in data collection and analysis.
- Developing a standard procedure for presentation of data and analyses on natural resources and the environment.

Assigning the central statistical office, in this case Statistics Norway, as the responsible agency for the development of the natural resource accounts turned out to be a wise choice. Statistics Norway is responsible for national accounting in Norway and also for the development and operation of some of the economic planning models employed by the Ministry of Finance and other ministries. Coordinating the work on the natural resource accounting with ongoing work on tools for economic planning turned out to be useful for a number of reasons:

- Locating the work on natural resource accounting to Statistics Norway has assured access to statistical expertise and closeness to primary statistics used in the development of the natural resources and environmental accounts.
- In Statistics Norway, the resource accounting framework was naturally based on existing economic standards and sector classification schemes, thus ensuring general consistency in the sectoral classification of economic and resource related data and statistics. In particular, the linkage to the UN

Standard of National Accounts (SNA) has made it possible to integrate important natural resource variables and relations within already existing macroeconomic models.
- Use of a common set of standards and models in the analysis of resource issues has facilitated the communication between the ministries responsible for the management of the economy and the ministries responsible for the management of the natural resources; e.g. the Ministry of Finance and the Ministry of Environment, and precluded the development of competing data sets, models, etc.

Thus, two good choices were initially made concerning the institutional location of the work on natural resources and environmental accounting and the emphasis of comparability between natural resource accounts and economic statistics.

3.2. The Norwegian accounting system

In the initial phase of natural resources and environmental accounting in Norway, considerable efforts were made to establish accounts for a relatively large number of natural resources and environmental issues (Alfsen et al., 1987, Alfsen and Bye, 1990). Thus, accounts were developed for: energy, minerals, sand and gravel, forests, fish, land use, fresh water, air pollution and waste. The list contains both renewable as well as non-renewable material resources. In addition air pollution and waste as (negative) environmental resources was included. The accounts were published in annual reports, but also in an overview report from 1981 (Central Bureau of Statistics, 1981).

Regarding the material resources, the accounts were kept in physical units and consisted of three parts covering 1) reserves or capital accounts, 2) extraction, conversion and trade accounts, and 3) end use accounts of the resources. By "reserves" is meant discovered resources that are economically extractable with today's technology.

A number of points are worth noting with regard to the structure of these accounts.
- First, the accounts consist of more than the reserves accounts alone (often presented as “natural resource accounts” in the international literature). This is of importance when it comes to employing the accounts for management purposes. It is then of relevance to know who is going to be affected by a change of policy. The end use account is essential for this kind of analysis.
- Second, although the accounts are kept in physical units, they are complemented with price information whenever market prices are available, allowing tables in monetary terms to be generated.
- Third, the sectoral structure of the extraction, conversion and trade accounts and the end use accounts followed the classification in standards for national accounts (SNA). This facilitated the inter linkage between the resource accounts and the national accounts, facilitating the integration of natural resources and environmental issues into sectoral macro economic models used for economic policy analysis.
- Fourth, the accounts for the different resources differed with respect to details in the various parts of the accounts. Thus, a biotic resource like fish required a relatively detailed reserve or stock account with specification of age structure and localisation of the different fish stocks. The end use part of the accounts is, however, quite simple, since relatively few sectors use fish as an input factor in their production. For other resources, like energy, the situation is different, since energy is an important input factor in almost all sectors of the economy requiring detailed end use accounts, while the reserve account could be kept relatively simple.
- Fifth and finally, most of the natural resources and environmental accounts were established by utilising already collected information and existing statistics in Statistics Norway.

3.3. Use and non-use of the accounts. An evaluation

By the middle of the 1980's, after close to ten year of efforts, time was ripe for evaluating the natural resources and environmental accounting experience. An evaluation was reported in Alfsen et al., (1987). The main message of the evaluation was that most of the account were under-utilized by the relevant decision makers. In fact, of all the accounts developed, only the energy account was actively and routinely used. The reason for the relative success of the energy accounts can be sought in the tight integration of energy issues with the economy, and hence with the macroeconomic modelling tools employed by the government. Already at an early stage, the economic models were extended to include energy as a separate input factor in production. Also, the energy producing sectors were described in great detail in the models. Finally, the energy accounts proved essential in the development of most of the emission inventories and in the modelling of emission scenarios.

For most of the other natural resources accounts, the utilisations were minimal. Somehow, the accounts did not interact with the day-to-day decision making processes related to minerals, forests, fish, land use, etc. in a meaningful way. One reason could be that not enough details were present in the accounts, or it could be that older and more well established ways of managing the resources in other terms than by economic sectors and with a flavour of economic national accounting, made it difficult for the decision makers to relate to the respective natural resource accounts. In the case of the fish accounts, a valid criticism is that they had clear short comings with respect to multi-

stock management. Overall, we must conclude that most of the initial effort in developing pilot accounts gave rather disappointing results in terms of relevance for policy making.

These experiences lead to a stronger focus on accounts for energy resources in Norway, and important environmental issues like air pollution where several international protocols regulate national emission levels. The analytical work was also extended to cover economic damages from energy use and air pollution, see Rosendahl (ed) (1998) who describes macroeconomic effects of air quality degradations. The forest, fish and land use accounts are, on the other hand, continued on a minimum basis only, while the mineral accounts at present are discontinued.

This experience with the development of natural resource accounts does not mean that the detailed statistics for these resources were abandoned or not used at all. Statistics Norway continues to produce rather detailed statistics for, for instance, forests. It is these statistics that are used for management purposes rather than the same data in an accounting framework. Thus, what has been abandoned is the structuring of this statistics into sectoral reserves, transformation and end use accounts.

Presently, the disaggregated macroeconomic models employed by the Ministry of Finance for medium and long term economic projections include various energy and air pollution variables, and integrated forecasts are now routinely made of economic development, demand for energy and the consequences for emissions to air of several important polluting compounds. In addition, the models have recently been extended further to also incorporate waste generation in manufacturing and consumption activities; see e.g. Bruvoll and Ibenholt (1997).

Summarizing, the development in natural resource accounting in Norway during the 1980s and 1990s went from a broad coverage of many, mainly natural, resource categories to a more selective approach with greater emphasize on analysis and integration of resource and environmental issues in the Norwegian economy and thus in economic planning. At the same time the focus also shifted from mismanagement of material resources to problems associated with environmental degradation, *i.e.* pollution.

Recently, an increased attention has been paid to the development of indicators for sustainable development and their use in policy making. We will return to this recent development below, but will first comment on the idea of correcting the national accounts aggregate for depletion of natural resources and deterioration of the environment, i.e. the idea of developing a measure of green GDP.

3.4. Why not a green GDP in Norway?

Summarising very briefly, the Norwegian history on green GDP can be said to have started with an ambitious development of natural resources and environmental accounts expressed in physical units, followed by analytical use of a limited part of these accounts in multi-sectoral macroeconomic models and at present focusing on developing a small set of sustainable development indicators and the underlying statistical basis. Seemingly, the idea of constructing green GDP as an environmentally corrected GDP number do not appear in this history. This is, however, only partially right. The idea was considered seriously some fifteen years ago, see e.g. Aaheim and Nyborg (1995), but was deemed to be impractical for a number of reasons described below.

3.4.1. Adjusting GDP for the value of environmental assets

First, in connection with correcting the GDP for environmental damages, we note that most valuation in the national accounts is done on the basis of market prices, i.e. prices that are actually used in transactions in shops and elsewhere. In a hypothetical ideal economy free from external effects these prices would reflect the social value of the goods. When valuation is such a simple matter it makes good sense to aggregate variables from the national accounts up to GDP.

Valuation of goods that are not traded in any market, for example environmental assets, is more problematic. Even so, such valuation is absolutely essential if we are to adjust GDP or any other economic indicator for changes in the state of the environment. Some of the problems of environmental pricing can be illustrated with an example.

Consider a plant that uses water from a river in the production process and discharges polluted water back to the river. Suppose also that a town situated downstream uses the river for of supply drinking water. What is the value of clean water in this case? From the *supply side* it can be argued that the *cost of purifying* the water to an acceptable drinking quality represents the value of the water. In other words, the value of clean water is determined on the basis of the cost of procuring pure drinking water. Seen from the *demand side* on the other hand, the value clean water equals the town's *willingness to pay*[1] for this commodity. The problem then is that the two methods of valuation are likely to give widely differing results, and it is by no means obvious which of them should be used to adjust GDP.

[1] A further aspect is that surveying willingness to pay in a reasonably reliable manner may pose problems. In the same way the factory's clean-up costs may be difficult to determine. Perhaps the factory has been issued with an injunction to prevent it polluting the river, and, instead of purifying its emissions, it closes down or starts producing other goods. What in this case is the "purification cost"? We will let these problems lie for the present.

The problem is compounded by the following factors. If the factory had in fact purified its wastewater, its production costs would increase, and thus probably the prices of its products increase too. This would in turn affect other prices in the economy, which would lead to changes both in what is produced and consumed in the economy. GDP itself would therefore be affected. This effect would be particularly important to take into account if the action taken is "big" in the sense that it affects large sections of the economy. General objectives of reducing emission levels in a country may be an example of a "big" initiative. In other words, it is not enough merely to find the value of clean water in order to adjust the value of GDP, the traditional GDP measure also has to be adjusted. Doing this requires a model of the economy, and the entire task of adjusting GDP becomes a fairly wide-ranging analysis of interrelationships in the economy, an analysis that differs from what we usually associate with keeping accounts[2].

The above is intended to illustrate some of the problems faced in valuing environmental assets. This is not to say that information on willingness to pay or cleaning costs is without relevance. On the contrary, it is clearly important for decision-takers to be provided with such information. But it is not correct for the statistical accountants to take controversial decisions about the value of environmental assets and to incorporate such decisions, and to some extent conceal them, in apparently neutral information about the trend in an environment-adjusted GDP. Such information should instead be presented for instance by way of analyses where assumptions and suppositions are clearly presented and discussed.

If the conclusion from the above is that adjusting GDP for changes in the state of the environment is a complicated matter, it may perhaps be hoped that fewer problems are presented by natural resources that are traded in the market? For instance, one should believe that in the case of Norway it should at least be possible to adjust GDP for the oil and gas that we drain from the North Sea each year? Let us consider this now.

3.4.2. Adjusting GDP for depletion of the natural resource wealth

A central element in the call for sustainable development is that our wealth should be passed on to the next generation intact. Besides foreign claims, fixed capital (machinery, buildings and infrastructure) and human capital (knowledge and technical insight), this wealth comprises *natural capital*.

The value of a capital asset is usually reckoned as the total discounted income accruing from it. In other words the value of Norwegian oil and gas equals the current value of future income from oil and gas production minus extraction costs. If p_t is the (net) price of oil and gas in future year t and x_t is the quantity of extracted oil and gas, the oil wealth is thus given by $V_0 = \Sigma_t p_t x_t/(1+r)^t$, where r is the (constant) discount rate. Hence the value of the oil (the oil wealth) depends on future earnings, and is therefore determined on the basis of what we believe are reasonable future prices and production levels. In practice it turns out that people hold widely differing views as to what are reasonable price and production paths. It goes without saying that the results, i.e. the estimated values of oil reserves, vary widely. Brekke et al., (1989) for instance, estimated the value of the oil wealth on the basis of official government price projections published in various contexts. They found that the year-on-year changes in the oil wealth essentially were due to changes in price expectations alone. Furthermore, for several years the changes exceed the actual GDP for Norway! In other words, the uncertainty as to future oil prices is so great that adjusting GDP for changes in the oil wealth renders the traditional GDP measure virtually irrelevant. Nonetheless analyses such as this represent useful information for politicians and others. But once again, we find that the results should not without further ado be incorporated into an accounting framework. Adjusting GDP for oil depletion is thus not as simple a matter as our intuition might lead us to believe.

3.4.3. An attempt at a recapitulation of the Norwegian debate

A reasonable interpretation of the concept of sustainable development is that national spending should not exceed national income in the long run. The question, however, is how to define income. The desire to adjust GDP can be seen in the light of this question. A definition of income that has gradually gained currency and is often attributed to the English economist John Hicks[3] is the following: income is that part of the monetary flow that a person or organisation can spend in the course of, say, one year without being worse off at the end of the year than at the start of the year. For simplicity's sake this could be said to correspond roughly to the net national product - NNP, i.e. GDP less consumption of real capital in the traditional national accounts. Adjusting GDP or, better, NNP would then include removal of consumption of natural and environmental capital.

We have, however, argued that defining the value of environmental capital is highly problematic. Calculating the consumption of such capital is of course no less difficult and controversial. Indeed, even for an

[2] The distinction between analysis and accounting is not always clear-cut, but in vague terms we could say that analysis results depend on a greater number of assumptions (often hypothetical and thus controversial) than those required for accounting purposes.

[3] Chapter 14 of Hicks (1946): *Value and Capital*.

"ordinary" commodity such as oil it proved difficult to find usable figures for the wealth it represents. These problems are closely related to the fact that definition of income depends on our vision of future events. John Hicks was himself very aware of the problems this entails for the concept of income. He says in the chapter containing his definition of income quoted above: "It is hard to believe that the social income which economists discuss so much can be nothing else but a mere aggregate of possible inconsistent explanations." And a little later he goes on to say that the concept of income is "one which the positive economist only employs in his argument at his peril". The problem of course is that since the concept of income is critically dependent on expectations as regards future events the concept gives precious little guidance as to what conduct should be adopted. Put another way: if a mistake is made, a mistake is made - and not even an environment-adjusted GDP can say much more than that about what arrangements should be made.

3.4.4. Life without a green GDP

What, then, can be done to persuade decision-makers and others to take sufficient account of the depletion of environmental and natural resources? Some proposals are as follows.

In the first place they should be made aware of what has happened to the environment and natural resources over time. This is best done by showing, for example, the trend in reserves of natural resources in *physical units*. Furthermore, priority should be given to devising a set of sustainable development indicators that provides concise information on the state of the nation's wealth. Such information, based on uncontroversial data, can provide a useful basis for politicians to judge the gravity of problems faced in the economic, social and environmental sphere.

Second, analyses should be made, based on economic and other models, of how various policy proposals can affect economic growth, the composition of such growth, the stock of natural resources and the state of the environment. The objective should be to base these analyses on information about the physical effects of for instance environmental degradation on the functioning of the economy. An example might be the effect of air pollution on the number of sick days in the workforce. If this is worked into the economic model, the model will calculate what the *value* of a lost workday represents. Adopting this approach avoids bringing in more or less controversial problems of valuation, but at the same time omits important aspects of environmental assets. Cleaner air results not only in fewer sick days, but also in other benefits, which however are difficult to quantify in monetary terms. Other analyses might address the problem of valuing the petroleum wealth as well as the wealth of other natural resources, and how this depends on factors believed to determine future prices. This could help to indicate whether we are spending more of our return on this wealth today, in other words whether we are "consuming" the family silver. These and other analyses will always be controversial, i.e. build on more or less well-founded suppositions about valuation of environmental "goods" and natural resources. The analyses will however point to uncertainties and prompt debate on central assumptions in quite a different manner from figures in a set of accounts. In other words, we believe that neither the environment nor public discussion are served by squeezing all this information into a single figure presented as an adjustment to another figure.

Of course these proposals face politicians and other decision-makers with a task more difficult than that of assessing a single indicator - a green GDP. On the other hand, they may serve to increase politicians' awareness that the challenge of ensuring sustainable development is wider than assessing one indicator value against another. Reality, and all the uncertainty attached to future developments, must be squared up to. A green GDP will in many contexts do more to obscure problems than resolve them.

3.5. From natural resource accounting to indicators for sustainable development. "Our Common Future" and the call for indicators for sustainable development

After the first decade with natural resource accounting and the realisation that the heavy investment in the development of these accounts generally did not pay off in terms of better management for the majority of resources considered, the question remained: How could politicians get the necessary information in order to secure a responsible development with respect to natural resources and the environment?

In the highly influential report "Our Common Future" from the World Commission on Environment and Development (WCED, 1987), and again at the UN conference in Rio de Janeiro in 1992, at least a part of the answer was sought by issuing a call to develop indicators for sustainable development (SDI). Some countries and institutions eagerly took up the call, while others, Norway among them, largely neglected or delayed the response. In broad terms three different paths seems to have been followed in the international work on indicators for sustainable development (Giovannini, 2004).

One path, the accounting path, underlined the need for a full set of natural resources and environmental accounts in addition to accounts for the economic and social dimension, in order to form more aggregated indicators for sustainable development. The UN handbook on Integrated Environmental and Economic Accounting (SEEA, United Nations et al. 2003) remains the main reference on this. In this tradition, the Netherlands at an early stage developed methods for grouping together economic- and environment-related

variables in its so-called NAMEA-system. Norway has made some limited efforts along the same lines; see e.g. Sørensen (2000) and Hass et al. (2002a). However, these types of accounts involve large sets of numbers, and it is a demanding task to extract from the systems easily understandable and politically relevant information. This approach therefore mainly provides information more suitable as a basis for detailed (environmental) analysis than as core indicators of sustainable development.

A second path emphasised the collection in a more or less ad hoc manner, of indicators for a large number of issues and problems thought to be of relevance to sustainability; usually without any underlying unifying framework or simply connected to policy statements, cf. various national sets of indicators, the UN's Commission for Sustainable Development, Eurostat, etc. A good summary of these and similar sets can be found in Hass et al. (2002).

A third path sought to define and work out a single or a few highly aggregated indicators based on more or less ad hoc methodologies for aggregating indicators for different environmental, economic and social themes (a short survey is provided in World Bank, 2003). The demand for a single “green GDP” index can be placed in this category. In this tradition the World Bank has developed and published an indicator called "genuine savings", see Hamilton (2000). Several others has already been mentioned in this report, see Chapter 2.

The end result is a plethora of different indicator sets based on different and more or less sound methodologies. We argue that none of the approximate measures listed above can be said to have been successful as indicators of sustainable development, neither on a professional basis, nor on the basis of their influence on practical policy. This may in some cases be due to the fact that rather large numbers of indicators, often representing measurements without theory, have been developed which only to a limited extent have been able to focus on issues of critical importance for the sustainability of development. Instead, attempts have been made to measure almost all aspects of development. On the other hand, the construction of single aggregate indicators has often made it difficult to judge how individual areas of importance for sustainability have been weighted and aggregated. This uncertainty tends to reduce confidence and usefulness in such aggregate indicators and it often leads to discussions of methodology rather than substance. To us, the challenge consists of striking a balance between these various considerations, while at the same time maintaining a sharp focus on matters that are or may be of great political and practical importance for policies to enhance the sustainability of future long-term developments.

3.6. Indicators for sustainable development in Norway: A proposal

Almost ten years after the Rio conference, and as a preparation for the follow up conference Rio + 10 in Johannesburg, Norway finally came around to formulate both a strategy and an action plan for sustainable development (Ministry of Foreign Affairs, 2002, Ministry of Finance, 2003). A key action in the action plan was to develop a limited and focused set of indicators for sustainable development in Norway. A commission was established to put forward a proposal for such a set, and they delivered their report in 2005 entitled "Simple signals in a complex world" (NOU 2005:5). An English summary is provided by the Ministry of Finance (2005, http://odin.dep.no/filarkiv/246109/Indicators.pdf). A major concern for the commission was to establish a theoretical framework for such an indicator set, and not to only propose a collection of more or less relevant individual indicators. Furthermore, they highlighted the need for the indicators to be as intuitively understandable as possible, and thus to avoid more dubious methods for aggregating numbers from very different areas. This was done in order to avoid endless and often frustrating discussions about methodological questions drawing attention away from the real concern: How to secure a more sustainable development of our societies.

To create a unifying framework, while at the same time keeping the indicators as intuitively understandable as possible, was clearly a challenging task. The solution, according to the commission, was to base the indicator set on *National wealth* as the key unifying concept. While sustainable development is often interpreted as a long-term development securing the welfare level of the population, i.e. with focus on the output of our combined environmental, economic and social systems, the commission lowered the ambition level and focused instead on securing the input or resource base of our societal systems.

The resource base clearly encompasses natural and environmental resources, financial resources as well as man-made equipment and infrastructure, in addition to social resources like human work capacity, knowledge and know how. Altogether this constitutes our national wealth in the form of natural and environmental capital, financial and real capital and human capital.

According to this interpretation, sustainable development is not about preserving some particular development pathway, but about protecting development options for the future.
However, if one wealth component, e.g. petroleum wealth declines, can this be offset by growth of other components such as human or financial capital? This question touches on a difficult point of whether, and to what extent, the various wealth components can be

expected to substitute for each other as far as welfare effects are concerned. On this point, opinions may differ. There are clear-cut cases where substitution can be denied on technical grounds (ecosystem services are a good example). In other cases, the matter cannot be decided on technical grounds alone. It is then best made on the basis of social preferences, expressed either through the market or democratic institutions or both. Robert Smith of Statistics Canada has noted (R. Smith, 2005) that marginality is a key concept here. To the extent that such decisions are truly marginal, then the liberal argument to allow the market and democratic institutions to decide holds. If, however, our impact on the environment is becoming less and less marginal, as many scientists believe, then the liberal argument weakens and may even become dangerous. In this case, there is no other recourse than to return to technical grounds for decision-making; regrettably, our technical knowledge of these impacts is generally insufficient to make wise decision-making a possibility. Then, in the last instance, the political authorities will have to decide.

Thus, the commission recognized that it is unwise to aggregate all the wealth components into a single total national wealth indicator, since the various components cannot always replace each other.

In addition there is an ethical consideration. Certain observers question the right of human beings to exploit nature and environment in a destructive manner, even if this, at least in the short run, may increase total national wealth. We shall not pursue this matter any further here, but only note that the arguments listed above are all important reasons why it is not sufficient to ensure that *total* national wealth is being maintained. We argue that individual components will also have to be maintained at certain minimum levels in order to secure sustainable development. It is therefore necessary to monitor the development of key resources and individual components of national wealth separately, in addition to assessing the development of total national wealth on a continuing basis.

This point is further strengthened by the fact that we today have only a limited understanding of how economic activity depends on and influences environment and social relations. Thus, an important aspect of conservation of biological diversity is the fact that many characteristics and potential values related to diversity are not well known. Nevertheless, most of the services of the eco-system that we benefit from depend on the existence of a minimum of biological diversity in these systems. These forms of incomplete knowledge provide an additional reason why key individual elements of the national wealth, and not only the total value, are important.

Even though making rather crude estimates of national wealth is now standard procedure in most national statistical agencies in OECD countries, it is well known, as discussed previously, that there are many practical problems associated with this. Thus, estimates of national wealth are usually incomplete.

It is at this point that *indicators of sustainability* are useful, if they are selected in such a way that they represent what the expected welfare effects of the key components of national wealth. The strategy as far as the selection of indicators of sustainability is concerned is therefore as follows: *to chose indicators that best reflect the value, defined as the welfare effects, of the various components of national wealth.* The Norwegian strategy is thus similar to the one Canada has described as "a capital approach", see Smith et al. (2001).

3.7. Links between accounting and indicators

Having concluded that the development of indicators for the (comprehensive) wealth of a nation (or a region) is a useful way towards securing sustainable development at the national or regional scale, we are of course confronted with the question of what kind of information is needed in order to construct and understand reliable indicators. It is at this point that we are brought back to the issue of accounting. Accounts have the potential of providing a dynamic framework for analysing and for increasing our understanding of the messages delivered by the indicators, and should encompass economic, natural resource and environmental issues, but also, in addition to previous exercises, measure human capital. The main audience of the accounts is thus no longer decision makers directly, but rather statisticians and other experts involved in compiling indicators of national wealth and sustainable development indicators.

Thus, over time we have come to understand that extended, or green, accounting is an exercise that should support and be directed by the development of policy relevant indicators for sustainable development. In light of this, the early Norwegian enthusiasm for green accounting was premature, focusing on too many issues and with a too short time horizon. The point is rather to identify long-term issues of high relevance to the sustainable development of our societies, and then to develop the necessary informational basis for understanding and analysing these issues and trends.

3.8. Conclusions and recommendations

Based on our, admittedly limited, experiences we would like to highlight the following conclusions.

1. A one-sided focus on the development of large-scale natural resources and environmental accounts without a clear plan for their eventual utilisation is likely to be a waste of efforts. Potential uses of the accounts are analysis of trends in more aggregated indicators, and as input to economic models for

analysis of interactions between economic development, natural resource use and the environment.
2. On the other hand: A one-sided focus on aggregated indicators (for sustainable development or in the green GDP tradition) without a theoretical framework and a solid statistical underpinning is likely to lead to little policy relevant information. As mentioned, we favour a broad theoretical framework based on the concept of comprehensive national wealth. This should be supported by capital accounts of the relevant assets, as well as conversion and end use accounts for analysis of policy impacts.

In considering the greening of national accounts and the development of appropriate indicators it is thus important to consider the whole chain encompassing:

- Observation and basic data collection
  ↓
- Production of statistics
  ↓
- Development of accounts
  ↓
- Extraction or construction of indicators and use of data by analytical tools, e.g. models
  ↓
- Use of the information in the decision process.

As always, the chain as a whole is no stronger than it's weakest link.

Traditionally, the weakest link is found at the very end of the chain; i.e. when it comes to secure that the available information (in whatever format) is well tailored to the need of the actual decision making process. Clearly this process will differ depending on the regional level under consideration (local, regional or national) as well as country specific circumstances. We have little to offer in terms of specific advice on this issue, except for highlighting the need to take this link of the chain into consideration when one is formulating a strategy for greening the accounts and developing indicators.

3.9. On the need for international co-operation and harmonisation

Finally, we argue that the time has come to work on a common framework for indicators for sustainable development among countries, based on a resource or capital approach for several reasons:

- It is a sound economic and conceptual approach;
- A number of Central Statistical Agencies compute, or can compete, National Wealth estimates[4].

This work should as far as possible be carried out by National Statistical Institutes with the competence in national accounting and social and environmental statistics. Efforts by independent bodies in this area have not been particularly successful.

Finally, it would – in addition to common *national* core sets in development countries – be desirable to establish an authoritative set of *global* indicators for sustainable development based on the concept of national wealth. Poverty and the global environmental commons would in our opinion also be central features in such a set, and the present UN Millennium Goals seem to be an obvious point of departure for further work in this area.

[4] You need separate measures for the main capital categories; human, real, financial, natural and environmental capital. A few indicators of key social conditions should also be included in a small core set that should be specifically linked to the key policy areas of sustainable development.

4. International experiences with green GDP

4.1. Environmental and economic accounting: an international perspective

Full implementation of the Systems of Environmental and Economic Accounting (SEEA) has not been undertaken by any country. This fact should not be taken as criticism of either the countries who are implementing the SEEA or of the SEEA itself but rather as an indication of the flexibility inherent in the SEEA. Countries are implementing only those portions of the complete and integrated set of environmental accounts described in the SEEA that are useful or needed. Each country implementing portions of the SEEA evaluate their national needs in terms of the information needed for managing natural resource assets, physical material flows and pollution, costs of environmental protection, and the development of related indicators. If for example, a country has limited natural resources, then the establishment of extensive natural resource accounts would not be warranted.

4.2. Historical background of the Systems of Environmental and Economic Accounting (SEEA)

In 1993 the United Nations published the "Handbook of National Accounting: Integrated Environmental and Economic Accounting (SEEA)" (Chinese version available at http://unstats.un.org/unsd/publication/SeriesF/SeriesF_61C.pdf). This handbook was the result of the discussion on environmental - economic accounting in international workshops organized by UNEP and the World Bank. The discussion of concepts and methods, however, had not come to a final conclusion and the handbook was issued as an "interim" version of work in progress. As a result of the publication of the SEEA handbook, several developing and developed countries started experimenting on the compilation of environmental and economic accounts.

The London Group on Environmental Accounting (http://unstats.un.org/unsd/envAccounting/londongroup.htm) - a group formed mainly by countries active in the field - was created in 1994 to provide a forum for practitioners to share their experiences in developing and implementing environmental accounts. The increased discussion of concepts and methods of environmental accounting together with country experience has facilitated the convergence of compilation methodologies for selected modules of the SEEA.

In 2001, UNSD and UNEP published the "Handbook of National Accounting: Integrated Environmental and Economic Accounting - An Operational Manual" (English version: http://unstats.un.org/unsd/publication/SeriesF/SeriesF_78E.pdf also available in Chinese from the UN in printed format) which was prepared by the Nairobi Group (a group of experts from national and international agencies and non-governmental organizations established in 1995). This handbook reflected the ongoing discussion on environmental accounts since the publication of the SEEA in 1993 and the experiences in developed and developing countries. It provides a step-by-step guidance on how to implement the more practical modules of the SEEA and elaborates the uses of integrated environmental and economic accounting in policy-making. User-friendly software to facilitate the SEEA compilation was developed by UNSD and the Fondazione ENI Enrico Mattei.

In parallel with the work of the Nairobi Group, the Statistical Commission, in 1997 at its twenty-ninth session requested the London Group to collaborate with UNSD on the revision of the SEEA. The revision that was carried out through a series of expert meetings and was built upon a wide public discussion process has concluded in 2002. The revised "Handbook of National Accounting: Integrated Environmental and Economic Accounting, Rev. 1" (English version: http://unstats.un.org/unsd/envAccounting/seea2003.pdf) (SEEA 2003) has recently been issued as a “white cover” publication prior to official editing and will be published jointly by the United Nations, the International Monetary Fund (IMF), the Organization of Economic Cooperation and Development (OECD), the Statistical Office of the European Communities (Eurostat) and the World Bank.

4.3. Need for environmental accounts and not just environmental statistics

Good environmental statistics are required for the establishment of environmental accounts. If environmental statistics are the pre-requisite to environmental accounts, what are the main differences between statistics and accounts? Environmental accounts are based on a well-founded framework, which has an inherent internal logic and structure. Environmental statistics, on the other hand, are often collected in a way that meets the specific needs of a few data users, but will generally not meet the needs of a wide range of users. Taking environmental statistics and placing them into an environmental accounting framework will identify inconsistencies and missing elements in the statistics. The accounting framework provides the data compiler with clear information as to where and how the data collection efforts need to be improved. Having the information organized in an accounting framework can make additional uses of the data. The SEEA defines the environmental accounts framework so that it is consistent with the economic accounts as defined by the System of National Accounts (SNA).

An example regarding the progressive change from waste statistics to waste accounts may be helpful in illustrating this process. Originally the waste statistics in Norway were gathered primarily according to geographic location. This provided information about how much solid waste was produced in a geographical area such as a municipality or county. This information was fairly readily available and so therefore this was why the statistics were initially developed according to geographic areas. These statistics, however, did not cover the entire situation regarding solid waste and could not provide information about which entities (for example, industries or households) produced the waste. Any policy that could be based on the geographically based information would have to be focused on changing the waste producing patterns by geographic areas. But the authorities wanted to establish waste policies according to different economic sectors and different types of waste fractions. In order to provide policymakers with the information they needed, the waste statistics needed to be redefined and reallocated according to which industry produced the waste and which kind of waste fractions were produced by each industry. Additional information was required in order to meet this policy need. New surveys and studies were made in order to provide this additional information.

By organizing these statistics according to economic activities and according to waste fractions it was easier to identify which sector needed the policy focus for different types of waste fractions. Once the statistics were reorganized and placed into the accounting framework, it also then became apparent that there were certain gaps. One gap, for example, included the import and export of waste. Currently the waste accounts in Norway are not fully implemented but improvements are made each year. The process of taking the waste statistics into a waste accounting framework has helped to increase the comprehensiveness, consistency and the coherence of the waste statistics within themselves and also with other types of data. As improvements are made to the waste accounts in Norway it is expected that the data will become even more useful to policymakers.

In summary, the advantage of having environmental data placed in an environmental and economic accounting framework is primarily to improve consistency, comprehensiveness and coherence. It also allows for combining environmental data with the corresponding economic accounts in a coherent way that allows for modeling and analyses.

4.4. Four main modules of environmental and economic accounts

Before reviewing international experiences regarding the implementation of the Systems of Environmental and Economic Accounting (SEEA), it is important to briefly describe the different modules that countries can implement. The SEEA can be broken down into the following four main modules:

1. Physical and hybrid flow accounts
2. Expenditure accounts and environmentally related transactions
3. Asset accounts in physical and monetary terms
4. Extending SNA aggregates to account for depletion, defensive expenditures and degradation

Physical and hybrid flow accounts

The first category of SEEA accounts focuses on physical data relating to the flow of materials and energy and organizes them as far as possible, according to the accounting structure of the System of National Accounts (SNA). The accounts of this type also show how flow data in physical and monetary terms can be combined to produce so-called hybrid flow accounts, also called NAMEA (National Accounts Matrix including Environmental Accounts).

Expenditure accounts and environmentally related transactions

This second category of SEEA accounts makes more explicit those elements of the existing national accounts which are relevant to the good management of the environment. An account of expenditures made by businesses, governments and households to protect the environment is an example of the accounts included in this category.

Asset accounts in physical and monetary terms

The third category of accounts included in the SEEA includes information about environmental assets which are measured in both physical and monetary terms.

Extending SNA aggregates to account for depletion, defensive expenditures and degradation
The final category of SEEA accounts considers how the existing SNA might be adjusted to account for the impact of the economy on the environment. Three types of adjustments are considered: those relating to depletion, those concerning so-called defensive expenditures and those relating to degradation.

At this point in time countries have only attempted to extend the SNA aggregates on a trial basis (see for example, Australia, Japan, Mexico and the Philippines). No country appears to be producing any of the adjusted SNA aggregates described in the SEEA on a regular and official basis. This means that the international experience reviewed below focuses on implementing the first three SEEA modules. It is important to remember that different types of information are needed to answer different types of questions. Once the questions and the information and data needs are identified, this will also help to indicate which of the SEEA modules needs to be implemented.

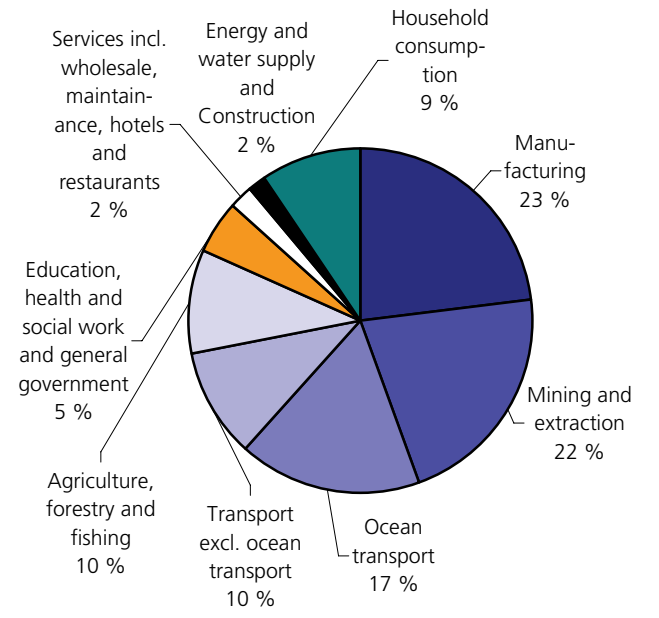
4.5. Norway's focus: Hybrid accounts and indicators

The development of environmental statistics and accounts in Norway has been described in detail earlier in the paper. Currently, the Division for Environmental Statistics is focusing primarily on the development of pollution statistics and is using limited time developing and maintaining natural resource asset accounts. Very basic asset accounts for fish and forestry are published annually in Natural Resources and the Environment (http://www.ssb.no/english/subjects/01/sa_nrm/). Our focus with regards to environmental accounting is primarily the development of hybrid accounts that combine environmental information and economic information. There is also some development of statistics regarding environmental protection expenditure in industry and in local and central government, environmental taxes and subsidies, and the environment industry (http://www.ssb.no/english/subjects/01/06/20/). Our most well developed hybrid accounts include air emissions. These hybrid accounts are also being expanded in the near future to include energy use and environmental taxes. In a longer time perspective the hybrid accounts will include solid waste, water use and chemicals. In addition to the hybrid accounts, environmental protection expenditure accounts for industry and government are also compiled regularly.

Hybrid Accounts
The key to developing economic models that include energy use and different types of air emissions (pollution) and to developing the hybrid (NAMEA = national accounts matrix including environmental accounts) accounts was the establishment of the energy statistics and the air emissions statistics according to industry breakdowns that corresponded exactly to the industry breakdowns in the economic models and the national accounts. Without the correspondence of the categories between the statistics and the economic models and the national accounts it would not have been possible to extend the economic models or produce the hybrid accounts. Since the categories did correspond it was possible to extend the general equilibrium economic models to include energy use and certain types of air emissions. The hybrid accounts were also fairly easy to establish due to the structure of the underlying statistics and now decoupling indicators are produced and published on an annual basis. The following figures show some of the results from the Norwegian hybrid accounts (additional figures and descriptions can be found at the Statistics Norway web site, see: http://www.ssb.no/english/subjects/09/01/nrmiljo_en/).

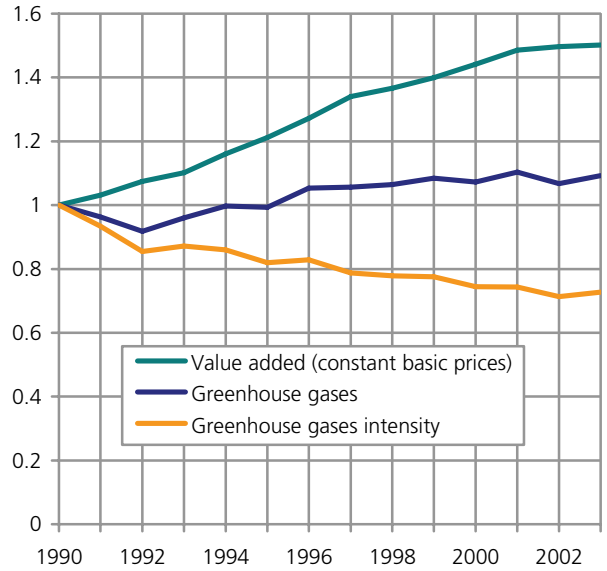
This first figure shows which economic sectors are responsible for greenhouse gases emissions (Greenhouse gases include: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and sulphur hexafluoride (SF_6). Total emissions of greenhouse gases are calculated by adding up emissions for each component given in CO_2-equivalents). This type of information can be used to help focus policy-makers' efforts along the different economic activities that contribute most to this type of pollution.

Figure 4.1. Emissions of greenhouse gases divided according to households and industries. 2003*



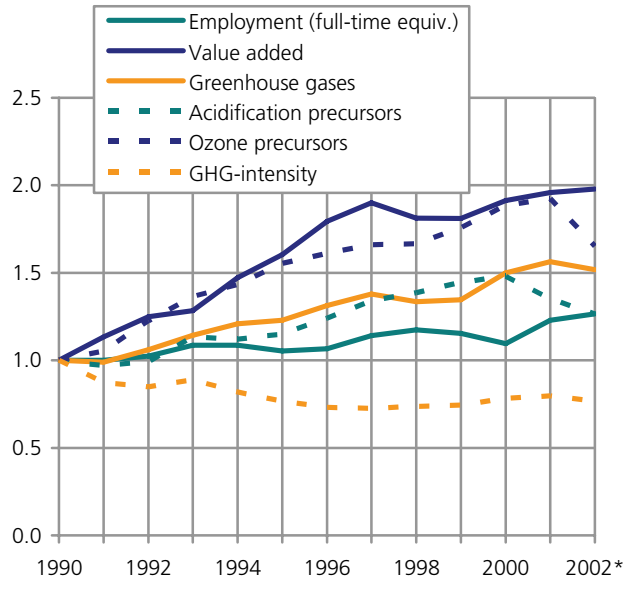
The second figure shows the development over time of total value-added, greenhouse gases, and the decoupling indicator labeled here as greenhouse gases intensity. The general downward trend in the greenhouse gases intensity indicator shows that the economy has been able to grow at a faster rate than the increase in the greenhouse gas emissions. This would be considered a desirable trend.

Figure 4.2. Value added (constant basic prices), greenhouse gases and greenhouse gases intensity. Norway excl. ocean transport. 1990-2003*[1] (Index: 1990=1)



[1] Ocean transport is excluded from calculations due to uncertainties in the emissions calculations

Figure 4.3. Economic, air emissions and GHG-intensity trends for mining and extraction of oil and gas. 1990-2002*. (Index: 1990=1)



The third figure shows the economic and air emissions trends only for the mining and extraction of oil and gas industries. The decoupling indicator shown here is again greenhouse gas intensity. This graph clearly shows that the policies that were implemented for this industry with the goal of reducing acidification precursors in 2000 and ozone precursors in 2001 were successful since the emissions for these gases show a marked downward trend starting in each of these specific years. In this case it was very easy to identify a clear connection between policy implementation and a reduction in emissions. In most cases, this is not so obvious and a decomposition analysis is required in order to identify what changes have occurred in the economy that resulted in the changes observed in the emissions patterns.

This same type of system could be developed for water emissions, water use, solid waste production, etc. Because the establishment of this kind of detailed industry-based data is time-consuming and expensive, the Ministry of Environment has requested that this type of work focus on environmental issues that the Ministry and the Norwegian Pollution Control Authority do not have close, detailed control over. The major sources of water emissions are closely monitored through the use of pollution emission permits. Because of these emission permits, developing water emissions data by detailed industry has not been made a priority since the authorities mean that they have good control over these specific types of emissions. The focus has, therefore, been on air emissions since these are widespread throughout the economy. When there are only large single point emission sources it is not a great problem to develop policies to try to control these limited emission sources. However when the problem is much more widespread throughout the economy, analytical tools and the respective statistics are needed in order to formulate and monitor policy. The priorities in the future at Statistics Norway include the development of statistics regarding the use of chemicals by all industries and households. These statistics are being developed so that they can easily be placed into hybrid types of accounts in the future.

4.6. Other international experiences

A brief summary of work being done in a number of different countries is presented below. The order of presentation is alphabetical order.

4.6.1. Australia

Work on environmental accounting in the Australian Bureau of Statistics (ABS) occurs in two departments - the National Accounts Branch and the Environment and Energy Statistics Section. The National Accounts Branch is responsible for the compilation of the Australia National Balance Sheet, which includes environmental assets. The Environment and Energy Section compiles the physical flow accounts (e.g. water and

energy) and environment protection expenditure accounts. Since water is a very important and limited natural resource in Australia, the water accounts have been a main focus and will continue to be improved in the future.
The environmental accounting in the ABS is currently limited to:

- Valuing of environmental assets on the balance sheet (see example below)
- Physical flow accounts for water
- Environment protection expenditure account for local government

Work on an energy account has been deferred until the second half of 2005, and it is highly unlikely that waste, minerals, fish, land or forest/timber accounts will be produced in the near future.

National Balance Sheet
The ABS continues to value environmental assets (London Group, 2004). The Australian national balance sheet recorded $4 190b worth of assets at 30 June 2003, of which $1 622b (39 per cent) were economic environmental assets. The value of environment assets is presented below. More detailed information is available (e.g. estimates are available for each of Australia's states).

Table 4.1. Australia's environmental assets - 30 June (billion Australian dollars)

	1995	1999	2003
Rural land	68	105	145
Other land	558	730	1,205
Oil and gas	55	72	124
Other subsoil	38	68	138
Native standing timber	2	2	3
Plantation standing timber	6	7	7
Total assets	727	984	1,622

Source: Australian System of National Accounts, 2002-03 (5204.0).

While land accounts for 83 per cent of the value of Australia's economic environmental assets, the value of rural land accounts for only 11 per cent of the total value of land (see table). Subsoil assets account for 16 per cent and timber (native and plantation) account for 1 per cent of Australia's economic environmental assets. The value of environmental assets in current prices grew strongly during the 1990s, more than doubling between 30 June 1995 and June 30 2003. Much of this growth was due to rising prices; environmental assets only grew by 6 per cent in chain volume terms during the same period.

The ABS is continuing to produce experimental estimates of GDP adjusted for the depletion and additions to environmental assets. Depletion adjustments have been made for subsoil and land assets, and in both cases these unambiguously lower the net values. If the value of discoveries is included in income in place of the value of mineral exploration, the net effect of that adjustment can be positive or negative.

4.6.2. Belgium

The work in Belgium related to environmental accounts includes NAMEA accounts for air (1990/1994-2002), for energy (1990/1994-2002) and for water (1997-1999). Environmental protection expenditure accounts and environmental tax accounts have been developed for 1997-2002. Forest asset accounts are made for 1999-2001.

4.6.3. Canada

At statistics Canada, the following environmental accounts modules are updated annually or biennially:

- Asset accounts for oil, gas, minerals and timber (physical and monetary).
  Data series cover generally the period 1976-2001. Work is under way to bring diamonds and offshore crude oil and gas extractions into the subsoil accounts.
- Energy use (1990-2000)
- Greenhouse gas emissions (1990-2000)
- Environmental protection expenditures (biennial; up to 2002)

Data for energy use and GHG emissions are presented for over 100 industries plus a wide array of household and government activities. Planning on increasing the timeliness of these accounts has started (from four to two years behind the reference year).

All asset accounts data are available electronically through Statistics Canada's socio-economic database (CANSIM). Data on environmental protection expenditures are available in the form of electronic reports while data for energy use and GHG emissions have been published irregularly at this point in time.

Irregularly updated accounts:

- • Water extraction and use (latest year 1996)
- • Land cover and use

Recent Projects
National Balance Sheets – For the first time in 2004, the value of natural resource assets (energy, mineral and resources) has been included in the National Balance Sheets Accounts. Annually, national wealth advanced 4.9 per cent without natural resources – 7.1 per cent if the increase in the value of natural resources is included. The value of energy resource assets accounts for more than 50 per cent of the resource wealth in 2003.

Land Accounts – Work is progressing in three areas: 1) analysis of the amount and growth patterns of urban areas in Canada and their impact on other land uses, including wildlife habitat and agriculture; 2) development of a Canadian land cover change matrix covering the years 1990, 1995 and 2000 using guidelines as established by SEEA; and 3) analysis and production of

various urban indicators related to urban transportation, land use mix and growth.

4.6.4. Denmark

Statistics Denmark regularly publishes the following environmental accounts:

- Energy supply and use
- Emissions to air
- Water extraction and use
- Environmental taxes and subsidies
- Asset accounts for oil and gas

Published data can be found in the StatBank section of Statistics Denmark's web site under the subject area, "environment and energy" and then using the link for "environment and economic activity" (http://www.statbank.dk/statbank5a/default.asp?w=1024).
New areas of work include asset accounts for forests and valuation of land. In addition, there are annual publications of the Danish input output tables (*Danish Input-Output Tables and Analyses - Imports, Employment and Environment*. The publication is available in paper as well as in PDF-format and can be purchased online from Statistics Denmark, http://www.dst.dk/publikation.aspx?cid=7594). The publication contains input-output tables combined with tables on the economy and with tables on air emissions and the use of energy. The publication presents data broken down by 130 industries and households as well as analytical results showing indirect flows (in Denmark and Global), causing final demands and different types of causing private consumption. The publication also shows the Danish NAMEA-table (NAMEA = national accounts matrix including environmental accounts), which summarizes the Danish environmental accounts.

4.6.5. Finland

Forest asset accounts have been developed as a part of asset accounts in the National Accounts. For monetary valuation of forest land and timber assets and flows, proper methods applicable for forest accounting and national accounting will be chosen and further developed as a close co-operation between environmental accountants, national accountants and the Finnish Forest Research Institute.

A comprehensive presentation of the framework of physical input-output tables and actual tables by branches of industry (according to the NACE classification) has been prepared by Thule Institute of University of Oulu. Analyses based on those tables were done especially for waste flows, material flows of combustion including emissions to air, household consumption, capital formation and total material flows of the Finnish economy.

Statistics on environmental protection expenditures, environmental taxation, total material requirement, forest assets and flows of wood material, waste flows and air emissions have been published in the annual Environment Statistics -compendium and Environment and Natural Resources -review.

4.6.6. France

The environmental accounts which are most developed in France are the environmental protection expenditure accounts. The SERIEE framework is used and they are published every year in a report and presented to the Commission of Accounts and Economy of Environment, chaired by the Minister of Environment.

Although these monetary accounts have been produced for many years, they need to be improved in different ways:

- All the domains (according to CEPA) are not yet covered: soil and groundwater are the main missing domains. According to the large nuclear energy production in France, the elaboration of nuclear waste management accounts was a priority. In addition to the environmental protection expenditure accounts some specifically environment-related accounts have been established for water abstraction and recycling.
- Improving the estimation methods being used has led to the revision of the air, noise and biodiversity accounts. In addition, new sources of data are being explored. For instance, they prepare a survey to ask the motorway firms how much they spend for reducing noise and protecting biodiversity and landscape.
- Finally, plans to expand the wastewater account to include basin level information will help provide information needed for they knew European water directive.

Progress is also being made in linking physical and monetary data. Published regularly are results on natural resource accounts for forest, with wooded land and forest products, and subsoil assets. The NAMEA matrix is also an analysis format used for air emissions. With regards to physical accounts, the focus has been on the development of water and water emissions accounts.

4.6.7. Germany

The German Federal Statistical Office has implemented a large number of the main modules of the SEEA system. A great deal of emphasis has been placed on the physical flow accounts. The following provides a brief description of each of the different modules.
Physical Flow Accounts

Energy and air emissions
The data of the German Environmental Economic Accounting (GEEA) on energy and air emissions in a NAMEA-type (NAMEA = national accounts matrix

including environmental accounts) breakdown are updated annually.

Physical Input-Output-Tables (PIOT)
Physical Input-Output-Tables (PIOT) were set up for Germany for the year 1995. The PIOT describe the flows of materials and energy within the economic system and between the economic system and the natural environment, including changes in the natural environment caused by human activities like using natural assets as source of raw materials and as sink for residuals. The PIOT consist of input-tables to show which sectors use which materials or pick up materials, of output-tables to show which sectors produce goods or give away materials and of material-integration-tables (Input-Output Tables) which show the material flows between the branches. The flows are measured in tonnes.

Water and wastewater
In the project "Environmental Accounts for Water and Waste Water (1991-1998)" data for water and wastewater are presented in a NAMEA-type breakdown. Water and wastewater data were calculated using an estimation method for those years for which no primary data are available. By another estimation model some important wastewater emissions were also worked out. Recently the data on water and wastewater flows have been updated until 2001.

Economy-wide material flow accounts
The data on the economy-wide material flow accounts are updated annually. In March 2004 a methodological revision of the German economy-wide material flow accounts from 1991 to 2001 on basis of Eurostat-Handbook "Economy-wide material flow accounts and derived indicators – A methodological guide", has been concluded. This project also yielded data on the supply and use of primary materials (raw materials and imports) in a NAMEA-type breakdown for the period 1993 to 2000.

Land Accounts
Work on land accounting continued by supplementing the previous concepts of area use by branches of production by a much more detailed NAMEA-type breakdown of the land use category of built-up and traffic area and by the implementation of a first methodological approach to address the land use category of agricultural land.

Environmental protection expenditure accounting
The data on environmental protection expenditure are updated annually. A methodological revision and a more comprehensive coverage on the basis of the SERIEE concept have been recently finished. Environment-related taxes are also published annually. Taxes related to transport are available in a NAMEA-type breakdown with about 2 year time lag.

Sectoral Reporting modules
In late 2001 GEEA started with the concept of integrating so-called sectoral reporting modules into the accounting framework. They are restricted to a specific sector of economic activities each (e.g. agriculture, transport, private households) and try to set up - as far as possible - the complete system of environmental-economic accounts for the sector examined. As such these sectoral reporting modules respond to the need to integrate environmental aspects into sectoral policy. The project on transport and environment provides among other things data for the transport sector in a NAMEA-type breakdown for a number of variables like energy use, emissions, land use, tonnes and person kilometers and environmental taxes. A project on "agriculture and environment" (in collaboration with the Federal Agricultural Research centre) is under way. In the project the agricultural sector is distinguished by different agricultural production processes for which economic data, data on special material and energy flows and intensity indicators are presented. For the sector private households a project "private households and environment" was started to examine this specific sector according to its environmental impact.
Applications/methodological work

National Strategy for Sustainable Development
The National Strategy for Sustainable Development of the federal government was adopted in 2002 (http://www.dialog-nachhaltigkeit.de). The indicator set is comprised of 21 indicators selected to measure progress towards sustainable development A paper of the GEEA department on "The Role of the National Accounts and its Satellite Systems for the German National Strategy for Sustainable Development" (http://www.destatis.de/download/e/ugr/sustainable.pdf) describes which contributions accounting systems can make to underlay the sustainability indicators with supplementary information in order to provide a data basis for an integrated sustainability analysis.

Decomposition analysis
A second focus of applications of the accounting data is to analyze the observed changes in, e.g. emissions, within a certain period by means of a structural decomposition method. The paper "Decomposition analysis of carbon dioxide emissions changes in Germany – Conceptual framework and empirical results" describes the theoretical background of this analytical tool and shows different methodological approaches before focusing on the method applied in German Environmental-Economic Accounting. The approach chosen is based on a method applied by Statistics Netherlands but is extended to be applicable to more general cases. (Available at: http://www.destatis.de/download/d/veroe/fach_voe/dekomposition.pdf)

Annual GEEA-reports and other publications

GEEA publishes annually a “Report of the German Environmental-Economic Accounts” with analysis and detailed tables. The reports show in a standardized way the complete picture of German environmental economic accounts. The report about the yearly press conference on GEEA, which highlights different issues every year, is available in English: http://www.destatis.de/allg/e/veroe/e_ugr02.htm. Other publications regarding the German environmental-economic accounting can be found at: http://www.destatis.de/allg/e/veroe/proser4senv_e.htm

Modelling
During the last years the data of the GEEA have been used in a growing number of econometric modelling projects by research institutes, mainly on the basis of the PANTA RHEI model. Examples are scenarios in the fields of energy use, carbon dioxide emissions, land use and transport.

4.6.8. India

Environmental accounting work began in 1991 and the first policy document was produced in 1993. The work is organized as cooperative projects between research institutes, such as the Integrated Research and Action for Developoment (IRADe), and the Central Statistical Organization (CSO). Areas of work have included estimating the annual cost of environmental degradation, environmentally adjusted net income, health costs from air and water pollution and air emissions from industry and households. Asset accounts for forestry have been the focus of other work. Natural resource accounting based on SEEA definitions, including waste and wastewater accounts, have been developed for the Goa region. Survey methodologies have been used to a large extent in establishing the data for the Goa work. Work on energy use and availability has also been the focus of a number of studies. Very often studies are made which focus on a specific geographic area and are not necessarily covering the whole country.

4.6.9. Indonesia

From the mid-1980s to the mid-1990s a number of project based empirical exercises have been made in Indonesia including the classic study by Repetto et al. (1989). In 1990 the Ministry of the Environment, the National Bureau of Statisitcs and CIDA established natural resource accounts for 3 commodities: forests, fuels and natural gas. Between 1993 and 2003 NBS has continued this work and expanded the asset accounts to now cover 8 commodities. In 2002 the National Development Planning Agency calculated a "green GDP" by including degradation factors in the calculations and in 2004 the Ministry of Environment made a study regarding "semi-green regional GDP" for the Krawang District (West Java Province).

The accounts are being used in the development of certain policies, for example, the implementation of wastewater discharge fees to internalise these externalities, maintaining optimal resource extraction paths, regulating property rights, royalties and concessions and natural resource management policies.

The development of the accounts has shown the need to strengthen the coordination among institutions, both in regards to data collection but also in terms of policy development and implementation. The key players include the National Bureau of Statistics (BPS) (responsible for: national statistics including the natural resource and environment statistics and SEEA), the Ministry of Environment (KLH) (responsible for: environmental quality standards, economic valuation of environmental impacts), the National Coordination Agency for Survey and Mapping (responsible for: physical and spatial data), National Development Planning Agency (responsible for: integrating green accounting principles into planning processes), Technology Research and Implementation Agency (responsible for: developing technology to better manage natural resources, carry-out research of green accounting), and universities/research centers (responsible for: carry-out research of green accounting, provide training on green accounting).

There are plans to produce a "green GDP" however the purpose of the green accounting in Indonesia is not to show a specific "green GDP" figure that is lower than the GDP but to understand the rate of resource depletion and environmental degradation.

4.6.10. Italy

After several years of methodological and experimental work, aimed at building the knowledge basis and the datasets required for the implementation of selected environmental accounts (EA) in Italy, this work is currently undergoing a phase of consolidation of production. In particular, time series of data have been published or are about to be published and data collection and elaboration processes are being organized in a way suited to ensure regular and timely production of the main current products of the Italian EA. The National Statistics Institute for (Istat) Italy is responsible for the development of the environmental accounts.
The following provides a brief summary of the current focuses for the environmental accounts work it at Istat:

- improve consistency with the European Strategy for Environmental Accounting and with the Italian Environmental Action Strategy for Sustainable Development;
- implementation of Economy-wide Material Flow Accounting, NAMEA and environmental protection expenditure accounts (EPEA) modules;
- dissemination of figures through the Istat web site and through contributions to the Istat environment statistics compendium and to the Report on the

State of the Environment addressed to the Parliament by the Ministry of the Environment;
- support the experimental work aimed at integrating environmental and economic issues in public planning.

Economy-wide material flow accounting
In the first half of 2004, the economy-wide material flow accounts and related indicators already made available in 2003 for the 1980-1998 period have been updated up to 2001. These indicators are now being calculated for 2002. A study of the feasibility of a Physical Input/Output Table (PIOT) of the Italian economy has been finalized in 2004.

NAMEA - air emissions (NAMEA = national accounts matrix including environmental accounts)
A time series of NAMEA-air tables has been recently completed, covering all years from 1990 to 2000. The coverage of air emission accounts for Italy has been enlarged in terms of pollutants: these now include ten air pollutants, namely CO_2, SO_x, NO_x, N_2O, NH_3, CH_4, CO, NMVOCs, PM_{10} and Pb (the latter two were not included before). The methodologies used for emission allocation to activities have been revised and improved through work of a Working Group of experts from Istat, the Agency for Environment Protection and Technical Services (APAT) as well as the Ministry of Productive Activities. E.g. emissions now refer to resident units, rather than to the Italian territory.

Besides air emissions, the data have been published for the direct intake from nature by economic activity of four resources: endogenous steam, fossil fuels, minerals, and biotic materials, providing a split by directly extracting activity of the MFA aggregate "Used domestic extraction". In the tables, emissions and resource intake data are linked to households' expenditure (by purpose) and to economic and social variables broken down by economic activity (production, value added, intermediate consumption; employment in full-time jobs and thousand persons). Finally, an ad-hoc joint Working Group set-up with a local research Institute is about to finalize NAMEA-type air emission and resource intake accounts for the region of Tuscany for 2000.

Environmental protection expenditure account (EPEA)
The available information basis is still not sufficient for a complete implementation of the EPEA. While working for the development of this basis, by studying sources and gathering data, the Institute works at the production of statistics on Environmental Protection Expenditure of the public and business sectors and at the partial implementation of the EPEA for selected environmental domains. New results statistics for the Central Government and the business sector have been recently published.

As far as the Central Government is concerned, a time series of environmental protection expenditure aggregates consistent with the EPEA schemes has been calculated for the 1995-2002 period. Some additional aggregates relating to important environment-related activities, not entirely covered by the EPEA – such as management and protection of soil, sea and coastal zones – have also been calculated for the same period. As far as the business sector is concerned, EPE data coherent with the EPEA and disaggregated by environmental domain according to the CEPA are now being regularly collected through the annual surveys on business economic accounts.

As far as future developments are concerned, projects are being started for the construction of a time series of the EPEA tables for the wastewater and waste management domains and for a complete SERIEE system of accounts for the water domain (i.e. including also the Resource Use and Management module of the system).

4.6.11. Japan
In 1991, several governmental research institutes in cooperation with researchers in universities started an inter-agency research project on environmental accounting and indicators in Japan. The National Institute for Environmental Studies (NIES) takes a leadership role in organizing the project and has focused on environmental accounting in physical terms. The Economic Planning Agency (EPA) of the Government of Japan compiles the national economic accounts and has been developing the economic portions of the environmental accounts.

The system of integrated environmental and economic accounting was implemented on a trial basis using the years 1985 and 1990. An environmentally adjusted domestic product (EDP) was calculated from these integrated accounts (Oda, et al., 1998). Although this work was done it is unclear whether these calculations continue to be made.

The next area that was focused on included environmental protection expenditures. Then the development of the NAMEA system was incorporated to try and provide a framework for organizing and connecting all of the physical and economic data that was being developed. Current efforts are focusing especially on material flow accounts and material cycles in society (Ariyoshi and Moriguchi 2004).
There is an annual white paper issued on the state of environment in Japan, which is available in English (http://www.env.go.jp/en/w-paper/index.html). Guidelines for environmental accounting for businesses have also been recently published. The government is encouraging enterprises to start environmental accounting within their organizations to try to strengthen their environment management and performance.

4.6.12. Korea

Korea is just starting to develop their environmental accounting systems. A plan to focus on physical input output tables, environmental protection expenditure accounts and certain physical environmental asset accounts. The development of integrated environmental and economic accounts will be a co-operation between the Korea National Statistics Office and the Bank of Korea.

4.6.13. Mexico

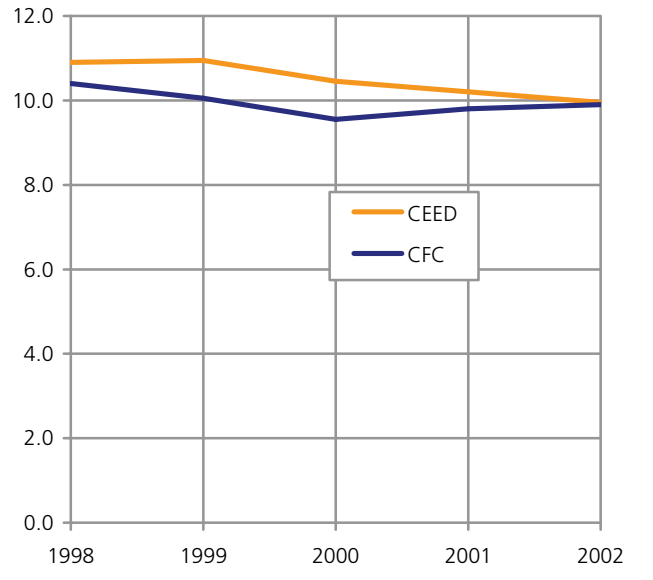
The System of Economic and Ecological Accounts, Mexico (SEEAM) is a project that includes information about variables from the System of National Accounts with data about natural resources, and specifically petroleum, water, air and land. From this system, a synthesis indicator called Net Ecological Domestic Product (NEDP) is obtained from GDP less consumption of fixed capital and attributed costs by environmental use. The attributed costs by environmental use represent natural resource depletion and environmental degradation.

The focus of the current work includes:

- identifying new ways of valuation to improve the presented statistics,
- expanding the coverage, which will allow the monitoring of economic pressure on natural resources,
- developing regional information that supports decision-making at the local level.

The work on integrated environmental and economic accounting in Mexico has been an ongoing project since the early 1990s.

Figure 4.4. Participation of natural resources, depreciations in the GDP, 1997-2002 average (in millions of current pesos)



CEED = costs for environmental depletion and degradation
CFC = consumption of fixed capital
Source: London group, 2004

4.6.14. The Netherlands

The Netherlands has primarily used the hybrid or NAMEA (national accounts matrix including environmental accounts) accounts approach to organizing their environmental accounts. Their NAMEA matrices have been systematically expanded to include more and more data as it has become available. Their extensive set of environmental statistics and accounts are further coordinated and balancing entries are made when the data are placed into their symmetric NAMEA accounting system. Air emissions data, water emissions data, environmental costs, different indicators, and selected asset accounts are all part of their matrix system. The Netherlands focuses much of their work on different types of pollution information and the related costs to managing and reducing pollution. In addition, they have extensive information regarding the management of water, both freshwater and seawater. Recently the energy accounts have been modified so that they are fully compatible with the national accounts.

4.6.15. New Zealand

Statistics New Zealand is concentrating on developing resource accounts for energy and water. Forestry accounts, including physical stock and flow accounts and monetary flows are also published. Initial work for fish, including both physical and monetary accounts, has been completed. Based on the experiences gained, only the monetary stock account for fish will be continued in the future.

Environmental protection expenditure accounts are currently being developed. The New Zealand tax department is proposing tax breaks for "environmentally beneficial" expenditure and is particularly interested in the new environmental protection expenditure accounts.

4.6.16. Philippines

Environmental accounting in the Philippines had its beginnings in 1991 through the USAID funded Environmental and Natural Resources Accounting project (ENRAP) using Peskin-based framework and definitions. The focus was on accounting for the depletion of various forest resources and then on account for environmental and natural resource services. The project had three phases and ended in 2000.

In 1995 an environmental and natural resource accounting (ENRA) project was started under the auspices of the United Nation's Development Programme's (UNDP) Country Programme on Integrated Environmental Management for Sustainable Developoment (IEMSD) using the SEEA framework and definitions. The National Statistical Coordination Board (NSCB) was the lead institute in the ENRA project. The ENRA project used some of the earlier work done under the ENRAP project, especially some of the ENRAP-established databases, to successfully compile five asset accounts, forest, fishery, minerals, land and soil and water resources. Environ-

mental degradation accounts brought about by economic activities like agriculture, fisheries, forestry, certain types of manufacturing, and mining. Environmental protection services of the government and private sectors were also included in the project.

A significant milestone for this work was the signing on March 21, 1997 of Executive Order No. 406, which institutionalized the Philippine Economic-Environmental and Natural Resources Accounting (PEENRA) System in the country and created environmental accounting units in the National Economic Development Authority (NEDA), the Department of Environment and Natural Resources (DENR) and the National Statistical Coordination Board (NSCB). In addition to establishing asset accounts at the national level, accounts are being established for some natural resources at the regional and at the province level.

The national level asset accounts include: physical and monetary estimates for agriculture land (1988-1998), physical estimates for forest land (1988-1998), physical and monetary estimates for metallic minerals (gold, copper, 1988-1996) and for non-metallic minerals (chromites, 1988-1996 and coal 1988-1998), physical estimates for water demand (1994-1998), physical and monetary estimates for plantation forest and for rattan (1988-1998), physical estimates for marine fishery (1995-1999) and freshwater fishery (1988-1999). National level activity accounts include: physical and monetary estimates for the poultry industry (1988-1998), upland palay farming (1995-1999), intensive shrimp aquaculture (1995-1999), the hog industry (1995-1999), physical estimates for coal energy (1988-1998) and electricity generation (1996-1998), physical and monetary estimates for the paint industry (1988-1998), the tuna industry (1994-1998), the sugar industry (1994-1998), the cement industry (1994-1998) and the petroleum industry (1994-1998). And finally, environmental protection expenditure estimates have been developed for the government and private sectors (1994-1998).

Calculations of environmentally adjusted net domestic product are the results of project-based work. These calculation are not considered official statistics and are not calculated on a regular basis.

4.6.17. South Africa

The National Accounts division in Statistics South Africa is responsible for the compilation of the natural resource accounts, which are satellite accounts to the national accounts. The natural resource accounts include water, minerals, land, and energy use. The water accounts include physical accounts for 19 water management areas. The mineral accounts contain physical and monetary accounts for gold, platinum and coal. The water and mineral accounts are official statistics and are published on a regular basis.

4.6.18. Spain

The National Statistics Institute (INE) for Spain has been responsible for developing the Spanish environmental accounts. The surveys on water, waste and environmental protection expenditure are the main statistical basis on which the environmental accounts have been constructed. Currently, the INE as published the following accounts: water accounts 1997-2001; air emission accounts, 1995-2000; environmental protection expenditure accounts 1995-2001; material flow accounts, 1996-2000; forest timber accounts, 1995-2000. At the present time, development work is focusing on the waste and energy accounts. In the future developing information at the territorial levels below the national level is considered an important goal.

4.6.19. Sweden

In the Swedish system of environmental and economic accounts the environmental pressure is viewed from a production and consumption activities perspective. Connected to this perspective, environmental indicators for industries, public authorities and households are developed. The data from the environmental accounts system forms an important basis for analysis of the national environmental quality objectives, and particularly for driving force indicators and economic instruments.

Data published annually broken down by industry include: energy use, chemical use, air emissions, value-added taxes, subsidies and statistics covering the environmental goods and services industry. Also generated annually are environmental accounts input-output tables. These input-output tables can be used for analyses of decoupling patterns, for calculating environmental pressures broken down by product group or by household types and also environmental pressures arising from trade. In recent years introducing the social dimension into the environmental accounts has been attempted by including different types of social statistics broken down by industry.

During 2003 the National Institute of Economic Research (NIER) developed a method (Gren, 2003) used to calculate the value of changes in natural capital and sustainable use of natural capital for Sweden. The starting point for estimation is the natural capitals production of ecosystem services. Given that monetary estimates are available for these services, it is possible to calculate the value of changes in ecosystem service provision. This is calculated as the discounted value of changes in future ecosystem services from the capital stock. The calculated value takes into account the ecosystems impact on the welfare of future generations and is defined as a natural capital accounting price. Empirically, the method has been applied to four kinds of natural capital; forest, agricultural landscape, wetlands and urban environment. The analysis has been extended to a ten-year period (Gren and Svensson, 2004).

A theoretical model for including health problems from air pollution into the environmental accounts has also been developed at NIER (Huhtala and Samakovlis, 2003). The model includes a production externality in the form of air pollution, which causes both direct discomfort and indirect health effects through its impact on the productivity of the labor force. The results show that the valuation of discomfort should be included in the environmental accounts.

4.6.20. United Kingdom

There are two institutions in the United Kingdom with the responsibility for implementation of the different parts of the environmental and economic accounts. The Office for National Statistics (ONS) has the responsibility for coordinating and the biannual reporting of natural resource accounts, physical flow accounts and monetary accounts. The Department for Environment, Food and Rural Affairs (DEFRA) has the responsibility for developing decoupling indicators and using the data from the environmental accounts for policy and public communication purposes. In addition, DEFRA has the responsibility for environmental accounts for agriculture.

The following information about the UK environmental accounts is taken from the December 2005 Environmental Accounts publication found at:
http://www.statistics.gov.uk/pdfdir/ea1105.pdf

UK Environmental Accounts look to provide information on the demands that UK economic activity places on the environment (in particular in the form of emissions of pollutants) and on the importance of natural resources to the economy. The information has been separated into three dimensions:

Natural resources

- Oil and gas extraction and reserves - providing information in physical and monetary terms
- Land cover - reporting on the amount and condition of habitats and landscapes in Great Britain
- Forestry - providing information on woodland area, diversity and consumption of wood products in Great Britain
- Fishing - giving information on selected catches and stocks in three sea regions

Physical flows

- Fossil fuel and energy consumption - a breakdown of fossil fuel use and energy consumption by industry
- Atmospheric emissions - a breakdown of greenhouse gas and acid rain precursor emissions by industry
- Material flows - presents information on the total mass of natural resources and products that are used by the UK
- Waste - estimating the total waste arising in the UK, including information on radioactive waste
- Water - showing amounts of ground water and non-tidal surface water used by UK industry

Monetary

- Environmental taxes - information on government revenue from environmental taxes
- Environmental protection expenditure - a breakdown of environmental protection expenditure by general government and UK industry
- UK environmental accounts are used to inform sustainable development policy, to model impacts of fiscal or monetary measures and to evaluate the environmental impacts of different sectors of the economy. Most data are provided in units of physical measurement (mass or volume), although some are in monetary units, where this is the most relevant or the only data available.

4.6.21. United States of America

The extent of the development of environmental accounts in the United States is not easy to evaluate. Although the USA participates in the London group, current information regarding environmental accounts in the USA has not been provided at the last London group meeting or any of the more recent OECD meetings. The OECD has recently carried out an environmental performance review and the report will be published in early 2006.

Due to the lack of information regarding environmental accounting, the following information regarding environmental and economic data is being presented instead.

The *Bureau of Economic Analysis* (BEA) (www.bea.gov) has primary responsibility for the preparation, development, and interpretation of the National Income and Product Accounts. BEA programs include the Gross Domestic Product (GDP); the wealth accounts, which show the business and other components of national wealth; the input-output accounts, which trace the interrelationships among industrial markets; personal income and related economic series by geographic area; and the U.S. balance of payments accounts and associated foreign investment accounts.

There are a large number of organizations involved in compiling environmental data. The following is a brief description of these different data sources.

The *Environmental Protection Agency* (www.epa.gov) monitors the quality of the air; the quality of drinking, surface and ground water; ecosystem status; and the introduction of toxic or hazardous substances into the environment. It conducts research and studies to provide baseline data and to evaluate and support environmental monitoring systems.

National Oceanic and Atmospheric Administration (www.noaa.gov) (NOAA) gathers worldwide environ-

mental data about the ocean, earth, air, space, and sun and their interactions to describe and predict the state of the physical environment. NOAA also maintains a national environmental data base, in which the agency's data are combined with selected environmental information collected by other agencies in support of their respective missions.

National Marine Fisheries Service (http://www.nmfs.noaa.gov/) (NMFS) in NOAA focuses on domestic commercial and recreational fisheries, fishery management monitoring, and stock assessments of the health of living marine resources. NMFS is responsible for such data as the volume and value of commercial fish and shellfish landings; the catch by recreational fishermen; employment of people and craft in the fisheries; number of recreational fishermen; production of manufactured fishery products; and fishery prices.

United States Geological Survey (www.usgs.gov) (USGS) collects information on nonfuel minerals and materials, including mineral resources, production, demand, use, recycling, and trade; maintains the Mineral Resource Data System, which contains information on the location and geologic occurrence of mines and mineral deposits; maintains the National Geochemical Data Base, for hydrogeochemical and stream sediment analyses, based on the National Uranium Resource Evaluation; maintains computer-based information systems of oil and gas resources -- an areal data file on size of oil and gas pools and fields, year of discovery, and rate of production and a point-source data file on individual wells; and operates the National Coal Resources Data System, which provides information on location, distribution, quality, chemical content, and availability of coal.

USGS, through its Water Resources Division (http://water.usgs.gov/), collects and maintains data on the quality, availability and use of the Nation's water, including streamflow data for hydropower plants, groundwater subsistence, erosion, backwater, flooding, water contamination, and sedimentation.

USGS' Biological Resources Division (http://biology.usgs.gov/index.html) (BRD) collects and analyzes data on birds and fish to determine trends in environmental contamination, tracks species and their habitats, and studies migratory game and non-game birds. Data from the annual breeding bird survey are used to identify species whose populations are declining and which may eventually become candidates for listing under the Endangered Species Act.
Forest Service (www.fs.fed.us) (FS) conducts renewable resource inventories of forest lands and collects statistics on forest products. These data are used to identify trends in the extent, condition, ownership, and quantity and quality of timber and other natural resources.

Natural Resources Conservation Service (http://www.nrcs.usda.gov/) (NRCS) in the Department of Agriculture conducts soil surveys and maintains and updates a national soils data base containing physical land facts; administers Water Supply and Snow Surveys used in water supply forecasts to manage seasonal use of water for irrigation, flood control, fish and wildlife, recreation, power generation, municipal and industrial water supply, and water quality management; and conducts a national resources inventory, providing data on the status and condition of natural resources of non-Federal lands.

U.S. Fish and Wildlife Service (www.fws.gov) (FWS) conducts annual surveys to monitor the fish and migratory bird populations, track diseases of cultured and wild fish, measure the changing status of waterfowl and game bird populations, and evaluate harvests by fishermen and hunters.

Energy Information Administration (www.eia.doe.gov) (EIA) collects and disseminates information on energy reserves, production, consumption, distribution, prices, technology, and related international, economic, and financial matters. Coverage of EIA's programs includes data on coal, petroleum, natural gas, electric, and nuclear energy.

Minerals Management Service (www.mms.gov) (MMS) collects data on off-shore and Federal and American Indian oil, gas, and minerals, as part of its responsibility for management of both the Outer Continental Shelf Lands and the Royalty Management Programs. The MMS is responsible for resource evaluation and classification, lease management activities, and the collection of revenues from minerals leasing.

4.7. Summary

This review of international experiences concerning the implementation of the different modules of the SEEA shows a wide variation among the countries. Some countries have taken a focused approach, where as others have used the SEEA as a framework for structuring both data and the development of indicators which are used in managing the natural resources. Different modules are implemented in order to establish and maintain good information regarding the environment and the associated economic activity. Each country implementing portions of the SEEA evaluates their national needs in terms of the information needed for managing natural resource assets, physical material flows and pollution, costs of environmental protection, and the development of related indicators and implements the corresponding SEEA module. No country has fully implemented the entire SEEA and, with the exception of perhaps Mexico, no country regularly publishes officially adjusted SNA aggregates.

5. Chinese experiences with green accounts and green GDP

The Division of Resources-Environmental Accounting was established in 1996 by NBS in the Department of National Accounts. The division started research and practice of SEEA since then. In the most recent couple of years, the Chinese government put forward a scientific approach to development according to the pressure of resources and environment caused by the rapid development of the economy. At present, it is just the beginning for NBS to work on resources and environmental accounting; there are still big gaps when compared with SEEA standards and developed countries.

5.1. Situation of green national accounting carried out in China

5.1.1. Bringing resources and environmental accounting into Chinese national accounts

In the Chinese System of National Accounts that is newly established in a 2002 version, physical accounting tables including land, forest, mineral and water resource and accounting scheme are established as satellite accounts. We have tried to compile national physical stock accounts of land, forest, mineral and water resources for the year 2000 with the help of the Ministry of Land and Resources, Ministry of Water Resources and Ministry of Forest. Since these accounts were compiled before the publication of SEEA-2003, there are still many areas that need to be improved.

5.1.2. Translation and transmission of international literatures

We have organized the translation and publication of SEEA-2003, SEEA-2000, Manual for Environmental and Economic Accounts for Forest: a tool for cross-sectoral policy analysis by FAO, and the European Framework for Integrated Environmental and Economic Accounting for Forests by IEEAF (2002 Edition). The publication of these manuals provides important theoretical and practical foundation to Chinese accountants in their work.

5.1.3. Compilation of energy accounts and inventory of air emission

From 1998 to 2002, a cooperation project Sino-Norwegian Project on Environment Statistics and Analysis has been carried out by NBS and Statistics Norway. During this cooperation, NBS has compiled Energy Accounts for the year 1987, 1995, and 1997. By using Input-Output Tables and Energy Statistics as data sources. The Energy Accounts include 33 sectors, urban and rural households, and 25 energy carriers. The Energy Accounts consist of Energy Balance Table, Energy Supply Table, Energy Demand Table, and Energy Final Use Table.

In the Energy Accounts, 33 sectors include manufacturing industry, which includes 24 industries, construction, freight transport and communication, commerce, restaurants, passenger transport, public utilities and services to households, etc. Energy carriers include solid energy (e.g. coal, waste, etc.), gaseous energy (e.g. natural gas), liquid energy (e.g. crude oil, gasoline), and bio-energy (e.g. crop residuals, biogas). These Energy Accounts reflect changes and development trends in energy production, consumption and utilization in China during the decade 1987-1997.

Based on the Energy Accounts, NBS has estimated air emission inventories of eight kinds of pollutants (CO_2, CH_4, N_2O, SO_2, NOX, NMVOC, PM_{10}, Pb). After that, NBS has forecasted the trend of energy use and air emissions for next two decades by using a CGE model. The estimation results show that China is one of the countries with a high level of greenhouse gas emissions. However, the average level of air pollutant emissions especially greenhouse emission per capita in China is still lower than developed countries.
At present, NBS is going to compile Energy Accounts of China for the year 2002 after the compilation of the Input-Output Table of 2002 is finished.

5.1.4. Trial work in provinces and cities

In 1998, Heilongjiang province carried out forest resources accounting in physical terms. From 2001 to 2002, Hainan province has carried out tropical forest resources accounting both in physical terms and in

monetary terms. In 2003, Chongqing municipality has carried out water resources accounting and industrial pollution accounting.

5.1.5. Forest resources accounting

NBS takes part in a corporation project on China forest resources accounting with State Forest Administration, China Academy of Forest, Beijing Forest University, and Renmin University of China. The main contents of the project include theoretical and methodological study, woodland and timber accounting in physical and monetary terms, research of biological accounting, research of Green GDP adjusted by forest resources, and research of green policy making.

The accounting scope of China forest resources includes forest and woodland in the whole country except Hong Kong, Macao and Taiwan. The data is from national forest resources statistics by national forest inventory in every five years.

Forest resources accounting in physical terms, which is the foundation of monetary accounting, is based on national forest inventory statistics and SEEA principles and methods. The accounts include accumulation of timber and area of woodland.

Forest resources accounting in monetary terms, which is valuation of timber and woodland, is based on physical accounting and investigation of timber and woodland price. The price investigation was carried out in 12 provinces.

NBS has compiled stock accounts of forest resources for the year 1999 and 2003. The accounting period is five years corresponding to national forest inventory years.

Change accounting of forest resources presents increase or decrease volume of timber and woodland during an accounting period caused by economic reason or by natural reason. NBS has compiled volume change accounts of forest resources for the period 1999 to 2003.

5.1.6. Environmental pollution accounting

NBS and SEPA cooperate together from 2004 to 2006 working on research of environmental pollution accounting. The main contents are as follows.

1. Environmental pollution accounting in physical terms. This is generation amount, elimination amount and emission amount accounting in physical terms of wastewater pollution, air pollution, industrial waste and living waste by areas and industries.
2. Regulation cost accounting of environmental pollution. This is real regulation cost and imputed regulation cost accounting of wastewater pollution, air pollution, industrial waste and living waste by areas and industries. Real regulation cost presents cost that has been paid while imputed regulation cost presents cost that will be paid to deal with pollutants emitted in environment. Information of real regulation cost is obtained from enterprises environmental protection expenditure investigation.
   Real regulation cost = elimination amount of pollutants × unit real regulation cost
   Imputed regulation cost = elimination amount of pollutants × unit real regulation cost
3. Expense accounting of environmental pollution.

5.1.7. Environmental accounting co-operation with Statistics Canada

Under the funding support from CIDA, Statistics Canada and NBS carried out an information management co-operation project since 2004. Environmental statistics and environmental accounting is one of the sub-projects. The main contents of this sub-project are:

1. Elaboration of resources and environmental accounting theory to be carried out in China and establishment of the accounting framework.
2. Evaluation of data availability from resources and environmental management sectors.
3. Confirmation of a set or sets of indicators that will be used in the accounting.
4. Implementation of trial works in one selected area.

At present the sub-project proposal is confirmed. The project will be carried out beginning in 2006.

5.1.8. Cooperation of water resources accounting with UNSD

As suggested by UNSD, China is going to carry out a research project of water resources accounting. The main contents of the project are: water resources accounting in physical terms, wastewater discharge accounting, and protection expenditure accounting of water resources, etc. At present, Haihe basin is selected to implement water resources accounting. Experts from UNSD came to China in November of 2005 to discuss project matters with NBS and the Ministry of Water Resources.

5.2. Experiences of green national accounts in China

1. It is important to study and use international methods and experiences for reference. Since the 1970s, more and more developed and developing countries pay great attention to environmental and resources accounting. So far there are more than 20 countries such as Canada, France, British, Germany, Finland, Norway, Korea, Japan, the Philippines, Indonesia, Brazil, etc. have carried out environmental and resources accounting and have obtained useful experiences. What China should do is to establish Chinese green national accounting system corresponding with not only the Chinese situation but also international standards under the help of international experts.

2. Establishment of a green national accounting system is a long-term hard work. China has just started this work and is facing many difficulties. First, we have to do allot of basic work such as theoretical study, framework establishment, data collection, etc. Secondly, methodologies for resources and environment valuation are immature. Thirdly, data collection and classification are difficult. Therefore, it will be a long period to implement green national accounting in China because of difficulties.
3. Green national accounting system should correctly reflect relationship between environmental resources and economic activities. It should not be simplified as a single indicator “Green GDP”. Green national accounting system should contain a set of data reflecting relationship between environmental resources and economic activities.
4. Implementation of SEEA in China based on the national situation should be practical.
5. Green national accounting can be implemented step by step. For instance, we can choose a specific or partial issue at first.

6. Policy Recommendations

6.1. Demand for Green GDP

In recent decades China's economy has been growing on average by more than 8 per cent per annum. On one side, this has been an obvious economic achievement; on the other side it also has resulted in many environmental problems. And China's environmental problems are getting more serious along with its economic development. From the view of environmental governance, there is a trend that the central government is hoping to keep a balance between economic development and environmental protection. However, local governments are currently paying more attention to economic development rather than environmental protection. Hence, in order to change the GDP-oriented development path at the local level, decision-makers in the central government are seeking to use new indicators to replace local GDP as a measure of the performance of local governments. Green GDP, which is supposed to integrate economic development and environmental damage costs together, is highly expected by the central government decision makers to fulfil the role as a better performance indicator for local governments. Based on these expectations there have been calls for the development of a green GDP from portions of the central government. The institutional arrangements for developing the data required for these types of calculations are being considered and some pilot projects are under development. One approach towards this goal has been to start demonstration pilot-phase studies in 10 provinces/cities in 2005 which are focusing on adjusting the GDP for environmental pollution. Although a pollution adjusted aggregate does not encompass all of the corrections necessary for green GDP, it does include some environmental aspects into that aggregate.

6.2. Barriers to the development and implementation of Green GDP

There are no reasons to doubt the need for an indicator like green GDP. However, from the supply side, there are many problems associated with the development of such an indicator. Here, we identify 3 kinds of barriers.

6.2.1. Methodological and theoretical barriers

When calculating green GDP, because of the common property characteristics of natural resources and environmental quality, there are normally no prices on such products. Determining the pricing of such common property goods and services is thus a challenge.

There are at least 3 methods available to determine prices for natural resources and environmental degradation which can be used when making adjustments to arrive at a green GDP. The so-called prevention cost method is based on a calculation of how much it would cost to prevent the environmental damage in advance. The damage cost method is based on an estimation of the costs emerging from environmental damages. Finally, willingness-to-pay (WTP) method is based on surveys of the willingness of environmental consumers to pay in order to prevent environmental damages. Alternatively, one could use estimates of the willingness to accept such damages.

Depletion of cultivated biological assets, such as livestock and cultivated plants, are included in the national accounts. However, the depletion of non-cultivated biological resources, land and sub-soil deposits are not currently included in the national accounts or in the national accounts aggregates. In order to make a comprehensive calculation of green GDP, values for depletion of natural resources would also need to be included. Calculating the values of the depletion of these types of natural resources can also be done using a number of calculation assumptions and methodologies.

The problem is that for each of the methods used for calculating degradation and depletion, the answer will generally be quite different, resulting in very different estimates of a green GDP. There is no unique or correct answer to the question of what is the value of green GDP.

There is also a potential double accounting problem since some of the prevention and damage costs are already included in the "ordinary" GDP number. These components will have to be carefully identified and

corrected for when estimating the green GDP value, in order to avoid double counting.

When making green GDP, the most challenging problem is the uncertainties regarding estimation results due to different methods, different scope, pricing system and data. And, when there are multiple estimation results, it is difficult to make judgments as to which result should be chosen. In principle, the accounting result should be unique.

6.2.2. Uncertainties of scope

There are also several difficulties stemming from uncertainties of the scope of the green GDP indicator in terms of geographical extent, time period covered, and actual content of the corrections to be undertaken.
Spatial scope: When estimating green GDP, it may sometimes be difficult to determine in what geographical region the various adjustments to GDP belong. Mr. Li Desshui, the former Director of NBS, raised the question of where the water damage costs resulting from upstream Huihe River provinces should be located. Should they go into the green GDP account of damaged downstream provinces or should they be put into the accounts of upstream provinces where the damage came from? This question is clearly linked to the question of whether one should rely on estimates of protection costs (upstream) or damage costs (downstream).

Time scope: Some of the environmental damages or costs of resource extraction could happen long after the economic benefit of the activities are accounted. The problem then is to determine into which time period the estimates of green GDP should be related. How to reflect the future environmental costs with their uncertainties into the present value of green GDP is also a technical problem.

Contents scope: Determining the number and types of environmental effects to take into account in a green GDP is also a non-trivial problem.

6.2.3. Information barriers

So far, there is a lack of reliable data and information related to calculations of prevention and damage costs. For instance, some necessary information for damage cost estimates, such as mortality and morbidity due to air pollution, are lacking due to missing health statistics.

Also, there are few first hand Dose-Response (D-R) functions based on Chinese realities. Most of them are from other countries that may or may not be suitable for China. D-R function is a fundamental necessary tool when calculating damage costs of health related problems.

6.3. The future of green GDP

There is no doubt that green GDP would have been a very useful indicator if it could be calculated in a reliable manner. Thus, green GDP is a good concept, but unfortunately too unreliable and difficult to use it at present, due to the above theoretical, methodological and practical problems. This is not only the situation in China, but also worldwide. Actually, none of the countries in the world uses green GDP instead of conventional GDP. This is a very important international signal that China should take notice of.

Still green GDP can be studied in academic circle. Some of the above mentioned theoretical and methodological problems may be solved in the future. However, green GDP cannot be used in practice in the near future. There is undoubtedly a long way to go before reliable results can be obtained.

Thus, it is necessary to find alternatives to green GDP, in order to meet the demand of decision-makers.

6.4. Alternatives to green GDP

Based on international and China's own experiences, there are several possible alternatives to green GDP which could serve the role of such an indicator.

System of Economic and Environmental Accounting - SEEA

For China, one of the most realistic alternatives is to develop a natural resource and environmental accounting system along the lines of SEEA. SSEA is a UN recommended flexible extension of the ordinary national accounts (SNA). Starting with accounts in physical terms, SEEA makes it possible to analyse effects both of a damages and control policies targeted at environmental problems. Since the accounts are kept compatible with the current statistical system, it is also possible to relate the physical and environmental accounts to the economic activities mapped out in the national accounts. Thus, SEEA is a very practical system that has been used in many countries, and is probably the best way for China to start green accounting.

Sustainable Development Indicators (SDI)

Furthermore, based on SEEA, it is also possible to develop some indicators that represent several aspects of sustainable development. The following indicators may be useful for the current situation in China:

- Fossil energy (carbon) intensity per GDP could be a very good indicator to reflect the elasticity of fossil energy consumption and carbon emission with GDP growth.
- SO_2 intensity per GDP is a similar indicator to reflect the elasticity of sulphur emission with GDP growth.
- COD intensity per GDP reflects the elasticity of organic effluent with GDP growth.

The above indictors actually are being used in the 11th five-year plan by Chinese Central Government. Such indicators of green accounting could be used as performance indicators in addition to the traditional GDP measure.

Norway, based on SEEA and using a "national wealth" approach, has developed a small indicator set to measure the development of its national wealth, including natural and environmental capital, real capital and human capital. A non-declining national wealth is seen as a prerequisite for a sustainable development. The approach could also be adapted to a local level. Thus, development of a Chinese SDI system could useful for China in its quest for long-term performance indicators, both at the national and the local level.

Other possible alternatives

Besides green GDP and Sustainable Development Indicators, there are other alternatives. The Index of Sustainable Development, normally a weighted average of many indicators, could measure the efforts and trends of sustainable development. However, it is often rightly criticized for its arbitrary weight setting and index choosing scheme. This invites methodological debates rather than debates aimed at solving the underlying problem.

From the perspective of economics, the New Economic Welfare indicator (NEW) is perhaps a good approach to measure all of social welfare of human being, including environmental welfare. However, it is only being used in theory at present and no practical applications have taken place so far.

At the product and firm level, green-labelled products and environmental auditing of enterprises are also a kind of alternative to green GDP.

6.4. Conclusion

Green GDP is a good concept, but not feasible in the foreseeable future. This applies not only to China, but also worldwide.

We suggest that China should work on establishing SEEA following international experiences. Based on SEEA, China can go further to develop indicators of Sustainable Development.

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