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Sustainable Development Indicators

Based on National Accounts

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Sustainable Development Indicators Based on National Accounts[1]

ABSTRACT National statistical institutes have recently presented a set of indicators for sustainable development. The indicators present different topics and the simultaneous achievement of different goals. That is, economic, social and environmental goals. Statistics Denmark also presented a series of indicators for sustainable development in 2003.

However, policy analysis of sustainable development requires instruments for further analysis of the underlying mechanisms and the reasons for change. The present indicator set cannot be used for such a purpose. The primary reason for this is that the indicators are often based on data originating from different statistical frameworks.

That is why a new indicator set should be derived from a statistical framework where individual indicators are embedded into an underlying database from which they can be derived by aggregation.

The System of Economic and Social Accounting Matrices and Extensions (SESAME) which is a detailed statistical information system is such a system. SESAME combines the System of National Accounts (SNA) with National Accounting Matrices Including Environmental Accounts (NAMEA) and Social Accounting Matrices (SAM), and in this way integrates economic, social and environmental statistics.

The most important message in this paper is that the underlying data for the individual indicators should be part of a comprehensive framework that integrates all relevant topics. In this way, it will be possible to analyse the interdependence between different topics and the simultaneous achievement of different goals.

[1] The views expressed in this paper are those of the authors and do not necessarily reflect the views of Statistics Denmark.

1. Introduction

The general idea throughout this paper is to argue for the need for establishing statistical systems where all data are based on the same classifications and from which sustainable development (SD) indicators can be derived by aggregation. The System of Economic and Social Accounting Matrices and Extensions (SESAME)[2] is introduced as such a system. The System of National Accounts (SNA) provides the cornerstone in this framework. Moreover, the paper provides an introduction to SD from an economic perspective.

The paper is structured into the following chapters.

The second and third chapters offer an introduction to sustainable development from an economic perspective. These chapters cater for those who are really interested in the economic theoretically side of SD-indicators and could therefore easily be skipped by those not interested. The fourth chapter gives examples of the current Danish indicator set and the potential problem with this. The fifth chapter gives examples of indicators derived from the system of National Accounting Matrices Including Environmental Accounts (NAMEA), i.e. indicators for the achievement of environmental goals. The SESAME framework is introduced in the sixth, seventh and eighth chapters.

2. Introduction to sustainable development from an economic perspective

It is now widely recognized that the goal of SD is principally an equity issue, rather than an efficiency issue. According to Hanley (2000), there exists a consensus about SD's general implication which declares that SD requires a non-declining level of well-being for future people. SD requires also equity both within generations and across generations. This doesn't mean that economic efficiency is not relevant for SD, but that economic efficiency is not a sufficient condition for SD.

One of the first ideas about SD appeared in 1987 in The Brundtland Commission report made by the World Commission of the Environment and Development. The Brundtland Commission defines SD as a development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs. However, it appears that there is no straight forward way in which this definition of SD can be understood.

Ecologists tend to address the unavoidable biophysical constraints of human action, while economists tend to translate SD into non-declining per capita wealth.

Neoclassical growth theory implicitly modelled SD as non-declining consumption over time. This theory incorporated natural resource constraints on economic activity. Later, non-declining consumption was replaced by non-declining utility, because individuals also derive utility directly from the environment, and not just from consumption.

According to Pezzey (2003) economic definitions of SD can be divided into two groups:

i) Ends-based definitions (for example, non-declining per capita utility)
ii) Means-based definitions (non declining stock of resources)

The resources mentioned here include three different types of capital: man-made capital (machines, infrastructure, etc.), human capital (education, knowledge, etc.) and natural capital. Natural capital is defined in economics to include all gifts of nature. In most economic work on this field, SD is taken to imply a time path for an economy where welfare is non-declining. However, in most of the practical and empirical work welfare is approximated by consumption. This implies a non-declining path for consumption. This causes a direct conflict with inter-temporal efficiency and SD. It is well known that the maximisation of discounted utility results in a consumption level which is eventually falling over time, given a constant discounting rate.

Another important presumption in connection with SD-indicators is that SD must be about either ensuring no degradation in environmental quality over time, or no degradation below certain benchmarks. These benchmarks have been set national and international for pollutants and polluting impacts or conceivably in terms of sustainable harvesting. However, there is yet no international consensus about these benchmarks.

[2] The SESAME framework has been developed by Steven Keuning, Statistics Netherlands. See Keuning et al. (1995).

3. Short review of possible indicators

This chapter introduces a series of indicators which have been introduced in the economic literature. According to Hanley (2000) all macroeconomic[3] indicators for SD can be divided into two big groups:

i) Indicators based on flows, centring on the concept of an environmentally adjusted national accounts, and
ii) Indicators based on stocks, centring on the concept of a non-declining capital stock

3.1 Flow based indicators

3.1.1 Green Net National Product (GNNP)

A wide range of economic literature discusses transformation of conventional SNA measures of economic performance, such as Net National Product (NNP), into exact measurement of welfare, given that economic activity and the environment are inter-linked. Correctly adjusted NNP, i.e. the Environmentally Adjusted National Product (EANP) can tell us whether a country is on a sustainable path, since NNP is shown to be a measure of maximum future consumption possibilities in an economy, given an initial capital stock. Most of the results in this area are funded on a paper by Weitzman from 1976. This paper showed that the current-value Hamiltonian of an optimal growth model is an expression for NNP in that economy. Theoretical work with adjustments of NNP to include environmental impact is based on Weitzman's results. Correct adjustments of NNP include at least three groups of adjustments:

i) Adjustments in connection with non-renewable resources
ii) Adjustments in connection with renewable resources
iii) Adjustments in connection with pollution

Let us first look at non-renewable resources, such as oil and natural gas. A general principle behind the adjustment of NNP in connection with non-renewable resources in economic literature says that conventional NNP must be adjusted for depreciation of the resource stock, valued at its Hotelling rent. However, new discoveries may be added to the resource stock, assuming that these are economic to exploit.

For renewable resources, such as fish and forests, NNP should be adjusted for the net change in the resource stock, valuated at the resource rent. It is not hard to se that adjustments of renewable and non-renewable resources are almost similar. The only difference between these two adjustments is the natural growth in the renewable resources.

Treatment of pollution in the national accounts has always been connected with problems. Therefore, the overall conclusion in connection with adjustments of conventional NNP for pollution is two-folded. For natural resources which are commercially exploited, NNP must be adjusted for depreciation in the stocks of these resources. For natural services, which are not priced, two adjustments are necessary: one which augments NNP by the value of the service flows from these non-marked assets, and one which reduces NNP by depreciation in the assets themselves. Unfortunately this requires a measure of environmental services. Note here, that all three adjustments are only correct if the prices and marginal costs used in the calculation are set at their optimal values.

However, there are several issues in connection with environmental adjustments of NNP. Some of the most important are:

i) Treatment of defensive expenditures[4] and pollution costs
ii) Treatment of transboundary pollution
iii) Treatment of technological change
iv) Treatment of new discoveries
v) Treatment of uncertainty.

[3] Measures which relate to the economic system for one country as a whole.

[4] Defensive expenditures include expenditures by households and governments on reducing the impacts of the current pollution level.

Several specific problem areas can also be identified in derivation of EANP. The efficiency price problem for instance, which says that it is unlikely that depreciation of renewable and non-renewable resources will be calculated correctly. It is more or less obvious that depletion of present resources may not follow the optimal path. Thus, observed prices are non-optimal. For renewable resources there is almost no evidence that extraction follows Hotellings rule, because of externalities, like for instance open-access problems, etc. Consequently, observed prices are non-optimal and only correct prices give the correct rents by which changes in stocks can be valuated correct.

Furthermore, Mäler (1991) points out that EANP can only be a trustworthy welfare indicator in a 'convex' economy.[5] Others have pointed out that the optimal adjustments derived are dependent on a structure of the model used. Furthermore, EANP has no predictive power. Rising EANP might tell us that welfare was increasing over the accounting period, but it tells us nothing about whether this trend is going to continue. Falling EANP would be a sign of an unsustainable development, but it also does not tell us anything about whether this trend will continue. It can bee concluded that EANP is a better SD-indicator than NNP. However, EANP is far from perfect.

3.2 Stock-based indicators

3.2.1 The Hartwick's rule

Hartwick presented as early as 1977 conditions under which an economy dependent on a non-renewable resource could maintain a constant level of consumption in the infinite future. Hartwick's rule says that constant consumption requires that the Hotelling rents evaluated along an optimal depletion path are reinvested in man-made capital (infrastructure, machinery, etc), given a Cobb-Douglas aggregate production function. The Cobb-Douglas function has an elasticity of substitution between man-made and natural capital equal to one.

The first criticism of Hartwick's rule deals with this substitution condition, because only if the substitution elasticity is equal to or greater than one, the rule will imply non-declining consumption, given the Cobb-Douglass production function. The second criticism is directed to the implication of being on an optimal depletion path, which might cause that, wrong prices are used to calculate the optimal re-investment. Cf. the argumentation above.

3.2.2 Genuine savings

The indicator known as 'genuine saving' is an empirical application of Hartwick's rule. The indicator tests whether one country is following the Hartwick rule, by comparing the saving rate with the sum of depreciation of natural and man-made capital. If all savings are reinvested in man-made and natural capital, then the aggregate capital will not be falling and constant consumption will be maintained. This indicator is referred to as a weak sustainability measure, since no special conditions are placed on the level of natural capital. 'Genuine savings' are also calculated under the assumption that man-made and natural capitals have the same ability to produce welfare.

There are several criticisms of 'genuine savings'. First, measuring of depreciation of natural capital is very difficult (for instance biodiversity). Second, it is not clear how investments in man-made capital can substitute some part of natural capital, as for instance photosynthesis, etc.

3.2.3 Natural capital stock approaches

The 'London School' offers a different approach where substitution possibilities between man-made and nature capital are limited. This approach says that some substitution is possible between certain elements of man-made and natural capital (better machinery causes a fall in the use of raw materials), but many elements of natural capital cannot be substituted (for instance biodiversity, etc.). Therefore, this approach is often referred to as 'strong sustainability'. However, the question is how much of the natural capital that should be held constant, and what measure natural capital should be measured in? Once these questions have been answered, the development of an indicator is practically straightforward.

Another approach, which is closely linked to non-declining natural capital, is the safe minimum standards (SMS). The SMS rule is that it should prevent reduction in the natural capital stock below the SMS, identified for each

[5] Convex economy: an economy with convex production possibilities and preferences.

component of this capital stock, unless opportunity costs of doing so are unacceptably large. The biggest difference between SMS and the non-declining natural capital approach is that SMS for any resource is allowed to decline if the opportunity costs of preserving are unacceptably large.

Even though the economic literature has offered a series of indicators for SD these are most unlikely to be used by national statistical institutes. The primary reason for this is that too many aspects of natural resource depletion are ignored by the SNA. For instance, expenditure on pollution cleaning is added to EANP, but any loss in welfare due to the pollution itself is ignored. Furthermore, economic indicators such as EANP are only useful in connection with sustainable development if they are used together with ecological and socio-political indicators. This leads us to the next chapter.

4. Indicators for sustainable development in Denmark

4.1 The first ideas about sustainable development

The first ideas about SD in Denmark came, as already mentioned, in 1987 with the Brundtland Commission report. The report highlights three components of SD:

i) Economic growth
ii) Environmental protection
iii) Social equity

Today, these three dimensions are recognised as dimensions that should be addressed by any SD-policy.

Later in June 2002, the Heads of the EU Member States adopted a strategy for SD at the Gothenburg Summit. The overall objective of the strategy was to disconnect economic growth from environmental impact and resource extraction.

In continuation of the Gothenburg summit, the 6th Environment-Action Program[6] was adopted in July 2002. This program should help the integration of the environment policy with other EU policies. The program was built on the main principle that environmental consideration should be part of all EU's sector-policies, especially those for agriculture and the energy sector. It was also adopted that EU countries should work targeted with priority areas. At the latest in 2006, EU's countries should develop strategies for soil pollution, sea environment, pesticides, ear pollution, town environment, sustainable use of resources and waste recycling.

The Nordic countries adopted in 1998 a declaration about SD in Scandinavia, called "Sustainable development – A new Course for Scandinavia"[7]. This strategy focuses on areas, where a common Scandinavian effort is of high priority, that is: clime, biodiversity, sea and chemicals. Another important task of this declaration is the introduction of ideas of SD to several sectors: energy, transport, agriculture, fishing and forestry.

4.2 Danish strategy for sustainable development

The first Danish strategy for SD called 'Common future – development in balance'[8] appeared in June 2002. The objective of this strategy was that Denmark should have high employment, a high standard of living and a good environment. That is, Denmark consolidates economic growth, social equity and environmental protection simultaneous. The Danish Government wants to ensure constant economic growth, which is socially balanced, and which does not have a negative impact on the environment, that is a development meeting the needs of the present without compromising the ability of future generations to meet their own needs.

[6] Det 6. Miljøhandlingsprogram

[7] Bæredygtig udvikling – En ny kurs for Norden

[8] Fælles fremtid – udvikling i balance

The Danish Government's strategy for SD is based on eight principles:

1) The welfare state has to be under constant development and economic growth and environmental impact has to be detached
2) It has to be a safe and healthy environment for everyone
3) Ecosystems have to be protected
4) The use of resources has to be improved
5) Denmark has to yield an active international effort
6) Environment consideration has to be part of every sector
7) The market has to support sustainable development
8) Sustainable development is a common responsibility (see Common future – development in balance)

Denmark's dataset, which will be used for the construction of indicators for SD, will at least contain three dimensions:

i) Economy
ii) Environment
iii) Sociologic factors

Ten subjects for measuring SD in Denmark will be presented:

1) Economic development and employment
2) Poverty
3) Elderly society
4) Health
5) Change in climate and energy
6) Sustainable production and consumption patterns
7) Protection of natural resources
8) Traffic and use of area
9) Public management
10) Global solidarity

Statistics Denmark presented in 2003 a series of indicators for SD[9]. These indicators are the result of the EU Commission's strategy, which is already passed, "Strategy for Sustainable Development". It is important to mention that work on these indicators is still ongoing. It is expected that these indicators will be produced annually. The list of SD-indicators should be seen as the beginning of a much more general set of indicators, which will be developed in due course.

However, we need to ask, will these indicators serve their purpose? According to Keuning (2003), the results in the EU member countries are so far a disjointed shopping basket with numbers. It is almost impossible to make a meaningful synthesis of these indicators. The extremely wide range of measures causes a problem with the understanding of what is central for SD. The comparison between very large numbers of opposite signs makes an overall view about SD impossible.

One can look at different elements when the criteria for establishing a good indicator is under loop, see Keuning (2003). Some of these elements are:

i) Sensitivity to the change indicators are intended to measure
ii) Capability of being updated on a regular basis
iii) Scientific quality
iv) Easily understandable

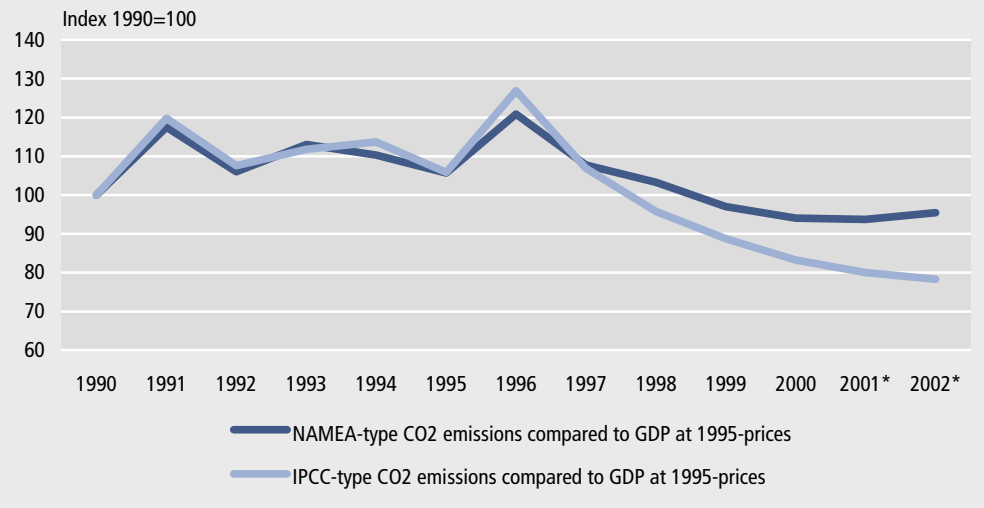
In practice, these rules can cause many problems. For instance, using the rule of "easily understandable indicators" may lead to unmanageable information. It is therefore unavoidable that a limited set of indicators is designed.

[9] Statistics Denmark's publication entitled "Indikatorer for bæredygtig udvikling" (Indicators for sustainable development) summarizes the current Danish set of SD-indicators.

4.3 Illustration of possible problems with the current set of indicators

There are various indicators, which have GDP in the denominator, while the numerator is not derived from the national accounts data. Some of the proposed Danish SD-indicators suffer from this problem, cf. the example below.

Figure 1: Different indicators for the development in Danish CO_2-emissions



Source: Statistics Denmark (2004)

One of the indicators in the Danish set of SD-indicators is emissions of CO_2 compared to GDP. Figure 1 clearly shows the problems, which can arise, when indicators are based on elements originating from different frameworks. Here, the indicator showing the NAMEA-type CO_2-emissions provides the example of the ideal indicator. Both the data on air emissions and, of course, the GDP stem from the national accounts framework, whereas the IPCC-type[10] CO_2-emissions inventory is based on a set of classifications different from that of the national accounts. As the figure shows, different developments are shown by the indicator, especially from 1999 and onwards.

The different development shown by the indicator in figure 1 is especially due to the fact that the IPCC-type emission inventory do not include emissions from international transport whereas the economic contribution from those activities is included in the national accounts and consequently in the NAMEA-type emissions. The contribution from international sea transport to GDP has especially been increasing in the last five years.

5. One integrated database that covers the three principal topics of a sustainability approach

Applied economic analyses of SD are often seriously troubled by the lack of a complete data framework. However, Statistics Denmark offers a wealth of different statistical information. Therefore, a lack of data is not a problem as such. The main problem is the lack of integration of these statistics implying that all kinds of events, which are interrelated in reality, can only be studied in isolation. Solving this problem is the key for the construction of indicators for SD. The keyword is integration.

A policy for SD cannot be a policy on its own. The objective of such a policy is a coordination of the different sector policies with the overall objective of finding a balance between conflicting goals. That is because improvement of one indicator influences the other goals of the overall strategy for SD. The relationships between indicators on the top of the data pyramid and the underlying data have to be regarded in the process of selecting the indicators and their base.

However, we need to start by asking ourselves what kind of information we expect from indicators for SD. The indicators are first and foremost a communication tool directed to the general public and the media. Moreover, they are often used to describe important problems in connection with SD and they can serve as an instrument for

[10] Emission inventories of this type are reported to the United Nations Framework Convention on Climate Change and used to the evaluation of the Kyoto-targets.

controlling of political measures. We know that the measurement of progress in the different policy areas requires that interdependencies between indicators can be identified and studied.

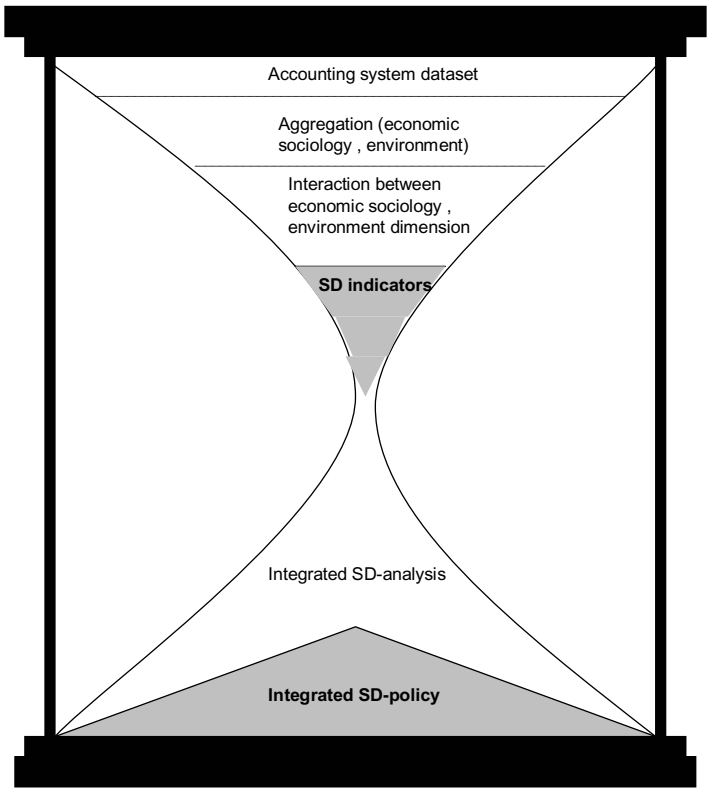
However, this approach requires a possibility of further analysis of the underlying mechanisms and reasons for change. That is why the individual indicators should be embedded into an underlying database from which they can be derived by aggregation. Also, the disaggregated data provide the necessary information for more detailed analyses. Another important point is that the underlying data for the individual indicators should be part of a comprehensive framework that integrates all relevant topics. In this way, it is possible to analyse the interdependence between different topics and the simultaneous achievements of different goals. That is, economic, social and environmental goals.

The SNA and its satellite systems Environmental-Economic Accounts and the Socio-Economic Accounts form an extended accounting data set. As we know, the accounts provide a most complete and theoretically sound system description of the stock and flows. Practically, the accounts are an effective tool for generating an underlying database by harmonising otherwise not fully coherent and incomplete data. It provides the basis for estimates which can close remaining data gaps. The SNA is the worldwide accepted standards for describing the economic activities. The satellite systems extend the economic accounts by description of the interrelationships between economic, social and environmental systems.

It is very important to notice, that the satellite systems in principle use the same concepts, definitions and classifications as those used by the SNA. This guaranties that the data of all three systems can be combined with each other. They form an integrated database covering the principal topics of a sustainability approach.

From the data set of the SNA, most of the economic and partly also social indicators can be derived. The SNA data set is the basis for already existing and proven analytical tools that are related to the economical process. However, for many socio-economic analyses the present national accounts can be improved. This can be solved by an extension of the national accounts, like for instance Social Accounting Matrices (SAM) and NAMEA.

Figure 2: SD-indicators sand watch



The indicators derived from such a system can be disaggregated in order to get an insight into the reasons of the development of the specific indicator and the interrelationships to other topics of the set. The indicators for SD are usually comprised of headline indicators, which were selected for representing a specific topic. It may also be necessary to supplement the headline indicators by additional indicators in order to obtain a more comprehensive

description of the problem. It means that one can turn around the SD-indicators sand watch in figure 2 and get information in one or another direction.

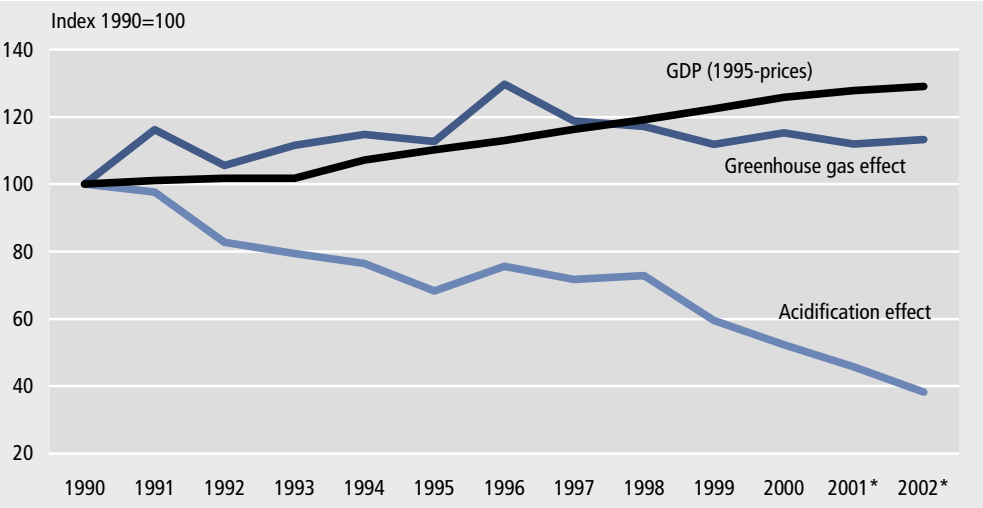
5.1 Examples of indicators derived from NAMEA

One example of indicators which is derived from a consistent framework are indicators derived from NAMEA, e.g. the development in environmental themes, see below. The indicators derived from NAMEA link the economic activity as described in the national accounts with the environment.

Figure 3 shows the development in GDP, the Danish contribution to the greenhouse effect and acidification in Denmark in the period from 1990-2002. It is not difficult to see that there has been a decoupling between economic growth and environmental problems.

The individual indicators here are embedded into an underlying database from which they are derived by aggregation. The underlying data for these particular individual indicators are part of a comprehensive framework that integrates two relevant topics, economics and environment. In this way it is possible to analyse the interdependence between different topics and the simultaneous achievement of different goals, in this case economic and environmental.

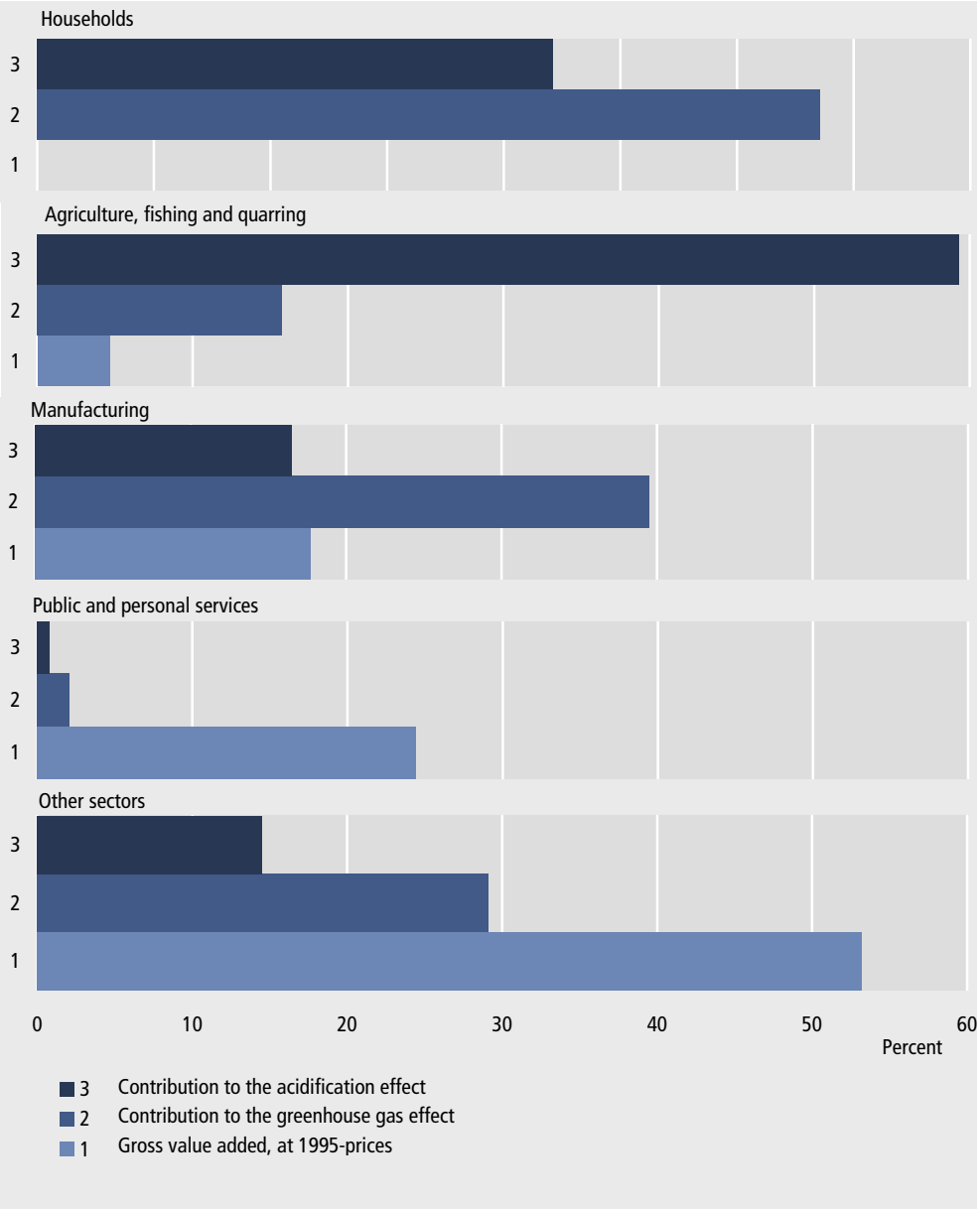
Figure 3: Acidification in Denmark, Denmark's contribution to the greenhouse effect and GDP, 1995-prices 1990-2002*



Source: Statistics Denmark (2004)

The disaggregated data provide the necessary information for a more detailed analysis. The indicators derived from this system can be disaggregated in order to get an insight into the reasons for the development of the specific indicator and the interrelationships to other topics of the set. Figure 4 shows more detailed information about these two indicators. It can easily be seen that 'agriculture, fishing and quarrying' contribute most to acidification, whereas households contribute the most to the greenhouse effect. These indicators can also be compared to 'gross value added', to get a more complete picture of the environment-economic problems.

Figure 4: Sector's and household's share of total economic growth and environmental themes in 2002*

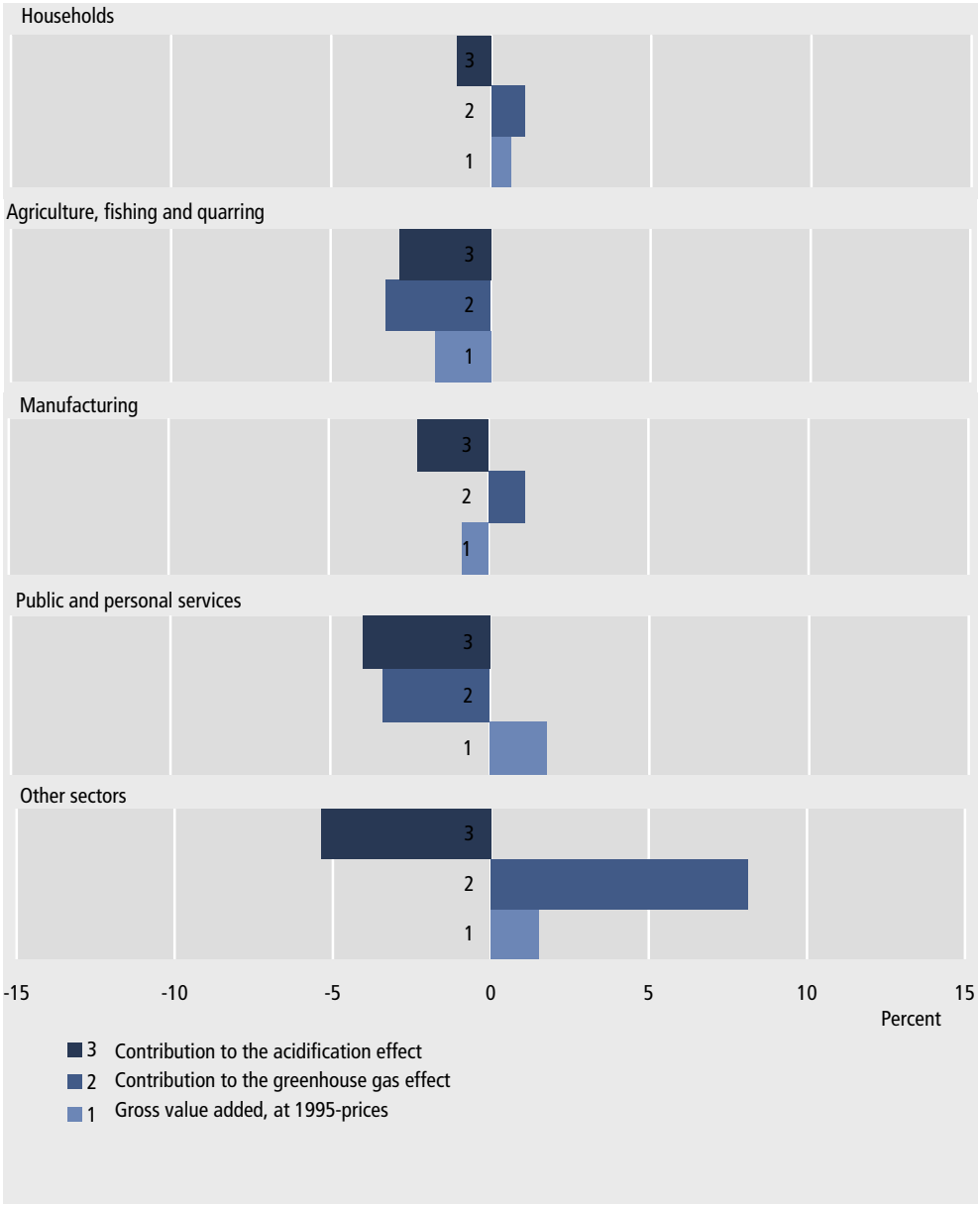


Source: Statistics Denmark (2004)

It is also possible to introduce a time dimension for these indicators. Figure 5 shows the development in indicators from figure 4 for the period 2001 to 2002. This can give us a new perspective in analysis of environment-economic problems. For instance, households and manufacturing still have problems with the reduction of the greenhouse gases. 'Public and personal service' had in contrast a rise in the economic activities, and a reduction in both acidification and in the contribution to the greenhouse effect.

The environmental goals related to SD can, as shown, be evaluated by using the NAMEA-framework. To take into account the social goals as well one should include the SAM -framework. This would create SESAME.

Figure 5: Development in chosen environment-economic aspects 2001*-2002*



Source: Statistics Denmark (2004)

6. System of Economic and Social Accounting Matrices and Extensions (SESAME)

SESAME is a statistical information system in matrix format, from which a set of core economic, environmental and social macro-indicators can be derived. The system is driven by the kind of information required for monitoring and policy-making at the macro-level. SESAME yields a framework for an integrated analysis and modelling of social, economic and environmental issues.

SESAME registers both the national value and its distribution among socio-economic household groups and categories of employed persons. SESAME implies the basic idea of present-day national accounts to a wider set of data. The national accounts provide an integrated and systematic account of an economy at the level of industries, sectors, etc., from which key economic indicators at the macro-level are derived. SESAME is extending this principle to a wider set of statistics, notably social and environmental accounts. In order to achieve a linkage between monetary and non-monetary data, the SAM-values are broken down into price changes and volume changes. The linkage with other data is typically established in non-monetary units as hours, calories, and joule and volume changes. In this way, the necessary connections are made without distorting the essential monetary SNA.

As mentioned, SESAME registers for all variables the national total value as well as the distribution among socio-economic household groups, categories of employed persons, etc. As a next step, a range of summary indicators can be derived from such a data set (e.g. GDP, population size, inflation, income inequality, environmental indicators, etc.). Consistent indices covering distributional aspects can also be derived for all variables included in the system. Whatever set of aggregates is preferred; they would all share two crucial features:

i) Every indicator is computed from a single, fully consistent statistical system
ii) Each indicator uses the most suitable measurement unit of the phenomenon it describes

The interaction between the design of an information system and the derivation of a set of core economic, social and environmental macro-indicators is a distinguishing feature of SESAME. SESAME does not squeeze all SD's attributes into a single indicator. This implies that SESAME is a statistical framework and not an implicit result of a model simulation. SESAME extends the central framework of the 1993 SNA by integrating the data and macro-indicators for, e.g. (un)employment, educational attainment and environmental degradation. SESAME provides a fully consistent analytical framework analogous to input-output tables and SAM.

6.1 Example of information obtained from SESAME

Table 1 shows some of the indicators derived from the Netherlands' SESAME in 1999. The Netherlands' 'agriculture, forestry and fishing' contributed with 2.7 percent to GDP, while at the same time it contributed with 15.1 percent to the greenhouse effect. 'Mining and manufacturing' contributed with 18.5 percent to GDP, but almost 81 percent of R & D expenditures went to the same sector.

Table 1: The Netherlands percentage contribution to a number of economic performance indicators, by industry, 1999

	GDP	Employment	Capital stock	R & D	Greenhouse effect
	pct.				
Agriculture, forestry and fishing	2.7	3.6	3.0	0.9	15.1
Mining and manufacturing	18.5	15.6	15.1	80.6	36.2
Electricity, gas and water supply	1.7	0.6	3.7	0.5	22.0
Construction	5.7	7.3	1.2	1.6	1.2
Trade, hotels, restaurants and repair	14.9	19.3	5.9	2.9	2.6
Transport, storage and communication	7.4	6.1	7.1	2.4	13.8
Finance and business services	26.4	20.0	44.0	3.4	2.4
General government	11.5	11.5	4.7	6.9	2.1
Other services	11.2	16.1	15.4	0.9	4.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Keuning 2003, p. 203

Table 2 represents a very good example of interaction between all three dimensions of SD. Table 2 shows selected economic and environmental indicators (columns) distributed among four different labour types (rows). Also, the table represents direct links between social, economic and the environmental dimensions derived from the SESAME framework. It is not difficult to se that 'male with high education' is a dominant group in the Netherlands' economy. It contributes with 49 percent of GDP and with 41 percent of the total employment. Another interesting thing is that 'male with low education' contributes with 27 percent of GDP, but at the same time with 42 percent to EEQ. It is possible to derive more similar indicators from table 2, which can be used to understand different problems, and possible causes of that particular problem. Another useful characteristic of this framework is that the SESAME framework makes it possible to analyse interdependence between different topics, like for instance between labour types, GDP and environmental themes.

Table 2: Contribution to GDP, employment and environment per type of labour in the Netherlands, 1990

		Gross Domestic Product (GDP)	Total employment	Greenhouse gas effect (GWP)	Ozone layer depletion (ODP)	Acidification (AEQ)	Eutrophication (EEQ)	Accumulation of waste (min KG)
		Pct. of total employed persons						
TYPES OF LABOUR	Male with low education	27	28	31	34	36	42	38
	Male with high education	49	41	55	55	51	45	48
	Female with low education	8	13	6	5	6	7	6
	Female with high education	16	18	8	6	7	5	7
	Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Timmerman (2000)

7. Use of indicators for SD derived from SESAME

Obviously, the communication between policy-makers and analysts is optimally served if the core macro-indicators are all derived from an integrated information system as SESAME.

Indicators derived from accounting frameworks are the best tool for monitoring. Efficiency, equity and intergenerational equity can be monitored by indicators and accounting frameworks. If some indicators show improvements and others show deteriorations, it is necessary to measure the trade-off between aims. In this case, indicators and the accounting framework provide all information necessary to conduct dynamic modelling.

The most important advantages of an accounting approach for measuring SD refer to two points. First, an accounting framework can enhance the indicators itself by an integrated underlying database, which is needed for analysing the development of and the interrelationships between the indicators and for working out the policy measures that are able to balance conflicting goals within the SD-policy. Second, compared to primary surveys, the accounting approach is a very cost-efficient tool for generating a database for SD-analyses. The problem with SESAME is that it doesn't tell us anything about goals of sustainability, or whether one country is on the sustainable path or not. It just tells us in which direction indicators are moving.

8. The path forward

Statistics Denmark offers a complete set of input-output tables and NAMEA. The only element of the SESAME framework, which is missing, is a SAM for Denmark. By making SAM and linking it with NAMEA, the SESAME statistical information system will be set up, and new possibilities for deriving SD-indicators will be made possible. This new set of SD-indicators will be different from the set already offered, because the indicators will be generated from an underlying database by harmonising otherwise not fully coherent and incomplete data. This will enable policy analyses of SD grounded on the development of SD-indicators. This statistical framework will make it possible for further economic modelling with CGE-models and can also be used for economic forecasting and planning.

9. Conclusion

The indicators are, on the first hand, a communication tool directed to the general public and the media. They are often used to describe important problems in connection with SD. They can also serve as an instrument for controlling political measures and economic modelling. However, use of SD-indicators requires a possibility of further analysis of the underlying mechanisms and reasons for change. That is why the individual indicators should be embedded into an underlying database from which they can be derived by aggregation. The underlying data for the individual indicators should be part of a comprehensive framework that integrates all relevant topics. In this way, it is possible to analyse the interdependence between different topics and the simultaneous achievement of economic, social and environmental goals.

We want to emphasize that we do not advocate for special statistical frameworks or specific methods. Different kinds of statistics and inventories all serve their specific purposes. However, the point is that indicators calculated

from elements originating from different statistical frameworks are a bad idea since they might be misleading. Hence, indicators should be derived from the same fully consistent framework.

SESAME is such an information system that integrates economic, social and environmental statistics. It is a statistical information system in matrix format, from which a set of core economic, environmental and social macro-indicators can be derived. The system is driven by the kind of information required for monitoring and policy-making at the macro-level. Every indicator derived from SESAME is computed from a single fully consistent statistical system and each indicator uses the most suitable measurement unit of the phenomenon it describes. SESAME does not squeeze all SD's attributes into a single indicator. This implies that SESAME is a statistical framework and not an implicit result of a model simulation.

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