EEA internal working paper

Environmental Indicators: Typology and Use in Reporting

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1. Introduction

A wide variety of environmental indicators is presently in use. These indicators reflect trends in the environment and monitor the progress made in realising environmental policy targets. As such, environmental indicators have become indispensable to policy-makers.

However, it is becoming more and more difficult for policy-makers to grasp the relevance and meaning of the existing environmental indicators, given the number and diversity of indicators presently in use. Moreover, new sets of environmental indicators are still being developed. Therefore, some means of structuring and analysing indicators and related environment/society inter-connections is needed.

The purpose of this report is to introduce the DPSIR framework (Driving forces, Pressure, State, Impact, and Response) and the 'Typology of Indicators' used by the European Environment Agency (EEA) in its reporting activities. The current report is an update of Technical report No 25 published in 1999. A main change compared with the previous version is the introduction of a category of "policy effectiveness indicators", which in itself marks the increased attention for the analysis of the developments depicted by the indicators.

The line of reasoning already present in the previous edition, that posing the right questions must precede selection of indicators, is elaborated in Chapter 5 of the current report which describes the process of indicator-based reporting.

This report still focuses purely on environmental indicators. It is envisaged that the next update of this typology report will cover the sustainable development context of environmental indicators, including a discussion on the global context of the DPSIR model.

We hope that the current paper will be useful to the EEA and all cooperating institutes in the EIONET by defining common standards for indicator reports. If we succeed in communicating a well-structured message to the users of our information through our reports and presentations, and if these users in return take relevant actions based on environmental indicators, then this report will have fulfilled its purpose.

2. Why do we need environmental indicators?

Communication is the main function of indicators: they should enable or promote information exchange regarding the issue they address. Our body temperature is an example of an indicator we use regularly. It provides critical information on our physical condition. Likewise, environmental indicators provide information on phenomena that are regarded typical for and/or critical to environmental quality. The abundance of Black Terns in a certain area and the total volume of substances emitted by industry over a certain period are only two of the numerous indicators that enable communication on environmental issues.

Communication demands simplicity. Indicators always simplify a complex reality. They focus on certain aspects, which are regarded as relevant and on which data are available. But their significance goes beyond that obtained directly from the observed properties. To know the number of Black Terns in a certain area may be satisfying in itself. It may be more relevant to compare the number in this specific area with the abundance of Black Terns in a similar, but less disturbed area. Then, the real significance is in the message the abundance of these birds conveys regarding environmental quality in that specific area. Environmental indicators communicate those aspects regarded as critical or typical for the complex interrelations between natural species and abiotic components of the environmental system.

In relation to policy-making, environmental indicators are used for four major purposes:
1. To supply information on environmental problems, in order to enable policy-makers to evaluate their seriousness;
2. To support policy development and priority setting, by identifying key factors that cause pressure on the environment;
3. To monitor the effects and effectiveness of policy responses, and
4. To raise public awareness on environmental issues. Providing information on driving forces, impacts and policy responses is a common strategy to strengthen public support for policy measures.

Box 2.1. What is an indicator?

An indicator is an observed value representative of a phenomenon of study. In general, indicators quantify information by aggregating different and multiple data. The resulting information is therefore synthesised. In short, indicators simplify information that can help to reveal complex phenomena.

Box 2.2. What is a good indicator?

An indicator that communicates in a sound way a simplified reality should:
- match the interest of the target audience;
- be attractive to the eye and accessible;
- be easy to interpret;
- invite action (read further, investigate, ask questions, do something);
- be representative of the issue or area being considered;
- show developments over a relevant time interval (a period in which changes can be shown;
- go with a reference value for comparing changes over time;
- go with an explanation of causes behind the trends;
- be comparable with other indicators that describe similar areas, sectors or activities;
- be scientifically well-founded; and
- be based on sound statistics.

3. Analytical framework

The analytical framework used for an assessment helps to determine the variety of indicators that are chosen to communicate the outcomes of that assessment. For its assessments of the relations between human activities and the environment, EEA uses an extended version of the well known OECD-model, which is called the Driving forces - Pressures - State - Impact - Responses (**DPSIR**) framework (see figure 3.1).

According to this systems analysis view, social and economic developments exert *pressure* on the environment and, as a consequence, the *state* of the environment changes. This leads to *impacts* on e.g. human health, ecosystems and materials that may elicit a societal *response* that feeds back on the *driving forces*, on the pressures or on the state or impacts directly, through adaptation or curative action. This model describes a dynamic situation, with attention for the various feedbacks in the system. By their nature, indicators take a snapshot picture of a constantly changing system, while the assessments that accompany the indicators can highlight the dynamic relations.

Most sets of indicators presently used by nations and international bodies are based on this DPSIR-framework or a subset of it. These sets are used to characterize the main environmental issues, such as climate change, acidification, toxic contamination and wastes in relation to the geographical levels at which these issues manifest themselves or are on which they are managed. In designing indicators for each of these problems on every geographic scale, the simplicity of the DPSIR framework is its strength: the principles are very easy to communicate. However, a simple concept needs to be applied where it can be applied, but not overstretched.

3.1. A short history of DPSIR

In describing environmental issues, environmental indicators often follow a causality chain. The first indicator framework commonly known is the Stress-Response framework developed by two scientists working at Statistics Canada, Anthony Friend and David Rapport (Rapport and Friend, 1979). Their STRESS framework was based on ecosystem behaviour: they distinguished: environmental stress (pressures on the ecosystem), the state of the ecosystem, and the (eco)system response. For the latter, one could think of, for instance, algae blooms in reaction to the higher availability of nutrients. The original ideas, however, encompassed all kinds of ecosystem and societal responses.

When the STRESS framework was presented to OECD, the ecosystem response was removed in order to make the concept suitable for the approach used by OECD. The rephrasing of “response” to mean societal response only, led to the OECD Pressure State Response (PSR) model (OECD, 1991). Pressures were all releases or abstractions by human activities of substances, radiation and other physical disturbances, and species in or from the environment. State was in the beginning limited to the concentrations of substances and distribution of species.

Because environmental statisticians dealt not only with data on pressures, state and responses, but also with their origins in economic activities, at various statistical offices an early DPSIR model came into use as an organising principle for environment statistics in the early 90s. This framework described: Human activities, Pressures, State of the environment, Impacts on ecosystems, human health and materials, and Responses. The Dobris report (EEA, 1995) also built on this idea.

With the development of the large environmental models such as RAINS and IMAGE by IIASA and RIVM, the DPSIR model became further formalised, with a more precise differentiation between driving forces, pressures, the resulting state of systems, the impacts (among others on the economy) and policy responses. The EEA helped to make this final DPSIR framework more widely known in Europe. The report “A general strategy for Integrated Environmental Assessment at EEA” (1995), which was accepted by the EEA Management Board as the basic document for the development of integrated environmental assessment, made DPSIR the main framework for EEA assessments and related activities.

During these twenty years of history, the framework has developed from a tool to describe natural ecosystems under stress to a framework for describing human - environment interactions and the related information flows. At the same time the need to define the categories precisely and consistently has grown, which is the main purpose of the next section.

As already noted in the introduction, the current DPSIR model is an evolving model. For example, practitioners in environment and health indicators have added additional steps to give DPSEEA, with: Exposure, Effect and Action as the last steps.

3.2. The DPSIR framework in detail

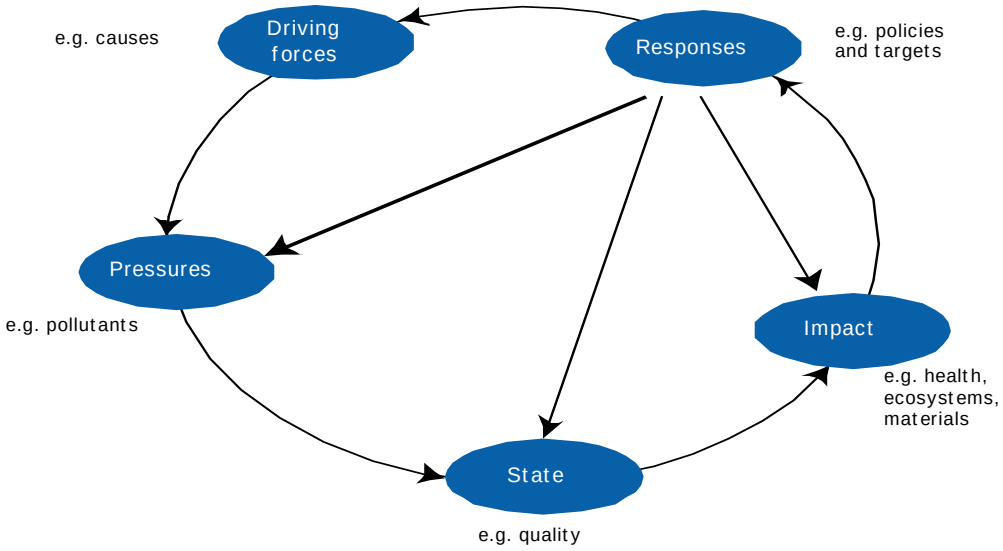
From a policy point of view, there is a need for clear and specific information on:

(i) *Driving forces* and
(ii) The resulting environmental *Pressures*, on
(iii) The *State* of the environment and the
(iv) *Impacts* resulting from changes in environmental quality and on
(v) The societal *Responses* to these changes in the environment.

Although the information needs of policy-makers may be rather wide, including statistics, background information, and summaries, the focus here is on indicators to communicate the most relevant features of the environment and other issues included in the assessments and policy analyses.

In order to meet this need, environmental indicators should reflect all elements of the chain between human activities, their environmental impacts, and the societal responses to these impacts (fig 3.1).

Figure 3.1. *The DPSIR framework for reporting on environmental issues*



Indicators for *Driving forces* describe the social, demographic and economic developments in societies and the corresponding changes in lifestyles, overall levels of consumption and production patterns. Primary driving forces are population growth and developments in the needs and activities of individuals. These primary driving forces provoke changes in the overall levels of production and consumption. Through these changes in production and consumption, the driving forces exert pressure on the environment.

Pressure indicators describe developments in release of substances (emissions), physical and biological agents, the use of resources and the use of land by human activities. The pressures exerted by society are transported and transformed in a variety of natural processes to manifest themselves in changes in environmental conditions. Examples of pressure indicators are CO_2-emissions per sector, the use of rock, gravel and sand for construction and the amount of land used for roads.

State indicators give a description of the quantity and quality of physical phenomena (such as temperature), biological phenomena (such as fish stocks) and chemical phenomena (such as atmospheric CO_2-concentrations) in a certain area. State indicators may, for instance, describe the forest and wildlife resources present, the concentration of phosphorus and sulphur in lakes, or the level of noise in the neighbourhood of airports.

Due to pressure on the environment, the state of the environment changes. These changes then have impacts on the functions of the environment, such as human and ecosystem health, resources availability, losses of manufactured capital, and biodiversity. *Impact* indicators are used to describe changes in these conditions. Although effects of human change in the environment occur in a sequence: air pollution may cause changes in the radiation balance (primary effect but still a state indicator), which may in turn cause an increase in temperature (secondary effect, also a state indicator), which may provoke a rise of sea level (tertiary effect, but still a state of the environment), it is only the last step: loss of terrestrial biodiversity, that should be called the impact indicator. It is the change in the availability of species that influences human use of the environment. In the strict definition impacts are only those parameters that directly reflect changes in environmental use functions by humans. As humans are a part of the environment, impacts also include health impacts.

Response indicators refer to responses by groups (and individuals) in society, as well as government attempts to prevent, compensate, ameliorate or adapt to changes in the state of the environment. Some societal responses may be regarded as negative driving forces, since they aim at redirecting prevailing trends in consumption and production patterns. Other responses aim at raising the efficiency of products and processes, through stimulating the development and penetration of clean technologies. Examples of response indicators are the relative amount of cars with catalytic converters and recycling rates of domestic waste. An often used 'overall' response indicator is an indicator describing environmental expenditures.

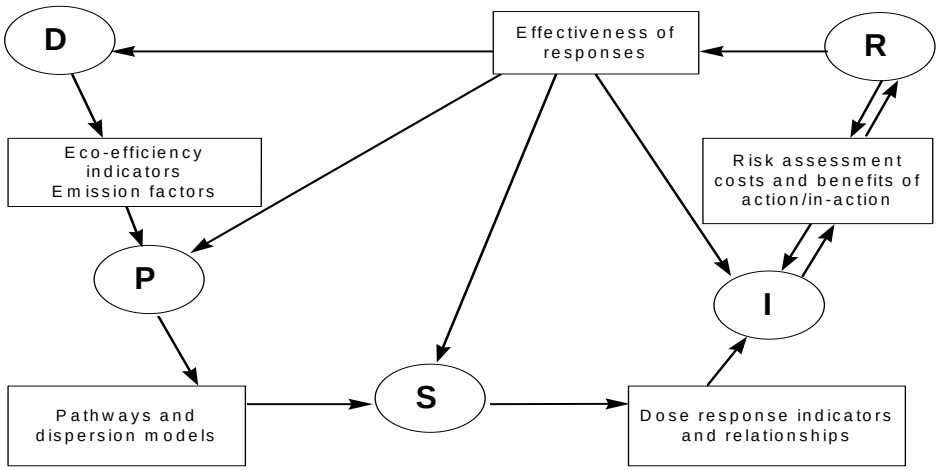
Although it is tempting to look at the DPSIR framework as a descriptive analysis with a specific focus on individual elements in the economic, social and environmental system, it is the relationships between the elements that introduce the dynamics into the framework and bring about changes. A focus *on the links between* the DPSIR elements reveals a number of processes and indicators describing these (see figure 3.2):

- Eco-efficiency indicators such as 'energy productivity' (or its inverse 'energy intensity') help determine the relationship between the driving forces and pressures. Increasing eco-efficiency means that economic activities can expand without an equivalent increase in pressure on the environment. This kind of information contributes to answering the question: are we making technological progress?
- The relationship between the pressure indicator: 'release of nutrients from agriculture' and the state indicator: 'development of nitrate concentration in surface waters' is mainly determined by the pathways and dispersion patterns of the nutrients. The combination of these indicators tells a story of time delay in natural processes and the 'time bombs' created in the environment. Knowledge of dispersion patterns can be useful to model current and future changes in the state of the environment and in impacts.
- Similarly, dose/response relationships determine the impacts of a certain state of the environment. 'Respiratory diseases in children' are through such a relationship linked to 'concentrations of sulphur and nitrogen dioxides'. Knowledge of dose/response relationships can be used to predict or quantify the health impacts of air pollution, or help in choosing the most appropriate state indicator to act as an early warning.
- The relationship between environmental impacts and societal responses such as taxes and regulation is often governed by societal perception that the impacts are serious, and this often requires data on the economic costs of the impact.
- Policy-effectiveness indicators generally summarise the relations between the response and targets for expected change in driving forces or pressures and sometimes in responses, state or even impacts. In general there is little information available on the effectiveness of environmental measures (EEA, 2001a).

The strength of these "in-between" indicators is that they express, more than other indicators, the dynamics of the interactions in the DPSIR system. Sometimes the information can be used in predictions of future changes in pressures, states, impacts, and responses.

The existence of these interrelations also shows that the DPSIR framework, although often presented as a linear chain or a circle, in fact resembles a very complex web of many interacting factors some of which may represent highly non-linear dynamics. In many cases the change in the state of the environment or impacts has several causes, some of which may be immediate and of local origin, others may be exerting their influence on a continental or even global scale. Reductions in pressures often result from a mixture of policy responses and changes in various driving forces.

Figure 3.2. *Indicators and information linking DPSIR elements*



3.3 Indicators and their relevance to the policy life cycle

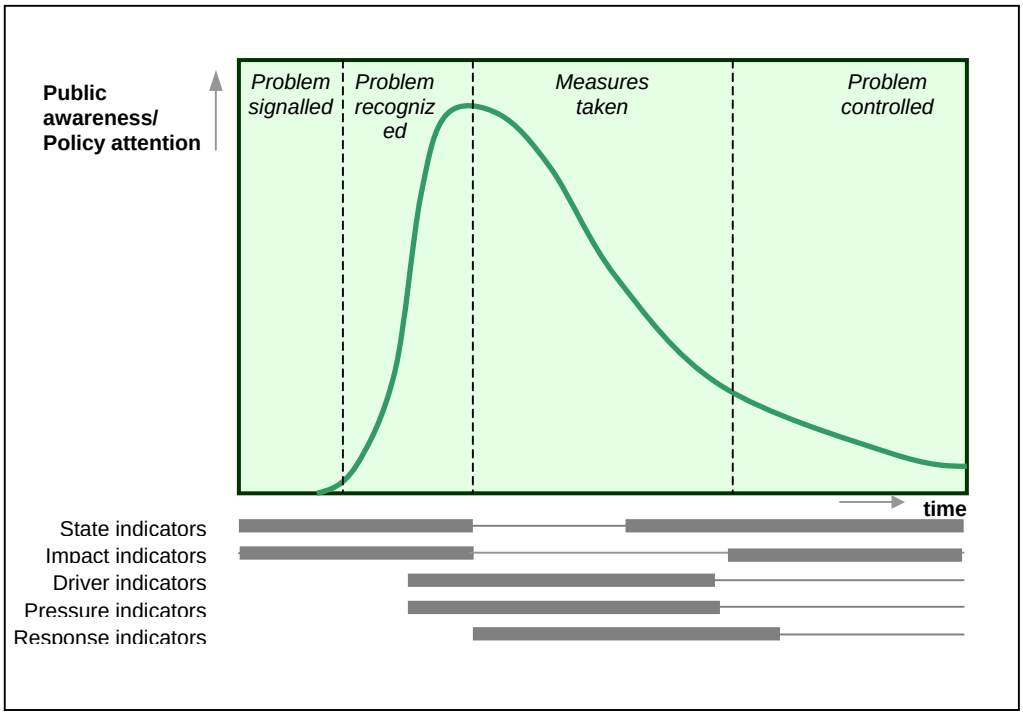
Indicators from different parts of the DPSIR framework have more or less relevance to policy makers depending on what stage the policy life cycle has reached (see figure 3.3). For problems that are in the beginning of their policy life cycle, that is, in the stage of problem identification, indicators on the state of the environment and on impacts play a major role. They will be mainly descriptive indicators, which identify alarming developments in the state of the environment. The most well known cases of 'state'and 'impact' indicators that gave rise to policy reactions are those on the sudden decline of selected species (fish in acidified Scandinavian lakes, seals in the Dutch Waddensea, for instance), surface water quality (concentrations of salt in the river Rhine which was used for irrigation in horticulture, for example) and on air quality in cities (summer smog in Paris and Athens). It is also in the problem recognition stage that estimates of externalities and other costs are relevant. The problem signalling function of 'state' and 'impact' indicators is thus limited in time: as soon as a problem is politically accepted and measures are being designed, the attention shifts to 'pressure' and 'driving force' indicators.

There is, however, a long period in which 'state' and 'impact' indicators support the process of getting political acceptance of policy responses. Greenhouse gas policies provide clear examples where indicators on climate change and its impacts, in terms of average temperatures, movement of the tree line or species distribution, are being used to gather political support for signing the Kyoto protocol.

In the next and longer stages of the policy cycle (formulation of policy responses, implementation of measures and control) policy-makers focus on what they can influence, the driving forces through volume measures, the pressures with technical measures and educational projects. Performance indicators on changes in driving forces and pressures are the most used. In this phase, the need for policy-effectiveness indicators is highest, but few of these have been developed thus far (see Section 4.4). The state of the environment is only a derived result of activities in society and policy reactions and hence 'state'-indicators are of lesser importance. The exception is, of course, management of biodiversity as such or when organisms play a role in the solution of environmental problems. In these situations indicators such as biomass production, forests as carbon dioxide sinks and forest composition can be important measures of progress.

In the last, the control phase of the policy cycle, ‘state’ and ‘impact’ indicators become important again to watch the recovery of the environment and a limited number of these indicators will be used to continuously monitor the state of the environment. They will be accompanied by an equally limited number of indicators on ‘driving forces’, ‘pressures’ and ‘responses’ to monitor the behaviour of the whole system.

Figure 3.3. *DPSIR indicator use in the policy life cycle*



Note: over time environmental problems pass through a policy life cycle with first increasing, and as the problem is more controlled, decreasing attention of the public and policy-makers. The horizontal bars under the graph illustrate the relative role of DPSIR-indicators in this process. The ‘linkage’ indicators in-between the DPSIR elements follow more or less the same pattern.

4. Indicator design – the EEA indicator typology

The DPSIR framework refers to the analytical significance of indicators in a policy context. Regardless of its position in the DPSIR system, an indicator should always convey a clear message, based on relevant variables. For this purpose, EEA uses a limited number of indicator designs, which are linked with an equal number of assessment approaches needed to produce and explain the indicator. Although some of these assessments and indicator presentations are generally applicable, most of them are particularly appropriate in certain sections of the DPSIR cycle.

4.1. A short history of the EEA indicator typology

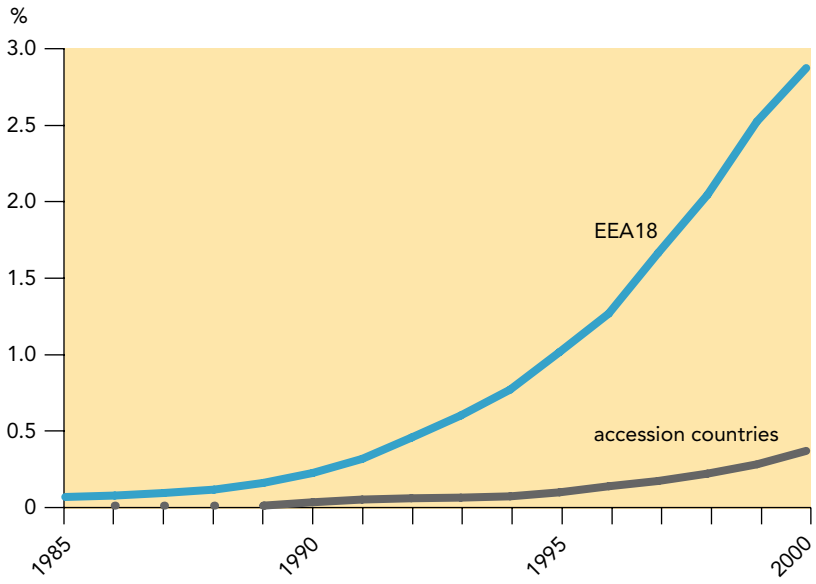
In the preparations of the RIO+5 conference on sustainable development, the EU Commissioner for the Environment asked the EEA to bring some clarity to the discussion on indicators: the sheer amount of proposals for indicators of all kinds caused confusion and there were doubts on their effectiveness.
A simple set of questions: what is happening (A) is this relevant (B) can we make progress in improving the way we do things (C), and does this contribute to our overall welfare (D)?, led to a first typology of indicators. The typology was used to demonstrate that (in 1997) the majority of indicators used in state of the environment reports and indicator sets were descriptive, answering only the question "what is happening?". The list of indicators developed consequently for the Transport and Environment Reporting Mechanism showed for the first time that moving from descriptive indicators (A-type) to performance and eco-efficiency indicators (B- and C-type) delivered more policy relevant information.
During the discussions on the EEA core set of indicators around 2000-2002, the typology of questions with the loosely connected indicator types given above, developed into the more formal typology of indicator designs and assessments presented below. At the same time an extra category of policy effectiveness indicators has been inserted.
With these changes the typology can still be used (as in the original context) to discuss the kind of information generated by a certain indicator set and, in the case of imbalances, to clarify systematically the possibilities to move to more advanced indicators. In addition, the typology allows for a structured discussion on the type of assessments that are needed for the various variables used for describing a problem. E.g. an assessment of policy actions to reduce water use (evaluated on the basis of water consumption distance to targets, type B), would be accompanied by water use efficiency in main sectors (type C) and water pricing (type A).

4.2 Descriptive indicators (Type A)

Descriptive indicators are usually presented as a line diagram showing the development of a variable over time, for example 'cadmium contents in blue mussels', 'number of indigenous species in biogeographical regions', or 'share of organic farming in total agricultural area' (see figure 4.1). They are most commonly used as state, pressure or impact indicators.

If descriptive indicators are presented using an absolute scale, such as in "mg/kg dry matter", the relevance of the numbers given is often difficult to assess for a layman. Presentation in comparison with another relevant variable (such as in figure 4.1) or as a performance indicator (see next section) often improves their communicative value.

Figure 4.1. *Example of a descriptive indicator: Share of organic farming in total agricultural area, EEA18 and accession countries*



Source: *FAO; Eurostat; Lampkin*

4.3. Performance indicators (Type B)

Performance indicators may use the same variables as descriptive indicators but are connected with target values. They measure the 'distance(s)' between the current environmental situation and the desired situation (target): 'distance to target' assessment. Performance indicators are relevant if specific groups or institutions may be held accountable for changes in environmental pressures or states. They are typically state, pressure or impact indicators that clearly link to policy responses.

Most countries and international bodies currently develop performance indicators on the basis of (nationally or internationally) accepted policy targets or tentative approximations of sustainability levels (often called Sustainable Reference Values) The choice between policy targets and sustainability levels has important implications for the presentation and the analysis of the indicators. Typical performance indicators are shown in figures 4.2 and 4.3.

Figure 4.2. *Example of a performance indicator: EU greenhouse gas emissions*

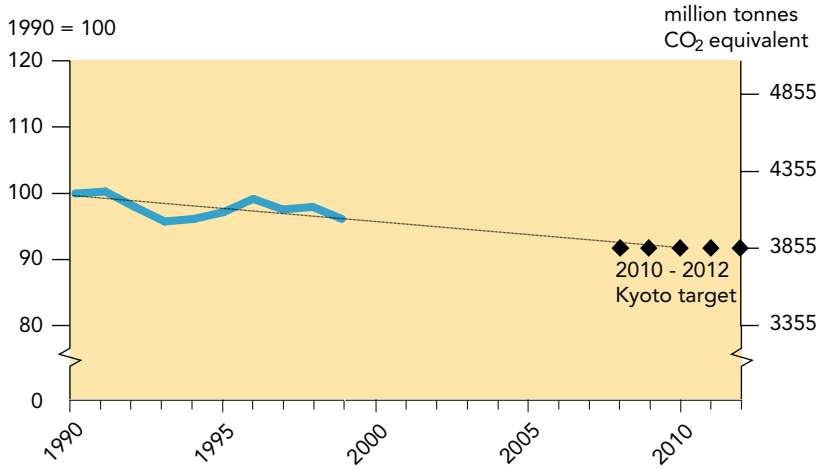
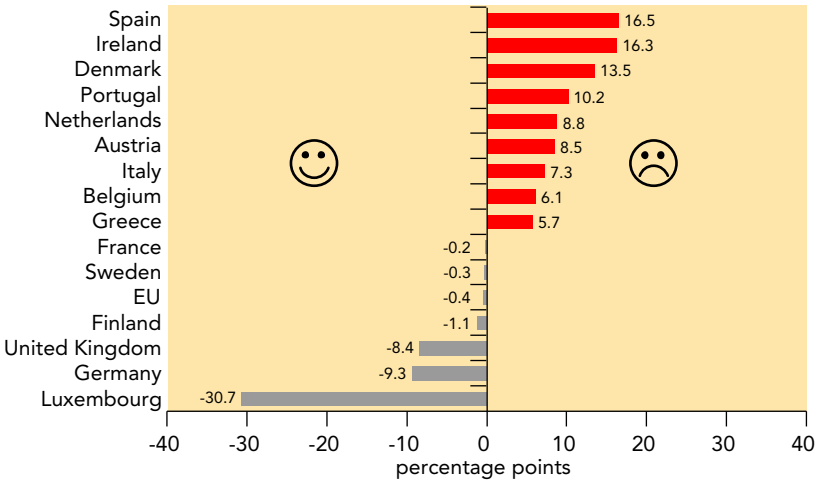


Figure 4.3. *Example of a performance indicator: Distance-to-target for greenhouse gas emissions for EU Member States in 1999 (Kyoto Protocol and EU burden sharing targets)*



Note: This is a specific variant of distance-to-target indicators in the sense that it does not show the absolute distance-to-target, but it gives a presentation of how close the current emissions (1999) are to a linear path of emissions reductions (or allowed increases) from 1990 to the Kyoto target for 2008-2012. The unit is percentage points with 1990 emissions being 100 %. For example, if a country's target is 10 % (by 2008-2012) from 1990 levels, the theoretical 'target' in 1999 would be a reduction of 4.5 %. If the actual emission in 1999 is an increase by 3 % the 'distance to target' index is 3+4.5 or 7.5 percent points.
Source: EEA, based on Member States data reported to UNFCCC and European Commission

4.4. Efficiency indicators (Type C)

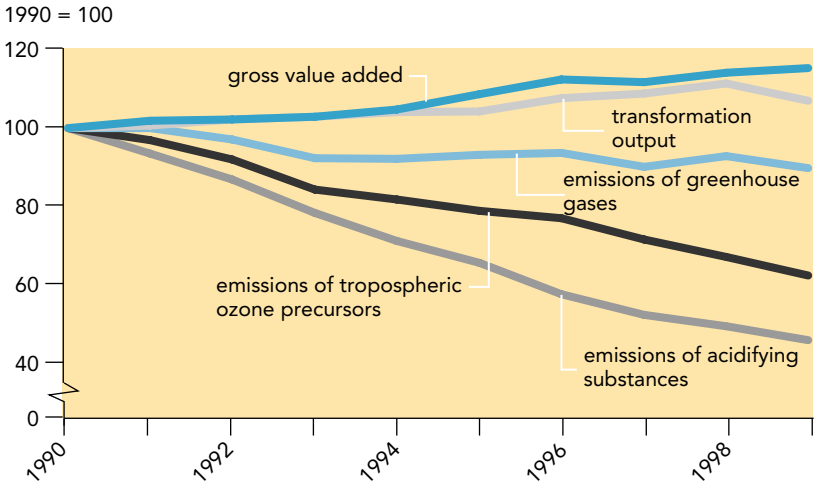
These indicators relate drivers to pressures. They provide insight into the efficiency of products and processes in terms of resources, emissions and waste per unit output. The environmental efficiency of a nation may be described in terms of the level of emissions and waste generated per unit of GDP. The energy efficiency of cars may be described as the volume of fuel used per person per kilometer travelled.

Most relevant for policy-making are indicators that show the most direct relation between environmental pressures and human activities. Sometimes an output measure in monetary terms, such as value added, can be a good representation of the development of human activities, but in many cases a physical output measure is more appropriate.
For clarity reasons, these indicators are best presented with separate lines rather than as a ratio. This is because eco-efficiency is a relative concept. If the growth of an activity outweighs the eco-efficiency gains, then the burden on the environment still increases. Therefore and absolute decoupling of environmental pressure from economic development is often necessary. Figure 4.4. gives a good example for the energy supply sector. The diverging lines for gross value added and transformation output on the one hand, and the emissions on the other, indicate increasing eco-efficiency.

Presented in this way, eco-efficiency indicators combine pressure and driving force indicators in one graph.

We speak of a relative decoupling if the pressure is still increasing though at a lower rate than the driving force variable. If the pressure decreases with an increase of the driving force, then an absolute decoupling of the two variables occurs.

Figure 4.4. *Example of an eco-efficiency indicator: eco-efficiency in the energy supply sector, EU*



Note: Gross value added of fuel and power products is at constant 1995 prices. Energy supply sector emissions include emissions from energy industries and fugitive emissions. Weighting factors have been used to aggregate emissions of individual substances according to their potential polluting effect.
Source: EEA; Eurostat; NTUA

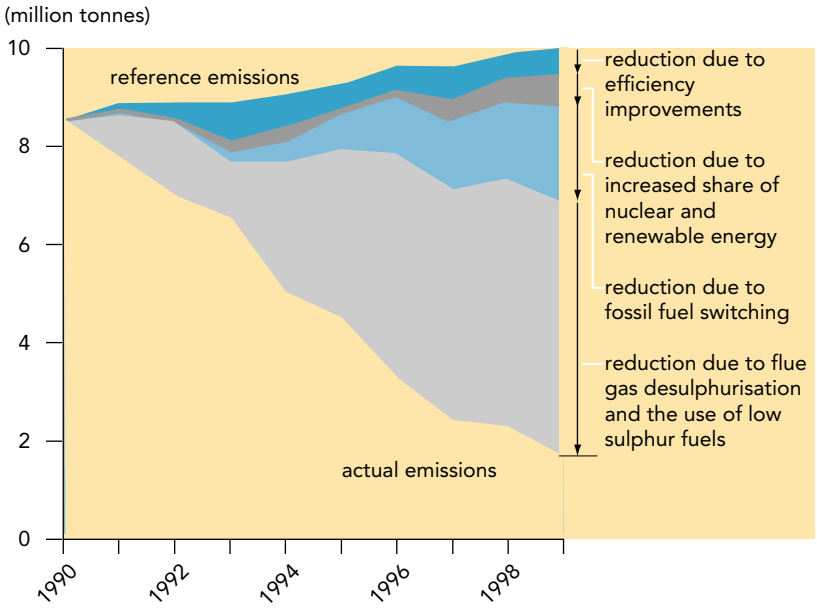
4.5. Policy-effectiveness indicators (Type D)

Policy effectiveness indicators relate the actual change of environmental variables to policy efforts. As such they are a link between response indicators on one hand and state, driving force, pressure or impact indicators on the other. They are crucial in understanding the reasons for observed developments. The Dutch yearly environmental indicator report (RIVM, 2000) contains several examples of this type of indicator. First examples for the EU have been published in EEA's Environmental signals report (EEA, 2001b and EEA, 2002).

Whereas for the previously mentioned indicators an assessment text is necessary to communicate the background information on the reasons behind the development of an indicator, for policy-effectiveness indicators much of this information is included in the graph. The production of this type of indicator requires a considerable amount of quantitative data and expert knowledge. With the expected increase in national and European capacities to do policy analysis, it is likely that this type of indicator will develop from the current model which links with technical measures (such as "desulphurisation" in the graph below) to a model that makes the link with the policy decisions that started off these technological changes.

Apart from the indicator as shown in fig. 4.5, there are several other ways to present information on the effects of policy measures. Often a presentation of two elements in one figure is used, for instance the development of a pressure indicator together with information on, for example, the timing of policy measures, or the price effect of economic instruments.

Figure 4.5. *Example of a policy-effectiveness indicator: Reduction of emissions of sulphur dioxide in the electricity sector, EU*



Source: EEA

4.6. Total Welfare indicators (Type E)

In any discussion on sustainability and human welfare, the balance between economic, social and environmental development will ultimately be crucial. Efforts are underway to design balanced sets of individual indicators to support decision-making. However for an integral assessment, some measure of total sustainability would be desirable to answer the question: "are we on the whole better off?". A variant of 'Green GDP', such as the Index of Sustainable Economic Welfare (ISEW) or "genuine savings", may be used for this purpose. In a possible next edition of this typology, more attention will be given to these indicators in the framework of a general discussion on sustainable development indicators.

5. Indicator based reporting

A framework and some understanding of various ways of presentation of indicators are, however, not enough to develop a working list of indicators and an indicator-based report. It is EEA's experience that a framework and a typology of indicators are only tools in an indicator development process. Setting up such a process and involving the various partners is equally important as scientific and technical knowledge of the issue.

This paragraph is a first description of requirements of an indicators based reporting process. Any good process of indicator based reporting can be summarised in six steps:

Box 5.1. *Indicator based reporting summarised*

1. Agree on a story: a description of the problem and its solutions;
2. List (most important) policy questions that arise from the problem description;
3. Select (ideal and actual) indicators that come close to answering these;
4. Data compilation;
5. Assessment;
6. Conclusion and communication of key messages (and modify, adapt, update and iterate).

Many coordinators of indicator reporting processes jump immediately to Step 3 and begin with a discussion on the selection of indicators. Instead it is better to start with Step 1 and agree on what the indicators should report about. This discussion about how the problem should be framed, should involve all relevant stakeholders to ensure that they "own" the resulting indicators. Ideally, the stakeholder consultation must include policy-makers, but also representatives of the non-governmental organisations involved in the problem as well as scientists. Together they should develop what is here called "the story": a description of the stakeholders' view on the problem and the ways they see it solved. The "story" focuses and frames the problem. It is here that the understanding of the DPSIR framework and its dynamics enters the process. DPSIR-thinking helps to systematise the causes of a problem and the various responses.
The "story" also describes the demarcation of the problem area. For instance, during the development of indicator based reporting on waste, the inclusion or exclusion of nuclear waste issues needs to be discussed.

Of course, there is a close relation between policies and strategies in an area and the indicators "story". The latter however, may go deeper into causes and measures that are slightly outside a specific policy and make the link with other policies and developments in society. The indicators' "story" will often also pay more attention to describing the scientific knowledge regarding a problem, to allow for a proper communication of all relevant factors in environmental and societal processes, like multi-causality, critical thresholds and incompatibility of the use of various functions of the environment. By doing that a possibly more complete overview of all possible policy levers is provided.

One should be clear that the development of the "story" brings out the hopes, beliefs and the ethical standpoints of those involved in developing the indicators, including the policy-makers who designed the policies the indicator are intended to follow.
An example of a short "story" on transport problems in Western Europe is given in box 5.2.

Box 5.2. *Description of transport problem in the EU*

- Growing greenhouse gas emissions from the transport sector jeopardise the achievement of EU's emission reduction target under the Kyoto Protocol;
- Impacts on air quality, noise nuisance and the increasing fragmentation of EU's territory, are equally worrying;
- Transport growth - which remains closely linked to economic growth - and the shift towards road and aviation are the main drivers behind this development;
- Technology and fuel improvements prove to be only partly effective to reduce impacts;
- They need to be complemented with measures to restrain the growth in transport and to redress the modal balance.

The next step is to become more precise on the issues and questions policy-makers are wrestling with. Within the framework of the "story" the main questions need to be defined. Ideally there should be a balance in questions related to causes, effects and solutions to the problem. Box 5.3 lists the main questions belonging to the transport storyline, which can be easily adapted to other sectors and issues. It should be noted that apart from describing the issue, there is a fair amount of attention to the various policy levers that might bring changes to the situation: planning tools, investment strategies, pricing policies, technology policy and improving the knowledge.

Box 5.3. *Seven key questions on transport and the environment in the EU*

1. Is the environmental performance of the transport sector improving?
2. Are we getting better at managing transport demand and at improving the modal split?
3. Are spatial and transport planning becoming better coordinated so as to match transport demand to the needs of access?
4. Are we optimising the use of existing transport infrastructure capacity and moving towards a better-balanced intermodal transport system?
5. Are we moving towards a fairer and more efficient pricing system, which ensures that external costs are internalised?
6. How rapidly are improved technologies being implemented and how efficiently are vehicles being used?
7. How effectively are environmental management and monitoring tools being used to support policy and decision-making?

The list of policy questions then becomes the main driver for the selection of indicators. The indicators will become the main tools to communicate the answers to the questions formulated. Hence, step 3 in the process is to select and define the indicators linked to the policy questions. It is important not only to consider indicators for which data are currently available, but also to define indicators for the future. This step results in a list of 'available' and 'desirable' indicators.

Of course, not all policy questions can be linked to a quantitative indicator for tracking progress. For example, a policy intention such as "to prevent smuggling of CFCs" should theoretically be followed up by an indicator on illegal imports and exports of CFCs, but in practice data for this are lacking. Still it is EEA's experience that the majority of policy questions phrased can be approached by indicators that are reasonably suited for tracking progress.

There is a connection between the kind of policy questions and the type of indicator and assessment (see the previous chapter) that is used to provide an answer to the questions. Generally questions on environmental performance will be answered using descriptive or, preferably, performance indicators. For questions regarding improvement of processes, eco-efficiency indicators are the most appropriate. For questions regarding the effectiveness of policies (such as # 7 in box 5.3) policy-effectiveness indicators would be ideal.

Often, indicators are constructed using various datasets. Before starting the data collection it is important to unravel the data requirements of the indicators proposed. Table 1.4 in the Guidelines for the data collection for the Kiev report (EEA, 2001c) provides an example of the splitting up of indicators in the individual datasets needed to compile them. The next step is then the gathering of the data.

Having done that, one of the most important steps in indicator reporting begins: the writing of the indicator-based assessment. Based on existing knowledge, outcomes of more detailed studies, literature, the comparison with other data and indicators, an explanation is provided on the reasons why an indicator is developing as it does. As far as possible the various factors steering the development of an indicator should be distinguished. These factors being: natural processes, changes in the size and structure of the economy or society, and finally changes deliberately brought about by environmental policies. If data are available, costs and other effects of the measures taken should be mentioned, as well as possible difficulties on the way to reaching targets or reference values. Specific regional phenomena influencing the indicator should be highlighted, such as for example a strong economic growth, or extreme poverty in one specific region.

Having done the analysis for each of the indicators, an assessment should be made on the developments as shown by the whole set of indicators. In this phase connections should be made between the processes influencing all indicators. This synthesising analysis should bring out successes and failures of environmental and other policies in the wider context of the problem. This phase also includes the identification of side effects of these policies, such as those identified and proposed in “multi-pollutant–multi-effect” strategies, or the intended and unintended impacts of the use of many economic instruments. The analysis may also show where the policy framework is fragmented. Often this writing stage involves the completion of the coverage of the report in areas, which cannot be described satisfactory with indicators. Descriptive text, supporting and anecdotic data help to complete the full picture.

In addition, assessments usually pay attention to what we do not know about the causes of environmental change or the effects of measures. Datagaps and uncertainties may be highlighted and possible new problems or policy options introduced.

The last and very important stage is the communication of the outcomes and conclusions to the network of people making or influencing decisions. The assessments are generally published in indicator reports, indicator bulletins or on the Internet, but in the six months after publication ample time should be reserved for reaching out with dedicated presentations.

Simultaneously preparations are made for an improved next round of reporting.

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