8

Frameworks for Environmental Assessment and Indicators at the EEA

David Stanners, Peder Bosch, Ann Dom, Peter Gabrielsen, David Gee, Jock Martin, Louise Rickard, and Jean-Louis Weber

Over the past 10 years the European Environment Agency (EEA) has published assessments and indicators on most European environmental issues. These assessments and indicators are changing to reflect the increasingly cross-cutting nature of new environmental issues such as water management, biodiversity and ecosystem services, climate change and biofuels, health, and chemicals. Assessments are also needed to capture changes across the enlarged European Union (EU)—which covers more socially, economically, and biogeographically diverse countries—to cover longer time spans, and to include more scenario analyses and models. These new and increasingly demanding challenges put a spotlight on the manner and underlying assumptions of knowledge creation.

In this context, this chapter presents some key EEA frameworks that underpin the approaches taken to build environmental data, information, and indicators. These frameworks have already proved useful to the EEA and others and appear to be robust. However, to help improve and extend their application to complex and persistent environmental problems, we welcome extended peer review as a step toward their improvement.

Why do we need frameworks? Applying frameworks to analyze and structure information helps us move from data to information and on to the structured knowledge needed to elucidate environmental and sustainability issues and to design effective responses. However, experience shows that available knowledge is not systematically put to use in policy: "Policy-makers only take that knowledge in consideration that does not cause too great tension with their values. . . . These values are embedded in 'policy frames' or 'policy theories.' Knowledge that does not fit into these policy theories is not agreeable and will be discarded" (Veld 't 2004:83).

Therefore, the purpose of these frameworks is to help improve the organization, structuring, and analysis of environmental information, to increase the use of information and the consistency of its handling, to minimize mishandling, and to help avoid gaps in analysis and assessments. "If the principal actors do not agree about the problem definition, the values that are at stake and the knowledge that is thought to be relevant, we consider the problem unstructured" (Veld't 2004:83). Thus, if we gain agreement on frameworks, information generated based on them has a greater chance of acceptance, improving the effectiveness of associated indicators and assessments. Work in this area contributes to the framing of complex environmental problems and helps policymakers frame sound and effective policy measures.

The DPSIR Analytical Framework

To structure thinking about the interplay between the environment and socioeconomic activities, the EEA uses the driving force, pressure, state, impact, and response (DPSIR) framework, a slightly extended version of the well-known Organisation for Economic Co-operation and Development (OECD) model (Figure 8.1). This is used to help design assessments, identify indicators, and communicate results and can support improved environmental monitoring and information collection.

According to the DPSIR system analysis view, social and economic developments drive changes that exert pressure on the environment; consequently, changes occur in the state of the environment. This leads to impacts on, for example, human health, ecosystem functioning, materials (such as historic buildings), and the economy, where *impacts* refers to information on the relevance of the changes in the state of the envi-

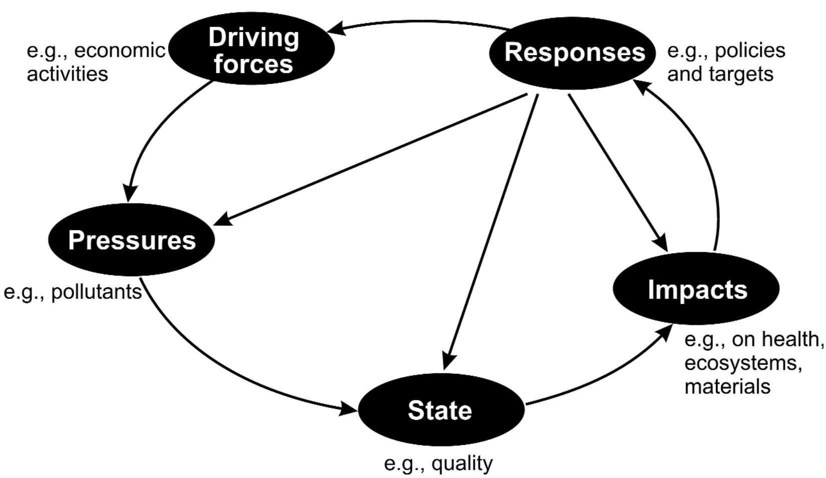

Figure 8.1. DPSIR framework for reporting on environmental issues (courtesy of the EEA).

ronment. Finally societal responses are made that can affect earlier parts of the system directly or indirectly. Many assessments and sets of environmental indicators used by national and international bodies refer to or use directly this DPSIR framework or a subset or extension of it (see the EEA's core set of indicators [CSI]).[1]

The first indicator framework commonly known is the stress–response framework, developed by two scientists working at Statistics Canada, Anthony Friend and David Rapport (personal communication, 1979). Their STress Response Environmental Statistical System (STRESS) framework was based on ecosystem behavior distinguishing between environmental stress (pressures on the ecosystem), the state of the ecosystem, and the ecosystem response (e.g., algal blooms in reaction to higher availability of nutrients). However, the original ideas encompassed all kinds of responses.

When the STRESS framework was presented to the OECD, the ecosystem response was taken out in order to make the concept acceptable to the OECD. The rephrasing of *response* to stand only for societal response led to the OECD pressure, state, response (PSR) model. *Pressures* encompassed all releases or abstractions by human activities of substances, radiation and other physical disturbances, and species in or from the environment. *State* was initially limited to the concentrations of substances and distribution of species.

Because environmental statisticians dealt not only with PSR categories, an early DPSIR model came into use at various statistical offices in the early 1990s as an organizing principle for environment statistics. This framework for statistics described human activities, pressures, state of the environment, impacts on ecosystems, human health and materials, and responses. The Dobris Assessment (EEA 1995a) was also built on this idea.

With the development of the large environmental models Regional Air Pollution INformation and Simulation Model (RAINS) and Integrated Model to Assess the Global Environment (IMAGE) by the International Institute for Applied System Analysis (IIASA) and the Dutch National Institute for Public Health and the Environment (RIVM), the DPSIR model became further formalized, with a precise differentiation between driving forces, pressures, the resulting state of systems, the impacts (including economic), and policy responses. However, it was the EEA that made the simplified DPSIR framework more widely known in Europe. The RIVM report "A general strategy for integrated environmental assessment at the EEA" (EEA 1995b) provided the analytical basis for the DPSIR framework. It was accepted by the EEA Management Board at that time as the basis for integrated environmental assessment.

Over the past 20 years, the analytical framework has developed from a tool to describe natural ecosystems under stress to an overall framework for analyzing many different environmental problems. Furthermore, the DPSIR model has not only been useful as a framework for analyzing environmental problems and identifying indicators. It has also been important for establishing the wide scope of work necessary for effective environmental assessments: When in its early years of operation pressure was being put on the EEA to confine itself to working on the "state of the environment," the DPSIR framework provided an effective tool to legitimize work on driving forces and responses.

From a policy point of view, there is a clear need for information and indicators on all parts of the DPSIR chain:

Indicators for *driving forces* describe the social, demographic, and economic developments in societies and the corresponding changes in lifestyles and 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 pressures 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. 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 by sector, the use of materials for construction, and the amount of land used for roads.

State indicators give a description of the quantity and quality of physical phenomena (e.g., temperature), biological phenomena (e.g., fish stocks), and chemical phenomena (e.g., atmospheric CO_2 concentrations) in a certain area. For example, state indicators may describe the forest and wildlife resources present, the concentration of phosphorus and sulfur in lakes, or the level of noise in the neighborhood of airports.

Impact indicators are used to describe the relevance of changes in the state of the environment. They are often compared against a threshold or may be measurements of exposure. Examples include frequency of fish kills in a river or the percentage of population receiving drinking water below quality standards.

Response indicators refer to responses by groups and individuals in society and 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 because they aim to redirect prevailing trends in consumption and production patterns. Other responses aim at raising the efficiency of products and processes by 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 broad response indicator is that describing environmental expenditures.

To use this framework to look at the dynamics of the system means that we have to understand what happens in the links between D, P, S, I, and R (Figure 8.2). For example, eco-efficiency indicators such as emission coefficients and energy productivity show what happens between driving forces and pressures. This kind of information

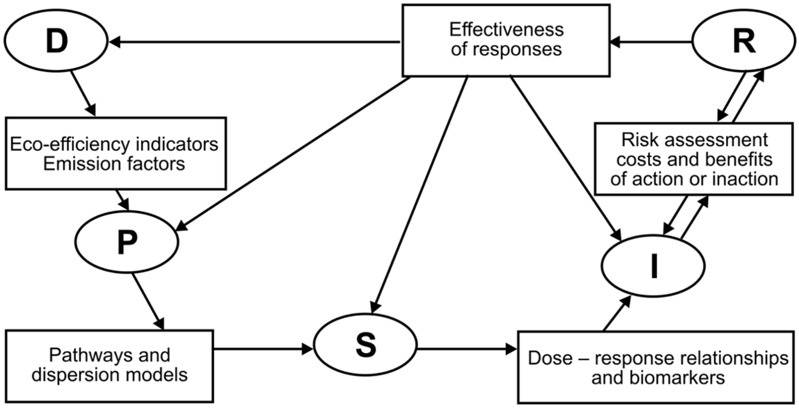

Figure 8.2. DPSIR links and associated information flows (courtesy of the EEA).

helps us answer such questions as "Are we succeeding in making shifts in the economy, such as decoupling?" and "Are we making technological progress?" The combination in one diagram of the pressure (release of nutrients from agriculture) and the state (development of nitrate concentration in surface waters) tells a story of time delay in natural processes and the possible "time bombs" created in the environment. A focus on links generates the need for new information flows (EEA 1999a).

To help better address the effects of human exposure to environmental factors, the World Health Organization (WHO 2002) has extended DPSIR to the DPSEEA model (Figure 8.3). How people react to environmental exposures depend in part on their individual makeup (e.g., their genetics, health, fitness, and age), where they live, frequency of exposure, and what they have been exposed to before. The effects of exposure therefore are the result of a multicausal chain of risks and probabilities. By adding an extra step in the chain between state and response, the DPSEEA framework attempts to capture the multicausal effects of exposure (see also Chapter 9). Although the effects of human exposures are not readily reduced to a simple linear cause-and-effect framework, the DPSEEA model is helping to guide the development of environmental health indicators to support the development of effective policies to protect human health and the environment and to measure their effectiveness (WHO 2004).

The DPSIR Framework and the Policy Life Cycle

When designing indicator lists, conscious use should be made of the DPSIR framework and the policy life cycle (Figure 8.4). For problems that are at the beginning of their policy life cycle (i.e., the stage of issue identification), indicators on the state of the environment and on impacts play a major role (Figure 8.5). In theory, sentinel indicators could play an important role giving advance warning of alarming developments in the

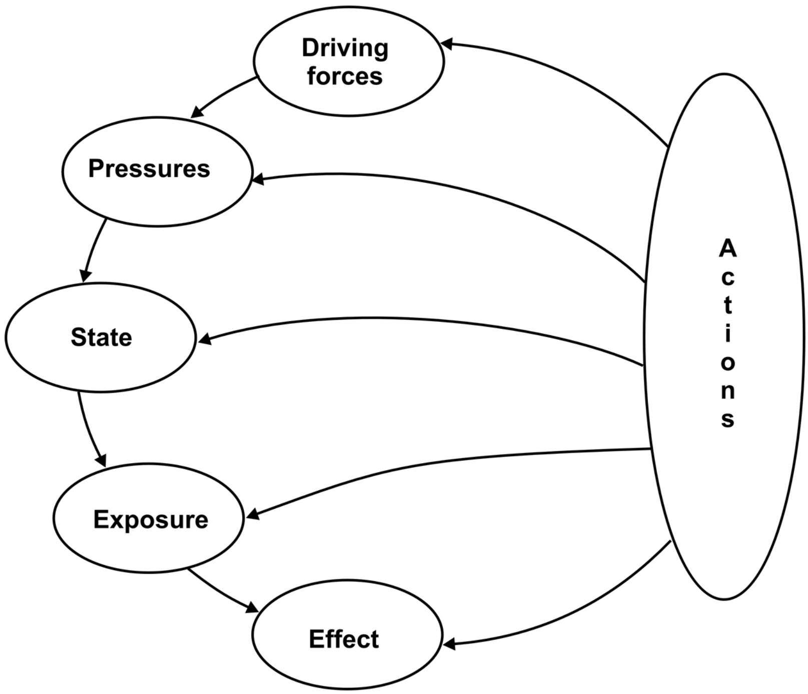

Figure 8.3. DPSEEA model of environmental health (WHO 2002).

state of the environment to allow precautionary measures to be taken. However, few such indicators have been identified that are reliable and would command the attention of decision makers. The best-known cases of state indicators that give rise to policy reactions are those showing the sudden decline of selected species (e.g., fish in acidified Scandinavian lakes, seals in the Dutch Waddensea), surface water quality (e.g., salt in the river Rhine, which was used for irrigation in horticulture), and air quality in cities (e.g., summer smog in Paris and Athens).

This function of state indicators is 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. Nevertheless, there is 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 in which indicators of climate change impacts such as extreme weather events (heat waves, floods, and storms), the number of hot summers, average temperatures, the movement of treelines, and species distribution are being used to gather political support for the Kyoto Protocol. Such indicators rise in importance when political opposition increases.

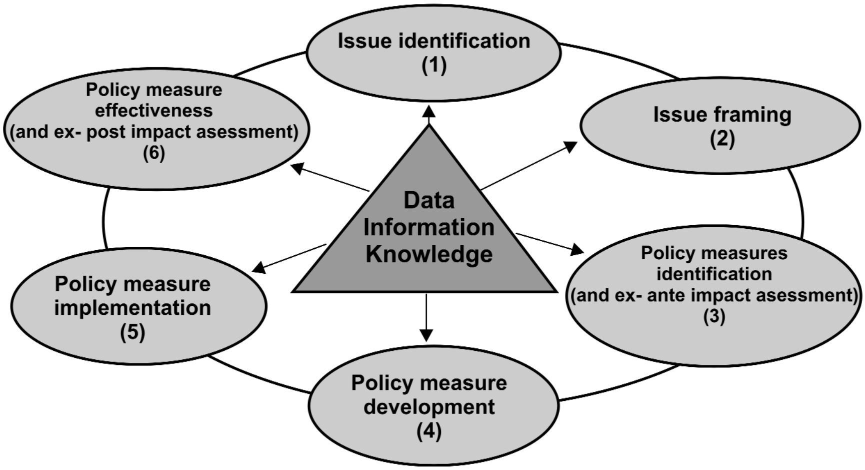

Figure 8.4. Main stages in the policy life cycle, supported by data, information, and knowledge (courtesy of the EEA).

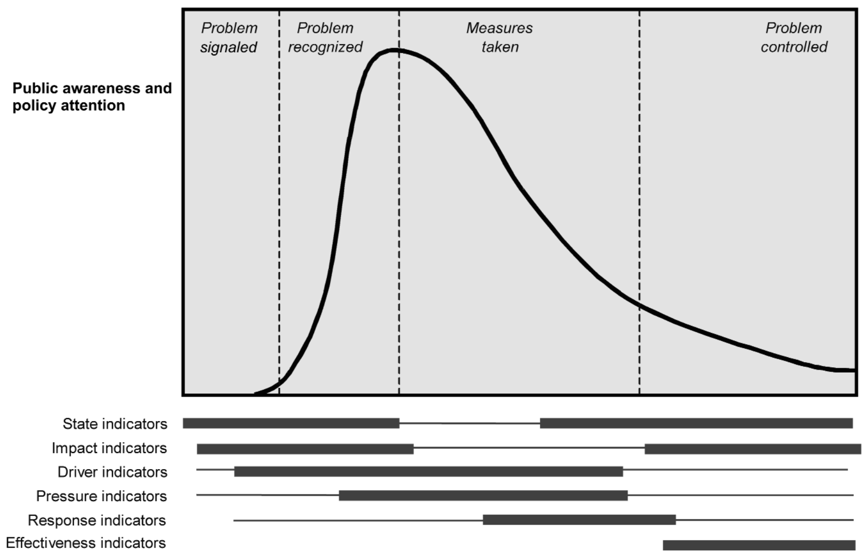

Figure 8.5. Indicator use in the policy life cycle (courtesy of the EEA).

In the next and longer stages of the policy cycle (formulation of policy responses, implementation of measures and control), policymakers focus on what they can influence: the driving forces through volume measures, the pressures with technical measures, and responses with educational projects. Performance indicators on changes in driving forces and pressures are used most often in this phase. The state of the environment is only a derived result of activities in society, and policy reactions and hence state indicators are less important, except in 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 are important measures of progress.

In the last, control phase of the policy cycle, state indicators become important again for watching the recovery of the environment, and a limited number of these indicators are used to continuously monitor the state of the environment. They are accompanied by an equally limited number of indicators on driving forces, pressures, and responses to monitor the behavior of the whole system. As implementation begins to demand effort and resources, impact indicators are again needed to remind people why efforts are needed and to reveal improvements. Effectiveness indicators then come into play to assess outcomes of the policy.

A Typology of Indicator Designs

The DPSIR framework has analytical significance for indicators in a policy context. In such a context, environmental indicators are used for three major purposes:

- To supply information on environmental problems, in order to enable policymakers to evaluate their seriousness (this is especially important for new and emerging issues)
- To support policy development and priority setting by highlighting key factors or places in the cause-and-effect chain that cause pressure on the environment and that policy can target
- To monitor the effectiveness of policy responses

Regardless of its position in the DPSIR system, an indicator should always convey a clear message, based on relevant variables (Box 8.1). The indicator typology outlined here aims to provide a classification to aid indicator design. As a means of structuring and analyzing indicators and their related environment–society interconnections, the typology can be used to analyze existing indicators to check their coverage and suitability and can also help to identify possible gaps, pinpoint indicator requirements, and support indicator construction.

Descriptive Indicators (Type A): "What's Happening?"

Descriptive indicators can be used for all elements of DPSIR, although they are seen most commonly as state, pressure, or impact indicators. They can be represented as

Box 8.1. What is an indicator?

Indicators always simplify a complex reality, focusing on certain aspects that are regarded as relevant and for which data are available. Indicators are meaningful only as part of a framework or story. Indicators are a necessary part of the stream of information we use to understand the world, make decisions, and plan our actions.

Indicators are communication tools that

- Simplify complex issues, making them accessible to a wider, nonexpert audience.
- Can encourage decision making by pointing to clear steps in the causal chain where it can be broken.
- Inform and empower policymakers and laypeople by creating a means for the measurement of progress in tackling environmental progress.

Indicators cannot replace scientific studies of cause and effect. They are presentations of associations and links between variables. When we choose to present variables together as part of an indicator, we make an explicit assumption of the connection between them. Indicators therefore can never replace statistical analyses of data or the development and testing of sound hypotheses.

Source: EEA.

numbers, in pie or bar charts, on maps or other forms, and in line graphs, which are commonly used to present trends in a variable over time, such as the cadmium content of blue mussels, the number of indigenous species in biogeographic regions, or the share of organic farming in an agricultural area (Figure 8.6).

If descriptive indicators are presented in absolute terms, such as "mg/kg dry matter," the relevance of the numbers given is often difficult for a nonexpert to assess. Comparison with another relevant variable (as in Figure 8.6) or as a performance indicator often improves their communication value.

Performance Indicators (Type B): "Does It Matter?" ("Are We Reaching Targets?")

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

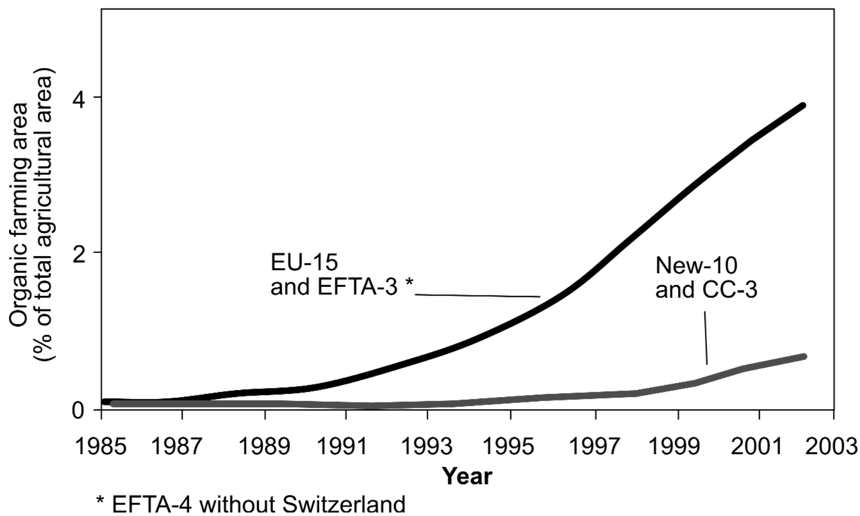

Figure 8.6. Example of a descriptive indicator: Share of organic farming in total agricultural area (courtesy of the Institute of Rural Sciences, University of Wales, Aberystwyth).

Most countries and international bodies develop performance indicators on the basis of nationally or internationally accepted policy targets or tentative approximations of sustainability levels. A typical presentation of a performance indicator is shown in Figure 8.7.

Efficiency Indicators (Type C): "Are We Improving?"

Efficiency 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 gross domestic product (GDP). The energy efficiency of cars may be described as the volume of fuel used per person per mile traveled.

An absolute decoupling of environmental pressure from economic development is necessary for sustainable development. Most relevant for policymaking, therefore, are indicators that show the most direct relationships between environmental pressures and human activities. For reasons of clarity, these indicators are best presented with separate lines rather than as a ratio. Figure 8.8 gives a good example for the energy supply sector. The diverging lines for energy consumption and GDP indicate increasing eco-effi-

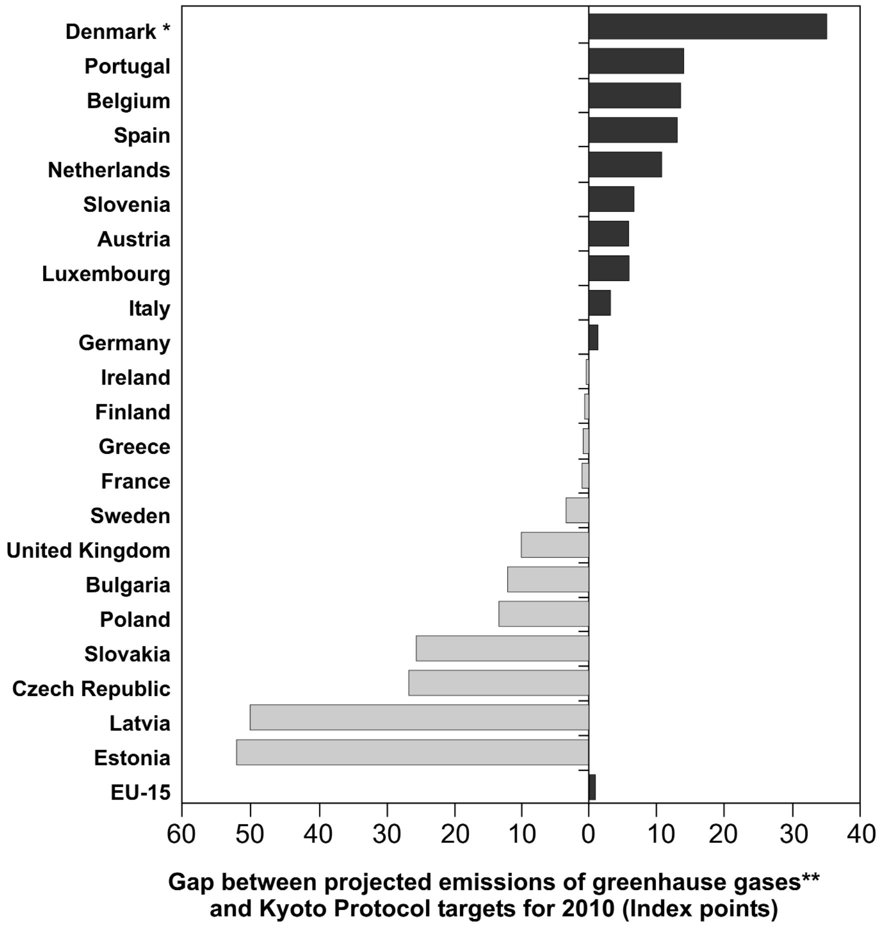

Figure 8.7 Example of a performance indicator: Projected progress toward Kyoto Protocol targets (courtesy of the United Nations Framework Convention on Climate Change UNFCCC, DG Environment, European Commission).

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

Policy Effectiveness Indicators (Type D): "Are the Measures Working?"

Policy effectiveness indicators relate the actual change of environmental variables to policy efforts. Thus, they are a link between response indicators and driving force, pressure,

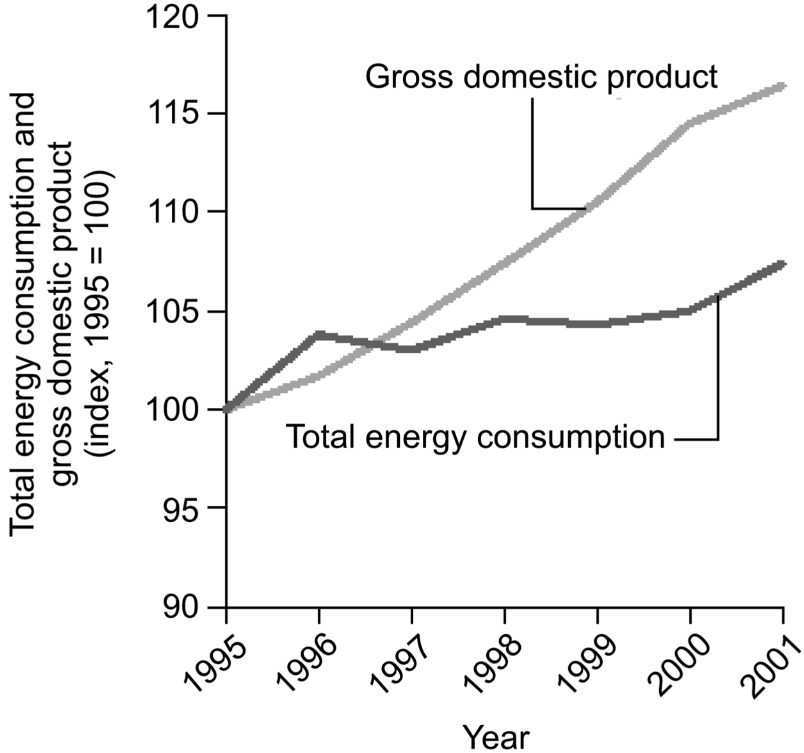

Figure 8.8. Example of an eco-efficiency indicator: Total energy consumption and gross domestic product, EU-25 (courtesy of Eurostat).

state, or impact indicators. They are crucial in determining the reasons for observed developments. The Dutch yearly environmental indicator report (RIVM 2000) contains several examples of this type of indicator. The first examples for the EU have been published in EEA's *Environmental Signals* reports (EEA 2001a, 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 takes a large amount of quantitative data and expert knowledge. With the expected increase in national and European capacities to carry out policy analysis, it is likely that this type of indicator will develop from the current model, which links with technical measures (e.g., decrease in sulfur emissions in Figure 8.9), to a model that indicates the link with the policy decisions that started off the technological changes.

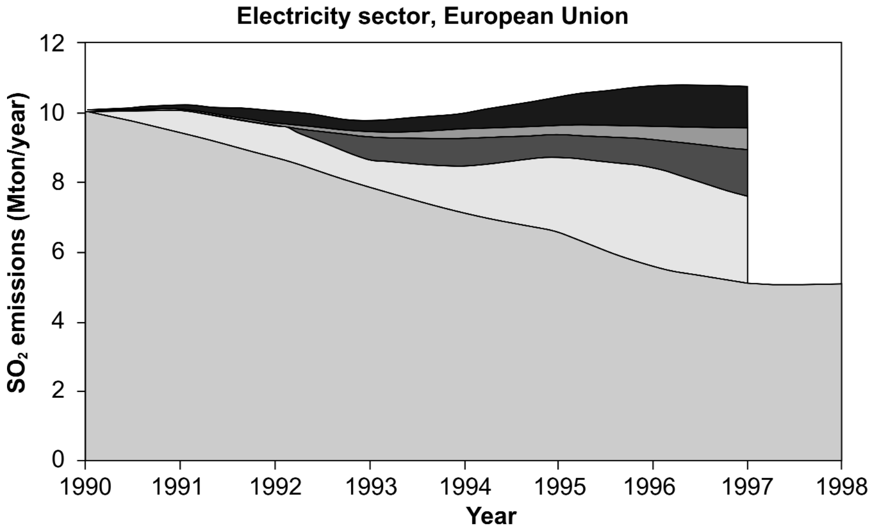

Figure 8.9. Example of a policy effectiveness indicator: Reduction of sulfur dioxide emissions in the electricity sector, EU (courtesy of the EEA).

Total Welfare Indicators (Type E): "Are We on the Whole Better Off?"

In any discussion of sustainability and human welfare, the balance between economic, social, and environmental development is crucial. For an integral assessment, some measure of total sustainability is needed in the form of a green GDP. The Index of Sustainable Economic Welfare (ISEW) is one such example that also includes measures of inequalities and of nonpaid work.

Toward a Common Indicator Development Process

Although the frameworks and typologies described in this chapter are useful tools for building indicators, the process chosen for building indicators can also have an important influence on the relevance, effectiveness, and scientific underpinning of the indicators. Based initially on EEA's experience with developing the Transport and Environment Reporting Mechanism (TERM)[2] (EEA 1999b and 2001b) and its CSI, six important steps have been identified for an effective indicator-building process (Box 8.2).

Beginning the indicator development process with agreement on a story establishes a clear and explicit understanding of the purpose of the indicators. The indicator story must be closely linked to relevant policies, strategies, and related objectives and should address causes, measures, and links with other policies and societal developments. In

Box 8.2. Six steps of indicator building.

1. Agree on a story.
2. List policy questions.
3. Select indicators (ideal and actual).
4. Define and compile data.
5. Interpret indicators.
6. Modify, adapt, update, and iterate conclusions.

Source: EEA.

addition, the story should describe relevant scientific knowledge, including factors such as multicausality, critical thresholds, and uncertainties.

To develop ownership and increase relevance, the story must be developed with all relevant stakeholders. The design of the story involves the description of the stakeholders' views about the issue, the limits of the problem being addressed, and how they think it should be solved. Such an approach brings out the hopes, beliefs and ethical standpoints of the stakeholders, including those of the policymakers who design the policies that the indicators are intended to track, improving the relevance of the resulting indicators. An example storyline for the environment–transport problem is summarized in Box 8.3.

Once a clear story is established, it is important to make explicit the relevant policymakers' questions. Ideally there should be a balance in questions related to causes, effects, and solutions to the problem. Box 8.4 lists the main questions of the environment–transport storyline.

Box 8.3. Description of the transport problem in the EU.

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

Source: EEA.

With the first two steps complete, defining and selecting indicators becomes a clearer and more focused exercise. When indicators for complex cross-cutting issues (e.g., measuring the positive and negative impacts of biofuels on the environment) are being developed, specific integrated frameworks must be built for assessing the broad, cross-sectoral environmental impacts to ensure that all important factors are taken into account. Indeed, even for less complex issues an explicit framework or model of relevant processes is useful to steer indicator development. The DPSIR framework can be a useful basis for such models.

To be effective, indicators must be selected that come close to answering the policy questions, taking into account the relevant environmental, societal, and economic interactions described in the framework or model for that issue and the relevant policy levers (i.e., the policy measures that could have an effect on the issue). We can improve the indicators by making connections between the type of policy questions and the type of indicators used to provide answers, as defined in the indicator typology. To ensure relevance, it is important not only to consider indicators for which data are currently available but also to identify ideal indicators that may have new requirements.

Because indicators are often constructed using a combination of data sets (e.g., map-based indicators derived from geospatially referenced data made up of multiple data layers combined in complex algorithms), it is necessary to define the algorithm of

Box 8.4. Seven key questions on transport and the environment in the EU.

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

Source: EEA.

indicator construction in the third step and unravel the data requirements before data collection in the fourth step.

Once produced, we must interpret the indicators, explaining why they are developing as they are and linking them back to the story and policy questions. This must be done in connection with other information using relevant literature, more detailed studies, and comparisons with other available data and indicators. The various factors steering the development of an indicator should be distinguished as much as possible (e.g., natural processes, changes in the size and structure of the economy or society, and changes deliberately brought about by environmental policies). Specific regional phenomena influencing the indicator should be highlighted, such as strong economic growth or differences in welfare.

The last step consists of making conclusions about the whole set of indicators, communicating them to the network of people making or influencing decisions, and preparing an improved indicator set for the next round of reporting.

Using common processes and frameworks for developing indicators will not necessarily result in a common set of indicators. Common processes, frameworks, and typologies are guides for the identification and development of indicators. They support a scientific, systematized approach, help enforce consistency with existing knowledge, and help provide balance in outcomes, including highlighting gaps. Each indicator-building process may require different indicators, but within a certain scope (and at different scales) the frameworks and typologies can be more universal. New frameworks may be needed or existing ones extended as the extent and purpose of the indicators vary, such as between environment and health issues (e.g., DPSIR and DPSEEA).

Consistency of indicators is important within a certain field for practical reasons, including data availability, coordination, and efficiency of data collection and processing. Consistent indicators can also be more effective and reliable communication tools because over time they become familiar and long-term trends can be built up. For all of these reasons, consistency and reliability favor a small core set of indicators, because the fewer the indicators, the more recognizable and manageable they are. However, a small core set does not have the flexibility of a larger indicator set for covering a full cause-and-effect framework. Also, there is a risk that as issues evolve and their scientific understanding improves, a small indicator set will stagnate unless regularly reviewed, updated, or expanded. To understand and manage this tension between stability and flexibility of indicator sets and to develop the necessary trade-offs, suitable processes must be established and run with the appropriate stakeholders. It is here that the common processes, frameworks, and typologies presented in this chapter are useful for enforcing consistent approaches and ensuring that the indicator development and selection process falls within scientific understanding and acceptable norms.

Conclusion

Indicators can be powerful tools in the communication of environmental issues to policymakers. They serve a useful function in simplifying complex issues, steering policymaking, and measuring environmental and policy progress. However, although the simplicity of indicators makes them powerful communication tools, it also represents their limitation. Determining what constitutes sustainability—environmentally, socially, and economically—and comparing current developments against these goals requires indicators to capture multidimensional trade-offs and comparisons in a single two-dimensional graphic.

Although indicators can provide the common language and the accepted yardstick for benchmarking between different countries, regions, or municipalities, they can also be misleading in their simplicity. The theoretical basis for indicator selection therefore must be modified continuously to capture current developments and maintain policy relevance.

Notes

1. The CSI, launched by EEA in March 2004 (eea.europa.eu/coreset), is intended to provide a stable and manageable basis for indicator reporting by EEA, to provide a means of prioritizing improvements in data quality from country level to aggregated European level, to enable streamlined contributions to other indicator initiatives (e.g., structural indicators), and to strengthen the environmental dimension in the sustainability debate.

2. The aim of TERM was to develop indicators to plot progress with the integration of environment into EU transport policies as part of the EU Cardiff process (CEC 2004).

Literature Cited

CEC. 2004. *Integrating environmental considerations into other policy areas: A stocktaking of the Cardiff process.* Commission Working Document COM(2004) 394 final. Brussels: Commission of the European Communities.

EEA. 1995a. *Europe's environment: The Dobris assessment.* Copenhagen: European Environment Agency.

EEA. 1995b. *A general strategy for integrated environmental assessment at the EEA.* An unpublished report for the EEA by RIVM.

EEA. 1999a. *Making sustainability accountable: Eco-efficiency, resource productivity and innovation.* Topic Report no. 11/1999. Copenhagen: European Environment Agency.

EEA. 1999b. *Towards a Transport and Environment Reporting Mechanism (TERM) for the EU: Part I and II.* Technical Report no. 18. Copenhagen: European Environment Agency.

EEA. 2001a. *Environmental signals 2001*. Environmental Assessment Report no. 8. Copenhagen: European Environment Agency.

EEA. 2001b. *TERM 2001: Indicators tracking transport and environment integration in the European Union*. Environmental Issue Report no. 23. Copenhagen: European Environment Agency.

EEA. 2002. *Environmental signals 2002*. Environmental Assessment Report no. 9. Copenhagen: European Environment Agency.

RIVM. 2000. *Milieubalans 2000. Het Nederlandse milieu verklaard* [*Environmental balance 2000, The Dutch environment explained*]. Alphen aan den Rijn, the Netherlands: Rijksinstituut voor Volksgezondheid en Milieu/Samson bv.

Veld 't in, R. 2004. The importance of being a boundary worker. In *Book of Abstracts* for "Bridging the Gap: Information for Action," Dublin, Ireland, April 28–30.

WHO. 2002. *Environmental health indicators for the WHO European region: Update of methodology*. Geneva: WHO report EUR/02/5039762.

WHO. 2004. *Environmental health indicators for Europe: A pilot indicator-based report*. Geneva: World Health Organization Regional Office for Europe.

9

Frameworks for Policy Integration Indicators, for Sustainable Development, and for Evaluating Complex Scientific Evidence

David Stanners, Ann Dom, David Gee, Jock Martin, Teresa Ribeiro, Louise Rickard, and Jean-Louis Weber

To assess sustainable development (SD), new approaches are needed to deal with the issues of system complexity, uncertainty, and ignorance. The necessary information must be condensed and made accessible to a wide and diverse audience ranging from policymakers, decision makers, and citizens who are striving to apply both precaution and prevention. These new and increasingly demanding challenges put a spotlight on the manner and underlying assumptions of knowledge creation. This chapter reviews some key approaches to building sustainability indicators, underlying models, and frameworks for evaluating complex evidence, all needed for a thorough appraisal of progress toward SD. The chapter begins by analyzing policy integration indicators, a key approach to addressing unsustainable development. It goes on to critique the SD models in use and describes how they can be misleading in the development of relevant indicators. Without a frame of reference for assessing the meaning of the generated indicators where there are complexities and uncertainties, the results can be difficult to interpret. Therefore, this chapter concludes with a framework for evaluating complex scientific evidence on environmental factors in disease causation.

Policy Integration Indicators

According to Article 6 of the EU Treaty, environmental protection requirements must be integrated into the definition and implementation of EU policies and activities. Thus, environmental policy integration (EPI) can be defined as inserting environmental requirements into other policies during their development and implementation (EEA 1999b, 1999c, 2005; CEC 2004). EPI is distinct from conventional environmental policymaking because it involves a continual process to ensure that environmental issues are reflected in all policymaking, which generally demands changes in political, organizational, and procedural activities. The aim is to secure coherent policies in all fields that can support environment and SD. Apart from demanding appropriate systems, structures, and processes to ensure that environmental considerations are taken into account, EPI should lead to real progress in terms of political commitment, policy change, and environmental improvement.

Why is there interest in EPI? It emerged because conventional environmental policy and legislation alone were insufficient to address the many driving forces and pressures exerted on the environment by key economic sectors such as energy, transport, and agriculture. Environmental concerns are insufficiently weighted in political, policy, and practical terms, leading to environmental concerns being traded off against economic concerns. Poor integration is caused by numerous factors, including a lack of high-level political commitment to environmental issues, diverging or conflicting policy objectives, and insufficiently coordinated administrations. There are many theories on the root causes of these problems, including the basic problem that organizations and their cultures are deeply entrenched and very slow to adapt to new demands and circumstances.

The European Commission's 5th Environmental Action Programme (5EAP), published in 1992, addressed integration of environment into key sectors, and in 1997–1998 increasing attention began to be paid to the critical role of key economic sectors in causing major environmental problems. This was reflected in the Cardiff Process on sectoral integration and in the EEA's "Europe's Environment: The Second Assessment" (EEA 1998). This raised the following question: How do we recognize progress and the related information gap? In order to fill this gap and to monitor progress toward sectoral integration, a number of criteria were proposed.

The criteria[1] (Table 9.1) were developed from the experience gained in applying them in particular to the Global Assessment of the 5EAP (EEA 1999b). Four sectors originally were covered at member state level: energy, transport, industry, and agriculture. Tourism was not included because it was not initially identified as a priority in the Cardiff Process.

These criteria are meant to steer assessments, information collection, and indicator development in order to be more effective for measuring integration, which is often overlooked and difficult to measure. The aim is to shed light on progress with integration in its different stages and manifestations by covering a wide range of facets of integration. This will lower reliance on end-of-pipe results arising from integration, which may take years to show up. Although these criteria were used by some organizations (e.g., CLM 1999), many of the criteria need further work to become operational.

After the initial focus in the EU in the 1990s on integrating environmental concerns into sectoral policies, increasing attention is now being given to policy coherence as a

Table 9.1. Some criteria for assessing environmental integration into economic sector activities.

A	Institutional Integration
1	Are environmental objectives (e.g., maintenance of natural capital and ecological services) identified as key sectoral objectives and as important as economic and social objectives) in a sector integration strategy?
2	Are synergies between economic, environmental, and social objectives maximized?
3	Are trade-offs between environmental, economic, and social objectives minimized and transparent?
4	Are environmental targets (e.g., for eco-efficiency) and timetables agreed? Are there adequate resources to achieve the targets within the timetables?
5	Is there effective horizontal integration between the sector, environment, and other key authorities (e.g., finance and planning)?
6	Is there effective vertical integration between the EU, national, regional, and local administrations, including adequate public and other stakeholder information and participation measures?
B	Market Integration
7	Have environmental costs and benefits been quantified by common methods?
8	Have environmental costs been internalized into market prices through market-based instruments?
9	Have revenues from these market-based instruments been directly recycled to maximize behavior change?
10	Have revenues from these market-based instruments been directly recycled to promote employment?
11	Have environmentally damaging subsidies and tax exemptions been withdrawn or refocused?
12	Have incentives been introduced that encourage environmental benefits?
C	Management Integration
13	Have environmental management systems been adopted?
14	Is there adequate strategic environmental assessment of policies, plans, and programs?
15	Is there adequate environmental impact assessment of projects before implementation?
16	Is there an effective green procurement (supply) program in public and private institutions?
17	Is there an effective product and service program that maximizes eco-efficiency (e.g., via demand-side management, eco-labeling, products to services)?
18	Are there effective environmental agreements that engage stakeholders in maximizing eco-efficiency?

(*continued*)

Table 9.1. Some criteria for assessing environmental integration into economic sector activities (*continued*).

D	Monitoring and Reporting Integration
19	Is there an adequate sector and environment reporting mechanism that tracks progress with these objectives, targets, and tools?
20	Is the effectiveness of the policies and tools for achieving integration evaluated and reported, and are the results applied?

Source: EEA (1999b).

whole. Coherence is a prominent feature of good governance (RMNO/EEAC 2003) and SD. Therefore, it is now the EU's SD strategy (European Commission 2001) and the EU governance agenda (European Commission 2001) that provide the broad framework for promoting the integration of economic, social, and environmental objectives in Europe. In practice this suggests a two-way integration, from environment into sectors and vice versa. However, EPI is specifically justified by the fact that environmental policy concerns have been persistently underemphasized in other policies. The more integrated and mutually reinforcing policies are in their formulation, the easier their effective (and cost-efficient) delivery should be. In the EU context, coherence at the political and policy levels eases the work of the institutions and subsequent (national, regional, or local) implementation efforts (Peters 1998; Wandén 2003). The burden on individual actors is also reduced if regulatory requirements are streamlined. Ultimately, policy coordination makes it more likely that multiple objectives will be met.

In this broader context, and in addition to the initial EEA EPI criteria, other attempts have been made to identify suitable ways to measure progress with integration. Prominent among these is the Organisation for Economic Co-operation and Development checklist on policy coherence and integration for SD (OECD 2002). This checklist contains five groups of questions, related to understanding, commitment and leadership, steering, stakeholder involvement, and knowledge and scientific input. Other approaches include national SD strategies and EU integration strategies (Persson 2002; Dalal-Clayton 2004; Fergusson et al. 2001).

The challenge still is to identify a small set of headline criteria and indicators that can be applied to assess progress at both the EU and the national levels, within different institutions, and relating to both cross-sectoral and sectoral efforts. Thus, building on past work, an evaluation framework for EPI was developed in 2003–2004 (Figure 9.1) from which a set of more concrete criteria were identified (Table 9.2). Presented as a checklist to ensure wide applicability, the criteria serve two main purposes: They provide a single framework for undertaking evaluations of EPI supporting consistency

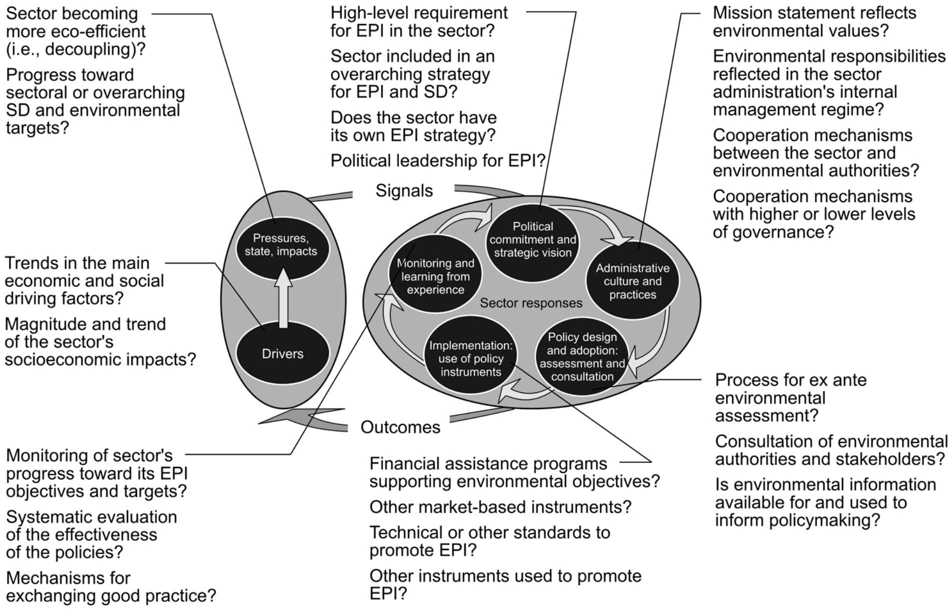

Figure 9.1. Virtuous cycle for EPI.

and shared learning between administrations and sectors, and they support understanding of how to promote integration.

Addressing the Context of Sustainability: Sustainable Development Models and the GEAR-SD Approach

The EEA role in the SD policy process lies mainly in ensuring that environmental concerns are addressed at an appropriate level in progress reports or when new policy proposals are being developed (sustainability impact assessment).

Assessing and reporting on progress with SD is a difficult and complex task. Current international SD reporting initiatives, such as the EU Spring Council reporting (using the “structural indicators”) and ongoing work of the UN Commission on Sustainable Development (CSD), consist mainly of the bringing together of some key indicators developed for each one of the three SD pillars or spheres of interest (i.e., combining environmental indicators, social indicators, and economic indicators). The CSD also includes a fourth, institutional pillar addressing governance issues. However, SD will not be achieved simply by combinations of different sets of policy objectives because this would result in a weak compromise. Rather, reformulation and integra-

Table 9.2. A checklist of criteria for evaluating sectoral and cross-sectoral EPI.

CONTEXT FOR EPI	CROSS-SECTORAL	SECTOR-SPECIFIC
1. Trends in drivers, pressures, changes in state of the environment, impacts	1a. What are the main economic and social driving factors facing the administration?	1a. What are the trends in the sector's main economic and social driving factors?
	1b. What is the magnitude and trends of socioeconomic impacts?	1b. What is the magnitude and trend of the sector's socioeconomic impacts?
	1c. Is society becoming more eco-efficient, i.e. decoupling its economic activities and outputs from environmental pressures and impacts?	1c. Is the sector becoming more eco-efficient, i.e. decoupling its economic activities and outputs from environmental pressures and impacts?
	1d. Is progress being made towards key overarching SD/environmental targets and objectives?	1d. Is the sector contributing appropriately to key overarching SD/environmental targets and objectives?
		1e. Is the sector on track to reaching its own environmental targets and objectives?
EPI CATEGORIES	**CROSS-SECTORAL**	**SECTOR SPECIFIC**
2. Political commitment and strategic vision	2a. Is there a high level (i.e. constitutional/legal) requirement for EPI in general?	2a. Is there a high level (i.e. constitutional/legal) requirement for EPI in the sector?
	2b. Is there an overarching EPI or SD strategy, endorsed and reviewed by the prime minister or president?	2b. Is the sector included in an overarching strategy for EPI and/or for sustainable development?
		2c. Does the sector have its own EPI or sustainable development strategy?
	2c. Is there political leadership for EPI and/or sustainable development?	2d. Is there political leadership for EPI in the sector?
3. Administrative culture and practices	3a. Do the administration's regular planning, budgetary and audit exercises reflect EPI priorities?	3a. Does the sector administration's mission statement reflect environmental values?
	3b. Are environmental responsibilities reflected in the administration's internal management regime?	3b. Are environmental responsibilities reflected in the sector administration's internal management regime?

tion of policy objectives are needed to improve policy coherence so that optimal benefits can be gained from the synergistic effects of environmental, social, and economic policies. For sustainability assessments, this means that existing tools may no longer be adequate and that new impact assessment methods and indicators are needed to measure progress, especially at the synergistic interlinkages and overlaps between the traditionally separate areas of economic, social, and environmental policy. Furthermore, when assessments are designed to address sustainability, guidance is needed to identify the key interfaces on which to focus attention. This was the incentive behind the Guidelines for Environmental Assessment and Reporting in the Context of Sustainable Development (GEAR-SD).

The EEA founding regulation[2] requires the agency to report on the state and outlook of the environment, including the socioeconomic dimension, in the context of sustainable development. The limited progress made in developing and delivering truly useful SD-relevant information in a political decision-making context, as exemplified by the quality of the EU structural indicators, gives an immediate political focus to this work. The EEA needs to report on the environment in such a way that it provides useful information to policymakers to understand and respond to sustainability issues relevant to high-level decision makers. However, because of the breadth of sustainability concerns and wide interpretations of this concept, there are fundamental difficulties associated with identifying the relevant assessments and indicators needed to deliver this knowledge. For progress to occur, agreement is needed in a number of areas. This section examines our assumptions about SD embedded in the models of sustainability that we use to explain the concept and then presents GEAR-SD, which identifies main features that make sustainability operational in assessments and indicators.

The way we envisage sustainability must be examined because this will directly affect the features identified as important and the associated assessments and indicators needed. International consensus on the most suitable framework for describing SD is lacking. Nevertheless, some general requirements for applicable framework can be formulated. For example, within the EEA Expert Group on Guidelines and Reporting,[3] the following requirements have been raised:

- Sound conceptual foundation
- Ability to capture key information to measure sustainable development by selecting indicators
- Ability to clarify relationships between different indicators and policies
- Ability to integrate different dimensions of sustainable development

The model of sustainability that predominates thinking is composed of the social, economic, and environmental pillars. This is often visualized as a three-legged stool (Figure 9.2). There are many assumptions implicit in this model. Its main purpose is to register the need to consider all three domains to support sustainability. Beyond that, however, it contributes little and probably misleads greatly. In particular, it misses explicit

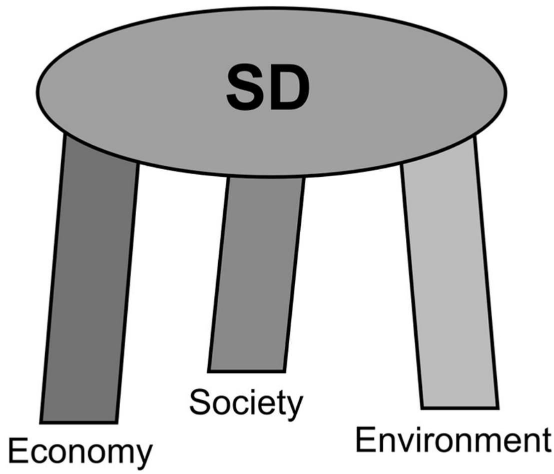

Figure 9.2. Three-legged stool model of sustainable development. The stool model emphasizes only the importance of the three pillars to support sustainable development but misses the all-important linkages (courtesy of the EEA).

representation of the all-important links between the pillars, where important synergies can be found and trade-offs are made. These are present in the model only implicitly in the need to keep the stool balanced to compensate for changes in one or the other pillar so that the stool does not fall over. A more explicit representation of this balancing act and the forces and trade-offs at play in such maneuvers would greatly improve the model and make transparent the hidden compensations in operation.

The three pillars sometimes are represented as overlapping circles (Figure 9.3). This model addresses the lack of linkages but offers no way of characterizing them. It promotes the notion that the nature of the three domains is the same and says nothing about the dependencies and dynamic interactions between domains. Furthermore, it does not illustrate the differences in problems within and between the different domains in regions and especially between developed and developing countries. These representations of SD are sometimes called the atomistic approach (EEA 2002).

Ironically, these models lead to a focus on addressing each pillar separately from the whole rather than a focus on the cooperation needed between the domains to produce the most efficient and effective sustainability outcomes. Furthermore, these models provide no insight on how to model the complex, reflexive interactions between domains. This leads to the false picture that each pillar can be organized and

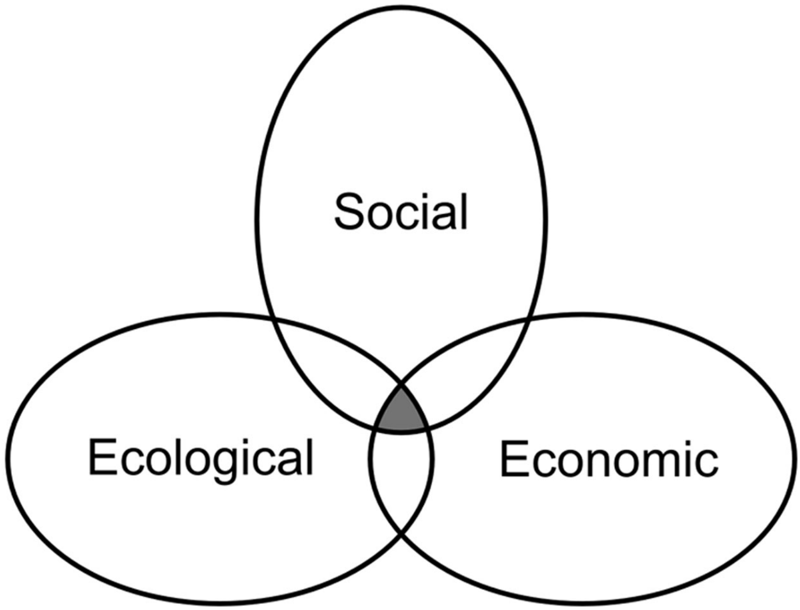

Figure 9.3. Sustainable development in three overlapping ellipses (Välimäki 2002).

measured independently of the others and that by adding them up, one can achieve SD (unconscious assumptions of independence and commutability, as seen in the EU structural indicators).

Within SD reporting, there is a strong emphasis on integrative or holistic reporting. The basic purpose of holistic reporting is to connect dimensions together (Figure 9.4). From the perspective of the holism–atomism debate, the basic question is whether it is reasonable to assume that sustainability is a property that can be found by simply incorporating the different dimensions together, or whether sustainability is more like an emerging property, not easily detected from the properties of different dimensions.

In contrast to these representations, the concentric ring model of SD (Figure 9.5) used in the EEA's "Turn of the Century" report (EEA 1999a) and the egg model of Prescott-Allen (2001) promotes an entirely different concept. It emphasizes the dependence of the socioeconomic system on the environment. It exemplifies the need to model both systems in order to understand the interactions and dependencies. It also visually encapsulates the concept of stocks of the socioeconomic and environmental systems so often forgotten in debates.

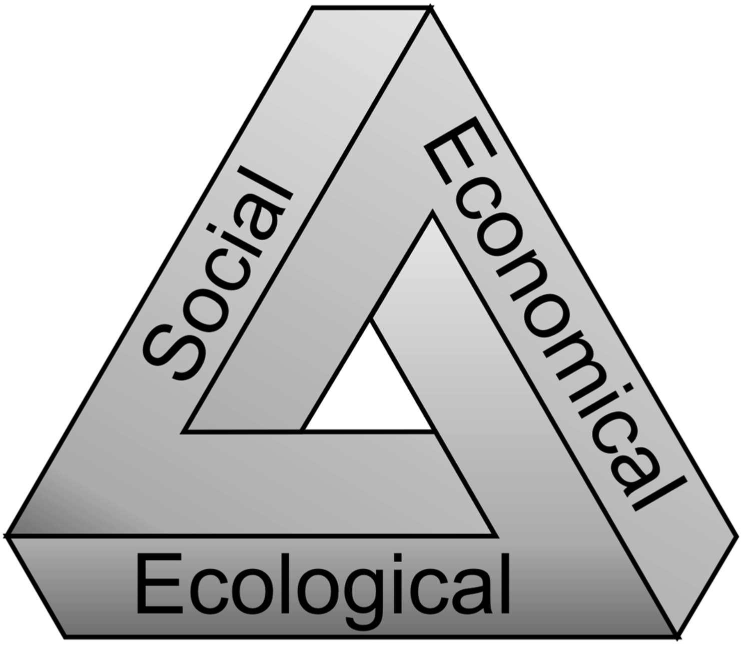

Figure 9.4. Never-ending triangle of sustainable development (Välimäki 2002).

The atomistic three-pillar model focuses not on cooperation but on strengthening the pillars separately. This can lead to false trade-offs being proposed, for example between social and environmental concerns against economic standards that are not commensurable in sustainability terms (e.g., pay for clean water for the whole world instead of reaching the Kyoto Protocol greenhouse gas emission targets). The overlapping circles model gives the impression that cooperation is needed only in the common areas; this suggests that only limited trade-offs are needed and puts no emphasis on looking for solutions in fundamental changes to whole systems. Finally, secondary (or system) benefits are difficult to identify and resolve in these discrete models.

The concentric ring and egg models instead emphasize symbiosis: The socioeconomic system is distinct but embedded in and dependent on the environment. From this flows integration and clearer trade-offs because the need for them to sustain the whole is apparent. Environment is not relegated to an optional extra ("if we try hard enough, perhaps we can stand on one or two legs only") but is identified as a system component, source, and sink.

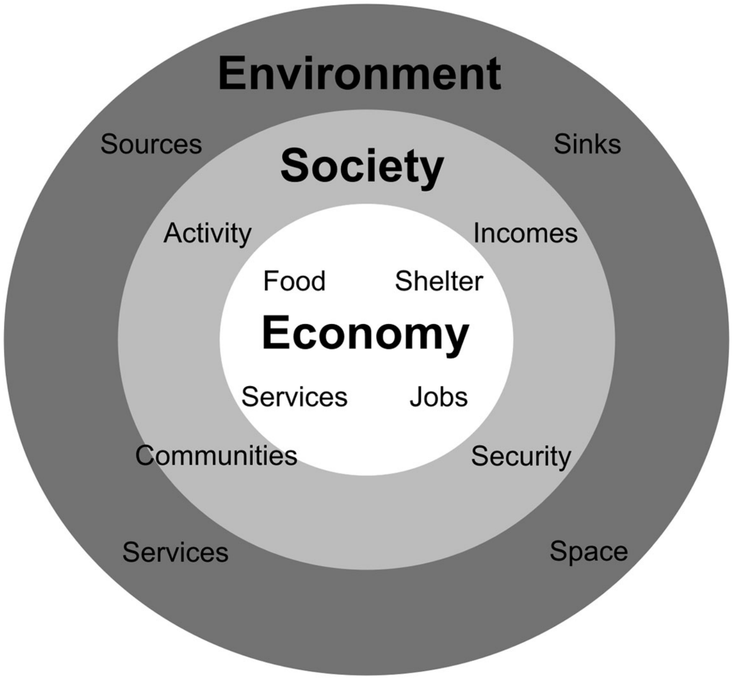

Figure 9.5. Concentric ring or egg model of sustainable development (EEA 1999a).

With these considerations in mind, it becomes clear that the SD models discussed here are too simple for guiding the identification of SD indicators. Indeed, once embedded in our thinking, they can explicitly or implicitly mislead us in the identification of important SD features. Crucial systemic and synergistic aspects of SD are particularly easy to overlook, and without them an oversimplified assessment of important characteristics can result.

To help guard against the pitfalls of inadequate models, some basic thinking was put into identifying underlying features of SD and what they mean for reporting on the environment. Emphasis was put on practical outcomes, which need to be made explicit in any analysis of environment and sustainability, regardless of which model is being used. The objective of going beyond the models in this way was to move the discussion away from trying to design an ideal framework of SD toward a practical means of identifying and checking that the agency was responding to its regulatory mandate and to assess the state, trends, and outlook of the environment in the context of SD.

As a first step, GEAR-SD is intended to stimulate thinking about what is meant by *sustainability* from an environmental point of view and to root this discussion in illustrative information and data. Eight SD key features (Box 9.1) have been identified that, from an environmental point of view, merit further analysis and development. These key features can be used as a checklist for testing the SD relevance of an assessment or indicator.

GEAR-SD does not address all SD-relevant aspects but focuses on those necessary to understand the SD context of environmental assessment. This domain is indicated in the diagram (Figure 9.6) as the overlapping areas between the environmental, economic, and social spheres and within the purely environmental sphere, which possesses some intrinsic aspects that demand SD thinking (e.g., long-term or irreversible environmental effects).

At the moment, GEAR-SD is simply a checklist, a guideline, and a tool: a checklist of key features to help tease out the important SD stories when conducting an assessment and to identify suitable indicators; a guideline to help identify SD-relevant issues to help compensate for unconscious biases and blind spots; and a tool and common language to help communicate SD issues.

The list is not complete and will be expanded and refined further. The checklist can be used to improve the reporting framework and can be useful for different actors at dif-

Box 9.1. GEAR-SD: A framework for environmental assessment and reporting in the context of SD.

- We want to provide future generations the same environmental potential as the current one (intergenerational equity).
- We want our economic growth to be less natural resource intensive and less polluting (decoupling).
- We want a better integration of sectoral and environmental policies (sector integration).
- We want to maintain and enhance the adaptive capacity of the environmental system (adaptability).
- We want to avoid irreversible and long-term environmental damage to ecosystems and human health (avoid irreversible damage).
- We want to avoid imposing unfair or high environmental costs on vulnerable population categories (distributional equity).
- We want the EU to assume responsibility for the environmental effects it has outside the EU geographic area (global responsibility).
- We want rules, processes, and practices to ensure the uptake of SD goals and implementation of cost-effective policies at all levels of governance (SD governance).

Source: EEA.

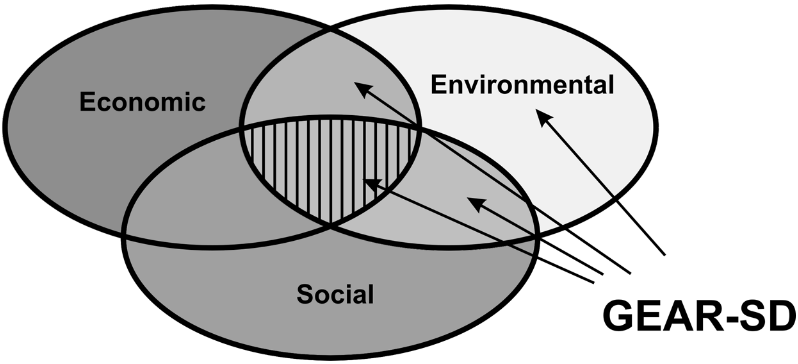

Figure 9.6. Scope of GEAR-SD (courtesy of the EEA).

ferent levels. Most important, it may help identify SD indicators at the critical SD interfaces. Similar analyses of the SD interfaces with the economic and social pillars, if applied, would greatly improve SD-relevant assessments of these domains and strengthen cross-sectoral, integrated thinking.

The Science–Policy Bridge: A Framework for Evaluating Complex Scientific Evidence on Environmental Factors in Disease Causation

In preparing a follow-up report to *Late Lessons from Early Warnings: The Precautionary Principle 1896–2000* (EEA 2001), the EEA has been developing a framework to assist with the practical application of the precautionary principle via common approaches to evidence evaluation at the science–policy interface. It has also been developing a simple analytical model for approaching such complex, multicausal phenomena as endocrine-disrupting substances, mediated diseases, and childhood asthma (EEA 2003).

The draft EEA framework in Table 9.3 uses just three strengths of evidence: weak (10–33% estimated probability), moderate (33–66% estimated probability), and strong (more than 66% probability), which are the same as the "low likelihood," "medium likelihood," and "likely" categories of the IPCC (Table 9.4). The draft framework also invites users to judge whether the overall evidence has become stronger or weaker over a relevant period of time between major evaluations of the evidence or since, say, 1992.

Preventive and precautionary actions must usually be taken on the basis of much less than scientific certainty and well before an understanding of the mechanisms of action

Table 9.3. An EEA framework for evaluating complex and conflicting scientific evidence on environment and disease.

Statement of Hypothesis*		Evaluation Factor				Overall Strength of Evidence	
Outcome (e.g., childhood asthma)	Relevant exposure (e.g., indoor air pollution [NO_x])	Association†	Plausibility†	Causality†	Mechanism of action?†	Overall weight of evidence (weak, moderate, or strong) ‡	Direction of evidence (stronger or weaker over last 5–10 years)

Note: This table is designed to be used to evaluate the scientific evidence for each hypothesis (at an appropriate level of detail, relevant to the expertise of those doing the evaluation) against the factors in the framework and judge the overall strength of evidence for the hypothesis and the direction in which the evidence is moving.

*From observations or theories.

†Commonly accepted among relevant scientists.

‡Commonly accepted by relevant scientists as “weak,” “moderate,” or “strong,” categories based on Hill (1965), IPCC (2001), and IPCS/WHO (2002).

Table 9.4. Different levels of proof for different purposes: Some examples and illustrations.

	Quantitative Descriptor (probability bands based on IPCC 2001)*	Qualitative Descriptor	Illustrations
100% probability	Very likely (90–99%)	• "Statistical significance" • "Beyond all reasonable doubt"	• Part of strong scientific "causation" evidence • Most criminal law; the Swedish chemical law, 1973 (for evidence of "safety" from manufacturers)
90%	Likely (66–90%)	• "Reasonable certainty" • "Sufficient scientific evidence"	• Food Quality Protection Act, 1996 (U.S.) • World Trade Organisation SPS Agreement, Art. 2.2, 1995, to justify a trade restriction • International Agency for Research on Cancer (IARC) Category 1: "Probable Human Carcinogen"
Increasing Probability 50%	Medium likelihood (33–66%)	• "Balance of evidence" • "Balance of probabilities" • "Limited evidence" • "Reasonable grounds for concern" • "Strong possibility" • "Scientific suspicion of risk"	• Intergovernmental Panel on Climate Change 1995 and 2001 • Much civil and some administrative law • IARC Category 2 B: "Possible Human Carcinogen" • European Commission on the Precautionary Principle 2000 • British Nuclear Fuels occupational radiation compensation scheme, 1984 (20–50% probabilities triggering different awards up to 50%, which triggers full compensation) • Swedish chemical law, 1973, for evidence required for regulators to take precautionary action on potential harm from substances
10%	Low likelihood (10–33%)	• "Some evidence of carcinogenicity" • "Available pertinent information"	• IARC criterion for selecting substances for evaluation • WTO SPS Agreement, Art. 5.7, to justify a provisional trade restriction where "scientific information is insufficient"
0% probability	Very unlikely (1–10%)	• Low risk • "Negligible and insignificant"	• Household fire insurance • Food Quality Protection Act, 1996 (U.S.)

*Simplified by removing the top (>99%) and bottom (<1%) levels. There is rarely precision on contested issues to allocate specific numerical probabilities, and the boundaries between categories are in practice fuzzy: The quantitative descriptors illustrate broad categories of evidence based on has been achieved. The appropriate level of proof varies in each case, depending on the likely nature and scale of the hazards and the availability and feasibility of alternatives.

After further discussion and improvements, the EEA believes that this framework for evaluating scientific evidence will be a helpful tool in the process of producing consistent overviews of the existing states of knowledge.

Conclusion

Measuring sustainable development requires innovative techniques and indicators, rigorous underlying models, and frameworks for interpretation of complex evidence. The approaches and frameworks presented in this chapter and the associated critique are expected to contribute to improved assessment of sustainability by shedding light on new techniques, providing criticism of existing systems, and contributing new approaches to analyzing and interpreting results.

Notes

1. The criteria were initially introduced by the EEA in 1998–1999 in *Europe's Environment: The Second Assessment*, p. 284, and in *Europe's Environment at the Turn of the Century*, p. 20 (EEA 1998, 1999b). The criteria were based on key environmental programs such as the Rio Declaration; the European Commission's 5th Environmental Action Programme; the Pan-European Environmental Programme for Europe; policy papers produced to implement the EU Treaty provisions on integration, including the Commission of the European Communities Communication on Integration; conclusions of the Cardiff, Vienna, and Cologne summits; draft council papers on sectoral integration for the Helsinki Summit; and associated commentaries from the European Environmental Bureau and member states.

2. Council Regulation (EEC) no. 1210/90 of May 7, 1990, as amended by Council Regulation 933/1999 of April 29, 1999.

3. The EEA Expert Group on Guidelines and Reporting brought together national experts on the state of the environment and indicator reporting, meeting twice a year to discuss topics of mutual interest and to advise the EEA on its reporting activities.

Literature Cited

CEC. 2004. *Integrating environmental considerations into other policy areas: A stocktaking of the Cardiff process.* Commission Working Document, COM (2004) 394 final. Brussels: Commission of the European Communities.

CLM. 1999. *EU Agricultural policy after 2000: Has the environment been integrated?* A report for the European Environmental Bureau (CLM-446-1999). Utrecht: G. van der Bijl, Centrum voor Landbouw en Milieu (Centre for Agriculture and Environment).

Dalal-Clayton, B. 2004. *The EU strategy for sustainable development: Process and prospects*. Environmental Planning Issues no. 27. London: IIED.

EEA. 1998. *Europe's environment: The second assessment*. Copenhagen: European Environment Agency.

EEA. 1999a. *Europe's environment at the turn of the century*. Copenhagen: European Environment Agency.

EEA. 1999b. *Monitoring progress towards integration: A contribution to the "Global Assessment" of the Fifth Environmental Action Programme of the EU, 1992–1999*. An unpublished report from the European Environment Agency, Copenhagen, December.

EEA. 1999c. *Towards a Transport and Environment Reporting Mechanism (TERM) for the EU: Part I and II*. Technical Report no. 18. Copenhagen: European Environment Agency.

EEA. 2001. *Late lessons from early warnings: The precautionary principle 1896–2000*. Copenhagen: European Environment Agency.

EEA. 2002. *Sustainable development reporting: Frameworks and aggregated indicators*. Unpublished report of the EEA Expert Group on SoE Guidelines and Reporting. Copenhagen: European Environment Agency.

EEA. 2003. *An approach to multi-causality in environmental health*. EEA Background Paper no. 5 for the EU SCALE process. Copenhagen: European Environment Agency, October. Available at www.Brussels-conference.org.

EEA. 2005. *Environmental policy integration in Europe: State of play and an evaluation framework*. Technical Report no. 2/2005. Copenhagen: European Environment Agency.

European Commission. 2001. *A sustainable Europe for a better world: A European strategy for sustainable development*. COM(2001) 264 final. Brussels: European Commission.

European Commission. 2001. *White paper on European governance*. COM(2001)428. Brussels: European Commission.

Fergusson, M., C. Coffey, D. Wilkinson, B. Baldock, A. Farmer, R. A. Kraemer, and A. Mazurek. 2001. *The effectiveness of EU Council integration strategies and options for carrying forward the Cardiff process*. IEEP Report to the UK Department of Environment, Transport and the Regions. London: Institute for European Environment Policy.

Hill, A. B. 1965. Environment and disease: Association or causation? *Proceedings of the Royal Society of Medicine* 58:295–300.

IPCC. 2001. *Third assessment report on climate change: Summary for policymakers*. Intergovernmental Panel on Climate Change, WMO, UNEP.

IPCS/WHO. 2002. *Global assessment of the state of the science on endocrine disruptions*. International Programme on Chemical Safety and World Health Organization.

OECD. 2002.*Improving policy coherence and integration for sustainable development: A checklist*. Paris: Organisation for Economic Cooperation and Development. Available at www.oecd.org/dataoecd/60/1/1947305.pdf.

Persson, Å. 2002. *Environmental policy integration: A draft for comments*. Stockholm: Stockholm Environment Institute.

Peters, G. B. 1998. Managing horizontal government. *Public Administration* 76:295–311.

Prescott-Allen, R. 2001. *The Wellbeing of Nations: A country-by-country index of quality of life and the environment.* Washington, DC: Island Press.

RMNO/EEAC. 2003. *Environmental governance in Europe.* Background study no. V.02, edited by L. Meuleman, I. Niestroy, and C. Hey. The Hague: Advisory Council for Research on Spatial Planning, Nature and the Environment and European Environmental Advisory Councils.

Välimäki. 2002. *Sustainable development reporting: Aggregated indicators.* Background paper for discussion at EEA SoE Expert Group Workshop, December 16–17, Helsinki, Finland.

Wandén, S. 2003. *Society, systems and environmental objectives: A discussion of synergies, conflicts and ecological sustainability.* Naturvårdsverket Report 5272.