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OECD CORE SET OF INDICATORS FOR ENVIRONMENTAL PERFORMANCE REVIEWS

A synthesis report by the Group
on the State of the Environment

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Paris 1993

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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INTRODUCTION

Demand for the development of environmental indicators by OECD has been expressed along two complementary lines. First, the OECD Council in 1989 called for further work to integrate environment and economic decision-making. This was reiterated in consecutive G-7 summits and led to the approval of an OECD Council Recommendation on Environmental Indicators and Information by OECD Governments in 1991. Second, the OECD has been entrusted by its Member countries to launch a new programme of environmental performance reviews with the principal aim of helping Member countries to improve their individual and collective performance in environmental management. Reviews are conducted under the auspices of the Group on Environmental Performance and evaluate individual countries' environmental performance in respect of environmental quality, national objectives and international commitments. One year after the UNCED conference in Rio de Janeiro, with several new conventions adopted, this international dimension is of particular relevance.

These demands are reflected in the OECD work programme on environmental indicators, comprising indicator development for the integration of environmental concern into sectoral policies, environmental and natural resource accounting and the development of indicators for use in environmental performance reviews (see also section "uses of indicators" below).

During the meeting of the Group on Environmental Performance on 15-16 April 1992, the Delegations of the Netherlands, Norway and the United States proposed to hold several workshops concerning environmental indicators to support work on environmental performance evaluation. The Group on Environmental Performance and the Group on the State of the Environment welcomed these suggestions.

The main objectives established for this work were:

-- to contribute to the harmonization of the many individual initiatives of OECD Member countries in the field of environmental indicators;

-- to prepare, in an OECD context, guidance for the use of environmental indicators in connection with the evaluation of environmental performance;

-- to stimulate, within the OECD programme on environmental indicators, the development of a core set of selected and/or aggregated indicators (so-called Indicators), thereby giving priority to the development of a limited set for international use.

The present document is organised accordingly:

-- Harmonization: Chapter 1 presents the common framework and terminology adopted by the OECD Group on the State of the Environment; the development of a common set of environmental issues and indicator proposals also contributes to the harmonization of individual countries' initiatives;

-- Guidance: Chapter 2 proposes general guidelines for the use of indicators in the context of environmental performance reviews and presents examples from reviews already carried out;

-- Core set of indicators: Chapter 3 summarises the discussion on the development of a core set of indicators, each indicator ranked with respect to data availability and measurability.

Chapter 1

TERMINOLOGY AND FRAMEWORK

1.1 Definition and functions of environmental indicators

In a very general way, an indicator can be defined as a parameter or a value derived from parameters, which provides information about a phenomenon (see Table 1). The indicator has significance that extends beyond the properties directly associated with the parameter value. Indicators possess a synthetic meaning and are developed for a specific purpose. This points to two major functions of indicators:

-- they reduce the number of measurements and parameters which normally would be required to give an "exact" presentation of a situation. As a consequence, the size of a set of indicators and the amount of detail contained in the set need to be limited. A set with a large number of indicators will tend to clutter the overview it is meant to provide. Too few or even a single indicator, on the other hand, may be insufficient to provide all the necessary relevant information. In addition, methodological problems related to weighting tend to become greater with an increasing level of aggregation;

-- they simplify the communication process by which the information of results of measurement is provided to the user. Due to this simplification and adaptation to user needs, indicators may not always meet strict scientific demands to demonstrate causal chains. Indicators should therefore be regarded as an expression of "the best knowledge available".

As indicators are used for varying purposes it is necessary to define general criteria for the selection of indicators. Three basic criteria have been used in OECD work: policy relevance, analytical soundness and measurability. Table 2 offers a more detailed presentation of these general criteria.

1.2 Indicators in the Pressure-State-Response framework

The Pressure-State-Response framework

There are several frameworks around which indicators can be developed and organised. There is no unique framework that generates sets of indicators for every purpose. Also, a framework may change over time as scientific understanding of environmental problems increases, and as societal values evolve. In the context of the work of the Group on the State of the Environment, the Pressure-State-Response (PSR) framework has been used. The PSR framework (Figure 1a) is based on a concept of causality: human activities exert pressures on the environment and change its quality and the quantity of natural resources (the "state" box). Society responds to these changes through environmental, general economic and sectoral policies (the "societal response"). The latter form a feedback loop to pressures through human activities. In a wider sense, these steps form part of an environmental (policy) cycle which includes problem perception, policy formulation, monitoring and policy evaluation.

While the PSR framework has the advantage of highlighting these links, it tends to suggest linear relationships in the human activity-environment interaction. This should not obstruct the view of more complex relationships in ecosystems and in environment-economy interactions.

Table 1. **Definition of Terms**

INDICATOR	A parameter, or a value derived from parameters, which points to/provides information about/describes the state of a phenomenon/environment/area with a significance extending beyond that directly associated with a parameter value.
INDEX	A set of aggregated or weighted parameters or indicators.
PARAMETER	A property that is measured or observed.
INDICATORS OF ENVIRONMENTAL CONDITIONS	Correspond to "state" box of the Pressure-State-Response framework. They comprise environmental quality and aspects of quantity and quality of natural resources.
INDICATORS OF ENVIRONMENTAL PRESSURES	Correspond to "pressure" box of PSR framework. They describe pressures on the environment caused by human activities. They comprise *indicators of proximate pressure* (stress indicators) and *indicators of indirect pressure* (background indicators).
RESPONSE INDICATORS	Correspond to "Response" box in PSR framework. In the present context, the word "response" is used only for *societal* (not ecosystem) *response*.
INDICATORS FOR USE IN PERFORMANCE EVALUATION	Selected and/or aggregated indicators of environmental conditions, indicators of environmental pressures and indicators of societal responses for the purpose of environmental performance evaluation.
ENVIRONMENTAL INDICATORS	Comprise all indicators in the Pressure-State-Response framework, i.e. indicators of environmental pressures, conditions and responses.

Indicators

Within the PSR framework, three broad types of indicators can be distinguished:

a) Indicators of environmental pressures correspond to the "pressure" box of the PSR framework. They describe pressures from human activities exerted on the environment, including the quality and quantity of natural resources. A distinction can be drawn between indicators of proximate pressures (pressures directly exerted on the environment, normally expressed in terms of emissions or consumption of natural resources) and indicators of indirect pressures (background indicators reflecting human activities which lead to proximate environmental pressures).

b) Indicators of environmental conditions correspond to the "state" box of the PSR framework and relate to the quality of the environment and the quality and quantity of natural resources. As such they reflect the ultimate objective of environmental policy making. Indicators of

environmental conditions should be designed to give an overview of the situation (the state) of the environment and its development over time, and not the pressures on it. In practice, the distinction between environmental conditions and the pressures may be ambiguous and the measurement of environmental conditions can turn out to be difficult or very costly. Therefore, the measurement of environmental pressures is often used as a substitute for the measurement of environmental conditions.

Table 2. **Criteria for Indicator Selection***

Policy relevance and utility for users

An environmental indicator should:

- provide a **representative picture** of environmental conditions, pressures on the environment or society's responses;
- be simple, **easy to interpret** and able to show **trends over time**;
- be **responsive to changes** in the environment and related human activities;
- provide a basis for **international comparisons**;
- be either **national in scope** or applicable to regional environmental issues of national significance;
- have a **threshold or reference value** against which to compare it so that users are able to assess the significance of the values associated with it.

Analytical soundness

An environmental indicator should:

- be theoretically **well founded** in technical and scientific terms;
- be based on international standards and **international consensus** about its validity;
- lend itself to being linked to economic models, forecasting and information systems.

Measurability

The data required to support the indicator should be:

- readily available or made available **at a reasonable cost/benefit** ratio;
- adequately **documented** and of **known quality**;
- **updated** at regular intervals in accordance with reliable procedures.

*These criteria describe the "ideal" indicator and not all of them will be met in practice.

c) Indicators of societal responses correspond to the "response" box in the PSR framework. Societal response indicators are measurements which show to what degree society is responding to environmental changes and concerns. Societal responses refer to individual and collective actions to mitigate, adapt to or prevent human-induced negative impacts on the environment and to halt or reverse environmental damage already inflicted. Societal responses

also include actions for the preservation and the conservation of the environment and natural resources.

Compared to indicators of environmental pressures and many indicators of environmental conditions, most indicators of societal responses have a shorter history and are still in a phase of development, both conceptually and in terms of data availability. This must be taken into account in their use to avoid misinterpretation. Two more specific points arise with societal response indicators.

First, the distinction between indicators of environmental pressures and indicators of societal responses may become blurred when response indicators capture the feedback effect of society's responses on environmental pressures. A reduction in greenhouse gas emissions or improvements in energy efficiency could, for example, be interpreted both as a pressure and as a response indicator for climate change. Ideally, the response indicator should reflect society's efforts in tackling a particular environmental problem.

Second, as indicators are of a quantitative nature, societal response indicators are limited to responses which are measurable in quantitative terms. Responses which can only be expressed in qualitative terms (e.g. whether an international environmental agreement has been ratified or not) are therefore absent in the present set of indicators. In a number of cases, responses may be measurable in principle but are too specific or too numerous to be measured in practice. A case in point is the area of technology-related regulations and standards with comprehensive, detailed rules which are difficult to express in a concise way or to compare internationally. In performance reviews, qualitative and scientific information typically supplements the quantitative indicators.

Use of indicators

Different users of environmental indicators have different needs. Thus, the appropriate set of indicators depends on their particular use. In the work of the Group on the State of the Environment four major categories of use are present:

-- measurement of environmental performance;

-- integration of environmental concerns in sector policies[1];

-- integration of environmental and economic decision-making more generally (e.g. through environmental accounting[2]);

-- reporting on the state of the environment.

[1] Indicators for integration of environmental concerns in sectoral policies are, in the OECD context, specialized sub-sets covering the whole range of indicators for use by sectoral decision-makers.

[2] Although indicators of environmental pressures, conditions and societal responses provide input for work on environmental accounting, frameworks different from the PSR model underlie the work on environmental accounting.

Conceptually, indicators for these specific purposes (performance evaluation, reporting on the state of the environment) should be distinguished from specific types of indicators, i.e. indicators of environmental conditions, pressures, societal responses (see Figure 1b). There is no one-to-one correspondence between indicators distinguished by their nature and indicators distinguished by their use: for each type of use, background, stress, environmental quality, natural resource, and response indicators are of potential relevance. For example, indicators for state of the environment reporting could well be drawn from all types of indicators -- pressure indicators, indicators of environmental conditions and response indicators.

Similarly, a set of indicators would be selected from all types to meet the specific needs of policy performance evaluation. Indicators for performance evaluation would encompass indicators of environmental pressures, conditions and societal responses. What characterizes such indicators would be that these indicators are used to evaluate performance, mainly by putting them into the context of national[3] and international goals, objectives and targets.

[3] This may include sub-national issues of national significance.

Figure 1a
Pressure - State - Response Framework

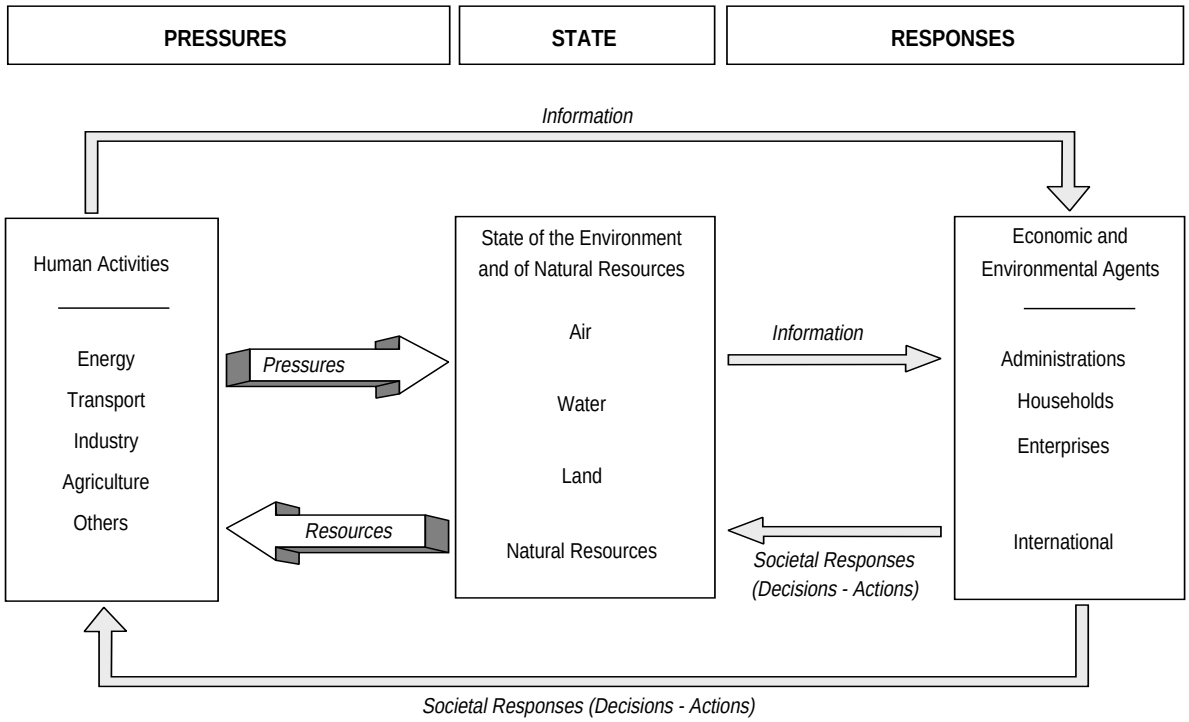
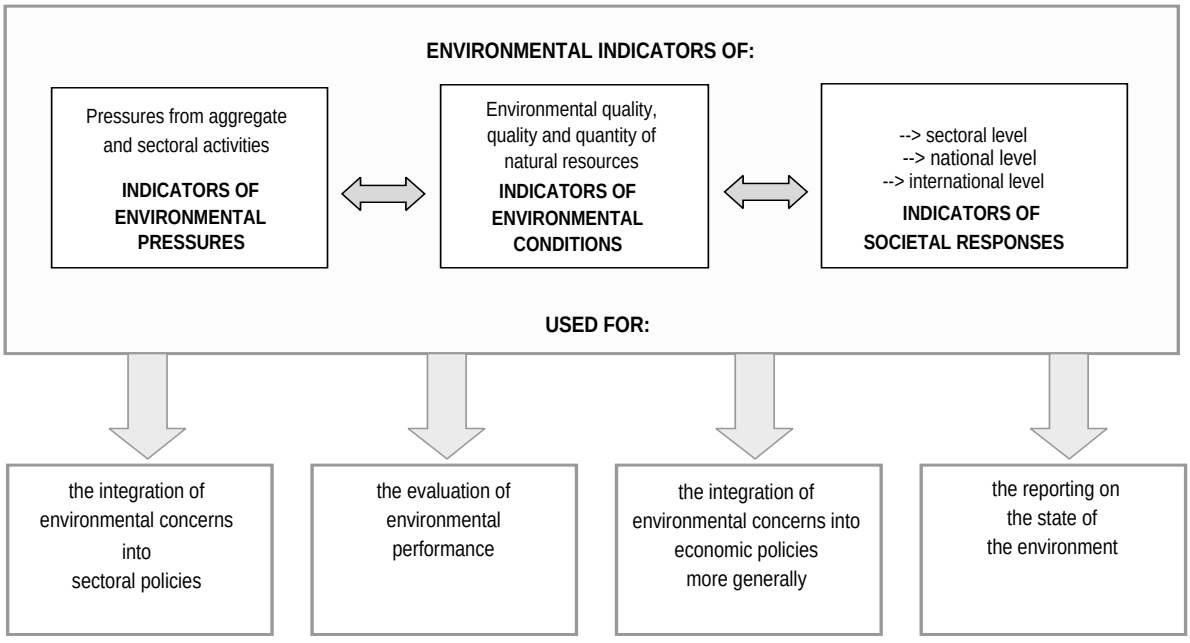


Figure 1b
Nature and Use of Environmental Indicators



1.3 Structuring elements: environmental issues and economic sectors

Environmental issues

The Pressure-State-Response framework structures and classifies types of indicators. The broad categories following from the PSR framework (indicators of environmental pressures, environmental conditions and societal responses), give, however, insufficient guidance for the choice of the specific environmental areas for which indicators need to be developed. In its February workshop, the Group on the State of the Environment identified a list of issues which reflect current environmental challenges. These issues represent the first structuring element. By necessity, they depend on changing and sometimes conflicting perceptions. The list of issues is not necessarily final nor exhaustive. In fact, the list is flexible and new issues can be incorporated or old ones abandoned according to their environmental relevance. The purpose of the list is to serve as a focus for indicator development: Figure 2 shows how indicators of environmental conditions, pressures and responses can be associated with individual issues.

Broadly spoken, issues 1 to 9 can be considered "sink-oriented", dealing with issues of environmental quality, whereas issues 10 to 13 are "source-oriented", focusing on the quantity aspect of natural resources. Not all indicators can be directly associated with a specific environmental issue (e.g., population growth, economy-wide environmental expenditure or public opinion on the environment). A category of general and/or not attributable indicators has therefore been introduced in the framework in Figure 2.

Sectors in the Pressure-State-Response framework

In principle, pressure and societal response indicators can be considered at a sectoral level. Data availability permitting, such a disaggregation is one tool in analysing the environmental pressures exerted by sectors such as agriculture, industry, energy or transport. Similarly, for societal responses, government responses could be distinguished from those of the business sector (including agriculture, energy, industry etc.) or private households (see Figure 3). Indicators at the sectoral level are therefore a useful tool in the context of environmental performance reviews for reviewing the integration of environmental and sectoral policies.

There exists a direct link to the work of the Group on the State of the Environment on indicators for the integration of environmental concerns into sectoral policies. So far, work has been undertaken in the areas of energy, transport, forestry and agriculture[4]. Selected indicators from these activities can provide a direct input to the core set of indicators for use in environmental performance reviews.

Sector disaggregation can be carried out in

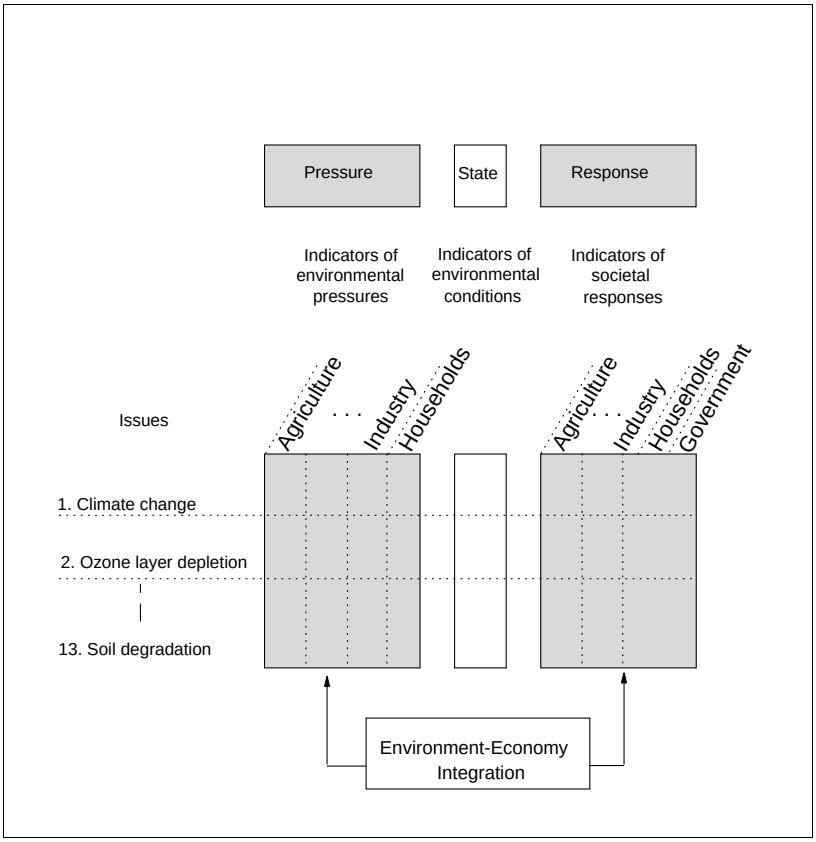
-- a functional sense (relating to sources of pollution): sectors relate to specific, environmentally relevant activities. The transport sector, for example, would comprise all transport activities, irrespective of whether they are carried out by manufacturing industry, private households or specialised transportation firms;

[4] See "Indicators for the integration of environmental concerns into energy policies" [ENV/EPOC/SE(92)4/REV1]; "Indicators for the integration of environmental concerns into transport policies" [ENV/EPOC/SE(91)17/REV1]; "Indicators for the integration of environmental concerns into agricultural policies" [ENV/EPOC/SE(93)2]; "Indicators for the integration of environmental concerns into forestry policies" [ENV/EC/SE(91)16].

Figure 2 **Structure of Indicators by Environmental Issue**

	PRESSURE	STATE	RESPONSE
	Indicators of environmental pressures	**Indicators of environmental conditions**	**Indicators of societal responses**
Issues			
1. Climate change			
2. Ozone layer depletion			
3. Eutrophication			
4. Acidification			
5. Toxic contamination			
6. Urban environmental quality			
7. Biological diversity			
8. Landscape			
9. Waste			
10. Water resources			
11. Forest resources			
12. Fish resources			
13. Soil degradation (desertification and erosion)			
14. General indicators, not attributable to specific issues			

Figure 3: **Sectors in the Pressure-State-Response Framework**



-- an <u>institutional</u> sense (relating to economic activity): sectors relate to the primary activities of economic establishments or firms. In this sense, the transport sector would be restricted to that part of the service sector dealing with transport services as a primary activity. Transport activities carried out in conjunction with manufacturing would be recorded in the sector "manufacturing industry". Industry classifications such as ISIC (International Standard Industry Classification) are based on this principle.

The following lists show sectors organised along the two approaches:

Institutional approach (economic sectors):	Functional approach (sources of pollution):
Agriculture	Agriculture
Forestry	Forestry
Fishery	Fishery
Mining and quarrying	Mining and quarrying
Manufacturing	Manufacturing
Electricity generation	Energy (extraction, production, distribution, use)
Transport services	Transport Tourism
Other services	Other services
Private households	Private households

It should be noted that private households are included as a sector. This category differs from the other sectors as it does not have a significant impact as a sector of production, but underlines the role of households as consumers. According to the specific question under consideration, sectoral sub-divisions can be developed either in a functional or an institutional sense. If double-counting is to be avoided, however, consistency of use (functional or institutional) needs to be assured. Also, with a view to combining data on sectoral pressures and economic activity, environmental data and economic data need to be collected and applied in a consistent manner.

Issue-profiles

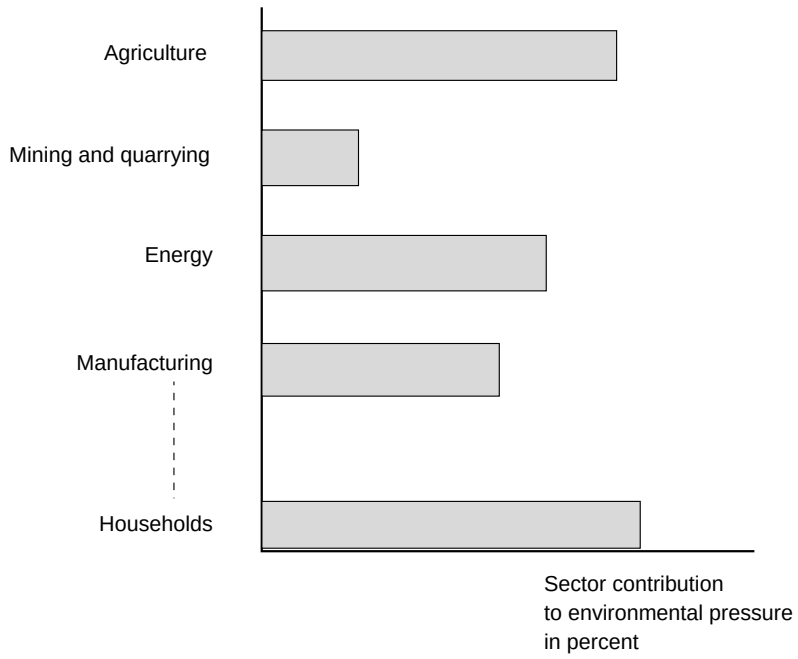
In principle, it is possible to establish a systematic link between environmental pressures and different sectors in the form of issue-profiles[5]. An issue-profile consists of the contributions of relevant sectors to a particular environmental pressure (e.g. greenhouse gas emissions) which in turn can be linked to an issue (e.g. climate change). Figure 4 presents a stylised issue-profile. Issue-profiles could help to identify the economic activity causing a particular environmental problem and, combined with information on sectoral responses, provide useful information for performance reviews. At present, however, problems of data availability and measurement severely constrain any systematic development of issue profiles at the international level.

Future developments

As a medium-term perspective, further integration of economic and environmental information should be possible with a view to fostering sustainable development strategies. Pressure indicators could, for example, be related to parameters reflecting economic activity thus providing an analytical tool for the integration of economy and environment in decision making.

[5]Conceptually, issue profiles are distinct from the approach taken in other OECD work on indicators for the integration of environmental concern into sectoral policies. The latter are broad sets of indicators covering the whole interface between sectoral policies (energy, transport, agriculture etc.) and environment. Issue profiles would be more constrained in the sense that they only deal with one particular environmental issue and that they focus on environmental pressures. On the other hand, they permit the systematic allocation of environmental pressures across sectors -- a feature not present in other work on sectoral indicators. Also, issue profiles can be organised along economic sectors, i.e., in an institutional sense whereas the work on indicators for the integration of environmental concerns into sectoral policies follows a functional approach.

Figure 4 **Issue-profile by sector**



Chapter 2

THE USE OF INDICATORS IN ENVIRONMENTAL PERFORMANCE REVIEWS

Efforts of the OECD programme of environmental performance reviews are directed at promoting sustainable development, with the principal aim of improving the individual and collective performances in environmental management. Environmental performance reviews are structured to further the following principal goals[6]:

- reducing the overall pollution burden and managing natural resources in a sustainable way;
- integrating environmental and economic or sectoral policies;
- strengthening international co-operation.

Environmental performance is to be assessed by comparing achievements or progress with:

- national objectives;
- international commitments;
- absolute levels of environmental quality, taking account of each country's physical, human and economic context.

Seven principles apply for the use of environmental indicators in performance reviews. This chapter briefly discusses these principles and presents examples of the use of indicators in environmental performance reviews.

1. Indicators provide **one of the tools** in the process of performance evaluation and need to be supplemented by other qualitative and scientific information.

Indicators have the advantage of being concise and having a meaning that goes beyond the simple parameter value. However, there is a danger of misinterpretation if indicators are presented without appropriate supplementary information. Such information is particularly needed to explain driving forces behind indicator changes which in turn form the basis for any assessment of environmental performance. Box 1 presents an example from the review of Iceland where indicators of air emissions are embedded in supplementary information about the source of emissions.

2. There is no unique **normalisation** for the comparison of environmental variables across countries: where possible, normalisation by unit of GDP should be shown in parallel with a normalisation by the number of inhabitants. Other possibilities such as total surface exist for normalisation and may be appropriate for specific environmental pressures.

When comparing emissions across countries, the outcome of the assessment will depend greatly on whether GDP or population size are chosen as denominator. Although standardisation is needed to facilitate cross-country comparisons, absolute values may be the appropriate measure where, for example, international commitments are linked to absolute levels of emissions.

[6] As set forth by the OECD Environment Ministers in their 1991 communiqué on the "OECD Environmental Strategy for the 1990s".

3. The set of indicators developed in the series of workshops of the Group on the State of the Environment is a **core set**. In the context of performance reviews, this core set is common to all or most Member countries, and will generally be supplemented by more detailed, country-specific indicators.

Boxes 1 and 2 are examples of this principle put into practice: core indicators on air pollution (Box 1) provide a cross-country comparison but are confined to a particular point in time. In addition, air pollution in Iceland is shown for a larger number of pollutants and for several years. Similarly, in the review of Germany (Box 2) types and evolution of waste water treatment in Germany are shown in detail to supplement the cross-country comparison provided by the core indicator on the percentage of the population connected to waste water treatment plants with biological and/or chemical treatment.

4. For performance evaluation, indicators must be **reported and interpreted in the appropriate context**, taking into account the ecological, geographical, social, economic and structural features of countries.

In performance reviews, this principle is followed in two ways. First, the text directly accompanying the indicator contains a certain amount of contextual information (see, for example, the first paragraphs in Box 1 and Box 2). Second, in every performance review, an introductory chapter deals with the overall physical, demographic, economic and administrative context of the respective country.

5. Not every area of assessment lends itself to the use of **quantitative information**. Certain policy areas may be assessed in qualitative terms. Thus, the issues covered by environmental indicators are a subset of the issues covered by performance reviews.

6. In conceptual and in empirical terms, **indicators of societal responses** tend to be less advanced than indicators of environmental pressures or indicators of environmental conditions. Thus, **particular caution** needs to be applied when interpreting and using indicators of societal responses.

   More generally, key information on methodology for indicator derivation should accompany the use of indicators in performance reviews.

7. There is no necessary one-to-one correspondance between environmental issues and the indicators identified: a specific indicator can be relevant for more than one environmental issue.

Box 1. The Use of Indicators: Example from the Environmental Performance Review of Iceland

Air pollution

Although Iceland's per capita consumption of energy is high and is higher than that of any other OECD country, its unusually high proportion of hydro and geothermal energy contributes substantially to maintaining pollution at low levels. Total primary energy supply (TPES) per unit of GDP in 1990 was 84 per cent above the OECD average and 69 per cent above the average for the other Nordic countries. TPES per capita was 71 per cent greater than the OECD average and 57 per cent higher than the average for other Nordic countries. The Icelandic authorities successfully reduced oil consumption through substitution of renewable resources. Electricity is generated almost exclusively from hydropower, and geothermal energy contributes a high share of space heating.

Context and supplementary information

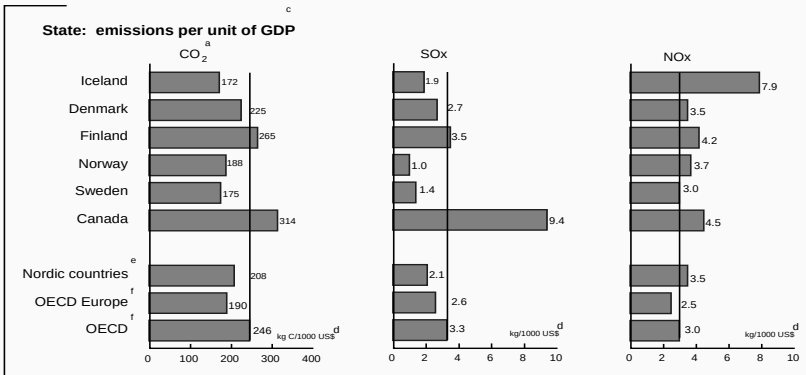
Country-specific indicators and data

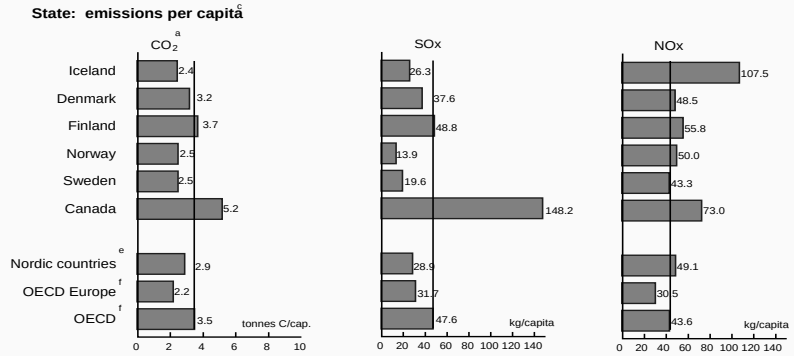
Core indicator

Assessment

Trends in Iceland

		1975	1980	1985	1991	% change 1975-1991
SOx	1 000 tonnes	5.5	8.6	6.6	6.7	21.8
NOx	1 000 tonnes	15.0	13.7	20.8	27.4	82.7
Carbon Monoxide	1 000 tonnes	26.0	29.1	32.8	44.9	72.7
Volatile organic compounds	1 000 tonnes	4.9	5.4	5.9	9.6	95.9
CO2	million tonnes of C	0.54	0.53	0.53	0.60	11.1





a) From energy use only.
b) Data for the late 1980s include emissions from waste treatment and disposal.
c) 1990 or latest available year.
d) GDP at 1985 price levels and Purchasing Power Parities.
e) Nordic countries include Denmark, Finland, Iceland, Norway and Sweden.
f) Data include western Germany only.

Source: OECD, OECD-IEA

The implications of these increases in certain pollution emissions for human health and ecosystems may be minor due to the assimilative capacity of the environment. For example, in spite of the sharp expansion in NOx emissions, the level of depositions is at least three times lower than in any European country. Thus, the Icelandic authorities have drawn special attention to the need to consider pollution concentrations and ambient levels in implementing international commitments.

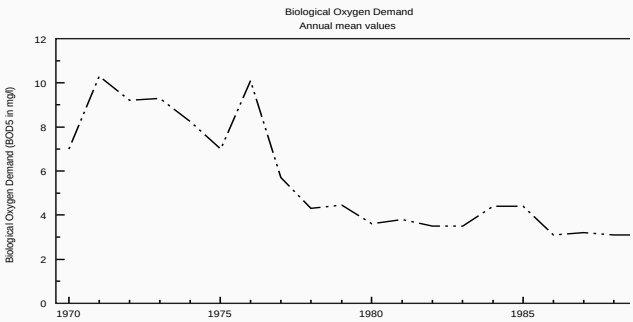
Box 2. The Use of Indicators:
Example from the Environmental Performance Review of Germany

Surface water

The authority to establish water quality objectives in surface or ground water rests with the Länder. The goal of the western Länder is to achieve Quality Class II in all rivers, i.e. Moderate Pollution, the third from highest quality in Germany's seven-tiered water quality ranking system. Class II is defined as: water sections with moderate pollution and good oxygen supply; a very wide variety of species and dense colonisation by individual algae, snails, entomostracans and insect larvae; aquatic plants covering large areas; and fertile fishing waters. No date has been set for achieving this overall goal.

Context and supplementary information

The Rhine: water quality at downstream border



Country-specific indicators and data

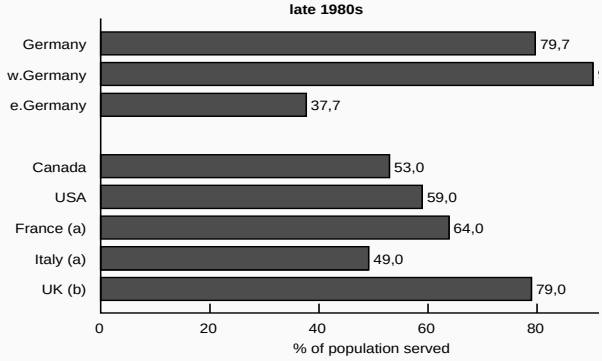
Development of public waste water treatment

% of

	Connected to public sewer system			
	Treated in public sewage treatement plant		Not treated in public sewage treatment plant	Not connected to public sewer system
	Biologically treated	Mechanically treated		
western Germany				
1969	44	20	15	21
1975	57	19	10	14
1979	72	10	7	11
1983	82	5	4	9
1987	87	2	3	8
1990	90	1	1	7
eastern Germany				
1990	36	22	15	27

Core indicator

Population served by waste water treatment plants (biological and/or chemical treatment) late 1980s



Notes: a) OECD Secretariat estimates.
b) England and Wales only.

Source: OECD

Assessment

Major improvements in the quality of surface waters have occurred in western Germany, particularly with respect to oxygen-demanding substances and toxic compounds such as heavy metals. These improvements can be explained both by the progressive equipment of municipalities with sewage treatment plants providing relatively efficient biological and advanced treatment of waste waters and by impressive progress in the installation of treatment equipment at industrial facilities. This has led to significant improvements in the waters of the Rhine, Danube, Neckar and Main rivers.

Chapter 3

INDICATOR DEVELOPMENT BY ENVIRONMENTAL ISSUE

This chapter summarises the work on indicator development, carried out during the workshops of the Group on the State of the Environment. In addition, a number of lead countries provided specific input for the different issues. In this sense, significant parts of the indicators or elements of indicators described below represent an interim consensus. None of them should, however, be perceived as final or necessarily exhaustive in character: they may change as knowledge and perception of environmental problems evolve, they still require detailed technical descriptions and they may be of varying relevance for different countries.

In this chapter, first-choice indicators are highlighted and placed in white boxes. Where these are not readily measurable, one or several proxy indicators are added in grey fields. Grey fields also contain supplementary indicators to round up the picture provided by the core indicator or its substitutes. All indicators or elements of indicators are classified according to their availability: "S" for indicators measurable in the short-term; "M" for indicators which require additional empirical work and data collection efforts and which are therefore only measurable in the medium term and "L" for indicators measurable only in the long term because they would need significant data development work. All the indicators measurable in the short run are brought together in the overview in Figure 5 at the end of this chapter.

The treatment of indicators for each environmental issue comprises the following elements:

a) a table summarising indicators and classifying them by degree of measurability;

b) a short description of the environmental concern and policy relevance of the issue with reference to major international agreements or conventions (e.g. Agenda 21, the Montreal Protocol);

c) a brief discussion of the indicators of environmental pressures, environmental conditions and societal responses where possible;

d) a note concerning the data availability for each category of indicator.

Issue 1: Climate Change

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Index of GHG emissions***	S/M
○ Emissions of CO_2	S
○ Emissions of CH_4	S/M
○ Apparent consumption* of CFC 11 and 12; halons	S/M
○ Emissions of N_2O	M
Environmental conditions:	
● ***Atmospheric concentration of greenhouse gases***	S
● ***Global mean temperature***	S
Societal responses:	
● ***Energy efficiency***	M/L
○ Energy intensity	S
○ Implicit and explicit tax on energy/CO_2	M/L
○ Expenditure on energy efficiency, alternative energies, climate change research	M

*Apparent consumption = production plus imports minus exports.

The environmental concern and policy relevance: in recent decades, the balance in the radiative energy budget of the earth-atmosphere system has been disturbed by the addition of gases generated by human activities. An increase of the atmospheric concentration of these greenhouse gases changes the radiative energy balance and leads to temperature and climate change.

One of the major international agreements which emerged from 1992 "Earth Summit" in Rio de Janeiro was the UN Framework Convention on Climate Change. A number of countries have made commitments to reduce their emissions of greenhouse gases over the coming years.

Indicators of environmental pressures: four different radiately active gases have direct effects on climate change: carbon dioxide, methane, nitrous oxide, halocarbons. The indicators of environmental pressures relate to gross emissions, i.e., they do not consider sinks of greenhouse gases. For an aggregate indicator of greenhouse gas emissions, all four gases should be taken into account. Aggregation supposes a weighting scheme, based on global warming potentials (GWP) as proposed by the Intergovernmental Panel on Climate Change. To date, however, major uncertainties exist about the size of these weighting factors. Until definitive weighting factors are put forward, it is proposed to consider each greenhouse gas individually. In the future, it may also be necessary to include emissions of substitutes for CFCs with high GWP.

Data availability: CO_2 emissions are well covered, in particular emissions from energy use (Source: OECD/IEA). For CFCs, apparent consumption is monitored under the Montreal Protocol. Estimates on methane emissions exist but country coverage is smaller and there are wide divergences between estimates from different sources (Source: OECD). Information on halons is very limited. Significant measurement problems exist with N_2O.

Indicators of environmental conditions: the atmospheric concentration of greenhouse gases and the changes in global mean temperature are common indicators for climate change. These indicators remain of limited direct use for environmental performance reviews as they cannot be related to a particular country's environmental performance.

Indicators of societal responses: efforts to reduce GHG emissions include a large number of individual actions and policy instruments (taxes, regulations, subsidies etc.), mostly designed to improve energy efficiency. The different efforts are difficult to capture in a single indicator. It is therefore proposed to employ an indicator of energy efficiency, reflecting, at least partly, society's efforts to reduce greenhouse gas emissions. Supplementary indicators such as energy and CO_2 tax rates and environmental expenditure should help to trace individual policy instruments. As always, expenditure data need to

be put into the right context for appropriate interpretation.
Data availability: measures of energy efficiency are not readily available. As a first step, it is therefore proposed to use energy intensity measures (Source: OECD/IEA), although they reflect structural factors as well as changes in energy efficiency. Data on government R&D expenditure on energy efficiency and alternative energy sources are partly available (Source: IEA); implicit and explicit tax rates on CO_2 have also been evaluated (Source: OECD), although country coverage is incomplete.

Issue 2: Stratospheric Ozone Depletion

Environmental concern and policy relevance: in 1974 it was discovered that chlorine-containing substances pose a threat to the ozone layer. Ozone is mainly found in an atmospheric layer at stratospheric altitudes, between 20 and 40 kilometres, and acts as a shield against harmful solar ultra-violet radiation.

In 1985, the Vienna Convention for the Protection of the Ozone Layer was signed, followed by the Montreal Protocol and London and Copenhagen Amendments on Substances that Deplete the Ozone Layer.

Indicators of environmental pressures: principal among the ozone-depleting substances are CFCs, halons, methyl chloroform and carbon tetrachloride, and HCFCs, plus methyl bromide. Individual substances vary considerably in their ozone-depleting capacity. To reflect the combined depletion capacity, the apparent consumption of each individual substance has to be weighted in proportion to its ozone-depleting potential relative to CFC-11.
Data availability: CFC-11 and CFC-12 account for half of the ozone-depleting substances and are therefore proposed as parameters. Actual emissions of CFCs are difficult to measure but production or apparent consumption can be used as a proxy. Data on halons are less readily available so that a short-run indicator will be confined to CFCs (Source: OECD).

Indicators of environmental conditions: first choices for an indicator of environmental conditions are the global atmospheric concentration of ozone-depleting substances, and, closer to effects, the radiation of UV-B at ground level. Changes in the concentration of CFC-11 and CFC-12 help to track the magnitude and rate of change of the atmospheric reservoir of the most abundant ozone-depleting substances. As in the case of greenhouse gases, the indicator remains of limited use in the specific context of environmental performance reviews as it cannot be related to a particular country and its environmental performance. A second indicator, more closely associated with particular countries, is the trend in stratospheric ozone levels over selected measurement points.
Data availability: information on global atmospheric CFC concentrations is readily available. Trend data of ozone concentrations for individual monitoring stations are available for 19 OECD countries.

Indicators of societal responses: recovery rates of CFC and society's expenditure for that purpose as well as for replacement technologies are possible indicators. Important contextual information is the extent to which a country has committed itself to the phasing-out of CFCs. These targets could then be compared to environmental pressures in terms of production and/or consumption of CFCs. A different indicator for governments' specific efforts at the international level are countries' contributions to the Interim Multilateral Fund associated with the Montreal protocol. The fund, which was established on a pilot basis for three years, aims at helping developing countries to adopt replacements for CFCs.
Data availability: information on CFC recovery rates is scattered and virtually no data are currently obtainable for expenditure on CFC recovery or replacement.

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Index of apparent consumption* of ozone-depleting substances***	M
○ Apparent consumption of CFCs halons	 S M
Environmental conditions:	
● ***Atmospheric concentration of ozone-depleting substances*** ● ***UV-B radiation at ground level***	M M
○ Atmospheric concentration of CFCs ○ Stratospheric ozone levels over selected areas	S S/M
Societal responses:	
● ***CFC recovery rates***	M
○ Expenditure for CFC recovery and replacement technologies ○ Countries' contributions to the Interim Fund associated with the Montreal Protocol	L M

*Apparent consumption equals production plus imports minus exports.

Issue 3: Eutrophication

Environmental concern and policy relevance: The consequences of over-nourishment of aquatic plants (eutrophication) has become a major problem of water pollution in Member countries, affecting surface water, groundwater and marine waters. Excess nutrients can also be found in soil and sediments. The annual mean concentration of nitrates has, for example, been increasing at the downstream frontiers of rivers, mainly as a reflection of pollution from agricultural origins such as animal manure or excess fertilizers.

Acceptable levels of dissolved oxygen and nutrient levels in receiving waters have been established in national and international standards and agreements such as the International Joint Commission Agreement on Great Lakes Water

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Emissions of N and P into water and soil***	L
○ Apparent consumption of fertilizers, measured in N,P	S M
○ Waste water discharges	S/M
○ Livestock density	
Environmental conditions:	
● ***BOD/DO, concentration of N and P in inland and marine waters***	S/M M/L
Societal responses:	
● ***Percentage of population connected to sewage treatment with biological and/or chemical treatment***	M/L
○ Percentage of population connected to waste water treatment	S
○ User charges for waste water treatment	M
○ Market share of phosphate-free detergents	S/M

Quality in North America.

Indicators of environmental pressures: a complete set of pressure indicators would comprise emissions of nitrogen and phosphate from manure, fertilizer, domestic and industrial waste water, sewage sludge, dredge spoil and solid waste, corrected for the absorption of phosphates and nitrogen by crops. This could be further extended to reflect a proper nutrient balance.
Data availability: at the international level, few data are available for the entire range of emission sources of phosphorus or nitrogen as well as for the absorption of phosphates and nitrogen by crops. Currently, measurements are confined to the apparent consumption of fertilizers and general information on waste water discharges. Aggregate amounts of fertilizers must be measured in terms of N or P to account for different types of fertilizers. Livestock density provides a rough but measurable proxy for potential eutrophication from manure.

Indicators of environmental conditions: direct indicators of the extent of eutrophication relate to the phosphate and nitrate contents of inland and marine waters. Biological oxygen demand of water bodies or the degree of dissolved oxygen can also be considered indicative of eutrophication.
Measuring excess nutrients in soil complicates matters significantly. The focus of indicators is therefore on water. A general problem related to indicators of ambient quality is how to carry out spatial aggregation to present meaningful national figures: forming averages is seldom a satisfactory solution so that often data of representative sites are shown rather than national figures.
Data availability: at the international level, data are available for BOD, phosphate and nitrate concentrations for selected rivers in OECD countries (Source: OECD).

Indicators of societal responses: several indicators would appear useful to show society's efforts towards reducing eutrophication and excess nutrients: the extent of chemical and/or biological waste water treatment, the extent to which levies on sewage water treatment cover actual costs, the market share of phosphate-free detergents. For non-point sources, in particular agricultural ones, an indicator reflecting best farming practices could be introduced.
Data availability: for OECD countries, data on the share of the population connected to sewage treatment plants are available in the short run (Source: OECD). Information on the type of treatment and on waste water charges remains partial. Data on the market share of phosphate-free detergents should be available more easily (Source: industry associations).

Issue 4: Acidification

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Index of acidifying substances***	M/L
○ Emissions of SOx and NOx ammoniac	S M
Environmental conditions:	
● ***Exceedence of the critical loads of potential acid in water and soil***	S/M
○ Concentration in acid precipitations (pH, SO_4, NO_3) ○ Total depositions of acidifying substances	S M
Societal responses:	
● ***Percentage of car fleet equipped with catalytic converters***	S/M
● ***Capacity of SOx and NOx abatement equipment of stationary sources***	M/L
○ Expenditure for air pollution abatement	S

Environmental concern and policy relevance: in the atmosphere, emissions of sulphur and nitrogen compounds are transformed into acidifying substances such as sulphuric and nitric acid. When these substances reach the ground, acidification of soil, water and buildings arises. Soil acidification is one important factor causing forest damage. Acidification of the aquatic environment may severely impair the life of plant and animal species.

Problems of acidification have triggered several international agreements to reduce emissions, e.g., the 1979 Convention on Long-range Transboundary Air Pollution and the 1985 Helsinki Protocol on the reduction of sulphur emissions as well as the 1988 Sophia Protocol on the control of emissions of nitrogen oxides.

Indicators of environmental pressures: as sulphur and nitrogen compounds are at the source of acidification, emissions of SOx, NOx and NH_3 provide meaningful indicators of environmental pressures.

Data availability: international data on SOx and NOx emissions are immediately available (Source: OECD); information on NH_3 is more difficult to obtain at the international level.

Indicators of environmental conditions: there are several possibilities to reflect the state of acidification of soil and water: a) by means of an indicator of acid precipitations and/or depositions (exceedence of the critical loads of potential acids in soils and waters); b) by means of the direct indication of the pH-value of lakes or soil; c) through indirect measures such as the crown density of forest.

Data availability: for the short-run, only concentrations of acidifying substances in precipitation can be measured at the international level (Source: OECD). Data on depositions, exceedence of critical loads and measurements of pH-values in surface waters and soil are available in a number of countries (Source: EMEP, OECD) but further efforts to improve data collection and harmonization are needed internationally.

Indicators of societal responses: physical and expenditure data on the capacity of equipment to abate SOx and NOx emissions provide meaningful indicators with respect to industry's efforts. Households' efforts could be reflected through the percentage of the car fleet equipped with catalytic converters. More generally, efforts of environmental policy could be captured through comparison between ambient standards for SO_2 and NO_2 concentrations.

Data availability: currently, data on pollution abatement expenditure are only available for air pollution abatement as a whole, including expenditure for non-acidifying air emission abatement (Source: OECD). Partial information is at hand for physical equipment, in particular for utilities. A comparison of ambient air standards necessitates further work to make them comparable across countries.

Issue 5: Toxic Contamination

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Emissions of heavy metals***	M/L
● ***Emissions of organic compounds***	L
○ Consumption of Pb,Hg,Cd,Ni	S/M
○ Apparent consumption of pesticides[a]	S/M
○ Generation of hazardous waste	S/M
Environmental conditions:	
● ***Concentration of heavy metals and organic compounds in environmental media and living species***	L
○ Concentration of lead, cadmium, chromium, copper in rivers	S/M
Societal responses:	
● ***Changes of toxic contents in products and production processes***	L
○ Rehabilitated areas as percentage of total areas identified as contaminated	L/M
○ Market share of unleaded petrol	S

a) See notes below concerning problems of measurement and comparability.

Environmental concern and policy relevance: human activities lead to emissions and accumulation of toxic substances in environmental media and living species and present danger to human and ecosystem health. A number of international agreements extend to the control of toxic substances (e.g. 1989 Basel Convention on hazardous wastes). Agenda 21 also refers to the safer use of toxic chemicals and the management of hazardous waste.

Indicators of environmental pressures: the large number of toxic substances necessitates a selection based on risk assessments and quantities of individual substances. To the extent that such selections already exist, they could be examined for their relevance to performance reviews. Two major types of toxic substances could be considered: heavy metals and organic compounds, including pesticides. Currently, no internationally agreed list of substances with appropriate weighting factors exists. Indicators relate therefore to the consumption of selected individual toxic substances. Among heavy metals, consumption of lead, cadmium, mercury and nickel can be traced. Among organic substances, the consumption of pesticides is a first step towards a more comprehensive indicator. It is, however, important to recognise the differences among pesticides concerning toxicity, persistence and mobility. A less direct, but more readily measurable, indicator of potential toxic contamination is the generation of hazardous waste.

Data availability: data on the apparent consumption of pesticides (measured in tonnes of active ingredients) exist for a number of countries (Source: OECD) although problems of international comparability remain significant; there are data on the use of lead for many OECD countries (Source: OECD); information on the use of cadmium, mercury and nickel is more scattered. Data are available on the generation of hazardous waste (Source: OECD).

Indicators of environmental conditions: indicators concerning the condition of toxic contamination of the environment should show ambient concentrations of the various toxic substances in different environmental media and living species.

Data availability: short-run data availability confines empirical evaluations at the international level to indications of concentrations of key heavy metals in inland waters (Source: OECD).

Indicators of societal responses: many of society's responses concerning toxic contamination consist of regulations concerning notification, treatment and use of toxic substances. Typically, such responses are difficult to reflect in concise and internationally comparable indicators. A first choice to measure society's response are the changes in toxic contents of products and production processes, although such an indicator would need further elaboration. A more specific response concerning soil is society's actions and decisions to identify, assess and clean up contaminated sites. An associated indicator is the percentage of rehabilitated areas in the total area identified as contaminated. Another partial but measurable indicator is the market share of unleaded petrol.
Data availability: in the short run, only data the on market share of unleaded petrol are available.

Issue 6: Urban Environmental Quality

Environmental concern and policy relevance: an increasing part of the population of OECD countries is living in urban areas. Most pollution sources are found in or near urban areas, and other forms of environmental degradation also tend to occur with greatest severity in urban areas. As a result of the combination of these factors, the greatest potential for human exposure to deteriorating environmental conditions occurs in urban areas.

The promotion of sustainable human settlements, in particular urban ones, is an item explicitly considered in Agenda 21.

Indicators of environmental pressures: in principle, most environmental pressures apply, although at an urban scale. As the first choice for indicators, it is proposed to focus on key environmental pressures, i.e., air emissions (NOx, SOx, particulates, CO) and noise. Noise, which can be considered both a pressure and a condition, is dealt with under environmental conditions. These proximate pressure indicators are accompanied by selected indicators of indirect pressures such as traffic density (measured e.g. through car holdings per capita) and the degree of urbanisation (measured e.g. through percentage of population living in cities with more than 1 million inhabitants).

Data availability: for emissions, data availability at the international level is constrained by the need to collect information at the urban level. Data on traffic density is readily available for country averages and for many individual cities (Source: OECD). Information on the degree of urbanisation can be obtained from other international sources.

Indicators of environmental conditions: indicators of urban environmental conditions cut across the various media. They include the quality of urban air, drinking water, ambient surface and ground water. Whereas the quality of drinking water is an important factor in the urban quality of life, it only partly reflects environmental conditions as high-quality tap water can simply reflect an efficient treatment system. First choice indicators of environmental conditions relate to the exposure of population to air pollution and to noise. The quality of ambient surface and ground water is also a first choice indicator. It reflects environmental conditions and, often, the pre-treatment quality of drinking water.

Data availability: internationally comparable data exist for concentrations of major air pollutants (Source: OECD) but information on exposure is more scattered. Additional efforts of data collection are also needed to obtain comprehensive information on ambient water quality in urban areas.

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Urban air emissions: SOx, NOx, VOC***	M
○ Traffic density	S/M
○ Degree of urbanisation	S/M
Environmental conditions:	
● ***Exposure of population to:***	
-air pollutants	M
-noise	S
	M
● ***Ambient water conditions in urban areas***	
○ Concentration of air pollutants	S
Societal responses:	
○ Changes in green space as a percentage of total urban area/total urban population	M/L M
○ Regulations on emissions and noise levels for new cars	S/M
○ Expenditure on water treatment and noise abatement	

Indicators of societal responses: indicators of societal responses to urban environmental problems cut through the whole range of measures so that there is no single first choice indicator. Key areas for indicators are traffic (regulations on emissions and noise levels for new cars) and green space (with changes in green space compared to total urban area). Expenditure on noise abatement and water treatment complete the picture.

Data availability: due to definitional problems, data on green space is not available in an internationally comparable form. Information on car regulations and expenditure should be available with some additional effort.

Issues 7 and 8: Biological Diversity and Landscape

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Habitat alteration and conversion of land from its natural state***	L
○ Land use changes	S
○ Introduction of new genetic material and species	L
Environmental conditions:	
● ***Threatened or extinct species as a share of known species***	S
Societal responses:	
● ***Protected areas as a percentage of total area by ecosystem type***	S L
○ Protected species as a percentage of threatened species	M/L

Environmental concern and policy relevance: biological diversity can be defined as the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. An ecosystem is a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

The broad and complex nature of biodiversity would, ideally, suggest a treatment at three different levels:
a) the ecosystem level, dealing with the combination of physical and biological elements; b) the population or species level dealing with the change in the number of species due to alteration of living conditions by man; c) genetic diversity within species.

One of the major outcomes of the United Nations Conference on Environment and Development in 1992 was the signing of the Convention on Biological Diversity by over 150 governments.

Landscape: Specific types of human land use, such as certain agricultural practices, road and house building, hydropower projects, drainage of wetland, forestry and mining may pose a threat to ecosystems, and thus a form of environmental pressure on landscape. In addition, landscape can be seen as a part of environmental quality as such, important to humans for ethical, aesthetic and cultural reasons. Thus, degradation of landscape entails both a loss of naturalness and historic cultural values. So far, no internationally agreed definition of landscape exists and no attempt has been made to develop landscape indicators in this report.

Indicators of environmental pressures: three types of pressures on biodiversity have been identified: physical ones (e.g. habitat alteration); chemical ones (e.g. exposure to contaminants); biological ones (e.g. release of alien species, fishing). The main chemical pressures are covered by issue 3,4 and 5. Some of the biological pressures are captured in issues 10 and 11, some of the physical pressures appear, for example, in issue 13. Here, indicators are focused on additional physical and biological pressures. Indicators of habitat alteration and the conversion of land from its natural state would reflect such pressures. Increasing use of land for agricultural purposes is suggested as a measurable proxy for environmental pressure.
Data availability: there are internationally comparable data on land use changes (Source: FAO, OECD).

Indicators of environmental conditions: the most frequently used indicator of the state of biodiversity is the number of threatened or extinct species over the number of known species.
Data availability: international data exist for threatened or extinct species as a percentage of known species (Source: OECD).

Indicators of societal responses: responses to protect biodiversity and landscape include measures to protect areas, ecosystems and

species and to create biosphere reserves representative of different ecosystems. The suggested indicators of societal responses are therefore the size of protected areas by type of ecosystem and the number of protected species. Data availability: information on the number and extent of protected areas is available (Source: IUCN) but comparability is not sufficient to provide coverage of different types of ecosystems. Data development work is also necessary to quantify the share of protected species.

Issue 9: Waste

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Waste generation:***	
-- municipal waste	S
-- industrial waste	S
-- nuclear waste	S
-- hazardous waste	S/M
Environmental conditions: Not applicable	
Societal responses:	
● ***Waste minimisation efforts***	L
○ Charges for waste disposal	M
○ Expenditure on waste collection and treatment	S
○ Waste recycling and recovery rates	S

Environmental concern and policy relevance: different types and quantities of solid waste are generated by human activities in OECD countries: municipal waste (mainly from households), industrial waste, nuclear waste and other types including waste from energy production, agricultural production, mining, and demolition as well as dredge spoils and sewage sludge. The quantity of wastes produced in OECD countries has been steadily increasing. Wastes have potential impact on human health and the environment, and waste management issues are at the centre-stage of many countries' environmental concerns.

Several international agreements and rules exist for the transfrontier movements of hazardous waste: Directives of the European Community, OECD Decisions and Recommendations, the Lomé IV Convention and the Basel Convention. Management of solid waste and sewage is also an item explicitly considered in Agenda 21, endorsed by UNCED in Rio de Janeiro in 1992.

Indicators of environmental pressures: waste presents a potential environmental pressure for soil, water, air and landscape. The actual environmental pressure depends, however, almost exclusively on the waste handling and deposition practices. Any indicator on the amounts of waste generated is therefore only a first approximation of environmental pressure and more information will be needed on the actual environmental pressure. In addition, the composition of waste will influence its potential environmental impacts. Total amounts of waste generated should therefore be broken down by principal source, i.e., municipal, industrial and nuclear waste. It should be noted that the indicator on "generation of hazardous waste" is present both under the "waste" issue and the issue on toxic contamination.

Data availability: waste generation by major source can be evaluated for most OECD countries (Source: OECD). Many uncertainties concerning the quality of waste data and their international comparability do remain, however.

Indicators of environmental conditions: waste acts as a pressure on the environment; no indicators of environmental conditions can therefore be directly associated with the issue "waste". Changes in environmental conditions due to waste are reflected in various other issues

such as toxic contamination (Issue 5) or landscape (Issue 7).

Indicators of societal responses: society's responses have been mainly directed towards the collection, treatment and disposal of waste. Increasingly, waste management efforts are aiming at waste minimisation. This is reflected in the first-choice indicator. Charges for waste disposal are an indicator for an instrument to incite waste minimisation. Total expenditure on waste collection, treatment and disposal provides a general indication of society's financial efforts to deal with waste. Indicators on rates of waste recycling and recovery and charges for waste disposal complete the picture.

Data availability: data on waste recycling and recovery are available at the international level (Source: OECD), although further efforts will be necessary to complete international coverage and comparability.

Issue 10: Water Resources

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Intensity of use of water resources***	S
○ Share of discharged waste water in rivers	M/L
Environmental conditions:	
● ***Frequency, duration and extent of water shortages***	M
Societal responses:	
● ***Water prices and user charges for waste water treatment as percentage of cost***	M

Environmental concern and policy relevance: fresh water resources are of major environmental and biological importance because water is a basic support element for human life and ecosystems. Water withdrawal can be a major pressure on freshwater resources: in more arid regions, water resources may at times be limited to an extent where the demand for public water supply, agricultural purposes or industrial processes can be met only by going beyond a sustainable use of the resource in terms of quantity and possibly of quality. Information available for OECD countries suggests that water withdrawal has increased over the past two decades, contributing both to quantity and quality problems of water supply. Although the quality and quantity aspects of freshwater resources are interlinked, the present issue deals primarily with the quantity aspect of the resource.

The protection and the preservation of fresh water resources is an item explicitly considered in Agenda 21, endorsed by UNCED in Rio de Janeiro in 1992.

Indicators of environmental pressures: a necessary condition for sustainable use of water resources is that the withdrawal of water does not exceed the renewal of the stocks over an extended period. An indicator tracing the intensity of the use of water resources is therefore the appropriate measure. This indicator would be

defined as the (gross or net) withdrawal of water resources, divided by the renewal of water resources. As opposed to net withdrawal, gross withdrawal accounts for total water withdrawal without deducting water that is reinserted into the natural environment after use. Whereas the use of a figure representing net withdrawals focuses on the quantitative side of water use, the use of gross withdrawals has a qualitative component: even if water is reinserted into the natural environment, it tends to be of inferior quality after use.

At the same time, it must be kept in mind that a measure of intensity based on a national average may be misleading, in particular for large countries: major differences in regional water use may not be adequately reflected in the national indicator.

Data availability: information on the intensity of the use of water resources is available for most OECD countries (Source: OECD).

Indicators of environmental conditions: water resources are characterised by a significant variance of stocks, during different times of the year as well as between different years. These variations are likely to affect water quality and ecological equilibria. An indicator to measure these variations would take into account the duration and the extent of a shortage of water supply. At its extremes, in the form of droughts and floods, the question of regularity also presents a specific dimension of environmental risks.

Data availability: none of the indicators of environmental conditions are immediately available at international level.

Indicators of societal responses: society's efforts to reduce unsustainable water use consist of either measures constraining the quantities of water available or measures increasing the price of water to encourage efficient use. The price of water and the charges for waste water treatment are therefore proposed as suitable indicators. Put in relation to actual cost of water treatment and supply, the resulting ratio gives an indication of the direct accountability of consumers of water for the use of the natural resource.

Data availability: data on water prices and user charges are only partly available (Source: OECD) and need further development.

Issue 11: Forest Resources

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Short-run sustained yield/actual harvest***	S/M
Environmental conditions:	
● ***Area/volume and distribution of forests***	S
○ Share of disturbed/deteriorated forest in total forest area	M/L
Societal responses:	
○ Percentage of harvest area sucessfully regenerated (incl. natural regeneration) or afforested	M/L
○ Percentage of protected forest area in total forest area	M

Environmental concern and policy relevance: forests are among the most diverse and widespread ecosystems on earth. Forest resources have many functions: they provide timber; they provide ecosystem services including regulation of soil, air and water quality; they provide recreation benefits; they are a reservoir for biodiversity and act as a carbon sink. There is general concern over human impact on forest health and the natural processes of forest growth and regeneration.
Combatting deforestation to preserve soils, water, air and biological diversity is an item explicitly considered in Agenda 21, endorsed by UNCED in Rio de Janeiro in 1992.

Indicators of environmental pressures: the harvest rate set by any country is a function of the size of its forests, the proportion of the forest area dedicated to timber production, the productivity of the forest and the age class structure of the forest, and management objectives and sustained yield policies of the country. The indicator relating sustained yield to actual harvest expresses the relative balance between forest growth and harvest, considering forest characteristics such as age classes. The sustained yield in North America would reflect aggregate allowable annual cut, and in other OECD countries could reflect current growth rates or increments of forest estate.

Data availability: information on short run sustained yield is available for many OECD countries, or can be derived with standard formulas.

Indicators of environmental conditions: the state of forest resources can be represented through a measure of total forest area or volume. This information can be supplemented by more precise indicators incorporating species groups, maturity classes, and rates of disturbance by natural and anthropogenic forces such as forest fires.

Data availability: data on the area, volume and distribution of forests and the types of disturbance are readily available (Source: OECD/FAO/UN-ECE).

Indicators of societal responses: a major societal response to preserve forest resources relates to the efforts of regeneration and afforestation of harvested areas. The protection of forest areas is also an element in the overall conservation effort although it applies at least equally to concerns about the loss of biodiversity.

Data availability: data on total protected forest areas are available for a significant number of countries, although a breakdown by IUCN category necessitates additional data development work. Similarly, more data development is needed before efforts of regeneration and afforestation can be presented in an internationally comparable way.

Issue 12: Fish Resources

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Fish catches***	S
Environmental conditions:	
● ***Size of spawning stocks***	M
○ Overfished areas	M/L
Societal responses:	
○ Number of stocks regulated by quotas	M
○ Expenditure for fish stock monitoring	M/L

Environmental concern and policy relevance: by the end of the 1980s, marine fisheries yielded between 80 and 90 million tonnes of fish, with an overall trend that has been increasing by over 40 percent during the past two decades. Many of the more valuable fish stocks are overfished, and the steady trend towards increased global fish landings is achieved partly through exploitation of new and/or less valuable species. Coastal development has also turned out to be a significant pressure on fish stocks. Over-exploitation can be found both with freshwater and marine fish stocks. As with other natural resources, the quality of fish resources (existence of diseases, contamination etc.) is in itself an important factor for the quantity of the resources. The current issue on fish resources focuses on marine fish resources but extends to freshwater fish resources. Stocks associated with aquaculture are, however, explicitly excluded from current considerations.

The protection and sustainable management of oceans to prevent over-fishing and degradation of coastlines and coral reefs are items explicitly considered in Agenda 21, endorsed by UNCED in Rio de Janeiro in 1992. In addition, there are a number of international agreements such as those reached under the Northwest Atlantic Fisheries Organization.

Indicators of environmental pressures: OECD countries play an important role in world fisheries and the trend in national fish catches is a primary indicator for the pressure exerted on fish stocks. As it is difficult to allocate fish stocks to national boundaries, it is not possible to calculate ratios of sustainable use (fish catches over growth of stock) on a national basis. Nonetheless fisheries and environment remain relevant topics for environmental performance reviews. Where national quotas exist, fish catches can be related to them to get an indicator of potential over-exploitation.

Data availability: fish catches and production data are available at significant detail and for most OECD countries (Source: OECD/FAO).

Indicators of environmental conditions: the size of spawning stocks is a relevant indicator for environmental conditions if it can be related to a measure of sustainability. Defining and measuring sustainability remains, however, a difficult task. A different indicator would present overfished areas, although this indicator needs further elaboration. Again, it is difficult to associate fish stocks with a particular country.

Data availability: data on the size of major fish populations exist but are scattered across national and international sources.

Indicators of societal responses: a comprehensive indicator for countries' efforts to protect fish stocks would include information on the various types of expenditure for this purpose as well as information on restrictions on landings of fish. Supplementary indicators for societal responses include expenditure for the monitoring of fish stocks. Other responses such as the use of environmentally friendly fish- catching methods are important but difficult to make operational in a single indicator.

Data availability: no data are readily available on the expenditure for the protection of fish stocks.

Issue 13: Soil Degradation (Erosion and Desertification)

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Erosion risk: potential and actual use of soil for agriculture***	L
○ Land use changes	S
Environmental conditions:	
● ***Degree of top soil losses***	M
Societal responses:	
● ***Rehabilitated areas***	M/L

Environmental concern and policy relevance: desertification and erosion are processes of physical land degradation caused by human impact and by changes in climate. Soil erosion arises when the rate of new soil formation is inferior to soil losses. When soil quality and moisture content decline, a productive semi-arid region can be converted into a desert, a process known as desertification. The environmental problems of erosion and desertification are large. Seventy percent of the world's drylands are already affected by degradation. This is one quarter of the world's land. Although the problem is most severe in the developing world, a number of OECD countries are equally affected. Soil degradation is not limited to physical degradation but encompasses problems such as toxic contamination, excess nutrients, salinisation and acidification. These problems of soil quality are dealt with under the respective issues.

The promotion of sustainable land management practices to prevent erosion and soil degradation as well as combatting desertification and drought are two prominent items in Agenda 21, endorsed by UNCED in Rio de Janeiro in 1992.

Indicators of environmental pressures: primary factors in erosion and desertification are unsustainable land use, including farming and grazing. Land use changes as for instance from forest to agriculture, could therefore be a meaningful, though general, indicator for the danger of erosion and desertification. A more specific indicator would be the comparison between potential and actual use of land for agricultural purposes. To the extent that the actual use of land for agriculture exceeds the carrying capacity of land, this provides an indication for the risk of erosion and soil degradation.

Data availability: data on the actual use of land are available throughout OECD countries (Source: OECD). Information on the risk of erosion and on potential use of land is still very scarce and does not permit indicator development in the short run.

Indicators of environmental conditions: the degree and extent of erosion is best indicated through the degree and extent of top soil losses, terrain deformation and overblowing.

Data availability: at present, data on the degree and extent of soil degradation are available but not at a national level (WRI, International Soil Reference and Information Centre).

Indicators of societal responses: it is difficult to pinpoint all specific efforts to combat erosion and desertification. One relevant and measurable effort to counter soil degradation is the size of rehabilitated areas; it is suggested as a first-choice and though general indicator in this context which would need further specification. Indicators could also be developed related to best management practices in agriculture.

Data availability: data on rehabilitated areas are at present not available at the international level.

General Indicators, Not Attributable to Specific Issues

Summary of Indicators

Indicator	Measurability
Environmental pressures:	
● ***Population growth and density***	S
● ***GDP growth***	S
● ***Industrial production***	S
● ***Energy supply***	
● ***Structure of energy supply***	S S
● ***Road traffic volumes***	
● ***Road vehicle stock***	S
● ***Agricultural production***	
Societal responses:	
● ***Environmental expenditure***	M S
● ***Public opinion***	
○ Pollution abatement and control expenditure	S

Indicators of environmental pressures: general indicators of environmental pressures consist mainly of indicators of indirect pressures (background indicators). The indicators presented here are the ones most commonly used and readily available at the international level. The main function of these indicators is to provide contextual information -- a key feature of environmental performance reviews. Achievements in pollution reduction, for example, must be seen in the context of economic growth: assessments will differ when reductions in pollution are achieved during periods of weak or declining economic activity rather than during phases of strong economic growth.

Data availability: most data for these indicators are accessible without difficulty for a large number of OECD countries.

Indicators of societal responses: two major general indicators of societal responses are suggested: a) environmental expenditure at the national level and for broad economic sectors (public sector, business sector, households): although expenditure, when considered by itself, does not provide any information on the state of the environment, it is a useful indicator for the financial efforts undertaken by society to mitigate or abate pollution; b) public opinion on environmental issues: this indicator aims at capturing one of the major factors in triggering societal responses by government, business and households. A third, more general, area suggested for indicator development is environmental information: examples of these societal responses are the introduction of eco-labels or regular reports on the state of the environment.

Data availability: many OECD countries collect data on environmental expenditure, although they are often limited to pollution abatement and control activities. Such data have been compiled by OECD. Similarly, information on public opinion in Member countries is available from OECD. At OECD level, no comprehensive and internationally comparable information exists currently as to the use of eco-labels.

Figure 5 **Summary of Short-Term Indicators[a] by Environmental Issue[b]**

	Issues	PRESSURE Indicators of environmental pressures	STATE Indicators of environmental conditions	RESPONSE Indicators of societal responses
1.	Climate change	Emissions of CO_2	Atmospheric concentrations of greenhouse gases Global mean temperature	Energy intensity
2.	Stratospheric ozone depletion	Apparent consumption of CFCs	Atmospheric concentration of CFCs	
3.	Eutrophication	Apparent consumption of fertilizers, measured in N,P	BOD, DO, N and P in selected rivers	% of population connected to waste water treatment plants
4.	Acidification	Emissions of SOx and NOx	Concentrations in acid precipitations (pH, SO_4, NO_3)	Expenditure for air pollution abatement
5.	Toxic contamination	Generation of hazardous waste	Concentration of lead, cadmium, chromium, copper in selected rivers	Market share of unleaded petrol
6.	Urban environmental quality		Concentrations of SO_2, NO_2, particulates in selected cities	
7&8	Biological diversity and landscape	Land use changes	Threatened or extinct species as % of known species	Protected areas as % of total area
9.	Waste	Generation of municipal, industrial, nuclear, hazardous waste	not applicable	Expenditure on waste collection and treatment Waste recycling rates (paper and glass)
10.	Water resources	Intensity of use of water resources		
11.	Forest resources		Area, volume and distribution of forests	
12.	Fish resources	Fish catches		
13.	Soil degradation (desertification and erosion)	Land use changes		
14.	General indicators, not attributable to specific issues	Population growth and density GDP growth Industrial and agric. production Energy supply and structure Road traffic and vehicle stock	not applicable	Pollution abatement and control expenditure Public opinion on the environment

a) Only indicators which are available in the short term at international level are shown in this table. See Chapter 3 for other indicators. This table identifies key elements of indicators: at this point, no normalisation with respect to GDP, population, etc. is suggested. See Chapter 3 on use of indicators for a discussion.

b) For a brief discussion of each individual issue, see Chapter 3.

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