Unclassified ENV/EPOC/SE(2001)2/FINAL

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

26-Apr-2002

English - Or. English

ENVIRONMENT DIRECTORATE
ENVIRONMENT POLICY COMMITTEE

ENV/EPOC/SE(2001)2/FINAL
Unclassified

Working Group on Environmental Information and Outlooks

AGGREGATED ENVIRONMENTAL INDICES

REVIEW OF AGGREGATION METHODOLOGIES IN USE

This report is part of the OECD programme on environmental indicators, steered by the Working Group on Environmental Information and Outlooks (WGEIO). It complements the work carried out since 1990 that resulted in the adoption, at OECD level, of a common framework for environmental indicators.

The report responds to the increasing interest in and reservations on aggregated environmental indices that potentially simplify the communication process by which major environmental trends and policy results are provided to the public and to high-level decision makers.

The report was prepared by Mr. Eduard Goldberg (consultant), discussed in the WGEIO (Paris, October 2001) and revised accordingly. It is published on the responsibility of the Secretary General.

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JT00125240

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FOREWORD

This report is part of the OECD programme on environmental indicators, steered by the Working Group on Environmental Information and Outlooks (WGEIO). It complements the work carried out since 1990 that resulted in the adoption, at OECD level, of a common framework for environmental indicators, including the definition of a common language and terminology, the use of PSR-based models to structure the indicators work and the formulation of general principles and guidance for the selection and use of environmental indicators.

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AGGREGATED ENVIRONMENTAL INDICES
REVIEW OF AGGREGATION METHODOLOGIES IN USE

EXECUTIVE SUMMARY

Aggregated environmental indices receive increasing interest, but …

…. their use is still controversial

Policy makers and the public at large need reliable and well-synthesised information about the environment without getting lost in detail. This is why OECD countries have recently expressed increasing interest in a reduced number of environmental indicators selected from existing larger sets. The call for higher-order, more integrative indices is also becoming louder. At the same time reservations continue to be voiced about the limitations of aggregated indices, their perceived opacity, and potential for misinterpretation.

The review of 23 environmental indices ….

This report reviews 23 aggregated environmental indices used in OECD countries. The surveyed indices are classified into four groupings:

– Indices solely based on the natural sciences;
– Policy performance indices;
– Indices based on an accounting framework; and
– Synoptic indices.

… shows that …

The report discusses the various aggregation methodologies used for each of the above groupings and identifies the strengths and weaknesses of the resulting indices for decision making and public information.

… aggregated indices help to convey simple messages and to reach new audiences, …

… but also run the risk of being misinterpreted.

By combining the information contained in two or more indicators, aggregated indices make it possible to convey simple messages about complex environmental issues. Among their strengths is the potential to simplify the public communication process and to reach audiences that currently receive little environmental information at all. However, reducing the number of indicators by condensing information also runs the risk of misinterpretation because users are not always aware of the scope and limitations of the index methodology, and because the message conveyed may be distorted by data gaps. (see table next page)

To find broader acceptance …

…the indices need to satisfy several quality criteria …

… and be interpreted in their proper context.

Both the indices and the index aggregation process should therefore satisfy several quality criteria in order to be credible and find acceptance from users. Aggregated indices should first satisfy the same criteria as other indicators: policy relevance, analytical soundness and measurability, including transparency and ease of understanding. Since the calculation of an index usually requires a series of steps that involve more or less subjective choices and judgements, the aggregation process itself should in addition satisfy a number of more specific quality criteria keeping in mind the intended use of the resulting index. In general, a balance needs to be struck between the wish to have as few indices as possible and the need to keep each as intelligible, robust and transparent as possible. As for other indicators and depending on their purpose, additional information and interpretation in context is required for aggregated indices to acquire their full meaning.

Strengths and weaknesses of aggregation methodologies

STRENGTHS	WEAKNESSES
Group 1: Indices solely based on natural sciences	
♦ One-step only calculation ♦ Relatively objective ♦ Power to simplify scientific complexity ♦ Consensus about validity reached easily	♦ Difficult to interpret significance of index score in the absence of a benchmark ♦ Limited scope of application (physical, chemical, biological phenomena)
Group 2: Policy performance indices	
♦ Easily accepted by the public ♦ Promote accountability of decision-makers ♦ Capable of conveying clear messages ♦ Low risk of misinterpretation ♦ Able to accommodate changes in environmental standards ♦ Consensus about validity easily reached at local and national level	♦ Potential lack of continuity ♦ Not always representative of the whole problem ♦ Applicable only where policy targets are set ♦ Consensus about validity at international level more difficult to reach and dependent on international agreements
Group 3: Indices based on an accounting framework	
♦ Easy to understand because expressed in familiar metrics (e.g. $) ♦ Generally accepted framework ♦ Computationally simple ♦ Theoretically sound	♦ Sensitive to weaknesses in constituent variables including data gaps ♦ May depend on controversial assumptions ♦ Accounting framework constrains choice of variables ♦ International consensus about validity more difficult to reach
Group 4: Synoptic indices	
♦ Potential to stand next to main economic indices ♦ Potential to convey simple messages	♦ Computationally often complex ♦ Highly sensitive to data gaps ♦ Lack of transparency ♦ International consensus about validity difficult to reach

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BACKGROUND AND CONTEXT

One of the major objectives of the work conducted by the OECD Working Group on Environmental Information and Outlooks[1] (WGEIO) is to promote and facilitate the exchange of experience among Member countries to support national efforts in the field of environmental information and reporting and to ensure the development of objective, reliable and comparable environmental indicators, statistics and information at international level.

Over the past ten years, the WGEIO has thus played a key role in the development of national and international environmental indicators, notably through the adoption, at OECD level, of a common framework for developing and using environmental indicators including the definition of a common language and terminology, the use of PSR-based models to structure the indicators work and the formulation of general principles and guidance for the selection and use of environmental indicators.

Much progress has been made in the 1990s in the field of indicators. In a number of OECD countries, environmental indicators have gained in importance and a very wide variety of them are already in use. Recently OECD Member countries have expressed increasing interest in a reduced number of environmental indicators selected from existing larger sets to draw public attention to key environmental issues of concern and to inform about progress made.

Since the mid-1990s, the call for higher-order, more integrative indices combining two or more variables or indicators is also becoming louder: a number of non-government organisations and official institutions have promoted various types of aggregated environmental indices; several national and international organisations have already published indices or are contemplating to do so. While some of the simpler ones – notably air pollution indices – are in daily use and widely known to the public, others are still part of research-oriented work.

At the same time, serious reservations continue to be voiced about the inevitable limitations of these indices, their perceived opacity, methodological shortcomings, and potential for misinterpretation and misuse.

Given these developments, the WGEIO agreed to further deepen its analysis of aggregated environmental indices and to explore in what way such indices could provide a useful tool for environmental decision-making and public information.

PURPOSE AND SCOPE OF THIS DOCUMENT

The purpose of this document is to:

- Provide an overview of the use of aggregated environmental indices in OECD countries on the basis of selected examples.
- Identify the strengths and weaknesses of aggregation methodologies in use keeping in mind the practical significance of the resulting indicators for decision making and public information.
- Draw lessons from the aggregated indices in use and provide guidance on their use in policy making and public communication.

Focus is given to aggregated indices actually used or promoted by intergovernmental organisations, government institutions at federal, national or state level, and international NGOs. The many indices proposed in the academic literature are not considered here.

1 . Former Working Group on the State of the Environment.

ENVIRONMENTAL INDICES

FUNCTIONS

A major function of environmental indicators is to convey clear and simple messages about what is happening to the environment to non-expert decision makers and the public at large (Inset 1). Aggregated Environmental indicators have been called "executive summaries of complex realities" (Jesinghaus, 1999a) and this description applies even more to indices. The challenge is to make these messages pithy as well as accurate.

Policy makers need highly condensed information that can shed light on the most relevant aspects of complex environmental issues without getting lost in detail. Aggregated environmental indices are often seen as tools that make these complex issues more tractable and hence serve to make decision makers accountable to their constituencies for the outcomes of environmental policies, and to enhance public understanding of environmental problems. They are further often seen as part of the effort to integrate economic and environmental decision-making. Genuine integration at the highest political level, so the argument goes, cannot be achieved as long as the present economic indicators (notably the three main ones GDP, unemployment rate and inflation rate) are not complemented and counterbalanced by an equally authoritative set of environmental indicators including aggregated indices.

PERCEPTION AND CREDIBILITY

Most indices are built from environmental indicators. Simple indicators measure only one variable and often are perceived more objective and "scientific" than composite indices, because their value does not depend on subjective choices or an attempt to add "apples and oranges." The more highly condensed indices could probably not find widespread acceptance until and unless potential users are confident they can trust the messages conveyed. Index makers should therefore promote a better understanding of the assumptions, limitations and methods used in index design.

TERMINOLOGY: INDICATORS, INDICES

In the early stages of its work on environmental indicators, the OECD has, together with its member countries, defined a common language for the terms "indicator", "index" and "parameter" (Inset 1).

Inset 1 Definitions and functions of environmental indicators*

The terminology adopted by OECD countries first points to two major functions of indicators:

- they reduce the number of measurements and parameters that normally would be required to give an "exact" presentation of a situation;
- they simplify the communication process by which the results of measurement are provided to the user.

It then defines the terms "Indicator", "Index" and "Parameter" as follows:

- 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.

Extract from "Environmental indicators for environmental performance reviews", OECD, 1993.

But the environmental indicator literature has not yet yielded full consensus on the use of the terms *indicator* and *index*. Some publications still use the two words interchangeably. Most authors, however, accept the convention that indices condense information to a higher level of abstraction than most other indicators, even if the boundary is seldom drawn sharply.

This review follows the terminology adopted by the OECD for its work on environmental indicators. The term "index" is thus only used for aggregated or composite numbers computed as a function of two or more parameters, indicators or sub-indices clustered together to represent some system or phenomenon (e.g. air pollution or sustainable development). Such indices are often dimensionless, but sometimes a common, real metric is used (e.g. $, oil equivalent, acidification equivalents or hectares). The term "index" is not used here for ratios and other numbers derived from parameters or variables that, in the statistical literature, are called index values or indices (e.g. pollution indices showing trends in the concentration of a given pollutant with respect to a base year (base=100). Unless the context suggests otherwise, the term "environmental indices" is intended to include certain indices of sustainable development or of human welfare.

The inclusion in this review of the various approaches aimed at "greening" the GDP may need some explanation. After all, the ISEW (Indicator of Sustainable Economic Welfare), the Genuine Progress Indicator or the Genuine Savings Indicator are called indicators and their value is expressed in dollars. The reason why they are counted as indices here lies with the fact that their value is only partly determined by real market prices. The other component of their value (e.g. costs of climate change or crime) is not measured, but synthesised from series of – more or less – reasoned assumptions and choices.

AGGREGATION

Aggregation methods are crucial in the field of environmental data and affect data quality in many ways. Aggregation requires that classification systems, definitions, nomenclatures, data production methodologies, measurement methods, etc., be consistent among the contributing data sources. One generally distinguishes:

- Spatial aggregation that is dependent on geographic scale. National environmental statistics are often based on the compilation and aggregation of data produced at sub-national level. The choice in geographic scale influences the area over which monitoring results can be estimated and whether the data can be aggregated on an ecosystem, administrative boundary or other geographic level and be representative of conditions over that area.

- Temporal aggregation is linked to the natural "variability" of the parameters monitored and to the need for more synthesised and usable information (e.g. annual averages for parameters measured daily or even hourly).

- Thematic aggregation is linked to the need for more readable and digestible information. Thematic aggregation establishes totals based on data for subcategories (e.g. total SOx emissions based on emission inventories, or total water resources based on water accounts). It may further be used to establish indices of urban air quality, global warming potential, acidifying substances, nutrient balances, etc., through the use of proper conversion factors.

In this document, the term aggregation is used to refer to the grouping and amalgamation of two or more different variables into one index. It is not used to refer to the grouping of the values of the same variable at different sites to achieve some overall representative value of that variable over a larger area. Nevertheless, most indices discussed here are also based on some kind of geographical aggregation.

THE "INDEX UNIVERSE"

OVERVIEW AND MAJOR GROUPINGS

As many readers will already be familiar with the indices discussed in this report, it will suffice here to present a general overview:

- Table 1 lists the name and sponsoring agency of each index and describes what it aims to measure.
- Table 2 summarises the intended purpose, function, target audience and time scale of each index.

The main characteristics, including information about aggregation methods, of each of the 23 indices included are described in the Annex (page 26).

Since the mid-1990s, a considerable number of organisations have proposed a host of indices and it is becoming difficult to "see the wood from the trees". Some kind of structured overview, showing how each index fits into the overall index universe, may therefore be helpful. The four groupings proposed below, although perhaps not representing a rigorous classification, can be seen as having been arranged in order of increasing "ambition," from the simplest to the most synoptic:

Group 1: Indices solely based on the natural sciences

These indices use the most straightforward method of aggregation by way of a reliable scientific relationship between the (time-averaged) concentration of different variables in a medium and their "strength" in terms of a common attribute (e.g. acidity, toxicity, eutrophication). Included are the indices for global warming potential, ozone depleting potential, tropospheric ozone forming potential, toxicity, acidification, and eutrophication. Also the WWF Living Planet Index, which perhaps should properly be classed as an indicator because it is a simple count of population changes of animal species. In a sense, biochemical and chemical oxygen demand (BOD and COD) could also be classed in this group, because they measure the oxygen demand of many different substances, except that in this case the aggregation is measured directly rather than calculated.

Group 2: Policy performance indices

These indices are linked to either a regulatory standard or to policy targets.

The first type of indices are in some way linked to environmental quality standards or emission/discharge limits. The aggregation required for the indices in this group is still conceptually straightforward involving comparison with ambient environmental quality standards. Included are the three air pollution and the two water pollution indices.

For the second type, the linkage with particular environmental policies may be either relatively loose (as when sub-indices are grouped according to the various themes of a general policy), or very rigorous (as when indices directly correspond to the quantitative targets of a policy). Included are the German Environmental Barometer (including the DUX) and the performance indices associated with the Dutch National Environmental Policy Plan.[2]

Group 3: Indices based on an accounting framework

This group includes the World Bank genuine savings measure and three "green GDP" indices, where aggregation must be achieved by way of imputing money values to non-priced variables. For the two other indices in this group (Ecological Footprint and Total Materials Requirements) the aggregation requires translating the values of the constituent variables into physical measures (respectively hectares and tonnes of material). The three green-GDP indices aim to measure human well-being, the others are intended to convey a message about the well-being of the environment. Group 3 indices are potentially attractive because they are based on more or less widely accepted accounting frameworks.

Group 4: Synoptic indices

Synoptic indices aim or claim to give a comprehensive view of very complex issues. Included in this group are the EUROSTAT environmental pressure indices, the UNDP Human Development Index, the IUCN Well-being Index, the CHS City Development Index and WEF Environmental Sustainability Index.

2 . The aggregation methods used in this second type of indices are, in fact, close to those of Group 4. This suggests an alternative way of grouping the indices in groups 2 and 4: if the second type indices of Group 2 were moved to Group 4, the former could be renamed "Single-issue indices" and the latter "Multi-issue indices." However, the focus on policy performance, as a distinctive feature among indices, would then be lost.

Table 1 Overview of aggregated indices reviewed in this report

Name	What does it aim to measure?	Sponsor*
♦ Living Planet Index	State of animal species in the world's forests, freshwater ecosystems and oceans and coasts	WWF
♦ Natural Capital Index	Combination of pressure and state concerning ecosystems and related species: link to the CBD	WCMC and RIVM
♦ Global Warming Potential GWP	Pressure on the earth's atmosphere in terms of greenhouse gas emissions	UNFCCC
♦ Ozone Depleting Potential ODP	Pressure on the ozone layer)	UNEP Ozone Secr.
♦ Group of similar indices	Pressure on various aspects of environmental quality (e.g. toxicity, acidification, eutrophication), TOFP (Tropospheric Ozone Forming Potential)	Various
♦ Ecological Footprint EF	Pressure on the environment by consumption of food, materials and energy	RP
♦ Environmental Pressure Indices EPI	Pressure on the environment in 10 policy fields	EUROSTAT
♦ Total Materials Requirements TMR	Pressure on the environment in terms of the volumes of displaced materials	WRI
♦ Pollution Standards Index PSI	State of air quality by five pollutants in terms of meeting air quality standards	US EPA
♦ German Environmental Barometer & Index DUX	Achievement of pressure reduction policy targets in terms of six policy fields; DUX combines 6 sub-indices into one	UBA and ZDF
♦ Dutch NEPP policy performance indices	Achievement of the pressure reduction policy targets of the National Environmental Policy Plan	VROM
♦ Mexican Metropolitan Index of Air Quality IMECA	State of air quality by six pollutants in terms of meeting air quality standards	SEMARNAT
♦ French urban air quality index ATMO	State of air quality by four pollutants in terms of meeting air quality standards	ADEME
♦ French water quality index SEQ-Eau	State of water quality measured in 15 categories (covering 170 parameters), including in terms of meeting water quality standards	French water agencies
♦ British Columbia Water Quality Index WQI	State of water quality in terms of seven types of use (e.g. drinking water, aquatic species) in terms of meeting water quality standards	BC Ministry of Env., Lands & Parks
♦ Well-Being Index	State of human and ecosystem well-being in terms of health and population; wealth; knowledge and culture; community; and equity and land; water; air; species and genes; and resource use	IUCN
♦ Italian Urban Ecosystem Index	Urban sustainability through 18 pressure, state and response indicators covering air and water, transport, green space, health, local Agenda 21	Legambiente
♦ Human Development Index HDI	State of human development in terms of longevity, educational attainment and standard of living	UNDP
♦ City Development Index	State of a city's development in terms of infrastructure, waste, health, education, and the city product	UNDP/UNCHS
♦ Index of Sustainable Economic Welfare ISEW & Simplified Index of Sust. Econ. Welfare SISEW	State of human well-being taking account of economic, social and environmental factors and making up to 30, resp.12 adjustments to GDP	none
♦ Genuine Progress Indicator	State of human well-being taking account of economic, social and environmental factors and making 26 adjustments to GDP	TAI
♦ Genuine Savings	State of a country's "true" saving after taking account of natural resource depletion and pollution damages.	World Bank
♦ Environmental Sustainability Index	Combination of pressure, state and responses in terms of environmental systems, the reduction of environmental stresses and human vulnerability, social and institutional capacity and global stewardship.	WEF

* ADEME= Agence de l'environnement et de la maîtrise de l'énergie (French environment agency); CBD= Convention on Biological Diversity; EUROSTAT= Statistical Office of the European Commission; IUCN=World Conservation Union; Legambiente=Italian NGO; RIVM= National Institute of Public Health and the Environment (The Netherlands); RP= Redefining Progress; SEMARNAT= Secretaría de Medio Ambiente y Recursos Naturales (Mexican environment ministry); TAI= The Australia Institute; UBA= Umwelt Bundes Amt (German environment agency); UNCSH= UN Centre for Human Settlements (HABITAT); UNDP=UN Development Programme; UNEP= UN Environment Programme; UNFCC= UN Framework Convention on Climate Change; USEPA=US Environmental Protection Agency; VROM= Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieu (Dutch environment ministry); WCMC= World Conservation Monitoring Centre (UK); WEF= World Economic Forum; WRI=World Resources Institute; WWF=Worldwide Fund for Nature; ZDF= Zweites Deutsches Fernsehen (German television station).

Table 2 Purpose, function and target audience of the aggregated indices reviewed

Name	Purpose	Main function	Target audience	Time scale
♦ Living Planet Index	Characterise ecosystem welfare by quantifying changes in the state of the Earth's natural ecosystems over time	Public information, published in the WWF Living Planet Report	Public	Longer term
♦ Natural Capital Index	Evaluate progress made in conservation of biodiversity, link to the CBD	Policy formulation, public information	Policy makers, public	Longer term
♦ Global Warming Potential GWP	Provide common metric for GHG emissions	Policy formulation, public information	Policy makers, public	Continuous
♦ Ozone Depleting Potential ODP	Provide common metric for ODP substances	Policy formulation, public information	Policy makers, public	Continuous
♦ Group of similar indices (e.g. acidification,	Provide common metric for various parameters	Policy formulation	Policy makers	Continuous
♦ Ecological Footprint EF	Quantify the human pressures on the natural environment arising from the consumption of renewable resources and pollution	Public information, analysis of geographic patterns in pressures on the environment, or of impact of specific activities, products or firms	Public information, decision makers	Annual, continuous
♦ Environmental Pressure Indices EPI	Quantify env. pressures in 10 policy fields	Env. policy formulation, public information	Env. & sectoral policy makers, public	Annual
♦ Total Materials Requirements TMR	Estimate physical flows of materials underpinning industrial economies	Policy formulation	Policy makers	Medium term
♦ Pollution Standards Index PSI	Compare ambient air quality with certain thresholds	Operational, accountability	Env. policy makers, public	Daily
♦ German Env. Barometer/Index DUX	Track pressure reductions towards targets	Env. policy formulation, accountability	Env. policy makers, public	Annual
♦ Dutch NEPP policy performance indices	Track pressure reductions towards targets	Env. policy formulation, accountability	Env. policy makers, public	Annual
♦ Mexican Metropolitan Index of Air Quality IMECA	Compare ambient air quality with certain thresholds	Operational, accountability	Env. policy makers, public	Daily
♦ French urban air quality index ATMO	Compare ambient air quality with certain thresholds	Operational, accountability	Env. policy makers, public	Daily
♦ French water quality index SEQ-Eau	Serve as a basic tool for the classification and management of water	Env. policy formulation, accountability	Env. policy maker, publics	Annual
♦ British Columbia Water Quality Index WQI	Compare water quality with certain standards and objectives	Env. policy formulation, accountability	Env. policy makers, public	Medium term
♦ Well-Being Index	Quantify human and ecosystem well-being based on 5 components each	Public information	Public	Medium term
♦ Human Development Index HDI	Rank countries in terms of longevity, educational attainment and standard of	Public information	Public	Annual
♦ Italian Urban Ecosystem Index	Performance (incl. meeting env. standards) of 103 Italian municipalities in improving urban sustainability	Public information, accountability	Public, elected municipal officials	Annual
♦ City Development Index	Characterise the condition of a city in terms of 5 components (Infrastructure, waste, health, education & city product)	Urban policy formulation	Urban planners	Medium term
♦ Index of Sustainable Economic Welfare ISEW & Simplified Index of Sust.Ec. Welfare SISEW	Provide a measure of human welfare based on adjustments to the GDP	Integration of economic, social and env. decision making	Economic and env. decision makers	Annual
♦ Genuine Progress Indicator	Provide a measure of human welfare based on adjustments to the GDP	Integration of economic, social and env. decision making	Economic and env. decision makers	Medium term
♦ Genuine Savings	Provide a measure of env. sustainability by deducting resource depletion and pollution damages from net savings	Integration of economic, social and env. decision making	Economic and env. decision makers	Annual
♦ Environmental Sustainability Index	Provide a measure of env. sustainability based on 67 indicators in 5 categories	Integration of economic, social and env. decision making	Economic and env. decision makers	Various

Note: For acronyms, see Table 1

PERCEIVED SUBJECTIVITY

The transition from a simple indicator to a composite index often entails a shift from objectivity to subjectivity. The score of indices listed in Table 1 could also be regarded as lying on a spectrum of various degrees of perceived subjectivity. At one end, the WWF Living Planet Index simply combines population estimates of a large number of species in different parts of the world and compares the current situation with the one prevailing in 1970. Subjectivity is limited to the choice of species included. Other Group 1 indices involve subjective judgements made by scientists in the face of scientific uncertainty.

At the other end of the spectrum is the WEF Environmental Sustainability Index (ESI), which is constructed from pressure, state and response indicators that together form a very partial representation of environmental, social and economic aspects of environmental sustainability. Calculation of the ESI involves a whole series of judgements, assumptions and choices that are inevitably subjective. Moreover, these judgements, assumptions and choices are made on different grounds, ranging from the scientific to the political.

LINK TO THE PSR MODEL

Many indicators and indicator sets are based on – or on some variation of – the OECD Pressure-State-Response framework. It therefore makes sense to check how the indices examined here fit into such a framework (Table 3). Of the 23 indices, eight are pressure and thirteen are state indices. There is no response index, but the WEF Environmental Sustainability Index combines all three elements of the P-S-R framework.

The bottom-right hand cell of Table 3 could be said to represent the most "ambitious" corner of the index universe. At present, only the WEF Environmental Sustainability Index occupies that cell. It is worth noting that any sustainable development indices that could emerge from the sets of sustainable development indicators now being compiled (OECD, UNCSD, individual countries) would also fit in that cell.

THEMATIC SCOPE

A different way to look at the selected indices is to group them by the scope of the issues included in them (Table 4). The scope of twelve indices is limited to a single-medium (e.g. air) or single issue (e.g. eutrophication). Four indices can be classed as environmental and seven could be captured under the heading of "progress towards sustainability," because their scope is wider than the environment.

AGGREGATION METHODS

Aggregation has been defined as "the process of adding variables or units with similar properties to come up with a single number that represents the approximate overall value of its individual components" (UNDESA, 2000). Even though each of the indices discussed in this document uses its own unique aggregation methodology, some elements are common to all.

The aggregation of two or more indicators into one index typically involves several steps, to wit:

- selection of variables
- transformation
- weighting and
- valuation.

SELECTION OF VARIABLES

The first step of all aggregation methods invariably involves the selection of a set of variables that are representative of the topic, policy issue or phenomenon of interest. Each of the variables should satisfy the criteria used for the selection of indicators, and the total set must be representative of the problem at hand.

Table 3 Index groups classed in terms of P-S-R framework

	Pressure indices	State indices	Combined P-S-R indices
Group 1: Indices solely based on natural sciences	Global Warming Potential Ozone Depleting Potential Similar indices like equitox, TOFP, acid eq., eutrophication equivalent	WWF Living Planet Index Natural Capital Index	
Group 2: Policy performance indices	Performance indices of the Dutch National Environmental Policy Plans German Environmental Barometer (6 indices) German Environment Index DUX	USEPA Pollution Standards Index (air quality), Mexican Metropolitan Index of Air Quality IMECA, French air quality index ATMO French water quality index SEQ BC Water Quality Index	Italian Urban Ecosystem Index
Group 3: Indices based on an accounting framework	WRI Total Materials Requirements RP Ecological Footprint	TAI Genuine Progress Indicator Index of Sustainable Economic Welfare/Simplified Index of Sustainable Economic Welfare World Bank Genuine Savings	
Group 4: Synoptic indices	Proposed) Eurostat Environmental Pressure Indices	UNDP/CHS (Habitat) City Development Index UNDP Human Development Index IUCN/PADATA/IDRC Well-Being Index and Progress Towards Sustainability Index	World Economic Forum Environmental Sustainability Index

Note: For acronyms, see Table 1

Table 4 Index groups classed in terms of scope of included issues

	Single-medium or single-issue indices	Environmental indices	Social/ or "Progress towards sustainability" indices
Group 1: Indices solely based on natural sciences	WWF Living Planet Index Natural Capital Index Global Warming Potential Ozone Depleting Potential Similar indices like equitox, TOFP, acid eq., eutrophication equivalent		
Group 2: Policy performance indices	USEPA Pollution Standards Index (air quality), Mexican Metropolitan Index of Air Quality IMECA, French air quality index ATMO French water quality index SEQ BC Water Quality Index German Environmental Barometer (6 separate indices)	Performance indices of the Dutch National Environmental Policy Plans German Environment Index DUX	Italian Urban Ecosystem Index
Group 3: Indices based on an accounting framework	World Bank Genuine Savings WRI Total Materials Requirements	RP Ecological Footprint	TAI Genuine Progress Indicator Index of Sustainable Economic Welfare & Simplified Index of Sustainable Economic Welfare
Group 4: Synoptic indices		(Proposed) Eurostat Environmental Pressure Indices	UNDP Human Development Index IUCN/PADATA/IDRC Well-Being Index and Progress Towards Sustainability Index UNDP/CHS (Habitat) City Development Index WEF Environmental Sustainability Index

Note: For acronyms, see Table 1

TRANSFORMATION

The second step of the process, transformation, is necessary when the selected variables do not have the same dimension ("apples and oranges") and to ensure that changes in one variable do not dominate those of the others in the final score of the index.

Before the variables making up an index can be aggregated, it may be necessary to make them "behave" in a broadly similar fashion. For example, if a variable can change by several orders of magnitude (e.g. the number of e-coli in surface waters), it makes sense to take the logarithm of the measured e-coli count so that the resulting variable (sub-index) behaves similarly to those representing, say, BOD and nutrient content. Sometimes it is necessary to truncate values below or above certain threshold values.

The process of expressing different variables in a common metric is easy when scientific research can provide information about the relative "strengths" or power of the various variables to contribute to the phenomenon the index is intended to represent (e.g. the global warming potential of various greenhouse gases).

In other cases, normalisation (= measured value divided by some benchmark value [e.g. sample average or the value of a regulatory standard] of the same variable) or standardisation (= [measured value minus sample standard deviation]/standard deviation) will make the scales of the different variables similar.

The calculation of the sub-index for income of UNDP Human Development Index (HDI) may serve to illustrate the procedures described in the foregoing paragraphs. Rather than starting from unmodified income figures, the HDI sub-index takes a square root of income above a threshold level in order to limit the influence of very high national incomes (this is because higher incomes are judged to contribute less than proportionally to human welfare). Then the variables are normalised as a percentage along the range between the maximum and minimum values (among all countries included in the HDI), so that the minimum value becomes 0, the maximum 100, and intermediate values are spaced accordingly.

Other ways of transforming "raw" indicator values include plotting values in terms of the distance to a policy target, by comparing values to a reference or average value, or by comparing with the best or least performing countries. Every method emphasises a different aspect and resulting scores will convey different messages, depending on the method selected. For example, the distance-to-target method ignores performance-to-date and therefore gives no credit to countries that have already done well and have also set themselves an ambitious target.

WEIGHTING

The third step involves the weighting of the constituent variables before combining them into the index. Weighting is the process of judging the relative importance of various components of an index. Weighting can be carried out in several different ways. Often, each component is given equal weighting, either by design or default. Sometimes it is possible to use the natural sciences (e.g. the different weights of various greenhouse gases in terms of their power to cause climate change). In other cases, it can be done empirically (e.g. the Consumer Price Index weights items according to their importance in the average household budget). In yet other cases, the social sciences can provide an answer by soliciting the preferences of particular groups (e.g. scientists, politicians, members of NGOs) by way of recognised procedures (e.g. the Analytical Hierarchical Process).

It should be noted that, apart from this explicit weighting process, the procedure for selecting variables has already introduced an implicit weighting to each variable. This is because the number of variables chosen affects the relative importance of each in the overall index and thus already assigns a weighting of sorts.

VALUATION

The final step involves the valuation of index scores, in other words comparing scores with a predetermined classification of what constitutes good or poor values. For many indices, the field of possible index scores is divided into coloured bands signifying the range from "excellent" to "poor." For example, the French ATMO index has six bands: Very Good, Good, Average, Mediocre, Bad and Very Bad. In this case the value judgment is directly related to a regulatory air quality standard and the narrative descriptors give the public an indication of how air quality within each band relates to public health.

PRESENTATION AND LAYOUT

The final score of an index most often is either the arithmetical sum or average of the sub-indices, but this does not need to be the case. For instance, the overall index may take the value of the highest or lowest scoring sub-index (as with the various air pollution indices). Another case is the BC Water Quality Index, whose three sub-indices are treated as vectors and added accordingly. Instead of – or sometimes in addition to – consolidating the scores of all sub-indices into a final score, some methodologies take an approach of visual aggregation, in which the values of the constituent sub-indices are in some way displayed together.

Examples are the:

- "dashboard"-type presentation proposed by the International Institute for Sustainable Development and applied to several indicator sets (Annex 1, page 40);
- rosette of pressure indices and indicators proposed for the EUROSTAT pressure indices (including the single Environmental Pressure Index proposed by Jesinghaus) provides another example;
- "egg-of-well-being" presentation used with the IUCN Well-being methodology (Annex 1, page 37)
- pentagon presentation used to display the individual score of the five sub-indices of the WEF Environmental Sustainability Index (Annex 1, page 39).

SELECTION CRITERIA

Criteria for selecting environmental indicators have long been established, partly thanks to earlier OECD work in this area. They typically cover such factors as measurability, data availability, simplicity, scientific validity, policy relevance, accuracy, comparability over time and space, responsiveness, reliability, etc. In addition to all these things, indicators should also be easy to understand. (Inset 2)

There should not be an *a priori* assumption that indices based on indicators satisfying the above criteria will automatically meet the same criteria as well. But should aggregated indices be re-tested against all indicator criteria? Are there any additional tests that aggregated indices should satisfy? Do all criteria apply equally to the various groups of indices identified in this report?

CRITERIA LINKED TO THE AGGREGATION PROCESS

Rather than, or perhaps in addition to, formulating criteria for indices, it has been proposed (e.g. UNDESA 2000, Jesinghaus 1999a) that the aggregation process should satisfy certain criteria, for instance:

- The aggregation process must be completely transparent, i.e. every step in the process should be traceable. Users should be aware of all assumptions and choices made in terms of weighting, how missing data have been imputed, etc.
- The variables to be grouped should be independent, i.e. not show cause-effect relationship.
- All components of an index should be part of the problem and amenable to change in response to human intervention (e.g. although temperature is an important factor in ozone formation, it is not a valid component of an air quality index).
- All components of an index should show about the same order of magnitude.
- The variables being aggregated should be situated at the same step in the cause-effect chain. For instance, it is acceptable to aggregate fertilisers and pesticide use, but not together with biological oxygen demand or biodiversity of

species. This rule also excludes the aggregation of pressure and state indicators.

- The conversion (transformation) of indicators prior to their aggregation with other indicators should follow certain explicit rules. Also, the rules for comparing the results should be defined before selecting an aggregation method (because the choice of aggregation method affects the message conveyed).
- Weighting factors needed to aggregate indicators from different categories or themes (which are difficult to compare using the tools of the natural sciences) need to be set with the help of tools from the social sciences.
- Never combine objective (i.e. by way of accepted methods used by the natural and social sciences) and subjective weighting methods in the same step of aggregation.
- An index should be tolerant to inconsistencies arising from aggregation and valuation.

CRITERIA LINKED TO THE INTENDED USE

The intended use of the index may also affect what criteria it should satisfy. For example, a list of criteria to be used with policy performance indicators (Jesinghaus 1999a) suggests the following criteria:

- robustness/independence of assumptions – could the value of the indicator change drastically by changing some of the assumptions?
- “non-ambiguity of the welfare message,” – does everybody agree that more is better or vice-versa?,
- accountability – does the indicator/index point at those who should be held responsible?

Inset 2 Criteria for selecting environmental indicators

As indicators are used for various purposes, it is necessary to define general criteria for selecting indicators. Three basic criteria are used in OECD work: policy relevance and utility for users, analytical soundness, and measurability.*

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 can 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.

Extract from “Environmental indicators for environmental performance reviews”, OECD, 1993.
**These criteria describe the “ideal” indicator; not all of them will be met in practice.*

STRENGTHS AND WEAKNESSES OF THE METHODOLOGIES USED

The strengths and weaknesses of any particular aggregation methodology can be divided into two types. First, they can be generic, i.e. associated with the particular group to which the index belongs. Secondly, there are the strengths and weaknesses proper to the index itself, such as the choice of variables or the particular weighting and valuation given to each, etc. Of course, in addition to strengths and weaknesses associated with the aggregation methodology used, indices also have strong and weak points related to other aspects (e.g. underlying assumptions). For instance, the Ecological Footprint has been criticised for implicitly ignoring the potential of international trade to even out "sustainability deficits" of individual countries.

Within the scope of this review it is not possible to discuss the full detail of both types of strengths and weaknesses for each examined index. Therefore, only those generic to the various groups identified earlier will be evaluated here (Table 5).

GROUP 1: INDICES SOLELY BASED ON THE NATURAL SCIENCES

A strong point of Group 1 indices is that their construction calls for a one-step-only transformation of the original variables. Moreover, that single step is a simple conversion formula determined by relatively objective science and and benefiting, in many cases, from an international consensus about its validity. Yet, this objectivity is not absolute, because in most cases some uncertainty remains about the underlying science, so that the actual value of conversion factors is a matter of – sometimes collective – judgement, and therefore still vulnerable to criticism. Policy makers will generally be happy to accept the collective judgement, whereas individual scientist may continue to hesitate in the face of the remaining uncertainty.

Another strength is that by combining all the substances responsible for a problem (say, acidification) it will be easier to communicate progress to the public, as it will no longer be necessary to report separately about the deposition and relative strength of each substance causing acidification. For example, the public may be ready to accept the GWP index as a common measure for all greenhouse gas emissions because by now it understands that CO_2 is not the only greenhouse gas causing climate change.

While simplicity is a strength, it can also be a weakness. Indices in this group do not automatically convey a clear message, because it is difficult to interpret the significance of any particular value of the index in the absence of a benchmark (e.g. regulatory standard, performance target, or reference to a classification). Nevertheless, if scores are ranked (e.g. GWP/capita) they convey a relative "best or worst in class" message without saying anything about the performance of the class as a whole. Finally, it is obvious that the applicability of Group 1 indices is confined to the physical, chemical or biological variables. They are equally relevant at local, national and international level. Finally, Group 1 indices become Group 2 indices as soon as a benchmark is set (e.g. GWP values can be transformed to Kyoto Protocol performance indices).

GROUP 2: POLICY PERFORMANCE INDICES

The strength of the policy performance indices of Group 2 is that they are benchmarked and thereby capable of conveying clear messages about policy performance. The indices related to regulatory standards can accommodate changes to these standards. On the other hand, policy-target indices are so closely linked to their policies that they will lose their continuity (and therefore significance of time trends) when the policy is changed. Their relevance is highest at local and national level. Their use at international level is dependent on the existence of internationally agreed benchmarks, standards or policy commitments such as those included in multi-lateral environmental agreements (e.g. CLRTAP, UNFCCC).

The air pollution indices in Group 2, if judged by their prominence and public acceptance in urban conglomerations, are probably the most successful indices formulated so far. They probably correspond better with public understanding of air pollution than information about individual substances such as nitrogen oxides, particles, etc. From a scientific perspective, they are more representative of actual pollution exposure to the cocktail of pollutants and consequent health impacts, even if the exact cause-effect relationships are not yet well understood. However, their weakness is that, as so far they do not include hazardous air pollutants, they do not represent the whole truth about air pollution.

The strength of the distance-to-target indices in Group 2, as long they are directly linked to explicit numerical targets (say of emission reductions), consists of avoiding the need to satisfy some of the criteria listed above. By virtue of being clearly associated with the achievement of particular policies, they run a lesser risk of misinterpretation and misuse. The continued, actual use in policy formulation and decision-making of the indices associated with the Dutch National Environmental Policy Plans shows the potential of this type of indices.

GROUP 3: INDICES BASED ON AN ACCOUNTING FRAMEWORK

Group 3 indices are easy to understand because they are based on already-familiar accounting frameworks (e.g. national accounts framework for genuine savings, resource accounting framework for the ecological footprint) and expressed in concrete metrics (dollars, tonnes, hectares) rather than as more abstract ratios. By the same token, not all variables are easily captured in an accounting framework, notably those reflecting quality rather than quantity. Group 3 indices also tend to be more transparent because their computation only involves simple addition and deduction.

The same trait, however, causes shaky estimates of one or more of the constituent variables to feed directly into the final value of the main index. This renders indices in this group less tolerant of injudicious choices and data gaps than some of the indices expressed as ratios.

Another weak point is that Group 3 indices either require the imputation of money values to non-priced goods or a “translation” of some other kind of one variable into another, very dissimilar one (e.g. the Ecological Footprint expresses air pollution in hectares). The assumptions required in either case are probably equally subjective and debatable, and also lack international consensus about their validity.

Table 5 Strengths and weaknesses of aggregation methodologies

	Strengths	Weaknesses
Group 1: Indices solely based on natural sciences	♦ One-step only calculation ♦ Relatively objective ♦ Power to simplify scientific complexity ♦ Consensus about validity reached easily	♦ Difficult to interpret significance of index score in the absence of a benchmark ♦ Limited scope of application (physical, chemical, biological phenomena)
Group 2: Policy performance indices	♦ Easily accepted by the public ♦ Promote accountability of decision-makers ♦ Capable of conveying clear messages ♦ Low risk of misinterpretation ♦ Able to accommodate changes in environmental standards ♦ Consensus about validity easily reached at local and national level	♦ Potential lack of continuity ♦ Not always representative of the whole problem ♦ Applicable only where policy targets are set ♦ Consensus about validity at international level more difficult to reach and dependent on international agreements
Group 3: Indices based on an accounting framework	♦ Easy to understand because expressed in familiar metrics (e.g. $) ♦ Generally accepted framework ♦ Computationally simple ♦ Theoretically sound	♦ Sensitive to weaknesses in constituent variables including data gaps ♦ May depend on controversial assumptions ♦ Accounting framework constrains choice of variables ♦ International consensus about validity more difficult to reach
Group 4: Synoptic indices	♦ Potential to stand next to main economic indices ♦ Potential to convey simple messages	♦ Computationally often complex ♦ Highly sensitive to data gaps ♦ Lack of transparency ♦ International consensus about validity difficult to reach

GROUP 4: SYNOPTIC INDICES

The potentially strongest point of the main Group 4 synoptic indices (including any sustainable development indices still on the drawing board) is that they are sufficiently comprehensive in scope to stand next to the main economic indices that often dominate decision-making. That comprehensiveness also is the greatest obstacle to Group 4 indices finding widespread acceptance, because every further dimension incorporated in an index adds to the number of assumptions, approximations and data manipulations required to calculate the final score of the index. As a result, it will be difficult to make Group 4 indices sufficiently transparent to win the confidence of a wider audience and to reach international consensus about their validity. Another weak point is their sensitivity to data gaps and deficiencies that may distort the message conveyed towards traditionally well covered issues.

CONCLUDING REMARKS

This review will have made it clear that the construction of aggregated indices requires a considerable number of data manipulations, all involving more or less subjective judgements. Some of the required judgements concern the "big" issues, such as:

- what is the index supposed to measure?
- how and by whom will it be used?
- which variables have been chosen for what issues?
- how have the variables been weighted?
- what index score is considered "good" or "poor"?

Most of these issues are closely interrelated, the two first ones often steering the others.

In addition, a welter of judgements is required concerning data transformations, truncation of values, how to deal with missing or inadequate data, etc. When used in international work, aggregated indices thus require some consensus about their validity among the countries concerned.

A QUALITY LABEL ?

While it may be possible to inform and educate prospective index users about how the big issues have been treated, it will be very difficult to explain all the detail of the many smaller judgements. Yet, some of the latter may well affect the message conveyed by an index. Perhaps some kind of industry standard (or "quality label") of agreed criteria for index aggregation methodologies and computational procedures could help give indices the necessary credibility and make users confident they would not need to know every underlying detail of an index. At the very least, index users will need guidance on the questions to ask when contemplating the use of indices. Users should also be aware that by accepting higher-order aggregated indices, the also accept the principle of compensation, for instance, that a deterioration in air quality can be compensated by an improvement in water quality. As for other indicators and depending on the purpose for which the indices are to be used, they need to be accompanied with additional information and require interpretation in context.

The scope for a much wider application of Group 1 indices is probably limited, but as governments begin to make greater use of target setting in their environmental policies, there should be greater opportunity to develop and implement Group 2 indices. The experience with the Dutch NEPP indices demonstrates that Group 2 indices are worthwhile accountability tools to promote implementation of environmental policies and should not trigger as much controversy as the higher-order indices.

Much of the debate about aggregated indices is centred on Group 3 and 4 indices and the issues are far from settled. It may be tempting to let the debate run its course and wait for the outcome. However, credible and mature indices are unlikely to emerge "fully cooked" from a research environment. Resolution of the issues can only come from experimentation in the real world and a dialogue between index makers and users. NGOs are already playing a vital role in this experimentation. Co-operation between NGOs and official institutions, as is also happening, is equally important.

SELECTED KEY INDICATORS VS. AGGREGATED INDICES

Official institutions are adopting different positions towards index development. EUROSTAT has identified pressure indicators in ten policy fields with the original objective of combining these into an overall pressure index, but as yet has abandoned this idea and publishes individual indicators. The UNCSD is cautiously exploring a possible aggregation of its set of sustainable development indicators.

The OECD instead is using "key indicators" selected from its Core set of environmental indicators. This is similar to the approach taken in the UK government report *Quality of Life Counts* (DEFRA 1999, paragraph 2.18/19), which presents 15 headline indicators from amongst its set of 150 sustainable development indicators. The same report also clearly summarises the prevailing reservations about indices:

> *"The [UK] government takes the view that, while some of these ideas [i.e. for aggregated indicators] are useful as tools for raising awareness, they are not yet scientifically valid or technically robust and so cannot be used to monitor progress year on year in a reliable way. The choice of components, and the way in which they are weighted together, is largely subjective. A different choice of components, or of weights, would give different results, and hence the resulting measures are potentially misleading. Further, conflicting movements in the individual components may result in the masking of important underlying trends. Perhaps the most important difficulty with such indicators is that they are less easily understood by the public, so they do not meet the objective of helping people to understand what sustainable development means, nor will individuals feel that their actions could have any influence on a composite index.*
>
> *The [UK] government considers that the headline indicators present an alternative, more transparent and comprehensive, picture than any aggregated measure, which would inevitably be subject to criticism about the choice of components and weights used."*

No doubt, the official organisations will continue to have different views about the balance to be struck between the wish to have as few measures as possible and the need to keep each as intelligible, robust and transparent as possible. Ten, fifteen or twenty headline indicators may be a small enough number to be accepted among government policy makers, the question remains whether such a number will really capture the newspaper headlines next to the three main economic indicators.

Each audience (e.g. policy makers, politicians, general public) has its own information needs and the two approaches (i.e. indices and headline indicators) need not be mutually exclusive. Now that the Internet is becoming ever more accessible, environmental information can easily be made available in different forms and at various levels of detail, and people can choose for themselves how much detail they want. On the one hand, highly condensed indices potentially reach new audiences that currently receive little environmental information at all. On the other hand, the higher the level of aggregation, the greater the sensitivity to data deficiencies and gaps and risk of misinterpretation.

The perfect aggregated index probably does not exist and decisions will continue to be made with or without them. The history of the imperfect GDP serves to illustrate both the power of a highly condensed measure for decision-making and the risk of misinterpretation once such a measure finds widespread acceptance and use.

ANNEX I. BRIEF DESCRIPTION OF INDICES EXAMINED IN THIS REVIEW

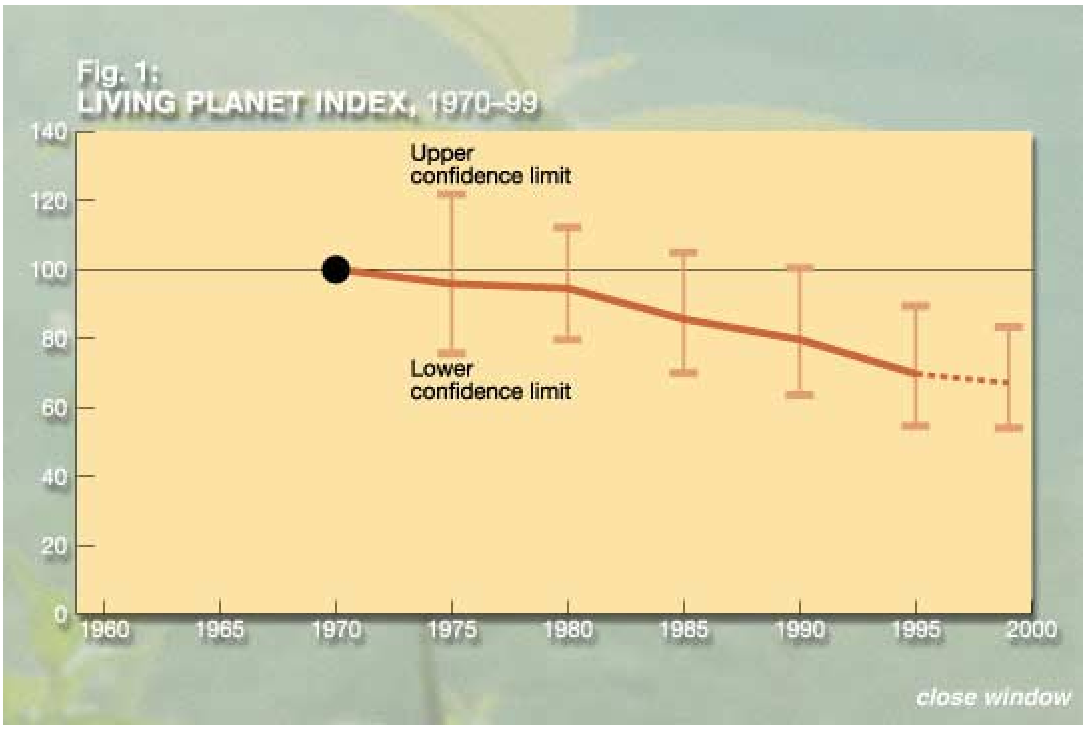
GROUP 1: INDICES SOLELY BASED ON THE NATURAL SCIENCES

WWF Living Planet Index (LPI)

The LPI is a “state” index intended as a measure of the natural wealth of the earth's forests, freshwater ecosystems and oceans and coasts. It is the average of three indices that monitor the changes over time in populations of animal species in forest, freshwater and marine ecosystems respectively. The LPI takes the value of 100 for the situation as of 1970. Each ecosystem index measures the average population trend over time of a sample of animal species. The three ecosystems indices are calculated on a regional basis (Figure 1).

- The forest species population index includes 319 species, mostly birds and mammals. It is the average of separate trends in temperate (275 species) and tropical (44 species) forests.
- The freshwater species population index includes 194 species and combines average trends from six continents as follows: 7 species from Africa, 32 from Asia-Pacific, 8 from Australasia, 55 from Europe, 11 from Latin America and the Caribbean, and 81 from North America.
- The marine species population index comprises 217 species and is based on trends in six regional oceans as follows: 72 species from the North Pacific, 65 from the North Atlantic, 16 from the Indian Ocean, 17 from the South Atlantic, 35 from the South Pacific and 12 from the Southern Ocean.

Figure 1 The WWF Living Planet Index



Data are sourced from the UNEP World Conservation Monitoring Centre. A useful feature is that the graph displaying the LPI also shows the confidence interval associated with the data used.

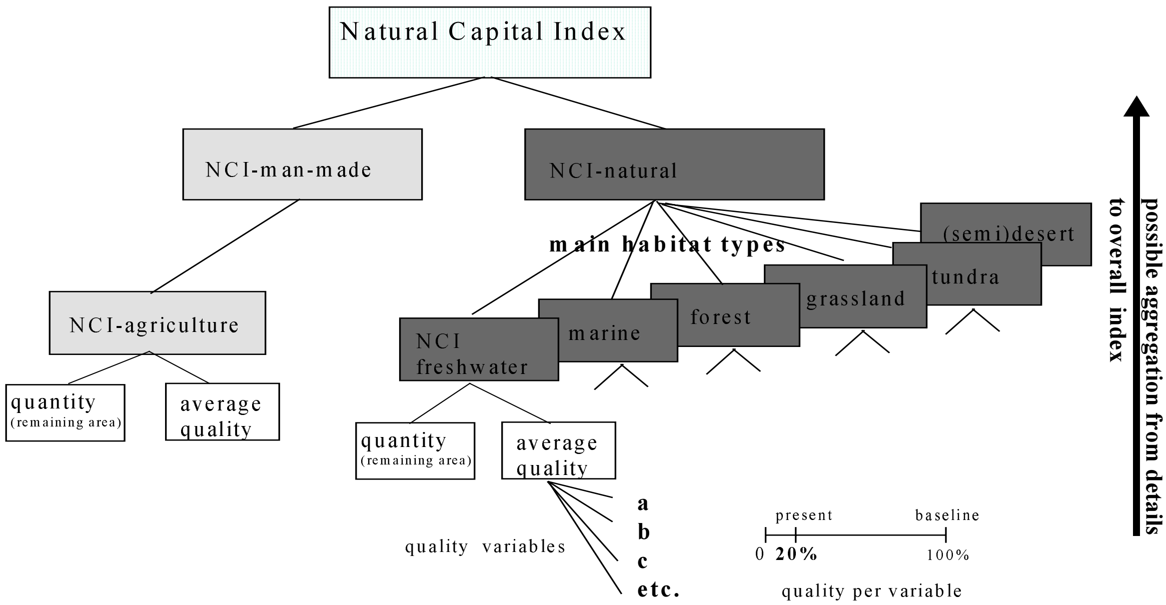
RIVM/WCMC Natural Capital Index (NCI)

The NCI was developed as an assessment tool for the Convention On Biological Diversity (CBD). Had the CBD contained numerical policy targets, the NCI would have had to be classified as a policy performance. This "state" index defines *natural capital* as the product of ecosystem quantity and quality. The NCI framework has been used in UNEP's 1997 Global Environment Outlook and in a background study for the 2001 OECD Environmental Outlook. It can be applied at different scales and to any or all ecosystem types. Ecosystem quantity at the national level is taken as the areal extent of a country's natural ecosystems and expressed as a % of a country's total area.

Ecosystem quality is calculated as a function of different ecosystem quality variables–such as abundance of various species, variables on ecosystem structures and/or species richness–and expressed as the ratio between the current and a baseline state. As it is impossible to measure all species, genes and ecosystem features, a representative core set of quality indicators must be selected (cf. the shopping basket of the Consumer Price Index). Each is expressed in terms of percentage of the baseline. The baseline state could be some assessment of the natural or pre-industrial state or the status quo at the time when the Convention on Biological Diversity was ratified (1993). The authors of the NCI suggest that, if there are no data on ecosystem quality available, a pressure index may be used as a substitute to provide an indication on ecosystem quality. The underlying assumption is that the higher the pressure on biodiversity the lower the probability of high biodiversity. Pressures could be climate change, eutrophication, acidification, fragmentation, etc.

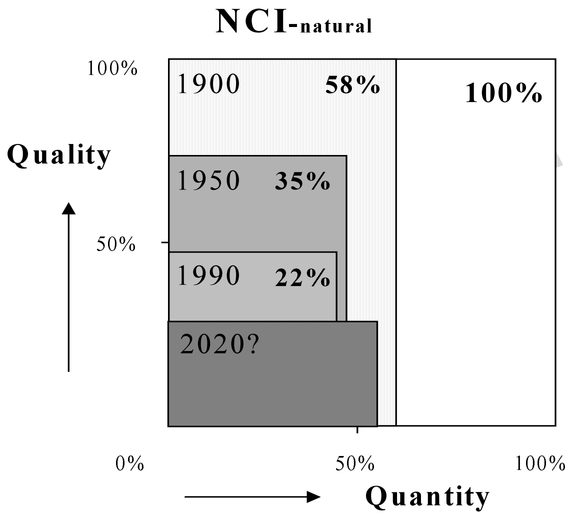
The NCI potentially ranges from 0 to 100% (e.g. if 50% of a country still consists of natural area and the quality of this area has been reduced to 50%, than the $NCI_{natural\ area}$ is 25%). An $NCI_{natural\ area}$ of 0% means that the entire ecosystem has deteriorated either because there is no area left, or because the quality is 0% or both. An $NCI_{natural\ area}$ of 100 % means that the entire country consists of natural area of 100% quality (Figure 3).

Figure 2 Components of the NCI



The Natural Capital Index consists of two components: $NCI\text{-}_{natural}$ and $NCI\text{-}_{man\text{-}made}$. Each covers various habitat types (third layer). Each habitat type has a quantity (area size) and a quality (fourth layer) aspect. Ecosystem quality is determined by a core set of quality variables, which are measured in specific sample areas (fifth layer). The ecosystem quality is calculated by averaging the current/baseline ratios of the core set of quality variables.

Figure 3 Example of Natural Capital Index



Note: Figure shows the quantity and quality of Dutch natural ecosystems (aquatic and terrestrial) in 1900, 1950 and 1990.

Global Warming Potential (GWP) Index

The purpose of the GWP is to allow emissions of different greenhouse gases (GHGs) to be added up. The GWP, expressed as tonnes of CO_2-equivalents per annum, assigns a “strength” to each greenhouse gas (GHG) in terms of its cumulative effect on the atmosphere’s energy budget. Because the various GHGs have different residence times in the stratosphere, conversion factors reflecting the relative strength of each GHG have been calculated with reference to three time horizons: 20, 100 and 500 years. The GWP index should be classified as Group 2 as soon as the Kyoto Protocol will have entered into force. GHG emission indices are regularly published and are part of the OECD Core Set of Environmental Indicators.

Ozone Depleting Potential (ODP)

The ODP is constructed following the same principles as the GWP. Basic data are weighted with the ozone depleting potentials (ODP) of the individual substances. The ODP is used in the implementation of the international ozone treaties (Convention for the Protection of the Ozone Layer (Vienna, 1985), the Montreal Protocol (1987) on substances that deplete the ozone layer and subsequent London (1990), Copenhagen (1992), Montreal (1997) and Beijing (1999) Amendments). Indices using ODP are published regularly and are part of the OECD Core Set of Environmental Indicators.

Indices measuring acidification, eutrophication, toxicity, etc.

The construction of this group of indices is similar to that of the GWP in the sense that the score of various variables is calculated as a function of their strength in terms of a common attribute (e.g. acidity, toxicity, eutrophication). This type of index is used in several countries (e.g. equitox in France, acidification and eutrophication equivalents in the Dutch National Environmental Policy Plans).

GROUP 2: POLICY PERFORMANCE INDICES

Group 2a: Indices linked to regulatory standards

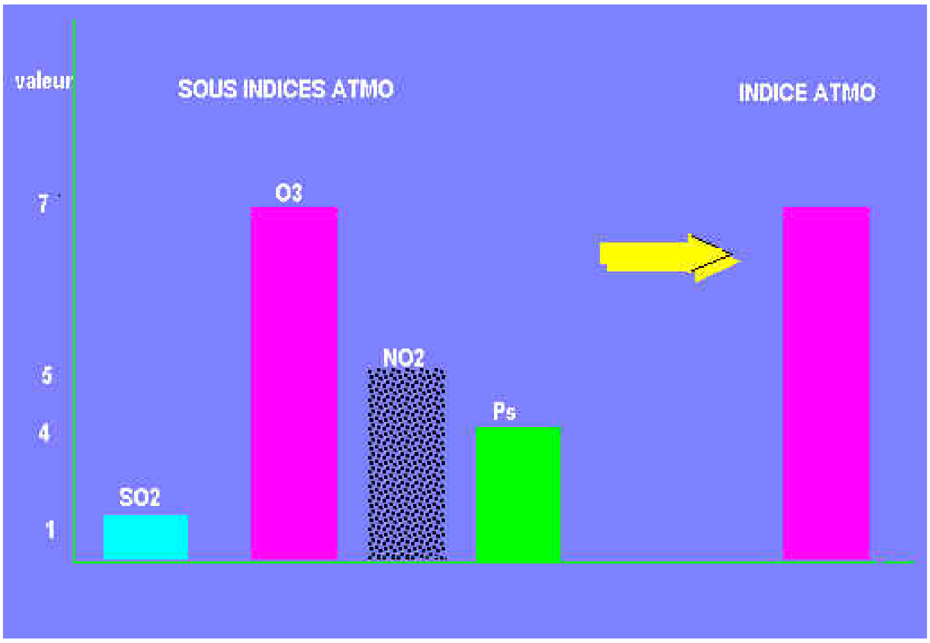
Air Pollution Indices

◆The U.S. Pollution Standards Index – PSI - (also referred to as the Air Quality Index AQI) is an index mandated under the Clean Air Act. It includes sub-indices for O_3, PM, CO, SO_2, and nitrogen oxide (NO_2), which link ambient pollutant concentrations to index values (i.e. a numerical score) on a scale from 0 to 500. The index is normalised across pollutants by defining an index value of 100 as the numerical level of the primary National Ambient Air Quality Standards (NAAQS) for each pollutant and an index value of 500 as the Significant Harm Level (SHL). Both levels therefore have a scientific basis relating air quality and public health.

◆Mexican Metropolitan Index of Air Quality (IMECA) is composed of six pollutants (TSP, PM_{10}, SO_2, NO_2, CO and O_3) and is constructed in a similar way as the U.S. PSI. It takes a value of up to 500. The current ambient air quality standard value is set as IMECA 100. The IMECA is used in all metropolitan areas of Mexico.

◆French urban air quality index ATMO is composed of four pollutants (O_3, SO_2, NO_2) and takes a value of between 1 and 10 on a scale that is linked to French and EU air quality regulations. The ATMO is used in 64 French urban agglomerations with a population greater than 100 000 (Figure 4).

Figure 4 The French urban air quality index ATMO



French Water Quality Index SEQ-Eau

The French Water Quality Index was developed jointly by the six French water agencies for use in water management, including the classification of water bodies, setting water quality objectives, reporting on water quality and achievement of objectives. It is based on the SEQ-eau (système d'évaluation de la qualité des eaux), the water quality monitoring system developed by the Ministry for Land Use Planning and the Evironment, and the Water Agencies.The index is constructed from up to 170 variables in 15 separate categories (e.g., organic matter, nitrates, suspended particles, pollution by heavy metals and pesticides – both in the water itself and in bryophytes, acidification). In each category, a score of between 0 and 100 is determined by comparing to regulatory standards or scientific information. The score of the overall index corresponds to the worst of any category (i.e. the same as the principle used in the urban air quality indices). The method is flexible: it can be used even if data are not available for certain categories, and new categories can be added if needed.

BC Water Quality Index (BCWQI)

The BCWQI is intended to communicate to the wider public the extent of compliance with the water quality objectives adopted for surface waters in British Columbia. BC water managers also use the index as a priority-setting tool.

The methodology used is unique among the indices discussed here in that it attempts to capture compliance with standards over a longer time scale (e.g. one year) not just in terms of whether or not thresholds have been exceeded, but also take account of the frequency and severity of exceedences over the period considered.

Water quality objectives have been set for more than 140 water bodies in BC with the number of objectives set for each water body dependent on the uses being made of it (i.e. drinking, recreation, irrigation, livestock watering, aquatic life, wildlife). The objectives generally specify safe limits for the concentration of various substances, which are expressed in a variety of ways (e.g. minimum or maximum value, range of values, mean, 30-day ninetieth percentile).

The construction of the BCWQI is quite different from that of the other indices discussed in this document. The BCWQI requires the calculation of three factors F_1, F_2 and F_3, that measure:

- F_1 - the number of objectives that are not met, expressed as a percentage of the total number of objectives for the water body at hand;
- F_2 – the frequency with which objectives are not met, expressed as a percentage of all instances of objectives being checked;
- F_3 – the amount by which objectives are not met, expressed as a percentage of the highest measured value. Accordingly, F_3 equals 0 when all objectives are met. F_3 is given one-third of the weight of the other two factors to prevent it from dominating the overall index.

The BCWQI is then computed as a vector in the three-dimensional space formed by F_1, F_2 and F_3, i.e. the square root of the sum of $(F_1)^2 + (F_2)^2 + (F_3/3)^2$. The result of this calculation is then divided by 1.45 (approximately the square root of 2) in order for scores of the BCWQI to range from 0 for the best water, to 100 for the poorest water.

The index as calculated in this way will only yield realistic results if at least three objectives have been set for the water body at hand. When only one or two objectives have been set for a water body, the factor F_3 is omitted. Scores are assessed in terms of a scale of five performance bands ranging from *excellent*, through *good*, *fair* and *borderline* to *poor*.

Group 2b: Indices linked to policy targets

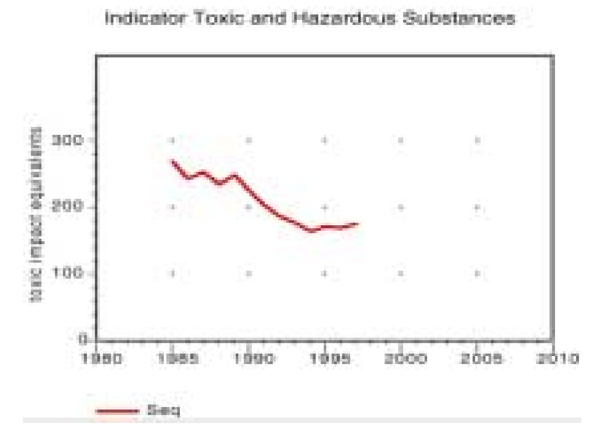
Dutch National Environmental Policy Plan performance indices

The environmental efforts of the Netherlands have since 1990 been guided by a series of National Environmental Policy Plans (NEPPs). The plans are structured according to 8 themes (e.g. acidification, dispersion of toxic waste and hazardous substances) and 12 target groups (e.g. agriculture, construction industry, consumers). Most themes have a number of quantitative targets and deadlines associated with them. Responsibility for achieving each target is shared among the target groups.

This structure makes it possible to formulate a specific performance index for each theme with numerical targets and for each target group. Such an approach poses few methodological problems, as it has been possible to find a common, science-based numeraire for each theme (e.g. acid equivalents to express the comparative effects of SO_2, NO_x, NH_3 and VOC). The indices provide continuity between the successive versions of the NEPP and are a reporting tool about the achievement of the NEPP's objectives. They are also used as an accountability tool in reporting the performance of the plan to the Dutch parliament.

The various theme indices, in the course of a research project (Adriaanse, 1993), have subsequently been combined into an overall performance index, requiring a weighting of each theme. The same research project formulated performance indices for each target group, providing an overview of the overall performance of each target group across the various themes. However, this approach has not been incorporated in the public reporting on the NEPP.

Figure 5 Example of Dutch performance indicator on toxic and hazardous substances



The Italian Urban Ecosystem Index

Legambiente, an Italian non-government environmental organisation, in association with Istituto Ambiente Italia, an independent research centre, developed this index in 1994. The index is published annually for 103 Italian municipalities by various Italian press media. The index is in the form of a table listing the overall score for each city as a percentage of the best achievable performance.

The index comprises 18 indicators that are based on 42 separate parameters. The indicators cover air quality (3 indicators), water and wastewater treatment (3), waste and recycling (2), public and private transport (2), urban amenities (3), fuel use and household electricity consumption (2), health (1), the number of ISO 14000-certified industries (1) and local Agenda 21 (1).

The indicators cover all three dimensions of the pressure-state-response framework. For each indicator an appropriate target was defined, as well as a performance scale. Targets are either national ones or stem from European or international agreements or commitments. Where no targets exist, comparison is made to average or best performance among Italian municipalities. Individual indicators were weighted by a panel of representatives of 20 cities and from Legambiente.

The German Environmental Barometer and the German Environmental Index DUX.

The German Environmental Barometer, drawn up by the German Environment Agency UBA, consists of six indices representing performance in the policy fields of climate, air, land fragmentation, water, energy and raw materials (Figure 6).

A single target has been specified for each policy field. The target is expressed in terms of a quantified reduction in environmental pressure or of a desirable state to be achieved by a certain date. Performance is measured from base year 1990 and the maximum score (i.e. when the target is achieved) is 1000 points. Negative scores are possible when the situation is worse than in the base year.

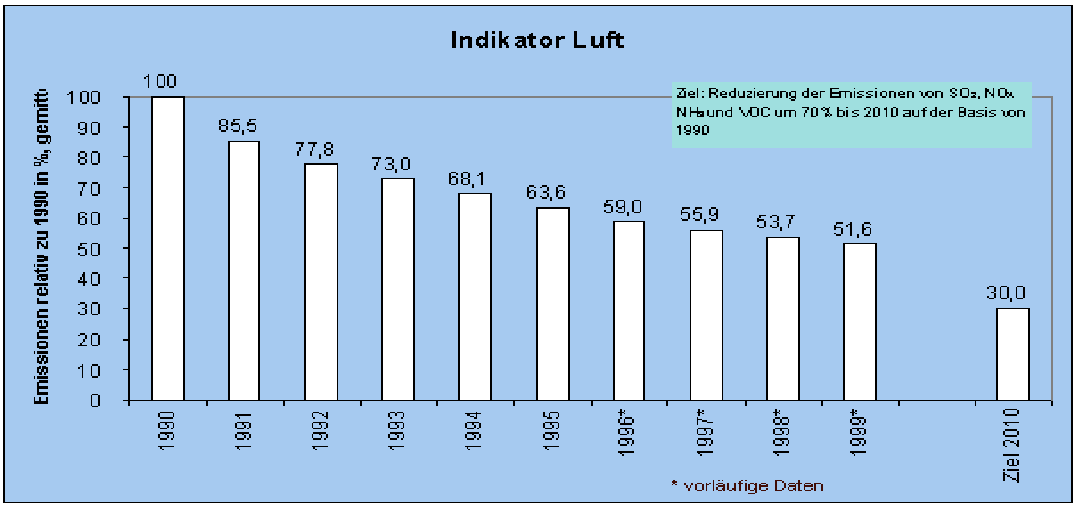
The DUX (Deutsche Umwelt indeX, the name also is a pun on the German stock market index DAX) combines (by simple addition) the individual scores of the six indices of the barometer. Hence, the six policy fields are given equal weighting. The DUX is published every six months by the German television station ZDF. In October 2000, the DUX was 1505, up from the April 2000 score of 1426.

DUX (September 2001)
1714
(max. 6000 points)

Climate	604	(max.1000 points)
Air	682	(max.1000 points)
Land	-100	(max.1000 points)
Water	260	(max.1000 points)
Energy	199	(max.1000 points)
Raw materials	69	(max.1000 points)

http://www.umweltbundesamt.de/dux/

Figure 6 The German environmental barometer (air quality)

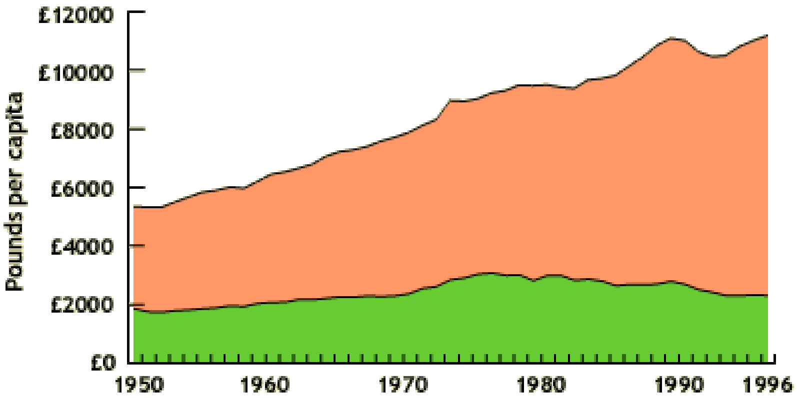


GROUP 3: INDICES BASED ON AN ACCOUNTING FRAMEWORK

Index of Sustainable Economic Welfare (ISEW) and the Simplified Index of Sustainable Economic Welfare (SISEW).

Like all approaches based on "correcting" the GDP in one way or another, the ISEW and SISEW are measures of human welfare. Both indices take account of economic, social and environmental factors by making up to 30 (ISEW), resp.12 (SISEW) adjustments to GDP. For example, adjustments are made for unpaid household production, unequal income distribution, or the costs of air pollution. Although neither the ISEW nor the SISEW have been adopted by any governmental or NGO organisation, they are included here because they are quite well known. The ISEW has been calculated for Australia, the United Kingdom and the United States, although the number of adjustments made varies among countries (Figure 7).

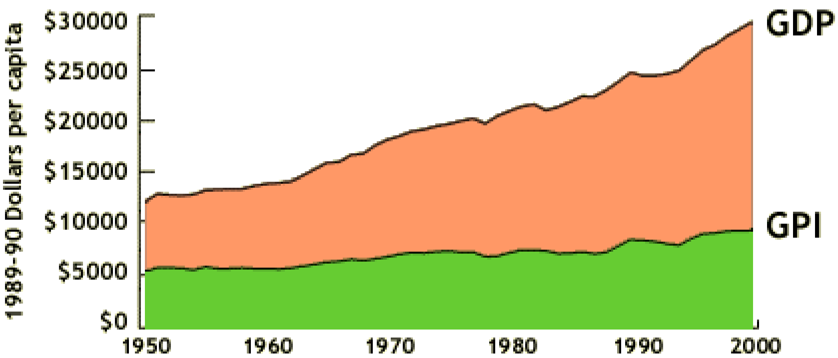
Figure 7 Index of Sustainable Economic Welfare, UK



The Australia Institute Genuine Progress Indicator.

As with the ISEW/SISEW, the purpose of this index is to provide a better indicator for well-being and it uses a similar methodology. The GPI makes 27 adjustments to the GDP. It has been calculated for Australia (Figure 8).

Figure 8 The Australian Genuine Progress Indicator

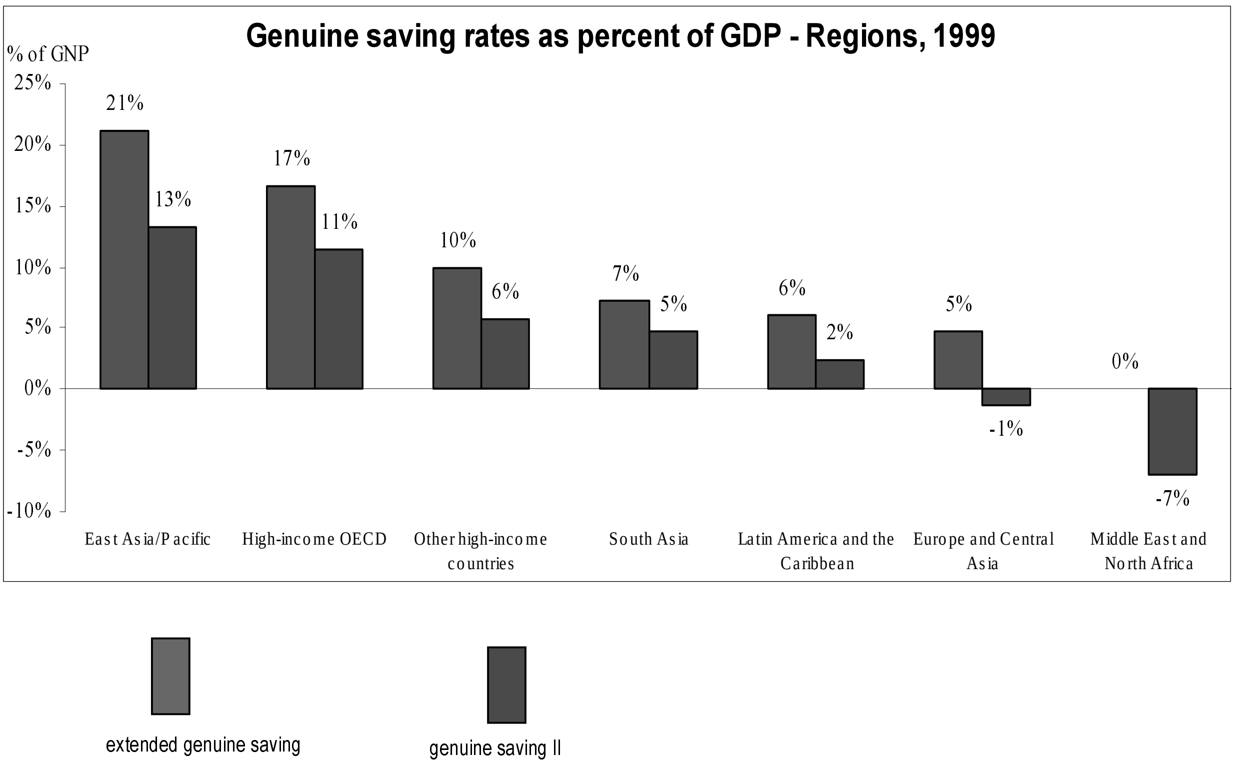


World Bank Genuine Savings methodology.

Genuine saving departs from standard national accounting. The rationale of this approach is that persistently negative rates of genuine savings must eventually lead to declining well-being. Genuine saving is calculated by subtracting natural resource depletion and pollution damages from net saving (net saving is gross saving minus the value of depreciation of produced assets). Resource depletion is measured as the total rents on resource extraction (bauxite, copper, gold, iron ore, lead, nickel, silver, tin, coal, crude oil, natural gas, and phosphate rock) and harvest (forests). Finally, genuine saving estimates consider current educational spending as an increase in saving, since this spending may be considered to be an investment in human capital.

How to calculate the genuine savings estimates

"Extended domestic investment" is measured as gross domestic investment plus current educational expenditure (expenditures on books, teachers' salaries, and so on). While this does not make a substantial difference for some countries (for example, China) it increases the rate of domestic investment quite a lot for others (the United States, for instance). The next calculation steps are to deduct net foreign borrowing, add net official transfers, and subtract depreciation of produced assets to arrive at an 'extended' measure of net saving. The next two adjustments produce the genuine saving rates. The first step is to deduct the value of resource depletion from extended net saving to arrive at "genuine saving I". Genuine saving II equals genuine saving I less pollution damage. Because many pollution damages are local in their effects, and therefore difficult to estimate without location-specific data, the estimates are limited to including global damages from CO_2 emissions for which a damage figure of US$20 per tonne is assumed.



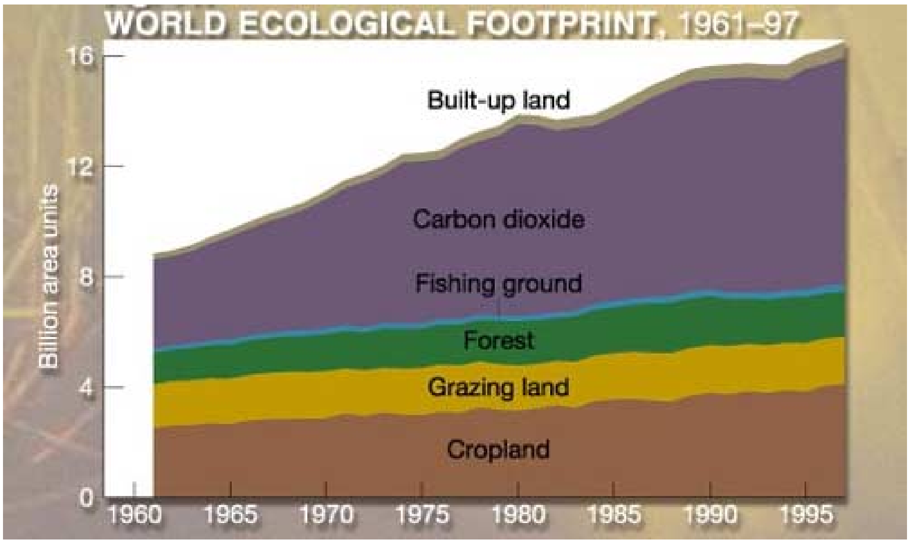
Redefining Progress Ecological Footprint.

Developed by the public policy research organisation Redefining Progress, the Ecological Footprint methodology is also used by the WWF in its Living Planet Report 2000 (Figure 9). The method estimates (part of) a population's consumption of food, materials and energy and expresses these in terms of the area of biologically productive land or sea required to produce those natural resources or, in the case of energy, to absorb the corresponding carbon dioxide emissions. The dimension of the Ecological Footprint is an "area unit," measured in hectares. An area unit is the equivalent of one hectare with world average productivity; each standardised hectare represents the same amount of biomass productivity. The Footprint of any individual is the sum of six separate, equally weighted components:

- cropland required to produce the crops which that individual consumes,
- grazing land required to produce the animal products,
- forest required to produce the wood and paper,
- sea required to produce the marine fish and seafood,
- land required to accommodate housing and infrastructure, and
- forest that would be required to absorb the CO2 emissions resulting from that individual's energy consumption.

A nation’s consumption is calculated adding imports to, and subtracting exports from, domestic production. This balance is calculated for 72 categories, such as cereals, timber, fishmeal, coal and cotton. In other words, the Footprint translates economic data into area rather than money units. The technical notes to the Living Planet Report 2000 state that the “calculations’ crude simplifications aim to obtain a first-order estimate of humanity’s ecological demand on nature and measure it in units that can be compared with the biosphere’s supply of ecosystem services.” Even though the Footprint takes the dimension of an area unit, it should be considered as a pressure index.

Figure 9 World Ecological Footprint

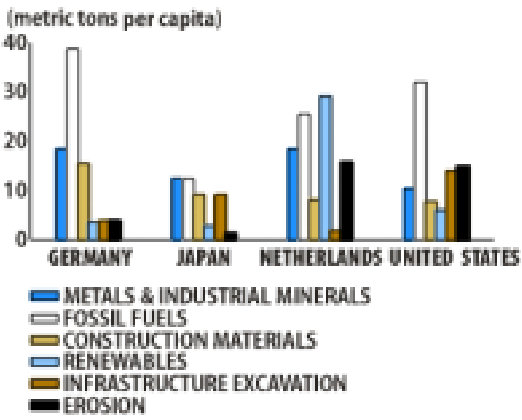


World Resources Institute's Total Materials Requirements (TMR) methodology.

The TMR number is a measure of the physical flows (expressed in tonnes per capita), or the magnitude of economic activity measured in physical terms, that underpin an industrial economy (air, water and agricultural tillage are excluded).

The approach attempts to capture "activities of environmental consequence" that do not appear in national accounts because they do not involve commodities that are bought and sold (e.g. the amounts of overburden removed in mining operations or infrastructure development). The TMR takes account of both these hidden flows and of the direct input of natural resources into the economy. For example, agricultural and forestry production is counted as the net weight of all major crops and the associated non-saleable above ground biomass. The authors claim the method can be considered an approximate measure of the potential pressure exerted by an economy on the global environment. The TMR has so far been calculated for Austria, Germany, Japan, the Netherlands and the United States.

Figure 10 Primary Contributions to the Total Material Requirements of Selected Economies, 1991



Source: A. Adriaanse et al., *Resource Flows: The Material Basis of Industrial Economies*, a joint publication of the World Resources Institute (WRI), the Wuppertal Institute, the Netherlands Ministry of Housing, Spatial Planning, and the Environment, and the National Institute for Environmental Studies (WRI, Washington, D.C., 1997), p 12.

GROUP 4: SYNOPTIC INDICES

IUCN/PADATA/IDRC Barometer of Sustainability/Well-Being Index.

The barometer and index are based on a different metaphor for portraying sustainable development. It substitutes the so-called Egg of Sustainability for the familiar graphic of the three interlocking circles representing society, economy, and the environment. The Egg of Sustainability illustrates the relationship between people and ecosystem as one circle inside another, like the yolk of an egg, thereby suggesting that people are within the ecosystem, and that ultimately one is entirely dependent upon the other.

This is an innovative tool for assessing human and ecological well-being at the same time, but without submerging one into the other. It presents the Human Well-Being Index (HWI) and the Ecosystem Well-Being Index (EWI) visually on the Barometer of Sustainability. The two indices are considered equally important. The Barometer provides a picture of the overall Well-being Index (WI), which is shown as an egg-yolk picture with the values of the HWI and EWI written inside it (Figure 11).

The HWI is constructed from the following five sub-indices (or dimensions): health and population; wealth; knowledge and culture; community; and equity. The EWI also consists of five dimensions: land; water; air; species and genes; and resource use. The dimensions are considered of roughly equal importance. Each of the sub-indices is built up from a number of indicators considered to be representative of that particular dimension.

The two indices form the two axes of the Barometer: one for human well-being, the other for ecosystem well-being. This ensures that an improvement in one does not mask a decline in the other. The scale of both axes runs from 0 to 100. A lower score on one axis overrides a higher score on the other. Hence, overall well-being is based on which subsystem -- people or the ecosystem -- is in worse condition. The Barometer also is divided in five L-shaped coloured “performance bands” that provide a valuation from bad to good (Figure 12).

The assessment method permits the construction of a further, very innovative, index. The Index of Progress Towards Sustainability is the ratio of human well-being and ecosystem stress and takes the value of HWI/(100 – EWI). Therefore, a high score represents good progress towards sustainability. The Barometer has been used to assess the sustainability of 170 countries. The assessment method used to construct the barometer and indices can be applied from the project to the national level. Users can organise and combine indicators according to their needs.

Figure 11 The “Egg of Well-being”

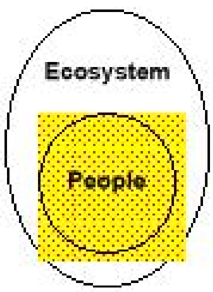
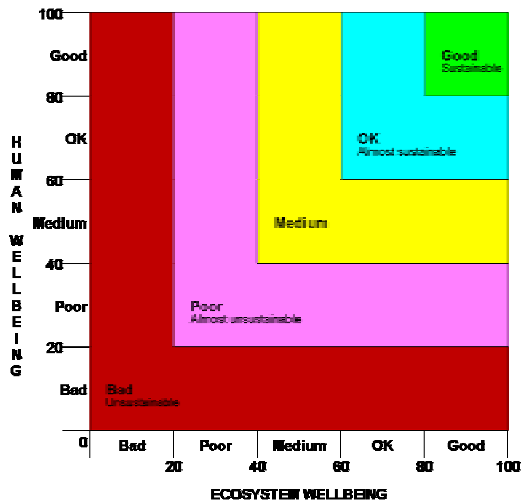


Figure 12 Egg-of-Well-being "Performance Bands"



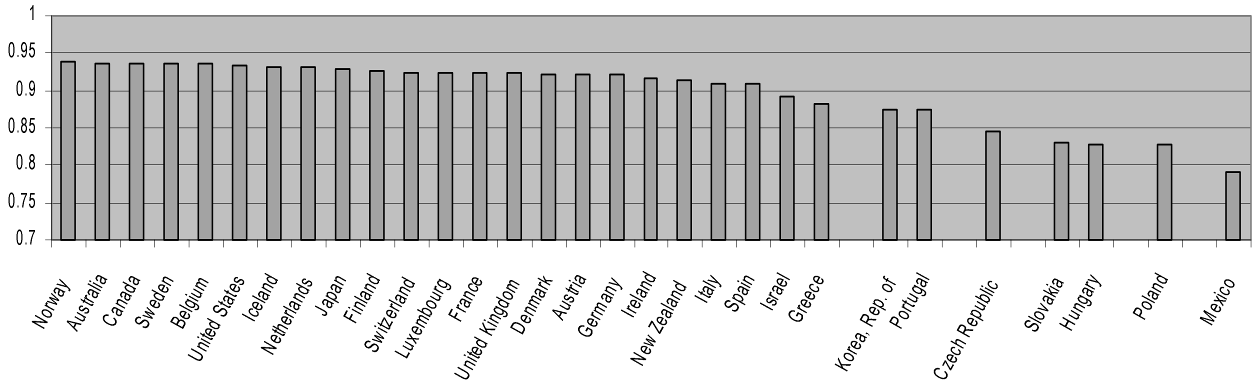
UNDP Human Development Index (HDI).

The HDI has in recent years become a well-known indicator and receives widespread press coverage at the time it is published. Although the actual value of the HDI will be meaningless to most people, the index attracts attention as a result of the HDI-*ranking* of individual countries in the annual UNDP Human Development Report.

The HDI is the average of three sub-indices representing longevity (as measured by life expectancy at birth), educational attainment (as measured by a combination of adult literacy [two-thirds weight] and the combined first-, second- and third-level gross enrolment ratio [one-third weight]), and standard of living (as measured by real GDP per capita [PPP$]). The variables making up the sub-indices are subjected to different transformations, depending on the variable involved.

For example, the construction of the longevity sub-index requires the setting of a minimum (25 years) and maximum (85 years) value. The sub-index then takes the value of (life expectancy at birth – 25)/(85 – 25); if the life expectancy is 65 years, the sub-index becomes 0.667.

Figure 13 HDI value, 1999



European Commission EUROSTAT JRC Environmental Pressure Indices.

This project is still in the research stage, but the aim is to produce ten pressure indices based on the pressure indicators selected for the 10 policy fields of the EU Fifth Environmental Action Programme. It would then be possible (but at present is not foreseen) to combine then 10 individual pressure indices into one overall Environmental pressure Index (EPI). The methodology to be used for aggregating the indicators into indices has not been decided/published yet. Currently Eurostat focuses on publishing individual pressure indicators.

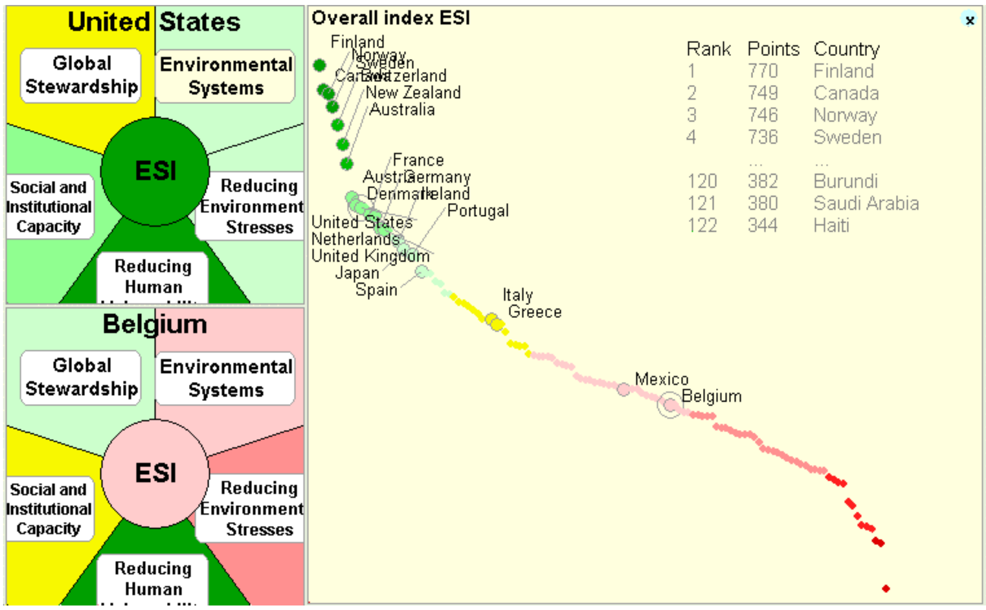
World Economic Forum Environmental Sustainability Index (ESI).

The ESI is intended as a "measure of overall progress towards environmental sustainability." It is a four-tier structure of 67 variables (in WEF terminology, they are indicators in the definition used in this document), 22 environmental sustainability indicators (sub-indices), five components and one overall index. All variables and indicators have been given equal weighting in the first (2001) version of the ESI. The final score of the ESI represents the percentage of countries expected to have a lower level of environmental sustainability, it is therefore a ranking of countries (Figure 14).

The five components and the associated 22 sub-indices include many aspects also covered by the other indices discussed in this document, but some are quite different:

- Environmental systems (with sub-indices air quality, water quantity, water quality, biodiversity, and terrestrial systems);
- Reducing stresses (air pollution, water stress, ecosystem stress, waste & consumption pressures, population pressure);
- Reducing human vulnerability (basic human sustenance, environmental health);
- Social and institutional capacity (science/technology, capacity for debate, regulation and management, private sector responsiveness, environmental information, eco-efficiency, reducing public choice distortions);
- Global stewardship (international commitment, global-scale funding/participation, protecting international commons).

Figure 14 Dashboard presentation of WEF Environmental Sustainability Index



UNCHS City Development Index (CDI).

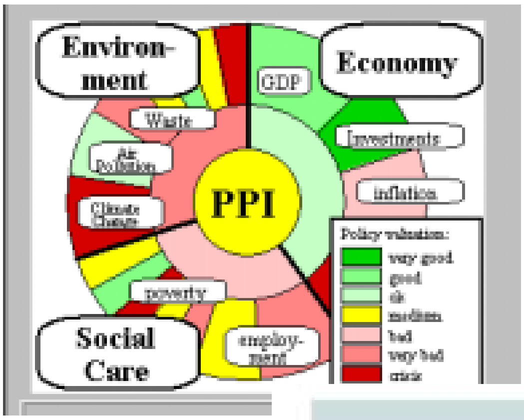
The CDI is a "state" index and comprises 5 sub-indices with in total 13 indicators. The five sub-indices represent infrastructure, waste, health, education, ands the city product. The CDI is calculated even if not all indicators can be evaluated. Individual scores of sub-indices are added. Each sub-index comprises one or more components constructed from indicators and weighted in different ways. The basic methodology can be summarized by asking the question, "What would a well-functioning sector look like, from the point of view of each of the key stakeholders or players in the arena?" Therefore, the CDI is also normative even if not linked to a regulatory standard.

IISD/Consultative Group on Sustainable Development Indicators Dashboard of Sustainability.

The Dashboard, rather than an index in its own right, primarily is a visual display methodology that is being applied to a variety of datasets. The dashboard image is a metaphor for using information presented on dials to steer a system in a defined direction, e.g. towards sustainable development (Figure dashboard). The methodology includes "do-it-yourself" software (downloadable from the Internet) that allows users to assign their own weightings or to apply the methodology to their own datasets.

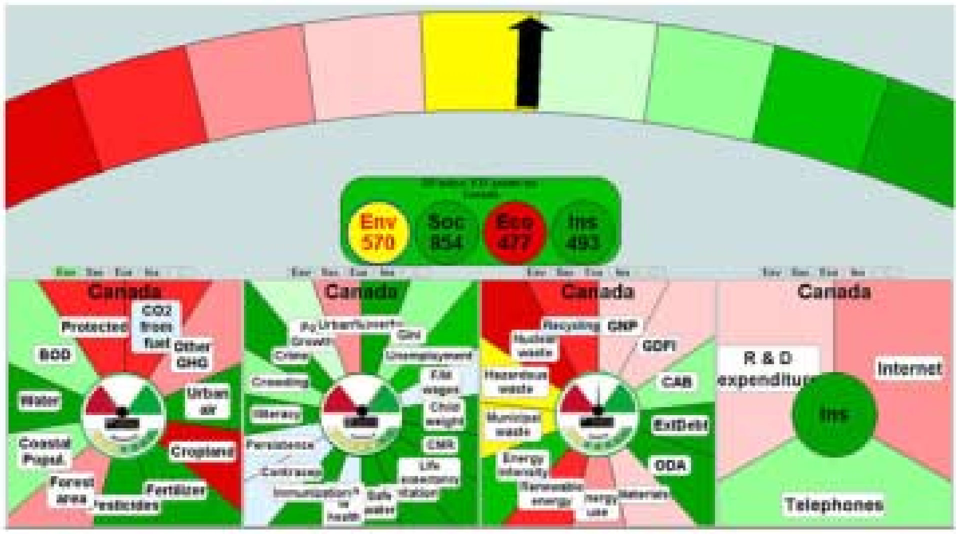
The methodology allows users to visually aggregate a limited set of elements without submerging the information about the value of each individual element. As in an airplane cockpit, the dashboard shows a variable number of dials representing the highest-order groupings in a dataset, such as the environment, social well-being, and economic well-being in a set of sustainable development indicators. Each dial is a sub-index constructed from a variable number of indicators, depending on the dataset to which it is being applied. A colour coding system assigns a valuation ("excellent," "poor") to each of the elements displayed. It represents a country's overall score as a needle on an odometer that ranges from dark red to dark green.

In addition to the dataset on which it was tested, the Dashboard has been applied to the datasets underlying the UNCSD sustainable development indicators, UNDP Human Development Index, WEF Environmental Sustainability Index, the European Environment Agency's Environmental Signals 2001, Eurostat's Towards Environmental Pressure Indices, and the urban and regional environmental performance indices compiled by the Italian environmental NGO Legambiente.



Basic principle of the "Dashboard presentation": the policy performance for any issue can be characterised through: 1. Importance (reflected by the size of the segments) and 2. "good vs. bad performance" (expressed on a green-to-red colour scale).

← This example uses a three-cluster dial comparing nations, but the tool can be analogously applied to urban or regional indices. The Policy Performance Index (PPI) is calculated on the basis of the overall points achieved, and the PPI colour results from the position of the country (city) in the database (which is not necessarily the same as the sum of the colours of the sub-indices).



ANNEX II. GUIDING PRINCIPLES FOR USING ENVIRONMENTAL INDICATORS[3]

When using environmental indicators in analysis and evaluation, the OECD applies the following principles:

- **ONLY ONE TOOL**

  Indicators are not designed to provide a full picture of environmental issues, but rather to help reveal trends and draw attention to phenomena or changes that require further analyses and possible action. Indicators are thus only one tool for evaluation; scientific and policy-oriented interpretation is required for them to acquire their full meaning. They often need to be supplemented by other qualitative and scientific information, particularly in explaining driving forces behind indicator changes which form the basis for an assessment.

- **THE APPROPRIATE CONTEXT**

  Indicators' relevance varies by country and by context. They must be reported and interpreted in the appropriate context, taking into account countries' different ecological, geographical, social, economic and institutional features.

  In the OECD environmental performance reviews, international indicators derived from the Core Set are generally used in combination with specific national indicators and data. These national indicators provide a more detailed picture of the country's situation through further sectoral and/or spatial breakdown (e.g. subnational data) and often point at particular issues of concern.

- **INTERCOUNTRY COMPARISON AND STANDARDISATION**

  Most OECD indicators focus on the national level and are designed to be used in an international context. This implies not only nationally aggregated indicators, but also an appropriate level of comparability among countries. Despite a number of achievements in this area, further work is needed on internationally harmonised definitions and concepts.

  There is no single method of standardisation for the comparison of environmental indicators across countries. The outcome of the assessment depends on the chosen denominator (e.g. GDP, population, land area) as well as on national definitions and measurement methods. It is therefore appropriate for different denominators to be used in parallel to balance the message conveyed. In some cases absolute values may be the appropriate measure, for example when international commitments are linked to absolute values.

3. Based on "Environmental indicators for environmental performance reviews", OECD, 1993

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