1

Challenges to Sustainability Indicators

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The most difficult challenge facing policymakers is deciding the future directions of society and the economy in the face of often conflicting requirements for short-term political success, economic growth, social progress, and environmental sustainability. The wrong decisions can carry heavy consequences, increase human suffering, and even precipitate crises. Improving the basis for sound decision making, integrating many complex issues while providing simple signals that a busy decision maker can understand, is a high priority. At a time when modern information technologies increase the flow of information but not our ability to absorb it, we need information tools that condense and digest information for rapid assimilation while making it possible to explore issues further as needed. This is the goal of indicators.

Indicators are symbolic representations (e.g., numbers, symbols, graphics, colors) designed to communicate a property or trend in a complex system or entity. Traditionally, most indicators for decision makers have been numbers calculated by statistical services, including complex indices such as the gross national product (GNP) or percentages such as the unemployment rate.

Chapter 40 of Agenda 21 acknowledges that "commonly used indicators such as GNP and measurement of individual source or pollution flows do not provide adequate indications of sustainability" and states that "indicators of sustainable development need to be developed to provide solid bases for decision-making at all levels and to contribute to a self-regulating sustainability of integrated environment and development systems" (UNCED 1992:paragraph 40.4). Although 12 years later much progress has been made in refining the concept of sustainable development, the challenge of Agenda 21 has not been met in a satisfactory way. Many indicator sets have been assembled, but none has been widely implemented, and their integration to support self-regulating sustainability is still a major challenge. The development of

indicators is still seen as one of the major topics within sustainable development projects and programs (OECD 2004).

This book focuses primarily on the assessment of existing indicators in order to assist those who need to apply indicators now and to shed some light on the way ahead. The successes and failures are analyzed, gaps in knowledge exposed, and research needs identified. In addition, some new approaches are proposed. Progress in sustainability indicator development is reviewed in this book in the following three domains: conceptual challenges, methodological frontiers, and policy relevance. The review focuses on indicators broadly concerned with sustainable development, including its economic, social, and environmental dimensions and other relevant perspectives, largely as used at the national and international levels. Although many of the issues raised apply equally to indicators used at the local level, there are too many interesting initiatives at that level to include them in this review.

Probably the only generalization one can make about indicators or indices used or proposed is that there is no ideal indicator that fully encompasses all the desired qualities. There are always trade-offs, and the goal is not to eliminate the trade-offs completely but to make them transparent and to identify and avoid major constraints. Thus there is no one recommended indicator set but different approaches that may be appropriate for particular uses.

Conceptual Challenges of Sustainability

Assuming that indicators are intended to report on sustainability, the most important and difficult definition is that of sustainability itself. Sustainability is the capacity of any system or process to maintain itself indefinitely. Sustainable development thus is the development of a human, social, and economic system able to maintain itself indefinitely in harmony with the biophysical systems of the planet. Sustainable development is perhaps the most challenging policy concept ever developed. Its core objective—a kind of ethical imperative—is to provide to everybody everywhere and at any time the opportunity to lead a dignified life in his or her respective society. It is essentially an anthropocentric concept of sustained intergenerational and intragenerational justice (Grunwald et al. 2001), claiming for humans the right to a dignified life (Littig 2001). This demand for a high quality of life is assumed to include a decent standard of living, social cohesion, full participation, and a healthy environment (WCED 1987).

Sustainable development, as elaborated in Agenda 21 and confirmed at the World Summit on Sustainable Development, has three explicit dimensions, domains, or pillars: social, economic, and environmental. A fourth pillar, institutional, was included in the system of sustainability indicators adopted by the UN Commission on Sustainable Development (CSD), although very few institutional indicators were identified. More often, institutions are seen as providing the underlying enabling framework for action and change. Other approaches may recognize only human or social and natural or environmental dimensions or may subsume all compartmentalization into a more integrated and dynamic framework. Wherever such subdivisions are used for conceptual convenience or to make the concept more accessible and policy relevant, they immediately raise the challenge of integration across the subdivisions.

Most indicator sets for sustainable development have assembled indicators for each of the pillars while neglecting the links between them despite their key relevance for policy and planning. Development of interlinkage indicators is thus a particular challenge. The so-called decoupling indicators are highly relevant in this respect (OECD 2002), and other cross-cutting indices have been proposed.

Indicators of sustainability should measure characteristics or processes of the human–environmental system that ensure its continuity and functionality far into the future. Specifying the characteristics of the system or entity to be maintained can be very subjective and specific, and political, philosophical, and cultural differences may prevent any wide consensus. More effort is needed to apply the techniques of system science to this issue, developing more alternative models that reflect the diversity and complexity of human systems and cultures. These will help to explain the behavior of such complex nonlinear systems and their sensitivity, resilience, and capacity to switch between alternative steady states. The resulting understanding can contribute to more adaptive management, with indicators serving as monitoring and signaling mechanisms. The optimal sustainability indicators are those that capture the essential characteristics of the system and show a scientifically verifiable trajectory of maintenance or improvement in system functions. Science cannot always validate the goals set for the system, but it can validate the ability of the indicators chosen to measure the trajectory toward those goals or the reduction in damaging factors threatening the system's sustainability.

It is probably not possible or even desirable to arrive at one standard definition of sustainability. Such a dynamic concept must evolve and be refined as our experience and understanding develop. Rather than trying to resolve this issue, this review examines some of the basic underlying concepts and their relationship to indicators. The idea of carrying capacity, for instance, with the exception of the ultimate limits of life conditions on the planet, depends on political choices about an acceptable standard of living and thus is a very subjective and normative concept that cannot easily be captured in indicators. Resilience is a more useful aspect of sustainability that can be defined in terms of vulnerability, adaptability, and responsiveness or sensitivity. This allows a better understanding of the behavior of this system property integrating and clarifying synergies between various human economic, social, and cultural characteristics. The goal is to identify irreversible changes beyond which recovery is not possible. However, this entails defining how critical the loss is to overall system functions, whether substitutions are possible, what compensation may be needed, and the level of uncertainty that may necessitate the application of the precautionary approach.

The notions of weak and strong sustainable development have been debated in the recent literature, and a number of indicators or frameworks have been proposed to capture them. For weak sustainability, efforts have focused on whether the well-known macroeconomic indicators gross national product (GNP) and gross domestic product

(GDP) can be transformed to produce an indicator of sustainable development. For strong sustainability, the concept of critical natural capital (CNC) was introduced for the stocks of capital that cannot be substituted by other stocks of environmental or other capital to perform the same functions (Ekins et al. 2003).

The packaging of data into indicators is a way of simplifying complex and detailed information. Decision makers and the public lose interest rapidly if presented with more than a few indicators. It is therefore highly desirable to keep the number of indicators to a minimum while still representing the issues of sustainable development. The ultimate test of any indicator effort is its suitability for a specific use and the impact the indicators have on policies and public awareness. The issue of aggregation is very important in this respect because it can both generate useful information and facilitate its communication. Assessments that do not combine their indicators into a small set of indices are extremely hard to interpret, whereas those that do communicate their main findings instantly. When indicators are combined into indices, they provide a clear picture of the entire system, reveal key relationships between subsystems and between major components, and facilitate analysis of critical strengths and weaknesses. No information is lost if the constituent indicators and underlying data are available to be queried. However, there is a problem with the selection of indicators to be aggregated, which can intentionally or unintentionally introduce arbitrary weightings or other distortions.

Policy Relevance

Sustainability indicators generally are intended to target ongoing political processes, yet they often are developed with surprising political naïveté. Because such indicators are at the interface of science and politics, framing the issues in a policy-relevant way is particularly important and generally entails a participatory process. To be effective, indicators must be credible (scientifically valid), legitimate in the eyes of users and stakeholders, and salient or relevant to decision makers.

Policy has a life cycle, from the realization that there is a need for a policy instrument to tackle a certain issue, to the design of the policy and its implementation, evaluation, and adaptation, and finally to its phasing out or integration into another policy instrument. Indicators must meet different information needs at various stages of the policy life cycle. One function would be early warning, raising awareness of an unfavorable trend that may be evidence of a new and emerging issue or signaling a policy gap for an existing issue. Other indicators are used in impact assessments or outlooks, when new policy proposals are being developed, and still others contribute to the mid-term to long-term monitoring of policy implementation.

The policy life cycle for the design of indicator sets necessitates flexibility. Some indicators designed for monitoring will remain policy relevant for a long time, whereas others in the indicator set may need to change for maximum policy relevance. However, flexibility must be offset against the risk of losing familiarity and continuity in the indicators, which are both key elements in their adoption and use.

Indicators often are distinguished from raw data and statistics in that they contain reference values such as benchmarks, thresholds, baselines, and targets. Such values have various functions, but the most important is to transform meaningless data into information. A reference might be a target (distance to target), a baseline (distance to a certain meaningful state), a threshold value (distance to a collapse), a reference year (change in time), or a benchmark (difference with another country). All these reference points lend meaning and political weight to data and are used mostly in the interpretation of indicators. There are still many indicators for which reference values or baselines have yet to be established.

Distance-to-target indicators measure performance in reaching policy goals. Three distinct types of targets can be identified: political or hard targets; soft targets, such as those for sustainability reference values, minimum viable populations, and thresholds; and benchmarks.

Hard targets are set through political processes and can be very useful in producing effective indicators. Where hard targets are vague or qualitative and need clarification or definition, the indicator community can highlight this. Indicator producers can also draw attention to the lack of targets.

Indicators for soft targets, despite their uncertainty, can use ranges transparently, especially when such scientific targets highlight the inadequacy of political targets derived through a consensus process.

Benchmarking adds context to indicators, for instance by ranking countries. The comparison should be acceptable and relevant. However, if all countries are doing badly on a measure, benchmarking against the average will not encourage sustainability. Generally, peer pressure is a good thing among partners in any community, be they scientists, enterprises, or countries. National-level indicators therefore should be developed to allow intercountry comparison. The comparability should be as direct, simple, and evident as possible.

Capturing Diversity

In a world of great differences between countries, it is not easy to select indicators that provide a completely objective assessment of sustainable development. Those living within the Western economic paradigm naturally will choose indicators that reflect their conception of development. Data also are more available in industrialized countries. Developing countries may have different perspectives and priorities. For example, traditional economic indicators may overlook the informal economy and subsistence sector. Designers of indicators for use at the global level must accept a plurality of legitimate perspectives reflecting economic, cultural, environmental, and other differences, with particular attention to a better balance of indicators relevant to different stages of development. Any biases or value assumptions should be acknowledged.

Cultural differences may be expressed in the choice of indicators or in the levels or targets that are seen as sustainable. Because most indicator work has been done in the

North, one of the present challenges is to look again at the various indicator sets dealing with sustainable development, such as the Millennium Development Goals (MDGs), the United Nations Environment Programme (UNEP) Global Environment Outlook, and the indicators of the CSD and others, from different cultural perspectives and see whether significant cultural biases can be identified and, if possible, repaired. Cultures probably differ most in social needs such as freedom, acceptance, respect, equity, participation, and gender issues. Nevertheless, a common foundation of values is expressed in UN declarations and conventions on human rights, child labor, and others that identify specific issues (the indicator) and minimum levels. There is a need to distinguish the objective and normative components of indicators and to develop indicators for dimensions such as equity and participation.

Ideally, indicators should be chosen that are not too influenced by such diversity. Features of a robust indicator include a simple and unified method, commonly agreed issues and targets of wide applicability, transparency in the process, and agreement between partners on the process.

Use and Users

Indicators are by definition communication tools. Failure to communicate makes the indicator worthless. However, because sustainable development is a multistakeholder process, indicators must communicate to a variety of different actors. It is the capacity of the indicator to reach its target audience that determines its success as an indicator of sustainable development. Some users need simple, structured information (voters, the nonspecialist media, and decision makers), whereas others prefer an intermediate level of detail (local government, policy implementers, nongovernment organizations, funding bodies, and industries), and policymakers and academics may need more technical information.

In targeting governments, it is useful to distinguish between ministers and parliamentarians who make decisions, policy implementers and enforcers such as regulatory bodies and environmental protection agencies, and policymakers who are mostly civil servants, scientists, economists, and social scientists who design policy portfolios, evaluate policy alternatives, construct and evaluate indicators of sustainability, and brief ministers.

Most present indicators have been developed by governments and intergovernmental bodies in response to their needs. This ensures policy relevance, but it often fails to capture what is going on at the grass roots of society. Other indicators have been created by nongovernment organizations or academics to draw attention to policy issues. There are few indicators by and for the real agents of change: businesses and individuals operating at a decentralized level in all societies. Because the most effective indicators and feedback loops are those created and managed directly by users for their own purposes, only broad processes of education for sustainable development can equip individuals, local institutions, and small businesses with knowledge and indicators they can use to make their own behavior more sustainable. The issue of how to reconcile the centralized approaches needed to produce standard comparable indicators and the decentralized nature of most decision making affecting sustainability has not yet been explored.

The business community is an essential actor for sustainability that is not captured well in indicators. Indicators of sustainable business behavior would complement indicators at the government level. Although many corporate reports now include information on environmental and social performance that could be used for indicators, it is still difficult to get businesses to share the information they collect. Some information is seen as confidential because it provides a commercial advantage, and businesses are not motivated to share negative information that might damage their reputation or profitability. Yet much of the effort to move toward sustainability involves identifying and reducing problems such as pollution. This is an important gap that must be filled, particularly for small and medium enterprises that are responsible for the bulk of business activity.

User involvement is important to indicator design and acceptance. Stakeholders may have local knowledge that can contribute to more effective indicators. Participation also ensures relevance to the decision-making process, political commitment, and ownership of the results. Participatory processes can reveal conflicting social interests, values, and preferences that must be taken into account. The quality of the process is important.

Acceptance and use of indicators are a continuing challenge. Indicators that reflect badly on politicians, corporate executives, and senior officials will be rejected or suppressed, and most indicators of sustainable development show negative trends. Careful indicator development processes, outside pressure, and objectivity will be necessary to overcome this obstacle.

Democracy and Equity

Sustainable development includes an important ethical component, expressed as the right of every human being to a fair share of the benefits this planet offers. Democratic processes help to ensure access to all the dimensions of development. In particular, with the transformation to a knowledge-based service economy, access rights become essential for societal well-being and a critical element of a dignified life. These rights include the following:

- *Biophysical environment:* This includes access to land and natural resources, safe drinking water and sanitation, and housing and energy, both from the environment and through adequate infrastructure, including the technologies of a modern information society (computer, telephone, Internet).
- *Economic dimension:* On the individual level this includes a secure minimum income to guarantee active participation in society, including access to the sociocultural system. In the context of the national economy, this should include fair access to the benefits of the economy and the ability to contribute to wealth generation, in both the market economy (salaries and employment) and the nonmarket economy (unpaid

work, caring work, voluntary community work, and the resulting services). This entails access to markets for all potential producers, with no entrance barriers, and access to finance (i.e., nondiscriminatory credit conditions). On the international level this entails the removal of obstacles to participation in the global economy, such as old (and long written-off) debt and trade barriers erected by the affluent societies.

- *Social dimension:* This includes access to knowledge, information, and experience, such as nondiscriminatory education, the opportunity to work and participate in social processes, access to information technology, and the ability to select and transform information into relevant knowledge.
- *Institutional dimension:* This includes access to information (newspapers, the Internet, oral communication, and expertise), information exchange (the right to free speech and the right to provide content), and decision making. Components include the legal right to participation, equal access (e.g., racial, ethnic, and gender equity), a participatory political system, nondiscriminatory social security systems, access to justice, and legal provisions for access to economic, social, and environmental resources.

The distribution of access is a measure of the intergenerational justice within a society. There is increasing recognition of the risk, in choosing the conceptual framework and governance of sustainable development, that certain ideas become embedded as authoritative whereas others are marginalized. Democratic processes therefore are particularly important in defining ends, means, and indicators of sustainable development in order to ensure access to and inclusion of the diverse perspectives in a society. In the end, the institutional structures should reflect the aggregated preferences expressed by this process. Democratic representation helps these institutions to be transparent, accessible, and accountable.

One of the critically important enabling conditions for democratic participation is capacity building. This applies broadly to all indicator processes, not only to indicators of sustainable development, and is needed in several areas. First, there is a need to improve the capacity of decision makers to understand and use indicators, especially in relation to setting and monitoring targets. Capacity also must be built, particularly in developing countries, to increase public participation in the processes of defining indicators and setting targets for sustainability. This requires that the public understand the role and use of indicators. The introduction of indicators as a topic in school curricula or other awareness or educational initiatives should be explored, as in the UN Decade of Education for Sustainable Development (2005–2014) and the European Consumer Citizenship Network.

Scales and Frameworks

The economic, social, and environmental dimensions or pillars of sustainable development have different characteristic time scales, ranging from a long-term view of sustainability in general to the short-term perspective of policy and economic measures. Environmental systems evolve slowly and have longer time lags between cause and effect than economic systems. A parallel mismatch in time scales occurs between the methods in the disciplines that study the different pillars. This makes it hard to present sustainability to policymakers, who tend to act on experience rather than insight and therefore take action only when a problem is observable, not when a problem is predicted, especially if the prediction is uncertain. A key challenge for sustainability indicators therefore is to reflect time lags, the trade-offs between the short and long term, and the distinction between weak and strong sustainability.

There are similar challenges in relating indicators at different spatial scales, where the same indicator may have different meanings in different contexts or when applied at different scales. Unsustainable states, trends, and drivers may be apparent only when indicated at the appropriate scale. A local community can appear sustainable if it exports its unsustainable consumption or waste disposal. Similarly, indicators may show a high per capita income at the national scale, for example, while hiding significant inequities between subregions and societal groups. To compensate for this we need indicator sets in a nested hierarchical structure covering different geographic scales or units. One significant gap is in indicators appropriate for measuring global sustainability and planetary limits.

Policy is implemented on the basis of political boundaries. In indicator design, reporting by political units usually is needed for policy relevance. In the environmental field, this generally means remapping ecological boundaries onto political boundaries. In deciding on reporting units, a key factor is that averaging for large political units or regions may not always capture important issues of sustainability, especially if there are large disparities within regions.

Sustainability indicators may be easier to understand and interpret when assembled in some conceptual framework, perhaps with a hierarchical arrangement of subdomains. The three pillars (economic, social, and environmental) are one such framework, but many others are possible. Such frameworks may reflect different values and weightings, which should be transparent. Frameworks may help to interrelate indicators from the natural and social sciences, to position both stock and rate indicators, and to identify interlinkages.

Measurability

Indicators necessarily limit themselves to the sphere of the measurable. Like models, indicators can reflect reality only imperfectly. However, even within the measurable, the quality of indicators is determined largely by the way reality is translated into measures and data, be they quantitative or qualitative. Although present scientific knowledge is inadequate to understand many aspects of human–environment interactions, and some feedback loops between human and environmental systems are irreducibly complex, many issues are sufficiently well understood to necessitate scientifically accurate indicators. The quality of indicators inevitably depends on the underlying data that are used to compose them. The prevailing data gaps in monitoring of human–environment

interactions and the poor quality of many databases (especially on the global and local levels) are potential threats to the quality of the related indicators.

The quality of an indicator can be judged on five methodological dimensions: purpose and appropriateness in scale and accuracy, measurability, representation of the phenomenon concerned, reliability and feasibility, and communicability to the target audience. There is seldom a perfect indicator, so the design generally involves some methodological trade-offs between technical feasibility, societal usability, and systemic consistency.

Although it may always seem desirable to enhance data quality and to develop new data sets on a number of issues and scales, indicators can grow into costly enterprises. It should not be forgotten that indicators are merely assessment tools, for which the cost of improvements should not limit the capacity to implement policy. The two must be matched in cost-effective ways.

Data Availability

Many indicator projects are constrained by the availability of relevant and reliable data. Data availability often is a selection criterion to ensure a rigorous quantitative underpinning for the indicators. As a result, most indicators have been constructed on the basis of existing data. This often rules out the inclusion of "ideal" indicators because of the paucity of appropriate information, and new indicators must be derived from existing data. It can take 5–10 years to develop new data flows. This excludes relevant indicators for newly emergent issues, based on more recent scientific insights and political priorities. To furnish these flows often means breaking away from old data sets and collecting new data. If indicators can be selected only when there are existing data, a vicious circle ensues, blocking the desired evolution.

The root cause of this problem lies not just in changing data demands, inefficient data collection processes, and resource constraints but also in a lack of clarity on data needs in the first place. This has meant that demanding data collection processes have been set in train that limits future flexibility. Therefore, it is very important to get the conceptual understanding right about the phenomena to monitor and the indicators to use before invoking the data availability criterion.

Types of Indicators

Most existing sustainability indicators are quantitative. They are based on quantitative measurements of variables from which indicators and indices are derived. Some definitions of indicators actually include quantification as a defining characteristic of indicators alongside simplification and communication. This limitation of quantitative indicators can exclude significant factors or otherwise bias indicators of sustainability. Some relevant issues can be assessed only through qualitative measurement (e.g., social cohesion, happiness, or sense of place). The social sciences are generating qualitative indicators, such as through surveys that can be answered on scales ranging from "not happy–noncompliant–disagree" to "totally happy–compliant–agree." Integrating these data with quantitative data remains a critical methodological issue. What is important is that the feasibility and reliability criteria for indicators impose strict scientific quality standards regardless of the quantitative or qualitative nature of their underlying measurements.

Indicator presentation may also use qualitative representations such as smilies, barometers, and color coding to strengthen communication of the results. These qualitative outputs give an indicator value or direction and signal whether it is good or bad.

Where direct indicators do not exist, perhaps because of missing data or insufficient knowledge of interactions, proxy or substitute indicators are widely used. Proxy indicators usually are representations of complex systems and can be useful for communicating complex issues. Examples are greenhouse gas emissions instead of climate change, bird presence as a proxy for biodiversity, and GDP as a proxy for economic welfare. Although most proxy indicators do not comprehensively represent the issue, they will change with that issue and thus signal general trends. However, they are less suitable for identifying the precise dynamics of change and possible intervention points.

A few basic types of indicators or indices may be distinguished by their methods of construction and level of aggregation:

- *Indicator:* This includes results from the processing (to various extents) and interpretation of primary data. Examples include SO_2 emissions for a particular country per year and employment rates.
- *Aggregated indicator:* This combines, usually by an additive aggregation method, a number of components (data or subindicators) defined in the same units (e.g., tons, monetary units). Examples include material flow aggregates as domestic material consumption, the Living Planet Index, or the GDP.
- *Composite indicator:* This combines various aspects of a given phenomenon, based on a sometimes complex concept, into a single number with a common unit (e.g., years, hypothetical hectares). Examples include life expectancy and the Ecological Footprint.
- *Index:* This generally takes the form of a single dimensionless number. Indices mostly require the transformation of data measured in different units to produce a single number. Examples include the Human Development Index and Air Quality Index.

Assessment of Specific Indicators

The SCOPE review examined the specific features of indicators both in general terms and in terms of some of the more widely known or innovative indicator sets, frameworks, and individual indicators or indices. Special attention was devoted to the ways in which the following indicator approaches illustrated certain issues or challenges or represented the present state of the art in indicator development:

Commission on Sustainable Development indicator set (UNCSD 2001)
Millennium Development Goals (MDGs) indicators
UNEP Global Environment Outlook indicators
Structural indicators (European Commission)
Human Development Index (HDI)
United Kingdom Headline indicators
Material Flow Analysis–based indicators
Energy Flow Analysis–based indicators
Ecological Footprint
Living Planet Index
Environmental Sustainability Index (ESI)
Environmental Vulnerability Index (EVI)
Well-being of Nations
Biodiversity indicators
Driving force–Pressure–State–Impact–Response framework
Three-pillar versus four-pillar frameworks
Corruption Perception Index, Freedom Index
Well-being Index

Conclusions

What conclusions can be drawn from this review of the state of the art in indicator development for sustainability? There has been useful progress since the Rio Earth Summit in 1992 adopted Agenda 21 and launched an international indicator process. Many indicator sets have been assembled; countries have started their own indicator programs at the national level, as called for by the Commission on Sustainable Development; and many aspects of sustainability have been given a more precise definition or measure through indicators. Methods are gradually becoming standardized, and policy decisions increasingly provide clear directions and targets, as exemplified by the MDGs and their indicators. However, as the following chapters demonstrate, major conceptual challenges remain, methods need further development, and more must be learned about the most effective ways to influence policy. We are still far from fully integrated sets of indicators or indices to support self-regulating sustainability.

There is also at present no international strategy or clear future direction for indicators of sustainability, including its environmental, economic, and social dimensions, and no mechanism is providing international leadership in this area. Since the Rio Earth Summit launched the CSD indicator process, there has been a healthy multiplication of international initiatives, some intergovernmental but regional (Organization for Economic Co-operation and Development [OECD], EU, South Pacific Applied Geoscience Commission [SOPAC], EVI), but most nongovernment and academic (ESI, Ecological Footprint, Wealth of Nations, Living Planet Index). Some of these have been one-off efforts,

and others have continued without really becoming operational. The quality, often poor at first, has been slowly but steadily improving, with some of the latest versions such as the EVI and ESI launched in January 2005 being sufficiently good to earn some intergovernmental credibility and political momentum. The demand for indicators as status and performance measures relevant to international policy goals and targets will only increase. At some point, one or more appropriate indices will need to become institutionalized in some intergovernmental process to provide sufficient stability and credibility for widespread use by governments, but it is not clear how this will happen.

There are two options for the future of indicators of sustainability: letting the present anarchy continue until survival of the fittest prevails or implementing more strategic intervention and guidance of the process. The former might lead to the survival of the financially and politically strongest rather than the scientifically most appropriate, with a bias toward the wealthiest countries. It would be in the interest of the international community to try to make the process more balanced and objective by giving it some direction or leadership.

Governments need to buy into this process, but this is politically perilous because a good index makes some countries look bad, and no leader likes that. Country rankings do attract the attention of political leaders and can motivate governments to do something about the problems uncovered. Such indicators bring to the public sector a little of the competitive spirit that helps make the business sector more efficient. However, only UN bodies have the strength and universality to ensure that scientific credibility and objectivity win out over political expediency, as the United Nations Development Program (UNDP) has demonstrated with the HDI. The process still needs to be designed with care, perhaps with an ongoing dialogue with government experts to breed familiarity before the process becomes too political.

There is a vacuum in this area at the moment. Indicators are not a visible part of the CSD extended work program. There has been some acceptance in the UN of the work on economic vulnerability indices, but more could be done on long-term economic sustainability measures. UNEP might logically lead on the environmental side, but the principal environmental sustainability and vulnerability indices are outside UNEP and gaining their own momentum and acceptance. There is still a big gap on the social indicator side, with no adequate measures of social resilience or sustainability despite some work in Latin America. The work on indicators should also be linked more closely to the global observing systems and the Global Earth Observation System of Systems process, which could generate new global data sets. Some combination of indices, appropriately harmonized for complementarity while responding to relevant policy mandates, may be most appropriate. At a minimum, sustainability indicator activities should be the subject of regular informal consultations among the UN partners most concerned.

The most important message from this assessment probably is that progress is sufficient to apply indicators now at the national level and make international comparisons in support of sustainability goals and targets. What is needed is not a fixed approach to

be applied everywhere but a process of adaptive implementation, with indicators evolving as the science of integrated indicators, frameworks, and models advances. We need to learn by doing. Each country or institution should select indicators and approaches suited to its needs, priorities, and means and use them to guide policy and action toward sustainable development. This is the only way to ensure a more equitable and sustainable society for future generations.

Appendix 1.1. Comments on selected indicators, indices, and indicator sets.

During the deliberations of the working groups, several categories of concrete indicators were assessed. Some of them were discussed by all three working groups, some by only one or two of them. There was no attempt to reach a final authoritative opinion on any indicator or indicator set, but many useful comments were made. Here we summarize the results of the groups' discussions. We present opinions that did not encounter any serious objections. References and contacts for the presented indicators can be found in the Annex.

Title, Type, and Source of the Indicator or Set	Description	Comments
Corruption Perceptions Index (CPI) *An index developed by Transparency International (TI)*	The TI CPI ranks countries based on experts' perception of corruption (CPI sources are surveys). It measures the overall extent of corruption (frequency and amount of corruption) in the public and political sectors. CPI ranks a record 146 countries.	• Focuses on corruption in the public and political sector (corruption means the abuse of public office for private gain). • Sources do not distinguish between administrative and political corruption or between petty and grand corruption.
Dashboard of Sustainability (DS) *An indicator software tool developed by the European Joint Research Center in Ispra*	The DS presents complex relationships between economic, social, and environmental issues in a highly communicative format aimed at decision makers and citizens interested in sustainable development. It contains various indicator sets, including the UNCSD and MDG sets.	• A tool, not an indicator itself. • Allows various aggregation mechanisms. • User friendly. • Includes statistical tools for testing simple hypotheses. • Attractive design. • Allows good links between pillars.

Appendix 1.1. Comments on selected indicators, indices, and indicator sets (*continued*).

Title, Type, and Source of the Indicator or Set	Description	Comments
Ecological Footprint (EF) *A composite indicator introduced by Redefining Progress*	The EF is the corresponding area of productive land and aquatic ecosystems needed to produce the resources used and assimilate the wastes produced by a defined population at a specified material standard of living, wherever on Earth that land may be located. Thus EF is a measure of the load imposed by a given population on nature.	• Deals with important aspects of sustainability (carrying capacity, overconsumption, and biocapacity) but covers only the environmental pillar. • High level of aggregation (underlying information is less accessible). • The methods are not unified. • Data quality varies across indicators and countries. • Used mainly at the national level but can be applied at any scale, including individuals. *Global targets included.* • Used by the scientific community and the media. • Strongly communicative on public and policy levels (raises public awareness efficiently). • Low global and supranational policy relevance but stronger at local level. • Uses ranking. • Communicates the urgency of environmental sustainability, emphasizing effects of exported impacts.

Appendix 1.1. Comments on selected indicators, indices, and indicator sets (*continued*).

Title, Type, and Source of the Indicator or Set	Description	Comments
Economy-wide material flow indicators *A framework of aggregated pressure indicators standardized by Eurostat*	The material flow indicators are based on economy-wide material flow analysis, which quantifies physical exchange between the national economy, the environment, and foreign economies on the basis of total material mass flowing across the boundaries of the national economy	• Focuses on the environmental pillar (use of natural resources). • Used for different scales (supranational, national, local). • Methods discussed by scientific community. • Highly aggregated indicators. • Data quality differs between indicators. • No ranking, but possible to find clusters of countries. • Likely to be long-lived.
European Environment Agency (EEA) core set indicators *A set of environmental indicators developed by the EEA*	In early 2004 the EEA proposed its core indicator set. These indicators aim to cover the entire environmental pillar of sustainable development. Indicators are sorted into 10 subgroups: climate change, fisheries, water, agriculture, energy, transport, biodiversity, waste, air pollution, and terrestrial.	• EEA core set will be internationally evaluated (based on 11 criteria such as data availability, timeliness, and representativeness). • A standard set of environmental indicators. • Some important issues are not covered: forests (both healthy and cut), soil (erosion, desertification), and material flows.

Appendix 1.1. Comments on selected indicators, indices, and indicator sets (*continued*).

Title, Type, and Source of the Indicator or Set	Description	Comments
Environmental Sustainability Index (ESI) *An index developed by the Yale Center for Environmental Law and Policy and the Center for International Earth Science Information Network (CIESIN) at Columbia University*	The ESI is an aggregated index capturing the environmental dimension of sustainability. It is based on a set of 21 core indicators, each of which combines 3–6 variables for a total of 76 underlying variables.	• High aggregation. • Covers environmental domain of sustainable development. • Arbitrarily selected variables. • Mix of variables and components from different parts of causal chain. • Good communication tool, has media attention. • Reliability is lessened by flaws in international databases. • No attempt to capture linkages.
Eurostat sustainable development indicators *A set of sustainability indicators developed by Eurostat*	The set contains 63 indicators, of which 22 are mainly social, 21 are mainly economic, and 16 mainly environmental. This list is structured along a more policy-oriented classification than the previous one, according to the relevant sustainability dimensions (4), themes (15), and subthemes (38).	• The set draws on and extends the UNCSD list of 58 core sustainable development indicators (more than 66% of the indicators are comparable with those in the UNCSD core list). • Driven by data available at European level. • Based on the existing work on pressures and sectoral indicators. • No major policy impact so far (structural indicators receive more attention); work is under way.

Appendix 1.1. Comments on selected indicators, indices, and indicator sets (*continued*).

Title, Type, and Source of the Indicator or Set	Description	Comments
Freedom in the World *An index developed by Freedom House*	Freedom in the World is the annual comparative assessment of global political rights and civil liberties. The survey includes both analytical reports and numerical ratings for 192 countries and 14 territories.	• Measures freedom according to two broad categories: political rights and civil liberties. • The survey method establishes universal standards that are derived in large measure from the Universal Declaration of Human Rights. • An element of subjectivity is inherent in the survey findings. • Assists policymakers, the media, and international organizations in monitoring trends in democracy and tracking increases and decreases in freedom worldwide. • No use of targets and ranks.
Global Environmental Outlook (GEO) indicators *A set of indicators highlighting key global and regional environmental issues, developed by UNEP*	A set of 18 indicators first published in the *GEO Year Book* in 2003. They highlight some of the key global and regional environmental issues and trends identified in GEO reports. Indicators are structured along the following themes: • Atmosphere • Natural disasters • Forests • Biodiversity • Coastal and marine areas • Freshwater	• Provides an annual overview of major environmental changes. • Availability of reliable, up-to-date global data sets still limits the choice. • The indicators are not very well balanced: too many indicators on climate change relative to other priority areas, and some important issues are missing; no indicators on urban issues; no land indicator besides forest cover; no

Appendix 1.1. Comments on selected indicators, indices, and indicator sets (*continued*).

Title, Type, and Source of the Indicator or Set	Description	Comments
	• Global environmental issues	direct climate measures; water quality is not measured; no indicator on use of chemicals (an index of land use combining forest, cropland, and urban land use might usefully be included). • Two or three indicators per issue would be desirable (or just one indicator per issue; this would entail using aggregated indicators). • No framework, therefore not very useful for policy guidance.
Human Development Index (HDI) *An index developed by UNDP*	The HDI is a composite index that measures a country's average achievements in 3 basic aspects of human development (quality of life): longevity, knowledge, and a decent standard of living, measured by income.	• Integrates a small number of variables to keep the indicator simple. • High data quality and reliability. • Used for national level. • No use of targets. • Neglects environmental issues. • One easy-to-communicate number. • Frequently used by developing country governments.
Indicators to measure decoupling of environmental pressure from economic growth *Set of sustainable development indicators developed by the OECD*	The set comprises 31 indicators covering a broad spectrum of environmental issues such as climate change, air pollution, water quality, waste disposal, material use,	• Shows linkages between environmental and economic pillars. • Plots environmental parameters against economic parameters (GDP).

Appendix 1.1. Comments on selected indicators, indices, and indicator sets (*continued*).

Title, Type, and Source of the Indicator or Set	Description	Comments
	and natural resources. They aim at measuring and plotting the decoupling of environmental pressure from economic growth.	• Used for different scales (national, sectoral). • Aggregated as well as headline indicators. • Data quality varies across indicators and countries. • Uses ranking. • Issue of decoupling highly policy relevant.
Living Planet Index (LPI) *An aggregated indicator promoted by the World Wildlife Fund*	The LPI is an indicator of the state of the world's biodiversity. It measures trends in populations of vertebrate species living in terrestrial, freshwater, and marine ecosystems around the world. The LPI is the average of 3 separate indices measuring changes in abundance of 555 terrestrial, 323 freshwater, and 267 marine species around the world.	• LPI includes national and global data on human pressures on natural ecosystems arising from the consumption of natural resources and the effects of pollution. • All three individual components are given an equal weighting. • Appropriate for respective countries. • Participatory process. • Simple, appealing, and measurable (measures changes in species abundance).
Millennium Development Goals (MDGs) *A set of goals commonly accepted as a framework for measuring development progress, developed by the UN*	MDGs grew out of the agreements and resolutions of world conferences organized by the UN in the past decade. The goal is to assist in achieving significant, measurable improvements in	• Under the goal "ensure environmental sustainability," 3 targets and concrete indicators (e.g., forest areas, protected areas, energy sources, CO^2 emissions) are defined.

Appendix 1.1. Comments on selected indicators, indices, and indicator sets (*continued*).

Title, Type, and Source of the Indicator or Set	Description	Comments
	people's lives in 8 areas: poverty, education, gender equality, child mortality, maternal health, HIV and AIDS, other diseases, environment, and global partnership. The first 7 goals are mutually reinforcing and are directed at reducing poverty in all its forms. The last goal, global partnerships for development, is about the means to achieve the first 7.	• Environmental target indicators are not directly related to sustainability (e.g., land covered by forest is a poor proxy indicator for degradation of the terrestrial environment). • MDG set uses existing data sets. • Not picked up by scientific community (no challenging methodological issues). • Media attention is growing. • Not appropriate for communicating sustainability.
OECD core environmental indicators (CEI) *One of the indicator sets developed by OECD*	This set of indicators helps track environmental performance and progress toward sustainable development in this domain. It is based on the Pressure-State-Response (P-S-R) framework and covers 15 major issues (e.g., biodiversity, climate). It contains about 50 indicators. CEI can be disaggregated at the sectoral level (SEI) or territorial level (TEI).	• Covers mostly environment. • Uses some less sensitive indicators. • Used for influencing environmental policy. • Helpful for state reporting and national comparison. • Good coverage of links. • Does not include developing countries. • Widely used by organizations and the scientific community. • Part of a greater framework.

Appendix 1.1. Comments on selected indicators, indices, and indicator sets (*continued*).

Title, Type, and Source of the Indicator or Set	Description	Comments
Structural indicators *A set of indicators developed by Eurostat for the European Council*	The agreed set is to support assessment of annual progress by the EU member states in the *Synthesis Report*. Originally 35, then 42 indicators are organized along 5 policy domains: employment, innovation, economic reform, social cohesion, and environment and economic background indicators. In 2004 the set was shortened to 14 indicators.	• The indicators are by definition macro-level and performance-oriented indicators, focused on short-term development. • Purpose: comparison between countries, primarily on regional, social, and economic development. • High focus on employment issues. • Only one true environmental indicator. • No attempt to capture linkages. • Uses national data. • Good at present state and trends over time. • Might be meaningful to the private sector.
UNCSD indicators *Set (theme indicator framework) of sustainable development indicators developed by UNCSD*	The set comprises 58 indicators organized according to sustainable development dimensions and themes (e.g., education, atmosphere, economic performance). The set aims at covering sustainable development as a whole, addressing all 4 dimensions of sustainability.	• Covers all important aspects of sustainability but fragmented, no integration or linkages. • Top-down (closed) process, weak public participation. • Aggregated and headline indicators. • Data quality varies across indicators and countries. • Used for national level. •No use of targets and ranks. • Weak policy impact globally. • Likely to be supplanted by MDGs.

Appendix 1.1. Comments on selected indicators, indices, and indicator sets (*continued*).

Title, Type, and Source of the Indicator or Set	Description	Comments
Well-being Index (barometer of sustainability) *An index introduced and published by IUCN*	It combines 36 indicators of health, population, wealth, education, communication, freedom, peace, crime, and equity into a human well-being index and 51 indicators of land health, protected areas, water quality, water supply, global atmosphere, air quality, species diversity, energy use, and resource pressures into an ecosystem well-being index. The two indices are then combined into a Well-being/Stress Index that measure how much human well-being each country obtains for the amount of stress it places on the environment.	• Applies a concept of equal treatment of people and ecosystems; very illustrative symbols of the egg with its yolk (human) and white (ecosystem). • Relative scaling of results is used in the framework of sustainability (bad, poor, medium, fair, good); scaling of each indicator was affected by international standards, targets, expert opinion). • Target value for each component is set but is biased by specific development concept. • Results are user-friendly; indices are presented as a barometer of sustainability; both barometer and maps are easy to read. • Majority of indicators are based on existing and regularly updated sources (some elements are just theoretical and data are missing, e.g., shelter, culture, seawater). • Top-down process, isolated methods.
Environmental Vulnerability Index (EVI) *An index developed by SOPAC*	The EVI combines 50 indicators, each related to sustainability thresholds, to produce country profiles of	• Measures vulnerability and resilience of environmental systems. • Includes reference values.

Appendix 1.1. Comments on selected indicators, indices, and indicator sets (*continued*).

Title, Type, and Source of the Indicator or Set	Description	Comments
	the resilience and vulnerability of environmental systems and resources. Indicators for weather and climate, geology, geography, resources and services, and human population are also used to generate subindices for climate change, natural disasters, biodiversity, desertification, water, agriculture and fisheries, and human health.	• Created by developing country organization with wide consultation and country participation. • Country profiles useful guide to priority setting and policy action. • Covers only environmental vulnerability; similar indices needed for social and economic vulnerability.

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PART I
Cross-Cutting Issues