Sustainable Development for Engineers

A Handbook and Resource Guide

Edited by
Karel Mulder
Delft University of Technology,
The Netherlands

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6 Measuring sustainability

This chapter outlines how sustainability can be measured. The complexities involved in measuring changes in social, natural and economic capital are enormous and there is no unique standardised method for measuring sustainability. Various measuring methods have been proposed. However, it is possible to detect some common features, which all have their origin in the UN Conference on Environment and Development held in Rio de Janeiro in 1992.[1]

Perspectives on sustainability differ in regard to the relationship between human development and nature. To measure sustainability, it is necessary to integrate spheres that have traditionally been measured separately.

The main objective of measuring sustainability is frequently to monitor the evolution of variables and indicators over time. In this way, we can understand where we are and where we are going. It helps us to choose targets for the future and to determine how far we are from where we want to arrive.

Comparison between countries or regions is also important. Indicators and indexes help to identify problem areas and to establish the path to find solutions.

To measure sustainability it is necessary to have:

- An appropriate methodological framework
- Contrasting and trustworthy data
- A strategy of appropriate communication
- A system of permanent evaluation

1 This conference is also known as the Earth Summit.

General principles

Sustainable development is not something that is achieved in a passive way. Decisions must be taken and strategies defined in order to establish a certain route for development. It is necessary to adopt a specific course of action, which has to be communicated to a range of actors. Those such as regional authorities or city councils should be able to monitor their problems and their progress towards solutions in order to make decisions.

It is important that decision-making is based on accurate information. To achieve this, it is necessary to create an information system that integrates the principles and approaches of sustainable development. The information that is generated by these systems must be easily accessible in order to facilitate public participation.

Due to the complexity of sustainable development, such information systems can never provide a complete overview of all its relevant aspects. Moreover, too much information can create an 'information overflow' for decision-makers. To reduce this complexity, indicators are needed that give an overview of specific segments of reality.

Strategies for measuring sustainability should be able to:

- Monitor the dynamics of problems
- Evaluate the consequences of proposed solutions

In this way, information systems can form the basis for a more appropriate method of taking decisions.

Indicators and indexes

Words such as index and indicator are often used interchangeably. This gives rise to interpretation errors. We define a **variable** as those characteristics of a system that can be measured.

Indicators represent a specific phenomenon that cannot be measured directly. They are obtained by the combination of different variables (e.g. energy intensity as energy consumption per capita, etc.). They should generally give enough information for a subjective evaluation of the problem. This evaluation is usually made by comparing the value of the indicator with a threshold value.

> Indicators are constituted to facilitate the process of decision-making. They help to measure and to gauge the progress toward the goals of sustainable development. On the other hand, they can be constituted as warning signals that prevent social, environmental and economic damages.[2]

2 United Nations, *Indicators of Sustainable Development: Framework and Methodologies* (9th session of the Commission on Sustainable Development held in New York, 16–27 April 2001; New York: United Nations Publications, 2nd edn, 2001); www.un.org/esa/sustdev/natlinfo/indicators/indisd/english/english.htm, 10 November 2005.

Indexes are values that communicate overall information on a specific problem. They are obtained by aggregating various indicators or variables that are assumed as components of the phenomenon under study. The indicators and/or variables are often weighted to create the index.

A life-cycle assessment (LCA; see Chapter 8) is an example of a product-related index.

Sustainability indicators

Sustainability indicators are tools that communicate information of a complex phenomenon such as gross domestic product (GDP), emissions of carbon dioxide (CO_2) per person, etc. They can be calculated per period and/or per area and allow one to evaluate the progress of a region/city/country towards a specific goal.

To allow policy assessments, it must be clear which value of the indicator is more or less desirable.[3] This requires a gradient that can have different forms:

- **Nominal scales** consist of only two values such as yes/no. Nominal scales provide little meaningful information, but are easy to agree on in case of controversial themes. For example, whereas the effectiveness of a national sustainability council may be questionable, their existence is easy to report
- **Ordinal scales** are based on a hierarchy of qualitative states, e.g. the quality of training of personnel, the transparency of decision-making processes or the possibilities for public participation in them. To apply these scales properly, the hierarchy has to be made explicit and the relative distances between the different classes defined. However, these distances are often based on value judgments and not easily agreed on
- **Cardinal scales** give quantitative information. If sustainable development goals are linked to a quantitative target, the distance towards this goal can be measured. Such indicators are called 'performance indicators'. To derive the scales, quantified targets have to be agreed on

Cardinal performance indicators are preferred, with ordinal indicators providing an alternative. In general, indicators have to be:

- **General**, i.e. not dependent on a specific situation, culture or economic organisation

3 Sustainable Europe Research Institute (SERI); www.seri.de, 10 November 2005.

- **Indicative**, i.e. truly representative of the phenomenon intended to be characterised
- **Sensitive**, i.e. they have to respond early and clearly to changes in what they are monitoring
- **Robust**, i.e. with no significant changes in case of minor changes in the methodology or improvements in the database

Sustainable development indicators need a benchmark (sustainable value) that gives an objective. The assessment process can then begin, in which sustainable and unsustainable tendencies are measured.

The process of information collection for decision-making is summarised in Figure 6.1.

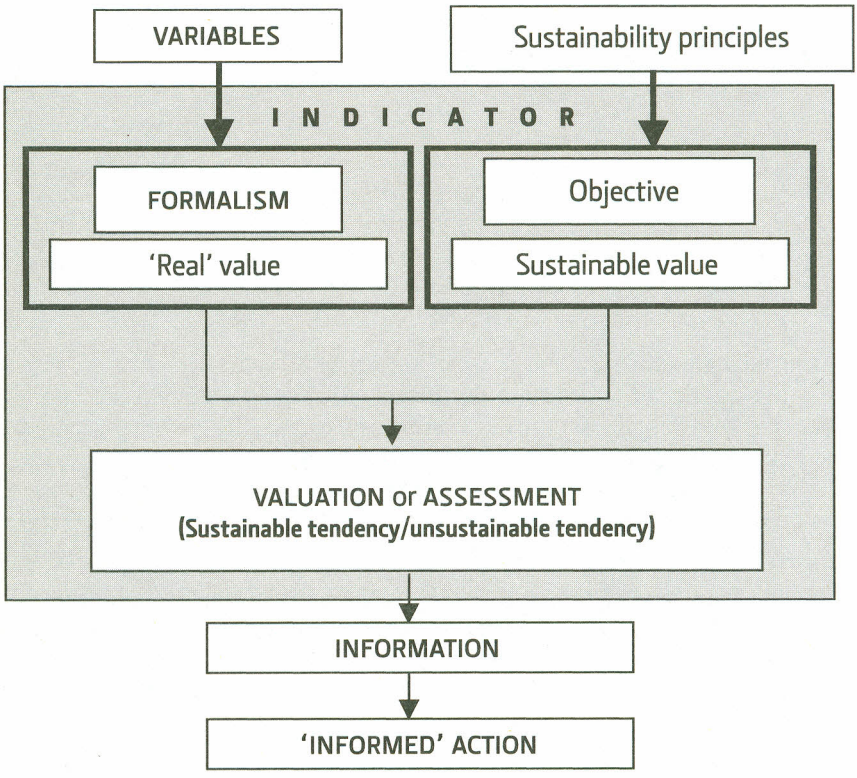

FIGURE 6.1 Information collection for decision-making

The Bellagio Principles

In November 1996, the International Institute for Sustainable Development (IISD) developed a set of principles to measure sustainable development known as the Bellagio Principles (Figure 6.2). These aim to assess progress towards sustainable development.

Methodological frameworks

Sustainable development indicators are generally presented in structured tables. The purpose is to articulate a coherent framework that facilitates the visualisation of the information. The use of frameworks is indispensable for a correct application of a group of indicators.[4]

There is currently no one universal framework that offers concrete rules regarding design, selection or development of indicators. Various factors (e.g. developed or developing country) determine the visualisation of reality and the scales of application of the indicators (local, regional, national, global, etc.). Major frameworks include: [5]

- Integrated national environmental–economic accounting systems or other national accounts-based recordings of stocks and flows of natural resources and environmental services—in most cases expressed in monetary terms
- Environmental statistics that list statistical variables in a systematic manner without establishing functional relationships among those variables
- Ad hoc environmental indicators using selected 'themes', 'issues' or 'subsystems' of models
- Overall policy frameworks or conventions, which were not designated for data collection but reflect the concerns to be monitored (e.g. Agenda 21)

4 United Nations Environment Programme (UNEP) and Department for Policy Coordination and Sustainable Development (DPCSD), 'The Role of Indicators in Decision-Making', joint paper by UNEP and the UN Division for Sustainable Development, DPCSD, presented at an International Workshop on Indicators of Sustainable Development for Decision-Making held 9–11 January in Ghent, Belgium (The Ghent Report; Geneva: UNEP, 1995): 6.

5 See G.C. Gallopin, 'Indicators and their Use: Information for Decision-making', in B. Moldan and S. Billhartz (eds.), *Sustainability Indicators: Report on the Project on Indicators of Sustainable Development* (Scientific Committee on Problems of the Environment (SCOPE) Report 58; Chichester: John Wiley, 1997): 13-27; www.icsu-scope.org/downloadpubs/scope58/ch01-introd.html, 10 November 2005.

1. Guiding vision and goals

Assessment of progress toward sustainable development should be guided by a clear vision of sustainable development and goals that define that vision.

2. Holistic perspective

Assessment of progress toward sustainable development should:

- Include review of the whole system as well as its parts
- Consider the well-being of social, ecological, and economic sub-systems, their state as well as the direction and rate of change of that state, of their component parts, and the interaction between parts
- Consider both positive and negative consequences of human activity, in a way that reflects the costs and benefits for human and ecological systems, in monetary and non-monetary terms

3. Essential elements

Assessment of progress toward sustainable development should:

- Consider equity and disparity within the current population and between present and future generations, dealing with such concerns as resource use, over-consumption and poverty, human rights, and access to services, as appropriate
- Consider the ecological conditions on which life depends
- Consider economic development and other, non-market activities that contribute to human/social well-being

4. Adequate scope

Assessment of progress toward sustainable development should:

- Adopt a time horizon long enough to capture both human and ecosystem timescales, thus responding to needs of future generations as well as those current to short-term decision-making
- Define the space of study large enough to include not only local but also long-distance impacts on people and ecosystems
- Build on historic and current conditions to anticipate future conditions—where we want to go, where we could go

5. Practical focus

Assessment of progress toward sustainable development should be based on:

- An explicit set of categories or an organising framework that links vision and goals to indicators and assessment criteria

FIGURE 6.2 The Bellagio Principles (continued opposite)

Source: www.iisd.org/measure/principles/bp_full.asp, 10 November 2005

- A limited number of key issues for analysis
- A limited number of indicators or indicator combinations to provide a clearer signal of progress
- Standardising measurement wherever possible to permit comparison
- Comparing indicator values to targets, reference values, ranges, thresholds, or direction of trends, as appropriate

6. Openness

Assessment of progress toward sustainable development should:

- Make the methods and data that are used accessible to all
- Make explicit all judgements, assumptions and uncertainties in data and interpretations

7. Effective communication

Assessment of progress toward sustainable development should:

- Be designed to address the needs of the audience and set of users
- Draw from indicators and other tools that are stimulating and serve to engage decision-makers
- Aim, from the outset, for simplicity in structure and use of clear and plain language

8. Broad participation

Assessment of progress toward sustainable development should:

- Obtain broad representation of key grass-roots, professional, technical and social groups, including youth, women and indigenous people—to ensure recognition of diverse and changing values
- Ensure the participation of decision-makers to secure a firm link to adopted policies and resulting action

9. Ongoing assessment

Assessment of progress toward sustainable development should:

- Develop a capacity for repeated measurement to determine trends
- Be iterative, adaptive, and responsive to change and uncertainty because systems are complex and change frequently
- Adjust goals, frameworks, and indicators as new insights are gained
- Promote development of collective learning and feedback to decision-making

10. Institutional capacity

Continuity of assessing progress toward sustainable development should be assured by:

- Clearly assigning responsibility and providing ongoing support in the decision-making process
- Providing institutional capacity for data collection, maintenance and documentation
- Supporting development of local assessment capacity

The main framework models for the integration, design and presentation of indicators are described below.

PSR and DPSIR models

The Pressure–State–Response (PSR) framework model is used by international institutions—especially the Organisation for Economic Co-operation and Development (OECD).[6] The indicators are structured according to three basic categories (Figure 6.3).

- **Pressure** refers to human activity that creates some type of pressure on natural systems such as emissions of greenhouse gases, production of waste, etc.
- **State** refers to the changes in the quality and in the quantity of natural resources, and the measure of these changes evaluated in a certain period of time. This gives us the 'state' of the natural system. Examples of state indicators include global mean temperature, threatened species and concentrations of substances
- **Response** refers to the answer in terms of policies or specific actions that were taken as a response to changes detected in the natural system such as recycling rates, international commitments, etc.

As well as the OECD, the PSR model and its variants have been used by other institutions including the United Nations Commission on Sustainable Development (UNCSD),[7] Eurostat[8] and the European Environment Agency.[9]

However, the PSR model has a number of disadvantages:

- It is focused on environmental issues
- It tends towards a linear visualisation
- It is focused on processes of tension (decline of forests, climate change, etc.), which tends to lead to the development of fundamental options for remedy
- It tends to work back from the requested state without taking external developments into account

An enlarged version of this model is called DPSIR (Driving forces–Pressure–State–Impact–Response). It widens the PSR framework by adding the Driving forces of Pressure and Impacts of state on society (Figure 6.4).

6 www.oecd.org, 10 November 2005.
7 www.un.org/esa/sustdev/csd/csd.htm, 10 November 2005.
8 Statistical Office of the European Communities; europa.eu.int/comm/eurostat, 10 November 2005.
9 www.eea.eu.int, 10 November 2005.

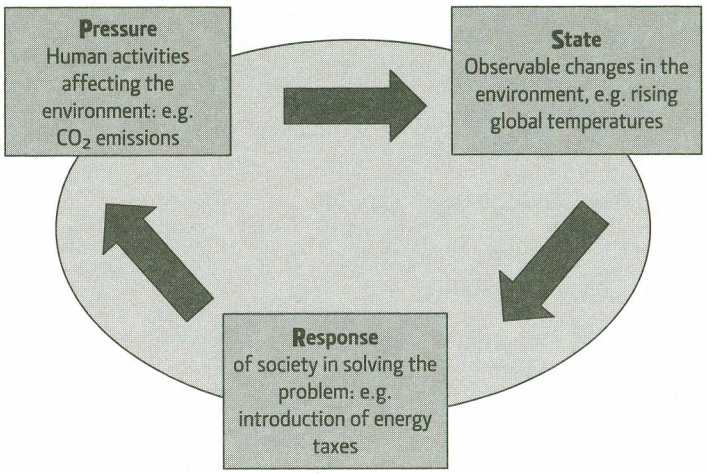

FIGURE 6.3 PSR model

Source: Eurostat

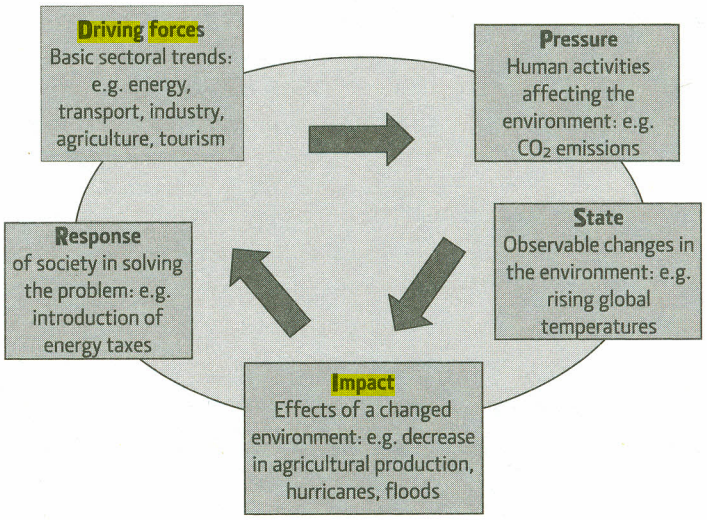

FIGURE 6.4 DPSIR model

Source: Eurostat

Hierarchy model based on principles and objectives

One possibility is to introduce a hierarchy that leads from a general objective to more specific principles and criteria to indicators. In this way, the resulting set of indicators can be divided into modules that refer to the same sustainability principle such as:

- Sustainable economic development
- Eco-efficiency
- Sustainable use of resources
- Precautionary principle

Figure 6.5 shows such a model.

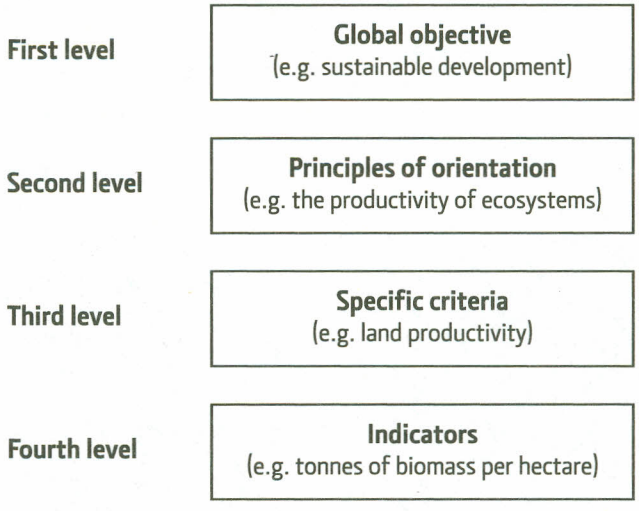

FIGURE 6.5 Hierarchical model

Source: modified from R. Quiroga, *Indicadores de Sostenibilidad Ambiental y Desarrollo Sostenible: Estado del arte y perspectivas* (Serie Manuales CEPAL; UN, 2001)

Framework of themes and sub-themes

This framework, which was drawn up by the UN World Commission on Sustainable Development (CSD), recognises four key dimensions of high priority:

- Environmental
- Social
- Economic
- Institutional

Each of these dimensions is divided into themes and sub-themes that reflect the main priorities established in the chapters of Agenda 21.[10] Finally, each sub-theme leads to one or more indicators (Figure 6.6). The set of indicators obtained presents the four dimensions, 15 themes and 38 sub-themes (Table 6.1).

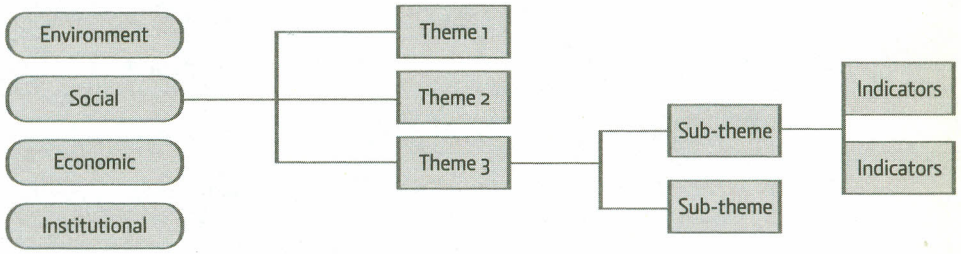

FIGURE 6.6 **CSD framework**

We are seeking indicators that reflect how well basic needs are satisfied under given circumstances. There are various ways of determining fundamental environmental properties.

In physical environments, we can analyse the physical signals we receive, e.g. using various instruments. Six fundamental properties of relevance are found (Figure 6.7).

As an example, let us examine these properties for a family:

- **Normal environmental state.** A family living in a small town in a European country has to deal with specific economic, social, cultural, legal and political environments that are different from those in, say, India
- **Resource scarcity.** The family needs money, water, food, electricity, consumer goods, medical services, sanitation, etc., all of which can be secured only with considerable effort
- **Variety.** The family has to exist in an environment containing a host of very different actors and factors, e.g. neighbours, friends,

10 Adopted at the Earth Summit in 1992; www.un.org/esa/sustdev/documents/agenda21/index.htm, 10 November 2005.

SOCIAL DIMENSION

Themes	Sub-themes
Justice	• Poverty • Equity
Health	• Nutritional state • Mortality • Sanitation • Drinking water • Health benefits
Education	• Educational level • Illiteracy
Housing	• Living conditions
Security	• Crime
Population	• Population dynamics

ENVIRONMENTAL DIMENSION

Themes	Sub-themes
Atmosphere	• Climate change • Ozone layer • Air quality
Land	• Agriculture • Forests • Desertification • Urbanisation
Oceans and coasts	• Coastal areas • Fisheries
Freshwater	• Water quantity • Water quality
Biodiversity	• Ecosystems • Species

INSTITUTIONAL DIMENSION

Themes	Sub-themes
Institutional framework	• Strategies for sustainable development • International co-operation
Institutional capacity	• Access to information • Communications infrastructure • Science and technology • Preparation for, and aid capacity in natural disasters

ECONOMIC DIMENSION

Themes	Sub-themes
Economic structures	• Economic development • Trade • Finance
Patterns of consumption and production	• Energy use • Production and management of waste • Transport

TABLE 6.1 CSD themes and sub-themes

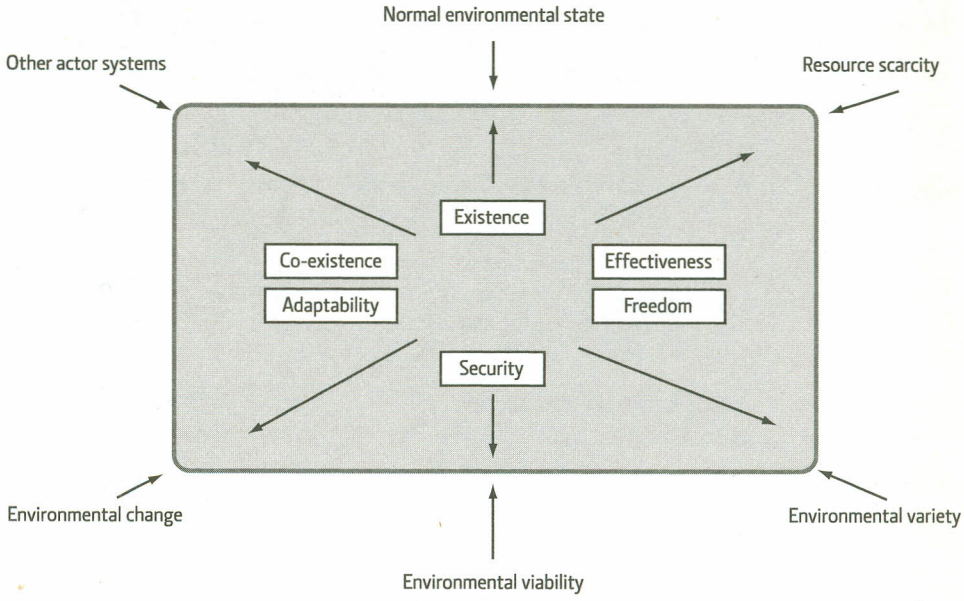

FIGURE 6.7 Fundamental properties of system environments and their basic orienting counterparts in systems

bosses, colleagues, authorities, different shops and a multitude of social and cultural offerings

- **Variability.** The variety also changes rapidly—a new neighbour moves in, members of the family become ill, change their friends, lose their jobs, or have to move
- **Change.** There is not only normal variability. Economic and social conditions can change and new technologies can become available in the house and the workplace
- **Other systems.** The family has to care for their pets and ageing parents and accommodate the interests of an employer, neighbours or other drivers in traffic

Measurement tools

How are aspects of sustainable development measured? LCA is especially targeted at products and is therefore discussed in combination with product

Orientor	System performance	Possible indicators
Existence	Is the system compatible with and able to exist in its particular environment?	Availability of shelter, clothing, food, water, sanitation, life expectancy
Effectiveness	Is it effective and efficient?	Work hours necessary for life support, efficiency of resource use
Freedom of action	Does it have the necessary freedom to respond and react as needed?	Income level, job opportunities, health, mobility
Security	Is it secure, safe and stable?	Safe neighbourhood, savings, insurance, social security scheme
Adaptability	Can it adapt to new challenges?	Education and training, flexibility, cultural norms
Co-existence	Is it compatible with interacting sub-systems?	Social skills, compatibility of language and culture
Psychological needs	Is it compatible with psychological needs and culture?	Emotional stress, anxiety, dissatisfaction, family quarrels

TABLE 6.2 Finding indicators for the viability of a family

design in Chapter 8. In this section, we examine the ecological footprint method and visual representation methods.

Ecological footprint

One of the best-known sustainable development indicators is the ecological footprint. This method produces an index that gives a quantitative reference of the way of life of a (certain group of) person(s), a region or a country.[11]

This index is not measured in monetary units, but in surface area. The ecological footprint is the quantity of land that a person needs, directly or indirectly, to:

- Consume products and services
- Produce resources and assimilate waste

11 W. Rees and M. Wackernagel, *Our Ecological Footprint: Reducing Human Impact on the Earth* (Gabriola Islands, BC: New Society Publishers, 1996).

This in turn means the land needed to produce the food and the materials for housing, buildings, roads, infrastructure and the trees that regenerate the CO_2 produced by burning fossil fuels.

The name 'ecological footprint' therefore refers to the land area that people, a country, a region or a city would use if they were sustainable.

The ecological footprint is the inverse concept of the carrying capacity of a region. The carrying capacity measures the quantity of people that can live within the given area, whereas the ecological footprint measures the quantity of land that a given group of people needs to live.

The size of the ecological footprint depends on a number of factors, including:

- The development and lifestyle of the subject
- The quantity of utilised resources
- The utilised technology
- Social and economic organisation

It would be desirable that the ecological footprint of a country should not surpass its territory. In that case, the country could provide for itself in a sustainable way (including trade).

Regrettably, many countries—most of them industrialised—have a much larger ecological footprint than their own territory. They consume many imported resources. An extreme example is the Netherlands, which has an equivalent footprint of 15 times its territory. This is caused by the high population density combined with high oil consumption and major food imports such as soy fodder for pig farming. Japan's ecological footprint also greatly exceeds its territory.

In a symmetrical way, many developing countries have much smaller ecological footprints than their territory; they do not exploit all their territory and they export many of the resources that they produce.

Table 6.3 shows the ecological footprints of various countries. The mean world ecological footprint per person is 2.8 hectares. This is much more than the area available given the bio-capacity of the Earth. The area that we use is larger than future generations will have. In other words, the ecological footprint indicates that the current way of living is not sustainable.

However, using the ecological footprint as an indicator has some disadvantages:

- The calculation of the area of the ecological footprint is not accurate because it is impossible to make an exhaustive list of the various ways in which we use the Earth
- Not all social costs are included in the indicator. For example, replacing monuments in overcrowded cities such as Gaudi's famous cathedral, the Sagrada Familia, in Barcelona with trees would reduce the ecological footprint, but it is not desirable

Country	Ecological footprint per capita (ha)
USA	10.3
Australia	9.0
Canada	7.7
Russia	6.0
Sweden	5.9
Germany	5.3
Netherlands	5.3
Great Britain	5.2
Belgium	5.0
Japan	4.3
Italia	4.2
Austria	4.1
France	4.1
Spain	3.8
Portugal	3.8
Venezuela	3.8
Brazil	3.1
Thailand	2.8
México	2.6
Chile	2.5
Turkey	2.1
Colombia	2.0
Peru	1.6
Nigeria	1.5
China	1.2
Egypt	1.2
Ethiopia	0.8
India	0.8
Pakistan	0.8
Bangladesh	0.5
Mean world ecological footprint	2.8
Available bio-capacity	1.7

TABLE 6.3 World ecological footprint, 1997

Source: M. Wackernagel, N. Chambers and C. Simmons, *Sharing Nature's Interest: Ecological Footprints as an Indicator of Sustainability* (London: Earthscan, 2000)

- The ecological footprint is a 'reductionist' indicator. A single indicator (money or area) cannot describe everything. It is necessary to use multiple approaches

Visual tools: the Dashboard and the Compass

A number of visual tools have been developed to measure sustainability. Two of the most important are:

- Dashboard of Sustainability[12] developed by the IISD
- Compass Index of Sustainability[13] developed by AtKisson Group

Dashboard of Sustainability

The Dashboard of Sustainability is an online tool that visualises the performance for sustainable development and helps politicians or citizens to make decisions.[14] The software provides a user-friendly format that allows people to compare the sustainability performance of countries, regions and communities.

The Dashboard is based on the UNCSD methodological indicators framework, divided into 19 social, 20 environmental, 14 economic and 8 institutional indicators (Figure 6.8).

Compass Index of Sustainability

The Compass offered by the AtKisson Group (a US/European consultancy) is a software package for developing a measure of genuine progress at different levels, e.g. community, business or organisation. It encompasses four aspects of sustainability:

- Nature
- Economy
- Society
- Well-being

The methodology allows all stakeholders to participation in every Compass point. They are introduced to sustainability concepts and principles, develop a set of assets and concerns, and then develop the indicators that will reflect critical long-term trends in every relevant area. They also explore the linkages between indicators and prepare the ground for creating co-operative action programmes.

12 esl.jrc.it/envind/dashbrds.htm, 10 November 2005.
13 www.atkisson.com/accelerator/#compass, 10 November 2005.
14 www.iisd.org/cgsdi/intro_dashboard.htm, 10 November 2005.

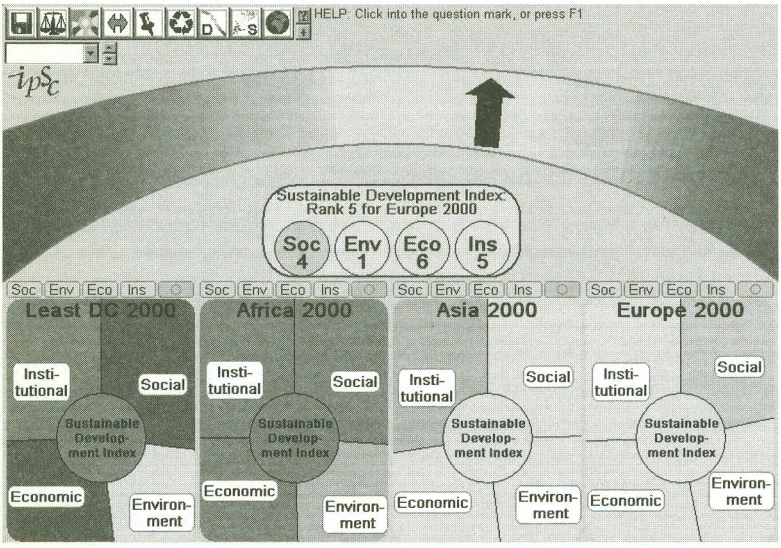

FIGURE 6.8
Dashboard of Sustainability

Source: esl.jrc.it, 10 November 2005 Special thanks to Jochen Jesinghaus

This tool provides a feedback to the stakeholders engaged in the decision-making process. This means that updates can be published on a regular basis and allows new sets of relationships among stakeholders to be developed, which might lead to new initiatives.

Technology indicators

Technology can also be measured for its contribution to sustainable development. The indicators for technology and sustainable development can be classified into two main categories:

A. Indicators of the relationship of a technology with the natural system

B. Indicators of the relationship of a technology with the social system

The indicators of the first group can be split into two groups of basic indicators:

A1. **Eco-efficiency indicators** that show the grade of dematerialisation of the technological system. This group includes indicators that refer to resource properties, e.g. if a resource is renewable or not

A2. **Indicators of environmental quality** that show the impact on the environment generated by the technology, e.g. emissions to atmosphere, water or land

The LCA of a product (see Chapter 8) is an indicator that performs this task.

The indicators of the second group include those that provide information about the social effects of the technology:

B1. **Social aspects**, such as creation of employment by the technology

B2. The degree of **decentralisation** of the technology

B3. The degree of **complexity** of the technology and the degree of education required for its use

B4. The **investment** required for the technology

Indicators that measure the social effects of technology are not generally available. The social effects of a technology are usually dealt with by technology assessment (see Chapter 4). However, scorecards such as social compatibility analysis[15] do exist.

Checklists can be useful for ensuring that all relevant effects are retrieved and can be used to create an indicator. However, this does not happen very often because a single issue might make the technology unacceptable regardless of the score for the other issues. Figure 6.9 shows an example checklist.

Questions, discussion and exercises

1. Calculate your personal ecological footprint at www.ecofoot.org. Compare it with the footprint of your classmates. Develop options to reduce your footprint by 30%.
2. Apply the checklist for social sustainability effects of technology to an example of your choice from the following list:
   - Nuclear fusion
   - Large-scale near-shore wind turbine parks
   - High-speed rail transport
   - Hybrid cars
   - Unbreakable bicycle locks

15 Developed by V. Carabias-Hutter and H. Winistorfer, School of Engineering, Zurich University of Applied Sciences Winterthur (ZHW), Switzerland; zsa.zhwin.ch/cms/zsa/upload/pdf/SCA_poster.pdf, 10 November 2005.

A. How acceptable is the research and development work that accompanies the formation of the new product and its production process?

1. Do counteracting social forces exist against the methods used in the research and/or development work or against the collection and storage of certain data?
2. Is the research and development work scientifically interesting or does the development of this technology provide a special contribution to (a) technical and/or scientific discipline(s)?
3. Can it be foreseen that investing in the development of a technology at this moment could prevent a better alternative from being developed in the future?

B. How acceptable is the new product in itself?

1. Are any social values connected to the product in itself, or the product that it replaces?
2. Is the product considered unacceptable in the ethical system of specific religious or cultural factions?
3. Will the costs of the new product be likely to attract criticism?
4. What effects on the environment will the product have? Which changes in behaviour will the product cause, and what environmental effects result from that?
5. What are the risks the use of the product entails, both for the user and others?
6. Does the use of the product clash with habitual behavioural patterns of large groups of people?
7. Are there financial or psychological barriers that hinder acceptance of the product?
8. Does the product permit new (economic or otherwise) activities? How should these activities be judged?
9. Does the product threaten existing activities, which hold a certain social or cultural value?
10. Does the product influence the social structure (private life, local community, cultural region)?
11. Does the product have any other (possible) uses than the one primarily intended for it?

FIGURE 6.9 Example of checklist for social sustainability effects of technology
(continued opposite)

C. How acceptable is the production of the new product?

1. Are any ethical standards and/or values threatened in production?
2. Are the working conditions in the production process acceptable?
3. Which are the physical effects of the production facility on the environment?
4. Which are the expected (primary and secondary) effects of the production on employment? What level of schooling is required for personnel?
5. What other consequences does the product have for the local environment?
6. What are the social implications of the production for the local community?
7. Does a potent breeding ground for local activism exist?
8. Can choosing a suitable location drastically reduce negative effects?
9. Which (either existing or planned) economic activities are threatened by production?
10. Is the existing balance of power influenced by new production? Consider the following relations between:
    - Employees (or unions) and employers
    - Different producers
    - Producers, clients and suppliers
    - Government and industry sector
    - Different governmental institutions
11. What does new technology mean for the development of third-world countries? Are relations between global trade blocs influenced by production?

- A worldwide data analysis and exchange system that could reduce corporate administrative fraud

3. Look through a report on the environmental performance of your city or town. Suggest three variables that are easy to measure and which could be used to create a sustainable development indicator for the city or town. Discuss the advantages and disadvantages of using these three variables.

4. Fill out the DPSIR for the problem of climate change. Identify areas where there are differences between countries.