

INDICATORS FOR SUSTAINABLE DEVELOPMENT

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Summary

Since the emergence of sustainable development as a widely used objective of government policy in many countries, the question of how to measure its achievement has become urgent. This led to a worldwide search for indicators of sustainable development. Several approaches have been tried. They range from indicators that summarize the sustainability of development in one indicator or index, to indicator sets that consist of an exhaustive list of subindicators in their own dimensions. As yet, no consensus has been achieved on the best indicator design. In this brief review of indicator development, the focus is on the nature and functions of indicators and a conceptual framework is suggested for indicator development. For the purpose of illustration, several (types of) indicators are considered. A separate section discusses the development of indicators at the firm (company) level.

1. Introduction

Sustainable development is a policy objective of many governments and other decision-making bodies across the world. Once adopted as a policy objective, a natural question that follows is how to measure its achievement. Is a specific policy or a specific economic or technological development favorable for sustainable development, or not? Would an alternative policy or an alternative development be better or worse? Should institutions be changed or should completely new ones be created? All of these

questions are difficult to answer if the impacts of these policies, developments and institutions cannot be measured on some scale of sustainable development. At least it needs to be known whether the right direction is being followed. Understanding of all the economic, environmental and social aspects of sustainable development and their interactions is still far from being achieved. Nevertheless, there needs to be some indication of the sustainability of the development path being followed. Agenda 21, the action program of UNCED adopted at the Rio de Janeiro conference, thus called for the development of indicators for sustainable development. This was in 1992—this article addresses the issue of what has been learned about indicator development since then.

2. Nature and Functions of Indicators

Before discussing indicators of sustainable development, it is important to be clear on the nature and functions of indicators in general. So, what exactly is meant by an indicator, why are they used, by whom and for what purpose? Do indicators of sustainable development have to meet special requirements?

2.1 What are Indicators?

Indicators are observable phenomena or states of nature that are believed to tell the observer something of unobservable phenomena or states of nature. Indicators always point at something else, something beyond direct observation. There can be many reasons why something is unobservable; sometimes it may be too costly to directly observe, in its entirety, the phenomenon of interest. One area of life that is fundamentally beyond direct observation, is the future. Very often, however, information about the future is of great value for decisions that must be taken today. So many indicators have been developed that are believed to inform on something about this future. If outdoor activities are being planned for the next few days, the upcoming weather conditions are of interest. A look at the barometer gives an indication; air pressure, as measured by a barometer, is used as an indicator of upcoming weather conditions. As another example, a share price index, such as the Dow Jones of the New York stock exchange, is an indicator of the confidence of investors in the short-term future of the economy.

Indicators of the future are indispensable for many day-to-day decisions, but they can, of course, never be perfect. Indicators of sustainable development belong to this class of indicators of the future. They are of great importance, but however well designed, they will always remain imperfect. The future is *terra incognita*.

2.2 What are Indicators for?

Indicators are meant to support decisions. They do this by simplification and quantification. Future weather conditions depend on a myriad of meteorological variables, and their sometimes complex and nonlinear, interactions. Even the most sophisticated forecasting systems get it wrong, now and again. The barometer simplifies the problem of weather forecasting by only considering one variable—air pressure. The barometer quantifies by means of a simple correspondence between air pressure and weather conditions (stormy, in-between, fair). Notwithstanding its utter simplification,

the barometer can sometimes support decisions concerning outdoor activities. It can when a wrong prediction is not catastrophic. A farmer who needs a few dry days for haying will most likely not rely on the barometer alone; but will seek additional information. This points to an important conclusion regarding indicators: the quality of an indicator cannot be assessed in isolation from apart from its intended use. Different kinds of decisions need different kinds of indicators, ranging from the simple to the quite elaborate.

Thus, policymakers are in need of indicators to identify and analyze actual developments in policy fields for which they assume responsibility. Firm (company) managers have the same need with respect to their business. Indicators can help to come to grips with interacting developments and to identify the trade-offs between opposite effects of policy options and strategies. Indicators then become a planning tool.

Apart from an instrument for decision support and planning, indicators may perform an important communicative function. Indicators inform the general public and draw attention to certain environmental threats. This quite often mobilizes people to take action or to ask for action from their government representatives or from private companies.

3. Sustainable Development

For a proper understanding of the indicator issue, it is of importance to recoup a few central characteristics of sustainable development:

- Sustainable development is a forward-looking concept: it asks whether society's current development path is fair and can be maintained in the future.
- Sustainable development is a multidimensional concept: it looks, at least, at issues of economy, environment and social justice.

Following on from these first characteristics, sustainable development envisages the interests of both present and future generations: it has to do with intragenerational and intergenerational equity:

- Sustainable development is a complicated concept: it looks at the interrelationships among economic, environmental and social development paths.
- Sustainable development is a vague concept: it is not very precise on the conditions that must be fulfilled to make development sustainable.

Indicators of sustainable development must, therefore:

- be forward-looking;
- look at different dimensions;
- envisage equity;
- simplify, and
- quantify.

Besides these specific requirements, indicators of sustainable development should also conform to the general requirements of indicators. These general requirements include first of all validity, meaning that an indicator must be based on sound scientific knowledge and be accurate, while at the same time provide concise information on the issue at stake, in this case the sustainability of development. Next, an indicator must be sensitive to the states and developments it is supposed to inform on. An indicator whose value is insensitive to private or public policies to support sustainable development is of little use for planning purposes. Also, of course, an indicator must be reliable. Reliability has many aspects, but especially relevant for an indicator of sustainable development is the requirement that such an indicator can be used for a longer time period. As yet, not one of the indicators that have actually been constructed has received universal approval, not least because of the difficulties in meeting these general requirements.

4. A Conceptual Framework for Indicator Development

Without any additional information, the best indicator for future development is past development. As a first approximation, past trends can be appropriate indicators of future trends in the economy, the environment, and in social issues. For example, an indicator could point to the present rate of exploitation of a natural resource, and predict that this resource would be depleted in x years time if the present rate of exploitation continues over time. This development could be classified as not sustainable. Such an indicator extrapolates a past trend to the future.

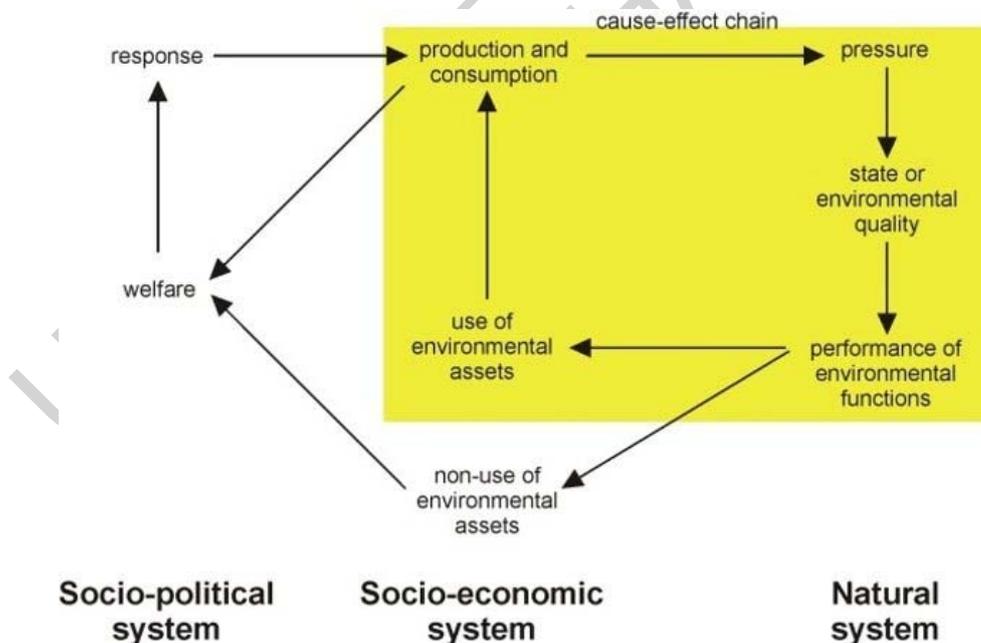


Figure 1. P-S-I-R chain

Time series can be constructed for a multiplicity of indicators in different units of measurement and dimensions. A comprehensive framework for indicator development is the Pressure-State-Impact-Response (P-S-I-R) framework. Economic and technological forecasts are used to predict future environmental pressures, for example,

emissions of an air pollutant. These pressures lead to changes in the state of the environment, which in their turn, may lead to impacts on nature and human society in various ways. The actors in the system (public and private) may respond to these impacts. Figure 1 shows a graphical representation of a P-S-I-R chain.

Indicators can highlight several aspects of this P-S-I-R chain, and can be classified accordingly. Indicators relating to the pressure (P) part of the chain, express pressure on the environment at a specific spatial level caused by pollution, exploitation of resources, and modifications in landscapes and ecosystems. Usually, pressure indicators express for subsequent time periods the levels of emissions or depositions related to certain economic activities. For instance, the level of carbon dioxide (CO₂) emissions per year emanating from industry in country A, or the volume of waste from households in region X. Environmental pressures affect the state or quality of the environment, and thereby the functions environmental goods perform for society. These effects can be expressed by environmental quality or state (S) indicators and impact (I) or effect indicators. Water quality indicators are an example of state indicators.

Effect indicators express the consequences of changes in the state of the environment for those who directly and indirectly use environmental goods. Thus, environmental users not only refer to producers and consumers, but also to plants and animals, such as fish populations. Examples of effect indicators include health effect parameters, the purification costs of water treatment plants, and changes in the agricultural productivity of arable land. Effect indicators also include time series data, and indices of repercussions on aspects of human welfare. Well-known examples are (the growth rate of) Gross Domestic Product (GDP), whether or not corrected for environmental damage, and the Human Development Index (HDI) calculated and published by UNDP. The latter index is a quality-of-life indicator, that apart from GDP, is based, among other factors, on average life expectancy at birth, literacy level and number of years at school. Finally, of more recent origin, is the development of Response (R) indicators. Response indicators intend to take measure of national and local governments in their pursuit of sustainable development. Response indicators are also being developed at the firm level. The idea is to substantiate policy intentions in terms of concrete actions and measures, the implementation of policy instruments and procedures, monitoring and enforcement.

Factors such as uncertainty, irreversibilities, nonlinearities, time lags, and diverging spatial scales, mean that pressure, state and response indicators may not be closely linked to each other. Therefore, the choice of focus is very important. In addition to this P-S-I-R classification, indicators can also be grouped, and eventually aggregated, under the heading of the sociopolitical system, the socioeconomic system, and the natural system. Because of the limited knowledge of the precise structure and dynamics of the cause-effect chain underlying the P-S-I-R, a system of subindicators in different parts of the chain gives more reliable information than a single indicator at one position only.

A system of subindicators poses the following design questions:

- how to select the subindicators;
- how to combine the subindicators; and
- how to present information to the decision-maker.

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Biographical Sketches

Prof. Dr. Harmen Verbruggen is head of the department of Economics and Social Sciences of the Institute for Environmental Studies, Vrije Universiteit Amsterdam. Since 1990 he has also been deputy director of this Institute. In 1994 he became professor of International Environmental Economics. His major field of specialization is the interplay between development economics, international economic relations and environmental studies. Recent research interests include the interrelationships between environment and international trade, the international coordination of environmental policies, environmental policy instruments, and clean technology. He is the author of many articles and research memoranda. Articles have appeared in journals such as *Environmental and Resource Economics*, *Ecological Economics* and Dutch periodicals. He is member of various advisory committees. He is: Chairman of Programming Group IV (Integration) of the Dutch National Research Program on Global Air Pollution and Climate Change; Chairman of the program commission Environment and Economy of the Netherlands Organization for Scientific Research (NWO); Vice-chairman of the National Committee for International Cooperation and Sustainable Development (NCDO); Member of the Steering Committee of the research program Collaborative Research in the Economics of Environment and Development (CREED); Consultant for UNCTAD and OECD on international trade, environment and development issues; Member of various advisory committees of the Social Economic Council (SER), as international environmental economic expert; and Member of the working group Greening of the Fiscal System of the Dutch Ministry of Finance.

Mr. Onno Kuik studied economics at the Agricultural University of Wageningen. In 1984 he worked as a research assistant at the Department of Agricultural Economics in Wageningen. In 1985, he joined the Institute for Environmental Studies of the Vrije Universiteit in Amsterdam. He is project leader and researcher within the program International Environmental Economics within the Department of Economics and Social Sciences. His main interests are international trade and the environment, the monetary valuation of environmental change, market-based instruments of (international) environmental policy, and economic aspects of interactions between agriculture and the environment. He has published many articles and research memoranda. Articles have appeared in journals such as *Environmental and Resource Economics* and *European Review of Agricultural Economics*.