Sustainable Development Indicators: An overview

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Abstract

Indicators have evolved as a very useful tool for implementing sustainable development, evaluating progress made and illustrating concepts and parameters involved. In this paper indicators' characteristics, functions, advantages and pitfalls are presented. An overview of international efforts for indicators development is following presenting the theoretical framework, the advantages and disadvantages of each method. This overview, in relation to indicators' functional characteristics as well as to the needs rising up from implementation efforts, results in identifying trends and future needs in developing sustainability indicators.

1. Indicators for sustainable development

1.1. General

One of the tools recently proposed for measuring sustainability is the estimation of indicators (Mowforth and Munt, 1998). Indicators are being used for some decades in order to provide instant information on parameters people are interested in and have been traditionally used to measure economic development. As the notion of sustainable development expanded, it became apparent that traditional indicators such as GDP failed to address issues inherent in the sustainability concept and therefore different measures had to be developed. Sustainability indicators emerged to fill this gap while after the Rio Summit in 1992 they started to become widespread. It is stated in Agenda 21 the need for acknowledging the importance of sustainability indicators by both national governments and the international organizations which should be followed by the identification of relevant indicators (U.N., 1992). Nowadays, many international organizations (UN-DPCSD 1996; OECD 1993 and 1998) as well as national governments (Environment Canada 1996; U.K. 1996) are in the process of developing their own set of indicators for sustainable development.

The reason for this consensus on the need for indicators development emanates from the necessity to operationalize the term of sustainable development and evaluate the development followed on the basis of environmental and socio-cultural criteria besides the economic ones.

1.2. Use of Indicators

Indicators are used in everyday life most commonly to alert the change in a “normal” situation. For example fever is an indication of threaten on human health, the fuel red light in the car is an indication of running out of fuel and so on. In science as well indicators are widely used in order to provide information on pre-established target areas. Information is essential in everyday life, in science and in policy making in order to make accurate, on time evaluations of a situation and take decisions.

In particular, sustainability indicators are about information:

- On the state of the environment, the economy, and the society; they describe a situation (U.N., 1998; World Bank, 1997).
- On weaknesses and potential problems; they alert on issues which should be taken care of.
- On performance of actions and policy taken; they are *performance assessment tools* (Hardi & Barg, 1997; World Bank, 1997; U.N., 1998) which check how successful have been developmental and policy choices made and eventually how well humans are doing on their way to sustainable development.
- As a result of the above it could be argued that indicators offer support in policy making; they are *planning tools* (Hardi & Barg, 1997) which help choose among alternative policies

Additionally, indicators:

- Help clarify objectives and set priorities; they are *explanatory tools* (Hardi & Barg, 1997; World Bank, 1997) which contribute to the translation of the sustainability concept into practical terms.
- Rise awareness among the public on sustainable development and necessary action to be taken (Hardi & Barg, 1997).
- Help identify data gaps and establish a conceptual framework for data collection (Hardi & Barg, 1997).
- Ideally, provide the link between the different components of sustainability reflecting the significance of the dynamics developed in a complex system than a report of each component separately (IISD, 2000).

1.3. Advantages and pitfalls

Indicators are different than primary data or statistics in the sense that they provide meaning beyond the attributes directly associated with them and thus providing a bridge between detailed data and interpreted information (UN, 1998), they have significance beyond the value of the parameter (Hardi & Barg, 1997). Thus, indicators provide meaning and concentrated information which otherwise would require an extended detailed amount of information. As a result, evaluation as well as communication of important parameters become instant and easy to understand. Of course this strongly depends on the selection of proper indicators. Another advantage emanating form the use of indicators is the reproducibility and comparability of the results. If indicators are based on a coherent methodology then, they could be used to make comparisons over time and across space, find correlations (OECD, 1993) and monitor changes and trends.

However, there are also problems which could appear while choosing and using indicators. One major pitfall is that of subjectivity. Subjectivity enters in two fields: on the selection of the representative indicators and on the evaluation of the indicators results. Someone has to choose the indicators to be used and this is a person with limited knowledge –what Meadows (1998) refers to as *dependence on a false* model- and certain scientific and social background and therefore certain degree of subjectivity is inevitable (Bossel, 1999). Other problems include: lack of appropriate data which may result on missing vital information, this further could lead to *measuring what is measurable rather what is important* (Meadows, 1998); and *overaggragation* (Meadows, 1998) of too many things resulting in an unclear meaning and therefore bad communication and analysis capability. If indicators are not chosen carefully and as systematically as possible they will carry the wrong message resulting in misleading conclusions.

2. International experience on sustainability indicators

Some of the best known international efforts on the development of sustainable development indicators are examined here in order to give an outline of the conceptual frameworks on sustainability indicators and to highlight trends and future needs.

The frameworks examined here are:

i. OECD’s Pressure-State-Response framework
ii. World Bank: measuring the wealth of nations
iii. United Nations –CSD Indicators
iv. Barometer of Sustainability
v. Ecological Footprint

The first three frameworks are developed by international organizations while the last two are experimental well promising frameworks. Of course these are not the only contributions on research and application of sustainability indicators. There are much more at different scales of applications (international, national, sub-national, *ad hoc* etc) but it would not be possible to cover all of them within the limits of this overview. Each of them however to have some contribution at certain aspects of indicators development and implementation.

2.1. International frameworks

i. OECD’s Pressure-State-Response framework

OECD’s work on the field of environmental indicators initiated in 1991 with the approval by OECD countries of a Council Recommendation on Environmental Indicators and Information (OECD, 1993) as a consequence of a request at the 1989 G-7 summit (World Bank, 1997). In 1993, the “OECD Core Set of Indicators for Environmental Performance Reviews” was publicized. This report includes the definition of the Pressure-State-Response framework for the development of indicators. The fact that it was one of the very early efforts on indicators development could partially explain the focus given on the environmental aspect of sustainable development. However, The *Pressure-State-Response* framework proposed remains one of the most wide-spread conceptual frameworks till nowadays.

The Pressure- State-Response Framework

“The PRS framework is based on a concept of causality: human activities exert *pressures* on the environment and change its quality and the quantity of natural resources (the “*state*”). Society responds to these changes through environmental, general economic and sectoral policies (the "*societal response*"). The latter form a feedback loop to pressures through human activities" (OECD, 1993).

Accordingly, in the PSR framework there are three types of indicators:

i) The *indicators of environmental pressures* which describe the pressures posed on the environment by human actions;

ii) The *indicators of environmental conditions* which describe the current state –the quality- of the environment; and

iii) The *indicators of societal response* which describe the society's response to environmental changes and concerns

The definition of indicators is based on a number of environmental issues: climate change, ozone layer depletion, eutrophication, acidification, toxic contamination, urban environmental quality, biological diversity, landscape, waste, water resources, forest resources, fish resources, soil degradation, while, there is a last 14nth issue called general indicators not attributable to specific issues (OECD, 1993).

As mentioned earlier, The PSR framework has formed the base for several indicators definition. However, as stated by the reporting group itself the approach has its own limitation which is the linear relationships in the human activity-environment interaction which cannot capture the more complex and dynamic nature of the processes (OECD, 1993; Bossel, 1999).

The idea of including pressures as well as state indicators although may appear as integrating the causal relationship, in practice may reveal to be meaningless as state indicators can actually measure the pressure which is behind them. In other words they are more or less reflections of the same attribute. As it is mentioned by the reporting group (OECD, 1993) "In practice, the distinction between environmental conditions and the pressures may be ambiguous and the measurement of environmental conditions can turn out to be difficult or very costly. Therefore, the measurement of environmental pressures is often used as a substitute for the measurement of environmental conditions".

Another disadvantage, related rather to the implications of future use of the conceptual framework for the definition of indicators for sustainable development than directly related to the core set of indicators, is the number of the indicators which should be proposed. Although the core set includes around forty indicators, in the hypothetical situation that three indicators (pressure-state-response) should be defined for each parameter of concern for sustainable development plus the necessary interlinkages, the outcome would be a very long, and therefore difficult to measure, list of indicators.

ii. World Bank: measuring the wealth of nations

World Bank has been encaged in a very ambitious attempt to offer a tool for measuring sustainable development through the measurement of the wealth of nations. In 1995, in its initial publication "Measuring the Wealth of Nations", measurements include natural resources (the natural capital), produced assets (man-made capital) and human resources (human capital). Realizing the missing link of institutional elements on economic growth, in the posterior publication "Expanding the Measure of Wealth" (World Bank, 1997) this was introduced as social capital without however including the methodology for its measurement. The World Bank has determined the dollar value of natural capital, produced assets and human resources for 192 countries using mostly existing data and traditional measurements adjusted to include environmental parameters. The idea is based on the concept of *genuine saving* as an indicator to explore the dynamics of creating and maintaining wealth. Genuine saving is "the true rate of saving of a nation after accounting for the depreciation of produced assets, the depletion of natural resources, investments in human capital, and the value of global damages from carbon emissions. Negative rates of genuine saving must lead eventually to declining well-being." (World Bank, 1997). It is actually the evolution of gross saving and net saving to include natural and social parameters in order to keep in touch with the sustainability concept aiming to an aggregate measure for progress report.

Measuring the wealth of nations offers a structured approach with aggregated monetisized results easy to compare among nations based on easy to acquire data sets and using existing knowledge in indicators development. Moreover, the need for clear policy targets to relate measurements and for complementary work to be done are recognized (World Bank, 1997).

However, there are some inherent problems in the concept and methodology. What in OECD is referred as substitution (OECD, 1997) appears here under the concept of "investment" and "genuine saving". Consumption of natural resources can be regarded as investment if genuine saving is positive. However, this "investment" can be in another asset no matter if produced or natural. For example, if crude oil is depleted is not negative if genuine saving is positive. Although, critical limits on depletion are recognized, it tells us nothing whether part of this saving is invested on research and technology development on renewable energy. However, if the latest happens then, non-conditioned crude oil depletion forms a lack of sustainable use. Therefore, World Bank's approach could not be regarded as sustainable development measurement.

The conversion of environmental function to monetary terms places focus on the instrumental or use values of natural resources. Although, the need to include critically important ecological and life-support functions provided by natural systems as well as its aesthetic value is acknowledged, at the time being they are not considered on the estimations. Moreover, the World Bank is giving special attention to developing countries while the calculations needed are complex and highly technical to handle (Hardi & Barg, 1997), adding some more limitations in the use of its approach.

Focus is on economic growth placed in a context of sustainability while social capital is defined and examined in terms of how it affects economic growth. Economic growth may be an important aspect, especially in developing countries which is the target area of The World Bank, however, the distinction between growth and development as well as the identification of economic sustainability as one of the components that constitute sustainable development, have long been recognized. Regarding the sustainable development issue, as one of market mechanisms appears to be a very pragmatic procedure, which is well founded on the reality of an open global market. However, in this way, the essence of sustainable development, which is about building a new ethic to define interactions of humans with their environment and as a result to form the guideline of developmental choices, is left aside.

iii. United Nations –CSD Indicators

In the Earth Summit, held in Rio de Janeiro in 1992, it was emphasized the need for the development of sustainability indicators in order to guide and facilitate decision-making. Following up this recommendation, UN Commission on Sustainable Development (CSD) initiated, in its third meeting in 1995, a work programme on the development of sustainability indicators. In 1996 the first draft of the publication "Indicators of Sustainable Development: Framework and Methodologies" was publicized. It included a list of about 140 indicators as well as detailed methodological aspects. Indicators are organized in four categories: social, economic, environmental and institutional and are related to the chapters of Agenda 21.

Indicators were framed in a Driving Force-State-Response System in which existing experience and knowledge from the PSR framework developed by OECD (1993) was used. However, Pressure indicators were replaced by Driving Force indicators as in this way it was believed that human activities, processes and patterns that impact on sustainable development were better encompassed (U.N., 1999). Indicators were developed for use by nations while many international, governmental and non-governmental organizations cooperated on this effort.

The methodology sheets -developed to accompany and provide information on the use of the indicators, their definition, their policy relevance, data needed etc.- are very detailed offering useful information to those wanting to use indicators, acquire necessary data or wanting to get a deeper appreciation of the methodology. Moreover, these detailed information are necessary when indicators are to be estimated from different countries and results to be compared globally.

However, regarding the indicators themselves, in some occasions their relevance to policy goals of sustainable development is not apparent. For example Chapter 40 of Agenda 21 is about information and decision-making and is classified on the institutional category of indicators. The State indicator proposed to measure this parameter is "main telephone lines per 100 inhabitants" which is not transparently related to the information and decision-making aspect. Moreover, indicators have a clear focus on the needs and the situation in developing countries. Even though this could be a target, it excludes their use from developed countries and nevertheless comparisons between developed and developing countries. The later, however, has been realized by PDCSD and measures have been taken by proposing an additional set of indicators in the framework of another programme called “Changing consumption patterns” (Spangenberg and Bonniot, 1998).

2.2. Experimental Sustainable Development Measurement tools

iv. Barometer of Sustainability

Developed in 1997 by Robert Prescott-Allen, in his book “The Well-being of Nations”, offers an aggregate indicator of sustainability. The indicator is visualized in two axes: one for ecosystem well-being and the other for human well-being. The judgment of overall sustainability is based on the axe with the lower score (with the worst performance). This is in order to prevent that trade-offs are made between human and ecosystem well-being. This is also reflected from the starting point of the barometer which regards that ecosystem and human well-being are equally important.

Each indicator defined is measured on a performance scale. In this way it is possible to compare and aggregate indicators. The Barometers scale is divided into five sectors giving a fully controlled scale. Although, the later gives rise to arguments concerning the subjectivity which is implied, its author argues that this stimulates the clear definition from the users of what constitutes sustainable development, what issues are important to be measured and what indicators are representative to measure them, contributing thus to clearly established policy goals as well to the clarification of the sustainability concept. Indicators are then aggregated up to the subsystem level (ecosystem and human well being) giving the Barometer of sustainability.

The Barometer approach -or the Well-being approach- is a promising one in the sense that it is easy to understand and to calculate and gives an immediate easy to understand reflection of ecosystem and human well-being. Moreover, it allows the interested parties to define their own criteria for sustainability and thus the overall process to be participative. One of the most important points which, should be selfevident in all the sustainable development measurement frameworks- is that there is no substitution between ecosystem and human-well being; they are both prerequisites for sustainable development.

Limitations recognized by other authors concerning the subjectivity the procedure implies (Hardi & Barg, 1997) have some ground but it is more likely to be the ground of general questioning over what constitutes sustainable development and whether there is a unique set of clearly defined to criteria to assess sustainability.

v. Ecological Footprint

The Ecological Footprint is an accounting tool to measure how much nature a given population or country is using. The measurement is in land units and is made on the assumption that each human activity uses resources and has waste flows which can be converted to a biologically productive area necessary to provide these functions (Wackernagel and Rees, 1996; Wackernagel et al, 1997).

Ecological Footprint is rather an indirect way for measuring sustainability. It actually measures consumption of goods and translates them in productive land units. Taken the fact that consumption patterns is a major issue of sustainability it manages to capture this basic element and relate it to the other very basic element, which is resources use. However, socio-cultural aspects are indirectly reflected in the results while there are environmental issues such as contamination, which are not included to provide a full picture of the state of the environment. Therefore, it offers a good tool for global and national monitoring of aggregated crude results but when detailed information is needed to proceed to national and sectoral policies, more detailed information would be necessary.

Still, it remains very useful, especially if time series are available, to monitor and compare changes in a global scale or between nations in their consumption patterns and give a picture of the state and trends over time. Its contribution on the sustainability concept lies on the fact that highlights the issue of equity between nations, between developing and developed societies. There is only one pie and everybody wants a piece. If some countries have big shares inevitably, some others will be limited to small shares otherwise the unsustainability of the planet is definite (Wackernagel et al, 1997).

2.3. E.U. and development of sustainability indicators

E.U. has recognized the need of sustainability indicators to guide decision-making and evaluate policies and progress made. More specifically, as a response to the Cardiff European Council (June 1998), the Commission has proposed an overall indicator system which includes two types of indicators: environmental indicators and sectoral integration indicators. They are foreseen to provide information on the progress in the state of the environment; to report whether environmental concerns are incorporated into sector policies; and highlight whether sustainable development is achieved in sectoral policies and in society as a whole (CEC, 1999).

With respect to Environmental Indicators two subcategories are identified:

1. *Annual Indicator Report*: It is a report conducted by the European Environment Agency (EEA) which covers a wide range of environmental topics and includes 60-70 indicators
2. *Environmental Headline Indicators*: This is a shorter set of headline indicators to detect trends in some key environmental areas. Work is curried out by representatives of Member States, Eurostat and EEA.

Indicators for Integration into Sectoral Policies are to link environmental concerns with the activities in the sector. Transport, energy, agriculture and industry are the sectors to be considered.

What is important on this new policy of EU is that:

- Indicators are recognized to be necessary in every single step of policy formulation and implementation in order to evaluate the process itself as well as the results achieved and assure accountability and transparency
- Indicators are recognized as a very basic tool which is rather integral in the policies and strategies than follow and be used for an *a posteriori* assessment

- Sustainable development is not narrowly related just to environmental quality but on socio-economic policies guided by sustainability paradigms and reinforced environment policies.

3. Limitations and future work

Indicator framework for use at an international scale can be very significant as it allows the reproduction of the approach in any country and therefore the comparisons between nations and through time. Although, this review is concentrated on international efforts on measuring sustainability the importance of sustainability measurement in lower levels such as the regional and the local level should not be overwhelmed. Each of them has certain contribution to the achievement of sustainable development and cannot be replaced by more general or more specific measurements. Moreover, there is no unique set of indicators to be applied in all geographical areas and scales. In each case there are unique aspects which should be considered. Concerning the frameworks reviewed here it could be argued that there is a disproportional emphasis on developing countries. The need for an in depth assessment of the developed world should be considered as well as that of large geographical entities such as the Mediterranean Basin.

Another issue on sustainable development measurements is the unit in which it is measured. This is of major importance when one aggregate result is the target and when comparisons are to be made. The most popular unit so far has been money. Monetization has received much appreciation as well as criticism (Hardi & Barg, 1997). Another suggestion to a unique unit is the performance scale (Prescott-Allen, 1997; Bossel, 1999) which enables users and policy makers to compare and aggregate different components and give an immediate outlook of the situation even for aspects which could not be monetized, with quite simple estimations rather than complicated mathematical equations.

However, the use of one aggregate indicator or an index should be considered carefully. While aggregation allows easy at once reflection of a situation and facilitates comparisons especially between nations it does not offer detailed anδ in depth information. Therefore, it constraints the analytical function of indicators which is necessary for policy making. Both indices and detailed sets of indicators could prove to be useful and the trend which is noticed for one single indicators of sustainability should be critically considered.

The later introduces the challenge with which bodies enacted in indicators development are facing: to interpret and measure the complex phenomena of sustainable development while keeping indicators as simple as possible and their number in low levels. As IISD (2000) is pointing out there is a demand for simple and effective indicators without compromising the underlying complexity.

Although there are various international efforts on measuring sustainability, only few of them have an integral approach taking into account environmental, economic and social aspects. In most cases the focus is on one of the three aspects. Although, it could be argued that they could serve supplementary to each other, sustainability is more than an aggregation of the important issues, it is also about their interlinkages and the dynamics developed in a system. This point will be missing if tried to use them supplementary and it is one of the most difficult parts to capture and reflect in measurements.

The need for an integral systematic approach to indicators definition and measurement is recognized (Bossel, 1999) in order to give well structured methodologies, easy to reproduce and to assure that all important aspects are included in the measurement. However, before developing the methodology and the indicators what is needed is the clear definition of the policy goals towards sustainability. This appears to be even more difficult since in most cases the development of indicators has started while there are still arguments over what constitutes sustainable development. This is not necessarily a loop but on the contrary it could be a contributor to move forward and an indication of the need for measurement tools to help deal with uncertainty (Hardi & Barg, 1997). Academical debate on such issues will be always on and it is how it should be on an evolutionary process. Measurement efforts could be both a tool for evaluation and implementation as well as stimulus for clarification.

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