

The role of indicators and scientific research in sustainable development

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Abstract: This paper presents an overview of the progress in the development of indicators of sustainable development (SDI) and scientific research in sustainable development (SD). The analysis of the indicators is based on the national set of sustainable indicators developed in recent time by different developers with focus on the EU level in comparison with other regions in the world. Key challenges include (1) comparability and aggregation variability of SDI in relation to the quality of data determined by the sustainable development policies; (2) impacts and reflections of compiled SDI on different kinds of user needs; and (3) contribution of R&D to sustainability.

Keywords: Sustainable development, Statistics, Indicators, Measurement, Challenges,

Introduction

The essential objective of sustainable development (SD) is to harmonise economic growth and human welfare in order to preserve economic, social and environment base for future generations. The role of public policies and national/transnational governments in managing such a growth and provide scientific research for improvements of SD is critical. Adequate public policies and closely related government funded scientific research are the main channels of exercising social responsibility and public care for SD. The common efforts of many governments in the world already provide an overall policy framework for SD and starts cooperative project on sustainable development research such as those in energy efficiency, natural resources preservation, waste minimisation, pollution prevention, etc. Indicators belong to preconditions of efficiency and effectiveness of these efforts.

Agenda 21 and other basic documents concerning sustainable development

The Agenda 21¹ was adopted by the “Earth Summit” in 1992 in Rio de Janeiro as a plan of action to stimulate progress towards SD. The full implementation of Agenda 21 was strongly reaffirmed at the World Summit on Sustainable Development (WSSD) held in Johannesburg 2002. Chapter eight of Agenda 21 recommends that governments draw up national sustainable development strategies (NSDS). WSSD reiterated this recommendation: the Johannesburg Plan of Implementation urges countries to make progress in the formulation and elaboration of NSDS and begin their implementation by 2005. The European Council in Göteborg (2001) adopted the first EU Sustainable Development Strategy (SDS). This was complemented by an external dimension in 2002 by the European Council in Barcelona in view of the World Summit on Sustainable Development in Johannesburg (2002). Following the outcome of Johannesburg, the Environment Council conclusions of 17 October 2002, urged Member States to implement these strategies. Many European Union member states and associated countries have only recently adopted national strategies and have not yet fully implemented them, especially with regard to improving the coherence of sustainable development policies across sectors and levels of governance.

The turning point for sustainable development in the EU was in 2006 when the recognition of climate change and energy use as a threat to the social and economic life and national security has reached its peak. The problems related to the public health, poverty and social exclusion, demographic pressure and ageing, management of natural resources, biodiversity loss, land use and transport still persist and new challenges are arising. Since these negative trends bring about a sense of urgency, short-term action is required, whilst maintaining a longer term perspective. The main challenge is to gradually change our current unsustainable consumption and production patterns and the non-integrated approach to policy-making (Council of the European Union, 2006: 2).

Scientific research activities have an important role in developing and communicating sustainability to the EU policy makers and wider public. Besides, the interfaces between scientific disciplines and industry, policy and with civil society require collaboration with all contributing partners. The multiple ways through which European research contributes to global sustainable development include: improved understanding of the environment, technological solutions, changing mindsets and behaviours, bearing in mind that it is also at the roots of unsustainable trends. Moreover, today's key input to further progress in the policy making area will be to gather scientists, industry, civil society and R&D policy-makers to confront their views and stakes regarding

¹ <http://www.un.org/esa/dsd/agenda21/>

what R&D can and cannot do for sustainability. Putting European R&D (also R&D by other region in the world) at the service of sustainable development is indeed needed from a societal point of view (European Commission, 2009).

The role of research and technology in efforts for sustainable development

A cutting-edge science and new technology and innovation are essential to improve SD. It is commonly accepted that science contributes to solving the problems of environmental problems and SD in four fundamental ways (OECD (2000a:30):

1. Diagnosing why change is taking place;
2. Suggesting solutions for solving the problems;
3. Understanding and defining the boundaries of uncertainty;
4. Reducing the uncertainty.

Therefore, it is vital for SD and for the environmental progress to have not only a strong national science base, but also a sound international scientific and technological cooperation in defining and investigating problems related to SD which nowadays have pervasive global and international character.

Scientific research is also important for assisting business sphere to overcome different restrictions which are usually imposed by SD policies in order to preserve sustainable production and consumption. Scientific research produces numerous new technologies and innovations that open new markets, sectors and jobs such as renewable energy resources, new materials, sustainable agricultural practices, clean-coal technologies, etc.

The cooperation between science, industry and government is inevitable ingredient of research related to SD since private companies, even the powerful corporations, are always reluctant to invest in expensive and commercially risky technologies. Therefore, national and transitional governments are expected to close the investment gaps in risky technologies and new research and provide in this way incentives for private business to follow social responsible path of production. Private companies tend to neglect the fact that clean technologies open new kinds of employment and business (e.g. small energy power plants) which provide new sorts of profits and revenues.

Besides, international cooperation in research and new technologies is of special importance, since phenomena such as climate changes, acid rains or threats to national security due to scarce energy resources do not recognise boundaries between the states, but are common to many countries. Less developed countries that suffer the lack of resources for research and technology should be, therefore, integrate in the large scale international projects of more developed countries. They usually bear the greater and more serious consequences of social irresponsibility regarding SD of those developed countries, since their economies are more dependent on natural resources than technology advanced countries.

The Concept and Measurement of Sustainability

Sustainability has to be a choice, a choice of a global society that thinks ahead and acts at any time, and ask: 'Should we be doing this and, if so, are we fully aware of the risks involved in uncertainty? There are over 100 definitions of sustainability and sustainable development, but the best known is the World Commission on Environment and Development's. This suggests, that development is sustainable, if it "meets the needs of the present without compromising the ability of future generations to meet their own needs." (GDRC, 2009)

Most experts and organizations prefer to define SD as a pattern of resource use that aims to meet human needs while preserving the environment so that these needs could be met not only in the present, but also for future generations. The term was used by the [Brundtland Commission](#) (WCED, 1987). Based on this definition and using the available SD strategy and group of individual indicators and composite indices, we attempt to assess the extent to which we can measure a country's progress. The assessments are based on comparisons between standard indicators and recently developed core indicators for SD.

We find that indicators for measuring and comparing SD are commonly used for both developed and developing countries and contain information vital for assessing performance, monitoring and evaluating progress, predicting future trends, identifying priorities and for formulating policy and decision-making. However, the characteristics of developing countries' research systems are quite unlike those that gave rise to the *sustainable development standards*. The standard methodology, which determines priorities for international comparability does not produce results that are relevant for policies suiting the countries' particular characteristics. Therefore, methodology for SDI statistics should be adapted to produce policies that better meet the needs of all involved countries. In addition to standard indicators, a set of indicators specially designed to take into account the very different conditions and characteristics of developing countries. The challenge is how to make and use statistics and indicators that are both cross-nationally comparable and able to adequately reflect a country's specific economic and societal features.

There are several ways to measure the overall situation of a country but three of them attract particular attention: the first extends traditional economic accounts based on GDP; the second way is to develop composite indicators of wellbeing that combine detailed information into a single measure; and the third seeks to identify a certain number of key indicators covering economic, social and environmental domains, without deriving any particular single measure (Giovannini, 2004).

The strength and weakness of indicators lie in their selection, which facilitates decision-making, but also opens the door to data manipulation. SDIs are more in the nature of indices that reflect the state of overall concepts or social goals such as human development, SD, the quality of life or socioeconomic welfare. Indicator lists of varying length seek to capture the different – economic, environmental, social and institutional – dimensions of SD. They differ in the particular selection of ‘representative’ and/or „core“ indicators of these dimensions and related sustainability concerns. Certainly, an alternative is the aggregation of indicators into composite indices. However, different composite indices have varying definitions of sustainability since they are focused on different components of sustainability.

The fact that countries have different perspectives on SD makes matters more complex. Demands for information are multiple, change over time and originate from many sources – public and private. At the same time, there is a need to maintain balance between short and long-term information needs and continuing efforts and investments to improve information quality. We can summarise the common characteristics of research systems of SDI for all countries in the following way: SDI researchers should identify the type of work they do, the institution and sectors for which they work, and whether their research work is in line with national policies and priorities.

Overview of Approaches to Sustainable Development Indicators

Today more information about guidelines for selecting and maintaining SD indicators is available for download. More information about developments, including a database of SD indicators, forums, initiatives and projects around the world are available and obtainable on websites: The Millennium Development Goals (MDGs) UN initiative and MDG Indicators², the Millennium project³, Beyond GDP – International Initiative⁴, United Nations Division for sustainable Development (UNCSD indicators)⁵, Community Indicators Consortium (CIC), The Virtual Exhibition project⁶, The Dashboard of Sustainability⁷, JRC indicators⁸, SUS.DIV (Sustainable Development in a Diverse World)⁹, The International Sustainable Development Research Society (ISDRS)¹⁰, etc.

Accordingly, many indicator projects, publications and networks have been launched by institutions such as the United Nations, OECD, the World Bank, the European Commission and its agencies (e.g. Eurostat, JRC and the EEA), and by different NGOs. Many more indicators than ten years ago are nowadays available. The „Beyond GDP Initiative“ identifies a few key approaches, such as: Adjusted GDP; Environmental accounts; and, Quality of life measures, and indicators used in recent years at the national and international levels (Beyond GDP, 2007).

EU countries use their national strategies for SD (NSSD) as the organizing framework for indicators. The EU Sustainable Development Strategy (SDS), which was renewed in June 2006, sets out a coherent approach to how the EU will more effectively live up to its long-standing commitment to meet the challenges of SD. Sustainability indicators are tools helping to prepare structure, implement, assess and communicate sustainability strategies and policies. The SDI framework on the EU level is based on ten themes:¹¹

- Socio-economic development;
- Sustainable consumption and production;
- Social inclusion;
- Demographic Changes;
- Public Health;
- Climate Change and Energy;
- Sustainable Transport;

² <http://mdgs.un.org/unsd/mdg/Default.aspx>

³ <http://www.unmillenniumproject.org/>

⁴ <http://www.beyond-gdp.eu/>

⁵ United Nations Division for sustainable Development (DSD); the UN Commission on Sustainable Development (UNCSD) (http://www.un.org/esa/dsd/dsd/dsd_index.shtml)

⁶ The "Virtual Exhibition" was a project of the Sustainable Europe Research Institute (SERI).

⁷ <http://esl.jrc.it/envind/dashbrds.htm>

⁸ <http://esl.jrc.it/envind/index.htm>

⁹ <http://www.susdiv.org/>

¹⁰ <http://www.isdrs.org/>

¹¹ <http://epp.eurostat.ec.europa.eu/portal/page/portal/sdi/introduction>

- Natural Resources;
- Global Partnership,
- Good Governance.

OECD countries have adopted different types of frameworks:

- (1) Based on the Brundtland Report's definition of SD, involving four integrated themes: efficiency, contribution and equality, adaptability, and values and resources for coming generations.
 - (2) Some countries use their national strategies for sustainable development (NSSD) as the organizing framework for indicators; and:
 - (3) A "capital" approach where the focus of measurement is on the stocks and flows of different national assets: natural capital, financial capital, produced assets, human capital, etc.
- (Stevens, 2005: 2).

In OECD countries the concern has mainly been on ecological/environmental sustainability. A review of DSIs assembled by OECD countries, however, shows great diversity in the measures selected under each of the categories and themes proposed by the UNCSD (OECD, 2002). The key approaches to measurement of sustainability and SDI used to OECD on national and international levels includes: (1) Adjusted GDP; (2) Environmental accounts; and (3) Quality of life measures. A recent list of indicators by developers is provided below (OECD, 2009):

- [Adjusted Net Savings](#) (Alexandra Sears and Giovanni Ruta, The World Bank);
- [Canadian Index of Wellbeing](#) (Lynne Slotek, CIW National Project Director);
- [Capability Index](#) (Ingrid Robeyns, Radboud University Nijmegen and Robert van der Veen, University of Amsterdam);
- [Comparing welfare of nations](#) (Hans-Olof Hagén, Statistics Sweden);
- [Corruption Perceptions Index](#) (Transparency International (TI); Other TI indicators: [BPI](#), [GCB](#), [NSI](#), [PRT](#));
- [EEA Core Set of Indicators](#) (Ove Caspersen, European Environment Agency);
- [European Benchmark Indicators](#) (Edward Vixseboxse, Netherlands Environmental Assessment Agency);
- [Ecological Footprint](#) (Mathis Wackernagel, Global Footprint Network);
- [Environmentally Sustainable National Income](#) (Roefie Huetting, Foundation SNI);
- [EU set of Sustainable Development Indicators](#) (Laure Ledoux, European Commission, Eurostat);
- [Human Development Index](#) (Amie Gaye, UNDP Human Development Report Office)
- [Index of Individual Living Conditions](#) (Heinz Herbert Noll, GESIS, Social Indicators Department);
- [Genuine Progress Indicator](#) (John Talberth, Redefining Progress);
- [Happy Life Years](#) (Ruut Veenhoven, Erasmus University Rotterdam, The Netherlands);
- [Happy Planet Index](#) (nef, (the new economics foundation), and Friends of the Earth UK);
- [JFS Sustainability Vision and Indicators](#) (Kazu Kobayashi, Japan for Sustainability)
- [MDG Dashboard of Sustainability](#) (Jochen Jesinghaus, European Commission, DG JRC);
- [The Natural Capital Index framework](#) (Ben ten Brink, Netherlands Environmental Assessment Agency);
- [\(Regional\) Index of Sustainable Economic Welfare](#) (Prof. Tim Jackson, RESOLVE, University of Surrey, UK; Nat McBride; and Saamah Abdallah, nef (the new economics foundation);
- [System of Environmental-Economic Accounting](#) (London Group on Environmental Accounting);
- [Sustainable Society Index](#) (Geurt van de Kerk and Arhur Manuel, Sustainable Society Foundation);
- [Time Distance Method](#) (Pavle Sicherl, SICENTER, Slovenia);
- [World Happiness Index](#) (Pierre le Roy, www.globeco.fr);
- [Global Peace Index](#) (Institute for Economics and Peace, www.visionofhumanity.org.)

Due to a different approach and different set of themes / indicators mentioned above, some dimensions of SD (such as human development/human rights and democracy) are difficult to measure from the statistical point of view and in the form of comparable numerical statistics. The presented practices present serious challenges to the quality of results from different SD surveys, and this must be taken into account when designing data collection procedures and analyzing their results., Cross-country comparisons and the ones in international relations provide a platform for analysis of the key factors explaining successes (and failure) in the many practices of implementation of governance at the national, sector, and regional level for SD across the world.

Findings and lessons to be learned

We have no room here to provide data on application of the above findings to Croatia. Hence, we keep to general findings.

SD encompasses three different pillars of policies - economic, environmental and social values. These different perspectives make matters more complex. Demands for information are multiple, change over time, and originate from many sources – public and private. At the same time, there is a need to maintain balance between short and long-term research and information needs and continuing efforts and investments to improve information quality, scientific excellence and transformation of research results into new technologies.

In addition to international organizations, many countries and groups have elaborated sets of indicators for monitoring SD. The process of construction of the indicators is exposed to many difficulties, which usually obstruct unprejudiced considerations regarding SD. The difficulties are mainly related to the following issues:

- *Aggregation of indicators* -The problem of more or less lengthy indicator lists is comparability and aggregation. Integrative concepts of SD or the state and trend of the environment require evaluation or combination of indicators capturing the ‘gist’ of these concepts.
- *Compilation and publication of indicators* - It is hardly possible to give a reasonable overview of the large variety of national and international programs of compiling and publishing social, environmental and sustainable development indicators. In general these programs include some or all of the following topics (Bartelmus, 2008: 2-3):
 - Population (growth, migration, refugees);
 - Human needs (health, food, housing, education, equity, security, etc.);
 - Renewable and non-renewable natural resources;
 - Environmental quality (air, water, land);
 - Ecosystems (acidification, eutrophication, biodiversity),
 - Economic sectors (and their impacts, including emissions, natural resource use, production and consumption patterns, technologies);
 - Natural and man-made disasters;
 - Global environmental problems (climate change, ozone layer depletion);
 - Globalization;
 - Institutions.
- *Use and usefulness of indicators and indices* – There is no universal set of environmental indicators. Although many indicators appear to be the same, most indicators are developed narrowly by an agency or organization for specific, mission-oriented needs. *Composite indices* are the ‘nutshell’ indicators favoured by policy makers. However, they suffer in most cases from limited and subjective indicator selection, conducive to supporting more or less transparent agendas.
- Finally, the term ‘SD’ has been used (and misused) in a variety of ways by different groups and entities - and there is a constant needed to rethink its basic meaning, and adopt/contextualize it to different situations and scales. Therefore, it is important to take into consideration how different countries make revision of existing indicators and indices and develop new ones. The national priorities for management of sustainable development usually have an important role in construction SD indicators. For example, national policies usually determine whether these indicators will be developed within the *accounting framework* or within the *analytical framework*.

Conclusions

We can conclude that a number of challenges and consequent limitations are present in SDI collection and international comparability. This includes distinction between the levels of indicators and how each organization’s description of indicators reflects different kinds of user needs. The set of SD indicators also describes indicators which are not yet fully developed, but would be necessary to get a more complete picture of progress. The difference between indicators that are expected to become available within two years, with sufficient quality (‘indicators under development’), and those to be developed in the longer term (‘indicators to be developed’) should be taken into account. The key challenges in comparability of SD indicators can be summarized in the following way:

- Coverage, definition and statistical validity;
- Variability in the quality of data available in the context of adopted sustainable development policies;
- Absence of harmonization of socio-demographic variables for some data;
- Issues arising on how the compiled sdi indicators should reflect different kinds of user needs;
- Implementation of indicator(s) in comparison on national, regional and international levels;
- Issues arising on how research contributes to sustainability.

Due to a different approach and a slightly different set of indicators in many countries, especially the poor ones, individual capacity building should be embedded in a framework of building the SD specifically. Weaknesses in countries' statistical systems and practices present serious challenges to the quality of results from

different SD surveys. It should be taken into account when designing data collection procedures and analyzing their results. International initiatives and organizations may play a significant role. They should involve local staff and address local issues and assist in building up new and more effective ways of linking local knowledge with the sustainable development of nations.

In the area of scientific research, the main challenges are to develop:

- National scientific base for SD and environment research;
- International research cooperation specially within EU programmes;
- Public-private partnership in order to link (private) finance, technologies and entrepreneurial experience with the (public) scientific competences, research equipment, etc.

Scientific research helps to identify and measure the problems related to SD and points to the ways of solution. It raises the awareness of the importance of SD and especially social responsibility. Croatia is still lacking the critical mass of well- trained, technicians, engineers and scientists which are required to generate and/or apply innovation. In this context intensive interaction among education, scientific and industrial spheres is needed to achieve the synergy and the critical mass for international cooperation.

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