



Original article

Achievements and gaps in indicators for sustainability

Arthur Lyon Dahl*

International Environment Forum, 12B Chemin de Maisonneuve, CH-1219 Chatelaine, Geneva, Switzerland

ARTICLE INFO

Keywords:

Indicators
Sustainability
Systems
National
Values
Ethics

ABSTRACT

In a world faced with accelerating climate change, economic instability and resource limits, it is urgent to find better indicators of progress towards sustainability. The available indicators mostly succeed at measuring unsustainable trends that can be targeted by management action, but fall short of defining or ensuring sustainability. A recent review of environmental assessment and reporting at the national level for the United Nations Environment Programme shows about half of reporting countries to be using indicators and provides some lessons learned. However indicators at the national level are not sufficient. The challenges ahead include finding indicators of change in dynamic systems, establishing sustainability targets towards which national progress can be measured, developing global level indicators of planetary sustainability, and providing individuals with indicators reflecting their own progress and providing positive incentives for further efforts. Finally, since achieving sustainability is fundamentally an ethical challenge, a new set of values-based indicators is required to measure and motivate the implementation of ethical principles necessary to guide the transition towards sustainability.

© 2011 Elsevier Ltd. All rights reserved.

1. Introduction

There have been significant changes in the world since the relatively recent SCOPE review of indicator use for measuring and reporting sustainability (Hak et al., 2007). Climate change has reached the top of the political agenda. The 2007 report of the Intergovernmental Panel on Climate Change (IPCC, 2007) has been shown to have seriously underestimated the speed and extent of climate change and sea level rise (Richardson et al., 2009), but the political response has fallen short of the scientific challenge. A rapid rise in food and energy prices showed the vulnerability of the systems supporting the growing world population. The collapse of the financial system and subsequent global recession challenged the economic certainties upon which much national policy had been based. As a result, the debate on sustainability and the need to find better measures of progress in that direction have taken on a new urgency. This introductory paper starts from an overview of some of the achievements and lessons learned in sustainability indicator development and use at the national level since 1992, to propose a few key areas where progress is still needed if indicators are to fulfil their potential to guide society towards environmental sustainability.

The starting point for this reflection is a comprehensive review of national environmental assessment and reporting, prepared by the author for the United Nations Environment Programme (UNEP)

as an information document for the UNEP Governing Council in February 2009 (UNEP, 2008). This involved compiling an inventory of 1700 national reports on the state of the environment and sustainability, personally examining 1200 of them, preparing 196 country profiles of national and sub-national processes for environmental assessment and reporting, and drafting the overview document and parts of other documents for the Governing Council. This has provided a reasonable foundation for an assessment of the use of indicators for national reporting on the environment and sustainability over the last decade and a half. The reports and country profiles are available on the UNEP PEARL (Prototype Environmental Assessment and Reporting Landscape) web site (<http://www.unep.org/pearl/>) and will be a valuable resource for further research.

2. The design of sustainability indicators

Progress in designing indicators of sustainability has come from initiatives across the institutional spectrum. At the highest level of intergovernmental organizations, the United Nations launched the programme of work on sustainable development indicators for the Commission on Sustainable Development after the Rio Earth Summit in 1992 (http://www.un.org/esa/dsd/dsd_aofw_ind/ind_index.shtml). Another intergovernmental organization, the South Pacific Applied Geosciences Commission, prepared the Environmental Vulnerability Index including 50 indicators (<http://www.vulnerabilityindex.net/>). Initiatives from the academic community have included the Environmental Sustainability Index (<http://www.yale.edu/esi/>) and the

* Tel.: +41 022 797 0211.

E-mail address: dahla@bluewin.ch

Environmental Performance Index (<http://epi.yale.edu/Home>). One of the most widely adopted has been the Ecological Footprint designed by a non-governmental organization (<http://www.globalfootprint.org/>). These and many other initiatives have recently been reviewed (Hak et al., 2007), and some are further discussed, along with the definition of sustainability, by Moldan and Janouskova (2012).

It is difficult to assess the impact of these indicators on progress towards sustainability. Ranking countries by one or more of the indices can stimulate decision-makers to try to improve their position in the rankings. In the revision of the Environmental Sustainability Index, the government of the Republic of Korea sent experts to consult with the indicators team so that they could understand what would be required to improve their position in the rankings. Certainly GDP has not been dethroned as the first indicator most national leaders look at. Indicators are only a tool, and many other factors can influence a policy process. The most significant effect of an indicator, particularly early in its adoption, can simply be to make a problem visible. The rising priority given to sustainability issues in many countries suggests that these indicators may at least be sensitizing decision-makers and the public and expanding the basis for decision-making.

At the national level, the link between indicators and policy action is clearer. Many national governments have developed their own indicator sets documented in the UNEP review (UNEP, 2008). Good practice in indicator development requires that the users be consulted in the choice of indicators, and many national indicator sets are clearly linked to national sustainability policies and frameworks adopted by governments at the highest level. Where the indicators are updated and reported regularly, they provide clear signals on the success or failure of national policy initiatives and actions.

These multiple initiatives have all helped to advance the science of sustainability measurement, but we are still far from what most would consider adequate indicators of sustainability. Nor have these indicators had sufficient impact to reverse the tide of environmental destruction and unsustainability that threatens the well-being of all humanity.

Unfortunately, scientific information such as that conveyed by indicators is usually not sufficient to produce change in either national decision-making or individual behaviour. Political expediency, the weight of vested interests, short-term perspectives and immediate satisfactions often weigh more than scientific facts when priorities are set or choices made. Indicators are more effective when they are aligned with the values of their target audience; the prominence today of economic indicators reflects the dominance of materialistic and self-centred values. Where social and environmental sustainability goals threaten rather than reinforce such values, their indicators will meet more resistance. Individuals are motivated as much by emotions and personal values as they are by information. Even the best system of indicators will need to be complemented by other measures and inputs to ensure decisions in the interest of long-term sustainability, but this is beyond the scope of this paper. The focus here is on what can be done to strengthen the scientific underpinning of sustainability indicators so that they earn the confidence of users.

Part of the problem is that sustainability cannot be addressed solely at the national level. In a globalized world, we are all part of a single human and natural system with complex interactions among all its parts, and many nested subsystems (Dahl, 1996). National territories, economies and societies are only one level of system organization, although perhaps the most significant level today because governance is presently strongest at the national level.

The ultimate limits to sustainability are planetary, and the sustainability of the human population, economy and lifestyle must

ultimately be calculated at the planetary level. The ecological footprint and its complementary biocapacity index (WWF/ZSL/GFN, 2008) are one attempt to do this. While there is debate about the methodology used, consistent use of the same methodology does permit relevant comparisons between countries or individual lifestyles. Most of the present indicators are in fact measures of dimensions of economic, social or environmental unsustainability which must be minimized to keep on a sustainable trajectory. These are very important guides to management action, but they cannot be said to define or ensure sustainability.

Even at the national level, present indicators address what might be called the “hardware” of national sustainability in the measurable status of and trends in environmental, social and economic parameters (pollution levels, energy consumption, poverty, education, etc.) rather than the processes of decision-making and control (the “software”) that determine whether sustainability is really taken into account in decision-making. Adding indicators of processes and the dynamics of change would help to discriminate between conscious progress towards a sustainable system and incidental improvements or correlations that result, perhaps, from rising levels of economic prosperity.

Finally, sustainability (or the lack of it) depends on the individual actions of over 6 billion human beings, the choices they can and do make, the lifestyles they adopt, and their decisions on family size, consumption patterns, etc., recognizing that poverty greatly limits choice. The effect of national policy is limited if there is no public support for implementation. While the ecological footprint and similar indicators of individual impacts can sensitize people to the unsustainability of their lifestyles and consumption choices, they are not sufficiently refined to track progress with changes in behaviour. Indicator systems are still needed that can show progress towards individual sustainability targets.

A complete set of multilevel sustainability indicators would aim to capture key factors for success from individual motivation and behaviour through to respect for planetary limits as a complex integrated system. No indicator system has yet aimed at this level of complexity, but without it, significant parts of the sustainability challenge will go unrecognized and unmanaged.

One reason for this imbalance is the dominance (until recently) of national economies, where the structure, framework and rules have been traditionally determined at the national level by governments and by companies organized and recognized under national legislation. The recent long periods of economic success have entrenched the growth paradigm in the economic system. While lip service has been paid to sustainability goals, these were not allowed to derail the economy. However the financial crisis and subsequent recession have shaken many of the economic certainties on which most government policy and private sector planning have been based, and created opportunities for fundamental change in the direction of global society. Just as economic indicators have been important in the design and management of the economic system, so could sustainability indicators play a significant role in guiding decision-making at all levels in the necessary new directions.

3. Implementation of sustainability indicators at the national level

3.1. Indicators in national assessment and reporting

The UNEP review (2008) demonstrates the great progress made in the last two decades in the use of environmental and sustainability indicators at the national level. With the impetus of Agenda 21 and its recommendation of indicators for sustainable development in 1992, followed by the Commission on Sustainable Development work programme on indicators, many countries have adopted indicators as one tool in providing information for decision making.

While there is no clear distinction in national reporting between the use of illustrative data or statistics, and indicators, it is generally agreed that indicators have a wider meaning concerning a pressure, state or trend in some parameter. Using this distinction, about half (68) of the 144 countries that have produced state-of-the-environment (SOE) reports or sustainability assessments have used indicators as an evaluation and communications tool.

The evolution of national experience in this area is quite clear. Some of the earliest SOE reports were scientific studies with dense text and data tables that could only be understood by other specialists. The desire to be comprehensive in integrating all the dimensions of the environment led to massive volumes of 500–700 pages or more, which no decision-maker would ever find the time to read. It was rapidly apparent that a requirement, say, for annual reporting could not be met in this way. Many countries reduced the size and frequency of their reports, so that few reports today are of more than 100 pages. More space was devoted to graphics, maps and photographs, and of course indicators made it possible to summarize the important messages in complex data.

Countries have generally used a national indicators selection process, often with a wide process of consultation with users, to produce a set of indicators appropriate to their requirements and priorities. It is possible to trace the learning process in some countries through the sequence of national reports. A country might start with 20–50 indicators, with more added each year. After reaching 150–200 indicators, the choice became more selective and the number dropped, or a full indicator set was complemented by a small selection of indicators for the general public. Some countries have reported regularly on a national set of 50 or more indicators. Others focus on a selection of 10–15 headline indicators.

The United Kingdom, for example started in 1999 with a core set of 147 quality of life indicators including 15 headline indicators on which they reported annually. In 2005 they revised the indicator set, using 127 indicator measures to make up 68 indicators related to the government's Sustainable Development Strategy. These indicators form the basis for national SOE reporting, which is otherwise decentralized to the regional level.

In general, there has been increasing sophistication and targeting in the use of indicators in national reporting. It is common for a state-of-environment or sustainability report to be complemented by an environmental data or statistics report. Some countries now produce a variety of reports. Mexico, for example, publishes a large SOE report, a compendium of environmental statistics, an environment in summary report, and basic indicators of sustainable development. The UK, Portugal and Switzerland produce pocket versions of their indicator reports.

The approach can also be regional. In Latin America and the Caribbean, countries through the regional ILAC process agreed on a common set of sustainable development indicators, and are now producing national reports using those indicators.

3.2. *Lessons learned*

The review of national experience highlighted some of the lessons learned over the last two decades. Indicators must be adapted to their target audience, and preferably selected in consultation with their users. While managers and policy makers may find a wide set of indicators useful, decision-makers and the general public prefer a limited set of 10–15 indicators of the most relevant trends.

It takes time and effort to establish a national data collection and assessment programme able to generate a useful set of indicators. Among countries with long-established reporting programmes, 80% use indicators in their reports. This figure drops to 60% in countries that only started regular reporting after 2000, and

40% among countries that only report irregularly on the state of their environment.

The most coherent indicator sets are those, such as in the UK and Switzerland, that have been mapped to a national strategy or concept of sustainability. This ensures that each indicator is policy relevant. In Switzerland, where sustainable development is enshrined in the federal constitution, the Federal Office of Statistics first developed a detailed policy framework (MONET) with postulates for each dimension of sustainability, and then selected indicators for each postulate in the framework. Progress on all the targets is reported on an annual basis (<http://www.bfs.admin.ch/bfs/portal/en/index/themen/21.html>), and a national office for sustainable development follows up with all the departments concerned.

Indicators are only as good as the data behind them. In one case, an impressive national report with many indicators was backed by data so sparse and out-of-date as to have no real meaning.

It is also revealing to consider what is not covered by national indicators at present. Considerable effort has gone into collecting data on environmental states and trends to produce a set of environmental indicators comparable to economic and social indicators in defining national sustainability. However these environmental, economic and social states are the result of complex processes of development. Policy and management interventions will be more effective if aimed at the process rather than the result, but process indicators have been harder to define. There is an increasing recognition that the “three pillars” of sustainable development need to be complemented by a dimension that is variously described as institutional, cultural or ethical, and that would include governance, efficiency, motivation, values and other less tangible factors that may be important determinants of sustainable human prosperity. One of the rare national efforts in this direction is Bhutan's Gross National Happiness, which includes sustainability and environmental dimensions (<http://www.grossnationalhappiness.com/>), although this indicator has not featured in Bhutan's state of environment reporting.

4. *Challenges ahead*

While there has been real progress in implementing sustainability indicator systems at the national level and using them for policy making and public education, we are still a long way from realizing the full potential of indicators to support the increasingly urgent transition to sustainability. The following are a few proposals for needed new developments in measuring and reporting on sustainability using indicators.

4.1. *Dynamics of change*

One of the characteristics of technological progress and globalization is the accelerating rate of change in many economic, social and environmental processes. Climate change, for example, is occurring more rapidly than predicted by even the most recent scientific projections (Richardson et al., 2009). There is thus a critical need for sustainability indicators to capture the dynamics of changes and trends and the trajectories of important features of both the earth system and social and economic pressures. Data problems, methodological changes and a lack of adequate time series have limited the use of indicators for trends over time. The pioneering work on climate change has shown what can be done. These approaches should be extended to a wider range of sustainability issues.

It is also necessary to capture the dynamic interaction between different processes, environmental sectors and social and economic trends. No part of the earth system exists in isolation.

Sustainability can only be understood as the result of many complex inter-relationships and feedbacks between economic, social and environmental systems. Sustainability science must research the most significant driving forces and impacts and their causal relationships, and identify the indicators relevant to the points in the system where management actions would be most effective.

Such dynamic indicators, coupled with systems models that allow projections of trends and their interactions, would provide valuable additional tools for policy making and public education. Too much planning is still based on narrow sectoral information. The collapse of the financial system was caused in part by detailed risk calculations for each financial instrument that provided a false sense of security, because the overall behaviour of the financial system when pushed beyond certain limits was not included (Jamison, 2008). Simply compiling many separate indicators of sustainability cannot provide an adequate measure of the overall sustainability of the system. Modelling system dynamics, exploring resilience and tipping points, and developing alternative scenarios, can help to anticipate vulnerabilities in the natural, social and economic systems. Indicators can be used to flag and explain significant parameters in the system. While no such tools will ever be perfect, they can reduce the risks of being surprised by unexpected interactions and feedbacks. The efforts in modelling climate change could serve as a model for the wider sustainability modelling that was first pioneered by the “Limits to Growth” studies (Meadows et al., 1972, 2004). The progress today in many kinds of indicators and global data sets should make this target more reachable.

4.2. National progress towards targets

Even governments have come to recognize that vague goals and promises about sustainable development are too easy to ignore. The Millennium Development Goals (MDGs) were a first attempt to set realistic quantitative targets against which governments could be held responsible for their performance. Most of the MDGs have associated indicators that are being tracked internationally. However, there are still few good indicators of the implementation of the MDGs at the national level.

Targets are being set in other areas of sustainability, such as greenhouse gas emissions causing climate change, and may be expanded to other mitigation and adaptation measures. Again, indicators will be needed to signal national progress towards these targets. If such indicators are sufficiently reliable, they could become the basis for systems of accountability and even sanctions. Developing such indicators is an urgent priority.

The MDGs and greenhouse gas emission targets are determined by political processes deciding what is desirable or practical. Much more needs to be done to provide scientific foundations for what the planetary limits for sustainability really are. The difficulty in setting and scientifically justifying the 2 °C limit for global temperature rise with climate change (Richardson et al., 2009) shows how challenging the process is. The Environmental Vulnerability Index (<http://www.vulnerabilityindex.net/>) and the Environmental Performance Index (<http://epi.yale.edu/Home>) are two cases where the indicators are scaled with reference to sustainability targets with some scientific foundation. There is still a great gap here that needs to be filled if indicators are really to guide us towards sustainability.

4.3. Global-level indicators

As demonstrated above, most sustainability indicators have been targeted at the national level and intended to leverage action by governments. While governments have a critical role in setting economic and social policy, in land use and infrastructure planning,

in investment decisions, research support and nature conservation, all of which are relevant to sustainability, this is not sufficient. There has also been some progress in indicators relevant to the community level and local government. However two levels are still missing, without which the total system cannot be understood and managed.

At the level of the whole planetary system, there are only some rough first approximations of indicators of planetary carrying capacity and of human impacts on that capacity. Progress is most rapid again in climate change, where greenhouse gas levels and emissions are being studied intensively. Other critical dimensions such as anthropogenic influences on the nitrogen cycle, rates of soil degradation and replenishment, or the total percentage of primary productivity captured for human use have only been estimated. With the rapid growth in the human population and its impacts, we need a much better set of indicators of global sustainability limits, or climate change will be followed by other potentially tragic surprises.

4.4. Individual indicators of process and progress

There is a similar gap at the other end of the multi-level human system: the individual. While institutions like governments are the expression of a certain social consensus and take action on behalf of their citizens, each individual human being is a center of decision-making and an autonomous actor. What happens to the planet is the cumulative result of over 6 billion independent producing and consuming individuals. Without their support, sustainability actions at other levels have little effect.

One of the first responses to effective environmental education is to ask “what can I do to address the problem?” There are many lists of simple actions one can take to become more sustainable, but the results may seem inconsequential. It is hard for individuals to appreciate the significance of the cumulative impact of many small actions. Often global environmental problems like climate change and other challenges to sustainability appear so big that individuals do not see how they can have any impact, and are discouraged from making the effort. Even when they do try to make changes in their lifestyle or consumption, there is little positive feedback to encourage such behaviour.

We are sorely lacking in indicators that evaluate the level of individual action or commitment, and that people can use to manage their own behaviour with reference to their individual goals. The ecological footprint (<http://www.globalfootprint.org/>) is one sustainability indicator that scales down to the individual level (<http://www.myfootprint.org/>), but the tools presently available for its calculation are based too much on national averages and are not sufficiently responsive to individual changes in behaviour to motivate continuing improvements.

There is a real need for indicators of sustainability appropriate to individuals, families or villages. These should be sufficiently sensitive that they give positive feedback for even small efforts and encourage further actions. Indicator methodologies for individuals need to cover a wider range of individual actions and choices for sustainability relevant to different situations, with sufficient sensitivity that effective actions are appropriately signalled and rewarded. This is the frontier of indicator development with the greatest potential to leverage significant changes towards sustainability.

4.5. Values-based indicators

As stated above, scientific information such as indicators is usually not sufficient to motivate fundamental change, yet the achievement of sustainability will require fundamental changes in lifestyles, consumption patterns, resource use and economic

systems. In response to the slow implementation of Agenda 21, the global action plan for sustainability, the United Nations launched the Decade of Education for Sustainable Development (2005–2014). However it is increasingly apparent that education about the environmental, social and economic problems behind present unsustainability, and the scientific and technological options available, is not sufficient to change public behaviour, just as indicators themselves are not sufficient to change government decision-making.

The values required to move society towards sustainability, such as justice, moderation, solidarity and respect for the environment and its limits, contradict the dominant materialistic and self-centred values of the economic system and the consumer society. Sustainability is thus fundamentally an ethical challenge, and must also be addressed at the levels of people's values, and of the ethical principles to which the institutions of society must be held, whether governments, the private sector or civil society organizations. While science is values-neutral and cannot be used to support value choices directly, it can help to measure the implementation of choices made. It is now possible to approach the assessment of values scientifically, and to use indicators to draw attention to this level of decision making.

Values are the basic code of human social behaviour, much as the genetic code determines basic biological functions and the relationships within and between species. Unless the deep transformation in human consumption patterns required for sustainability is rooted in accepted ethical principles and reflects justice and equity in the distribution of effort and benefits, there will not be the widespread public support and personal commitment necessary to allow and encourage change at the community, national and international levels (BIC, 1995). One problem with discussions of values or efforts to educate about them is that they are often implicit and unconscious, and are taken as given within a cultural context. People may not be aware of what their basic values are and how they are influenced by them, nor may they recognize that certain values and inherited assumptions may be contradictory, producing behaviour that is in conflict with other values that they hold as important. Building awareness of values is an important part of the process of change towards sustainability, and indicators can be a supporting tool for this.

Moral values state what is good and of primary importance to human civilization. They are often articulated as ideals which define right from wrong. A capability of moral reasoning starts from abstract general ethical principles to resolve conflicts that arise from moral dilemmas and ethical problems. Ethical principles are the operational expression of moral values that provide guidance to decision-making and action (Anello, 2006). This is precisely what is needed in an ethical foundation for sustainability. Effective ethical principles for sustainability should be general, universal in application, publicly known and accepted, able to impose an ordering on conflicting demands, and have a condition of finality in practical reasoning (adapted from Anello, 2006).

The sources of values have become more complex with the information technology revolution and the spread of communications media. These have driven a globalization of access to information and allowed a wide choice of information sources. As a result, where their penetration has gone far enough, traditional education to transmit values, culture and social norms by parents, teachers and religious leaders in the family and community is being eroded and losing its importance. More subtly, advertising and the mass media intentionally manipulate individual values for commercial and political ends, often in directions (like excessive consumption) opposite to the requirements of sustainability. The determinants of individual behaviour have thus become more complex. However the same media have the potential to counteract destructive tendencies and to communicate sustainability values.

In this context, considering only the economic, social and environmental dimensions of sustainability is like describing the fabrication, cost and manipulation of a tool without reference to its ultimate purpose. The environmental dimension of sustainability can be based on objective scientific evidence. However the economic and social dimensions relate to human society and cannot be divorced from some reference to its ultimate purpose. Sustainability is not an end in itself, but a process of dynamic balance and a means to achieve other goals for society in terms of human happiness or prosperity, fulfilment of human capacity or the advancement of civilization, however these terms may be defined in particular cultures, societies or spiritual traditions.

The concept of sustainability has always had an ethical dimension of justice for all the planet's inhabitants and for future generations, but this has never been elaborated or reflected in sustainability indicators. Many of the classic works contributing to the concept of sustainability have acknowledged the importance of values. This is stated at the end of *The Limits to Growth* (Meadows et al., 1972) and amplified in subsequent reports (Meadows et al., 2004). They quoted John Maynard Keynes, who wrote in 1932:

The problem of want and poverty and the economic struggle between classes and nations is nothing but a frightful muddle, a transitory and unnecessary muddle. For the Western World already has the resource and the technique, if we could create the organization to use them, capable of reducing the Economic Problem, which now absorbs our moral and material energy, to a position of secondary importance. Thus the . . . day is not far off when the Economic Problem will take the back seat where it belongs, and . . . the arena of the heart and the head will be occupied . . . by our real problems – the problems of life and of human relations, of creation and behaviour and religion. (Keynes, 1932)

Similarly, Aurelio Peccei wrote in 1981:

The humanism consonant with our epoch must replace and reverse principles and norms that we have heretofore regarded as untouchable, but that have become inapplicable, or discordant with our purpose; it must encourage the rise of new value systems to redress our inner balance, and of new spiritual, ethical, philosophical, social, political, aesthetic, and artistic motivations to fill the emptiness of our life; it must be capable of restoring within us . . . love, friendship, understanding, solidarity, a spirit of sacrifice, conviviality; and it must make us understand that the more closely these qualities link us to other forms of life and to our brothers and sisters everywhere in the world, the more we shall gain. (Peccei, 1981, pp. 184–185)

The World Summit on Sustainable Development in Johannesburg in 2002 added a short paragraph 6 to its Programme of Action: "We acknowledge the importance of ethics for sustainable development and, therefore, emphasize the need to consider ethics in the implementation of Agenda 21." (UN, 2002).

Since values are difficult to define and measure, with few widely accepted or standardized methodologies (Hitlin and Piliavin, 2004), they have often remained beyond the realm of scientific enquiry and indicator development. This is now changing.

There are an increasing number of organizations, ranging from the Earth Charter Initiative arising out of the Rio Earth Summit, through a variety of non-governmental organizations and faith-based groups, that are working to sensitize the public to the ethical challenges of sustainability, encourage debate, and motivate people to action. However, without indicators relevant to the values and ethics underlying sustainability, there is no way to demonstrate the effectiveness of these efforts. Values-based indicators of education for sustainable development can draw attention to this important level of action, and encourage more

efforts to transform public attitudes towards the changes that are required. A recent project funded by the European Commission has addressed this challenging problem (<http://www.esdinds.eu/> and <http://www.wevalue.org>). Research teams from the University of Brighton (UK) and Charles University (Czech Republic) partnered with a variety of civil society organizations from businesses to religions to help them find indicators for the values-based educational activities they are undertaking. When these indicators are internally validated, they can be used to evaluate the state of values in people and organizations and to measure progress in their expression and implementation, just as indicators do for other aspects of sustainability. This scientific approach to assessing values for sustainability is providing a useful addition to the efforts of governments and organizations to make society more sustainable.

5. Conclusions

Indicators can be powerful tools for making important dimensions of the environment and society visible and enabling their management. For an issue as challenging and urgent as planetary sustainability, adequate indicators can help to guide the major efforts needed for the economy and society to make the necessary transition. There are now working indicator systems for some elements of sustainability at the national level and these need to be strengthened and applied more consistently and universally. However much more still remains to be done both to produce indicators of planetary sustainability at the global level, and indicators at the individual level relevant to the changes in personal motivation and behaviour essential if a sustainable society is to be built while there is yet time.

Acknowledgements

The author acknowledges the support of the United Nations Environment Programme for the review of national environmental assessment and reporting on which parts of this article have been based. The author has also received support through the ESDinds (*Development of Indicators & Assessment Tools for CSO Projects Promoting Values-based Education for Sustainable Development*)

collaborative research project funded by the European Commission under its Seventh Framework Programme.

References

- Anello, E., 2006. Ethical Infrastructure for Good Governance in the Public Pharmaceutical Sector. Working draft for field testing and revision, November 2006. World Health Organization, Geneva (including material adapted from Rawls, J., 1999. *A Theory of Justice*. Rev. Ed. Harvard University Press, Cambridge).
- BIC, 1995. *Prosperity of Humankind. A Statement by the Baha'i International Community*. Baha'i Publishing Trust, London.
- Dahl, A.L., 1996. *The Eco Principle: Ecology and Economics in Symbiosis*. Zed Books, London.
- Hak, T., Moldan, B., Dahl, A.L. (Eds.), 2007. *Sustainability Indicators: A Scientific Assessment*. SCOPE 67. Island Press, Washington, DC.
- Hitlin, S., Piliavin, J.A., 2004. Values: reviving a dormant concept. *Ann. Rev. Sociol.* 30, 359–393.
- IPCC, 2007. In: Pachauri, R.K., Reisinger, A. (Eds.), *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Core Writing Team. IPCC, Geneva, Switzerland.
- Jamison, R., 2008. The blunders that led to catastrophe. *New Scientist*, 27 September 2008, pp. 8–9.
- Keynes, J.M., 1932. Foreword to *Essays in Persuasion*. Harcourt, Brace and Company, New York (quoted in Meadows et al., 2004).
- Meadows, D., Meadows, D., Randers, J., Behrens III, W.W., 1972. *The Limits to Growth. A Report for The Club of Rome's Project on the Predicament of Mankind*. Universe Books, New York.
- Meadows, D., Randers, J., Meadows, D., 2004. *Limits to Growth: The 30-Year Update*. Chelsea Green Publishing Company, White River Junction, Vermont.
- Moldan, B., Janouskova, S., 2012. How to understand and measure environmental sustainability. *Ecological Indicators* 17 (C), 4–13.
- Peccei, A., 1981. *One Hundred Pages for the Future*. Pergamon Press, New York (quoted in Meadows et al., 2004).
- Richardson, K., Steffen, W., Schellnhuber, H.J., Alcamo, J., Barker, T., Kammen, D.M., Leemans, R., Liverman, D., Munasinghe, M., Osman-Elasha, B., Stern, N., Waever, O., 2009. *International Scientific Congress: Climate Change: Global Risks Challenges & Decisions – Synthesis Report*. Copenhagen, 10–12 March 2009. University of Copenhagen, Copenhagen.
- UN, 2002. *Plan of Implementation of the World Summit on Sustainable Development*. United Nations, New York, http://www.un.org/esa/sustdev/documents/WSSD_POL_PD/English/POIChapter1.htm (last accessed on 28 July 2009).
- UNEP, 2008. *Overview of Environmental Assessment Landscape at National Level: State of State-of-the-environment Reporting*. Note by the Executive Director. UNEP/GC.25/INF/12/add.1. <http://www.unep.org/gc/gcss-x/download.asp?ID=1015> (last accessed on 28 July 2009).
- WWF/ZSL/GFN, 2008. *Living Planet Report 2008*. World Wide Fund for Nature. Zoological Society of London, Global Footprint Network. WWF, Gland, Switzerland, http://www.panda.org/news_facts/publications/living_planet_report/index.cfm (last accessed on 28 July 2009).