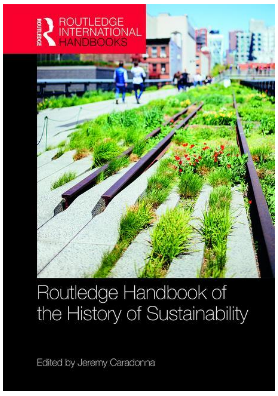

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A basis for systemic sustainability measurement

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A BASIS FOR SYSTEMIC SUSTAINABILITY MEASUREMENT

An update

Simon Bell and Stephen Morse

Introduction

In our various writings during the first decade of the twenty-first century on sustainability indicators (SIs), our goal was to take a systemic approach to understanding sustainability measurement. We had read many books and papers on SIs, some of which date to the late 1980s, but we were not entirely satisfied with what we had found. Our reading spanned an eclectic range of SIs, including ecological concepts such as the maximum sustainable yield (MSY) for fisheries, which is still in use and indeed forms part of the new Sustainable Development Goals (SDGs) released by the United Nations (UN) in early 2016, as well as other, well-established indicators, such as the Shannon-Wiener index of biodiversity (H). We also covered SI frameworks, such as the AMOEBA framework, developed by Dutch researchers for assessing the sustainability of the North Sea, and wrote about it in a form that would appeal to non-specialists. We reviewed the development of SIs as part of the concept of sustainable cities and communities during the early to mid-1990s, of which there were many following the release of Local Agenda 21, which came out of the Rio 1992 conference. "Sustainable Seattle" was perhaps the best-known example at the time that this chapter was originally written, in the late 1990s, but the integration of sustainability and SIs into municipal planning has now spread throughout the world. We were also intrigued by the growing use of SIs as a means to help achieve what were called "sustainable institutions," and these were largely based on microfinance as a means to help achieve sustainable development. Microfinance gained a great deal of attention following the first Microcredit Summit held in 1997, and was being strongly promoted by its adherents, almost as a "silver bullet," as the sustainable way forward in sustainable development. Here the indicators were designed to monitor dependency of such institutions on continuing donations from aid organizations with the ultimate intention of eliminating such funding and encouraging the institution to fend for itself and live off the interest gained from microcredit. It presented an apparent win-win in development terms with the resource poor of the world gaining access to finance to help them improve the basis for their livelihood and institutions that would gradually lessen their dependence on funds from the developed world. The example we covered was the Subsidy Dependence Index (SDI) created by the World Bank. Finally, we were fascinated by the emergence and promise of the Environmental Sustainability Index (ESI) in the late 1990s; the first attempt that we were aware of to develop global rankings of nation-state environmental sustainability based upon a complex set of indicators, data transformation and aggregation methods.

It was clear to us that SIs were rapidly growing in popularity, largely because they followed the basic adage that to manage something you have to measure it. From the 1990s onward, a whole range of new SIs appeared, including Ecological Footprint (EF), Carbon Footprint (CF), Ecosystem Based Fishery Management (EBFM), the Triple Bottom Line (TBL), the Index of Sustainable Economic Welfare (ISEW), and many others. A few of the other indicators that often appear in discussions of SIs are summarized in Table 13.1 based on year of first publication.

Be it via a single index or a suite of SIs, the general motive was to create tools that set out what it is we want to see in a "system" (a fishery, city, community, corporation, institution, etc.), and, perhaps more critically, why it is we want to see it, and to assess progress towards a goal. The new "indicator epistemology" made a lot of sense and also allowed researchers to move away from rather vague definitions of sustainability, including, it has to be said, the oft-quoted Brundtland definition ("*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*") published by the United Nations World Commission on Environment and Development (WCED) in 1987. Such definitions provide a broad and useful sense of mission with regard to sustainability, but offer little else in terms of tangible goals. Our feeling at the turn of the century was that for SI"s to "work," a measurement needed to identify real and tangible positions of sustainability, and it needed to give a clearer sense, to the individual or institution doing the measuring, what

Table 13.1 Some common sustainability indicators

Index	*Abbreviation*	*Starting year*
Happiness Index	HI	1987
Big Mac Index	BMI	1988
Human Development Index	HDI	1990
Ecological Footprint	EF	1993
Genuine Progress Indicator	GPI	1994
Gender Empowerment Index	GEI	1995
Gender-related Development Index	GrDI	1995
Corruption Perception Index	CPI	1996
Environmental Performance Index	EPI	1996
Global Competitiveness Index	GCI	1996
Human Poverty Index	HPI	1997
Living Planet Index	LPI	1998
Bribe Payers Index	BPI	1999
Environmental Sustainability Index	ESI	2000
Carbon Footprint	CF	2001
Mothers Index	MI	2001
Press Freedom Index	PFI	2002
Commitment to Development Index	CDI	2003
Democracy Score	DS	2004
Failed States Index	FSI	2005
Climate Change Performance Index	CCPI	2006
Happy Planet Index	HaPI	2006
Global Hunger Index	GHI	2007
Global Peace Index	GlPI	2007

it is that one wanted, what this wanting might imply, and how one intended to know when one had obtained what we wanted.

As noted above, at one level the SI literature of the period made a lot of scientific sense to us, but at another level we were concerned. This chapter will seek to set out some of those concerns and how we proposed at the time to address them. We certainly did not claim to have all the answers, but we did feel that a critical but supportive voice would help. This chapter is based upon a version we first published in a 1999 book with Earthscan, with a second edition published in 2000 that allowed us to include the ESI among other developments. The book was entitled *Sustainability Indicators: Measuring the Immeasurable*. While the book, and this chapter, was published in 1999, the ideas in it had been developed over the preceding years when we were both based in the School of Development Studies at the University of East Anglia (UEA), Norwich, UK. During the early 1990s, we were constantly exposed to and engaged in participatory methods to help engage the urban and rural poor communities of Africa, Asia and elsewhere.[1] These ideas of "participation" gained a prominence within development that one simply did not see in places such as the UK. The 1992 "Earth Summit" brought the concept of sustainability gradually to the fore, and in the years immediately after the summit Norwich City Council was something of a pioneer in the development of SIs within the UK, using "Sustainable Seattle" as a role model, and was thus a major influence upon us. We were fascinated by the trade-offs that Norwich were trying to address with regard to the three pillars of sustainability (economic, social and environmental) and how they saw their SIs being put into use by communities within the city. They were obviously going through a major learning curve but the "buzz" that surrounded all of this was infectious, and we could see clear parallels with our participatory work in the developing world. It was an intriguing nexus.

The context of this chapter

One of the features of SIs that struck us in the late 1990s was that they reflected a mindset based upon assumptions that suggested a mechanistic and reductive vision of the world. This was epitomized for us in the pressure–state–response (PSR) framework that had emerged from OECD and others in the 1980s, with its inherent "cause–effect" mentality but could also be seen with concepts such as the MSY. The idea that something as rich and as complex as, for example, the sustainability of a city such as Norwich or Seattle could be reduced to a few dozen SIs was a nagging concern to us and we wondered about what was being lost in the trade-offs, while trying to use SIs as a way of achieving sustainability. Not only that but, of course, much depends on who is setting the SIs and for what purpose. We did not hear many voices from those people living and working in the system and instead it seemed to us that the SIs were being created and controlled by what we might consider to be an isolated technical elite – and yet sustainability is the issue of our age and impacts on all lives. We sought to provide what we called an "alternative system mindset" that would raise an awareness of this disparity in power and also serve to provide the basis for how it may be addressed. But it has to be stressed that we were certainly not interested in only providing criticism of the dominant mindset surrounding SIs; that is far too easy and not very constructive. It also has to be said that we took a fairly eclectic view of SIs and had no intention to focus on any one of them or indeed on one group. Our intention was to focus on the ideas behind them rather than the "nuts and bolts" of the SIs. Each of the SIs in Table 13.1 is constructed in a particular way, and some of them are relatively simple in a mathematic sense while others are more complex. Where we talked about their construction in the book this was within the context of the assumptions that were made rather than the mathematics.

While this chapter is understandably dated, despite our best attempts to update it, it does provide one of the very first attempts that we are aware of to make the case for a more systemic and participatory approach to SIs, and was followed by other chapters that set out a practical methodology for how it could be put into practice. At the time of first publication we called the methodology "Systemic Sustainability Analysis" (SSA), but this later evolved into "Imagine" and more recently (and radically) into "Triple Task." It was meant to be a generic approach that could be applied in any context, be they cities, communities or institutions, and was designed to be as participatory as possible. This chapter does not cover the details of SSA/Imagine – the reader will have to look at the book or our other writings for that – but instead sets out the epistemological foundation upon which SSA was built.

The chapters before this one in the original book set out the details of some of the SI examples we mentioned above: MSY, biodiversity, institutional sustainability, etc. The breadth of examples was purposely selected to illustrate how SIs can – and indeed do – have a wide usage in sustainability, and we knew that this choice would be contentious. We expected comments along the lines of "why did you leave out indicator X or indicator Y" and we were not disappointed. Indeed, it was nonetheless quite astonishing how people had their "favorites" when it came to SIs and the degree of passion with which they held their position. Needless to say, we could not cover every indicator, even with the limited literature on SIs at the time, and we wanted to ground our analysis within practical use of SIs, rather than just offering a theoretical treatise. In this chapter the reader will come across references to example SIs from the early chapters of the 1999/2000 book, and our intention was to show how the broader points can be observed in those examples. We ask the reader's indulgence with regard to the referencing to the other chapters.

The chapter begins with our setting of the case against a reductionist approach to SIs. To some extent we feel that this is as relevant today as it was at the time of first writing. Narrowness disguised as scientific excellence, contempt for local people's values, disguised as a lofty focus on strategic issues and denial of the right to hold a contrary view, disguised as hierarchic prioritization of perspectives, are still prevalent in contemporary approaches to sustainability, and they have not gone away. By way of contrast we follow this with our systemic perspective.

The chapter presented here is more or less as it was published in the 2000 edition. We have made a few minor changes to create this version of the chapter, including some notes in square brackets, in order to help the reader follow the argument in a stand-alone mode without the other chapters of the book, but other than that it is much the same. Hence the references are rather dated, although we have updated them with the newer editions where relevant and that explains why the reader will come across publications dated after 2000. Some of the examples we cover in this chapter (and indeed book) have been superseded. The ESI, for example, was replaced in 2006 by the Environmental Performance Index (EPI) and while microfinance is still an important tool in the development toolbox, it is now regarded as part of a mix of approaches rather than the "silver bullet" it was presented as by some in the 1990s. The chapter also misses out on some other important initiatives that were just beginning to gain prominence in the late 1990s such as the rise of the Sustainable Livelihood Approach (SLA) promoted by DfID and others, and, of course, the Millennium Development Goals (MDGs) – and now Sustainable Development Goals (SDGs) and the indicator sets and targets that were/are associated with them.

We were very happy with the impact the book made, and continues to make, within the field of SIs. It is still widely cited and occasionally we receive a request for it to be made available on sites such as ResearchGate, which, unfortunately, we cannot do for copyright reasons.

The five premises we present at the end of this chapter as the basis for our participatory approach to SI development are – we would argue – still relevant to this day. Indeed, we would argue that one of the key and still under-explored frontiers of SI research is located within the general realm of "use" and all that is associated with that. For that reason, we have always resisted invitations to select what we see as the "best" SDI or even to construct one. Such questions miss the point. There is no "best" SI in an objective sense and neither can one be made; it is a mirage. Much depends upon context and also much depends upon making an SI "usable" in the sense of facilitating a beneficial impact. It is this focus on "use" and "impact" that would allow for an evolution of SIs to take place and those doing badly should be allowed to leave the stage while others can take their place or perhaps evolve in ways that enhance their use and impact. And, of course, all of this takes place within human societies that are themselves changing in many ways, including what is regarded as "need" (in a Brundtland definition sense of the term). In our view we need to facilitate the evolution of SIs and in order to do that we need to better understand it, while accepting all the time that we live "in" and "on" a planet that is itself undergoing change. SIs have to work within that change and indeed help bring about a change for the better. Whether the reader agrees with us or not we hope they will enjoy the chapter and imagine the exciting process of discovery we were going through at the time.

Speaking of paradigms and professionals

We will start the chapter by setting out the thoughts of two authors – Chambers and Hobart – who provide some seeds of thought for us to develop. Drawing from Plato's *Republic*, Chambers powerfully sets out problems with mindsets:

> Unwitting prisoners, professionals sit chained to their central places and mistake the flat shows of figures, tables, reports, professional papers and printouts for the rounded, dynamic, multidimensional substance of the world of those others at the peripheries. But there is a twist in the analogy. Platonism is stood on its head. Plato's reality, of which the prisoners received only the shadows, was of essences, each simple, unitary, abstract and unchanging. The reality, of which core professionals perceive only the simplified shadows, is in contrast a diversity: of people, of farming systems and livelihoods, each a complex whole, concrete and changing. But professionals reconstruct that reality to make it manageable in their own alien analytic terms, seeking and selecting the universal in the diverse, the part in the whole, the simple in the complex, the controllable in the uncontrollable, the measurable in the immeasurable … For the convenience and control of normal professionals, it is not the local, complex, diverse, dynamic and unpredictable reality of those who are poor, weak and peripheral that counts, but the flat shadows of that reality that they, prisoners of their professionalism, fashion for themselves.[2]

On a similar, illustrative theme Hobart argues:

> Local knowledge often constitutes people as potential agents. For instance, in healing, the patient is widely expected to participate actively in the diagnosis and cure. By contrast, scientific knowledge as observed in development practice generally represents the superior knowing expert as an agent and the people being developed as ignorant, passive recipients or objects of his knowledge.[3]

Elsewhere [in *Sustainability Indicators*] we have reviewed the state of play with SIs generally, although not exclusively without reference to local peoples and their knowledge. ESI, MSY and AMOEBA are all the constructs of experts. But, in this chapter we renew our discussion of the value of different approaches to thinking about SIs, and we question again if SIs should be "scientifically" derived in all cases. The process of their development, for instance, may be based on science, as with the MSY, but may just as plausibly be developed by a technocratic belief process or pseudo-science such as with the ESI. We would argue that this would account for as much distortion in the final SIs as would be seen in purely subjectively gathered indicators.

In this chapter we will look at a number of topics:

- changes in thinking;
- the demise of narrow scientism;
- a systemic approach to problem solving;
- introducing a range of systems approaches;
- new definitions and new thinking – holism, eclecticism, systemism;
- emerging premises for SI development.

Building upon the layered examples of sustainability indicators set out in the previous chapters (single SI, AMOEBA, sustainable cities and communities combining SIs, institutional sustainability), and taking forward the scientific or technocratic approaches to sustainability analysis which we described there, the aim of this chapter is to introduce and discuss an alternative, systemic approach to thinking and problem solving. We will compare this with what we might call the traditional, scientific and technocratic approach. In this process we draw out the implicit problem of using SIs – by definition a reductionist technique and tool – to describe sustainability – by definition a vision of wholeness. In this chapter we justify why we are using a systems approach to developing a different way of gauging sustainability. In our view, our approach builds off and develops from a practitioner perspective the work begun by Clayton and Radcliffe.[4]

Changes in thinking – from science to systems

The value of different perceptions and the necessity for individuals involved in problem situations to learn from one another in a participatory fashion are two of the themes of this chapter. Changes in perception can involve changes in thinking, and this can be thought of as a "paradigm shift." A definition might be helpful here. A paradigm is "an outstandingly clear or typical example or archetype … a philosophical and theoretical framework of a scientific school or discipline within which theories, laws and generalizations and the experiments performed in support of them are formulated."[5]

We might say that there is a Western–Middle Eastern scientific tradition that is a paradigm of thinking. This paradigm is dominant but there are alternatives to it. One alternative might be described as a systemic approach. This is an alternative paradigm of thinking, but one which we feel does not deny the value of science; instead, it complements it and is sympathetic to its contribution while recognizing that there are other contributions which can also be made by other forms of thinking, from other individuals and groups.

Alternative views or even multiple views of reality are encouraged in a true systems approach. The unpacking of ideas relating to participation, learning and thinking in different ways requires an understanding that local people often have clear ideas of their own about what is sustainable (from their own perspective and in their own terms) without an expert's view.

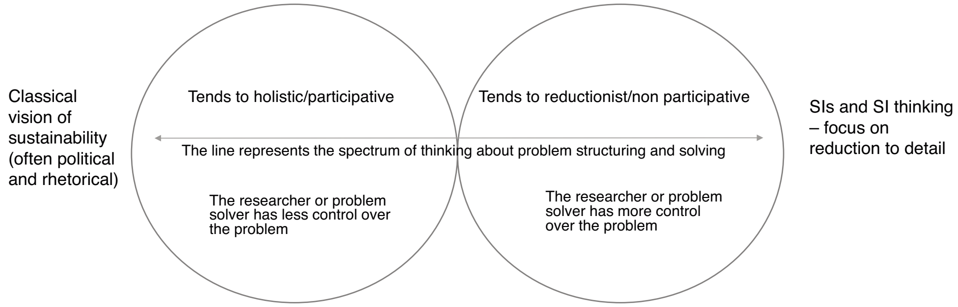

Figure 13.1 A continuum of research approaches

From one perspective the development of SIs, as set out [elsewhere in *Sustainability Indicators*] exemplify the hegemony of the technocrat. We have already reported in other aspects of the review that this hegemony is challenged by individuals within the scientific community.

There has been a dramatic change in thinking in many related areas among sections of the scientific community. The changes we are discussing here do not represent movement from a wrong way to a right way of thinking; rather it is a movement from one paradigm (and thus a set of assumptions about the world) to another. In an earlier work, Bell described this movement of mindset in terms of a continuum[6] (see Figure 13.1).

The horizontal line, the spectrum or continuum, provides one perspective of the range of thinking which can be undertaken in any problem-solving exercise. The range extends from the most reductionist to the most holistic. Koestler describes these two as referring to individuality and wholeness respectively, but again does not see either approach as being opposed to the other: "'partness' and 'wholeness' recommend themselves as a serviceable pair of complimentary concepts because they are derived from the ubiquitously hierarchic organization of all living matter."[7]

Whether we argue with the "hierarchic organization of all living matter" or not, the idea of complementary concepts is one which we support. However, it is possible to see them as being opposed. Therefore, before going on, we need to define these terms and understand more clearly what they include and exclude. In our work we intend to show that holism, in reality, always includes scientific and reductionistic modes of thinking. If holism were to be seen as exclusive or extreme, then it would not be holistic (by definition). To clarify the meaning of the terms, we will set them out against the background of current trends in the discussion within the academic community. An overall and rather dramatic phrase that we use to describe this stage of our description is "the demise of narrow scientism."

The demise of narrow scientism

Before we look at what reductionism and holism mean, let us get a clear idea about scientism.

According to Webster, scientism is defined as follows:

> Scientism n. (1877) (1) methods and attitudes typical of or attributed to the natural scientist (2) an exaggerated trust in the efficacy of the methods of natural science applied to all areas of investigation (as in philosophy, the social sciences, and the humanities).[8]

The key word to keep in mind here is "exaggerated." There are a range of approaches to sustainability which worked on the premise that sustainability was a quantity which could be more or less defined in an absolute sense: "The measure of sustainability for wheat production, as a weighted figure, is …" This form of approach (if expressed a little facetiously here) might also be defined as an "exaggerated trust in the efficacy of the methods of natural science applied to all areas of investigation." This type of approach is exemplified in sustainability analysis that makes use of mathematical formulae to gain quantitative measure. Such formulae give the analysis a degree of respectability, but the formulae themselves colossally simplify the true complexity of the context. Unfortunately, the definition of scientism used here also raises another phrase that we need to define for clarity's sake – scientific method. What is *the* scientific method?

Here, again, is Webster:

> Scientific method (1854): principles and procedures for the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of hypotheses.[9]

The method of science seems to involve observing the world in a systematic way, seeing problems (or opportunities), collecting data and testing theories about why the problems are there and rejecting hypotheses that are perceived to be "wrong." In this approach, questions arise, such as: Whose problems? Whose perception of problems? Whose justification for action? Whose idea about what data is legitimate? Who are legitimate stakeholders in the problem context? What are their views? On a similar tack, Richard Dawkins has put the essence of this issue as follows:

> If I ask an engineer how a steam engine works … I should definitely not be impressed if the engineer said it was propelled by "force locomotif." And if he started boring on about the whole being greater than the sum of its parts, I would interrupt him: "Never mind about that, tell me how it works." What I would want to hear is something about how the parts of an engine interact with each other to produce the behaviour of the whole engine.[10]

Dawkins's statement is indicative of the mindset of many scientists and also expresses the notion that within the scientific community there is an assumption that science is its own justification, that parts explain the whole and that objectivity is an accepted given truth of a well-undertaken scientific method. We will return to these issues. To get back to our definitions of reductionism and holism, it can be argued that this idea of scientific method finds its logical extreme in reductionism.

Again, Webster:

> Reductionism n. (1943) (1) the attempt to explain all biological processes by the same explanations (as by physical laws) that chemists and physicists use to interpret inanimate matter; also: the theory that complete reductionism is possible (2) a procedure or theory that reduces complex data or phenomena to simple terms.[11]

Reductionism reduces wholeness to individual parts and bits to make them understandable. Its scientific approach to understanding is to stand back, take an objective (scientific?) worldview, and seek the truth. As Bell puts it:

> A reductionist approach rejects ideas about the reality and importance of unscientific aspects of life (hunches, guess-work, instincts for rightness and even in certain circumstances illogical activity, i.e. activity which is not consistent with narrow definitions of efficiency). The universe is seen through empiricism as fixed, knowable, measurable and, therefore, predictable.[12]

Developing an understanding of what we mean by reductionism, Dawkins argues that there are two forms: "reductionist" and "hierarchical reductionist." The first type, which we might refer to as the classical reductionist, is in Dawkins's words set up by "trendy intellectual magazines" as a kind of straw man: "To call oneself a reductionist will sound, in some circles, a bit like admitting to eating babies. But, just as nobody actually eats babies, so nobody is really a reductionist in any sense worth being against. The non-existent reductionist tries to explain complicated things directly in terms of the smallest part."[13]

Alternatively, the second type of hierarchical reductionist, of which he counts himself, "believes that carburettors are explained in terms of smaller units," which are "explained in terms of smaller units … which are ultimately explained in terms of the smallest of fundamental particles. Reductionism, in this sense, is just another name for an honest desire to understand how things work."[14]

The problem is that this form of analysis does not stop at carburetors but is used in all forms of social, environmental, and ecological analyses as well. In these contexts, the limitations of the approach are already evident. Something which has many units all in various states of interaction would require a substantial effort over many years using hierarchical reductionism to understand in full. In practice what happens is that a few of the key units and interactions are singled out for analysis. Reductionism as a paradigm adopted by scientific professionals, whether the baby-eating or hierarchical form, is one extreme of the continuum we set out in Figure 13.1. It is expressive of one way of thinking about the world and how we understand it. It is arguably the approach or method of understanding the world that has been the basis for much of Western and Arab science and it has been responsible for amazing and revolutionary advances in all branches of human thought and discovery. However, on the negative side, the process of dividing up the world in order to identify small parts is questionable in many areas of understanding and has led to partial analyses and the development of answers to problems which themselves cause still greater problems (a difficulty with all approaches which extrapolate from the part to the whole).

There is another problem with reductionist approaches. Dividing an entity means that the concept of wholeness is often rendered dead by the process of examination. Studying "dead" parts can be informative but can often do little to help us understand the living whole. Furthermore, the paradigm of a reductionist can be very limiting.[15] If one considers the world as disconnected parts rather than as an inclusive whole, the resulting worldview can be restricted in terms of understanding the relationships and processes that combine to make the whole. However, we are developing the argument for our approach before providing the definitions. So far we have looked at what we mean by reductionist approaches and have argued that such approaches deal with parts. Set against this is holism, which Webster defines in the following terms: "Holism n. (1926) (1) a theory that the universe and esp. living nature is correctly seen in terms of interacting wholes (as of living organisms) that are more than the mere sum of elementary particles."[16]

Another definition takes us even further into our understanding of this approach: "The theory that the fundamental principle of the universe is the creation of wholes, i.e. complete and self-contained systems from the atom and the cell by evolution to the most complex forms of life and mind."[17]

Holism deals with wholes and in this paradigm we see the universe composed of "self-contained systems." This kind of approach can be said to find a logical end-point in the notion of the world as a living system, as expressed in the work of James Lovelock and the establishment of the theory of Gaia.[18] Systems approached as wholes are fundamental and need to be understood in their entirety. To break them down into elements is to lose the point of the wholeness. Lovelock has discussed wholeness and reductionism in terms of Gaia:

> Consider Gaia as an alternative to the conventional wisdom that sees the Earth as a dead planet made of inanimate rocks, ocean and atmosphere, and merely inhabited by life. Consider it as a real system, comprising all of life and all of its environment tightly coupled so as to form a self-regulating entity.[19]

Lovelock went on to develop this theme in terms of sustainability and its corollary, health:

> Only when we think of our planetary home as if it were alive can we see, perhaps for the first time, why farming abrades the living tissue of its skin and why pollution is poisonous to it as well as to us. … The living Earth's response to what we do will depend not merely on the extent of our land use and pollutions but also on its current state of health.[20]

To adopt an approach that deals with wholes has many implications. Possibly the first point is to recognize that the premise of the traditional, reductionist scientist – which is that the knowing process works by "a procedure or theory that reduces complex data or phenomena to simple terms" – is no longer valid for us (nor would we agree that simplicity depends on reductionism). This does not mean that the traditional scientific approaches are invalid in all cases and in all contexts. However, if we are to understand complex wholes, we will need to adopt a different paradigm or extend the old. Later in this chapter we will describe a process within the systems thinking movement, from first-order to second-order cybernetics, which attempts to explain this adoption of a different paradigm. The process can be thought of as a movement of mindset from an observer divorced from context (first order) to an observer deeply involved in the context (second order). For now, it is worth noting the comment of Buddrus upon this process: There is a parallel between first- and second-order cybernetics (which we discuss in more detail shortly) and with the movement from reductionist to holistic paradigms:

> What is needed is a transformation of awareness from cybernetics of the first order to cybernetics of the second order … This seemingly simple transformation has fundamental impacts when applied to self-awareness and belief systems. It can cause considerable mental problems in orientation: the transition of oneself from an observer of a reality which is considered to be outside oneself, to a participant in the same reality, and then towards being a co-creator of that reality, requires fundamental cognitive and emotional reorientation.[21]

In understanding sustainability, we argue that we need to recognize and work with unities, of which we, as observers, are also a part. This is not to suggest that complex unities cannot be better understood by identifying key components, interactions and processes, but that scientific approaches need to be seen in terms of the greater whole of which the observer is a part; the observer therefore brings ideas and actions into the context.

The traditional scientific paradigm has its value and its place in our understanding, but as one view among many – and we would argue that it should not be the meta-theory that dominates all others. The benefit of the holistic approach is that we can deal with complex wholes without losing their complexity or "killing the whole,"[22] and we can ask wider questions than those which relate to individual parts. The downside for our analysis is that analysis itself becomes terribly difficult and can lose all sense of focus and organization if the practitioner is not careful. To make holism work we need to grasp the principles of systems thinking which lie at its heart.

The "seed" idea that we want the reader to take away is the value of a more holistic approach within the analysis and measurement of sustainability.

Systems approaches to problem solving

In this chapter the word "system" probably arises more often than any other. Often, the word is not used in a strict and exact fashion. In terms of daily usage, the word is almost redundant, occasionally meaning little more than "thing" or a set of related things (for instance, a dish washing system, a driving system, an office system). We now want to develop what we mean by system – but we should say at the outset that there is considerable discussion within the systems community about this definition and there are many interpretations of what a system is. There is also a vigorous and developing discussion on systems and sustainability.[23] Here we make use of widely accepted definitions. One view of the systems approach is, as the American systems thinker Peter Senge puts it, the primacy of the whole: "The primacy of the whole suggests that relationships are, in a genuine sense, more fundamental than things, and that wholes are primordial to parts. We do not have to create interrelatedness. The world is already interrelated."[24]

From this perspective, the idea of systems is a perfect foil for Senge's thinking: "A system is a perceived whole whose elements 'hang together' because they continually affect each other over time and operate toward a common purpose. The word descends from the Greek verb *sunistánai*, which originally meant 'to cause to stand together'. As this origin suggests, *the structure of a system includes the quality of perception with which you, the observer, cause it to stand together.*"[25]

This view of systems has echoes of the work of Peter Checkland in the UK, where there is great emphasis placed upon systems existing within the human mind, as perceptions, which we project into the world as a means of describing and understanding it.[26]

Systems thinking has a number of strands but is fundamentally based upon a few simple concepts. The lists of components vary with different authors, but there are substantial similarities between them.[27] For our definition of a system we make use of the one provided by Avgerou and Cornford.[28] These authors present the major features of systems as six-fold, and these are set out in Table 13.2.

Although there are different ideas about the fundamentals of systems, a systems analysis of a problem context can be undertaken. Such an analysis, whether of an information system or an ecological or a social organization, would be expected to provide an understanding of processes and relationships within a "wholeness." Emerging from this set of features and the earlier description taken from Senge, we can say some fundamental things about the basis for a systems approach:

1 System is a term that can be applied to a vast number of different things, and this application is variable depending upon the individual or shared perception of an onlooker. A system can be a physical entity (such as the carbon cycle), a social entity (a political constitution), or an abstract idea (the idea of sustainability – as we shall demonstrate).

Table 13.2 Defining features of systems

Systems feature	*Description*
Identification of a boundary	This defines the system as distinct from its environment
Interaction with the environment	The environment is not the system itself since it lies outside but it does affect it
Being closed or open	Concerns the interaction of the system with what lies beyond its boundary
Goal-seeking	A system is capable of changing its behaviour to produce an outcome
Being purposeful	Systems select goals
Exerting control	A true system retains its identity under changing circumstances

2 Once defined the system will have a boundary (unless it is an infinite system!), and the boundary is defined by the onlookers – or we might say stakeholders. Ison, quoting Russell, draws actor and boundary together in saying "the observer is seen as part of the system's construction and not independent of the system. Russell takes this debate further. He emphasizes that 'a system' is always a short-hand way of specifying a system environment relationship."[29]

3 The system conceived by the onlooker will take place in a larger environment that is defined by being outside the boundary agreed. The environment will have a relationship with the system but the degree to which it affects the system will largely be dependent upon the system itself.

4 Systems are changing and can be self-changing. As a purposeful wholeness, the system will be expected to seek its own optimum.

The final point is critical. If a system is purposeful then it might be expected to seek its own continuance and therefore sustainability.

Figure 13.2 provides one view of the systems approach so far described. Although it is rather artificial, let us compare this systems view of the world with an equivalent, taking the most reductionist stance possible (Figure 13.3). The difficulties that this approach raises for the study of sustainability can be juxtaposed to the advantages of systems as set out in Table 13.3.

Arising from the discussion thus far, the systems approach to understanding complex contexts is of interest for three reasons:

- The system is a construct in the mind of the onlooker(s) or stakeholder(s); the system is brought forth or created as an artificial construct by those studying it. Therefore, the system can be the result of an eclectic process, which Webster defines as elements drawn from various sources.
- The system is a whole and has the potential to change itself.
- The system is involved with its own sustainability; it can change as its environment changes in order to be sustained.

These three seed ideas, developing on the idea of wholeness set out in the previous section, will be fundamental to our thinking in later sections. So far we have described the reductionist

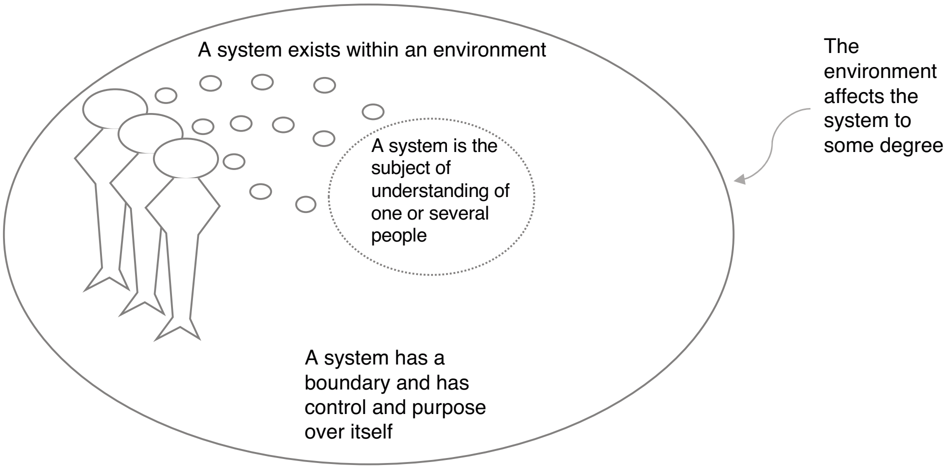

Figure 13.2 A systems view of a particular context

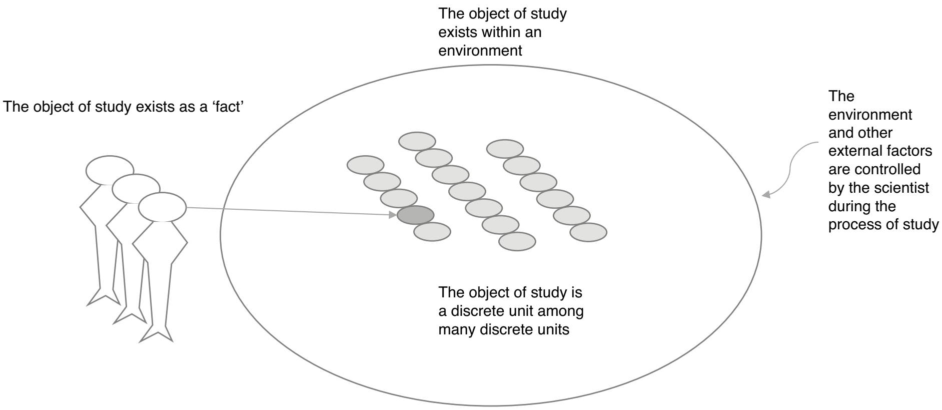

Figure 13.3 A reductionist view of a particular context

Table 13.3 Comparison of systems and reductionist approaches

Systems approach	*Reductionist approach*
The problem is shared by legitimate stakeholders in the problem context	The problem is in the mind of the scientist
A wholeness is reviewed	A part of a complex whole is analysed
The environment affects the system	The environment is expected to be controlled
The boundary of the system is flexible and dependent upon the perception of the stakeholder	The boundary of the part is defined by the expert

mindset, which we argue is behind much of the scientific method expressed by many of the conventional advocates and developers of SIs. We have not yet discussed systemic approaches to problem solving or SI development, but for now we want to briefly describe some forms of the systems approach to problem solving.

A range of systems approaches

As we noted in the previous section, there are numerous ways of thinking about and applying a systems approach. This is quite consistent with the systems view that the variable perceptions of different stakeholders in a problem context are legitimate but need to be justified. In this section we will quickly describe four different approaches, some analytic and some more descriptive, which are either explicitly or implicitly systems-based. We argue that they can all be understood in terms of the axis that we set out in Figure 13.4. The approaches that we illustrate here are from the fields of problem solving, problem description, project appraisal, and project planning.

The first form of systems approach is set out in Figure 13.5 and is known as the soft systems approach or soft systems method (SSM).

A problem-solving approach – the soft systems method

To describe this approach, we set out the main elements in Figure 13.5. This provides a view of all the elements of the approach and shows the manner in which they combine.

The SSM was developed, and has since been extended, by Peter Checkland and colleagues at the University of Lancaster in the UK, and has since been developed by him and others.[30]

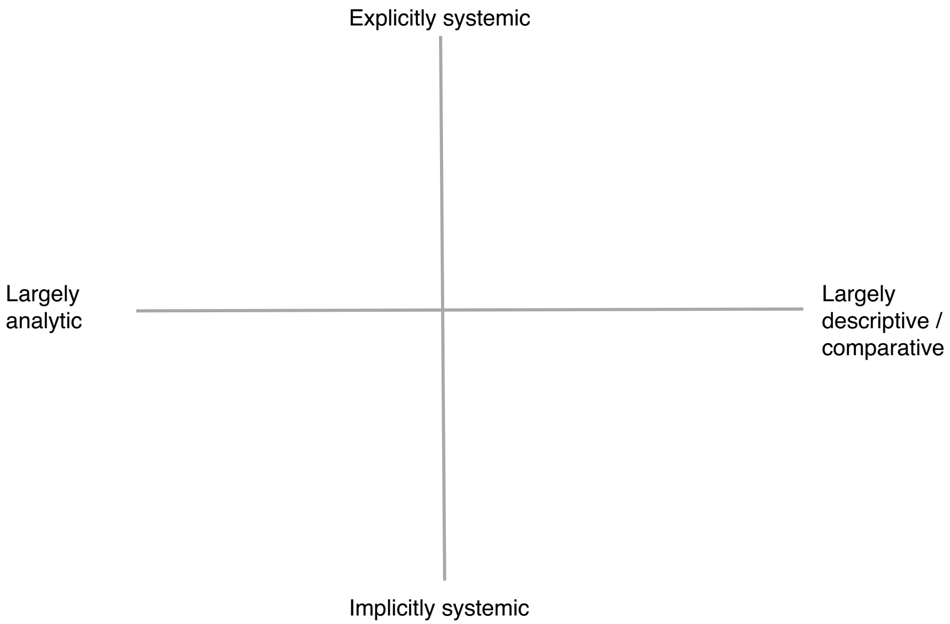

Figure 13.4 Axis for comparing systems approaches

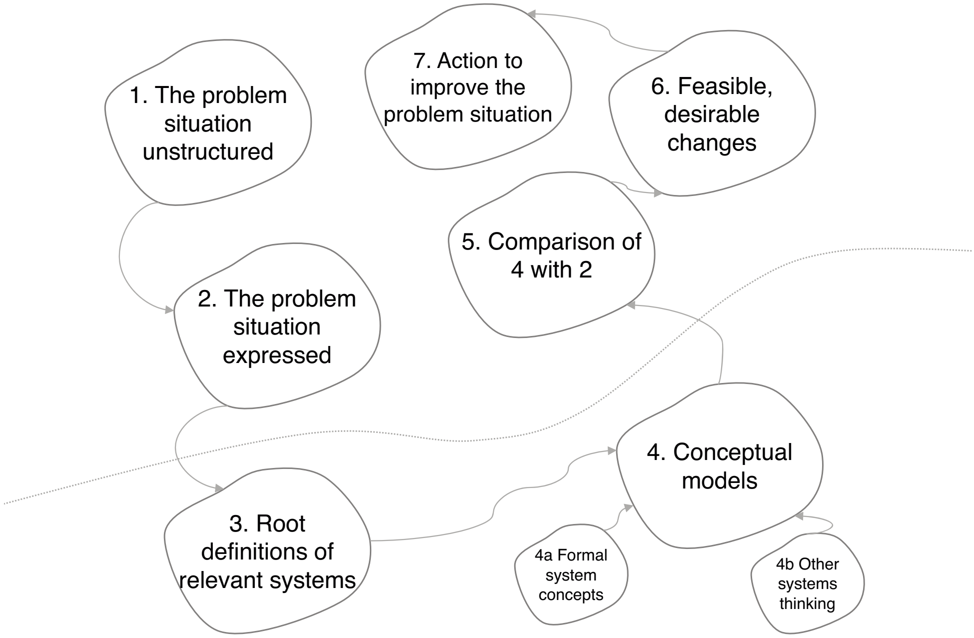

Figure 13.5 The soft system method

Today the approach is taught by universities and consultancy agencies in many locations and has taken on many nuances depending upon the requirements of the teaching and the specific aims and objectives of the practitioners. The way in which we develop our perception of the approach varies from others but is essentially related to the format set out by the Open University.[31] From our perspective, the fundamental insight of Checkland's work is that problems in the world are usually "soft." By soft we mean that objectives are unclear, purposes are muddled and solutions are not usually initially available. This contrasts to the traditional "hard" approach (of, for example, reductionist science, which sees problems as being definable and objectives as self-evident and open to empirical study), which has been the hallmark of problem investigation in much of academia. We will not go into detail about the nature of SSM, but features worth bringing out from Figure 13.5 are:

- It is often necessary to spend considerable time in perceiving the problem and exploring the tasks and issues implicit in it.[32] These are set out in elements 2 and 3 in Figure 13.5.
- There is not an assumption that the "problem" is clear. It may have many definitions.
- The next key point is that a definition of a transformation within the problem context needs to be agreed upon (element 3). It is not assumed that because, for example, I am a fish biologist looking at the problem, the solution to the problem will be maintaining production (as is often the case in MSY). We need to see that other domains may contain the "solutions" to a given problem. For example, in the Peruvian anchovy fishery, which collapsed essentially because of overfishing, the emphasis of fishery scientists was originally on setting an MSY of production, which itself became invalid because of the El Niño effect. But if the emphasis was on helping the fishing industry in more general terms,

perhaps other perceptions could have been brought to bear, such as livelihood diversification.

- The next point is that identifying a transformation is the basis for an activity plan which is then compared to the problem context as first reviewed (elements 4 and 5). It is often the case that in analyzing a given problem, one loses sight of the issues that first excited one's attention. This feedback loop requires constant recalibration and reappraisal of the original problem as first perceived.
- Stakeholders are brought together to discuss the analysis (element 6), whether that be community members affected by a specific development, or, say, an aboriginal group whose fisheries could be affected by a new approach to species management. Ideally this is not an expert-driven approach and stakeholders are performing the analysis too, but this idea of inclusivity prior to action is another strong feature of the SSM approach.
- Finally, the process is cyclical. One does not definitively "fix" problems. Rather, one achieves ways forward mutually and then works on the next issue that arises (elements 7 and 1).

The main features of the soft systems approach are that the process of thinking systemically about problems is iterative, participatory, and ongoing. The second systems approach arises from the work of Senge et al. and relates to his team's work on the learning organization (LO).[33]

Problem description – the learning organization approach

Senge has set out five "disciplines" for encouraging and developing the learning organization that is the focus for his work in making use of systems approaches. The five disciplines are: systems thinking, personal mastery, mental models, shared vision, and team learning. As with the work of Checkland and his collaborators, the five disciplines have been developed and applied by various agencies and academic institutions, in different contexts, and have produced a rich range of approaches and adaptations.[34] The five disciplines as we interpret them are set out in Table 13.4 with a brief definition of each discipline, a note on where they might be applied, and some indication of what might be the expected outcome of their application.

As with the work of Peter Checkland, the LO approach does not see problem solving as being easy or objective. Focusing heavily on dialogue and team learning, the list of outcomes shows how closely the LO approach relates to the relative merits of scientism and systemism. In defining sustainability, group consensus and insight are more vital than reductionist objectivity. In the LO approach, the systems approach is a core discipline associated with others in order to provide learning and consensus. As with SSM, processes are important and systems analysis relates to cycles of understanding. Senge makes use of what he calls "archetypes" to be compared against the real world. One such archetypal model is shown in Figure 13.6. In the snowball archetype, a situation of continuous decline or improvement is described – here demonstrated by the River Cynon example described earlier. The snowball is not a virtuous cycle in either contexts of decline or growth – it epitomizes continuous change, feeding on itself. It therefore requires a balancing and adapting action (contained in the balancing archetype described by Senge) to cause stability and equilibrium.

By using a range of archetypes such as these, situations can be considered and the consequences of actions modelled and discussed by stakeholders in the process. At first glance the approach may appear to be largely descriptive and comparative,[35] but it does allow contexts to

Table 13.4 The five disciplines

Discipline	*Definition*	*Where applied?*	*Expected positive outcome?*
Systems thinking	This focuses on links and loops – loops that can be reinforcing (small changes become big changes) or balancing (pushing stability, resistance and limits).	Contexts where cause and effect are unclear	Description and insight
Personal mastery	Numerous interpretations; but one threefold explanation of what this means is: (1) Articulating a personal vision. (2) Seeing reality clearly. (3) Making a commitment to the results you want.	Context where change processes threaten individuals' ability to cope	Empowerment
Mental models	We are all making mental models of the world as we experience it. The fifth discipline develops this tendency. Such models are based upon reflection and enquiry.	Any action learning situation	Clear self-analysis
Shared vision	Built around six core ideas: (1) The organization has a destiny. (2) A deep purpose is in the founders' aspirations. (3) Not all visions are equal. (4) There is a need for collective purpose. (5) There is a need to provide forums for people to speak from the heart. (6) Creative tension is useful and can be encouraged.	Contexts of dramatic change	Organization-wide clarity of purpose
Team learning	Learning through conversation, dialogue and skillful discussion – the aim is to achieve "collective mindfulness."	Contexts of team development	Group consensus

be reviewed for change processes, and therefore it appears a useful method to apply to analyzing sustainability – particularly where known forces of change are at work and their consequences need to be considered.

Appraisal – the participatory rural appraisal approach

Participatory rural appraisal (PRA), we argue, is a systemic approach to the range of issues that arise in project appraisal. Although PRA is not meant to be explicitly a "systems" approach, it contains much in common with what we described so far as central to a systems ethos in understanding complex situations – there is a shared epistemology.[36] There is no consensus as to what constitutes PRA techniques as opposed to any other set of methods for analyzing populations. As with SSM and LO, the PRA approach has been taken up and developed globally, and there is a rich literature on the various ways in which it has been applied and developed.

Working from literature produced from various sources, some of the techniques for PRA are set out in Box 13.1 with a brief description of what they involve.[37]

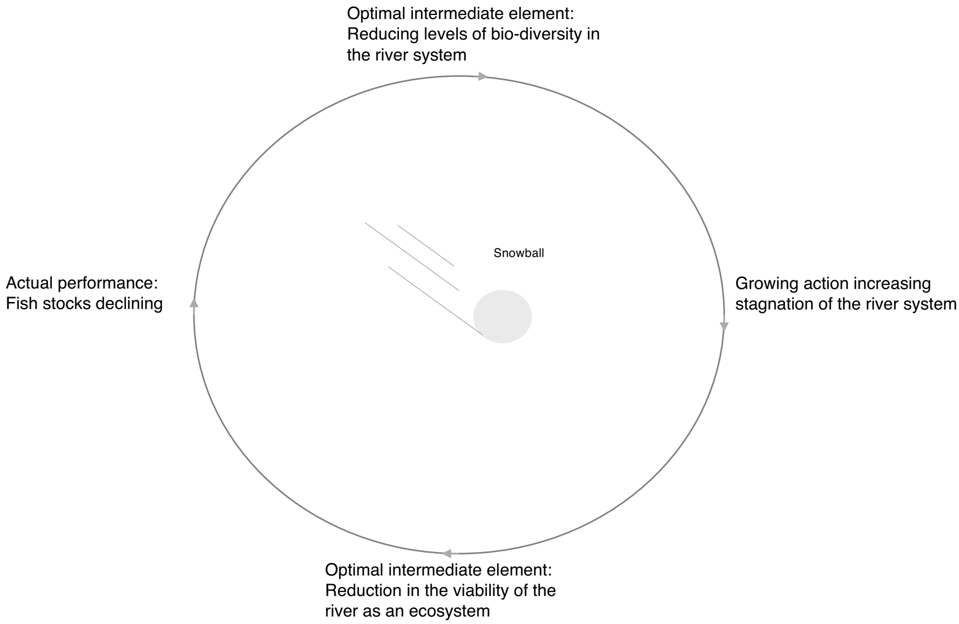

Figure 13.6 The reinforcing loop (snowball)

Box 13.1 Some of the techniques in participatory rural appraisal (PRA)

- *Participatory mapping and modelling* (all participatory diagramming). This technique encourages local people to draw and mark the ground with colors, sticks, cigarette packets and string (and anything that comes to hand, although one should be wary about bringing in pens and paper as these can block local people from expressing their views readily) in order to show variation from a local perspective of "mappable" phenomena.
- *Transect walks and participatory transect*. To gain a quick overview of local practices, the team walk a transect through the appraisal area.
- *Seasonal calendars*. This is a form of modelling or mapping where villagers are asked to show the seasonal or monthly distributions of inputs and outputs.
- *Activity profiles and daily routines*. This is used when it is important to understand how daily patterns of activity are evolving.
- *Time lines*. When there is a need to gain a view of local history. The time lines can be collected at community interview (see rapid approaches below).
- *Local histories*.
- *Venn (Chapati) diagrams*. To gain a systemic view of the overlaps between different groups, commodities, inputs and/or outputs in a village setting.
- *Wealth rankings*. To gain an insight into the distribution of wealth over time and space. Small groups can be asked to rank the wealthiest from the poorest in the village. Often piles of stones are used to indicate relative wealth. This can be done as part of the exercise to map the village social context. In this case the community as a whole might rank itself.

- *Matrices*. Communities are asked to set out a matrix for technologies and to set out attributes in the rows. Another approach might be to map the productive area of the village and then to set out problems and opportunities in the rows.
- *Inventory of local management systems and resources*. This can be used in focus group or community group interviews (see below). Local people know their management practices best. The interviews focus on how local management is undertaken. Use local classifications wherever possible.
- *Portraits, profiles, case studies and stories*. These include summaries of family histories, farm coping mechanisms, conflict resolving. Use focus group technique as described below.
- *Folklore, songs and poetry*. Sitting, listening (usually with an interpreter) and absorbing – principles of direct observation; see below.
- *Team interactions*. Evening discussion and morning brainstorming sessions with teams which can be mixed and changed but must be carefully monitored by one member of the team. The monitor should record locations of people during the interaction and draw attention to the way the team works: (i) draw a circle around the person who is talking; break the circle when they are interrupted; (ii) draw an arrow from the talker to the person being talked to with a note of duration; (iii) record each contribution in seconds.
- *The night halt*. When it is important to show that the outsiders are "with" the village: too often consultants are not in the village when people have time to talk – in mornings and evenings.
- *Survey of villagers' attitudes*.
- *Intriguing practices and beliefs*. When we have the time to try to absorb the richness of local life – taking a sideways look at expected project outcomes.
- *Key informant interview*. Interview a select group of individuals. They are preidentified as having insights and are usually owners or major stakeholders in problem areas. They are usually preidentified as being "reliable."
- *Focus group interview*. A recent addition to semi-formal techniques. The technique is historically based in market research to gauge reaction of customers to new products. The focus is on reactions to potential changes. Participants discuss among themselves.
- *Community interviews*. Focus groups are for local people to discuss their own issues and problems; in community interviews the investigator asks questions, raises issues and seeks responses. The primary response is to and from interviewer to participant.

Chambers, the major author of the approach, indicates three pillars to PRA. These are the:

- behavior and attitudes of the development professional;
- need for sharing between different actors;
- requirement for participatory methods.[38]

These three pillars are set out and developed in Figure 13.7.

SSM has many advocates and LO is now adopted by many practitioners in management science, but PRA has been adopted by the development community almost as a new orthodoxy in project practice. This has raised questions about its value and there is considerable debate around the capacity of PRA to work in context. Biggs indicates three concerns with the approach:

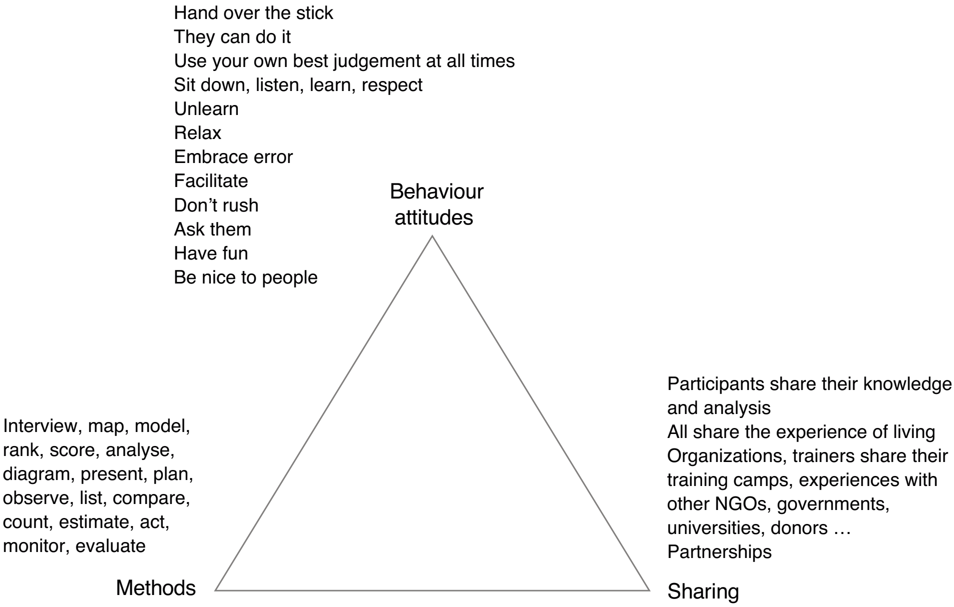

Figure 13.7 Three pillars of PRA

> Firstly, there is the risk that an exaggerated confidence in certain techniques and management tools associated, in this instance, with "participatory" approaches, can limit critical awareness of how their application proceeds in practice … Secondly, there is a tendency to assume that simply "including" certain kinds of people (in a team process) is sufficient to affect the "participation" of the group which they are taken to represent … Finally, it cannot be assumed that "inclusion" guarantees meaningful participation.[39]

We will return to this critique later as we develop our participatory model for measuring sustainability. PRA is widely regarded as including populations of stakeholders, and it values the insight of this population. As with both SSM and LO, all three approaches provide the stakeholders in a given context with a say in the process of understanding, as well as responsibility for the sustainability of the enterprise and a legitimate place in developing an analysis. PRA is interested in setting boundaries to appraisal, but not in narrowing the boundary to a pre-specified topic. The object of appraisal is treated as a system since it is recognized as a whole.

In this section we have been considering the PRA approach as a systemic manner of dealing with project appraisal. However, if systemism can work in appraisal, can it be applied to project development, planning, monitoring and evaluation? In the next section we examine one approach to such applications.

Project handling – the logframe approach

The logical framework can be a useful method for measuring sustainability, and incorporates cost-benefit analysis (CBA) to provide indicators of process and project impact. Much has been written about the logical framework or logframe (LF) approach to project planning and management.[40] Unlike SSM, LO and PRA, LF does not have a single point of reference or champion as provided by Peter Checkland, Peter Senge and Robert Chambers respectively. LF appears as an evolved approach with no single point of original authorship.

This approach is only implicitly systemic in that it encourages its users to think widely about their project and to represent it as a totality, with both hard and soft elements clearly demarcated. The approach can be participatory and requires a great deal of agreement within the project team to work effectively.[41] The basic LF is a four-by-four matrix and is shown in Figure 13.8.

The LF can be both descriptive and analytical. Descriptively, it allows a team or stakeholder group involved in a project to set out the formal aspects of the project (activities that lead to outputs, result in purposes and, hopefully, achieve the project goal), and also the informal or "soft" elements of the project at each level – this is shown in the "assumptions" column on the right. Therefore, the project is described in both soft and hard, formal and informal terms. Furthermore, the middle two columns allow the project to be monitored and analyzed, either qualitatively or quantitatively, in terms of the performance of the project. Performance can be measured on activities (the spending of money and the achievement of activities to date), on outputs (giving a notion of the projects, impact – has it achieved what it originally set out to do?), and at the level of purpose (evaluation – was the result as expected?).

In sum, the approach can be said to be systemic in that it sets a boundary around a complex unity and explicitly treats this unity as a whole. It should involve a range of participants in the project process (although this is not always the case in practice), and the project as a system is able to change in response to changes in the environment (it has properties of control and self-regulation). But how is the LF approach applied? When employing LF to develop or monitor a project, project activity is set out in the bottom-left cell. The activity described here can be measured and controlled by use of the related verifiable indicators and by means of verifica-

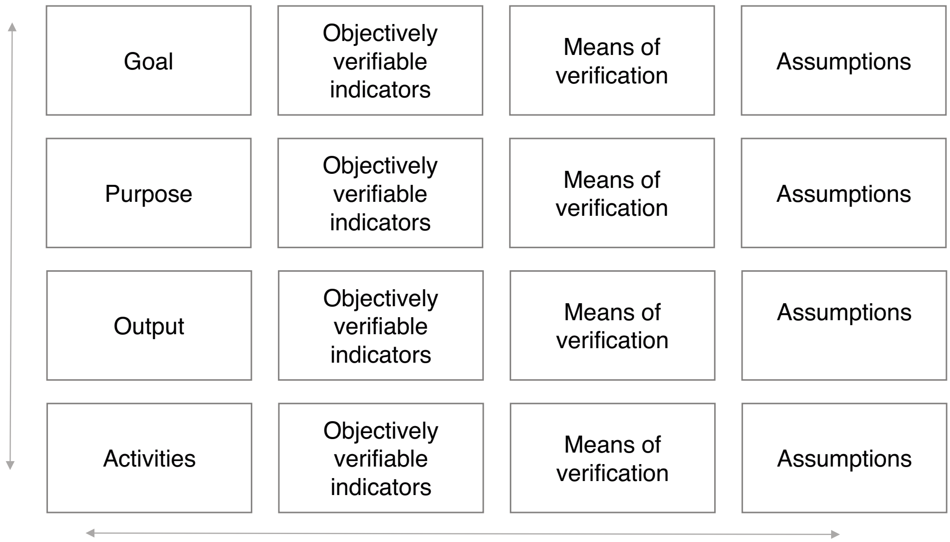

Figure 13.8 An outline of the logical framework concept

tion.[42] On the second row from the bottom, directly above activities, the verifiable indicators relating to outputs can be regarded as indicators of the project's impact. On the third row the indicators of purpose can be used as the main evaluation points for assessing the project's capacity to meet its original objectives. All indicators can, if required, be developed as indicators of sustainability. The diagram might be better understood as set out in Figure 13.9.

The LF approach might be argued to be "goal driven" and rather positivist.[43] The approach depends on the method of application for its systemic content (is it participatory; is it inclusive?) by the team involved.

Although LF was not used in the Norwich 21 example of sustainable cities discussed earlier in the book, we could apply it retrospectively to the first elements of the first column as shown in Table 13.5.

An overview of systemic approaches

The four systemic approaches are set out below in one frame (Figure 13.10) in terms of whether they are implicitly or explicitly systemic, whether they are problem solving, or descriptive or comparative. Before accepting that an approach is systemic or not, the quote from Buddrus given earlier in this chapter should be remembered as a caution (see above).

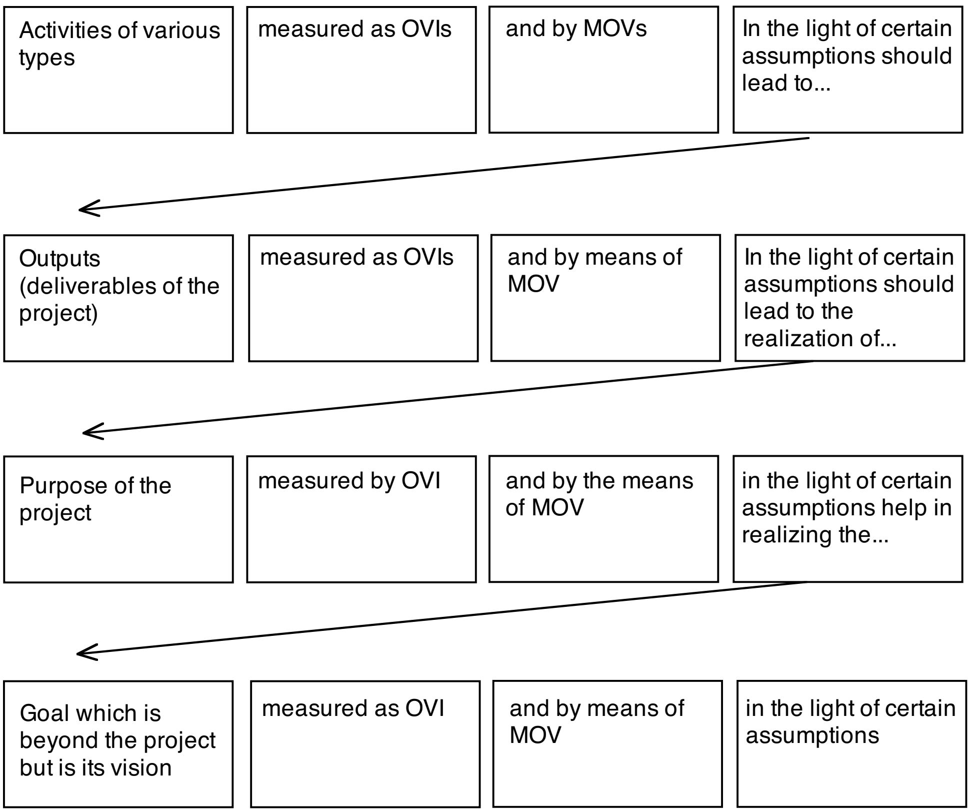

Figure 13.9 Explaining logical frameworks

Table 13.5 A partial log frame expression of Norwich 21

Goal (this would relate to the achievement of sustainability in cities at a national level)	*Objectively verifiable indicators (similarly this would relate to the measurement of sustainability in cities at the national level)*
Purpose	
"Promoting a prosperous and dynamic city with policies for sustainable long term growth and development that take account of the needs of the present generation of people without comprising the ability of future generations to meet their own needs" (Norwich 21, 1997)	This would relate to the achievement of the impact indicators set out below and the merging realization of sustainability which they would produce. This is an exercise for the owner of the Norwich 21 action plan
Outputs	
1. Clean air	1. 0 days poor air quality due to nitrogen oxides measured at Guildhall
2. Less domestic waste	2. Waste produced 0.36 tonnes per head, waste recycled = 0.018 tonnes per head
3. etc.	3. etc.
Activities	
Test against UK national air quality strategy standard, etc.	etc.

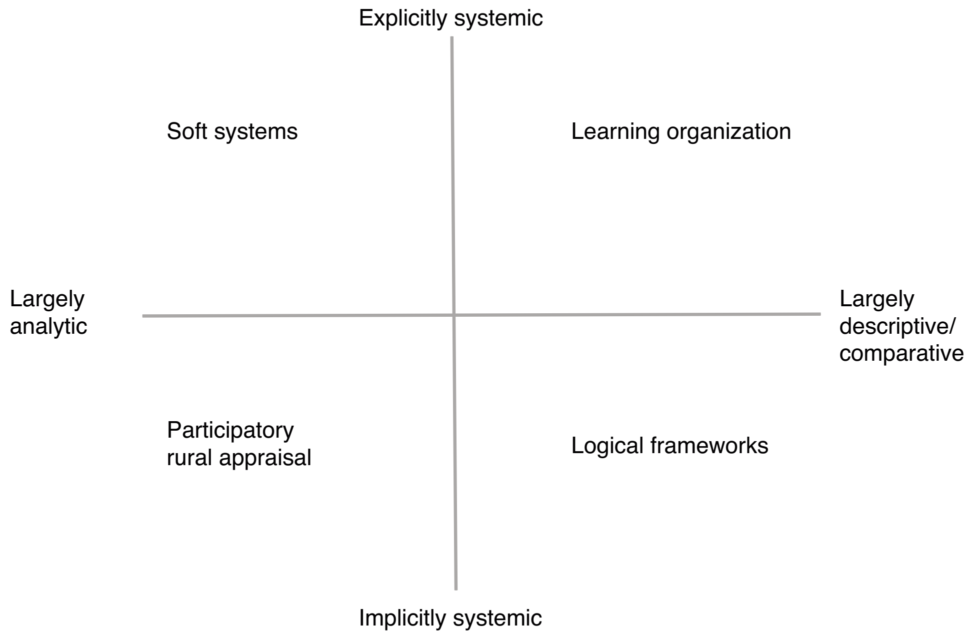

Figure 13.10 The four systemic approaches

A point made regularly among groups of managers training in the use of LF is the tendency to simplify the approach to "box-filling" in isolation, rather than exploring and describing a project context in a participatory manner. It is almost always possible to apply a systemic approach in a reductionist manner and thus lose the value of the undertaking.

In this section we have tried to demonstrate that systems approaches can vary considerably and can do quite different things, but that they retain some of the core ideas of what constitutes a systems study. We now go on to look at what implementing the systems perspective can mean to the development of a viable assessment of sustainability.

New definitions and new thinking – holism, eclecticism, systemism and future casting

We are interested in understanding the issues surrounding the measurement of the "immeasurable." It is our contention that the idea of measuring sustainability in absolute, traditional, objective, empirical, reductionist terms, as with SIs, is non-viable. It cannot be done because sustainability itself is not a single thing. Or better, it can be done but it will be done badly, oversimplifying complexity and reducing a variety of relevant and legitimate views and understandings to the dominant mindset of the scientist or analyst. A façade of objectivity can be generated, as with the ESI, but it is just that – a façade. Sustainability is, we believe, a highly complex and contested term open to a wide variety of interpretations and conceptualizations. In short, it is a concept dependent upon the various perceptions of the stakeholders residing within the problem context. Sustainability is not an absolute quantity to be measured. Sustainability changes as an idea (or as a system) in terms of the perception of the onlookers and they will also change with time. According to this approach, the view of sustainability must be developed so that it takes on-board the legitimacy of different views of the concept. When we adopt this mindset, we see that the view of a reductionist (even a mythical, "baby-eating" reductionist) may be legitimate and valuable. However, it is equally true that the view of a local inhabitant may also be legitimate and, although it may vary from that of the technical expert, may contain richness and detail that the expert does not have access to or actually loses in applying analytical tools. Narrow, expert-driven conceptions of sustainability have been problematic; the model for considering sustainability that we develop in this book is therefore developed around three premises. In measuring the immeasurable we are concerned with:

- eclectically derived, systemic wholeness; that is,
- the perception of systemic wholeness which derives from legitimate sources; and
- the sustainability of wholeness which is under observation.

In the following pages we will develop these themes in our approach and we will conduct our analysis using systems tools. It is not the purpose of this text to explore all the thinking and conceptualization behind the systems movement. However, we are aware that we are dealing with sets of concepts that require detailed analysis and justification. Such work has been undertaken elsewhere.[44] Behind the discussion of systems approaches and techniques explored in this chapter lies a theoretic discussion specifically expressed in the field of cybernetics; another definition is required. Here is Webster:

> Cybernetics … Gk *kybernetes* pilot, governor (fr. *kybernan* to steer, govern)… (1948): the science of communication and control theory that is concerned esp. with the

> comparative study of automatic control systems (as the nervous system and brain and mechanical-electrical communication systems).[45]

Developing upon this definition, the term was described by Wiener as the science of "control and communication in the animal and the machine."[46] Cybernetics is now organized into first, second, and third order categories which can be said to involve in sequence:

- the understanding of "feedback loops"[47] and control systems to explain how the world works in a scientific sense;[48]
- the understanding that individuals construct their own "reality"[49] and that this should lead to tolerance of alternative views;[50]
- reflection on the understanding of multiple realities and the means by which these multiple realities can be contained in a consensus view.

As Umpleby puts it:

> Whereas the first phase of cybernetics took an empirical approach to the nervous system, the second phase of cybernetics created a philosophy based on the findings of neurophysiological investigations. The third phase, the cybernetics of conceptual systems, looks at the community that creates and sustains ideas and the motivations of the members of that community.[51]

Our discussion in this chapter reflects thinking in the categories of first, second, and third order cybernetics.

Perhaps the issue of multiple and inclusive worldviews in the matter of sustainability is expressed most clearly in the work of Maturana and Varela.[52] Their work relates to the nature of biological systems but has implications in many related fields and is, at present, the source of much discussion among systems thinkers.[53] The core idea we wish to make use of here is that of "autopoiesis": the capacity of systems for self-making, self-renewal, or self-production. In a revolutionary departure from much of the background of systems thinking, Maturana and Varela postulate that systems are closed but there is an intimate interaction with the environment within this closure. The environment is not "out there," but as Morgan puts it, "the theory of autopoiesis accepts that systems can be recognized as having "environments" but insists that relations with any environment are internally determined."[54]

The exciting element for the sustainability debate is in working out what autopoiesis means – again, quoting Morgan, "Autopoietic systems are closed loops: self-referential systems that strive to shape themselves in their own image." Morgan gives some examples of what this means in practice. An example drawn from the fishing industry is illustrative, especially given the collapse of many fisheries in recent decades:

> the commercial fishing business … is also in the process of destroying itself because, historically, the key actors involved have seen themselves as being separate from the fish. The firms involved have enacted identities in pursuit of short-term goals, with the result that their actions have, in many parts of the world, already depleted the resource on which their business relies.[55]

The lesson seems to be that, for a truly systemic (or second or third order cybernetic) view of complex situations, the autopoietic approach explains why organizations can be progressive and inclusive or narrow and blinkered. Science, therefore, as an autopoietic system, can close itself off to factors which are not seen as central to the mindset of science itself. In this sense it can be as blinkered as the fishing industry is today. Revelations concerning the sudden explosion in cod stocks in the North Sea in 1997 suggest that the scientific analysis of sustainable fishing levels had been proved wrong – resulting in an explosion in stock rather than catastrophe.[56] This dramatic increase in stocks occurred against a background of numerous fishing boats being broken up and their crews made unemployed. In Morgan's example of a limited view, quoted above, the culprits are the fishing industry. In this example the problem is the limited understanding and incorrect quantification of stocks as provided by scientists. A fishing industry representative said on BBC Radio 4 that the job for the scientists was now to build trust with the fishermen since the scientists were no longer believed. However, the condition of the North Sea fish stock at the time of writing appears again to be facing catastrophe. The challenge for those predicting such crisis is to convince the fishermen that the future situation is more accurately understood than it is in the present. This raises the issue of futurology.

In an autopoietic sense, the systems approach to sustainability must mean that we include as much of our environment as possible in our self-referencing. As a result, the views of all involved in contentious projects are included (and their opinions valued) in the decision-making processes.

To truly engage systemically in the understanding of sustainability one final and often underutilized aspect of the wider environment needs to be "swept in" and that is the future condition of a system in question. After all, sustainability is about decisions we make now and how they impact upon this and future generations. Thus in the development of any plan, one must consider effects deep into the future. One of the great weaknesses of organizations is their resistance to change in the context in which they are embedded. For sustainability it is important to develop future plans that are capable of meeting the needs of tomorrow as well as today. Scenario Making is one means to grapple with the significant and unpredictable issue of possible future outcomes.

Michel Godet, a major thinker in the "French School" of Scenario Planning, has commented that "unfortunately there are no statistics for the future".[57] Matzdorf and Ramage add:

> no-one can predict the future. Many people have tried – from prophets to mathematicians – but most predictions go awry. One only has to look at the divergent predictions of Global Climate Models (GCMs), created at great expense of time and money, to predict future global climate to see how uncertain all this can be … Even here it is only the natural system that is being modeled based on variables such as greenhouse gas emissions. The models have now variables for human behaviour. However, we can identify a number of possible futures, and especially the areas in which major change is likely to occur. Scenario Planning is one way of doing this.[58]

One of the founders of Scenario Making, Peter Schwartz, in an interview described the spirit of contemporary Scenario Planning as follows:

> There is a recognition that big complicated methodologies and elaborate computer models are not the optimal way. It has moved away from formal planning-like processes more toward a thinking tool. And it is not much more profound than that. So it's a methodology for contingent thinking, for thinking about different possibilities and asking the question "what if?"[59]

Schwartz continues, "That's why I called my book *The Art of the Long View*. The second thing that is quite important is it has moved away from a focus on the external world toward the internal world of the executive."[60] Schwartz went on to describe the application of Scenario Planning in the following terms: "This was Pierre Wack's big insight at Shell. The objective is not to get a more accurate picture of the world around us but to influence decision making inside the mind of the decision maker. The objective of good scenarios is better decisions not better predictions."[61]

Scenario Making can be seen as an element of a systemic approach to intervention – as an additional means to improve decision-making. Matzdorf and Ramage, as advocates of the Schwartz approach, have described the scenario approach as follows:

> Scenarios are alternative images: possibilities, not predictions. Scenarios are not just wild guesses or science fiction stories. However vital imagination is to the process, there are some rules that need to be followed if scenarios are to help in strategic planning. In particular, we believe it is not useful to develop just one or two scenarios. Some approaches to Scenario Planning use an optimistic one, a pessimistic one and the status quo, or two opposing scenarios. Schwartz argues, by contrast, that a range of different scenarios helps people to "think outside the box", rather than in "black-and-white" opposites, making it possible for planners to develop strategies for many different futures rather than just for one or two options. Scenarios should help managers to become aware of the mental models and frames of reference they operate in, and not leave them caught up in their "mental ruts."[62]

Originally scenario planning was developed for strategic organizational planning, but it is also highly valuable for sustainability planning.[63]

Emerging premises for SI development

In the previous four sections we have taken a wide-ranging and provocative view of the role and nature of reductionism, and we have indicated that, although this approach is useful and valid for partial understanding of many areas of analysis, it is not valid as the basis for our understanding of sustainability. We have also described some elements of a systems approach, which is concerned with wholeness and is designed to take on-board the various viewpoints of actors and stakeholders in a problem context. We have described how this approach is related to developments in the field of cybernetics and, most centrally, the autopoiesis of Maturana and Varela. Finally, we have indicated that sustainability includes the future of the system in question. Scenario making or Prospective can be one means to address this issue of futurology.

For our study, these factors were vital in helping us to set the basic premises that we used to develop our hypothesis for systemic and scenario-based sustainability analysis, which has now resulted in the development of the Imagine approach. As we go through them, the reader should be able to see how they relate back to vital aspects of the discussion so far. The premises for the development of the Imagine approach are:

- Sustainability can provide a qualitative measure of the integrality and wholeness of any given system.
- Subjectivity on the part of the stakeholders in any given system (including researchers) is unavoidable.

- Subjectively derived measures of sustainability are useful if the subjectivity is explicitly accepted and declared at the outset and if the method for deriving the measures are available to a range of stakeholders.
- Measures of sustainability can be valuable aids to future planning, forecasting and awareness-building.
- Rapid and participatory tools for developing our thinking and modelling concerning measures of sustainability are of value to a wide range of stakeholders within development policy.

Notes

1 The participatory approach is exemplified by the work of Robert Chambers. See R. Chambers, "Rapid Rural Appraisal: Rationale and Repertoire," *Public Administration and Development* 1 (1981): 95–106; R. Chambers, *Whose Reality Counts? Putting the First Last* (London: Intermediate Technology, 1997); R. Chambers, *Participatory Workshops: A Sourcebook of 21 Sets of Ideas and Activities* (London: Earthscan, 2002).
2 Chambers, *Whose Reality Counts?*, 55.
3 M. Hobart, *An Anthropological Critique of Development: The Growth of Ignorance* (London: Routledge, 1993), 5.
4 A. Clayton and N. Radcliffe, *Sustainability: A Systems Approach* (London: Earthscan, 1996).
5 Webster, *Merriam Webster's Collegiate Dictionary* (Chicago, IL: Merriam-Webster, 1995).
6 See P. Richards, *Community Environmental Knowledge in African Rural Development: IDS Bulletin* (Brighton: IDS, 1979); S. D. Biggs, "A Multiple Source of Innovation Model of Agricultural Research and Technology Promotion," *World Development* 18(11) (1990): 1481–99; S. D. Biggs and J. Farrington, "Assessing the Effects of Farming Systems Research: Time for the Re-Introduction of a Political and Institutional Perspective," Asian Farming Systems Research and Extension Symposium, Bangkok, 1990.
7 A. Koestler, *The Ghost in the Machine* (London: Arkana, 1964), 290.
8 Webster, *Merriam Webster's Collegiate Dictionary*.
9 Ibid. On scientism, see also M. Stenmark, "What is Scientism?" *Religious Studies* 33 (1997): 15–32; T. Sorrell, *Scientism: Philosophy and the Infatuation with Science* (London: Routledge, 1991).
10 R. Dawkins, *The Blind Watchmaker* (Bath: Longman, 1986), 11.
11 Webster, *Merriam Webster's Collegiate Dictionary*.
12 Bell, *Learning With Information Systems*, (London: Routledge, 1996), 63.
13 Dawkins, *Blind*, 13.
14 Ibid, 13.
15 On reductionism, see R. H. Jones, *Reductionism: Analysis and the Fullness of Reality* (Lewisburg, PA: Bucknell University Press, 1990).
16 Webster, *Merriam Webster's Collegiate Dictionary*.
17 Chambers, *Chambers Twentieth Century Dictionary* (Edinburgh: W. and R. Chambers, 1979).
18 J. Lovelock, *Gaia* (Oxford: Oxford University Press, 1979); J. Lovelock, *Healing Gaia* (New York: Harmony Books, 1991); J. Lovelock, *Gaia: A New Look at Life on Earth* (Oxford: Oxford Paperbacks, 2000); J. Lovelock, *The Revenge of Gaia: Why the Earth is Fighting Back – And How We Can Still Save Humanity* (London: Penguin Books, 2007).
19 Lovelock, *Healing*, 12.
20 Lovelock, *Revenge*, 2.
21 V. Buddrus, *East–West European Centre for Integrative Humanistic Education and Psychology: Theoretical Background and Belief System* (Morschen: East–West European Centre for Integrative Humanistic Education and Psychology, 1996), 1.
22 See P. Hardi and T. Zdan, eds., *Assessing Sustainable Development: Principles in Practice* (Winnipeg, OH: International Institute for Sustainable Development, 1997).
23 The classic work on systems is D. Meadows et al. (Club of Rome), *The Limits to Growth* (New York: Universe, 1972); see also F. Stowell et al., eds., *Systems for Sustainability: People, Organizations and Environments* (New York: Plenum, 1997); and again, Clayton and Radcliffe, *Sustainability*.
24 P. Senge et al., *The Fifth Discipline Fieldbook: Strategies and Tools for Building a Learning Organisation* (London: Nicholas Brealey, 1994), 25.

25 Ibid., 90.
26 P. B. Checkland, *Systems Thinking, Systems Practice* (Chichester: Wiley, 1981); P. B. Checkland and S. Holwell, *Information, Systems and Information Systems: Making Sense of the Field* (Chichester: Wiley, 1998); P. B. Checkland and J. Scholes, *Soft Systems Methodology in Action* (Chichester: Wiley, 1990); P. B. Checkland and J. Poulter, *Learning for Action: A Short Definitive Account of Soft Systems Methodology, and Its Use, Practitioners, Teachers and Students* (Chichester: Wiley, 2006).
27 For alternative definitions, see Checkland, *Systems Thinking*; V. Bignell and J. Fortune, *Understanding Systems Failures* (Manchester: Manchester University Press, 1984); Open University, *Complexity Management and Change: A Systems Approach* (Milton Keynes: Open University, 1987).
28 C. Avgerou and T. Cornford, *Developing Information Systems: Concepts, Issues and Practice* (London: Macmillan Information Systems Series, 1993).
29 R. Ison, "Soft Systems: A Non-Computer View of Decision Support," in J. Stuth and B. Lyons, eds., *Decision Support Systems for the Management of Grazing Lands* (Paris: UNESCO, 1993), 94, quoting D. Russell, *How We See the World Determines What We Do in the World: Preparing the Ground for Action Research* (Hawkesbury: University of Western Sydney, 1986).
30 Checkland, *Systems Thinking*; Checkland and Scholes, *Soft Systems*; Checkland and Poulter, *Learning*; D. E. Avison and A. T. Wood-Harper, *Multiview: An Exploration in Information Systems Development* (Maidenhead: McGraw-Hill, 1990).
31 Open University, *Complexity*.
32 See Hardi and Zdan, *Assessing*.
33 Senge et al., *Fifth Discipline*.
34 See www.solonline.org.
35 There is a similarity here to the "failures" approach adapted by Bignell and Fortune, *Understanding*.
36 See the systems concepts as noted in Chambers, *Whose Reality Counts?*, 138.
37 See R. Chambers, *Rural Development: Putting the Last First* (New York: John Wiley and Sons, 1991); L. E. A. Natrajan, *Comparative Study of Sample Survey and Participatory Rural Appraisal Methodologies with Special Reference to Evaluation of National Programme on Improved Chulah* (1993); P. Shah and G. E. A. Hardwaj, "Gujarat, India: Participatory Monitoring," *The Rural Extension Bulletin* 1 (1993): 34–7; S. McPherson, *Participatory Monitoring and Evaluation* Abstracts (London: Institute of Development Studies, 1994); L. Webber and R. Ison, "Participatory Rural Appraisal Design: Conceptual and Process Issues," *Agricultural Systems* 47 (1995): 107–31; also, Bell, *Learning*; Chambers, *Participatory*.
38 Chambers, *Whose Reality Counts?*, 105.
39 S. D. Biggs, *Contending Coalitions in Participatory Technology Development: Challenges to the New Orthodoxy* (London: The Limits of Participation, Intermediate Technology, 1995), 4–5.
40 G. Coleman, "Logical Framework Approach to the Monitoring and Evaluation of Agricultural and Rural Development Projects," *Project Appraisal* 2(4) (1987): 251–9; D. Cordingley, "Integrating the Logical Framework into the Management of Technical Co-operation Projects," *Project Appraisal* 10(2) (1995): 103–12; Bell, *Learning*.
41 See M. Thompson and R. Chudoba, *Case Study Municipal and Regional Planning in Northern Bohemia, Czech Republic: A Participatory Approach* (Washington, DC: World Bank, 1994); Team Technologies, *TeamUp 2.0* (Chantilly, VA: Team Technologies, 1995). Note that this approach is not always participatory. See Chambers, *Whose Reality Counts?* 42–4, for a description of ZOPP (a version of logical frameworks).
42 See Bell, *Learning*.
43 For a discussion of this type of argument, see Checkland and Holwell, *Information*.
44 See F. Capra, *The Web of Life: A Synthesis of Mind and Matter* (London: HarperCollins, 1996).
45 Webster, *Merriam Webster's Collegiate Dictionary*.
46 See N. Wiener, *Cybernetics* (Boston, MA: MIT Press, 1948).
47 Capra, *Web*, 56.
48 See S. Umpleby, *The Cybernetics of Conceptual Systems, Department of Management Science* (Washington, DC: George Washington University, 1994).
49 H. von Foerster, "On Constructing a Reality," in his *Understanding Understanding: Essays on Cybernetics and Cognition*, 211–27 (New York: Springer, 2003).
50 Umpleby, *Cybernetics*.
51 Ibid., 13.
52 R. Macadam, I. Britton, and D. Russell, "The Use of Soft Systems Methodology to Improve the Adoption by Australian Cotton Growers of the Siratac Computer-Based Crop Management System,"

Agricultural Systems 34 (1990), 1–14; H. Maturana, *Knowing and Being* (Milton Keynes: Open University, 1997); H. R. Maturana and F. J. Varela, *The Tree of Knowledge: The Biological Roots of Human Understanding* (Boston, MA: Shambhala, 1992).

53 See J. Mingers, *Self-Producing Systems* (New York: Plenum, 1995).

54 G. Morgan, *Images of Organization: New Edition* (London: Sage, 1997), 255.

55 Ibid., 260.

56 BBC Radio 4, one o'clock news, 18 December 1997.

57 M. Godet, et al., *Scenarios and Strategies: A Toolbox for Scenario Planning. Paris, Laboratory for Investigation in Prospective and Strategy* (Paris: Conservatoire National des Arts et Metiers, 1999), 6.

58 F. Matzdorf and M. Ramage, "Out of the Box – Into the Future," *Organisations and People* 6(3) (1999), 29.

59 D. Dearlove, "Thinking the Unthinkable: An Interview with Peter Schwartz, Scenario Planning Futurist," *The Business* (September 2002), 3.

60 P. Schwartz, *The Art of the Long View: Scenario Planning – Protecting Your Company Against an Uncertain Future* (London: Century Business, 1992), 39.

61 Ibid., 39.

62 Matzdorf and Ramage, "Out of the Box," 30.

63 See A. de Geus, "Planning as Learning," *Harvard Business Review* (March–April 1988), 70–74; Schwartz, *Art of the Long View*; K. van der Heijden, Giving Scenarios a Context in the Organisation. In *"The Fifth Discipline Fieldbook"*, P. Senge, ed. (London: Nicholas Brealey, 1994).

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