SECOND EDITION

Sustainability Indicators

Measuring the Immeasurable?

Simon Bell & Stephen Morse

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Simon Bell and Stephen Morse

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List of Acronyms and Abbreviations

AMOEBA	general method for ecosystem description and assessment (Dutch)
ASC	Academy for Sustainable Communities
BAAC	Bank for Agriculture and Agricultural Co-operatives (Thailand)
BCCI	Belize Chamber of Commerce and Industry
BITAOC	beneficiaries, implementers, transformation, assumptions (or worldview), owner and constraints
BKK	Badan Kredit Kacamatan (Indonesia)
BOD	biological oxygen demand
BUD	Bank Rakyat Indonesia Unit Desa (Indonesia)
CBA	cost–benefit analysis
CBI	Confederation of British Industry
DDS	Diocesan Development Services (Nigeria)
DfID	Department for International Development (UK)
DPR	driving force, pressure, response
DPSIR	driving force, pressure, state, impact, response
DSD	degree of sustainable development
DSIR	driving force, state, impact, response
DSR	driving force, state, response
ECBA	economic cost–benefit analysis
EDJI	Ecological Dow Jones Index
EEA	European Environment Agency
EKC	Environmental Kuznets Curve
ESI	Environmental Sustainability Index
ESY	ecologically sustainable yield
EU	European Union
FAO	United Nations Food and Agriculture Organization
FS	financial services
FSR	farming systems research
FSR/E	farming systems research and extension
GB	Grameen Bank (Bangladesh)
GCM	global climate model
GIS	geographic information systems

H	Shannon–Wiener Index
IISD	International Institute for Sustainable Development
ISD	indicator for sustainable development
IUCN	World Conservation Union (formerly International Union for the Conservation of Nature)
LF	logical framework/logframe
LISA	low-input sustainable agriculture
LO	learning organization
M & E	monitoring and evaluation
MCA	multi-criteria analysis
MEY	maximum economic sustainable yield
MIS	management information systems
MOV	means of verification
MSY	maximum sustainable yield
N	nitrogen
NEF	New Economics Foundation
NGO	non-governmental organization
ODA	Overseas Development Administration (*now renamed* DfID)
OECD	Organisation for Economic Co-operation and Development
OVI	objectively verifiable indicator
P	phosphorous
PDR	pressure, driving force, response
PPP	purchasing power parity
PRA	participatory rural appraisal
PRAM	participatory and reflective analytical mapping
PSI	process SI
RRA	rapid rural appraisal
SCBA	social cost–benefit analysis
SCP	Sustainable Cities Programme
SDI	Subsidy Dependence Index
SI	sustainability indicator
SSA	Systemic Sustainability Analysis
SSI	state SI
SSM	soft systems approach or method
SWOT	strengths, weaknesses, opportunities and threats
TFP	Total Factor Productivity
TUC	Trades Union Congress
UEA	University of East Anglia
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
US	United States
USAID	US Agency for International Development
WCED	World Commission on Environment and Development
WEF	World Economic Forum

WHO	World Health Organization
WHOQOL	World Health Organization Quality of Life
WWF	World Wide Fund for Nature (*formerly* World Wildlife Fund)

Foreword

As we wrote in the first edition, this book remains the result or outcome of our personal journeys through a great deal of literature and opinion on sustainability – but now this is tempered with experience and reflection. Although both of us have spent many years working in development studies, Steve is an applied biologist with a background in the scientific tradition, whereas Simon defines himself as a systems thinker and action researcher with specific experience in the field of information systems development and computing. Both of us have come by separate routes to the current discussion relating to sustainability; and without being dramatic, this book can still be described as the fruit of a voyage of discovery.

For many years we have both been concerned, but from our different perspectives, with the literature on sustainability and the discussions that this literature has produced. On the one hand, we were worried by the numerous attempts to try and ascribe exact 'measures' to sustainability (for instance, sustainability = 42). On the other hand, it appeared that the politicians had created a storm by picking up on the word sustainability, which was intended to be the marker and driving force for the global development effort. Such an emphasis intensified the need for definition and measurement so we could assess our progress towards achievement (or not) of sustainability; and yet the very holistic and anthropocentric essence of sustainability continues to elude attempts at objective analysis and assessment. Managers love to 'measure' in order to know that they have managed successfully; but so much of life is immeasurable.

We came to the conclusion separately that in trying to tie down and measure sustainability, surely the civic, academic and developmental communities were engaging in a futile exercise of measuring the immeasurable? Although many have tried to quantify sustainability – with all the jargon and apparent rigour of the objective and reductionist mindset of much of the academic community – when looked at more closely, the approaches do not seem to work or, worse still, we end up measuring things that can be measured and not things that should be measured, if at all possible. Indeed, sustainability is not a 'thing' that can be measured, and an element of circularity appears inevitable: sustainability becomes defined by the parameters that can be measured rather than the other way around. *Our key premise is that the* *approach to measurement is always based on an individual's vision of sustainability, which in turn can be changed depending upon the measurement mindset.*

Our concern grew in our analysis of theory and in our own practice as consultants and researchers; despite being told by some colleagues in the early days of writing the first edition that to critically evaluate sustainability indicators was 'off the wall', we decided to both map our understanding of the sustainability indicator debate and to set out what we think might be a more holistic, realistic, participative and systemic approach to gauging sustainability. Now, in this new edition, we can further develop this theme by showing how we have applied the methodology and reflected on our experience.

At the outset, we need to bring to the reader's attention problems concerning the use of the words system and systemic. In the first three chapters of this book, which briefly review the work of academics and practitioners in developing sustainability indicators, the word system is frequently used; however, this is usually in a non-specific everyday sense – the word could be replaced with 'related entities' or even 'things'! In Chapters 4 to 7 we use the words much more specifically and provide definitions of what they mean in precise terms.

This book is both the outcome of a creative endeavour and the reflection of the current debate on sustainability indicators. We offer our thoughts on the discussion so far and suggest ways forward with humility. We both agree that there will be great need for fuller discussion before the issue is in any way resolved, and all we can hope to do is to contribute some personal insights.

The reader will find three distinct sections in the following pages:

1 Part I is a literature review on the use of sustainability indicators (SIs) in development. Chapter 1 provides background to the issue of SI development; Chapter 2 focuses on examples of single and multiple SIs; and Chapter 3 looks at institutional SIs and sustainable cities, and introduces the notion of using SIs in projects. Each of these topics can be (and have been) the focus of a book in itself; thus, the aim is to give the reader an overview of issues rather than an exhaustive review of all of the literature.
2 Part II sets out an alternative theory: a systemic manner for the development of SIs. In Chapter 4 the theory – Systemic Sustainability Analysis (SSA) – is introduced. SSA provides the underpinning of our thinking with regard to what is required for envisioning sustainability and linking this to indicators. Chapter 5 describes the growth of SI development tools within project contexts and Chapter 6 sets out a grounded version or methodology – Imagine – of the SSA theory to SI development, stressing the essential participative nature of understanding sustainability. There are many ways in which the SSA theory we espouse can be put into practice, and Imagine is presented as an example originally derived for a specific spatial context (coastal zone management), but which adapts to a wide range of circumstances.

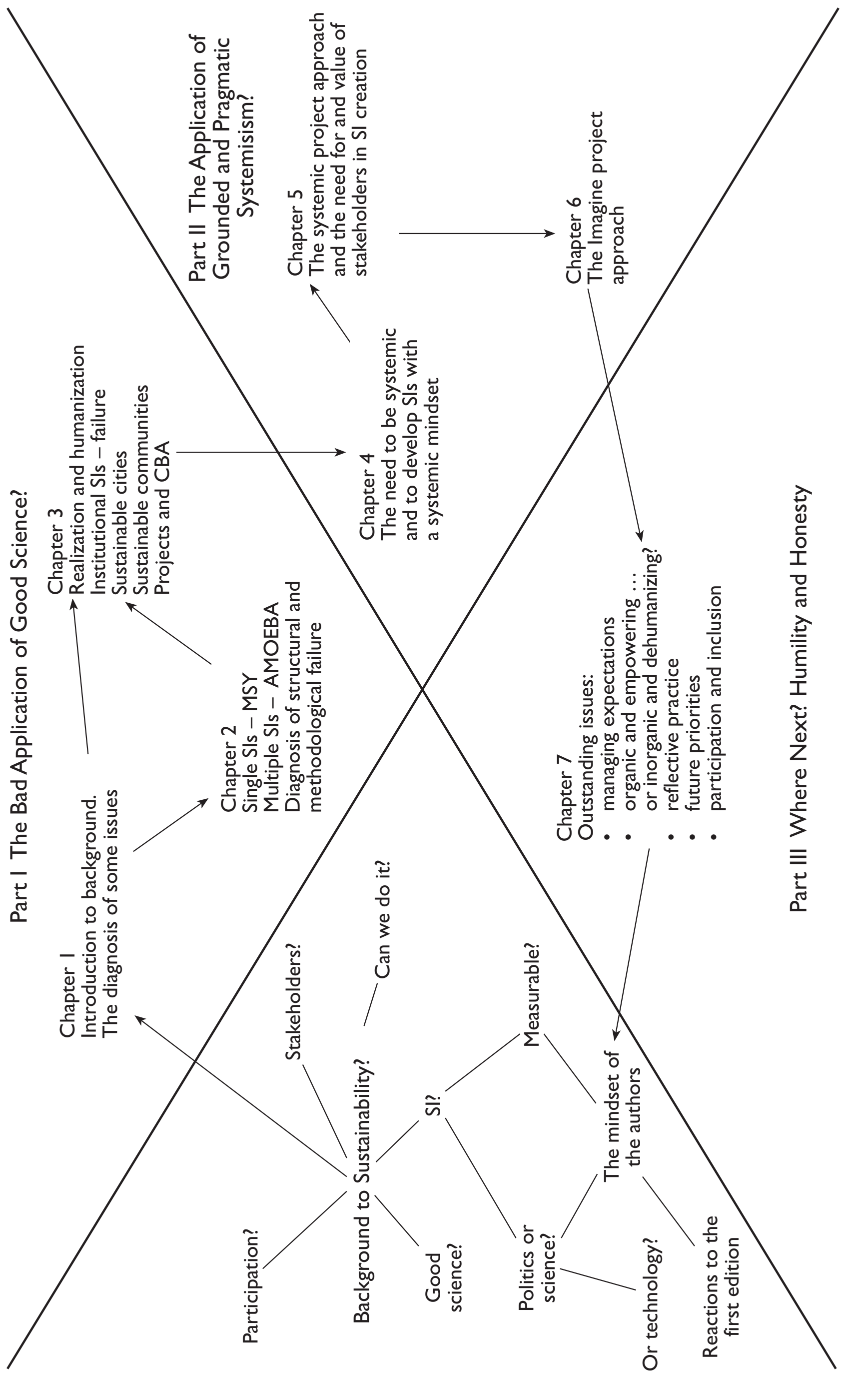

Figure F.1 *Overview of the book*

3 In Part III, Chapter 7 focuses on setting out a number of further questions arising from the discussion and provides an outline of future research interests.

We believe that the discussion that we present here comes together as one overall whole, bringing us back to some of the questions we started with. To assist the reader we have developed a route map of the conversation (see Figure F.1), and we provide step-by-step indicators on this as the conversation develops from chapter to chapter.

The authors encourage readers to engage in the discussion of SIs.

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It is impossible to thank all those who have provided contributions and insights to the formulation of this book; but we would like to express our gratitude to all our friends, colleagues and all of the silent recipients of development projects worldwide who have for the last 20 years worked with the authors and helped them in their intellectual, moral and spiritual development.

Part I

The Bad Application of Good Science?

1

Sustainability and Sustainability Indicators

Introduction and objectives

Few development interventions or research initiatives these days can successfully attract funding unless the words 'sustainability' or 'sustainable' appear somewhere in the proposal to the funding agency. Indeed, if one listens to speeches by politicians or reads articles by economists, policy-makers or scientists, the word sustainable appears with remarkable regularity:

> *Sustainable development has become the watchword for international aid agencies, the jargon of development planners, the theme of conferences and learned papers, and the slogan of developmental and environmental activists.* (Lele, 1991)

Although some have questioned the motives behind this popularity (Bawden, 1997), there is no doubt that sustainable development is now a very dominant theme. Some even go so far as to say that 'everyone agrees that sustainability is a good thing' (Allen and Hoekstra, 1992), although to Fortune and Hughes (1997) 'it [sustainability] is an empty concept, lacking firm substance and containing embedded ideological positions that are, under the best interpretation, condescending and paternalistic'. The main catalyst for this popularity in recent years, particularly in terms of sustainable development, was the Rio de Janeiro Earth Summit held in 1992. The Rio Summit agreed a set of action points for sustainable development, collectively referred to as Agenda 21 (agenda for the 21st century), and governments that signed up to these have committed themselves to action. In order to help put these points into practice, the summit established a mandate for the United Nations to establish a set of 'indicators of sustainable development' that will help to monitor progress. In fact, the idea of using indicators as a means of gauging sustainability has become extremely popular, with many governments and agencies devoting

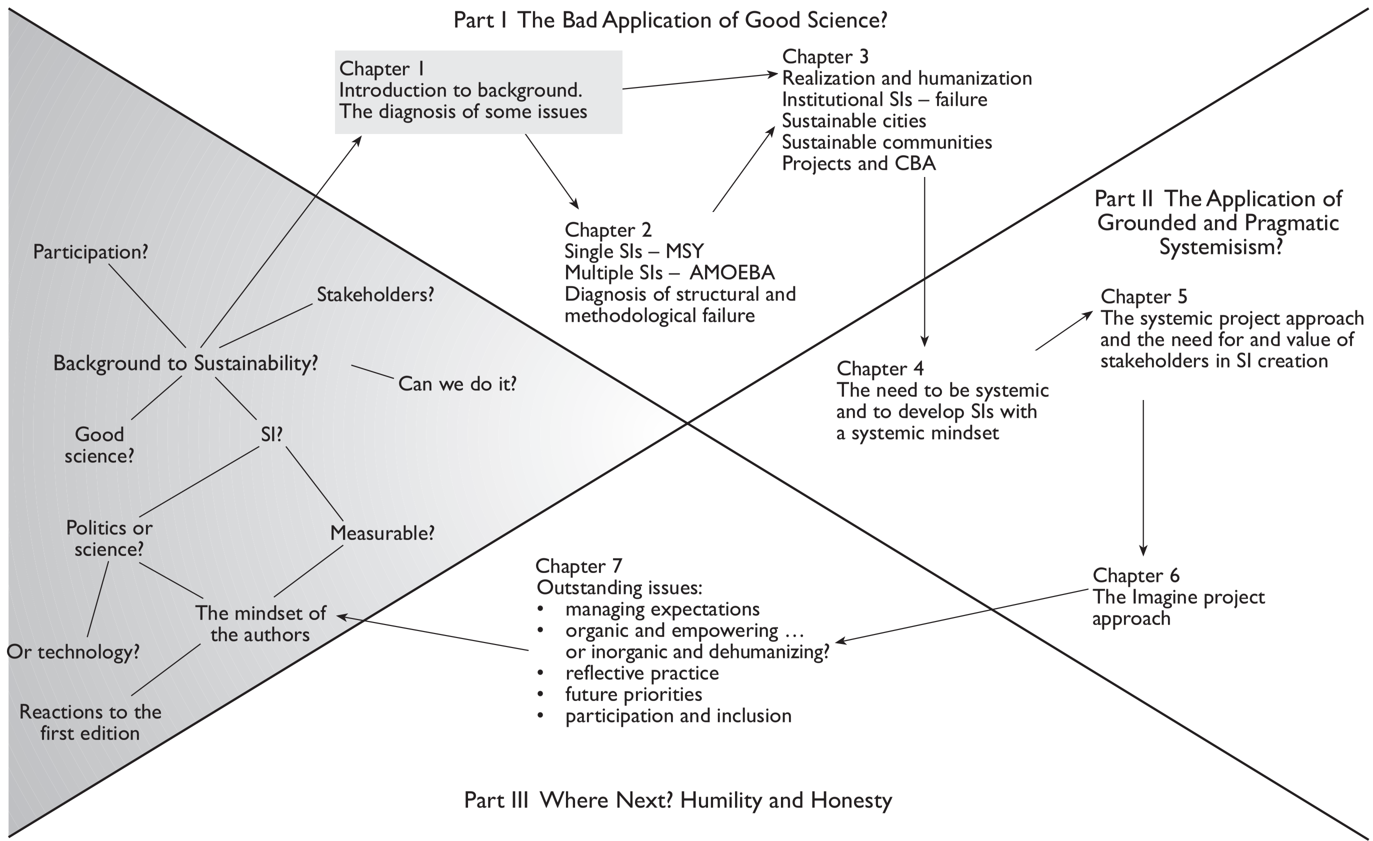


Figure C.1 *Chapter 1 in context*

substantial resources to indicator development and testing (Hak et al, 2007). Even the idea of a sustainable city, an apparent contradiction in terms, has become so popular that prizes are now provided for those cities deemed to be the most sustainable, and indicators play a major role in this process. The central idea behind the use of such indicators is very simple, and essentially they are designed to answer the question: 'How might I know objectively whether things are getting better or getting worse?' (Lawrence, 1997).

Sustainable development is an example of a paradigm quite distinct from what some see as the contradictory term of sustainable growth (see Daly and Townsend, 1992, for a discussion). Paradigms are important in that they are philosophical and theoretical frameworks within which we derive theories, laws and generalizations. In its broadest sense, the sustainable component of the sustainable development paradigm implies that whatever is done now does not harm future generations – a concept often paraphrased as 'don't cheat on your kids'. However, the precise meaning of sustainable, and what it embraces, varies depending upon who is using it and in what context, a critical point which we return to later. For example, can we sustain our environment within sustainable development, yet 'cheat our kids' on other aspects, such as decline in economic performance or worsening social conditions? Sustainable development has, indeed, become a quintessential example of practical holism, but at the same time embodies an ultimate practicality since it is literally meaningless unless we can 'do' it. As such, it is firmly rooted in the present.

This book is all about the 'doing' of sustainable development. In these pages the reader will frequently come across a liberal sprinkling of terms such as 'achieve', 'implement', 'practice', 'goal' and 'do' with regard to sustainable development. This reflects an important shift away from 'sustainable' as an appealing though rhetorical adjective to 'sustainable' becoming both a descriptor of something and a target to achieve. Indeed, since it is the 'sustainable' part of sustainable development which particularly interests us, we have tended to refer to 'sustainability' in a generic sense, and our discussions of sustainability could be employed to anything that has sustainable as an adjective. Therefore, the same broad points we make apply to sustainable agriculture, sustainable coastal zones, sustainable cities, sustainable communities, and sustainable organizations and institutions – for this reason we have ranged freely between all these domains. The latter two, in particular, will form the focus for Chapter 3. This may appear to be rather cavalier; but 'sustainable' in each case refers to much the same, although the detail can be quite different. Taking sustainability in a broad sense allows us to compare and contrast facets of application across these domains, and to apply lessons from one arena to another.

In order to provide the reader with some background, we have begun this chapter with a discussion of a few of the current visions of sustainability, with a particular emphasis on sustainable development. There is, of course, an additional and substantial literature on the meaning of development; but this will not be covered here (see Potter et al, 2003, for a summary). The aim will be to use these visions of sustainability to illustrate some of the difficulties inherent within its concept, and how some people have tried to address these.

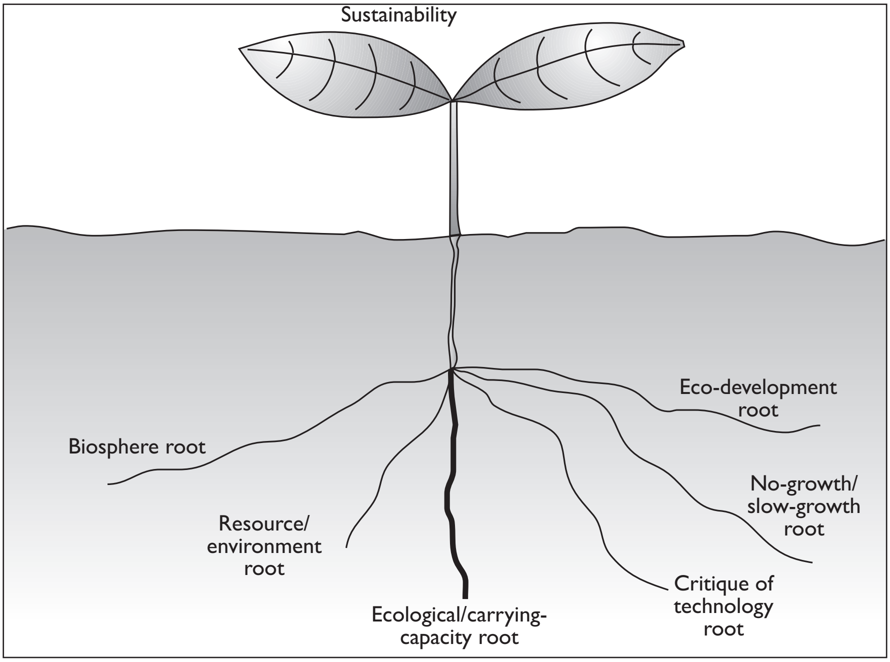
As described above, many individuals have noted the need for measuring sustainability, and this chapter will discuss a few approaches in this direction and the problems that people have faced. Again we cannot claim to be exhaustive; but the examples we have chosen illustrate the broad range of approaches with their associated advantages and disadvantages. In particular, the background to the use of indicators as a means of gauging sustainability will be discussed. Chapter 2 will deal with some specific examples of sustainability indicators in more depth. An important point to make is that the use of simple indicators as a means of following change in complex systems is not new. Biological indicators have been widely employed in environmental science for many years, and in this chapter we compare their use in this context to one of gauging sustainability. The final section of the chapter will draw together some of the main difficulties in using relatively simple indicators to gauge what is, in fact, very complex. These problems will be pursued further in Chapters 2 and 3.

Two roots of sustainability

In its original form, sustainability was closely associated with maintenance of environmental quality, although – as would be expected with a term that is so multifaceted – the origins of sustainability are complex. Excellent discussions can be found in Kidd (1992), Moffatt (1992), Munn (1992), Heinen (1994), Mitcham (1995), McEntire (2005) and Du Pisani (2006) and will not be repeated in depth here. Needless to say, concerns for the environment and views over humankind's place within the environment are ancient. Kidd (1992) suggests that the contemporary view of sustainability in a broad sense has originated from six separate strains of thought (see Figure 1.1). We do not intend to describe each of these; but two of them are particularly relevant for the purposes of this book as they will reappear in various guises in later chapters.

Ecological/carrying-capacity root

Of the six roots in Figure 1.1, a major contribution has come from the first: the ecological concept of carrying capacity and the idea of maximum sustainable yield (MSY) that partly flows from it. Carrying capacity is the notion that an ecological system (ecosystem) can only sustain a certain density (the carrying capacity) of individuals because each individual utilizes resources in that system. Too many individuals (overshooting the carrying capacity) results in overuse of resources and eventual collapse of the population. MSY is a related concept in that it implies a sustainable utilization of a resource. If the MSY is exceeded, perhaps because of population increase or



Source: adapted from Kidd (1992)

Figure 1.1 *The roots of the modern view of sustainability*

simply because of greed, then the system may collapse with potentially dire consequences for those dependent upon the resource (Botsford et al, 1997; Link et al, 2002).

Carrying capacity has been and remains a central concept in ecology (Meadows et al, 2004) and can be found at the heart of the other five strains of thought in Figure 1.1. For example, the second root ('resource/environment') stems from a number of influential books written during the late 1940s and 1950s that question the ability of the Earth to sustain a growing human population. In other words, these works argue that the Earth is approaching its carrying capacity, and great dangers are ahead if we push too close to, or exceed, that limit. In the introduction to one of these books, written by William Vogt and published in 1949 entitled *Road to Survival*, the author suggests that:

> Road to Survival *is, I believe, the first attempt – or one of the first – through fully chosen examples, in large part drawn from wide first-hand experience, to show man as part of his total environment, what he is doing to that environment on a world scale, and what that environment is doing to him.* (Vogt, 1949)

The critique of technology root

The critique of technology root of sustainability originated during the 1960s and 1970s as a counter to the perceived indiscriminate use and exportation of technologies that may pose dangers to the environment. A classic example is the well-known book by Schumacher entitled *Small Is Beautiful: Economics as if People Mattered* (1973). There are a number of examples that come under the critique of technology, including nuclear power; but probably some of the best-known examples are in agriculture. Indeed, it can be argued that the problems arising from the indiscriminate use of pesticides, in particular, have had a major effect on the evolution of the sustainability concept. These dangers were highlighted in an immensely influential book, *Silent Spring*, written by Rachel Carson and published in 1962. The title invokes a spring without songbirds as they become decimated by the widespread use of pesticides. More recently, we have seen a continued concern over the application of genetic engineering within crops and animals and the coining of the term 'Frankenstein food' by critics. Indeed, it could be argued that agriculture has been at the heart of much of the sustainability debate, and this is not particularly surprising for two main reasons:

1. Agricultural systems occupy large areas of land – far more land than any other industry with the possible exception of forestry. Therefore, what occurs within agriculture can often have major environmental effects.
2. The end product of agriculture is often food, and we all eat! Agriculture is therefore one of the foundations of human society.

The result has been a move towards the promotion of sustainable agriculture, although terms such as agro-ecology, alternative agriculture, ecological food production, low-input sustainable agriculture (LISA) and organic agriculture have also entered the fray and offer distinctive elements to their proponents. Alternative agriculture is taken to be a sort of antithesis to conventional agriculture without really being very clear as to what either term means (Frans, 1993). LISA is assumed to be sustainable agriculture with an accepted low level of artificial inputs, although where one draws the line between this and high-input agriculture is again rather nebulous. Of all the terms, organic agriculture is the most definable: produce can be certified as organic depending upon the absence of defined substances (mostly pesticides and artificial fertilizers) during production. Indeed, for many the terms sustainable agriculture and organic agriculture have become synonymous precisely because the latter, by definition, minimizes if not eliminates the use of technologies that may pose dangers to the environment. However, do we minimize or eliminate such technologies, and if to minimize is adequate, then by how much?

The answers, quite frankly, are very diverse and depend to a large extent upon who is defining sustainability in each individual context; the specific example of agriculture beautifully encapsulates this central paradox of

Box 1.1 Visions of sustainable agriculture

- Those who appear to see no problem in equating sustainability with 'high-input', 'high-yield' conventional farming:

  ... profitability, consumer safety, resource protection and viability of rural America. (Kelling and Klemme, 1989)

  What is sustainable agriculture after all? The only sustainable agriculture is profitable agriculture. Short and sweet. (Ainsworth, 1989)

  ... the concept of sustainable agriculture does not exclude the use of fossil fuels and chemicals: it only requires that the criteria of appropriateness and sustainability be applied to the whole system. (Wilken, 1991, quoted in Frans, 1993)

  One of the key charges of the environmental activists is the claim that high-yield farming is 'unsustainable'. This has resonated with the public, probably because it implies a lurking, hidden threat. Actually ... high-yield farming is more sustainable than organic farming... We also have strong evidence that high-yield farming can continue producing higher and higher yields on into the future. (Avery, 1995)

- Those who do not appear to equate sustainability with high-input, high-yield conventional farming:

  'Sustainable' means the capability to continue producing food and fibre indefinitely and profitably without damaging the natural resources and environmental quality on which all of us depend. (Schaller, 1989)

  For a farm to be sustainable, it must produce adequate amounts of high-quality food, protect its resources and be both environmentally safe and profitable. Instead of depending on purchased materials such as fertilizers, a sustainable farm relies as much as possible on beneficial natural processes and renewable resources drawn from the farm itself. (Reganold et al, 1990)

  A sustainable agriculture is one that equitably balances concerns of environmental soundness, economic viability and social justice among all sectors of society. (Allen et al, 1991)

  ... sustainable agri-food systems are systems that are economically viable, and meet society's need for safe and nutritious food, while conserving or enhancing ... natural resources and the quality of the environment. (Science Council of Canada, 1991, cited in Lehman et al, 1993)

  Sustainable agriculture refers to the use of agricultural land in such a way to ensure that over time no net quantitative or qualitative loss of natural resources occurs. (Fresco and Kroonenberg, 1992)

  Sustainable agriculture consists of agricultural processes – that is, processes involving biological activities of growth or reproduction intended to produce crops which do not undermine our future capacity to successfully practice agriculture. (Lehman et al, 1993)

  Only the most hard-bitten of intensive commercial farmers would now accept that conventional agriculture is sustainable. (Gibbon et al, 1995) sustainability. The comments in Box 1.1 provide a simple illustration of these diverse viewpoints. As can be seen from these, there are marked contrasts in how people envisage sustainable agriculture, and the views of Avery (1995) and Gibbon et al (1995) are very hard to reconcile.

The meaning of sustainability

The confusion over the meaning of sustainable agriculture is also apparent when the meaning of sustainability in other arenas – for example, in sustainable development – is considered. Although most would agree that sustainability implies 'not cheating on your kids', a clearer definition has proved to be elusive. This is a point that has been noted by many and appears to be a source of much frustration. Almost every article, paper or book on sustainability bemoans the fact that the concept is broad and lacks a broad consensus; this is usually followed by the authors' own preferred definitions, which in turn add to the lack of consensus! Some examples of this diversity can be found in Box 1.2, although it should be stressed that the examples in Box 1.2 are by no means indicative of the entire range of definitions that exist or, indeed, of the main elements that tend to be mentioned. To do this would be labouring the point and would make for rather staid and boring reading.

Given its ubiquitous use and popularity, the lack of a concrete definition of 'sustainable' may appear to be very surprising. How can something so

Box 1.2 Some definitions of sustainability

- General definitions of sustainability include the following:

  … the capacity of a system to maintain output at a level approximately equal to or greater than its historical average, with the approximation determined by the historical level of variability. (Lynam and Herdt, 1989)

  … maximizing the net benefits of economic development, subject to maintaining the services and quality of natural resources over time. (Pearce and Turner, 1990)

  The sustainability of natural ecosystems can be defined as the dynamic equilibrium between natural inputs and outputs, modified by external events such as climatic change and natural disasters. (Fresco and Kroonenberg, 1992)

- Definitions of sustainable development:

  … development that meets the needs of current generations without compromising the ability of future generations to meet their needs and aspirations. (WCED, 1987)

  … development that improves the quality of human life while living within the carrying capacity of supporting ecosystems. (IUCN, 1991)

vague be so popular? The essence of the problem has been captured by Schaller (1993): 'As a destination, sustainability is like truth and justice – concepts not readily captured in concise definitions.' We all want truth and justice; but what these mean can also vary greatly from individual to individual and between societies. My justice may be your exploitation, and my truth may be your lies! Indeed, this failure to obtain a universal and concise definition of sustainability has led some authors to take what may be thought of as a rather extreme position:

> *Many would argue that it is important to define what sustainability is, or might be, before any actions can be taken towards setting up more sustainable agricultural practices. We do not necessarily subscribe to the need to define sustainability in order to practise it; but the exercise of definitions is one useful way to examine several perspectives and to understand competing views.* (Gibbon et al, 1995)

This would seem to be an illogical stance and somewhat perversely hinges on what is meant by the term 'define'. If by 'define' we mean summarize in a single sentence what is meant by sustainability, then one can have some sympathy with the Gibbon et al (1995) statement that alludes to an unnecessary and unhelpful strait-jacketing of such a complex notion. But if the meaning of 'define' is extended more broadly, then the statement must surely be wrong. After all, how can we do something unless we know what we are trying to do? Surely we cannot farm or develop sustainably unless we know what this implies? If we don't know what we are trying to get, how do we know if we have it? While one can sympathize with the view that a simple, concise definition may not be possible, surely some idea of where one is trying to go is an absolute necessity. Even a statement of intent that some factors should increase while others decrease, without specifying an ultimate goal, is still a definition. For example, the Natural Step framework sets out guiding principles (or system conditions) for achieving sustainability (James and Lahti, 2004), which broadly demand that:

- Materials from the Earth's crust must not be systematically increased in the Earth's environment.
- Materials produced by society must not be systematically increased in the Earth's environment.
- The physical basis for the productivity and diversity of nature must not be systematically diminished.
- There must be fair and efficient use of resources with respect to meeting human needs.

While not set out here as a formal 'two-sentence' definition, such as that of the WCED (1987), the principles do define what should and shouldn't be done in order for sustainability to become a reality.

This uncertainty over the meaning of sustainability has not reduced the popularity of the concept. On the contrary, it could, perhaps, be cynically argued that the resulting flexibility has allowed the concept to attain the heights that it has. If those involved in sustainable development can give their own individual 'spin' to the meaning of sustainability, then all definitions can remain fashionable and mainstream, and this may help to strengthen its popularity. The uncertainty may, in fact, be self-reinforcing and sustainable in its own right. In a less cynical vein, this flexibility as to what sustainability means can also be a great strength in a very diverse world. People differ in the environmental, social and economic conditions within which they have to live, and having a single definition that one attempts to apply across this diversity could be both impractical and dangerous. As Kidd (1992) argues: 'there is not, and should not be, any single definition of sustainability that is more logical and productive than other definitions'.

Why is there so much diversity in viewpoint regarding the meaning of sustainability? After all, the oft-quoted World Commission on Environment and Development (WCED, 1987) definition of sustainable development appears to be a reasonable stance. Some of the fundamental reasons for this are briefly illustrated in Figure 1.2a. In this figure sustainability is represented by a change in a property referred to as 'system quality' – a very subjective term open to all sorts of value judgements. Sustainable equates to a situation where quality remains the same or increases. If quality declines, then the system can be regarded as unsustainable. This may at first sight appear to be clear; but there are numerous problems that arise even in this simple figure. These can be listed as follows:

- What exactly is the system to which we are ascribing some notion of quality? Who is in this system and who isn't? This may equate in a rather crude sense to the spatial dimension of the system being evaluated, and one can ask where the system 'boundary' resides? Indeed, is there really a boundary at all?
- What do we take as a time scale across which quality is being gauged? For example, in Figure 1.2b, system quality fluctuates with time; but taken across the whole length of the time axis, it remains more or less the same (= sustainable). If one only looked at small segments of the time axis rather than the whole length, the picture could be quite different. Some segments show marked unsustainability as quality declines rapidly, while other segments show a rapid increase.
- What is meant by system quality and how is it determined? This problem is probably the most intractable. Quite frankly, given the same system and time scale, it is possible for two people to arrive at very different views depending upon what they see as important components of quality (see Figure 1.2c). To one person the quality may be increasing, while to someone else it is decreasing. This point can be illustrated from another angle – the costs of achieving sustainability, or what some call the

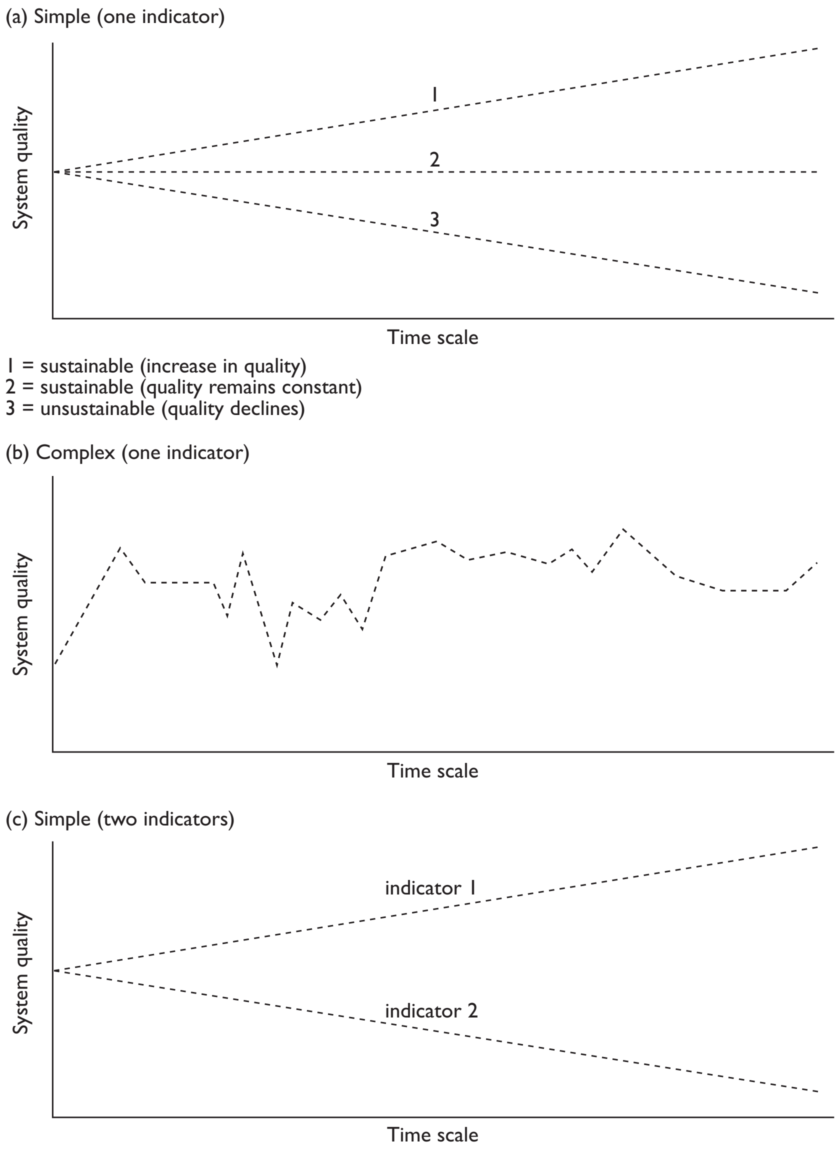


Figure 1.2 *System quality and sustainability*

'profitability versus environment debate' (Schley and Laur, 1996). In the literature there is frequent reference to two types of sustainability (see Box 1.3) depending upon the costs incurred in attaining them: strong sustainability and weak sustainability (Neumayer, 2003).

There are fundamental differences between strong and weak sustainability, and they can be regarded as mutually exclusive rather than as two ends of a spectrum. Quite simply, if one believes that sustainability should be strong,

Box 1.3 Two different visions of sustainability

1. *Strong sustainability:* in strong sustainability there is little, if any, consideration of the financial or other costs of attaining sustainability. It equates to what some call ecological sustainability and the focus is primarily on the environment. In this case, system quality is taken in terms of the physical measures of things (e.g. population, soil erosion and biodiversity).
2. *Weak sustainability:* the second type of sustainability is referred to as weak sustainability. Costs of attainment (financial or otherwise) are important and are typically based on a cost–benefit analysis (CBA), which inevitably involves trade-offs between environment and social and economic benefits. Weak sustainability equates to a sort of economic sustainability where the emphasis is upon allocation of resources and levels of consumption, and financial value is a key element of system quality.

then no trade-off between economic gain and environmental quality is acceptable. It should be noted that this is not just a matter of sentimentality. The strong sustainability argument implies that the environment is critical for our and our children's survival, and any damage will have negative repercussions. If one believes in weak sustainability, then environmental quality can be traded against economic gain; indeed, to help make all of this easier, the environment is 'valued' in monetary terms. Of these two the weak sustainability form is the one that currently dominates in the global economy.

The three questions regarding spatial and time scales and meaning of 'quality' have to be resolved before sustainability can be achieved because they provide the context within which the process takes place. In any one circumstance the answer may not appeal to all; but individuals need to have a clear vision as to what is being attempted. In the following sections we examine these questions in greater depth and illustrate how some people have attempted to provide answers. We begin with a discussion of spatial and time dimensions, and we progress to that most intractable of questions: what comprises system quality?

Space and time in sustainability

As mentioned above, there are two questions that need to be answered before achieving sustainability:

1. Over what space is sustainability to be achieved?
2. Over what time is sustainability to be achieved?

The answers to these may, at first, appear rather obvious. The spatial scale may correspond with a farm, village, town or city, region, country and so on until the whole planet is considered. However, the difficulty is that these scales are all interlinked. The smaller the scale, the harder it is to know where to draw the line. In other words, where does the system boundary reside? If the aim is to change the agriculture in an area from what is considered to be unsustainable to sustainable, then are the units for consideration fields, farms or a collection of farms? If the latter, where does the 'collection' stop? Political boundaries (such as local government, state or county) may not be of much theoretical use. Even within clear spatial units such as villages, towns or cities, there are difficulties. Urban areas are not self-contained entities, but have links with other urban areas and the rural environment, which may extend for many miles around the centre. Sustainability in the urban area may be heavily influenced or even dependent upon what happens outside of that area. Do we include these? Sustainability in urban centres will be returned to in more depth in Chapter 3. Even if a boundary can be defined, what lies outside it can be of great importance.

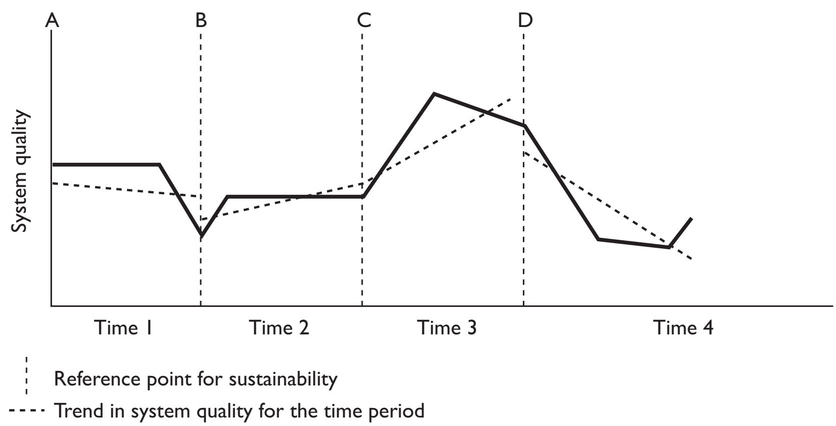
From a theoretical perspective, the spatial scale is clearly very important when one attempts to put sustainability into practice or when one judges the level of sustainability of an existing system. However, even if individuals can clearly define the boundary, there are problems in implementing sustainability. To begin with, there are simple logistical considerations brought about by limited budgets. The larger the scale and the more unsustainable the system, the bigger this problem is likely to be. What does one do? Redraw the spatial scale to take account of the budget? Limit one's objectives and perhaps even abandon the goal of full sustainability? Even worse may be the fact that development funding and, hence, project boundaries may well have to work within political borders, rather than with more reasonably formulated system boundaries. Clearly, what comprises the spatial scale for sustainability is of major importance and is by no means simple.

There are numerous examples in the literature illustrating how the spatial scale has been defined. In some cases, the boundary of the system was a defined 'settlement' (Izac and Swift, 1994; Jansen et al, 1995). Indeed, the clearest examples of defined spatial scales are those based on human habitations. 'Sustainable cities' is now a common phrase, and there are even awards for the most sustainable city in a number of countries and regions. One of the pioneers is the Sustainable Seattle programme in the US.

The time scale over which sustainability occurs is a further dimension. The definitions in Box 1.2 imply an intergenerational scale (also referred to as 'futurity') to sustainability, but over how many generations? Does one consider 10, 100 or 1000 years? Different systems may well require different time scales. Another complication is that different components of sustainability in the same system may best be measured in different time frames. For example, agricultural sustainability has a number of elements, including build-up of pests and levels of land degradation. In this case, Harrington (1992a, 1992b) suggests that pest problems are best looked at over scales of 5 to 20 years, while land degradation requires scales of 20 to 100 years. Indeed, Harrington (1992a, 1992b) also suggests that some factors are best looked at over 1000 years, although achieving this would certainly be a challenge unless one limits oneself to historical trends.

A very practical consideration flows from this discussion of relevant time scales. In Boxes 1.1 and 1.2, the reader encounters words such as current, future, improve, maintain, equilibrium, conserve and enhance. All of these words have one thing in common: they are relative and thus are open to the influence of personal values. This relativity lies at the heart of sustainability, and the latter is only meaningful if it is based on a trend over time and if we apply a value judgement as to what that trend should equate to. The non-attainment of 'sustainable' becomes *de facto* 'unsustainable'. Clearly, a starting point, or reference condition, is required in order for the trend to be gauged; but the choice of the starting point can influence the results.

Figure 1.3 presents an admittedly simplistic explanation of the problem. As in Figure 1.2, this figure presents the change in system quality over time; but the time axis has been divided into four blocks (each representing ten years, perhaps). The vertical lines labelled A, B, C and D are arbitrary starting points for the gauging of system quality. Over all four time periods, quality fluctuates; but a general trend would be more or less horizontal as, indeed, it was in Figure 1b (no increase or decline). However, if divided into smaller time horizons that may, perhaps, equate more to human planning horizons (e.g. ten years), then the interpretation of the trend in each block of time may be quite different. The last segment (number four) suggests a very unsustainable system, while segment three suggests the opposite. To make things even more complex, it is apparent that the situation could be quite different with smaller (e.g. five years) or larger (e.g. 20 years) scales. Although fixing a scale at X years (no matter how arbitrary) provides some clarification, it does not in itself yield all the



Time period	Reference point	Likely interpretation
1	A	unsustainable (slight decline in quality)
2	B	sustainable (improving quality)
3	C	sustainable (improving quality)
4	D	unsustainable (declining quality)
1 to 4	A	sustainable (overall trend in quality is level)

Figure 1.3 *Importance of the reference point for gauging sustainability*

answers. Clearly, we need to know where the length of the time scale is to start. Even if the time scale is kept constant at X years, one could 'prove' almost anything one wishes by careful selection of the starting point in Figure 1.3.

System quality

Spatial and time scales are key components of achieving sustainability; as has already been stressed, they are problematic in the sense that careful selection of scale or reference point can be used to prove almost anything. However, as difficult as these may be, they pale when put alongside another consideration in sustainability: the meaning of system quality and, in particular, the meaning of quality of life as an element of system quality. This element is a key component of many definitions of sustainability (especially sustainable development) and reflects a major evolution in the 'sustainable' concept. Earlier views of system quality and sustainability focused on the natural resource base and environment, with emphasis on physical entities such as the level of water and air pollution, soil erosion, soil acidity or alkalinity, crop yield, biodiversity, and so on. Gauging these over particular spatial and time scales may be difficult, and interpreting the results is open to some debate; however, at least one is dealing with measurable factors, and system quality may be expressed in a manner that is a composite of these. Later considerations of sustainability began to question whether human quality of life should be included as a component within system quality and, hence, sustainability, particularly since we are usually concerned with the sustainability of systems within which humans not only have a stake, but which they actively manage (Jeffrey, 1996; Phillipps, 2006). Sustainability, like development, is all about people, and there may be little point achieving a sustainable system that reduces the quality of life of the people in that system. This issue is returned to in Chapter 6.

Although a logical extension of the sustainability concept, this complicates the issue further. Just what does quality of life comprise? In a book as short as this it is simply not possible to discuss this question in any sort of depth. Indeed, an entire journal (*Quality of Life Research*) is dedicated to the topic. Perhaps one of the most quoted definitions is that of the World Health Organization (WHO):

> *An individual's perception of their position in life, in the context of the culture and values in which they live and in relation to their goals, expectations, standards and concerns.* (WHOQOL Group, 1995)

This definition is full of subjectivity and once looked at carefully says very little. Yet it is these very terms that many would see as central to what sustainability should be about maintaining or enhancing: people's standards and concerns. We will return to the key issue of 'expectation' later in the book.

There are a number of terms used more or less synonymously with quality of life, such as well-being. However, others see these as being quite distinctive. For example, a related term – level of living – has been defined by Knox (1974) as 'the level of satisfaction of the needs of the population assessed by the flow of goods and services enjoyed in a unit time'.

Although the approach of including quality of life within sustainability has been broadly accepted, especially when expressed in the somewhat vague language of the World Health Organization Quality of Life (WHOQOL) definition, there is not so much unanimity about what it means in practice and how it should be assessed. Pollution and erosion may be measured; but how can quality of life and well-being be assessed? There are numerous examples of gauging well-being through employment, income, crime, travel, migration and house prices. However, just which of these or others are important will presumably vary dramatically from individual to individual and over time. Calibration and interpretation would also appear to be problematic. Are they all to be treated equally, or is crime to be rated higher than travel? What about leisure activities and culture? Although the inclusion of quality of life considerations within sustainability may be desirable, the practice appears to raise many difficult questions.

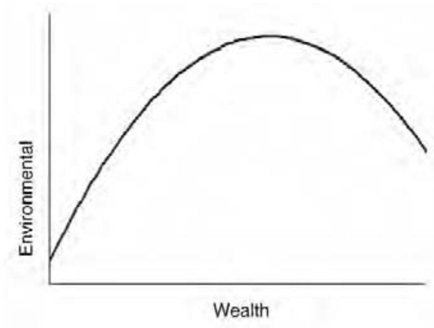
An illustration of the problems inherent in the meaning of 'system quality' can be seen in what must surely rank as one of the most iconic images in sustainability: the Environmental Kuznets Curve (EKC). The EKC embodies a sense of the tensions we experience today with the growing impact of emerging economies, such as those of China and India, upon the Earth's environment. It is named after a Noble Prize-winning economist – Simon Kuznets – who suggested that income equality had a curved relationship to national income (see Box 1.4). As the economy grows, there is an initial increase in income inequality; but at a certain point of inflection the curve turns downwards and income inequality lessens (the population becomes more equal). It was not until the early 1990s, ironically after Kuznets's death, that others began to think that his famous curve could equally apply to the relationship between environmental degradation and income. They reasoned that degradation would initially increase as a country industrialized and wealth increased, but would reach a point of inflection where matters would improve. This could, perhaps, be because of greater control over pollution through legal or voluntary measures, or perhaps because of better technology or a switch away from heavy industry to services. As a result, we have the classic 'good news' story for sustainability – yes, things do get worse, but only for a while. Once wealth exceeds a critical point, then the environment improves, or at least the degradation lessens, which is not quite the same thing.

Many have tried to prove that the EKC exists (Harbaugh et al, 2002; Khanna and Plassmann, 2004) and Box 1.4 is but one example. It has not been as easy as the reader may suppose, and, indeed, this one graph illustrates almost all of the contentious issues at the heart of sustainability. To begin with, it reduces human existence to just two dimensions: environment and income.

Box 1.4 The Environmental Kuznets Curve (EKC)

The theory

The relationship is quadratic in form:



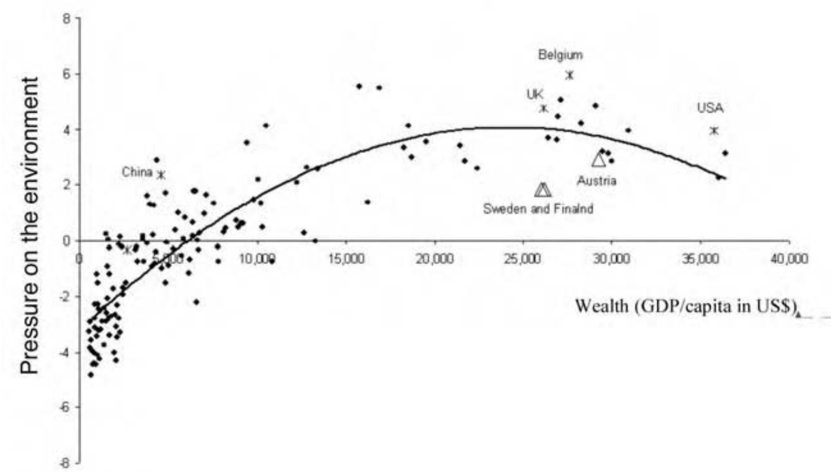
$$y = a + b x - c x^2$$

Degradation increases with wealth until at a certain point degradation lessens. This could be due to closure of polluting companies (or relocation) and the introduction of new methods of production and technologies to lessen pollution.

The evidence

This figure has been adapted from Morse (2008). The vertical axis represents pressure on the environment, while the horizontal axis is national wealth, assessed here by gross domestic product (adjusted for purchasing power parity) per capita.

The regression line shown in the graph is statistically significant and suggests that as wealth increases, largely because of industrialization, pressure on the environment from



pollution, etc. increases. At an income of around US$24,000 per capita, the pressure on the environment lessens. The reasons for this may be varied, including the introduction of new technology to lessen pollution or even the closure of some of the polluting companies.

Each point in the graph is a country. Some countries (such as the UK, the US and especially Belgium) have pressures on the environment that are greater than would be predicted by the regression for their wealth. However, note how some other countries (Sweden, Finland and Austria) have similar levels of wealth as the UK and Belgium, but much less pressure on the environment.

The simplistic implication of the EKC for a country such as China that has a relatively low level of wealth, but much pressure on the environment, is to increase its wealth as rapidly as possible in order to reach and exceed the point of inflection.

The EKC is based on an assumption that once a population reaches a certain quality of life, they will begin to value the environment and place pressure on polluters and degraders to do the same; but why should income be the sole or best measure of well-being? It would also seem that one can be happily 'traded' against the other – an initial decline in environmental quality appears to be fine if accompanied by an increase in wealth (= well-being?) provided the point is reached where the curve starts to turn downwards. This is the weak sustainability argument. Also note that each dot in the figure in Box 1.4 is a nation state, but could equally be any spatial unit where environmental degradation and income can be measured. The assumption, of course, is that the spatial units have a feedback mechanism so that at some point of wealth there is pressure to reduce degradation. But what exactly is meant by 'environmental degradation', how it should be measured and by whom, and what are the limitations of the national state as a spatial scale? The latter, of course, is problematic because the forces that cause such degradation (pollution and consumerism) can readily pass across our artificial boundaries. Visualizing the environment in different ways or using different methodologies could generate many versions of the EKC, even some without any inflection point at all suggesting that degradation may slow down but there is no reversal. Thus, while the figure in Box 1.4 may look very objective and scientific, it can hide much underlying subjectivity. Does it matter? Well, if we consider that some countries may take the EKC as 'truth' and, hence, push along the wealth axis at any cost with the assumption that environmental degradation will eventually reduce, then it can have major repercussions for us all.

Sustainability in practice

While the previous sections have discussed some of the questions central to sustainability, we are faced with a conundrum. Although sustainability may have much in common with truth and justice – what it comprises is heavily influenced by value judgements and ethics – like these two, it has to be put into practice by imperfect human beings. Given that sustainable development, like agriculture, cities and institutions, is a practical goal to be reached by intervention of some sort, one clearly needs to be aware of whether the system is still unsustainable or whether the goal of sustainability has been reached. Obviously, this will depend upon one's particular vision of sustainability and answers to questions regarding relevant spatial and time scales; however, even so, once the goal has been clearly identified, one needs to know whether the target has been reached:

> *Sustainability must be made operational in each specific context (e.g. forestry, agriculture), at scales relevant for its achievement, and appropriate methods must be designed for its long-term measurement.* (Heinen, 1994)

An illustration of the approach taken in this direction is provided by the results of a meeting held in November 1996 at Bellagio, Italy. The meeting was funded by the Rockefeller Foundation, and the aim was to set some principles for monitoring progress towards sustainable development. The results of the meeting are referred to as the Bellagio Principles for sustainable development (Hodge and Hardi, 1997) and are summarized in Box 1.5.

Some of these address broad issues already discussed, namely the:

- need for a clear definition (principle 1);
- focus on holism in sustainability (principle 2);
- importance of time and spatial scales (principle 4).

These are elements closely associated with the goal of sustainable development and finding them listed amongst the first principles in Box 1.5 is no surprise. Clearly, they need to be addressed before any progress on sustainability can be made.

As for gauging sustainable development, principle 5 emphasizes the use of a limited number of indicators, and this is followed by principles 6, 7, 8 and 9, which broadly set out how the indicators should be developed and employed. It should be noted that in recommending the use of indicators for this purpose the Bellagio meeting was simply echoing similar calls made by others. For example, in Chapter 40 ('Information for Decision-Making') of the Agenda 21 document flowing out of the Rio conference in 1992, there is a call for the development of indicators for sustainable development (ISDs). Indeed, there is a strong literature stretching back a number of years before 1992 calling for the use of indicators as a means of gauging sustainability (sustainability indicators: SIs), and indicators have been widely employed in a diverse range of circumstances for perhaps thousands of years. For example, farmers have long employed simple indicators of soil fertility, such as soil colour and presence of certain plant species, and other important considerations in agriculture (including the weather). Biologists have also been developing and applying

Box 1.5 A summary of the ten Bellagio Principles for gauging progress towards sustainable development

1. What is meant by sustainable development should be clearly defined.
2. Sustainability should be viewed in a holistic sense, including economic, social and ecological components.
3. Notions of equity should be included in any perspective of sustainable development. This includes access to resources as well as human rights and other 'non-market' activities that contribute to human and social well-being.
4. Time horizon should span 'both human and ecosystem time scales', and the spatial scale should include 'not only local but also long-distance impacts on people and ecosystems'.
5. Progress towards sustainable development should be based on the measurement of 'a limited number' of indicators based on 'standardized measurement'.
6. Methods and data employed for assessment of progress should be open and accessible to all.
7. Progress should be effectively communicated to all.
8. Broad participation is required.
9. Allowance should be made for repeated measurement in order to determine trends and to incorporate the results of experience.
10. Institutional capacity in order to monitor progress towards sustainable development needs to be assured.

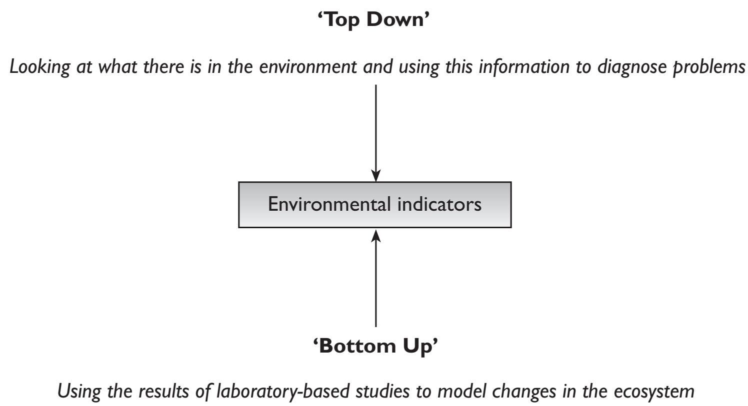
Source: adapted from Hodge and Hardi (1997)

indicators to ecological systems for many years. Ecosystems can comprise thousands if not millions of different components, some of which will be living (animals, plants, micro-organisms, etc.), while others will be inert (soil and water). Indeed, people (with all their attendant socio-economic and cultural dimensions) can also be components of the system. Clearly, with thousands, if not millions, of components and interactions in such a system, one cannot measure everything; instead, biologists focus on key components and interactions that represent the system as a whole.

Given the extensive experience of farmers, biologists and others, an extension of the indicator approach into sustainability is certainly not surprising, and one could even say is inevitable. In the following two sections we explore some aspects of the use of indicators to gauge complex systems. We begin by exploring the use of indicators by biologists to monitor the effects of pollution, and then progress to the use of indicators to gauge sustainability.

Indicators of ecosystem health

The widespread introduction of human-made chemicals and other pollutants into the environment has resulted in a substantial literature on the use of biological indicators as a means of gauging environmental impacts or, as some



Two of the most common methods in the top-down approach are to:

- *Measure the biological diversity (biodiversity).* When communities are put under stress (eg pollution), they generally become simpler as some species die and the relatively small number of tolerant species come to dominate the system.

Therefore, more biodiversity = better ecosystem health

- *Use the presence of certain indicator species.* Some species are very sensitive to a change in the environment (temperature, acidity, pollutants etc).

Therefore, presence/number of individuals of these species = better ecosystem health

Source: adapted from Cairns et al (1993)

Figure 1.4 *The two broad approaches to using environmental indicators*

put it, the health of the ecosystem (see Rapport et al, 1998, for theories and examples). Without wishing to oversimplify what is a complex field, there are two broad approaches to 'environmental indicators' (see Figure 1.4), with the top-down approach particularly popular and comprising two key methods:

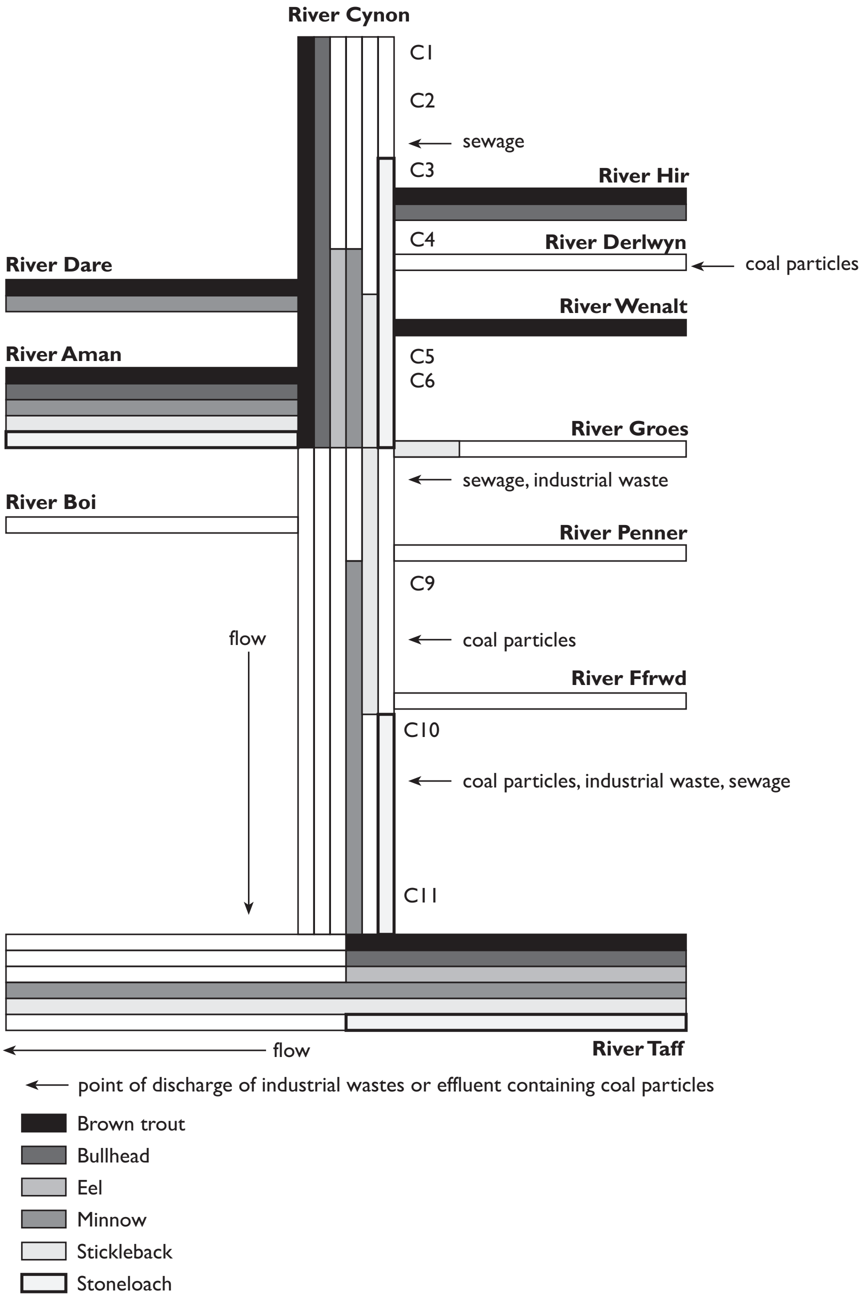
1 Look for certain 'indicator' species that are sensitive to changes in the environment.
2 Measure the biological diversity (biodiversity).

However, in practice, these two will often go together – the indicator species will be the first to be lost when a stressed system shows a reduction in biodiversity.

There are numerous studies that illustrate how species composition reflects ecosystem health, and one could select an example from almost any system or country worldwide. One particular example dating to the late 1960s and early 1970s is provided by Learner et al (1971). This example has the advantage of referring to a system with a clear spatial (and, to some extent, administrational and political) boundary – a river and its catchment – covering an area of 108 square kilometres. Furthermore, since a number of the key texts in the sustainability paradigm were published during the early 1970s, an example that predates them may be pertinent.

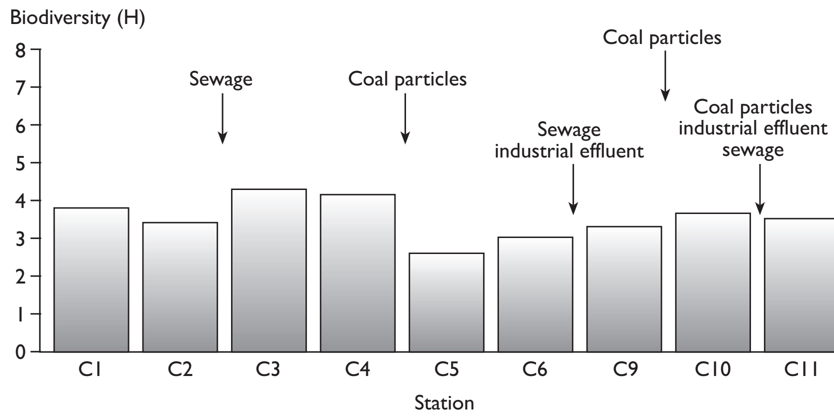
While published more than 30 years ago, the Learner et al (1971) study follows a commonly used approach in assessing environmental impact. The study is based on a survey of fish and macro-invertebrates (insects, worms, etc.) of the Cynon River, a tributary of the River Taff that flows through Cardiff, the capital of Wales. The study intended to determine how the distribution of species was influenced by effluents from sewers and various industries, including coal washery plants and coal tips that enter the river. Figure 1.5 is a diagrammatic representation of the river and its associated streams, along with an indication of where effluent enters the river and sampling stations (C1, C2, C3, etc.) where the fauna was checked. Distributions of six fish species (such as brown trout, bullhead and eel) are illustrated in Figure 1.5: there were clear effects on fish distribution, especially below the point where the Rivers Groes and Aman join with the Cynon. This corresponds with a major, but intermittent, discharge of industrial effluent. It is also noticeable that of all six species, minnows were found closer to the point of discharge, although this probably reflected their higher mobility and ability to re-colonize rapidly after pollution incidents, rather than an innate ability to withstand the toxicants. The results of the pollution could even be found some distance downstream of the point where the Cynon meets the Taff. Again, minnows in the Taff appeared to be the least affected.

A second method of gauging the state of the environment is to measure biodiversity. Ecologists have been measuring biodiversity for a long time, and various methods and indices exist (Southwood, 1978). These tend to be of a rather technical nature; one example is the Shannon–Wiener Index (H) illustrated in Box 1.6. The higher the value of H, the greater is the biodiversity of the sample. In effect, the index is a composite of the number of species in the sample (S) and the number of individuals of each species in the sample (represented by p_i). Example calculations of H are also shown in Box 1.6. The application of the Shannon–Wiener index can be illustrated by using the Learner et al (1971) example already described. Figure 1.6 presents the values of H for nine of the sampling stations (C1 to C6 and C9 to C11) on the River Cynon (location shown in Figure 1.5). The index has been calculated for species of macro-invertebrates (insects, worms, etc.), and fish and other animals have not been included. As can be seen from Figure 1.6, the value of H declines between stations 4 and 5, but gradually increases from stations 5 to 11. The point between station 4 and 5 corresponded with a discharge of coal particles into the river, and interestingly did not correspond with the location of the discharge that had a major effect on fish distribution as outlined above (this discharge lies between stations 6 and 9). It is also interesting to note that biodiversity increases between stations 2 and 3, probably as a result of sewerage entering the river and providing a source of enrichment.



Note: C1, C2, C3, etc. are sampling stations.
Source: adapted from Learner et al (1971)

Figure 1.5 *Fish distribution in the Cynon River system in South Wales, UK*



Note: arrows indicate points of discharge of sewage, coal particles and industrial effluent.
Source: adapted from Learner et al (1971)

Figure 1.6 *Change in biodiversity (Shannon–Wiener Index, H) along the River Cynon in South Wales*

The advantage of such an index is that it simplifies complexity into a single value that readily allows comparison. However, although this biodiversity index is useful for biologists, it does have a number of limitations.

- Strictly speaking, it can only be applied when the total number of species in the ecosystem is known, although in practice this may not be the case. For example, although Learner et al (1971) included a total of 126 macro-invertebrate species in their survey, and sampling was very thorough, there is no guarantee that all of the species were sampled.
- The index has no qualitative element since the same value of H can be found in the same system that has undergone a dramatic shift in species composition. For example, stations C1 and C10 in the Learner et al (1971) example both had an H value of around 3.7, yet the species composition at those two stations was quite different. In other words, it simply measures biodiversity without allowing for differences in the species that comprise that diversity.
- As can be seen from the equation and calculations, it is a rather technical expression that may not resonate very well with those who are not conversant with biology.

The first limitation is essentially technical in nature. The second represents an inevitable loss of information as we create a simple index out of complex data. The third is not a consideration for biologists fully conversant with the mechanics of H, but would be important if the index was employed as a means of informing policy-makers or the public about environmental quality. Although the fundamental ideas of indicator species and biodiversity do

Box 1.6 The Shannon–Wiener Index (H) of biodiversity

$$H = -\sum_{i=1}^{i=s} (p_i)(\log_2 p_i)$$

where:

- $\sum$ = sum of (in this case from species number 1 to species number S);
- S = the number of species;
- p_i = the proportion of total sample belonging to the ith species. It is found by n_i/N, where n_i is the number of individuals in species i and N is the total sample size;
- $\log_2$ = logarithm to the base 2.

The negative sign converts the results of the calculation from negative to positive. It is required because the logarithm to the base 2 of values less than 1 is always negative ($\log_2$ of 1 = 0). The higher the value of H, then the greater is the biodiversity of the sample.

Examples: in both cases there are two species (S = 2), and the sample size is 100 (N = 100).

(a) 50 individuals of each species:

$$\begin{aligned} H &= -(0.5 \times \log_2(0.5) + 0.5 \times \log_2(0.5)) \\ &= -(0.5 \times -1) + (0.5 \times -1) \\ &= -(-0.5 + -0.5) \\ &= 1. \end{aligned}$$

(b) 99 individuals of species 1 and 1 individual of species 2:

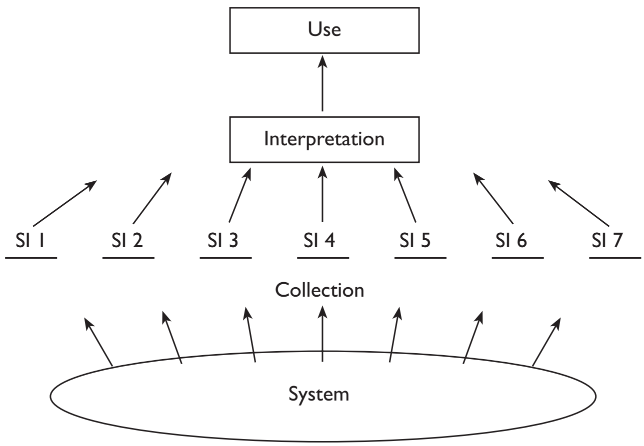
$$\begin{aligned} H &= -(0.99 \times \log_2(0.99) + 0.01 \times \log_2(0.01)) \\ &= -(0.99 \times -0.0145) + (0.01 \times -6.6439) \\ &= -(-0.0144 + -0.0664) \\ &= 0.08. \end{aligned}$$

Therefore, H is higher in (a) than (b), suggesting that there is more biodiversity.

resonate with lay people (Hawkins et al, 1994), the means of presentation is critical. Very technical expressions such as H that speak volumes to biologists may simply not be the best format to use in situations where a much wider audience is being addressed.

Sustainability indicators and indices

Given that indicators have been widely employed by biologists for many years to gauge ecosystem health, it is not surprising that indicators (and indices, which are amalgams of indicators) have been seen by many as the core element in operationalizing sustainability. However, unlike the sort of system



Note: SIs 1 to 7 collect 'pieces' of information (indicated by the arrows) about the large, complex system.

Figure 1.7 *The concept behind sustainability indicators (SIs)*

described in the Learner et al (1971) example, sustainability incorporates many more dimensions, including quality of life. While the presence of just a few indicator species and the calculation of biodiversity were all useful in tackling the specific problem of pollution in the River Cynon, the frontiers of sustainability are much grander and a number of indicators are almost certainly required. The theory is indicated in Figure 1.7. The values of the seven SIs shown here are gauged; one then has to interpret the results and make use of the interpretation. The problem, of course, is how many and which indicators to use? Clearly, one cannot use every SI that may potentially be available, and an element of simplification, while at the same time maximizing unique and relevant information, is essential.

SIs are often grouped in various ways depending upon what dimension or element of sustainability they are trying to gauge. The simplest division is into two groups:

1 *State SIs*. These are SIs that describe the state of a variable. For example, in the case of environmental quality, one may determine the soil's physical and chemical properties, or the concentration of a pollutant in water. Other more social examples may be the human population density, income equality, female and male wage ratio, life expectancy at birth and maternal mortality rate.
2 *Pressure SIs* (also referred to as control, process or driving force SIs). These are SIs that gauge a process that, in turn, will influence a state SI. For example, a control SI may be the rate at which a pollutant is passed into the environment. A good example is the amount of pesticide used in an area (e.g. the Biocide Index of Jansen et al, 1995).

State and pressure SIs can be related. An obvious example is that the rate of pesticide application in an area will have a major influence on the measured concentration of pesticides in drinking water. A suite of SIs may need to have both state and pressure SIs included since changes in a state SI may not necessarily provide information on the causes of change. The link between concentration of pesticides in water and application in a river catchment may be clear enough; but life expectancy at birth and income equality will be influenced by many factors, not just one.

This basic distinction between state and pressure SIs was also initially employed by the United Nations for their ISDs (= SIs), flowing out of the 1992 Rio Earth Summit; however, the UN included a third type called 'response' indicators. These are employed to gauge required progress in the response of governments, for example, to achieve adequate values of state and pressure indicators. It is also interesting to note that the term driving force instead of control was preferred by the UN when first developing its list of SIs in order to fully incorporate the notion that impact of a factor on sustainable development can be positive or negative. They regarded 'pressure' as implying a negative dynamic – making matters worse – while driving force can imply both a negative and a positive dynamic – making matters better. In effect, the driving force – state – response (DSR) is a cause–effect model: driving forces generate the state of what is experienced which, in turn, may require something to be done.

A further feature of the UN indicators is that they based their selection of SIs on the chapters of the conference document, so that the latter essentially becomes the frame. The chapters themselves can be broadly divided into four categories:

1 social aspects of sustainable development;
2 economic aspects of sustainable development;
3 environmental aspects of sustainable development – further subdivided into water, land, atmosphere and waste;
4 institutional aspects of sustainable development.

A 'working list' of SIs was then determined for points arising in each of the chapters. A summary of the results is presented in Table 1.1. For example, in Chapter 17 of Agenda 21, entitled 'Protection of the Oceans, all Kinds of Seas and Coastal Areas', there were three driving force SIs and two state SIs. The driving force SIs covered population growth in coastal areas and levels of pollution. One of the state SIs followed the first rule given by Rennings and Wiggering (1997) – namely, that resource use should not exceed regeneration. This is the much studied and discussed concept of maximum sustainable yield (MSY) mentioned earlier in this chapter and which will be returned to in Chapter 2. The second state SI for this chapter, the algae index, is an index of algal (includes phytoplankton) biodiversity and abundance. It comprises information on the type and quantity of algae present in a volume of water.

Table 1.1 *The United Nations working list of indicators of sustainable development (ISDs) based on Agenda 21 (Rio de Janeiro, June 1992)*

Categories, main chapter headings and chapter numbers (bracketed)			
Social	Combating Poverty (3) Demographic Dynamics and Sustainability (5) Promoting Education, Public Awareness and Training (36) Protecting and Promoting Human Health (6) Promoting Sustainable Human Settlement Development (7)		
Driving force: 11	*State: 21*	*Response: 7*	
Economic	Changing Consumption Patterns (4) Financial Resources and Mechanisms (33)		
Driving force: 9	*State: 11*	*Response: 3*	
Environmental	Promoting Sustainable Agriculture and Rural Development (14) Combating Deforestation (11) Conservation of Biological Diversity (15) Protection of the Atmosphere (9) Environmentally Sound Management of Biotechnology (16)		
Driving force: 22	*State: 18*	*Response: 15*	
Institutional	Science for Sustainable Development (35) Information for Decision-making (40) Strengthening the Role of Major Groups (23–32)		
Driving force: 0	*State: 3*	*Response: 12*	
Total	Driving force: 42	State: 53	Response: 37

Total number of sustainability indicators = 132

Example: Protection of the Oceans, all Kinds of Seas and Coastal Areas (Chapter 17)

Driving force	*State*	*Response*
Population growth in coastal areas Discharges of oil into coastal waters Releases of nitrogen and phosphorus to coastal waters	Maximum sustained yield for fisheries Algae index	None

Note: the UN prefers to use the term 'driving force' instead of 'control', 'pressure' or 'process' SIs.

The story of the UN list of SIs, and how it has evolved since the early 1990s, can be found at www.un.org/esa/sustdev/natlinfo/indicators/isd.htm. The UN published the results of its third revision in 2006 (the other two were published in 1995 and 2001), 14 years after the Rio conference, and is encouraging countries to test the SIs. Interestingly, it has abandoned the DSR framework in favour of a theme (poverty, governance, health, etc.) and sub-theme (income poverty, income inequality, life expectancy at birth, etc.) approach.

It has to be said that while the UN has dropped the DSR framework, it does remain popular. Indeed, some have also added 'impact' between state and response to give DSIR (driving force state impact response). Impact indicators could be factors such as the incidence of lung disease in humans, which in turn would be influenced by the level of air pollution. At the most sophisticated level, some have suggested the full framework of DPSIR – driving force, pressure, state, impact and response. The distinction between driving force and pressure in this framework can be illustrated as the link between 'number of cars' and car exhaust pollution. The 'number of cars' or, more accurately, the 'car density' is a socio-economic driver (pardon the pun), itself related to a range of factors, such as income levels or, indeed, 'fashion', and this driver will, in turn, affect the air pollution pressure (rate of release of noxious gases from car exhausts). The state of air pollution can be measured, and this could impact upon human health. An example of a response would be a tax on petrol purchases to encourage people to drive less.

Nevertheless, although there is much agreement that SIs are the way forward, there is disagreement over what SIs to use and even about the broad nature and characteristics of the SIs. However, the decision over what SIs to adopt is vital to the final outcome. Included here are just four more examples to provide the reader with a taste of the diversity of approach. No doubt the reader will have their own favourites and may wonder why they are not included here; but our choice has been designed to represent points of spread and associated issues, rather than any notion of them being the 'best' of their kind.

Sustainability indicators: Example 1

Another indicator framework developed as a response to the Agenda 21 document of the Rio Summit is provided by Harger and Meyer (1996). The framework was created by a UN interagency working group for South and South-East Asia, and, as would be expected, there is much overlap with the original UN SI list. Agriculture, fisheries, population and education all feature, and for the most part the indicators have much in common with the UN list described above. But this example has been chosen because there are some interesting and unique additions that illustrate the breadth of what could and arguably should be considered within sustainability. Military considerations, for example, are listed as a category and one can but speculate over what SIs could be included here and how they are to be measured and presented, given the enormous sensitivity of such a topic at any time, but with especial resonance given the events following the terrorist attacks of 11 September 2001 in the US and subsequent military interventions and terrorist attacks across the globe. The relationship between terror and sustainability is, unfortunately, going to be a growing theme during the early years of the 21st century. After all, returning to the quality-of-life definition provided by

WHOQOL (1995), which is contemporary to the Harger and Meyer (1996) paper, the perceived chances of being a victim of terrorism are clearly of major importance.

The Harger and Meyer (1996) paper sets out the following characteristics for SIs:

- simplicity;
- scope: the SIs should cover the diversity of issues mentioned above (environmental, social and economic) and overlap as little as possible;
- quantification: the SIs should be measurable;
- assessment: the SIs should allow trends with time to be determined;
- sensitivity: the SIs should be sensitive to change;
- timeliness: the SIs should allow timely identification of trends.

Unsurprisingly, these have much in common with the Bellagio Principles (Hodge and Hardi, 1997); indeed, there is much here in common with the selection of suitable bio-indicators by biologists to measure pollution or some other environmental change. The quantum jump from bio-indicators to SIs is clearly in the scope – the need for a range of SIs that cover the breadth of the sustainability vision.

Sustainability indicators: Example 2

Bossel (2001) has developed a system-based approach to developing SIs that is, perhaps, the most deeply rationalized of the four examples provided here. The framework attempts to provide a holistic vision of sustainability which recognizes that any system does not exist in isolation and that boundaries are permeable. No matter how we draw our boundaries, any system provides an influence and, in turn, is influenced by other factors that exist outside those boundaries. Bossel also sets out what he regards as 'six fundamental environmental properties' – namely (in his words):

1. *A normal environmental state*. The actual environmental state can vary within a certain range and still remain normal.
2. *Resource scarcity*. The resources (energy, matter, information, etc.) required for a system's survival and development are not immediately available when and where needed.
3. *Variety*. The system environment is seldom uniform; many qualitatively different processes and patterns of environmental variables occur and appear in the environment both constantly and intermittently.
4. *Variability*. The state of the environment fluctuates within the normal environmental range in random ways, and these fluctuations occasionally take the environment outside this range.

5 *Change*. Over time, the normal environmental state may gradually or abruptly change to a permanently different normal environmental state.
6 *Other systems*. The environment contains other systems or agents whose behaviour may have system-specific significance for the given system. (Bossel, 2001)

These are simplifying assumptions, of course; but they are reasonable nonetheless. Bossel (2001) then goes on to suggest seven orientors of 'system viability':

1 (X) existence;
2 (E) effectiveness;
3 (F) freedom of action;
4 (S) security;
5 (A) adaptability;
6 (C) coexistence;
7 (P) psychological needs;

and these are assessed within three sub-systems:

1 human;
2 support;
3 natural.

An indicator is developed for each 'orientor' within each sub-system = 21 indicators. Biodiversity, for example, appears as an indicator for 'adaptability' in the 'natural' sub-system. The key contribution of such a rationalization of system characteristics, orientors, etc. is to avoid:

> *… arbitrariness implicit in current and proposed indicator sets. It turns the focus from an uncertain* ad hoc *search and bargaining process to a much more systematic procedure with a clear goal: to find indicators that represent all the important aspects of viability, sustainability and performance.*

But specifying a framework like this still leaves plenty of scope for subjectivity in terms of SIs. Bossel (2001) attempts to address this by providing guidelines for the selection of SIs; but even so there is much room for personal choice. For example, he refers to 'air quality' as an indicator of 'co-existence' in the 'support' sub-system; but as we will see, this is a highly subjective term and much depends upon how it is measured, when and by whom.

A second feature of the Bossel (2001) approach that distinguishes it from the other three examples presented here is the identification of the need for people to be engaged in SI development, rather than it being a 'top-down' and expert-driven process. This is a central theme of this book and will be returned to later.

Sustainability indicators: Example 3

Izac and Swift (1994) have developed a matrix of SIs for small-scale agriculture in sub-Saharan Africa (see Table 1.2). The two scales of the matrix relate to spatial scale (cropping system, farm and village) and three categories of 'products' from the system (main products, by-products and amenities). As can be seen from the table, production forms a major element of their vision of sustainability. A second distinguishing feature of their framework is their clear identification of the important spatial scale as the 'village catchment'. While this is something of a movable line in the sand, it is at least an attempt to set out a defined spatial boundary (rather than a conceptual one) within which to assess sustainability. Izac and Swift (1994) also set out a time scale to assess the trend of their indicators – at least ten years. While both decisions can be open to critique (e.g. what about socio-economic relationships outside the village catchment?), they have at least provided a basis for analysis.

Table 1.2 *Some sustainability indicators proposed by Izac and Swift (1994) for sub-Saharan African agro-ecosystems*

		Scales	
	Cropping system	*Farm*	*Village*
Products	Ratio of annual yield for all products to potential and/or farmer's target yield	Profit of farm production	Economic efficiency
		Ratio of profit to farmer's target income	Social welfare
By-products	Soil pH, acidity and exchangeable aluminium content	Ratio of aggrading to degrading land area	
	Soil loss and compaction	Nutritional status of household	Nutritional status of community
	Ratio of soil microbial biomass to total soil organic matter		Stream turbidity, nutrient concentration and acidity
	Abundance of key pest and weed species		Human diseases and disease vectors
			Biodiversity and complexity
Amenities		Drinking water quality	Drinking water availability
		Source and availability of fuel	

Source: adapted from Izac and Swift (1994)

A second feature of the Izac and Swift (1994) framework that distinguishes it from the others given here is its focus on research. The framework was derived to help guide agricultural research policy, and thus the intended users are also clearly defined and, in fact, are a specialized group. The other three examples are vaguer with regard to intended users, perhaps because they have a much larger and more diverse group in mind.

Sustainability indicators: Example 4

The fourth example is the most recent and is, perhaps, the most ambitious of those presented here. The example selected is the Environmental Sustainability Index (ESI). The ESI was created towards the end of the 1990s by Yale and Colombia Universities in the US, a group which refers to itself as the Global Leaders of Tomorrow is and promoted by the World Economic Forum (WEF). Unlike the other three examples, the ESI is a single number derived mathematically from a list of indicators that are each given the same weight. While Bossel (2001) prefers to use a diagrammatic representation of sustainability (radar diagrams), and both Izac and Swift (1994) and Harger and Meyer (1996) are content to present their results as tables, the ESI is a single number.

The ESI is calculated on a nation-state basis with values for each country varying between 0 (most unsustainable) to 100 (most sustainable). The results are presented as a league table to invoke a sense of name and shame and thus encourage states to improve their performance, and the project has been successful to the extent that the ESI league tables have been widely reported in the popular press and there is some evidence that the high profile of the index has impacted upon national policy.

The methodology for arriving at the ESI is complex and the details need not concern us here. The interested reader can explore the many reports and documents available at www.ciesin.columbia.edu/indicators/ESI/). Here, it is only necessary to summarize the main features, and while the approach has been consistent the details do vary across the three published versions of the ESI to date (2001, 2002 and 2005). The indicators included in the ESI are diverse and span some that are obvious, such as the levels of ambient pollution, emissions of pollutants and impacts upon human health, but also response indicators, such as being a signatory to international agreements to limit release of pollutants or conserve biodiversity. It should be noted that while the indicators can be classified using the DSIR framework, it is not explicitly used in the ESI documentation. Instead they prefer to use the headings of:

- environmental systems;
- reducing environmental stresses;
- reducing human vulnerability to environmental stresses;
- societal and institutional capacity to respond to environmental challenges;

- global stewardship.

The first of these (environmental systems) equates largely to state indicators, while the second (reducing environmental stresses) mostly comprises pressure indicators. The other three categories are largely composed of response indicators.

The ESI of 2005 uses data sets for 76 variables, which in themselves can be thought of as indicators. However, the creators of the ESI decided to amalgamate related variables into what they term 'indicators' (76 variables into 22 'indicators'). Given the range of variables involved, this aggregation is understandably not a straightforward process. The first step is to smooth the data by removing extreme values. If a variable has a highly skewed distribution, then the skew is lessened by taking logarithms, and following this each variable is 'capped' to remove extreme values by employing the 97.5 and 2.5 percentiles. Missing data (and there may be many of them with some variables) are handled by a complex process of regression.

Once the variable data are ready for aggregation into the 22 indicators (in the case of ESI 2005), they first have to be standardized. This is achieved by using the mean (average) and standard deviation (a measure of variation in the data) of the variables. If higher values of the variables are deemed to be 'good' for sustainability (e.g. biodiversity), then the z value is given by:

$$\text{z value} = \frac{\text{country value} - \text{mean}}{\text{standard deviation}}$$

If high values are deemed to be bad for sustainability (e.g. emissions of pollutants and reduction in human health), then the z value is given by:

$$\text{z value} = \frac{\text{mean} - \text{country value}}{\text{standard deviation}}$$

The average z value is then found for each indicator.

Even without going into details, we are sure the reader is getting a sense of the complexity involved in generating the ESI; but this is not yet the end of the manipulations. The average z values (i.e. for the 22 indicators) are converted to a more intuitively meaningful statistic by calculating the 'standardized normal percentile', and the result is a set of numbers with a theoretical minimum of 0 and a theoretical maximum of 100. These are, in turn, averaged to yield the ESI. The closer the ESI is to 100, then the better the environmental sustainability for that country.

The ESI is promoted by a powerful group and has been designed to attract attention both in its collapsing of sustainability via a rather complex route to a single number and the league table style of presentation. No other effort to produce a single index for sustainability has arguably had anything like the success of the ESI, and it can also be argued that the ESI has outdone even the UN lists of SIs in terms of reporting in the popular press. While extensive reporting in the national press may be a good first step in attracting attention and raising awareness, there are some indications that the ESI has had an impact upon policy, although the extent of this and its durability are less known. It also has to be acknowledged that this high profile comes at a price in that many simplifying assumptions have had to be made to pin values to countries. For example, air and water pollution can cross frontiers; indeed, some countries will 'export' dirty and low-wage production to developing countries, thereby exacerbating the variation in the ESI (Lawn, 2007). Also, while the intention is no doubt well meaning, the ESI includes a significant proportion of variables which do not measure environmental quality as such but instead measure what countries are doing about it (e.g. variables that measure involvement in international collaborative efforts and investment in science and technology). There are two problems here. First, there may not necessarily be a cause–effect relationship between environmental quality and the doing of something about it. Second, variables that measure investment in research and facilities will tend to favour the richer countries: those with the resources to invest. However, most important of all is the underlying subjectivity of the ESI presented in a form that implies much objectivity. The methodology summarized above provides but a taste of the technical complexity of the index, and the documentation, while presented in great detail, does not lend itself to easy digestion by a non-specialist. Almost inevitably the tendency is for the 'consumer' of the index and league table to accept their validity and not contemplate how the decisions have been made to include only certain variables. Thus, the ESI is a reflection of what creators at Yale and Colombia universities feel is important for environmental sustainability, and others can and do disagree with these choices and thus create very different country 'rankings'. In 2001, *The Ecologist* journal provided an excellent example of this, and who is to say that its construct is any less valid that that of the Global Leaders of Tomorrow.

It is interesting to note that in all four of the above examples, those who have set the framework are, for the most part, politicians, policy-makers, social or natural scientists. All of the examples are 'top down' and technocratic in nature, and while this is perhaps most obvious with the ESI, it equally applies to the other three examples. Logically, one may feel that those best placed to define sustainability and to set relevant SIs would be the beneficiaries (also referred to as the stakeholders) of the programme. For example, Mitchell et al (1995) state the following as the first principle in the development of SIs:

> *Stakeholders [should] reach a consensus on the principles and definitions of sustainable development that are used and the objectives of the sustainability indicators programme.*

However, this has rarely been put into practice, and for the most part the SIs, or at least the methodology for developing SIs, have been set by outsiders, with perhaps a nod in the direction of those whom the SIs are ultimately meant to serve. Indeed, is sustainability really an important consideration for all stakeholders, and if it isn't, should an outsider impose it? The following comment by Tisdell (1996) related to agricultural sustainability is very sobering: 'In fact, sustainability is unlikely to be an overriding consideration of a farmer from an economic viewpoint.'

Given that participation has been central to much development since the late 1970s, particularly in terms of guiding research priorities, and the fact that a huge and highly accessible literature has grown around the subject (see Chambers, 1981, 1991 and 1997; Chambers et al, 1989; Scoones and Thompson, 1994), it is interesting how the 'sustainable' part of sustainable development has retained such a top-down and Western emphasis. The issue of participation in sustainability, and particularly in the development of an SI framework, is, we believe, of paramount importance and will be returned to in greater depth in Chapters 5 and 6.

Another issue is the way in which the indicators/indices have been presented for consumption by 'users'. To a large extent, this would depend upon who the consumer is meant to be and the four examples provide a quite different set of perspectives. At one extreme, some have attempted to encapsulate SIs using an appropriate weighting scheme into a single measure of sustainability, as illustrated with the ESI. There are other examples in similar vein, such as the degree of sustainable development (DSD) suggested by Niu et al (1993). Another, perhaps more focused, example is the use of an economic approach for measuring sustainability called Total Factor Productivity (TFP). TFP attempts to measure an efficiency of production by including all of the costs, even ones which are perhaps not so obvious. A classic application of TFP is in agriculture (see Box 1.7). It is, of course, possible to include the costs of fertilizer purchased in bags; but what about the nutrients already present in the soil and which the farmer has not paid for? Effectively, they can be regarded as 'free'; but mining these nutrients would mean that the farmer has to apply more fertilizer to get the same yields. Another example is the influence of rainfall. Farmers do not 'buy' rain, although they can invest in irrigation; but it is clearly an important factor in production. TFP attempts to account economically for all of these 'hidden' factors.

The notion of a numeric value for sustainability such as the ESI is attractive for the very reason that the Shannon–Wiener biodiversity index, and others like it, is attractive. Simplifying system complexity into single values that allow for easy comparison has a definite appeal, and this has been particularly exploited with the ESI in parallel with the use of country league tables. Others have sought to keep the richness of sustainability intact by using various tabular or diagrammatic formats, and the 'radar' diagrams of Bossel (2001) are an example. A variant on the 'radar' form of diagram is the AMOEBA of Gilbert (1996) and others (a general method for ecosystem description and assess-

Box 1.7 The theory behind the calculation of the Total Factor Productivity Index (TFP) of sustainability in tropical farming systems

Lynam and Herdt (1989) define the TFP as:

$$\text{TFP} = \frac{\text{value of outputs from farming system}}{\text{value of inputs into farming system}}$$

Lynam and Herdt (1989) suggest that changes in TFP over time equate to a measure of sustainability (i.e. change in productive capacity of the system). In its simplest form:

Increase in TFP = sustainability
Decrease in TFP = unsustainability (decline in resource base).

Tisdell (1996) suggests a slight modification of this idea to focus instead on profitability (P) of the system:

$$\text{TFP} = \frac{\text{value of output} - \text{value of input}}{\text{value of input}}$$

This is fundamentally an economic approach based on the productivity of the farming system, and works as long as inputs (including the natural resource base) and outputs can be given a monetary value. Other environmental and social effects that many consider central to sustainability are not included.

ment), which is described in Chapter 2. In some cases, the SIs are superimposed on maps of the area to illustrate how they vary over space. This may become more common with the increasing use and power of geographic information systems (GIS) on microcomputers.

Although a single SI may be relatively easy to interpret provided that one has a clear reference point, the interpretation of a suite of SIs may be problematic. What does one conclude if some are within the reference limits and some are not? Does one take an all or nothing point of view (the 'binary' view of sustainability – either a system is sustainable or not), or can one conceive of gradations of sustainability? Also, if SIs are taken over a period of time, they can be used to determine a trend – do they stay the same, increase or decrease, and, if so, by what rate? In a sense, the absolute values of the SI may not matter (just as well if it is based on 'guesstimates'!). Instead, the emphasis is on how they change with time. The problem is what happens if the trends for different SIs within a matrix go in opposite directions (see Figure 1.2c) – some stay the same while others go up and down. Furthermore, what if the same SI shows a complex pattern of increases and decreases with time as in Figures 1.2b and 1.3? In addition, although the trends can be useful to illustrate sustainability, they need to be combined with estimates of what is acceptable. After all, sustainability can be achieved at a very low level of system quality; but is the low level acceptable? Single values of SIs with units require some sort of baseline for interpretation. A value of X units is meaningless unless we have an idea of what range equates to sustainability or, in other words, what represents the target or reference condition. This is not easy! Jansen et al (1995) were able to establish limits to nutrient balances that reflect sustainability; however, for the biocide index mentioned earlier: 'No clear-cut relation exists between the calculated index of biocide use and the sustainability of the system, making calculation of a limit to the biocide index impossible.' Instead, a limit to the biocide index equating to sustainability could only be set 'subjectively'.

Once a set of SIs has been agreed upon, they have to be measured. The fewer the SIs to be considered, the easier this may be, although the tendency may be to include a large number of SIs in order to cover the breadth of sustainability.

Obtaining the value of an SI may be a relatively easy task if good-quality data is already available, or if the means of getting such data is already well established. Indeed, the availability of relevant data may not be a problem at all, and all the difficulties will revolve around choice, interpretation and use of SIs:

> *In the developed world, we often have far more data than we can ever use. In most cases, what is lacking is not data but an understanding of what is important and the resolve to act.* (Lawrence, 1997)

If new data has to be collected, then the precise methodology for determining an SI will, of course, depend upon what it is. For example, in the Izac and Swift (1994) set of SIs, the soil nutrient status, organic matter content, water-holding capacity, and the abundance of an animal or plant species can be determined by employing standard analytical and ecological sampling techniques. Clearly, there is the problem of variation, given that in the same field there can be marked differences in, for instance, nutrient status within very short distances depending upon slope, previous cultivation and the presence of trees or termite nests; however, given the resources, these problems are resolvable. The same would be true of water and air quality, once it is agreed what properties to measure. Issues surrounding social welfare and economic efficiency can also be assessed using standard social science surveying techniques. It should be noted, however, that although many of these tools are well established, they are not without limitations. For example, monitoring carbon monoxide levels may be a reasonable indicator of air quality; but this can vary dramatically within a short distance and during a day, let alone due to weather effects. Monitoring can be expensive; hence, the typical approach is to place monitoring stations at places which are prone to greatest risk – for example, near busy road junctions. But can the data from but a few stations be extrapolated to represent air quality for a whole town?

Sustainability indicators: A realistic and reasonable approach to measuring sustainability?

As one may construe from all of the foregoing, the selection and measurement of SIs is hardly a fine art and is subject to many pressures, agendas and biases. Governments often wish to portray themselves in the best possible light, and it is certainly not hard to imagine that 'reference' conditions may be set with a political agenda in mind. Indeed, given all of the above, the reader could be forgiven for thinking that the development and application of SIs as a way of gauging system sustainability may be unrealistic. There are a number of critics of SIs, and the following two chapters will illustrate some of the major planks upon which these criticisms are based. It should first be noted that the problems discussed so far in this chapter, including defining sustainability, and the setting of spatial and time scales, are well known to the proponents of SIs; as has already been illustrated, workers in the field attempt to provide various solutions.

One of the major criticisms regarding SIs is that they attempt to encapsulate complex and diverse processes in a relatively few simple measures. This is not a new problem. The world is a complex place, and people have had to make sense of it for a long time! The obvious approach is to deal with the world in manageable bits. Scientists deal with a complex system by breaking it down into its components and studying how they work in isolation and then together; this is the reductionist approach. Reductionism has received much criticism by authors (Capra, 1982, 1996, 2004) on the reasonable basis that some systems are so complex, with millions of interactions, that we are unable to look at every one. However, do we need to? Biologists have been dealing with complex ecosystems for many years, and they have long used indicators as a tool for gauging ecosystem health. Their experience suggests that:

> *The number of possible interactions among species is astronomical. If ecosystems science is strictly a study of species interactions, it is hopelessly complex. But just as we need not consider all cell-to-cell interactions whenever we discuss a single organism, so we need not consider all possible species-to-species interactions whenever we discuss ecosystems.* (Slobodkin, 1994)

Allied to reductionism is a common perception that scientists, policy-makers and others are obsessed with quantification. The distillation of information on biodiversity into a single value such as the Shannon–Wiener Index is only one example of quantification; but all four examples of SIs given above are number based. Interestingly, some argue that belief in quantification is itself generated and reinforced by paradigms; this, in turn, requires proof of the wider application of a paradigm. In other words, the evolution of sustainability as a paradigm inevitably leads to a need to quantify sustainability; hence, sustainability indicators were developed as a means of keeping the paradigm alive. Quantification, however, does have limitations, and clearly it is not possible to measure all human experience. Indeed, for all their attempt at holism (see, for example, the second Bellagio principle) and a desire to incorporate the richness of humankind's complex interrelationships with nature, SIs are still a classic reductionist set of tools based on quantification. Indeed, we find it very ironic that those who scorn attempts to give value to sustainability, or to produce tables of SIs such as those proposed by the UN, still employ a language that has quantification at its heart. This has clear relevance; indeed, we feel it is central to the whole sustainability debate. Can we really use simple SIs to gauge such a complex issue as sustainability? Although aware of these pitfalls, many, of course, do just that. As Harrington (1992a) points out: 'it is never possible to deal with any problem (not just sustainability problems) in all its real-world complexity'. Scientists 'have to simplify to survive'. But how much simplification is acceptable? Clearly there is a trade-off between necessary simplification and at the same time having SIs that are meaningful. However, this is not a problem unique to sustainability or, indeed, to ecology. As Slobodkin (1994) states:

> *Any simplification limits our capacity to draw conclusions, but this is by no means unique to ecology. Essentially, all science is the study of either very small bits of reality or simplified surrogates for complex whole systems. How we simplify can be critical. Careless simplification leads to misleading simplistic conclusions.*

Harrington (1992a and 1992b) rejects the notion that quantifying sustainability is not possible precisely because it has been successfully achieved with complex biological systems. After all, what about the species indicators and biodiversity measures described earlier in this chapter? Farming systems research has also provided a wealth of experience in dealing with complex systems. Indeed, here is the nub! If the development and application of SIs were purely an academic exercise with no real immediate and practical relevance, then one may be willing to accept initial problems of oversimplification as an essential and necessary part of a lengthy learning curve. It should be remembered that ecologists and agriculturalists can make predictions about system behaviour based on their knowledge of the system's components and their interactions. If the results do not match reality, it is back to the drawing board for refinement. Ecology is a science, and like all science any predictions (hypotheses or models) are compared to the hard reality of what actually happens. If the predictions fail, then a good scientist will acknowledge the fact and build this new knowledge into future predictions. The result is an evolving body of knowledge accumulated over many years by a rich process of hypothesis formulation and testing.

While it is true that ecologists are part of a wider society, and are not isolated from socio-economic, cultural and political pressures that set priorities for research and how results are used, the science itself should be immune to these pressures. Similarly, farming systems research (FSR, also sometimes referred to as farming systems research and extension – FSR/E – or, more generically, on-farm research) combines a systems framework of analysis with research in which the farmers and their families play a central role in the process (McNamara and Morse, 1996). The language is certainly similar to that of sustainability – holism, systems perspective, incorporation of social perspectives and methodologies are all central to FSR. However, the setting of hypotheses, and testing, acceptance or rejection are also a part of the FSR process, albeit under different guises and by different means than in ecological science.

Does the development and use of SIs parallel the scientific approach of ecology, or even FSR? Frankly, it does not since the sustainability–SI combination involves a degree of circularity. Sustainability itself is a human vision that by definition is laced with human values (political and ethical) and SIs are not necessarily developed through a long process of hypothesis setting and testing, intended to arrive at a deeper understanding of sustainability. Granted, an element of refinement can be built in; but one does not develop a host of SIs, then 'test' them to see whether they adequately describe sustainability. Rather, the starting point is a description of sustainability, with all of its human subjectivity, followed by an identification of SIs to gauge attainment of that description. Indeed, if we are planning to make major policy and economic changes to a system in order to get the SIs moving in the right direction, we do not want the SIs to be continually changing while all of this is happening. Not only can confusion result, but one is left open to the charge of changing SIs to suit. The reader should not take this to mean that SI selection is somehow inferior to more rigorous approaches in science. It is not inferior, but different.

An additional and very important factor is the role of those involved in setting agendas and the provision of funding for development initiatives. Money is inevitably a scarce commodity, and phrases such as value for money, cost effectiveness, project appraisal and evaluation are commonly employed by funding agencies. Given this background, donor agencies have become concerned about the sustainability of organizations charged with development in the field, as well as the sustainability of the outcomes of development. These two visions of sustainability are quite different and not necessarily complementary. An excessive emphasis on the sustainability of the method may inevitably result in less emphasis on the sustainability of the final outcome.

In the next two chapters we examine some of these two concerns in greater depth. In order to do this we describe SIs at a number of levels. To begin with, we illustrate the limitations of the reductionist, mechanistic and quantitative approach to sustainability by looking at some of the ecological ideas behind one SI recommended by the UN: the maximum sustainable yield in fishery management. This is followed by a description of an attempt to forge different

SIs together into one overall picture of sustainability – the AMOEBA approach. Since both MSY and AMOEBA are essentially located in natural resource management, we examine how holism in sustainability (combining environmental, social and economic concerns) is attempted by focusing on the use of SIs in sustainable city programmes. Finally, we discuss some of the points that arise out of the need for agencies to appraise field projects on the basis of sustainability. The example chosen is the expanding area of financial service provision in developing countries.

It should be stressed that sustainability and SIs cover a huge amount of ground, and the examples selected for Chapters 2 and 3 should not be read as implying that these are the only ones or, indeed, are necessarily the best. Our aim, instead, is to choose areas that link to debates in later chapters and, hence, are illustrative of general principles rather than specifics.

2

Sustainability Indicators in Practice

Introduction and objectives

Chapter 1 set out some of the background issues in the debate surrounding the development and use of sustainability indicators (SIs). In Chapters 2 and 3 we take this further and provide some examples of SIs in practice. The theme throughout the two chapters is to examine SIs at different levels:

- individual SIs and the combination of SIs;
- SIs with a narrow focus and those with a broad focus.

This chapter seeks to build upon some of the issues touched upon in Chapter 1, but sets out some of the practical issues involved in establishing SIs. It begins by examining a single SI in some detail, and moves on to discuss the combination of SIs to provide a picture of sustainability. In both cases, there is a narrow focus on the technical issues of natural resource and environmental management. Chapter 3 continues to look at collections of SIs; but this time we discuss how socio-economic factors can be included alongside environmental concerns.

We begin here with a detailed examination of one SI, suggested by the United Nations following the Rio Earth Summit in 1992. The example we have selected is maximum sustainable yield (MSY). MSY has been chosen for a number of reasons. First, it is founded on the important consideration of exploiting a resource for gain which is central to much of the sustainability literature. Second, MSY has been put forward by the UN as a state SI for the 'Protection of the Oceans, all Kinds of Seas and Coastal Areas' (Chapter 17 title of the Rio document). Our discussion of MSY is followed by a explanation of how SIs can be pooled to form an overall picture of sustainability. The example we have chosen is AMOEBA, which unlike the Environmental Sustainability Index (ESI) discussed in Chapter 1 has been developed to pictorially represent SI values relative to a baseline. The ESI, by way of contrast, is a single numeric presented in the form of country league tables as an exercise in

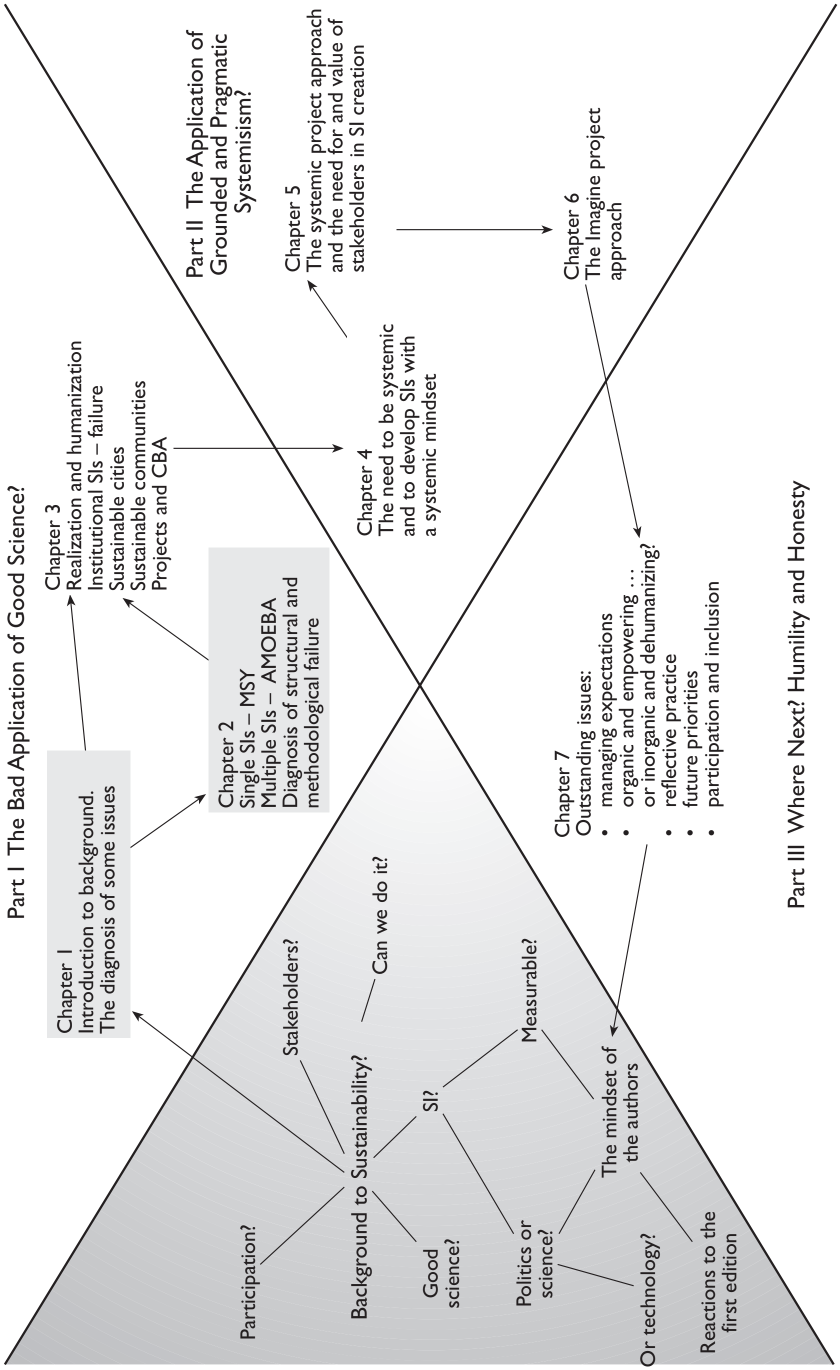


Figure C.2 *Chapter 2 in context*

name and shame. Thus, although it is by no means the only or the most common approach, AMOEBA is one of the first attempts made by a group of ecologists to assess sustainability in a way that is geared towards others who have the power to create policy or to manage. As a result, compromises have had to be made, not least in terms of how the information is to be presented to non-experts. Thus, its originators have given substantial thought to interpretation, and this immediately raises the issue of how one is to deal with a collection of SIs, some of which may be pointing in quite different directions. The ESI developed much later towards the turn of the 20th century is a different manifestation of much the same wishes on the part of its creators.

MSY and AMOEBA were also developed with a marine environment in mind and thus are assessments of the same system, but in quite different ways and with different emphases. MSY is concerned with the management for production of single fish species, while AMOEBA was developed with a much broader emphasis on environmental management to maintain or enhance a sense of 'quality', which includes but goes beyond production. MSY also has a long history dating back to the last century, although its more modern form originated during the 1930s. It now makes a regular appearance in many contemporary discussions of sustainability. In contrast, AMOEBA is a much more recent device for gauging sustainability, and its inventors have taken on board the need to combine a broad set of indicators into a visual device suitable for use by planners. For our purposes, MSY provides other advantages because:

- It is based on some fundamental ecological concepts of population growth that incorporate the notion of carrying capacity, often taken as a key element in the history of the sustainability concept. Indeed, MSY encapsulates in microcosm the very essence of sustainability – continuous but not detrimental exploitation of a resource.
- MSY encapsulates many of the arguments summarized in Chapter 1 with regard to the reductionist, mechanistic and quantitative nature of modern science. It represents one of the first attempts to sustainably manage a resource based on knowledge derived from ecological science.

MSY represents a useful example of an SI to illustrate some of the issues outlined in Chapter 1; however, in order to fully appreciate the origin of the concept and the problems with its use, one needs to have some background knowledge of the ecological principles that lie behind it. Therefore, we have included some of this theory in the chapter. It is not necessary for the reader to fully comprehend the mathematics, but to appreciate the relative simplicity of the equations being used.

Maximum sustainable yield

Carrying capacity basically represents the maximum number of individuals of a species that an ecosystem can sustain. It follows, therefore, that if the carrying capacity is exceeded, the population will be limited through lack of resources. Following on from this, in part, is the concept of MSY: the number or biomass of individuals that can be removed from an ecosystem without driving the population down (Gordon, 1954; Scott, 1955). Since these ecological concepts have had a major influence on the broad thinking that rests behind sustainability, it is worth spending some time looking at these concepts and their limitations in practice.

MSY is one of the key state SIs put forward by the UN in Chapter 17 ('Protection of the Oceans, all Kinds of Seas and Coastal Areas') of the Rio Summit document. It is described by the UN as 'an expression of the state of fishery resource exploitation to its sustainable size'. It is worth noting that there has been a large influence of ecosystem concepts and ecological theory in fishery management, and this influence goes back many years. Indeed, it may not be an exaggeration to say that fishery management was the first concerted attempt by humankind to effectively manage a resource based on fundamental ecological ideas, derived via classic Western science. This is reflected in research and published work on fish population dynamics and age structure that dates back to the last century. After World War II, MSY took root as a fishery management concept (Ostrom, 2001) and some have even called the decade after 1945 the 'golden age for the concept of maximum sustained yield' (Larkin, 1977). MSY appeared to offer a panacea for fishery management that can be summarized in the following dogma:

> *Any species each year produces a harvestable surplus,*
> *and if you take that much,*
> *and no more,*
> *you can go on getting it forever and ever.*
> *(Amen)* (Larkin, 1977)

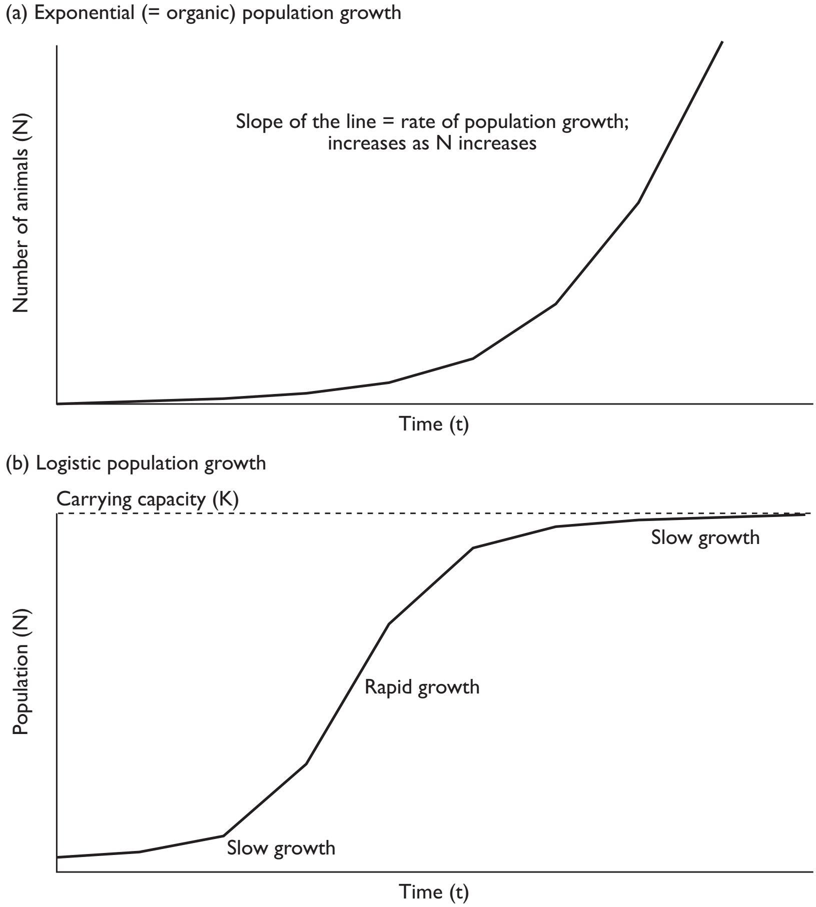
MSY's influence in fishery management worldwide has been immense (Larkin, 1977), and although it has had numerous critics, it has been remarkably resilient even to the point of its inclusion as an SI by the UN. Given this, one is entitled to ask why fishery management has received such a strong influence from ecology? It is interesting to note, for example, that this influence has been far less marked in the case of wild game management or, indeed, in the management of rangeland. There are a number of possible reasons (Wagner, 1969), one of which is that fisheries tend to have a clearly defined spatial boundary (Cushing, 1981). The spatial boundary is distinct if one considers a lake; however, even in oceans, fisheries often have defined boundaries where fish concentrate. These boundaries include:

- isotherms (patterns of temperature change in the water);
- physical boundaries (ridges and troughs);
- areas of upwelling or divergence (water rises from lower depths to the surface); these often bring nutrients to the surface and phytoplankton production can be intense.

As discussed in Chapter 1, defining a spatial boundary for sustainability is often problematic; but in fishery management the problem is made simpler.

The central question regarding population management is quite simply how many animals can be taken without destroying the stock? There are a number of ways of approaching this, and one has to consider the basic elements of population growth. Scientists have been producing mathematical models of animal populations for a very long time. The earliest (and simplest) examples were all based on the fundamental idea that at time (t) one individual in the population becomes two, and the overall effect is an acceleration of population growth with time. Therefore, at its simplest, population growth represents the difference between births and deaths in a population. The larger this difference is, the greater the rate of population growth. It is also reasoned that populations will continue to increase provided there is plenty of food or other vital resource and there are no natural enemies or disease (Figure 2.1a). An outline of the equations behind this curve is shown in Box 2.1. In reality, of course, populations do not increase to infinity since limitations of space and food usually become apparent. A population tends to increase up to a certain point until basic limitations start to operate and the growth rate slows down. Eventually the growth rate becomes zero (the population is static). The equations given in Box 2.1 do not reflect this process since they will always describe a population increasing to infinity. Nevertheless, a slight alteration in the equations can take these limitations into account, and the result is shown in Figure 2.1b. The equation behind Figure 2.1b is shown in Box 2.2.

The key point we would like the reader to take from Boxes 2.1 and 2.2 is not necessarily the mathematical detail; instead, we would like to emphasize the relative simplicity of the equations. Each only has a few components, and some of these (r and K) are assumed to be constant. Quite clearly, we are emulating nature in a very simplistic manner. For example, is it realistic to assume that carrying capacity (K) is a constant? After all, real environments fluctuate greatly from year to year; hence, the value of K may also fluctuate. One should also point out that, in practice, animals do not instantaneously disappear when the population approaches K! There is always a time lag for this influence, and populations can exceed the carrying capacity for short periods. Second, real populations are made up of two groups: sexually mature individuals (individuals who can contribute to population growth) and those individuals who cannot add to population increase because they are too old or not yet sexually mature. The value of r will be a constant only if the proportion of sexually mature individuals is constant. In other words, r is a constant only if the population has a stable age distribution (see Figure 2.2). In practice, age distri-



Note: numbers of animals (N) plotted at each time (t).

Figure 2.1 *Examples of population growth curves*

butions may not be stable over time. Therefore as Slobodkin (1994) points out: 'Due to the simplistic nature of their initial assumptions, these [logistic] equation systems, regardless of particular modifications, do not mimic any actual population.'

However, although it has its limitations, even the simple equation in Box 2.2 provides the basis for some resource management models that are referred to as the surplus yield models (or, more precisely, biomass dynamics models). These models introduce a further component – namely, harvesting – into the equation of Box 2.2, as shown in Figure 2.3. If immigration and emigration into a defined population are constant, then the numbers that can be removed by harvesting will depend upon the balance between births and deaths (on the population growth rate). Clearly, the maximum gap between births and deaths will be the maximum number of animals that can be removed without reducing

Box 2.1 The mathematical equations behind the population curve in Figure 2.1(a)

It can be shown that:

Population growth rate = constant x population size (N)

where:

- Constant = an indicator of the multiplication rate of each individual in the population (by convention, the constant is given the symbol 'r').
- Population growth rate = change in number of individuals (N) over a time period (t). This can be expressed as dN/dt, where 'd' means 'a very small change in' (we consider very small changes for technical reasons).

Therefore, the above expression in English can be written in mathematical language (a differential equation) as:

$$\frac{dN}{dt} = rN$$

Also, the differential equation can be rearranged to make it more useful in practice:

$$\frac{dN}{dt} = rN \longrightarrow N_t = N_0 e^{rt}$$

Differential form Integral form

where 'e' is another constant (2.71828, etc.), Nt is the population at time t and N0 is the population at time zero (starting population).

Therefore, higher values of 'r' → more rapid growth rates of a population.

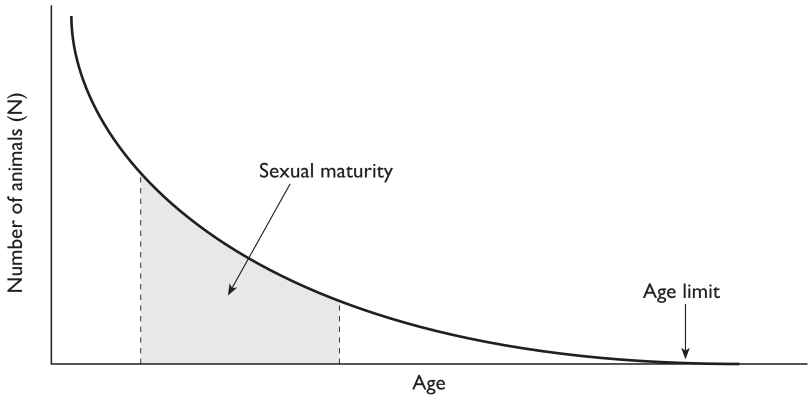
Box 2.2 The mathematical equation behind the population curve in Figure 2.1(b)

$$\frac{dN}{dt} = r\left(\frac{K - N}{K}\right)N$$

Differential form

where K = another constant commonly referred to as carrying capacity. Other symbols are defined as in Box 2.1.

Therefore, population growth rate changes depending upon how close the population is to K. As N approaches K, the (K–N)/K part of the equation becomes closer to zero and, hence, the growth rate becomes static.

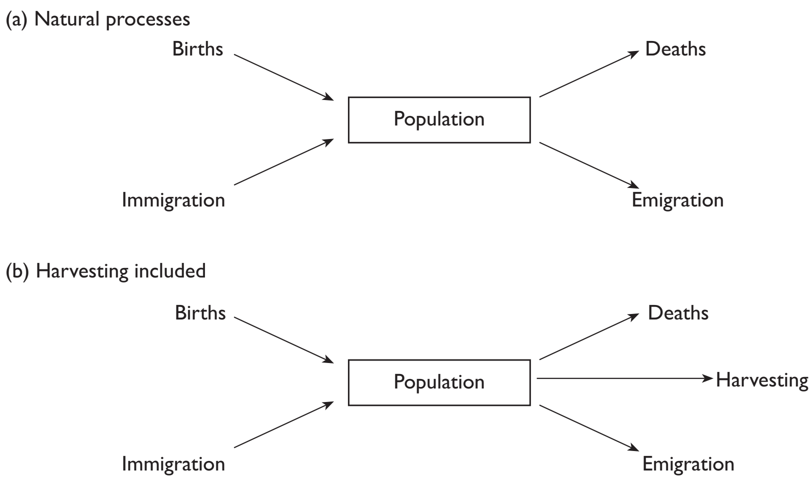


Note: a stable age distribution occurs when the proportion of adults at sexual maturity remains constant (curve moves evenly up and down but does not change shape). Intrinsic growth rate (r) is a constant only if the population has a stable age distribution. In this example there is a high mortality rate amongst the younger age groups.

Figure 2.2 *Example of an age distribution*

the size of the population. This is referred to as the maximum sustainable yield and is illustrated in Figure 2.4. The concept of MSY has been widely applied in fishery management, and problems that have been associated with this widespread use will be discussed later.

It should be noted that the basic ecological ideas behind MSY are not particularly complex or, indeed, new. The mathematics within which the basic ideas in Boxes 2.1 and 2.2 are expressed (calculus) was 'invented' by Leibniz (1646 to 1716). The logistic curve was proposed by Verhulst in 1844, while the



Note: population growth rate from the logistic curve is plotted against population (N).

Figure 2.3 *Main elements contributing to population change*

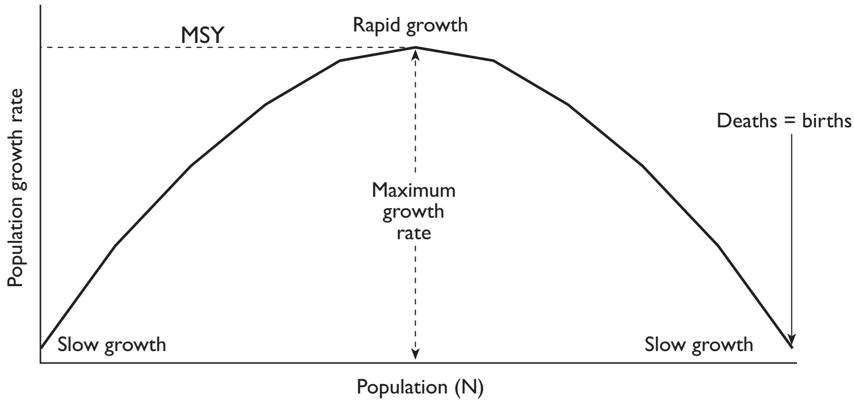


Figure 2.4 *The concept of maximum sustainable yield in harvesting a population*

application of the logistic curve to animal populations was proposed by many biologists from the 1930s onwards (e.g. Gause, 1934). However, the application of the MSY concept is much more recent. Given the age of the elements that make up MSY, why did it take so long to apply the concept? Part of the problem is that in order to use the MSY equation we have to create a curve such as that in Figure 2.4 by finding either the values of r and K or the population growth rate for a number of populations. In practice, it can be difficult to do this as it requires very detailed knowledge of the animal population. Fortunately, the yield obtained from a fishery is demonstrably related to the 'fishing effort' (catch per boat per day); MSY (and also optimum fishing effort) can then be found from this relationship (Schaefer, 1954, 1957). With a lot of mathematical juggling, starting with the basic logistic equation in Box 2.2 (and some assumptions), it can be shown that there is a theoretical link between yield from a fishery and the fishing effort. The relationship is illus-

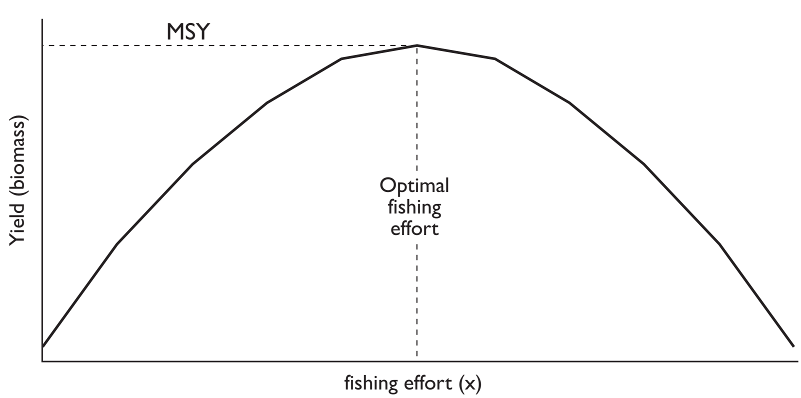


Figure 2.5 *The Schaefer model employed to determine MSY based on the fishery yield for a particular fishing effort*

Box 2.3 An equation relating fishing effort to yield from a fishery

The general equation for the curve in Figure 2.5 is:

$$Y_e = U\,f - b\,f^2$$

where:

- Y_e = the fishery yield for a particular effort;
- f = the fishing effort (usually expressed in terms of trawler fleet tonnage);
- b = a constant which comprises a number of factors, such as the efficiency of the fishing gear and the intrinsic growth rate of fish biomass (fish catches are normally expressed in biomass not numbers);
- U = maximum fish catch/unit fishing effort.

Both b and U are assumed to be constants.

The following is an example equation fitted to data from the Peruvian anchovy fishery (see Figure 2.7):

$$Ye = 0.722\,f - 0.0121\,f^2$$

trated in Figure 2.5, and the mathematical equation behind the curve is shown in Box 2.3. Again, the main point to note is the relative simplicity of the equation: yield is determined by just three factors, two of which (U and b) are assumed to be constants over the period in which the curve is fitted.

The beauty of the Schaefer approach is that it is simple: only data on yields and fishing effort are required, although, more recently, Gaertner et al (2001) have suggested how an MSY may be derived from only catch data. There is a relative abundance of such data for many fisheries and the individual values of 'b' and 'U' are usually found by fitting curves to these data. There are a number of ways of doing this; but, unfortunately, these methods can give different values for the optimal fishing effort. In addition, the determination of MSY by this method requires that there are some data points beyond the MSY in order to fit a curve. In other words, and perhaps ironically, some level of over-fishing (i.e. points beyond the optimal fishing effort) is required in order to obtain the MSY with a degree of confidence.

Given the foregoing, it is not difficult to see why MSY achieved the prominence it has – why, indeed, it became the Holy Grail of fisheries science (Jennings et al, 2001, p127). The equations are very simple and are firmly rooted in good mechanistic science. Given a reasonable set of effort and yield data – and many fisheries have such data – simple statistical techniques can be employed to fit curves. Indeed, one doesn't have to be a scientist to do this. Techniques have even been developed to estimate MSY in the absence of effort and yield time series data. There are variations on the MSY theme that take a different slant with regard to what 'sustainable' means in this context, such as:

- ecologically sustainable yield (ESY) – 'the yield an ecosystem can sustain without shifting to an undesirable state' (*American Scientist*, 2001);
- maximum economic sustainable yield (MEY) – takes into account the economic costs and benefits of harvesting and, hence, goes beyond a biologically based MSY.

MSY sees sustainability purely through maintenance of a population, while ESY takes a broader view of maintaining some notion of a desirable ecological state. MEY is an economic perspective. Nonetheless, putting these variants to one side for the moment, a reasonable point to make is that if MSY can deliver sustainable utilization of a resource, then all is well. But can it deliver?

Problems with applying maximum sustainable yield

Although surplus yield models (such as the Schaefer model) are useful, they do have a number of problems. These are largely centred on the assumptions made for the logistic curve, and while it may provide some interesting insights into population biology, there is a danger in using them as the basis of management models. An inkling of some of the problems encountered can be illustrated by deriving another surplus yield model from a different starting point. Instead of relating population size to time, what happens if it is related to the size of the population in the previous generation? After all, this is a far more logical stance to take rather than a more abstract linkage to time. Surely the population size in a generation will be related to population size in the previous generation rather than just because $t = 2$ rather than $t = 1$? The result of such a derivation is shown in Box 2.4. However, such a commonsense assumption can generate very complex population curves since they incorporate the notion of feedback. The size of the multiplication rate is a major factor in producing such chaotic behaviour (see Figure 2.6). Although higher values of the multiplication rate generate complex population curves, these capture the essence of what we observe in practice (May, 1989; Fielding, 1991). Wild populations fluctuate widely (an effect caused by an array of environmental and biotic factors) and do not increase smoothly to a maximum before levelling off (Dempster, 1975). Therefore, by taking another simple starting point, the foundations of the MSY appear to be insecure.

Quite clearly, MSY is a very simple concept, and equations evident in Boxes 2.1 to 2.3 do not fully take account of the complex nature of the ecosystem that MSY is meant to manage. As Pitcher and Hart (1982) point out:

> *In its classical form, MSY excludes the effects of competition, symbiotic or commensal relationships with other species, tropic relationships, or changes in carrying capacity due to pollution or other human influences.*

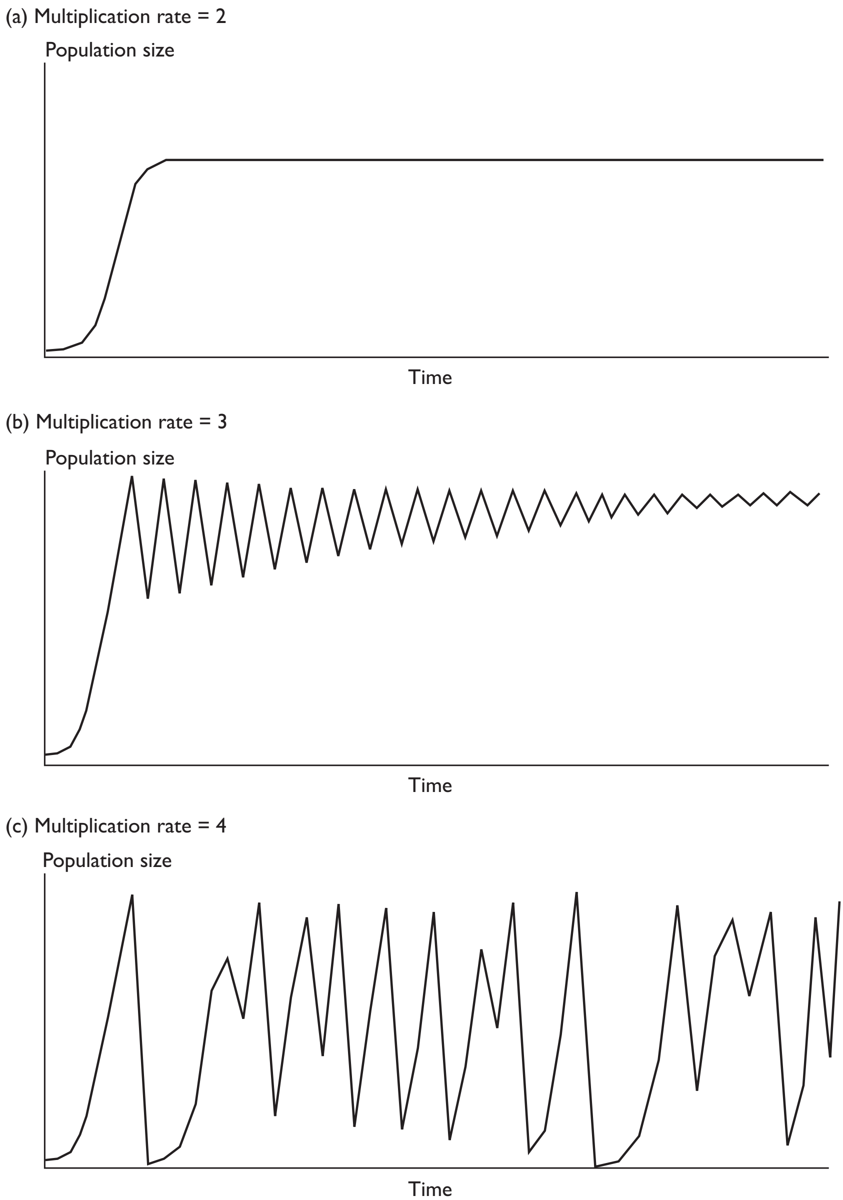


Figure 2.6 *Population growth curves based on the equation in Box 2.4*

Indeed, there are numerous echoes of this concern, and for the sake of brevity we only give two more spanning a 17-year period, beginning with Mohn's (1980) study of bias and error in estimating MSY:

> *As experimental verification of MSY is unlikely for a commercial stock and the yield is affected by many factors, sustainable yield*

Box 2.4 A population growth equation based on the assumption that the size of the population is linked to that of the previous generation

The simplest example is as follows (May, 1989):

$$N_{t+1} = N_t \lambda$$

where:

- N_{t+1} = population in generation t+1;
- N_t = population in generation t;
- λ = multiplication rate (number of offspring/individual between time t to t+1).

For example, assuming a one-year time period, this equation means:

population this = year (t+1)	population last × year (t)	number of offspring per individual

Allowing for carrying capacity (K) limitations as in the logistic equation:

$$N_{t+1} = N_t \left(\frac{K - N_t}{K}\right) \lambda$$

> *estimation will be slow in changing from an art to a science*. (Mohn, 1980)

> *… the supposed catch–effort relationship underlying the concept of MSY is apparently illusory. The level at which these stocks are 'sustainable' is not known and is unlikely to be known for many years, if ever, because of the lack of basic information on the landings and biology of fish species*. (Aikman, 1997)

A classic (perhaps 'the' classic) example of the problems that could occur from a narrow application of MSY to fishery management is that provided by the collapse of the Peruvian anchovy fishery in 1972 (Boerema and Gulland, 1973; Idyll, 1973; Pitcher and Hart, 1982; Laws, 1997; Ibarra et al, 2000). This fishery exists largely as a result of deep water being brought to the surface of the sea by the prevailing wind's moving the surface water north-westerly. The deep water brings nutrients to the surface, encouraging the growth of phytoplankton, which in turn provides a source of energy for the whole ecosystem. It has been estimated (Idyll, 1973) that this was the world's largest fishery, accounting at one time for 22 per cent of all fish caught throughout the world. Even in 1971, just prior to the collapse, the fishery still comprised 15 per cent of the world catch of fish (Pitcher and Hart, 1982).

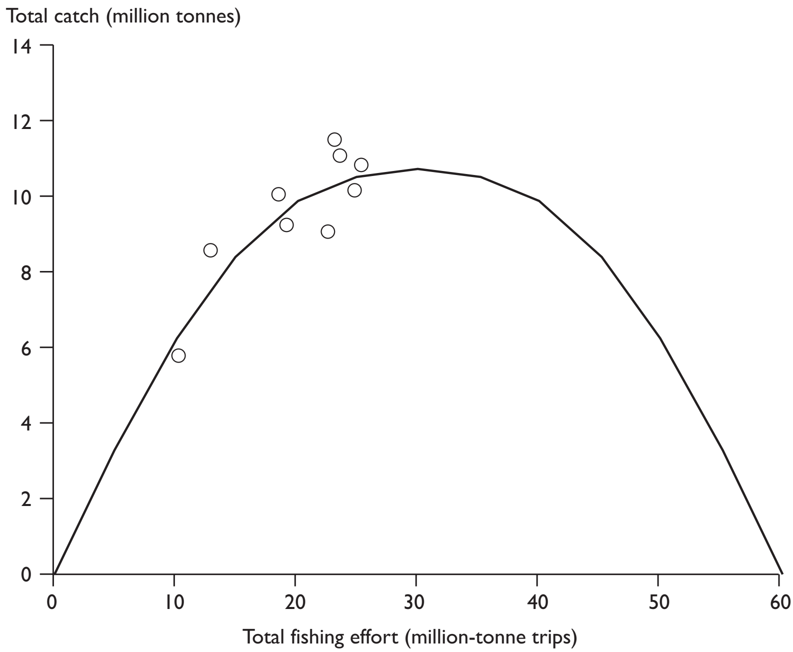


Figure 2.7 *Schaefer model fitted to data from the Peruvian anchovy fishery*

However, after the collapse, the fishery switched from one dominated by anchovy to one dominated by the South American sardine (*Sardinops sagax*); only in the late 1980s and early 1990s has there been any suggestion that the ecosystem may revert back to its pre-1972 conditions (Patterson et al, 1992). Just what caused this switch has been the subject of much research and debate, and an excellent history is provided by Laws (1997). There appear to have been three main causalities:

1. The anchovy was heavily exploited during the 1960s and early 1970s, although this exploitation was within the predicted MSY.
2. Anchovy and sardine appear to have a relationship in that a collapse in the population of one leads to a boom in the population of the other (Walsh et al, 1980). One link is that both may feed on the same organisms, but anchovy and sardine larvae are normally separated in space (Sameoto, 1982).
3. Conditions in the Peru upwelling were subject to regular disruption by a climatic fluctuation that occurs in the Pacific every two to ten years (the El Niño event).

Since the establishment of the anchovy industry in the mid 1950s, catches have soared, although this has been at the expense of the seabird population that also survived on the fish. Seabirds were not just of aesthetic interest, but were also the basis of a thriving guano industry. Estimations of total catch and fishing effort have been made (Boerema and Gulland, 1973), and a Schaefer model can be fitted to these data using standard statistical techniques that are readily available with many computer packages. Indeed, as Pitcher and Hart (1982) point out: 'MSY is seductively easy to calculate; in fact, no biologists need to be employed in the fishery and managers do not even have to get their hands and feet wet in examining actual fish.' An example for catches and effort in the 1960s (1960 to 1969) is shown in Figure 2.7. The fit of the curve is highly significant statistically (see Box 2.3), engendering a high level of confidence in the result. It is interesting to note that as the sea birds were significant catchers of fish up until the mid 1960s, the yield and fishing effort were based on a combination of human and bird activity. The total catch removed by the birds was estimated, and the total human fishing effort that would give this catch was calculated. The resulting curve suggests that MSY was approximately 10 million tonnes and occurs at a fishing effort of about 30 million-tonne trips.

As can be seen from Figure 2.7, the actual catches during the 1960s were generally at or below MSY, suggesting that the fishery was being exploited to the maximum and that the exploitation was sustainable. However, as mentioned above, the equations upon which all of this is based assume a stable age distribution in the population. If this is not the case due to an excessive removal of fish at reproductive age, or because of environmental fluctuations, then recruitment can decline rapidly. Such a decline occurred with anchovy during the early 1970s following a period of heavy fishing effort between 1967 and 1970. Ironically, the fall in recruitment was noted; but heavy fishing continued over the three-year period. Secondly, the El Niño event in 1972 started to bring warmer water into the fishery. This warmer water had a negative effect on the anchovy population in the fishery, possibly because it encouraged increased numbers of horse mackerel, which is a major predator of anchovy (Laws, 1997); nevertheless, heavy fishing was allowed to continue. It was almost as if the use of the Schaefer model generated a 'misplaced confidence' that the MSY was around 10 million tonnes. The result was a collapse in the anchovy population and an upsurge in the sardine population. When it was clear that the fishery had collapsed, the industry was nationalized by the military government and effectively reduced to half its size. The number of boats was cut from 1500 to 800, the number of fishmeal plants reduced from 100 to 50, and the number of people employed were reduced from 25,000 to 12,000 (Laws, 1997). Since the changes in the early 1970s, the fishery has been subject to other El Niño events, and the industry has passed through a number of changes. However, it can hardly be said to represent the epitome of sustainable resource utilization.

Maximum sustainable yield as a sustainability indicator

As will have been gleaned from the previous section, the MSY concept – in practice – has had its problems. Indeed, MSY has even received some light-hearted derision as the following poem (often quoted by fishery scientists) illustrates:

> *Here lies the concept. MSY.*
> *It advocated yields too high,*
> *And didn't spell out how to slice the pie,*
> *We bury it with the best of wishes,*
> *Especially on behalf of fishes.*
> *We don't yet know what will take its place,*
> *But we hope it's as good for the human race.* (Larkin, 1977)

MSY as a management tool has gradually been replaced by other more sophisticated approaches (Jennings et al, 2001), although the term has been remarkably resilient even if it has become somewhat de-linked from its origin within logistic growth curves. The UN, for example, while including MSY as one of its key state SIs, acknowledges that 'fishing at the MSY level is now seen to be excessive, and determining MSY where it is not yet known involves over-fishing, which is obviously undesirable'. Yet no fewer than five SIs based on MSY (plus one based on biomass rather than on MSY) were proposed by the UN to address issues in Chapter 17 ('Protection of the Oceans, all Kinds of Seas and Coastal Areas') of the Rio document:

1. ratio of MSY abundance and actual average abundance;
2. the deviation in stock of marine species from the MSY level;
3. ratio of current fishing effort to the effort at MSY;
4. ratio of current fishing mortality to that at MSY;
5. ratio of current population biomass (or spawning biomass) to that at MSY;
6. current biomass to that under 'virgin' conditions (before fishing began).

The last SI is an alternative indicator where MSY is unknown. Ratios of MSY to abundance, fishing effort and mortality are considered to be more precise than absolute estimates (Prager et al, 1996). It is suggested that the Schaefer method should be employed to find the MSY; once the SIs have been calculated it will be possible to check whether the resource is being exploited in a sustainable fashion. Problems with the MSY concept are acknowledged in the UN documents and are essentially those already highlighted above. Indeed, 'For many countries, suitable data to calculate these indicators are scarce. In addition, major deficiencies are characteristic of many available data sets.'

Given these problems, and the dangers with MSY as highlighted above, one may, perhaps, be forgiven for registering some surprise at the emphasis placed on MSY as an SI. After all, the Peruvian anchovy example was founded on an apparently good estimation of MSY, and SIs based on MSY under those prevailing conditions would have suggested 'sustainability' – while it was clear that the system as a whole was far from being sustainable. If that wasn't enough, the UN admits that: 'For many global fish stocks, MSY levels have not yet been determined.' While it may be argued that these SIs are better than nothing, and our knowledge of how to find, test and implement an MSY has improved, one still can't help but feel some anxiety about the expectation surrounding the use of MSY as an SI. Surely we have a classic example of reductionism applied to a complex ecosystem, with a strong emphasis on 'simplify to survive'; yet the potential dangers for the sustainable management of a resource are very apparent.

The supreme irony of all of this is that many scientists involved in natural resource management have pointed out, over many years, the simplified nature of MSY and the problems that may arise from its unquestioned use. Two of the most respected workers in this field have stated:

> *… like some other simplified concepts, maximum sustainable yield has become institutionalized in a more absolute and precise role than intended by the biologists who were responsible for its original formulation. It is being expected to perform functions for which it was never intended, serving, for example, as the sole conceptual basis for or goal of management in some cases. Once a concept has been adopted and institutionalized, it is difficult to change it. In this case, because of its institutionalization, the concept of maximum sustainable yield is now an obstacle to the acceptance of concepts that derive from present ecological knowledge, and that would provide a more adequate basis for management.* (Holt and Talbot, 1978)

Given all this, why has MSY enjoyed such longevity, including its presence in an exclusive list of SIs put forward by the UN at the turn of the 20th century? Why has it become so 'institutionalized'? For example, although the European Union no longer aims to fish at MSY, it still uses it as a sort of benchmark in the F0.1 objective (which corresponds to fishing slightly below MSY) – although 'arbitrary biological reference points' were also included for some stocks (Corten, 1996):

> *The [European] Commission considers that implementing fish stocks management systems based on the maximum sustainable yield will contribute to reverse this situation [a decline in fish stocks]. In addition to ensuring that stocks would not collapse, it would allow the development of larger fish stocks, leading to more fishing possibilities at lower*

> *cost and with a higher unit value, providing a greater guarantee of wealth… Fishing at MSY levels would reduce costs and increase profits for the fishing industry, as the amount of effort (and associated costs, such as fuel) required per tonne of fish caught decreases.* (EU, 2006, pp4–5)

Its relative simplicity as a concept, and the fact that equations such as that in Box 2.3 can be easily fitted to existing data, have no doubt been of enormous importance in this regard. It also provides a single figure answer as to what sustainability is – echoes here of the popularity of the ESI. Single figure crystallizations of complex data appear to have an instant appeal for some.

Sustainability indicators in marine ecosystems: The AMOEBA approach

In the previous section we looked in detail at one SI based on the MSY concept of fishery management. The main point was to provide the reader with some knowledge of the indicator, and to illustrate how SIs by definition imply a level of simplification, which can be dangerous when dealing with a very complex ecosystem. In this section we will move to the next level in the use of SIs and consider how a number of different sets of data may be combined to derive a composite SI for a system.

As mentioned in Chapter 1, indicator species and biodiversity have commonly been employed as a gauge of ecosystem quality. However, the limitations of technical measures of biodiversity such as the Shannon–Wiener index have led others to propose alternative approaches to measuring diversity as an element within an SI. An example is the AMOEBA approach (Ten Brink, 1991; Ten Brink et al, 1991; Laane and Peters, 1993), an acronym which in Dutch stands for 'general method for ecosystem description and assessment'. AMOEBA has one major advantage in that it is a highly visual approach to encapsulating sustainability, and this is largely a result of the fact that it has been created with non-specialists in mind. In Chapter 1 we pointed out that one of the limitations of the Shannon–Wiener biodiversity index, and others like it, is that they have been developed by scientists for scientists. The same is essentially true of MSY, and although MSY equations are relatively simple, a basic understanding of what is in them is still required. The AMOEBA approach attempts to reduce this limitation.

The AMOEBA approach arose out of the third national policy document on water management, which focused on managing the North Sea and Dutch inland waters. As well as stressing the need for a visual representation of sustainability, Ten Brink et al (1991) took a broad view of sustainability and concluded that there were three categories of 'valuable characteristics, whose sustainability is desirable':

1 yield;
2 biodiversity;
3 self-regulation.

The first two have already been discussed. The third characteristic, self-regulation, relates, in essence, to the stability or resilience of the system – how stable the system is in the face of interference by humans or natural 'shocks'. Ten Brink et al (1991) point out that 'self-regulating ecosystems have low management costs'. In other words, if the system is robust, then continual and expensive management from humans is not required to maintain it.

The second key element in their approach is to assume that they can define sustainability in terms of how far the current ecosystem departs from an identified 'reference' ecosystem. The reference represents the natural state of the ecosystem with as little human interference as possible. The assumption is that this natural state is a sustainable system. The further a system departs from this, the less sustainable it is assumed to be. However, how can one identify the reference system? One possibility is to refer to the same system some time in the past before human interference began to have a major impact, although a key question is whether there is data available on the ecosystem for the chosen time. This is especially the case if one has to go back a long time to find a suitable reference system. For example, Ten Brink et al (1991) suggest the year 1930 for the North Sea as this represents 'a pragmatic compromise between, on the one hand, the available knowledge and, on the other hand, a relatively low level of human interference'.

An alternative approach is to employ a reference system separated in space from the one studied, but which has not received any interference. Selecting a reference system that is separated in space is easier in the sense that one can see what is there and also identify whether there has been human interference. The main problem is quite simple: is such a 'twin' system available? For a relatively large ecosystem such as the North Sea, this may be impossible. Second, even if a likely ecosystem can be found, how sure can we be that it represents a true twin for the system interfered with by humans?

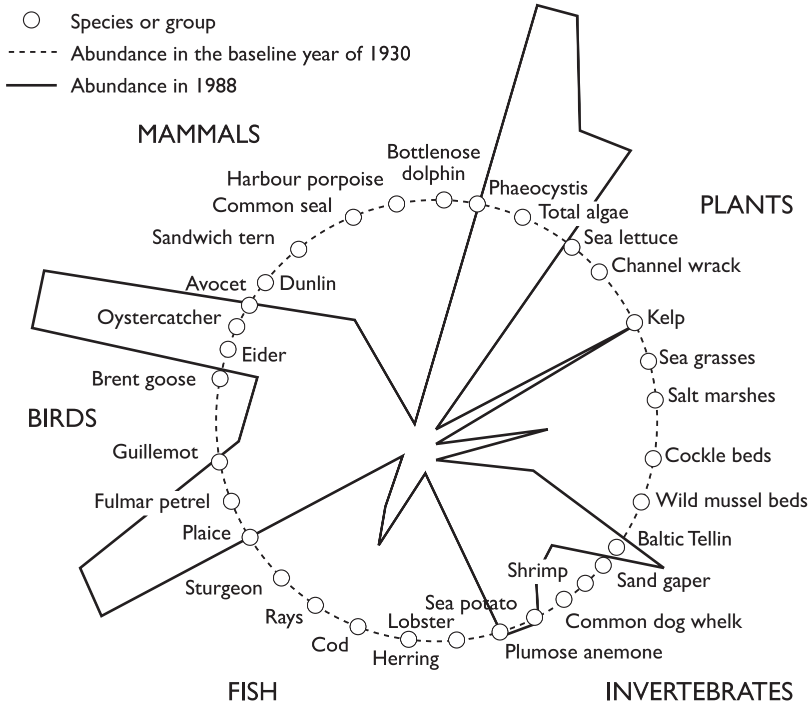
The third key element in the Ten Brink et al (1991) methodology is what to measure in order to gauge the three 'key characteristics'. In other words, what are the specific SIs? One could, presumably, include SIs for each of the three characteristics, or, indeed, any other characteristics that one wishes to apply to sustainability, including the more nebulous quality of life. In practice, Ten Brink et al (1991) describe the use of a population index for 60 selected target species that include managed fish species and others that are assumed to be indicators of pollution or ecosystem disruption. As mentioned in Chapter 1, the use of certain species to indicate pollution or disruption is not new in ecology; but even so, what are the criteria for selecting these species? After all, there are literally thousands or even millions that could be included, and as pointed out by Slobodkin (1994): 'the strength of the interaction between a particular species and the ecosystem in which it occurs varies enormously among species'. In the face of such an obvious and major problem, Ten Brink et al (1991) suggest the following list of criteria for selecting these species:

- Quantitative data on abundance must be available for the species.
- The species must be susceptible to human interference.
- The species must be accessible for easy and accurate measurement.
- The species should have some 'indicative value for the condition of the system'.
- The species should ideally have some 'political and social appeal'.

The first four criteria are logical from a standard ecological perspective, but the fifth is a novel departure from the more usual technical approaches in the ecological literature. Ten Brink et al (1991) state that 'we believe it to be more effective and more appropriate to select species which society and the authorities know and understand'. Therefore, although the species indicator and biodiversity example in Chapter 1 focused on macro-invertebrates (Learner et al, 1971), and these may be acceptable under Ten Brink's first four points, it is very doubtful whether they would fulfil the last point. Clearly, the kind of organisms that would satisfy point five are birds, fish and other large vertebrates, particularly mammals.

The final element in the methodology is presentation. One could, of course, use the sort of biodiversity indices and graphs already described in Chapter 1. It is interesting to note that this was rejected by Ten Brink et al (1991) because 'water authorities and policy-makers require a clear and simple presentation' rather than scientific models 'which nobody can understand'. Their suggestion was to use a visual presentation of diversity rather than calculated indices, and an example is provided in Figure 2.8. The circle represents the 'reference' condition (numbers/extent of that species in 1930), and the arms are the 1988 numbers/extent of the species as a proportion of the reference numbers/extent. The diagram is referred to as an AMOEBA because of the resemblance to the unicellular animal of the same name; as can be seen, the number of some species (e.g. common seal, harbour porpoise, bottlenose dolphin, herring and lobster) have declined dramatically from the 1930 reference condition, while others, notably algae and some seabirds, have increased dramatically.

One can extend the basic AMOEBA approach further and compare different AMOEBAE. These may be AMOEBAE calculated for different years; however, each is still related back to the reference year. For example, if data were available, one could calculate AMOEBAE for 1940, 1950, 1960 and 1970, as well as for 1988, in order to chart how the system's sustainability has changed with time. One could also calculate predicted AMOEBAE based on various policy interventions. In order to make multiple comparisons of AMOEBAE, Ten Brink et al (1991) have suggested the use of what they call an 'ecological Dow Jones index'. For each AMOEBA the sum of the gaps between the reference point and each of the arms is calculated. The assumption is that the smaller this value, the closer the system is to sustainability.



Note: abundance of selected species and groups (e.g. total algae and salt marsh) is shown relative to a baseline year. The example given here is based on that presented by Ten Brink et al (1991) with 1930 as the baseline year and the counts from 1988.
Source: adapted from Ten Brink et al (1991)

Figure 2.8 *Example of an AMOEBA approach to presenting sustainability indicators*

The AMOEBA approach based on the numbers of key indicator species addresses several of the issues outlined in Chapter 1. Sustainability is defined as changes in the number of those species from a clear reference position. The time scale is also handled by defining the reference condition as a sample year. In the above example, the time scale is between 1930 and 1988 – a period of 58 years. The spatial scale is also defined clearly since one has to draw geographical lines in order to estimate the number/extent of the indicator species within the 'North Sea'.

The approach has many advantages, and its appeal as a means of gauging sustainability is not difficult to understand. Sustainability is summarized in visual terms as AMOEBA with a clear, even if subjective, sense of a target (i.e. what the values should be in order to be sustainable). As a result, it has a very practical feel, primarily because it was designed to be used as a decision-making tool in environmental management. The ESI has a similar *raison d'être* but is a quite different approach. Here the reliance is not upon visual integration but mathematical – pooling values from each country into a single index – allied with a ranking of nation states as a 'name and shame' exercise to encourage action. The AMOEBA as applied in the Ten Brink et al (1991) example is not linked to a single nation state but to the quality of the overall system, and presumably it is then up to the nation states that have influence on that system to work collectively to do something about it. The AMOEBA idea has been extended into fishery management (Wefering et al, 2000; Collie et al, 2003).

However, the AMOEBA approach does have its critics (Rennings and Wiggering, 1997). To begin with, one should note that because the AMOEBA is fundamentally based on numbers (population sizes), it does not in itself provide any information on the mechanisms involved in the changes (the pressures) – these have to be inferred from elsewhere. In other words, the AMOEBA, at least as originally applied, is essentially a set of 'state' SIs without 'pressure' SIs. How can we manage the state unless we have a handle on the forces involved in creating it? Another problem is linked, ironically, to the underlying emphasis of combining different indicators within one diagram. Although there is an attempt at taking a holistic view of sustainability, the approach is based on simple addition (all indicators are combined into one diagram) with an equal weighting for each. This is not unique to AMOEBA, it has to be said, and the ESI also has an equal weighting: all of its many components and many published SI matrices make no effort at differential weighting of indicators. However, is this realistic when dealing with a diverse set of stakeholders all having quite different constructions of what is meant by 'quality' and production? Is it not likely that some groups are likely to weight some SIs more than others? For example, is not likely that fishermen will emphasize the importance of cod and herring numbers rather than Brent geese? It is also likely that members of the public will place more emphasis on mammals such as dolphins than kelp or the sea potato, a point we will follow up in Chapter 6.

The third problem with the AMOEBA approach is centred on the choice of a reference condition, and this can be illustrated by using the familiar Learner et al (1971) example referred to in Chapter 1. The reader will recall that the researchers looked at the fauna (fish and macro-invertebrates) of a river in South Wales subject to pollution from a number of sources along its length. The population of various fish species and macro-invertebrates changed in response to a number of factors; but pollution was a major factor. Of the sampling stations (C1, C2, C3, etc.) along the river, two of them (C1 and C2) occurred before the first input of pollution (a sewage inlet exists between C2 and C3). Therefore, it seems reasonable to use C1 or C2 as the reference condition and to compare incidence of species at other stations to one of these.

Following the logic of AMOEBA, and only including a few indicators to illustrate the point, it would make sense to focus on density (biomass/surface area of river) of trout and bullhead along with a number of individuals in the midge family of insects. Trout and bullhead were both found at stations C1 and C2, and biomass is a better indicator of relative abundance than numbers. These two species also have the advantage of being apparent (i.e. they have some 'political and social value'). Midges were identified by the authors as being the

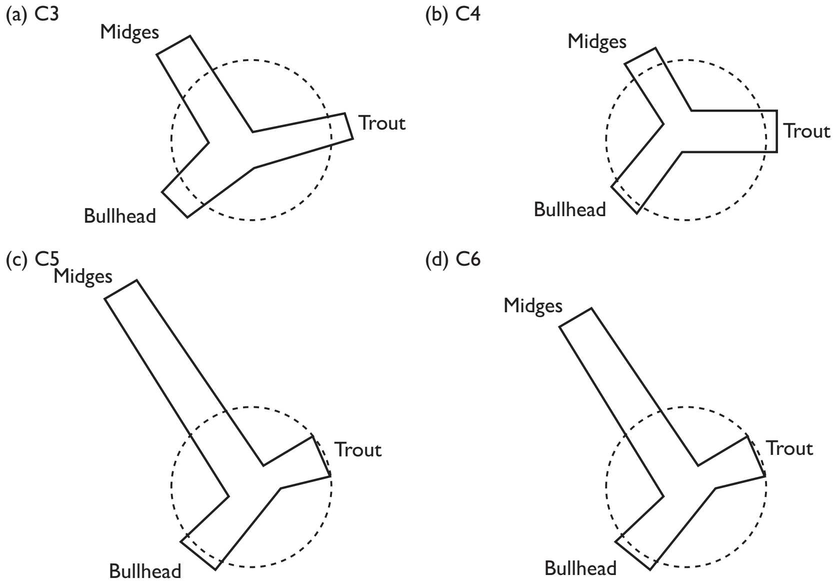


Figure 2.9 *Biomass of trout and bullhead and numbers of midges at four sampling stations on the River Cynon relative to station C1 (the reference condition)*

most abundant insects in the Cynon system, and, indeed, comprised almost half the total number of macro-invertebrates sampled at each station. Therefore, although midges do not have any positive particular social value (the opposite, if anything!), they do at least conform to the other criteria listed by Ten Brink et al (1991). Figures 2.9 and 2.10 are AMOEBAE constructed with C1 and C2 as the reference conditions. There are some similarities between the AMOEBAE, but there are also some differences. It should be remembered that in addition to the fact that both C1 and C2 are located upstream of the first pollution discharge point, the stations were only about two kilometres apart and had similar biodiversity indices. However, even a minor alteration in reference condition has resulted in significant changes in the AMOEBAE.

The choice of a reference becomes even more problematic if one calculates the Ecological Dow Jones Index (EDJI), as suggested by Ten Brink et al (1991). This can be found by summing the percentage change in the three indicators from the reference condition (i.e. C1 or C2), as shown in Box 2.5. The EDJI is, thus, an attempt to crystallize the gap between unsustainability and sustainability into a single figure, and therefore has some resonance with the ESI even if the latter is not a measure of 'gap' between unsustainable and sustainable. But what is chosen as the reference point can have a major influence on the value of the EDJI. The percentage change in these indicators relative to C1 is 100 times that relative to C2. Clearly, the two different reference conditions have had a major impact upon percentage change. If one takes a time dimension instead of the spatial dimension given here, the fundamental problem remains. Although Ten Brink et al (1991) provide a logical rationale

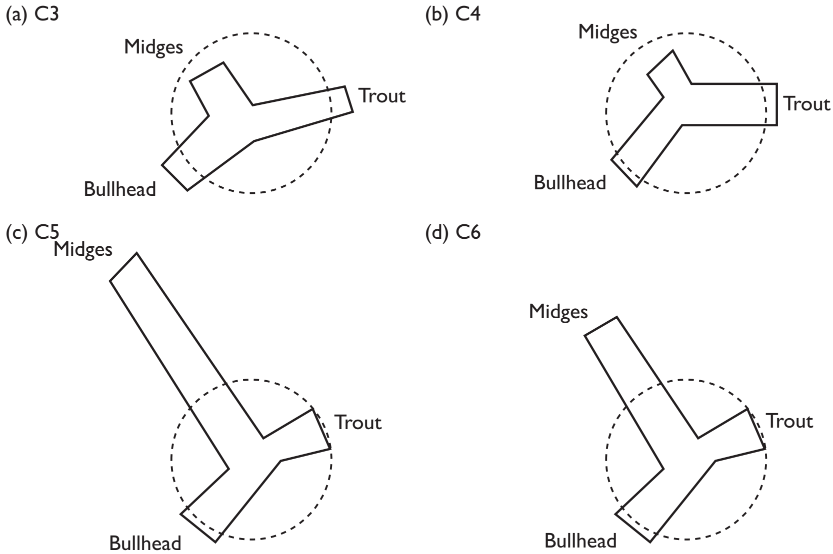


Figure 2.10 *Biomass of trout and bullhead and numbers of midges at four sampling stations on the River Cynon relative to station C2 (the reference condition)*

for the year 1930 as their reference condition, how would the results have looked if the reference year was 1920? Are we not faced with a C1:C2 dilemma in time as opposed to space, and could this potentially result in quite different conclusions regarding sustainability of the system?

The final point to make here is that given that AMOEBA has been developed as a practical tool, rather than as an academic exercise, one could ask the reasonable (although hypothetical) question: would it have helped with the case of the Peruvian anchovy collapse? Here we are dealing with a defined ecosystem that was well researched and which was under clear management (at least from 1965 onwards), receiving regular technical reports on the state of the fishery. Managers had the power to suspend fishing for any period of time if they saw fit or to change catch limits. Surely this should provide the ideal scenario under which SIs could be applied to allow a continued sustainable use of the resource. There were certainly signs in the ecosystem that something was wrong prior to the collapse in 1972. Recruitment was known to have declined in 1971, and there was 'increasing evidence of unusual oceanographic conditions' (Boerema and Gulland, 1973) in 1972 about the same time as the collapse. The El Niño phenomenon developed rapidly in 1972 with no prior warning, although in 1971 there was an unusual occurrence of a tropical crab (*Euphilax*) along the coast, which presumably was linked to an increase in sea temperature. It should be noted that although El Niño is a regular occurrence, it is unpredictable, and even now it is not known whether the perturbations in the ocean–atmosphere system originate in the atmosphere or the ocean. Presumably the SIs that would have helped to detect the collapse would include numbers of tropical species associated with warmer water (horse

Box 2.5 Calculation of ecological Dow Jones indices for three indicators (trout and bullhead biomass and midge numbers) from the River Cynon in South Wales

Example calculation

Stations		*Indicators* *Trout biomass*	*Bullhead biomass*	*Midge numbers*
Reference	C1	0.06	2.45	686
stations	C2	3.13	4.82	5369
	C3	7.36	11.8	2992

(a) Comparing C3 with C1
Total percentage change:
Trout = (7.3/0.06) × 100 = 12,167%
Bullhead = (9.35/2.45) × 100 = 382%
Midges = (2306/686) × 100 = 336%
Total = 12,885%

(b) Comparing C3 with C2
Total percentage change:
Trout = (4.23/3.13) × 100 = 135%
Bullhead = (6.98/4.82) × 100 = 145%
Midges = (2377/5369) × 100 = 44%
Total = 324%

Source: adapted from Learner et al (1971)

mackerel, yellowfin tuna, dolphinfish, manta ray and the hammerhead shark), as well as numbers of the anchovy itself and sardine.

Nevertheless, all of these were changing rapidly in just one to two years, and except for the clear decline in anchovy recruitment, it is highly debatable whether these SIs would have given adequate warning of a full-scale collapse. Indeed, the influence of a factor whose origin lies outside of the ecosystem represents a classic example of the problem of defining ecosystem boundaries. Even if an El Niño was known to be on the way, could the fishery managers have done anything about it? The answer quite simply would be no. On the other hand, the fishery was known to be under stress because of the observed poor anchovy recruitment, and it is likely that the eventual collapse was brought about by a combination of the two factors and maintained by the dominance of the sardine. The key indicator of recruitment was not given enough weight by the fishery managers, and catches remained high until El Niño arrived in full. Would an earlier suspension or reduction in fishing, in order to improve recruitment, have helped to prevent the impact of El Niño? In previous years (such as 1965) there had also been a devastating El Niño; but in that case the stock had been able to recover. Over-fishing during the late 1960s and early 1970s had greatly reduced this robustness; but what level of fishing could be sustainable when faced with an event such as El Niño, which has an unpredictable occurrence and also varies in force?

The use of a suite of SIs based on species abundance, as in the AMOEBA approach outlined by Ten Brink et al (1991), may not have prevented the collapse of the Peruvian anchovy fishery. The ecosystem itself is subject to massive disruption from an event that lies outside its boundaries and which is uncontrollable and unpredictable. Instead, the best one can do is build an element of 'white noise' into the management models in order to aim for the best sustainable yield over a period of time. However, the key information for management of the resource would still be centred on the population biology of the fish stock, rather than the sort of index that the AMOEBA represents. Where the AMOEBA approach could potentially play a role is as a measure of long-term ecosystem health, rather than as a predictor of drastic short-term events; however, even here care would need to be taken in the interpretation of the results. Wild fluctuations in abundance of key species are likely to follow El Niño events and may last for some years (for instance, seabird abundance after 1965). Comparing species abundance prior to and just after an El Niño event may not be of much benefit, but longer-term abundance may allow a measure of more subtle and yet still harmful environmental effects. Similarly, what does one choose as the reference condition? A year preceding a severe El Niño event is likely to be quite different from a year just after. The seabird population plummeted after the El Niño of 1965 not because of human activity, but because of natural causes. Quite clearly, one needs to be aware of the processes involved in changes in species abundance and not just the fact that those changes have occurred.

Conclusions

This chapter has examined two levels of SI: an individual SI (MSY) and an attempt at collecting individual indicators together as a single diagram (AMOEBA). Based on our discussion we can conclude that the main problem with such SIs is that they attempt to encapsulate a very complex system in a few simple measures. As has been illustrated, MSY makes many simplifying assumptions that may not exist in reality, and unquestioning adherence to MSY as a resource management tool can result in catastrophe. MSY itself is based on good scientific principles; but the scientific knowledge is simply incomplete. This is certainly not a criticism of those who have developed the ideas behind logistic population growth, yield–fishing effort relationships or even MSY. The criticism is aimed, instead, at those who extrapolate these ideas to complex systems without taking on board their inherent simplicity. Sustainable management is certainly a goal worth pursuing, and like Corten (1996), we too lament the fact that European Union 'biologists have lost their initial enthusiasm for optimal management, and have stopped recommending specific management actions'; but we have to be realistic about what we can achieve with the knowledge that we have or are likely to get in the near future. The problem with lists of SIs such as those produced by the UN is that the holistic nature of sustainability encompasses a huge breadth of knowledge – economics, social science and natural resources.

MSY is but one SI out of 132 in Table 1.1; but can similar pictures be painted for the others as we have done here for MSY? Have we been unfairly selective in our choice of the MSY? Each of the UN indicators produces its own difficulties, some of which have been identified by the UN itself. Moreover, if each is examined in the same depth as we have done for MSY, would other problems also emerge? By definition, each indicator is a simplification, and the dangers of taking them at face value without an appreciation of this simplification are just as real as they are for MSY. Lack of space prevents us from developing this argument for each of the SIs, and the reader is encouraged to pursue this line of thought as we have done for any of the SIs. However, to extend our horizons a little more we will consider the other SIs listed by the UN for Chapter 17 ('Protection of the Oceans, all Kinds of Seas and Coastal Areas'). As can be seen in Table 1.1, there are four other indicators (three driving force and one state) that relate to Chapter 17. Two of these (population growth in coastal areas and discharges of oil into coastal waters) are still under development at the time of writing and little information is available. The third driving force indicator – releases of nitrogen (N) and phosphorus (P) to coastal waters – has been described by the UN, and they list the following limitations for this indicator:

- Effects of N and P release depend upon assimilative capacity of the water body (i.e. how the water can cope with the N and P).
- The indicator does not include cumulative impact (it only looks at N and P release in a year).
- The indicator does not differentiate between sources of N and P unless more detailed information is collected. It can be difficult to differentiate between human-generated and natural sources of N and P.
- Very little data is available for the calculation of the indicator.

These appear to be formidable but, it has to be said, not insurmountable limitations. However, the very fact that limitations have been identified by the UN personnel concerned does not remove the potential dangers arising from simplification and decisions being made on incomplete information.

The second state indicator put forward by the UN alongside MSY for Chapter 17 is the algae index. This is described as the amount of algae, also called phytoplankton, measured in terms of biomass per litre of water. It is suggested that the algae is subdivided into species, and therefore the indicator combines a consideration of biodiversity with biomass. This indicator is particularly interesting since some of the early concerns with environmental damage that motivated meetings such as the United Nations Conference on the Human Environment, held in Stockholm in 1972, focused in part on concerns arising from the potential widespread poisoning of phytoplankton by pesticides (Munn, 1992). As a result, some scientists predicted a sharp drop in atmospheric oxygen concentration by the end of the century.

At first glance, the algae index would appear to be straightforward in the sense that it can be regarded as an extension of the Shannon–Wiener biodiversity index described in Chapter 1, with proportion of numbers (p_i) replaced by

Box 2.6 Two simple factors that complicate the use of the algae index as an SI

The algae index is calculated on the basis of algal biomass per litre of water, with subdivision into species. The two complications described in this box are, first, how biomass can alter measurements of biodiversity based on numbers, and, second, how a standing crop measurement of biomass may not necessarily provide a clue on productivity.

Biomass and biodiversity

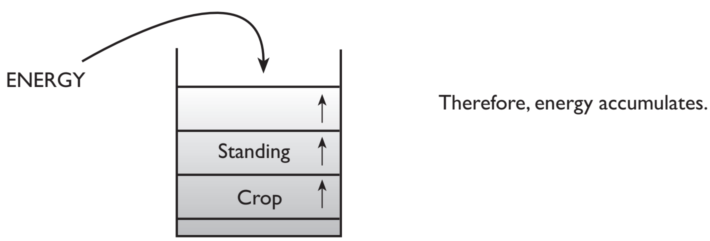
As in Box 2.5, this example has two species (S = 2) and a sample size of 100 (N = 100). Consider 50 individuals of each species, but individuals of species A weigh twice as much as individuals of species B. Let weight of an individual of species A = one unit, and the weight of an individual of species B = two units (total sample weight = 150 units):

- biodiversity based on numbers (see calculation in Box 2.5):
  H = 1
- biodiversity based on biomass:
  proportion of species A = 50/150 = 0.33
  proportion of species B = 100/150 = 0.77
  $H = -(0.33 \times \log_2(0.33) + 0.77 \times \log_2(0.77))$
  $= -(0.33 \times -1.6) + (0.77 \times -0.38)$
  $= -(-0.528 + -0.2926)$
  $= 0.82$

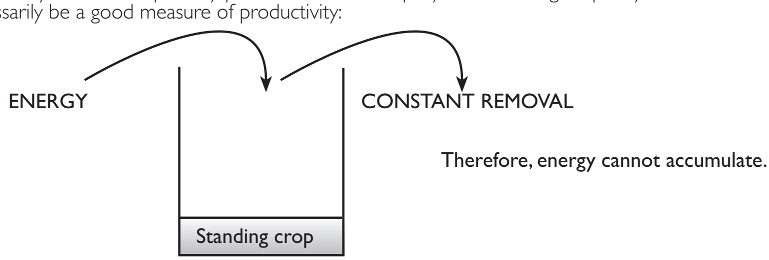
Therefore, in this case the Shannon–Wiener Index based on biomass suggests that biodiversity is less than the calculation based on numbers. If the individual biomass of species A and B were more or less the same, then the disparity would not be so pronounced.

Standing crop biomass as a measure of productivity

In an ecosystem where energy accumulates unused in an end-product, then standing crop can be an index of productivity.



In an ecosystem where primary production is used rapidly, then standing crop may not necessarily be a good measure of productivity:



proportion of total biomass for each species. Clearly, biodiversity calculated on the basis of numbers and biomass can give quite different results (see Box 2.6); however, provided the mass of each individual is more or less equivalent, then such an approach is perfectly reasonable. Biomass is also a far better indicator of productivity than numbers (Wagner, 1969), although again one should be careful: a 'standing crop' measurement can be a misleading measure of productivity (see Box 2.6). However, given the data, such calculations are straightforward, and, indeed, some examples of the calculation of the Shannon–Wiener Index have already been provided in Box 1.5, along with a discussion of some broad difficulties with the use of such indices. Nevertheless, the extension of this approach to algae in oceans introduces some methodological complications. Most of the oceans' algal biomass is in the form of phytoplankton, and these may be single cells (e.g. diatoms) or groups of cells rather than the large organisms counted by Learner et al (1971) in the River Cynon example used for Box 1.5. This is not to say that estimations of biomass are not possible with such small organisms. Given specialized equipment and expertise, estimations can be made, for example, by measuring chlorophyll fluorescence as a means of separating algae from other organisms (the zooplankton) present in samples.

There are well-established techniques for doing this and for relating chlorophyll to biomass. Dividing the biomass amongst individual species, and allowing for substantial spatial and temporal variability (patchiness) in both diversity and biomass, are certainly more difficult aspects of the methodology required by the algae index, especially when these will have to take place on a routine basis, rather than just once. After all, the river described by Learner et al (1971) is minuscule in volume, let alone biodiversity, when compared to the oceans, and Learner and his colleagues only worked with the relatively easy to count fish and macro-invertebrates. Interpretation of the algae index in the context of sustainable development provides yet more concern. How will human-induced change be separated from natural change, and how much time and data will allow us to make such a distinction in any one situation? In other words, do we really know enough about such complex ecosystems and are we going to commit realistic resources to making a reasonable judgement as part of a programme of sustainable development? Again, we are not criticizing those involved in such vital and challenging research; instead, it is the potential misuse of the data as part of a short-term drive towards someone's vision of sustainability that provides concern.

The second dimension of SIs examined in this chapter is an attempt to combine indicators into a single diagrammatic representation of sustainability. The AMOEBA approach of Ten Brink et al (1991) is fundamentally a visual representation of indicator species abundance; however, the species appearing in the AMOEBA represent but a small proportion of those existing in the ecosystem. Abundance can change dramatically due to natural events that may, in themselves, be poorly understood. With a system that can undergo rapid switching, the use of species abundance as a measure of sustainability can lead to erroneous conclusions if the time scale over which sustainability is being measured is too small. AMOEBA has other problems, as highlighted in this chapter; but the underlying concept has to be praised. For all its faults, the approach represents a genuine attempt to pool indicators together in a visual manner aimed at non-scientists. Unlike some other approaches that try to generate a single value for sustainability (like the Shannon–Wiener Index does for biodiversity), AMOEBA is an attempt to keep the richness intact and to let the reader judge. It is a pity that Ten Brink et al (1991) spoil it by collapsing AMOEBA into single indices (their Ecological Dow Jones Index).

Both MSY and AMOEBA share a feature of all indicators in attempting to reduce complexity, and like all indicators a price has to be paid. Indicators can be very useful, as illustrated in Chapter 1 with pollution in the River Cynon; but they work best when dealing with limited, well-defined situations and when the methodology and interpretation can undergo rigorous testing (with rejection of the indicator possible if it is found to be a poor representation). The concept of sustainability takes us away from limited, well-defined situations; allied with an emphasis on immediate implementation, this does not allow rigorous testing of indicators. Development of SIs usually takes place in tandem with a wish to implement sustainability now! River pollution can be defined chemically and then matched with species abundance and biodiversity. Workers may differ in what pollutants they consider to be important, and how they are to be measured; however, whatever the case each individual has to clearly define their viewpoint and their results are open to repetition and scrutiny – as a result, all views are open to rejection. It can also be acknowledged that the value of such changes in fauna and flora relative to the industrial output may well be subject to value judgements. It has to be said that the two SI examples given here (MSY and AMOEBA) are at least somewhat tangible. After all, we will ultimately know if the MSY indicator is successful by monitoring fish stocks and checking to see if these show signs of collapse. At least MSY is a very well-defined and clear (albeit simplistic) indicator to use in management that is open to scrutiny. However, do we limit our concerns purely in terms of a volume of water (and the life it contains) where fishing is done, or do we see a fishery in the context of an industry (the business of fishing)? If the latter, then the very point of sustainability is that it encompasses a broad range of considerations – the fishermen, their families, the micro- and macro-economy, politics and so on are all important considerations of a fishing industry. Ironically, given this wider perspective, it is possible for a fishing industry to become unsustainable despite the fact that fish stocks remain constant. Costs may increase or alternative sources of revenue may emerge that tempt fishermen away from the resource. Either way, the fish stock remains, but the industry collapses. It is these wider concerns about sustainability and SI development that form the basis of the next chapter.

3

Indicators, Cities, Institutions and Projects

Introduction and objectives

In Chapter 2 we examined sustainability indicators (SIs) at two levels. First, a detailed description of one SI, maximum sustainable yield (MSY), was provided. It was shown that although the MSY does have a solid base in 'good' science, has been popular as a basis for managing wild populations (such as fish stocks) and has been promoted by the United Nations as an SI, it is problematic for a number of reasons. The second level examined how a collection of SIs could be combined together to develop an overall picture of system sustainability – the AMOEBA approach. The AMOEBA is a pictorial representation of a collection of SIs based on an assumption that there is a 'sustainable' target to be aimed for (the state of the ecosystem in 1930 in the Ten Brink et al, 1991, example). The derivation and representation of the AMOEBA is a compromise between 'good' science (it is an incomplete representation of biodiversity based on a subjective choice of species to include) and the need to bring non-specialists such as politicians, policy-makers and managers on board.

Both the examples in Chapter 2 focused primarily on the management of natural resources and the ocean environment. MSY has its origin in fishing and can be regarded as having a theoretical basis in bio-economic calculus; therefore, it is essentially designed to maximize production output from a renewable resource. AMOEBA, in its original form, is a pictorial (graphical) representation of indicator species abundance, although the choice of species is subjective. However, do we take sustainability of a fishery, or any other resource, to be measured just in terms of production? What about the people whose livelihood depends upon that resource; do we not also consider their well-being? As can be imagined, the collapse of the anchovy fishery off the coast of Peru was devastating for the industry. However, if one implements changes in catch quotas that can vary, perhaps dramatically, from year to year, what will be the effect on the industry and the people who work within it? As

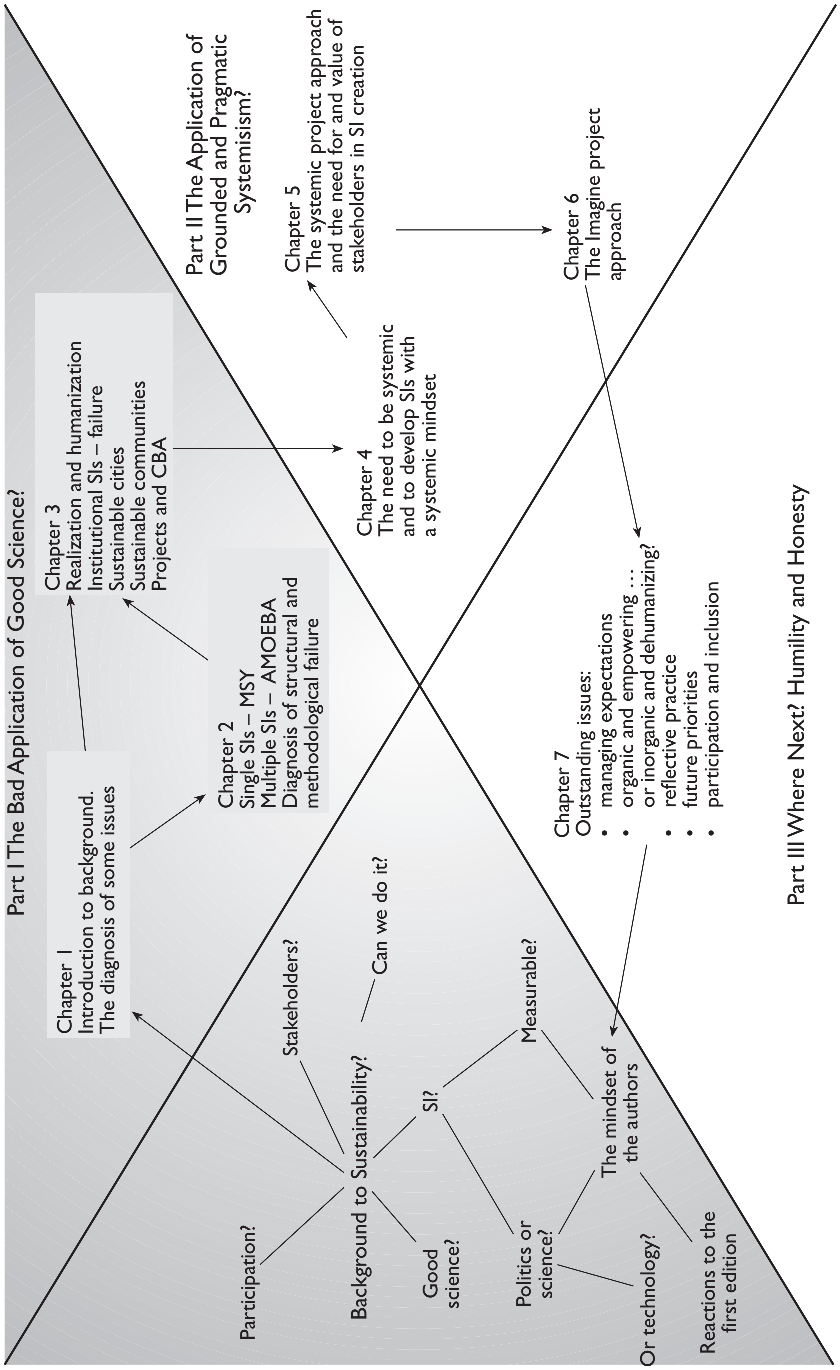


Figure C.3 *Chapter 3 in context*

Laws (1997) points out, 'maximizing the long-term fish catch does not necessarily maximize the social benefits or economic rewards of the fishery'. The SIs required here are beyond the scope of the relatively simple MSY and species abundance SIs described by Ten Brink et al (1991) in the AMOEBA approach, and much more complexity is introduced. Even the maximum economic sustainable yield (MEY) mentioned in Chapter 2 is problematic:

- Whose economic gain is being assessed: fishers, middle-men, consumers? These three stakeholder groups, themselves made up of diverse subgroups, may have quite different perspectives over what they think is needed.
- Livelihood is far more than just economics. The World Health Organization Quality of Life (WHOQOL) definition in Chapter 1 provides an insight into the subjectivity and complexity of 'livelihood'. Adequate revenue for fishers is important; but they may also want price stability, low costs, good working conditions, reasonable hours at sea, etc.

Indeed, the choice of the acronym MEY is interesting as surely it should really be MESY – close to an English word (messy) that neatly sums up the problem. Thus, as we have seen, even with the biologically based and defined MSY and AMOEBA, there are dangers of oversimplification, and these problems certainly do not disappear when socio-economic factors are introduced – quite the opposite.

In order to explore how socio-economic factors have been dealt with when considering sustainable development, we have chosen to focus on human communities, institutions charged with delivering development and development projects. In a sense, these provide the other extreme examples to those of Chapter 2 since they are all entirely human constructs that revolve immediately around human wants and desires. We have also selected these examples because of their very defined spatial, and often temporal, dimension. Urban centres have defined boundaries based on a responsibility for administration often allied with politics. Therefore, there are city, town and village councils elected by the population of the centre and responsible for an area or population that can be very clearly delineated. Furthermore, since urban centres are, by definition, collections of people in a defined space, sustainability concerns move far beyond environmental considerations; economics, culture, crime and entertainment all become very important.

The defined space and time dimensions also apply to development institutions and, indeed, to development projects. The sustainability of an institution charged with facilitating development can be quite distinct from the sustainability of a development process; nevertheless, it is still very amenable to the use of SIs. Indeed, as we point out in this chapter, we believe that institutional sustainability provides another example of how the use of SIs can be very dangerous in a development context. Development projects, typically implemented by an institution of some sort, in many ways provide the clearest context for the use of SIs and will form the basis of our discussions for the remainder of this book. Much development takes place via projects intended to achieve a specific set of goals in a defined space and time scale. Given that funding for development is always limiting, using projects as a vehicle facilitates easy monitoring of costs and benefits.

This chapter, therefore, has a number of aims:

- Broadly examine how socio-economic factors can be included in SIs.
- Discuss the use of SIs in one of the most common development contexts – the project.
- Look at the use of SIs to gauge institutional sustainability and the dangers inherent within this.

Sustainable communities

There are a number of examples of initiatives by urban administrators to make their centre more sustainable. Sustainable Seattle (www.sustainableseattle.org) in the US is one well-known example; but there are many others (Zachary, 1995; Pugh, 2000). There is a Sustainable City Award in Europe (details available at sustainable-cities.eu), and the UN has selected a number of cities worldwide to promote the sustainable city concept (Sustainable Cities Programme, or SCP; details are available at www.unhabitat.org). In the UK there is an Academy for Sustainable Communities (ASC; see www.ascskills.org.uk/pages/home) that includes urban-based communities within its remit.

However, what is meant by sustainable in the context of urban areas is interesting in terms of the breadth of dimensions considered. To begin with, the juxtaposition of the words sustainable and city may appear to be a gross contradiction – can any urban centre be regarded as sustainable when it clearly depends upon goods and services created from outside? However, sustainability in this context has quite a distinctive meaning. On the one hand, there are general statements in the same vein as those discussed in Chapter 1:

> *[Urban sustainability is] the process of developing a built environment that meets people's needs whilst avoiding unacceptable social or environmental impacts.* (Hamilton et al, 2002)

> *Sustainable urban development may be defined as a process of synergetic integration and co-evolution among the great subsystems making up a city (economic, social, physical and environmental), which guarantees the local population a non-decreasing level of well-being in the long term, without compromising the possibilities of development of surrounding areas and contributing by this towards reducing the harmful effects of development on the biosphere.* (Camagni, 1998)

> *Most people want to live in a place where they know their neighbours and feel safe. A place with good homes, local shops, lots of jobs and opportunities for young people to get a good education.* (ASC webpage, www.ascskills.org.uk/pages/home, 2007)

The subjectivity of terms such as 'need', 'safe', 'good', 'unacceptable', 'harmful' and 'well-being' have already been discussed, as has what is meant by 'people' and 'local population'. However, there are more grounded definitions as well. For example, at a seminar held in California in 1991, the following definition was adopted:

> *Sustainability may be defined as a dynamic balance among three mutually interdependent elements:*
> 1 *protection and enhancement of natural ecosystems and resources;*
> 2 *economic productivity; and*
> 3 *provision of social infrastructure such as jobs, housing, education, medical care and cultural opportunities.* (Dominski et al, 1992)

There are two points worth noting about this definition. First, although there is some resemblance to definitions of sustainable development given in Chapter 1, it is relatively precise, especially with regard to the 'social dimensions' (employment, housing, education, etc.). Second, there is a clear emphasis on the economic and social factors. Indeed, given this definition, what is the difference between a sustainable city and good planning? Provision of jobs, housing and education is a very clear mandate; but does it require the paradigm of sustainability as an umbrella? Politicians have been promising these long before sustainability became such a dominant paradigm. A similar conundrum is provided by the ASC list of factors, which they consider important for 'sustainable communities':

- Governance: well-run communities with effective and inclusive participation, representation and leadership.
- Transport and connectivity: well-connected communities with good transport services and communications linking people to jobs, health and other services.
- Services: public, private and community and voluntary services that are accessible to all.
- Environment: providing places for people to live in an environmentally friendly way.
- Equity: fair for everyone in our diverse world and for both today's and tomorrow's communities.
- Economy: thriving and vibrant local economy.
- Housing and the built environment: high-quality buildings combined with a strong, inclusive local culture and other shared community activities in a safe environment.

These headings form the basis of what is referred to as the 'Egan Wheel' after a task force established in 2004 by the Office of the Deputy Prime Minister and headed by Sir John Egan. But at first glance it is hard to see anything in this list which a politician hasn't promised for as long as politics has existed. Just what has the rise of 'sustainability' added to the mix? Environment is included as but one of the seven factors. Indeed, perhaps the most contentious term is 'equity', expressed here not just in terms of the futurity discussed in Chapter 1, but also 'fairness' in the world today. But even the most capitalistic of politicians have long been proclaiming a desire for equity; it's just how to achieve it that differs:

> *That nations that have gone for equality, like communism, have neither freedom nor justice nor equality: they've the greatest inequalities of all, the privileges of the politicians are far greater compared with the ordinary folk than in any other country. The nations that have gone for freedom, justice and independence of people have still freedom and justice, and they have far more equality between their people, far more respect for each individual than the other nations. Go my way. You will get freedom and justice and much less difference between people than you do in the Soviet Union.* (Margaret Thatcher, then prime minister of the UK, during an interview with Brian Walden, London Weekend Television, 16 January 1983)

What is noticeable is that the inclusion of all these dimensions, although central to many definitions of sustainability, introduces much more complexity into the choice and interpretation of SIs. A taste of the diversity is provided in Table 3.1. This table summarizes the results of surveys conducted in a small village in Scotland where people were asked to rank what factors they considered to be important for a sustainable community (MacGillivray, 1996). Not

Table 3.1 *Top ten key components of sustainable development by 100 households in a Scottish village, UK*

Component	*Percentage saying 'very important'*
Health	70
Security	69
Standard of living	59
Education	57
Environment	6
Culture, recreation and leisure	50
Housing	49
Transport/access to goods and services	36
Tranquillity	29
Community spirit	22

Source: adapted from a table in MacGillivray (1996) that summarizes data presented by the New Economics Foundation (1996) only was environment included, but also other components such as education, housing and transport. While these may be seen as relatively straightforward components to gauge (number of school places, new homes, length of roads, etc.), what does one do about components such as community spirit and tranquillity? Indeed, who is in the 'community' which supposedly has this 'spirit'?

Another example of SIs developed for an urban centre is provided in Table 3.2. This is a list of SIs initially adopted by Norwich City Council in the UK during the mid to late 1990s, although very similar examples can be found for many other sustainable city programmes. They are divided into three groups: environmental protection, economic development and social development – very much in line with the above definition from Dominski et al (1992). The SIs were largely developed in 1997 and 1998 with the intention that they would be reviewed on a regular basis. They were chosen by a Norwich 21 Steering Group, thereby representing a manifestation of a central element of UN Agenda 21 – the need for local involvement and planning (so-called Local Agenda 21). The steering group consisted of various prominent people in Norwich, and unlike the AMOEBA approach of Chapter 2 or, indeed, the Environmental Sustainability Index (ESI) of Chapter 1, the Norwich SIs did not originate with scientists or technocrats, but represented what can best be termed the views of at least some laypeople. There was some resonance with the spirit of the ESI in that the initial intention was for the results to be made widely available to the people of Norwich on a regular basis through the popular press and media.

It is interesting to note that although the Norwich 21 plan had its origins in UN Agenda 21, the SIs initially listed by Norwich were not broken down into driving force, state and response SIs, although there were some clear associations between the UN indicators and those of Norwich 21, as indicted in Table 3.2. Although there were a number of parallels with the UN SIs, especially in the environmental sphere, it is interesting that there were few associations with the UN indicators in the social sphere. Local services, democracy, sports facilities, arts, culture and heritage had no parallels with the original UN list, though as discussed in Chapter 1, the UN indicators were not meant to be definitive and each country and local group were encouraged to develop their own set of SIs. There are also echoes of some of the principles behind the AMOEBA. A good example was the focus on swan numbers as an indicator of wildlife (biodiversity). Clearly, swans are much more visible and recognizable by inhabitants of the city, and in addition have a strong sentimental value that other animals (such as the midges used for the AMOEBAE in Chapter 2) do not possess. Indeed, the choice of swans as an SI in Norwich mirrors the emphasis on numbers of salmon in local rivers by the people of Seattle (MacGillivray, 1996).

Clearly, the problems already highlighted in Chapter 2 regarding SI selection and interpretation of a collection of SIs apply to those of the Norwich 21 initiative, but with a vengeance! Each of the SIs listed in Table 3.2 are open to

Table 3.2 *The Norwich 21 set of SIs*

	SI	*Notes*	*Target*	*UN Chapter*
Environmental protection				
1	Clean air	Number of days of good air quality	Increase	9
2	Less domestic waste	Tonnes of waste produced per household; total domestic waste recycled	Decrease Increase	21
3	Saving water	Cubic metres of water consumed by all users in a year	Decrease	18
4	Saving energy	Energy (gas and electricity) consumed by domestic and industrial users per year	Decrease	4
5	Clean river water	Quality of water in the two main rivers in Norwich (dissolved oxygen, BOD, ammonia)	Increase	18
6	More wildlife	Number of swans living and breeding on the two main rivers in Norwich	Increase	15
7	Protecting open spaces	Area of green field sites developed within the Norwich area	Increase	
8	Clean streets	Amount of litter on the streets	Decrease	7
9	Less traffic	Number of trips each year by: • cars • public transport • cycle • foot	 Increase Increase Increase Increase	
10	Safer streets	Length of streets that are fully pedestrianized and traffic calmed	Increase	
Economic development				
11	Less unemployment	Unemployment rate	Decrease	3
12	More skilled people	Percentage of the population achieving national training and education targets	Increase	12
13	More jobs	Net increase in number of jobs	Increase	3
14	Regional capital for business	Number of medium to large firms with regional or national headquarters in Norwich	Increase	
15	More money from tourism	Number of overnight stays by visitors in hotels	Increase	
Social development				
16	Less poverty	Percentage of the population living at or below the poverty line	Decrease	3
17	Reduced housing problems	The number of: • homeless people • people in need of specialist accommodation • people in overcrowded accommodation	 Decrease Decrease Decrease	7
18	Improved local services	Number of people who live within walking distance of a centre of local services	Increase	
19	More people involved in local democracy	Percentage of eligible people voting in local elections	Increase	
20	More sports facilities	Number of sports facilities as measured against English Sports Council targets	Increase	
21	A safer city	The level of reported crime (domestic violence and burglary; non-domestic violence)	Decrease	
22	More arts and culture	Number of seats/venues (cinema, theatre, etc.)	Increase	
23	Maintaining our heritage	Number of listed buildings; number of collections/museums open to the public	Maintain Increase	

Source: Policy Unit, Norwich City Council, City Hall, Norwich much the same sort of problems of oversimplification as with MSY. While acknowledging that in a country such as the UK much of this data is readily available, some information is politically sensitive and the manner in which it is calculated has been changed over the years. Unemployment rate is a classic example: the methodology by which this is calculated has been altered 30 times since 1979 (MacGillivray, 1996), and we will leave the reader to judge how much of this change was politically driven. One should also note that like MSY, each of the SIs will be influenced by many factors, some of which lie well outside the administrative boundary of Norwich. Just as with MSY, examining any one of these without appreciating the underlying nature of the forces that drive it may be dangerous.

However, what were the Norwich SIs intended to achieve? It is interesting to note that SIs for urban communities have a very clear application that may, in part, be a reflection of the more precise vision of sustainability. Zachary (1995) suggests that there are four functions of such SIs:

1. enabling a community to identify what it values and allowing it to prioritize those values;
2. allowing the community to hold individuals and groups accountable for achieving goals identified by the community;
3. encouraging democracy;
4. allowing people to measure what is important and to make decisions based on those results.

The Norwich Agenda 21 SIs had a very similar set of functions. The city made it clear that they were intended as a 'snapshot, and not as a complete picture', and were intended to measure the health of the city. However, the broad approach was one of enablement in much the same mode as described by Zachary (1995). The Norwich SIs were intended to be presented to the public each year, and the public would be encouraged to both judge progress and, at an even more local level (blocks and streets), to develop their own set of SIs. Therefore, the SIs were an attempt to increase the appreciation of the many issues that are behind each SI, and the words of Gary Lawrence (1997), one of the people behind Sustainable Seattle, resonate very strongly here: 'For indicators to lead to change, there needs to be emotional content: people need to care in their hearts as well as in their minds.' The clear association of terms such as 'jobs', 'health' and 'education' with sustainability certainly provides an obvious resonance with central concerns of almost every human being and thus provides a good starting point.

Indeed, it is the participative nature of sustainable city programmes that largely distinguishes them from many other initiatives to put sustainability into practice. If one looks at almost all of the other examples of SI development, including those of the UN and the examples of Chapters 1 and 2, the flavour is very much one of top down, with a nod in the direction of those who are expected to benefit from the programmes. The Norwich initiative and others like it throughout the world were intended to start and end with the people; participation is supposed to be the bedrock of the whole process. Indeed, one can easily conceive of a further set of SIs alongside those in Table 3.2 that gauge participation (number of local initiatives, attendance at meetings, extent of feedback, etc.). It should be noted that quantification is just as much a part of this as it is with MSY, and it would be misleading to regard the Norwich approach as different in this regard. Granted: the Norwich SIs were directional (the concern was whether they move up or down); but the heart of that direction was still based on numbers.

What happened to the Norwich list of SIs? It has to be said that the original Norwich SI list had only a partial basis within public participation given that the 'lay' people were themselves representative of a specific group of leaders (heads of local colleges, business people, etc.). The thorny issue of who participates in participation (i.e. representation), and the dangers of process capture by individuals or groups, will be returned to in later chapters. Unfortunately 'participation' is often employed as a catch-all term for the legitimization of a set of decisions and actions imposed in a top-down fashion by managers. At its worst, 'participation' may be no more than a 'nodding committee' comprising a carefully selected group of individuals. Even so, the lesson is a sanguine one since unfortunately the original SIs are no longer part of the sustainability agenda in Norwich. This is largely because the local government had to bow to a set of top-down SIs imposed by central government (see www.sustainable-development.gov.uk for details). Thus, the good intention, even if far from perfect, arguably became lost within an agenda from central government for accountability and control.

In the next section we contrast this emphasis on participation in the development and application of SIs with a very different approach – one where the institution delivers the development (often referred to as institutional sustainability). While this may seem to be a quite different issue, there are many similarities, and the application of SIs in this context has been markedly different from their use as part of sustainable community initiatives. Indeed, in some respects, SIs as a gauge of institutional sustainability provide the other extreme to examples such as the Norwich initiative, and the results have been equally sobering.

Institutional sustainability

Development is often planned, initiated, implemented and evaluated by an institution. Earlier, we explored the role of local and central government; but 'institution' can take the form of a government agency or ministry, an international agency (such as the United Nations, World Bank or International Monetary Fund), an aid agency (e.g. the UK Department for International Development, or DfID) or a non-governmental institution such as the

Catholic Church. In this sense an institution, even a very diverse one, is like an urban area in that it is a very definable entity. It may consist of a group of people and physical structures. The boundary within which sustainability operates is therefore very clear. Second, what is meant by sustainability in this context is evident and is typically encapsulated in factors such as financial self-reliance or some other measurable activity (Gustafson, 1994). Therefore, although this is a different perspective from that of sustainability in a city, both share a clarity of purpose. There are two remaining advantages to viewing sustainability in an institutional context:

- The time scale over which sustainability is deemed to operate is also more defined (the emphasis is on shorter scales).
- The institution, although complex, may not approach the complexity of an ecosystem or a city.

Institutional sustainability has become a major consideration of the general process of sustainable development (Pfahl, 2005) and is featured within the UN indicator set (Spangenberg et al, 2002). For example, the Organisation for Economic Co-operation and Development (OECD, 1989) maintains that 'sustained and self-reliant development depends on the strength and quality of a country's institutions', and van Pelt et al (1990) point out that 'in general terms, sustainability refers to the long-term availability of the means required for the long-term achievement of goals'. Van Pelt et al (1990) also make the important statement that:

> *The OECD (1989), focusing on development aid, considers development sustainable when the recipient country is willing and able to provide sufficient means and resources (financial, managerial, ecological and so on) for an aid activity after the donor has withdrawn his assistance.*

However, it should be noted that sustainability in this context has two quite distinct, interrelated and perhaps even competing meanings. The institution itself may be sustainable in the eyes of the donor (i.e. it may not require further injections of resource to keep going); but what it is doing may not be sustainable in the longer term. Sustainability of the 'means to an end' is therefore quite distinct from sustainability of the 'end', and the information one needs to collect to determine the two will also be different. For instance, one could consider institutional sustainability as part of a sustainable city programme by focusing on the institutions promoting sustainability in the city (such as the city council and its departments). However, in all of the literature pertaining to sustainable cities (Norwich, Seattle, etc.), there is little if any reference to the sustainability of the institutions facilitating the vision – perhaps because of the political sensitivity behind the idea since it could be interpreted as sustaining administrators and even politicians in office! If institutional sustainability in a sustainable city context meant freeing the inhabitants from the necessary taxes to fund the programme, then the story would be different; but would this be popular with those charged with implementation?

Institutional sustainability has stronger roots within the broader development literature and is often interconnected with discussions over power differentials between donors and recipients. However, in this context is institutional sustainability not a good idea? After all, a reliance on constant injections of resource from donors could generate instability. It certainly has resonated well with funding agencies for obvious reasons. Of course, one must be careful not to be too naive. After all, many institutions producing 'valued outputs' have been closed for a host of reasons, not least of which is naked politics. Nevertheless, given all of the above, institutional sustainability is an achievable target desired by some powerful groups, and progress to that target can be measured. Nevertheless, although theoretically attainable, the practice may not be so easy (Gustafson, 1994). For example, Brinkerhoff and Goldsmith (1992) report two studies by major donors, one by the World Bank and the other by the US Agency for International Development (USAID), on the sustainability of projects that they have funded. Of 550 projects evaluated by the World Bank, nearly 50 per cent had 'sustainability difficulties'. Only 52 per cent had successfully achieved sustainability. Similarly, of 212 projects evaluated by USAID, only 11 per cent were thought to be sustainable (i.e. continued functioning once the time-limited project funding had ended).

One area of development activity where the increasing emphasis on institutional sustainability has been particularly noticeable is in the provision of financial services (FS) for the urban and rural poor (McNamara and Morse, 1998). The idea is very simple: problems of underdevelopment are assumed to be linked to a lack of money and if funds can be provided then people living in developing countries can invest in small-scale enterprises, including agriculture, thereby breaking the so-called poverty trap. For example, in agriculture, access to machinery, land, labour and agricultural inputs may be limited because of the inability of farmers to purchase or hire them. The argument is that if these farmers had access to FS, they could afford these inputs and improve their production. This 'free enterprise' vision of tackling development has proved to be extremely popular with a number of development agencies, and some have poured vast resources into FS schemes. Indeed, a high-profile series of summits on FS has been held since 1997 (www.microcreditsummit.org; Gibbons and Meehan, 1999). The first Microcredit Summit was held in Washington in early 1997 and put forward the target of expanding access of the world's poor to FS to 100 million by the year 2005. Since then there have been two more summits; Microcredit Summit +5 took place in New York during November 2002, and a further summit occurred during November 2006 in Halifax, Nova Scotia. The 2002 summit claimed as two of its goals the aim of ensuring that:

- 175 million of the world's poorest families, especially the women of those families, receive credit for self-employment and other financial and business services by the end of 2015.
- 100 million families rise above the US$1 a day threshold adjusted for purchasing power parity (PPP) between 1990 and 2015.

Because there are many borrowers collecting relatively small sums, the processing costs of such FS schemes reaching the poorest tend to be high. Furthermore, in order to reduce costs for the beneficiaries, interest rates for credit often have to be set much lower than commercial rates (Adams, 1984; Jackelen and Rhyne, 1991). Partly as a result of these and other factors, the formal FS sector (banks) tend not to be interested in the provision of FS for resource-poor individuals and groups (Bouman, 1984; Thomas, 1992; Soyibo, 1996), and instead the focus has been for non-governmental organizations (NGOs) and others, including government institutions, to step in and provide such a service. However, given the costs of FS provision, some subsidization is often required either from the government or from an outside donor, and this may need to take the form of regular grants. However, during recent years there has been a move towards encouraging the field partner providing the FS to achieve sustainability and thereby remove the need for a constant injection of funds (Jackelen and Rhyne, 1991; Yaron, 1992; Bennett and Cuevas, 1996; Dichter, 1996). The emphasis is firmly upon the sustainability of the field partner rather than on the sustainability of what is being financed (the outcome); this equates very simply to financial self-sufficiency.

The FS literature is vast and has a dedicated journal (*Journal of Microfinance*), and, as with so many of the other topics covered so far, it is impossible to cover the topic in much depth in a book such as this. One of the most famous examples is the Grameen Bank in Bangladesh founded by Mohammad Yunus, the winner of the Nobel Peace Prize in 2006 for his work (Yunus, 1999, 2003). Suffice to say that as sustainability in this context can be given a very narrow and defined meaning, it is no surprise that SIs have been developed in order to measure progress of the field partner towards achieving the goal of self-sufficiency. Two examples are presented in Box 3.1. Although the second equation (for the Subsidy Dependence Index, or SDI) may appear to be complex, it is, in fact, relatively easy to calculate since the values of the parameters can often be gleaned from an institution's accounts – provided one has access, of course. Some practical examples calculated by Yaron (1992) and McNamara and Morse (1998) are given in Table 3.3. Indeed, like MSY and all SIs, the relative simplicity of the SDI may be problematic. It is primarily expressed in terms of the increase required in on-lending interest rates for the institution to become sustainable, and does not take into account other possible options. For example, rather than increase the interest rate, the institution may try to reduce the amount of outstanding loans by applying more 'aggressive and efficient loan collection' (Yaron, 1992; Schreiner and Yaron, 1999).

Box 3.1 Two indicators that can be employed to gauge the self-sufficiency of development institutions in providing financial services to resource-poor groups

1 The percentage of total costs covered by income (Johnson and Rogaly, 1997) for any particular period of time:

$$\text{Sustainability indicator (SI)} = \frac{\text{total earned from financial services (FS) programme}}{\text{total FS programme costs}}$$

The higher the SI, the more self-sufficient the institution.

2 Calculate the change required in interest rates charged by the lender in order to remove the need for a subsidy; this is termed the Subsidy Dependence Index (SDI) (Yaron, 1992):

$$\text{SDI} = \frac{\text{subsidy received}}{\text{outstanding loans} \times \text{interest rate}}$$

The denominator in the equation is, in effect, the income due from loans that have not been paid. More precisely:

$$\text{SDI} = \frac{A(m - c) + [(E \times m) - P] + K}{LP \times n}$$

The numerator in the above equation is the annual subsidy received by the institution:
- A = concessional borrowed funds outstanding (annual average);
- m = interest rate that the institution would be assumed to pay for borrowed funds if access to borrowed concessional funds were eliminated;
- c = average annual concessional rate of interest actually paid by the institution on its average annual concessional borrowed funds that are outstanding (A);
- E = average annual equity (capital);
- P = reported annual profit (adjusted, when necessary, for loan loss provisions, inflation, etc.);
- K = the sum of all other types of annual subsidies received by the institution (such as partial or complete coverage of operational costs by the state).

The denominator is the income generated by loans:
- LP = average annual outstanding loan portfolio of the institution;
- n = average on-lending interest rate of the institution; this can be estimated by dividing the interest earned by the total value of loans issued.

The higher the SDI, the more the interest rate needs to be increased in order to make the FS institution self-sufficient. In other words:
- SDI = 0 (the institution has achieved sustainability – that is, it requires no annual subsidy from an outside donor).
- SDI = +ve (the institution has not achieved sustainability and requires an annual subsidy from an outside donor; the higher the SDI, the greater the annual subsidy required).
- SDI = –ve (the institution has not only achieved sustainability, but also makes a profit; the 'higher' the negative value, the greater the profit).

Table 3.3 *Values of the Subsidy Dependence Index (SDI) for some rural finance institutions*

Institution	*Country*	*Year*	*SDI (percentage)*
Badan Kredit Kacamatan (BKK)	Indonesia	1987	24
		1989	20
Bank Rakyat Indonesia Unit Desa (BUD)	Indonesia	1987	3
		1989	–8
Bank for Agriculture and Agricultural Co-operatives (BAAC)	Thailand	1986	28
		1988	23
Grameen Bank (GB)	Bangladesh	1987	180
		1989	130
Diocesan Development Services (DDS)	Nigeria	1982	89
		1987	20
		1996	11

Note: the SDI can be thought of as an indicator for institutional sustainability.
Source: adapted from data provided in Yaron (1992) and McNamara and Morse (1998)

Indeed, there are a host of other indicators that one could use to judge progress towards institutional sustainability or simply the performance, in general, of an organization providing FS. The number of loans issued, the number of savings accounts held, the amounts saved and loan repayment rates are all easily quantifiable. In contrast, other development activities such as provision of primary healthcare or an agricultural extension service are not so easily and readily quantifiable; as a result, Tendler (1989) has stressed that some 'organizations tend to look at commitment, honesty and hard work as proxies for performance. Mediocrity gets tolerated more, simply because the results of what these organizations do are more difficult to see.'

Even with just the two SI examples given in Box 3.1, it is clear that their use is a much easier and less daunting prospect than discussed in a wider context in Chapters 1 and 2, or even with the sustainable cities in this chapter. Given this, and a major emphasis on institutional sustainability from donors, it is interesting to note that FS institutions generally have a bad record of attaining sustainability (Yaron, 1992). Indeed, this drive towards sustainability based on such narrow criteria can be problematic in a practical sense (Dichter, 1996). To begin with, in order to attain sustainability, the field partner is pushed to take on the characteristics of more formal financial institutions (Jackelen and Rhyne, 1991; Schmidt and Zeitinger, 1996). In particular, interest rates have to be commercial, operational costs have to be covered and loan defaulting has to be minimized. The latter requires a screening programme akin to those implemented by commercial organizations; however, the danger is that only those best able to repay will benefit from the service, while those who are the poorest may be rejected (Slavin, 1996). Furthermore, in order to minimize costs and target effort into screening and repayments, there may be pressure for the partner to concentrate solely on the provision of FS and to disregard other types of development activity or support services (Mutua, 1994). This approach is referred to as minimalist FS delivery, or sometimes more specifically as minimalist credit (Berenbach and Guzman, 1994; Dichter, 1996), while the opposite viewpoint is often referred to as the non-minimalist or integrated approach.

It is possible, of course, that even in integrated programmes the FS element can be made sustainable, while the other activities are financed from grants (Holt, 1994). Indeed, some funding agencies (notably USAID) have required the supported institutions to split into two parts: a component that supplies the FS and which should become sustainable, and a second component supplying technical services and training that continues to be subsidized (Hulme and Mosley, 1996a).

There are well-recognized dangers in placing an excessive focus on FS and institutional sustainability. As pointed out by both Dichter (1996) and Slavin (1996), development is a complex process that may involve a number of different yet closely interrelated activities, and the idea that FS can solve these is simplistic, to say the least. The problem may be that since institutional sustainability is such a clear and easily measured concept, particularly in terms of FS provision, then it may encourage this narrowing of scope. Islam (2007) shows how even the most famous FS institutions, the Grameen Bank, has had problems with bringing a consideration for institutional sustainability together with a mission to help alleviate poverty. Given that sustainability has taken on such a holistic and all-embracing meaning in recent times, this is ironic. After all, the weakness of the concept of institutional sustainability is also its strength. By focusing on institutional sustainability one can develop clear and precise definitions and indicators. However, since the people in the institution know the importance of these indicators and how they are calculated, and given that they clearly wish the institution to be sustainable for their own benefit, is there not a danger that the emphasis will move away from the intended beneficiaries of the development (McNamara and Morse, 1998; Islam, 2007)?

Brown (1997), for example, describes a development project, the Belize Chamber of Commerce and Industry (BCCI), set up in 1920 as the representative body of large commercial enterprises in Belize City. Between 1989 and 1993 the BCCI grew into a national development agency involved in various activities, such as training, publishing, provision of guidance and assistance for exporters, and the organization of missions to international trade fairs. In order to fund these activities, BCCI received a grant from USAID to cover the 1986 to 1993 period, but came under pressure to demonstrate its 'potential sustainability', based purely on criteria of financial self-sufficiency. In response, BCCI devised a three-pronged strategy to achieve this:

1 expand and retain its membership;
2 become the local agent for Western Union;
3 establish a national lottery.

The third point, in particular, was intended to generate enough revenue to replace the USAID funds and to demonstrate its sustainability. However, the lottery quickly took on a life of its own and gradually came to dominate the organization to such an extent that development activities were severely neglected. The moral of this story for Brown (1997) is not that institutional sustainability is necessarily bad, but that donors need to recognize that an organization charged with development may have limited means to generate its own revenue and to become self-sufficient. Galvani and Morse (2004) describe a similar set of issues for some UN agencies in Latin America and their reinvention almost as 'consultancy' companies.

Nevertheless, given its appeal it is doubtful whether the drive for institutional sustainability and self-reliance, particularly with FS, will relent in the short to medium term. The concept is simply too well ingrained, and many NGOs will be reluctant to admit that what they are doing is unsustainable. It is likely that they will continue to pay lip service to the concept as a means of placating the donors. Some have even suggested that organizations that argue against sustainability may be doing so as a means of diverting 'attention away from their own highly cumbersome and inefficient operations' (Berenbach and Guzman, 1994). Even worse may be the danger of being described as following a 'paternalistic approach to helping the poor' (Microcredit Summit Document). Clearly, given such views, NGOs who dare argue against an overriding domination of financial sustainability could find themselves in a rather vulnerable position, and one is entitled to question whether this is healthy for development.

Institutional sustainability has one further point in common with the sustainable city programmes mentioned earlier: SI development and use have shown great progress. The SIs for each context are being applied as tools to help achieve concrete goals and not as academic curiosities or even as lip service. One can certainly question the goals, as in institutional sustainability; but the use of SIs remains a reality. There are a number of reasons for this, some of which have already been spelt out, including the fact that institutions and cities are well-defined entities. One also has to consider the limitations of what the SIs set out to achieve in each case. In the Norwich programme, the SIs act as a tool to encourage enablement, while in institutional sustainability the SIs are essentially measures of financial self-reliance. As for motive, the Norwich programme may have been sparked by the Rio Earth Summit and nurtured by city council officers; but the momentum has come very much from the people of the city. A cynic may suggest that this is only true in an indirect sense since sustainability is a word that tends to resonate very well with an electorate and, consequently, with politicians and their officers; however, this does not diminish the fundamental ethos of what is being achieved. In institutional sustainability the motive is also very clear, and like the Norwich programme, one tends to hear an emphasis on empowerment – although, can it be denied that there is also a desire on the part of those funding development to achieve value for their aid money?

Projects, appraisal and sustainability

In the final section of this chapter we continue to focus on the institutions charged with delivering sustainable development in the field, but also broaden the discussion to look at the development being 'delivered'. Sustainable development often takes place within the context of a defined project linked to an institution or set of institutions. A project may have a clear spatial dimension that typically relates to a political or administrative boundary (such as an urban centre, local government area or state). It will also typically have a clear life span, or at least the funding that it receives will be on a renewable (subject to performance or some other factor) basis. However, in many cases the aim of the development initiative may not just be to achieve a goal over a discrete area in a set time, and then simply evaporate, but to introduce an improvement that is intended to last after the money has been spent. For example, the project may be intended to improve the effectiveness of an existing government agency, and this improvement is supposed to be long lasting. Similarly, aid money may be intended to help establish a development project that will ultimately become self-sufficient in terms of finance – no longer requiring funds from the donor agency or others to fulfil its function.

More recently, there has been the rise of the so-called 'programmatic approach' where a series of projects are instigated to address an issue. While we readily acknowledge that programmes may represent a more sustained effort, we would argue that the fundamentals of the 'project' approach remain intact – defined implementer(s), time scale, resource allocation, outputs, etc. – and for the purposes of this book we will continue to refer to projects as the main vehicle.

Consideration of sustainability within a project context, whether institutional sustainability or sustainability of the changes being attempted, may be thought by the reader to represent a rather narrow perspective, as indeed it does! However, it should be noted that the 'blueprint project' approach is extremely common (even if the more recent trend is for them to be a part of a larger programme), and its popularity, in part, rests upon the fact that goals can be clearly set at the outset and performance matched against those goals. This is the 'projectified world order' of Bell and Morse (2004, 2005a, b, c, 2007a, b). One has to remember that funders are often constrained by the availability of financial resources, and not surprisingly or unreasonably they are anxious to ensure that they get the best value for money. Money is provided for finite periods of time and to achieve definable goals that can be monitored. This is nothing new, and in order to check whether the goals have been attained, the art and science of project evaluation and appraisal have been developed. Indeed, as narrow as it may at first appear, we believe that the major impact of the sustainability paradigm will be in the setting of project goals, plans and appraisal. It is also in this realm that the need for practical SIs will be greatest. As a result, the remaining chapters of this book will focus on the use of SIs within projects.

Problems with incorporating sustainability in the setting of project goals are essentially the same as those discussed in Chapters 1 and 2 – including definition and identification of spatial and temporal dimensions. One also has to be aware of what trade-offs there are between the need for sustainability and other desirable goals of the project (van Pelt et al, 1990). After all, the funders of the project are accountable to those who have ultimately provided the resources, such as taxpayers, and it is not difficult to imagine a situation where the overwhelming focus is upon measurable 'deliverables' and less upon more intangible and qualitative change (Bell and Morse, 2004, 2005a, b, c, 2007a, b). These are commonalities that also apply to the sustainable city concept and, indeed, to any situation where sustainability is a goal.

In terms of gauging whether a project has achieved its goals, we have already looked in depth at one such approach – financial self-sufficiency as the goal and two simple SIs as the means of gauging whether that goal has been reached. However, this is but one rather specific example, and in order to address the diversity of goals that projects have been charged with achieving (in education, health, transport, agriculture, etc.), a whole host of techniques and methods of project appraisal have been developed and applied. However, despite the diversity, these methods can be divided into two broad groups:

1 *Cost–benefit analysis (CBA):* the cost of the project relative to the benefits gained by that expenditure. CBA requires that the benefits can be expressed in financial terms.
2 *Multi-criteria analysis (MCA):* a generic term covering a host of different approaches that may well include an element of CBA. Some of these may generate quantitative results, as does CBA, while others may be based on systems of scoring more qualitative effects (Munasinghe and Douglas, 2007).

CBA may be understood in terms of an investment process. Money invested by a factory owner in a new machine will help to generate more output that is eventually sold, thereby providing a return on investment. The CBA may be the cost of the investment (allowing factors such as interest on any borrowing or additional maintenance that may be required) and the product of the quantity (number of units) and unit price of goods sold. This is a straightforward use of CBA since it is based on economic prices (economic cost–benefit analysis, or ECBA). One can extend the idea further and include social prices in a CBA (social cost–benefit analysis, SCBA). The aim here may be to look at distribution of effects in monetary terms in order to check equity across social groups. For example, are the costs and benefits equally spread between men and women?

As an approach, CBA may be attractive because it is fundamentally a quantitative technique, and as already discussed in Chapters 1 and 2, quantification is popular with scientists, technocrats, administrators and policy-makers. In addition, the quantification is monetary, and the appeal for those concerned with managing money and looking for best value is not difficult to imagine. However, there is substantial variation on the basic CBA theme. For example, Turner (1991) suggests that there are four main approaches to the use of CBA in project appraisal:

1 conventional CBA;
2 modified 'extended' CBA;
3 radically modified CBA;
4 abandonment of CBA.

These four approaches essentially represent a spectrum from narrow CBA at one extreme (the first approach), where all components are taken to have a use for humans, to the other extreme (the fourth approach), where components can have no practical use for humans but instead have an intrinsic value of their own. This latter situation prevails in what is termed the 'deep ecology worldview' (roughly equivalent to the strong or ecological sustainability mentioned in Chapter 1); the basic premise of CBA breaks down for philosophical rather than practical reasons. This is a point that will be returned to in Chapter 4. Modified CBA represents a relaxation of conventional CBA to accommodate intergenerational equity (sustainability). It allows for higher costs than gains if this means that natural assets are maintained. Even so, both the conventional and modified CBA can be thought of as occupying the weak sustainability (= economic sustainability) ground. However, it has to be said that in keeping with the diverse set of views of sustainability, all we can do with these different approaches to CBA is to treat them as peaks in a very complex landscape.

Nevertheless, even if we accept the premise that valuation is philosophically acceptable, what if the outputs of an investment cannot be readily converted into monetary terms? This is where the limitations of CBA as a basis for assessing environmental impact and sustainability begin to appear. If one just considers environmental impact within sustainability, as in the AMOEBA approach discussed in Chapter 2, valuation of effects is difficult because of the following:

- How does one translate biological indicators (such as species diversity and presence/absence of key indicator species) into a financial impact? Does one assign a monetary value to each of the 'arms' in the AMOEBA, with distance from sustainability representing a financial gap (positive or negative)? Pearce (1995) illustrates some of the issues involved in the valuation of species and biodiversity.
- One should remember that changes in the ecosystem can occur because of factors outside of the control of humans (e.g. the El Niño effect described in Chapter 2). How does one cost such factors, or should they be discounted?

One practical approach may be to estimate what it would cost to return the system to the sustainable condition. For example, with the AMOEBA, how much would it cost to return the individual arms of the AMOEBA to the reference condition, provided, of course, that the reference condition can be reasonably defined? One could perhaps think in terms of the cost of other projects required to achieve this compensation (Barbier et al, 1990; Pearce, 1993). If one could do this, one could literally assign a monetary value to sustainability. Therefore, once the arms of the AMOEBA have been defined, as illustrated in Chapter 2, one is costing the actions that would return them to sustainability rather than incorporating any value of the species themselves. Once the system has been returned to a sustainable medium, one could cost the actions designed to keep the system there. In a development project context the aim may be to design the project so that its outputs have little or no environmental impact so that the cost of compensation is either zero or as little as possible.

Nevertheless, the CBA approach to sustainability is problematic, and the problems involved can be illustrated using the River Cynon example already alluded to in Chapters 1 and 2. If one wishes to make the river system sustainable, then presumably the level of pollution noted in the 1971 publication is unacceptable. The costs are relatively easy to define and involve removing the pollution and returning the river to a natural state (perhaps defined in terms of the fish and other fauna found in a neighbouring river that is unpolluted), along with an ongoing cost to keep it that way. The system is clearly defined (the river and its tributaries), and since human influence is a major factor in determining the fauna of the river, then spending money on appropriate treatment plants and personnel would go a long way to returning the river to its natural state.

However, there are a number of complicating factors with this simple model. To begin with, how is futurity appraised? Costs of treatment and personnel are likely to change dramatically in the future for a whole host of reasons, including the fact that industries may close and new ones may arise. Defining this during the early 1970s for 30 years to the turn of the century would be difficult, to say the least. In addition, the 'benefit' side of the equation is also not very easy to determine. Clearly, a cleaner river closer to its natural state would have an intrinsic appeal to residents and visitors; but how does one cost that? One could try to value recreational activities (fishing and boating) on the basis of a nominal charge or some other rationale (Pearce et al, 1989); but how realistic would these figures be? Again, one needs to consider futurity and include estimations of future benefits. The central conundrum we are faced with is that sustainability is, by definition, a property defined by time; but accurate extrapolations into the future can be extremely difficult.

It has to be admitted that the River Cynon example, although illustrative of the complexities of CBA as the basis for measuring sustainability, is a rather extreme one in that it deals with a resource that is difficult to value financially. Agriculture, forestry and fisheries are much easier because the harvested product can be valued, and one can include adjustments for inflation. However, even here one has to remember that these activities can have undesirable environmental impacts, and essentially one is back in the same position as outlined above.

The alternative appraisal approach of MCA is intrinsically far more flexible than CBA, and this very diversity makes it more attractive to some as a means of approaching sustainability. However, although a diverse and unlimited number of criteria can be included in MCA, there is a fundamental requirement for standardization. Which criteria are included, and how does one 'weigh' the value of each of the criteria in relation to sustainability? Clearly, the choice of criteria to include and how they are to be weighted relative to each other are key decisions and will have a major effect on the final result (van Pelt et al, 1990). Indeed, replace 'criteria' with 'SI' and this language is already very familiar from the earlier chapters *vis-à-vis* the ESI for example. The ESI does not reduce all of the variables to an economic cost, but instead treats them as a set of criteria for environmental sustainability. The AMOEBA takes a similar approach although the criteria here are more limited. Therefore, MCA can be thought of as an appraisal approach that could incorporate SIs alongside other criteria that are deemed important.

As can be seen from the above discussion, gauging sustainability as part of project appraisal has received much attention. Indeed, so well established are many of the appraisal techniques that three problems could arise:

1 The temptation may be to take some of these 'off the shelf' and adapt them to gauge sustainability rather than to develop new, innovative techniques specifically for sustainability.
2 Project appraisal may not be carried out by staff trained in the broad issues that surround sustainability.
3 Appraisal may have to take place in a relatively short time scale (perhaps just a few days), although monitoring of the goals by the project may be continuous.

In the remaining chapters of this book we would like to revisit sustainability in a development project context and suggest alternative approaches, drawing upon the experience of others, such as those involved in the sustainable city programmes. Many of the issues and problems raised in Chapters 1 to 3 will reappear in the later chapters, and we will provide what we think are reasonable answers. Some key questions discussed are:

- Is sustainability important in the project context; if so, then whose visions of sustainability count and what are those visions?
- Can SIs help to address the problem?
- What SIs do we need?
- How are the SIs to be gauged?
- How are the SIs to be interpreted and used?

The glue that binds all five questions together is people and participation – who makes the decisions and how? Recognizing that sustainability means different things to different people is at the heart of the matter, and for this reason much of the discussion in Chapters 4 to 6 revolves around participation and stakeholders.

Part II

The Application of Grounded and Pragmatic Systemisism

4

Paradigms and Professionals

Introduction and objectives

So far in this book we have developed our discussion as follows:

- In Chapter 1 we renewed our review of the concept of sustainability, the problem and need for measurement and sustainability indicators (SIs).
- In Chapter 2 the issue of indicators was explored – individual technical indicators such as maximum sustainable yield (MSY) and the combination of indicators seen in AMOEBA (a general method for ecosystem description and assessment).
- In Chapter 3 we expanded this vision of indicators to the concept of sustainable cities, sustainable communities, development institutions and projects.

A number of problems have been identified in the development of SIs. At this stage we will step back from the SI discussion and move on to discuss problems relating to mindsets, particularly mindsets relating closely to reductionist and mechanistic worldviews – the worldviews which we argue are dominant in the work described in the first three chapters. This chapter focuses on an alternative 'systemic' mindset. We start the chapter by setting out the thoughts of two authors – Chambers and Hobart – who provide ideas for us to develop.

Drawing from Plato's *Republic*, Chambers (1997, p55) 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,*

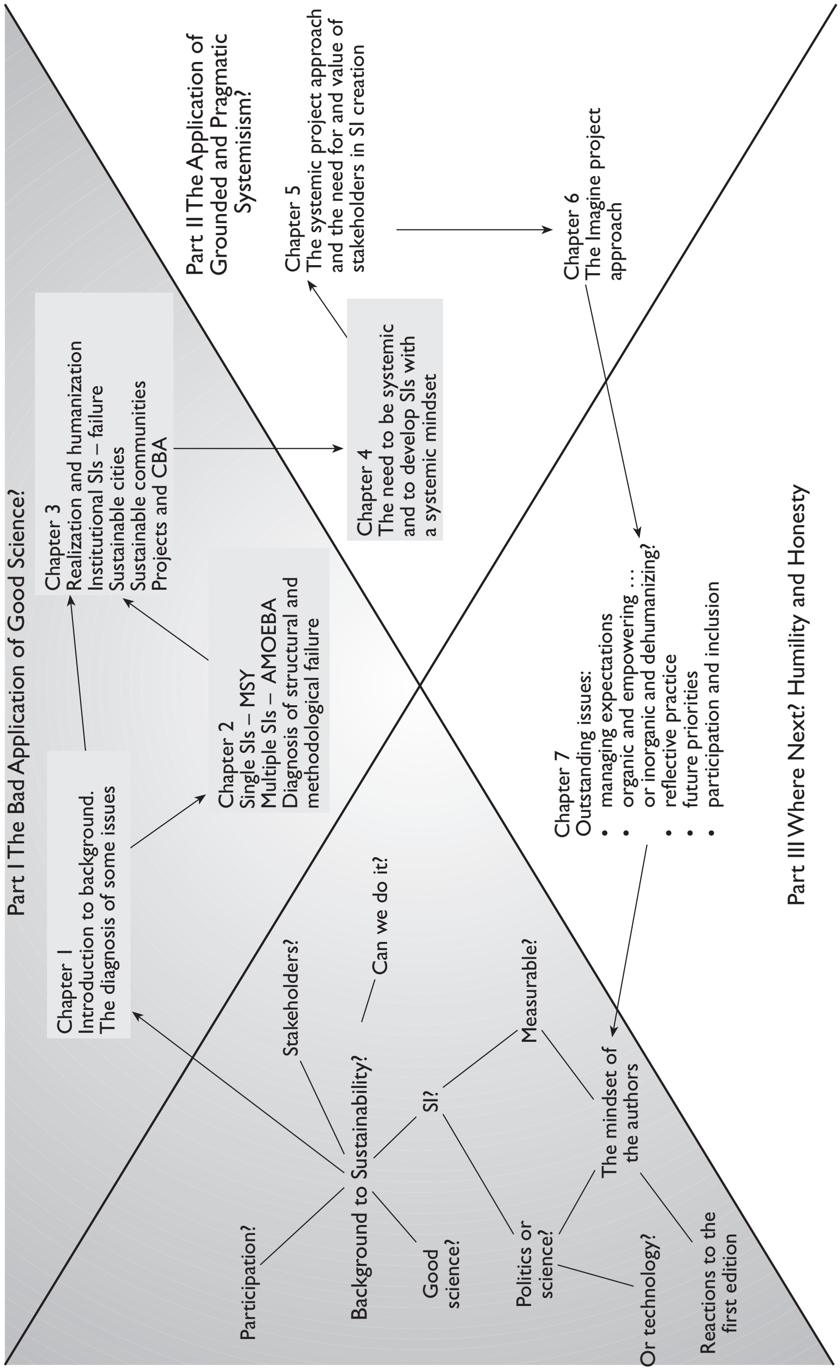


Figure C.4 *Chapter 4 in context*

> *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.*

On a similar, illustrative theme Hobart (1993, p5) 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.*

In the first three chapters of this book we have reviewed the state of play with SIs generally, although not exclusively without reference to local peoples and their knowledge. The Environmental Sustainability Index (ESI), MSY and AMOEBA are all the constructs of experts. In the chapters that follow an alternative approach is developed and described. This chapter discusses the value of different approaches to thinking about SIs, and we question 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 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 and systemisism;
- 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, and institutional sustainability), and taking forward the scientific or technocratic approaches to sustainability analysis that 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 that we describe in Chapter 6. In our view, our approach builds off and develops from a practitioner perspective the work begun by Clayton and Radcliffe (1996).

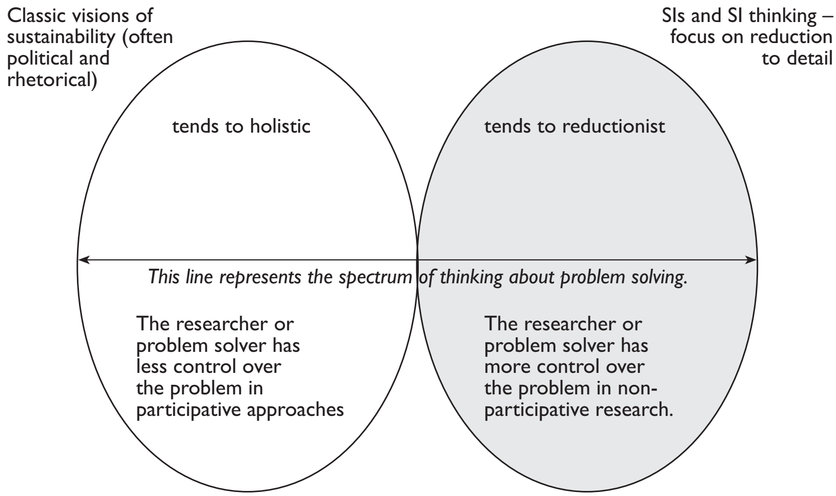
Changes in thinking: From science to systems

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 book. Changes in perception can involve changes in thinking, and this can be thought of as a 'paradigm shift'. A definition might be helpful here:

> *Paradigm = example, pattern … 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.* (Webster, 1995)

We might say that there is a Western–Middle Eastern scientific tradition that is a paradigm of thinking. We might argue that this paradigm is dominant, but that 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 that 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 truly 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. From one perspective the development of SIs, as set out in the papers described in Chapter 2, exemplifies 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 (see Richards, 1979; Biggs, 1990; Biggs and Farrington, 1990; Richards, undated).



Source: adapted from Bell (1996b, p66)

Figure 4.1 *A continuum of research approaches*

There has been a dramatic change in thinking in many related areas among sections of the scientific community (e.g. the focus on participatory approaches is exemplified by the work of Robert Chambers: Chambers, 1981, 1992, 1997, 2002, undated). 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 (1996b) described this movement of mindset in terms of a continuum (see Figure 4.1).

The horizontal line – the spectrum or continuum – provides one perspective of the range of thinking that can be undertaken in any problem-solving exercise. The range extends from the most reductionist to the most holistic. Koestler (1964, p290) 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 complementary concepts because they are derived from the ubiquitously hierarchic organization of all living matter.*

Whether we argue with the 'hierarchic organization of all living matter' or not (a subject for another discussion), 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

Another new term has been inadvertently introduced; so before we look at what reductionism and holism mean, let's get a clear idea about scientism:

> *… 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).* (Webster, 1995)

The key phrase to keep in mind here is the term 'exaggerated'. In Chapters 1 and 2 we discussed a range of approaches to sustainability which worked on the premise that sustainability was a quantity that could be more or less defined in an absolute sense: 'the measure of sustainability for wheat production, as a weighted figure, is 42'. 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'. For examples of this type of approach, the reader should recall that in Chapters 1 and 2 we provided examples of sustainability analysis that made use of mathematical formulae to gain quantitative measures. 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 which we need to define for clarity's sake – scientific method. What is the scientific method:

> *… 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.* (Webster, 1995)

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, issues 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, and what are their views are not relevant questions. On a similar tack, Dawkins (1986, p11) 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 locomotive'. 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.*

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:

> *… 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.* (Webster, 1995)

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 (1996b, p63) 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.* (Bell, 1996b, p63)

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.* (Dawkins, 1986, p13)

Alternatively, the second type of hierarchical reductionist, among 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.* (Dawkins, 1986, p13)

A problem is that this form of analysis does not stop at carburettors but is used in all forms of social, environmental and ecological analysis 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 it 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 or spectrum that is set out in Figure 4.1. 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 which has been the basis for much of Western/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 that 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. 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 which 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: but what is it?

> … *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.* (Webster, 1995)

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.* (Macdonald, 1979)

Holism deals with wholes and in this paradigm we see the universe comprised 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 (Lovelock, 1979, 1991, 2000, 2007). 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 (1991, p12) 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.*

Much later, Lovelock (2007, p2) went on to develop this theme in terms of sustainability and to 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.*

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 upon 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.* (Buddrus, 1996, p1)

In understanding sustainability we argue that we need to recognize and work with unities, of which we, as observers, are also part. This is not to suggest that complex unities cannot be better understood by identifying key components, interactions and processes (e.g. the River Cynon described in Chapters 1 and 2), 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 which 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' (as also recognized in Hardi and Zdan, 1997), 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. We will develop this idea and discuss potential means to achieve holistic analysis in Chapter 6. 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 book the word 'system' probably arises more often than any other. As we described in the Foreword, 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 (e.g. a dishwashing system, a driving system or 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; (see the discussions in Stowell et al, 1997, and Clayton and Radcliffe, 1996). 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.* (Senge et al, 1994, p25)

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 *[emphasis added]*. (Senge et al, 1994, p90)

This view of systems has echoes of the work of Peter Checkland (Checkland, 1981; Checkland and Scholes, 1990; Checkland and Holwell, 1998; Checkland and Poulter, 2006) in the UK, where there is great emphasis placed upon systems existing within our minds as perceptions that we throw out into the world as a means of describing and understanding it.

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 (for alternative useful definitions, see Checkland, 1981; Bignell and Fortune, 1984; Open University, 1987). For our definition of a system we make use of the one provided by Avgerou and Cornford (1993). These authors present the major features of systems as six-fold, and these are set out in Table 4.1.

Although there are different ideas about the fundamentals of systems, a systems analysis of a problem context can be undertaken. Such an analysis, whether an information system (as we might expect from the example of Avgerou and Cornford, 1993) 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 et al (1994), we can say some fundamental things about the basis for a systems approach:

- 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

Table 4.1 *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 is outside; but it does affect it.
Being closed or open	Concerns the interrelation 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.

Source: adapted from Avgerou and Cornford (1993)

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 will demonstrate).

- 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 (1993b), quoting Russell (1986), 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'.* (Ison, 1993b, p94)

- The system conceived by the onlooker will take place in a larger environment which 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.
- 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 4.2 provides one view of the systems approach so far described. Although it is rather artificial, let's compare this systems view of the world with an equivalent, taking the most reductionist stance possible (Figure 4.3). The difficulties that this approach raises for the study of sustainability can be juxtaposed to the advantages of systems as set out in Table 4.2.

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

1 The system is stated and explicit as a construct in the mind of the onlooker(s) or stakeholder(s); the system is brought forth or created as an

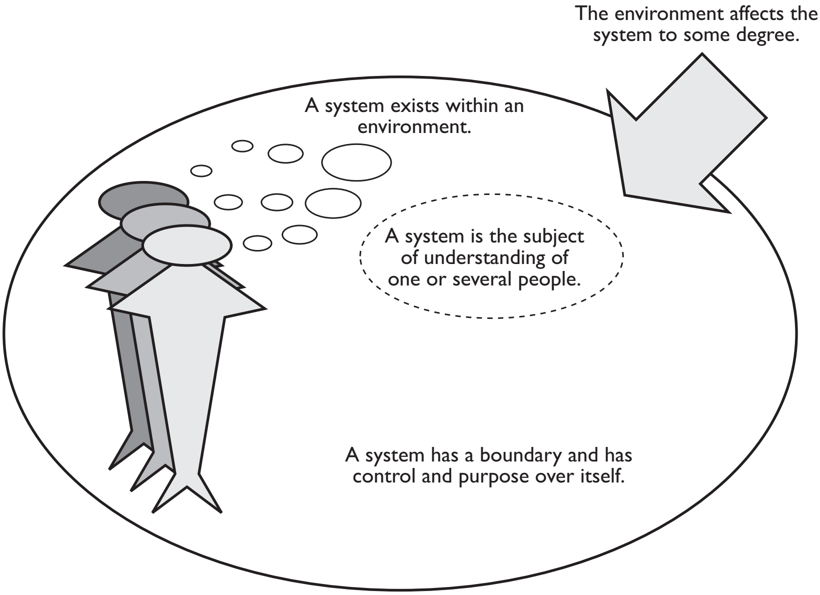


Figure 4.2 *A systems view of a particular context*

artificial construct by those studying it. Therefore, the system can be the result of an eclectic process (eclectic signifies elements drawn from various sources; Webster, 1995).

2 The system is a whole and has the potential to change itself.
3 The system is involved with its own sustainability; it can change as its environment alters in order to be sustained.

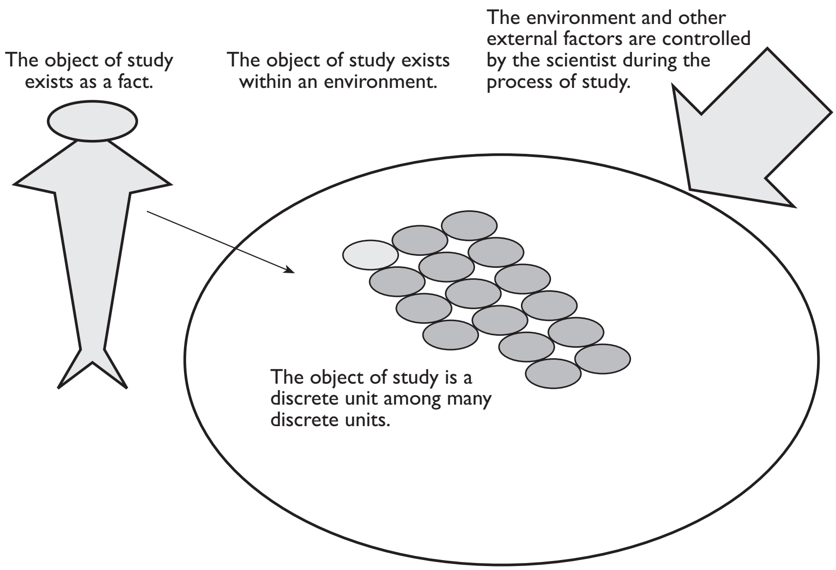


Figure 4.3 *A reductionist view of a particular context*

Table 4.2 *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.

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. In Chapters 1, 2 and 3 we reviewed the results of some approaches to SI development. So far we have described the reductionist mindset, which we argue is behind much of the scientific method expressed by many of the conventional advocates and developers of SIs. As yet, we have not discussed systemic approaches to problem-solving or SI development. This will be dealt with in detail using a specific approach in Chapter 6; but for now we want to briefly describe some forms of the systems approach to problem-solving.

A range of systems approaches

As we said in the previous section, there are numerous ways of thinking about and applying a systems approach. This is quite consistent with the systems

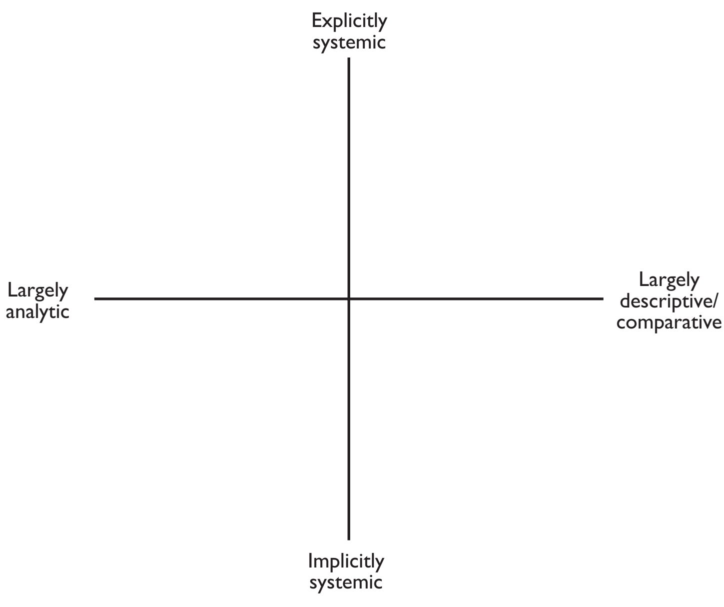
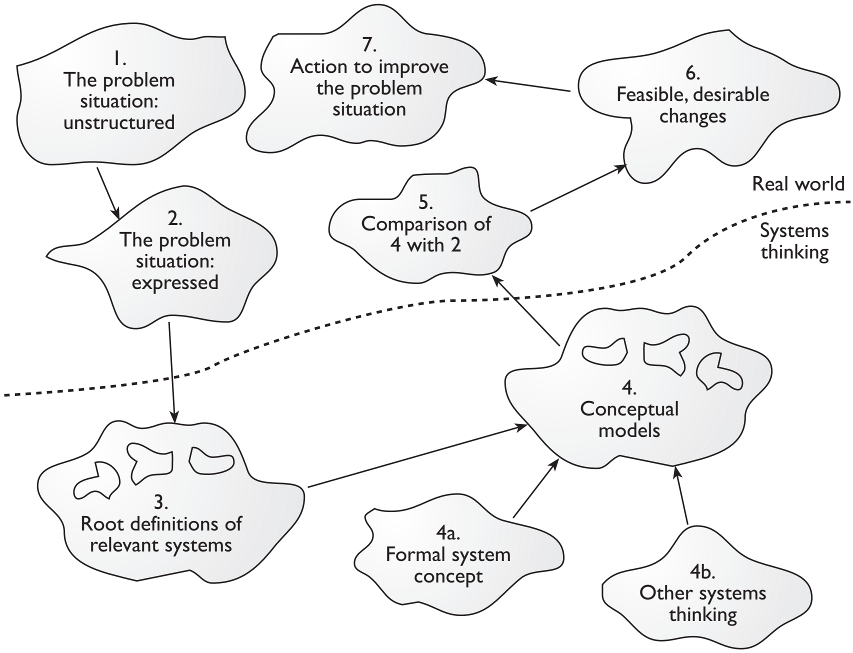


Figure 4.4 *Axis for comparing systems approaches*



Source: adapted from Open University (1987), building on Checkland (1981, p163)

Figure 4.5 *The soft systems method*

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, that are either explicitly or implicitly systems-based. We argue that they can all be understood in terms of the axis which we set out in Figure 4.4. The approaches that we illustrate here and which we will apply elements of later in Chapter 6 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 4.5 and is known as the soft systems approach or method (SSM).

A problem-solving approach: The soft systems method

To describe the approach, we set out the main elements in Figure 4.5. 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 (Checkland, 1981) and has since been developed by him and others (see

Avison and Wood-Harper, 1990; Checkland and Scholes, 1990; CCTA, 1993; Checkland and Poulter 2006). 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 (Open University, 1987). 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 often not 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 4.5 include the following:

- It is often necessary to spend considerable time in perceiving the problem and exploring the tasks and issues implicit in it (a point also recognized in Hardi and Zdan, 1997). These are set out in elements two and three in Figure 4.5.
- 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 three). 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 in the MSY example quoted in Chapter 2). We need to see that other domains may contain the 'solutions' to a given problem. For example, in the Peruvian anchovy example described in Chapter 2 where the fishery collapsed essentially because of over-fishing, 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 in, such as livelihood diversification.
- Next, identifying a transformation is the basis for an activity plan, which is then compared to the problem context as first reviewed (elements four and five in Figure 4.5). It is often the case that in analysing a given problem we lose sight of the issues which first excited our attention. This loop encourages us to compare our analysis with the problem as first perceived.
- The next point is that stakeholders are brought together to discuss the analysis (element six in Figure 4.5). 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. We do not definitely 'fix' problems. Rather, we achieve ways forward mutually and then work on the next issue that arises (elements seven and one in Figure 4.5).

The main features of the soft systems approach that we want to emphasize at this point 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 (1994) and relates to his work on the learning organization (LO).

Problem description: The learning organization approach

Senge et al (1994) set out five 'disciplines' for encouraging and developing the learning organization, which 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 et al, 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 (for a review of these it is useful to take a look at the Society for Organizational Learning website at: www.solonline.org). The five disciplines as we interpret them are set out in Table 4.3, 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.

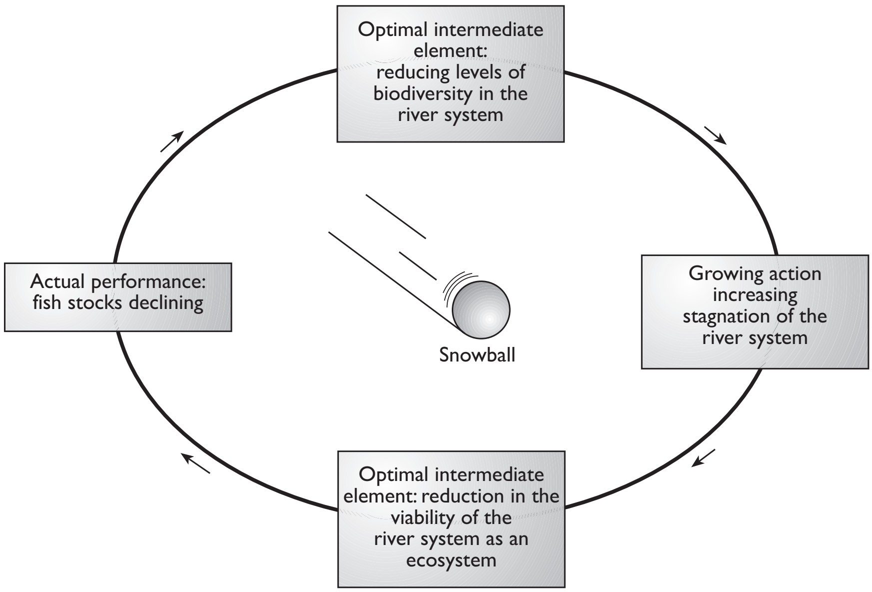
As with the work of Peter Checkland, the learning organization approach does not see problem-solving as being easy or objective. Focusing heavily on dialogue and team learning, the list of outcomes shows how closely the LO approach relates to the discussion that we have had so far about the relative merits of scientism and systemisism. In defining sustainability, group consensus and insight are more vital than reductionist objectivity, as could be witnessed in the sustainable cities examples given in Chapter 3 (see, for example, Norwich 21, 1997).

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 et al (1994) make use of what they call 'archetypes' to be compared against the real world. One such archetypal model is shown in Figure 4.6. 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 et al, 1994) to cause stability and equilibrium.

Table 4.3 *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.	Contexts 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 skilful discussion – the aim is to achieve 'collective mindfulness' (Senge et al, 1994, p359)	Contexts of team development	Group consensus

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 (there is a similarity here to the 'failures' approach adapted by Bignell and Fortune, 1984); but it does allow contexts to be reviewed for change processes, and therefore it appears a useful method to apply to analysing sustainability – particularly where known forces of change are at work and their consequences need to be considered.



Source: adapted from Senge et al (1994, p116)

Figure 4.6 *The reinforcing loop (snowball)*

Appraisal: The participatory rural appraisal approach

In Chapter 3 we discussed project appraisal. In that chapter the focus was largely on the inclusion of sustainability issues within cost–benefit analysis (CBA). Developing on from this we now describe the application of participatory rural appraisal (PRA), which we argue is a more systemic approach to the range of issues that arise in project appraisal.

Although PRA does not set itself out 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 (see systems concepts as noted in Chambers, 1997, p138) – there is a shared epistemology. There is no consensus as to what constitutes PRA techniques as opposed to any other set of methods for analysing 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 (see Chambers, 1992; Natrajan, 1993; Shah and Hardwaj, 1993; McPherson, 1994; Webber and Ison, 1995; Bell, 1996b; Chambers, 2002, undated), some of the techniques for PRA are set out in Box 4.1 with a brief description of what they involve.

Box 4.1 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 colours, 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 'mapable' 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 evolve.
- *Time lines.* This is helpful when there is a need to gain a view of local history. The time lines can be collected at community interviews (see rapid approaches below).
- *Local histories.* A means to capture the symbolic and mythic impressions of local people by encouraging them to tell the stories of their time and their locale. Much truth is revealed in an obscure and tantalizing manner in stories.
- *Venn (Chapati) diagrams.* This method enables individuals to gain a systemic view of the overlaps between different groups, commodities, inputs and or outputs in a village setting.
- *Wealth rankings.* In order 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 produce 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 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 and conflict resolution. Use focus group technique as described below.
- *Folklore, songs and poetry.* This involves sitting, listening (usually with an interpreter) and absorbing – principles of direct observation; see below.
- *Team interactions.* Here, evening discussion and morning brainstorming sessions with teams 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 in which the team works:
  - Draw a circle around the person who is talking; break the circle when they are interrupted.

  - Draw an arrow from the talker to the person being talked to with a note of duration.
  - 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, during mornings and evenings.
- *Survey of villagers attitudes.* Asking questions about attitudes and reactions to specific issues and concerns … deliberately leading questions.
- *Intriguing practices and beliefs.* 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 pre-identified as having insights and as being 'reliable', and are usually owners or major stakeholders in problem areas.
- *Focus group interview.* A recent addition to semi-formal techniques. The technique is historically based in market research to gauge the 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 (1997, p105), the major author of the approach, indicates three pillars of PRA:

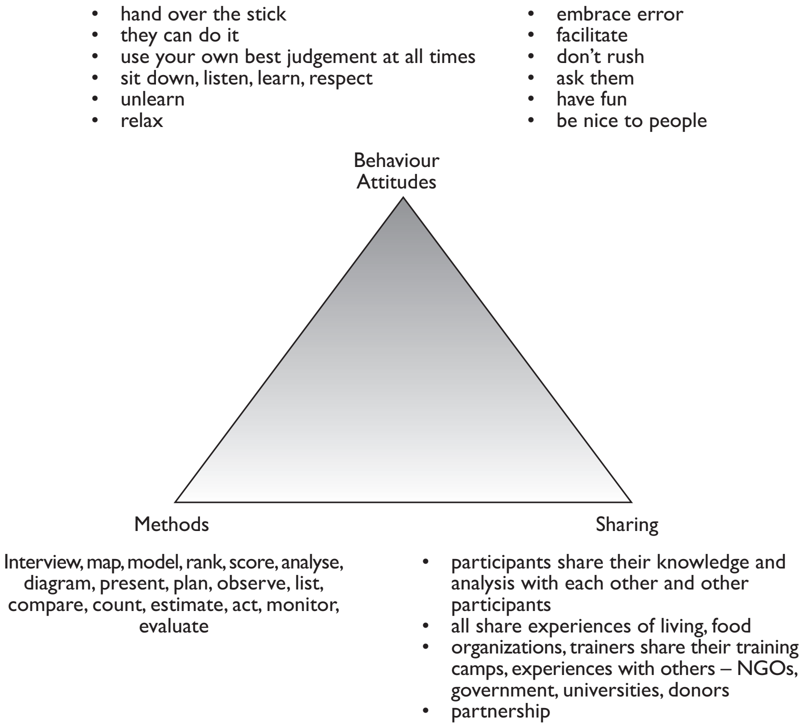
1 behaviour and attitudes of the development professional;
2 need for sharing between different actors;
3 requirement for participatory methods.

These three pillars are set out and developed in Figure 4.7.

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 (1995) indicates three concerns with the approach.

First, 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. Second, 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 whom they are taken to represent. Finally, it cannot be assumed that 'inclusion' guarantees meaningful participation (Biggs, 1995, pp4–5).

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



Source: adapted from Chambers (1997)

Figure 4.7 *Three pillars of PRA*

say in the process of understanding, a responsibility for the sustainability of the enterprise and a legitimate place in developing 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 systemisism can work in appraisal, can it be applied to project development, planning, monitoring and evaluation? In the next section we examine one approach that can be argued to provide this.

Project handling: The logframe approach

We have already described project appraisal by using CBA in Chapter 3. The value of CBA as described in Pearce (1993) lies in its ability to apply costs to processes and things. The logical framework, as we will discuss, can be a useful vehicle for applying CBA to provide indicators of process, project impact or sustainability. Much has been written about the logical framework or logframe (LF) approach to project planning and management (see Coleman, 1987a; Cordingley, 1995; Bell, 1996a). 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 (see Thompson and Chudoba, 1994; Team Technologies, 1995; Thompson, 1995; note that the approach is not always participatory; see Chambers, 1997, pp42–44, for a description of ZOPP – a version of logical frameworks.) The basic LF is a four-by-four matrix and is shown in Table 4.4.

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 leading to outputs, resulting in purposes and, hopefully, achieving 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 analysed, 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 project's impact – has it achieved what it originally set out to do?) and at the level of purpose (evaluation – was the result as expected?).

In all, 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 verification (these can be indicators of project progress as argued in Bell, 1996a). 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 (as we shall discuss further in Chapter 6). The diagram might be better understood as set out in Table 4.5.

Table 4.4 *An overview of the logical framework (LF)*

Goal The higher-level objectives towards which the project is expected to contribute (mention target groups)	**Verifiable indicators** Measures (direct or indirect) to verify to what extent the goal is fulfilled	**Means of verification** The sources of data necessary to verify status of goal-level indicators	**Assumptions** Important events, conditions or decisions necessary for sustaining objectives in the long run
Purpose The effect that is expected to be achieved as the result of the project	**Verifiable indicators** Measures (direct or indirect) to verify to what extent the purpose is fulfilled	**Means of verification** The sources of data necessary to verify status of purpose-level indicators	**Assumptions** Important events, conditions or decisions outside the control of the project that must prevail in order for the goal to be obtained
Outputs The results that the project management should be able to guarantee (mention target groups)	**Verifiable indicators** Measures (direct or indirect) to verify to what extent the outputs are produced	**Means of verification** The sources of data necessary to verify status of activity-level indicators	**Assumptions** Important events, conditions or decisions outside the control of the project necessary for achieving the purpose
Activities The activities that have to be undertaken by the project in order to produce the outputs	**Verifiable indicators** Goods and services necessary to undertake activities	**Means of verification** The sources of data necessary to verify the status of activity-level indicators	**Assumptions** Important events, conditions or decisions outside the control of the project necessary for the production of the outputs

Table 4.5 *Explaining logical frameworks*

Activities of various types	*Measured as objectively verifiable indicators (OVIs)*	*Measured through means of verification (MOV)*	*In the light of certain assumptions, should lead to …*
Outputs (deliverables of the project)	Measured as OVIs	Measured through MOV	In the light of certain assumptions, should lead to the realization of …
Purpose of the project	Measured by OVIs	Measured through MOV	In the light of certain assumptions, should help in realizing the …
Goal which is beyond the project but is its vision	Measured as OVIs	Measured through MOV	In the light of certain assumptions …

Table 4.6 *A partial logical framework expression of Norwich 21*

Goal	**Objectively verifiable indicators (OVIs)**
This would relate to the achievement of sustainability in cities at a national level.	Similarly, this would relate to the measurement of sustainability in cities at the national level.
Purpose	
'Promoting a prosperous and dynamic community with policies for sustainable long-term growth and development that take account of the needs of the present generation of people without compromising the ability of future generations to meet their own needs' (Norwich 21, 1997)	This would relate to achieving the impact indicators set out below and the emerging realization of sustainability that they would produce. This is an exercise for the owner of the Norwich 21 action plan.
Outputs	
clean air; less domestic waste, etc.	Zero days poor air quality due to nitrogen oxides measured at Guildhall: waste produced: 0.36 tonnes per head; waste recycled = 0.018 tonnes per head, etc.
Activities	
Test against UK national air quality strategy standard, etc.	etc.

The LF approach might be argued to be 'goal driven' and rather positivist (for a discussion of this type of argument, see Checkland and Holwell, 1998). The approach (as with all others) depends upon 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 set out in Chapter 3, we could apply it retrospectively to the first elements of the first column, as shown in Table 4.6.

An overview of systemic approaches

The four systemic approaches are set out below in one frame (see Figure 4.8) in terms of whether they are implicitly or explicitly systemic, whether they are problem-solving, or whether they are 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:

> *… the transition of oneself from an observer of a reality which is considered to be outside oneself [e.g. the traditional role of the scientist] to a participant in the same reality, and then towards being a co-creator of that reality, requires fundamental cognitive and emotional reorientation.* (Buddrus, 1996, p1)

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

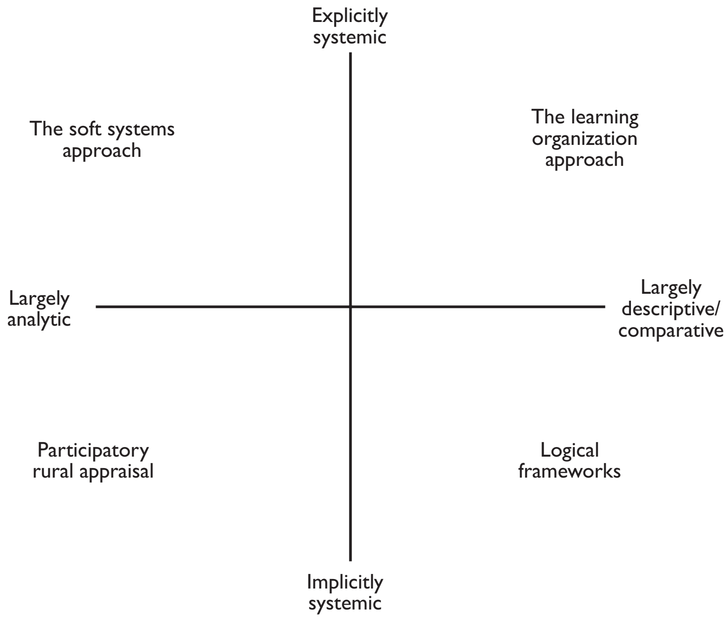


Figure 4.8 *The four systemic approaches*

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. This is a point that we will need to be aware of when we come to developing our own approach in Chapter 6.

In this section we have tried to demonstrate that systems approaches can vary considerably and can do quite different things, but that they hold to some of the seed ideas of what constitutes a systems study. In Chapter 6 we will make use of various elements drawn from some of the four approaches and will discuss practitioner issues. We now go on to look at what implementing the systems perspective can mean to developing a viable assessment of sustainability.

New definitions and new thinking: Holism, eclecticism, systemisism 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 and reductionist terms, as with SIs, is non-viable. It cannot be done because sustainability itself is not a single element. 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. 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 onboard the legitimacy of different views of sustainability. 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 the scientist's views, may contain richness and detail which the scientist does not have access to or actually loses in applying the tools of science. Narrow, expert-driven conceptions of sustainability have been problematic (as shown in Chapter 2 with the MSY microcosm); the model for considering sustainability which we develop in this book is therefore developed around three premises. In measuring the immeasurable we are concerned with:

1. eclectically derived, systemic wholeness – that is, we are concerned with:
2. the perception of systemic wholeness that derives from legitimate sources; and
3. the sustainability of wholeness, which is under observation.

In this section we develop these themes in our approach and we 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, the authors are aware that they are dealing with sets of concepts which require detailed analysis and justification. Such work has been undertaken elsewhere (see Capra, 1996). 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:

> *… 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).* (Webster, 1995)

Developing upon this definition, the term was described by Wiener (1948) as the science of 'control and communication in the animal and the machine'. Cybernetics is now organized into first-, second- and third-order categories that can be said to involve in sequence:

- the understanding of feedback loops (Capra, 1996, p 56) and control systems to explain how the world works in a scientific sense (Umpleby, 1994);
- the understanding that individuals construct their own 'reality' (von Foerster, 1981) and that this should lead to tolerance of alternative views (Umpleby, 1994);
- reflection on the understanding of multiple realities and the means by which these multiple realities can be contained in a consensus view.

As Umpleby (1994, p13) 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.*

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 (Macadam et al, 1990; Maturana and Varela, 1992; Maturana, 1997). 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 (for example, see Mingers, 1995). 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 (1992) 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.* (Morgan, 1997, p255)

The exciting element for the sustainability debate is in working out what autopoiesis means – again, quoting Morgan (1997, p257): 'Autopoietic systems are closed loops: self-referential systems that strive to shape themselves in their own image'. Morgan (1997, p260) gives some examples of what this means in practice; an example drawn from the fishing industry is illustrative:

> *… the commercial fishing business. This 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.*

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 to factors that 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 (BBC Radio 4, One O'clock News, 18 December 1997) suggested that the scientific analysis of sustainable fishing levels had been proved wrong – resulting in an explosion in stock rather than catastrophe. This dramatic increase in stocks occurred against a background of numerous fishing boats being broken up and their crews made unemployed. In Morgan's (1997) 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 they 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 situation in 2007 is more accurately understood than in 1997. 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. The premises that arise from this section regarding the development of a testable approach or hypothesis are developed in the final section of Chapter 4.

To truly engage systemically in the understanding of sustainability one final and often under-utilized aspect of the wider environment needs to be 'swept in' to the future condition of the 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 it is logical to consider the future world within which your planning will have to operate. 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 of grappling with the significant and unpredictable issue of possible futures.

Michel Godet – a major thinker in the 'French School' of scenario planning – has commented: 'Unfortunately there are no statistics for the future' (Godet et al, 1999, p6). Matzdorf and Ramage (1999, p29) have said:

> *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 modelled based on variables such as greenhouse gas emissions. The models now have 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.*

One of the founders of scenario-making, Peter Schwartz, in an interview (Dearlove, 2002, p3) 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?'*

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.*

In this book, we are concerned with the internal world of the local participant in sustainable development practices, as well as the executive, and Schwartz went on to describe the application of scenario planning in these 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.*

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 (1999), 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'.* (Matzdorf and Ramage, 1999, p30; see also de Geus, 1988, pp70–74; Schwartz, 1992; van der Heijden, 1994)

Originally, scenario planning was developed for strategic organizational planning. It is also highly valuable for sustainability planning.

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 onboard 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 (1992). Finally, we have indicated that sustainability includes the future of the system in question. Scenario-making (or 'Prospective') can be one means of addressing this issue of futurology.

For our study, these factors were vital in helping us to set the basic premises that we wished to use to develop our hypothesis for systemic and scenario-based sustainability analysis – which 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 integral nature 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 is 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.

These five features will be developed and expanded upon in the next chapter.

5

Projects and Sustainability Indicators

Introduction and objectives

Building on the discussion of systemic approaches to problem-solving and project development set out in Chapter 4, this chapter will develop our thinking concerning the specific use of sustainability indicators (SIs) in development projects. We will focus on four major aspects:

1 the project scenario: applying systemic methodologies in project contexts to build SIs;
2 the stakeholder scenario: how to develop participation and coalition in the use of SIs;
3 accommodating multiple views of sustainability within projects;
4 introducing the systemic sustainability analysis idea.

This chapter builds on the premises set out in Chapter 4 which provided us with our starting points for measuring sustainability. These starting points are:

- Sustainability is a qualitative property of a system.
- Subjectivity on the part of the stakeholders in understanding the sustainability of any given system is unavoidable.
- Subjectively derived measures of sustainability are nonetheless useful aids to planning.

These three elements will be combined in an approach that is both participatory and systemic. The next step is to consider where we want to develop this theory into useful practice. In this chapter we set out our views on where SIs can be developed. In Chapters 1, 2 and 3 we discussed various interpretations of sustainability. We also discussed ways in which sustainability could be considered. It is worth recalling that by sustainability we refer to four domains of practice, which are the:

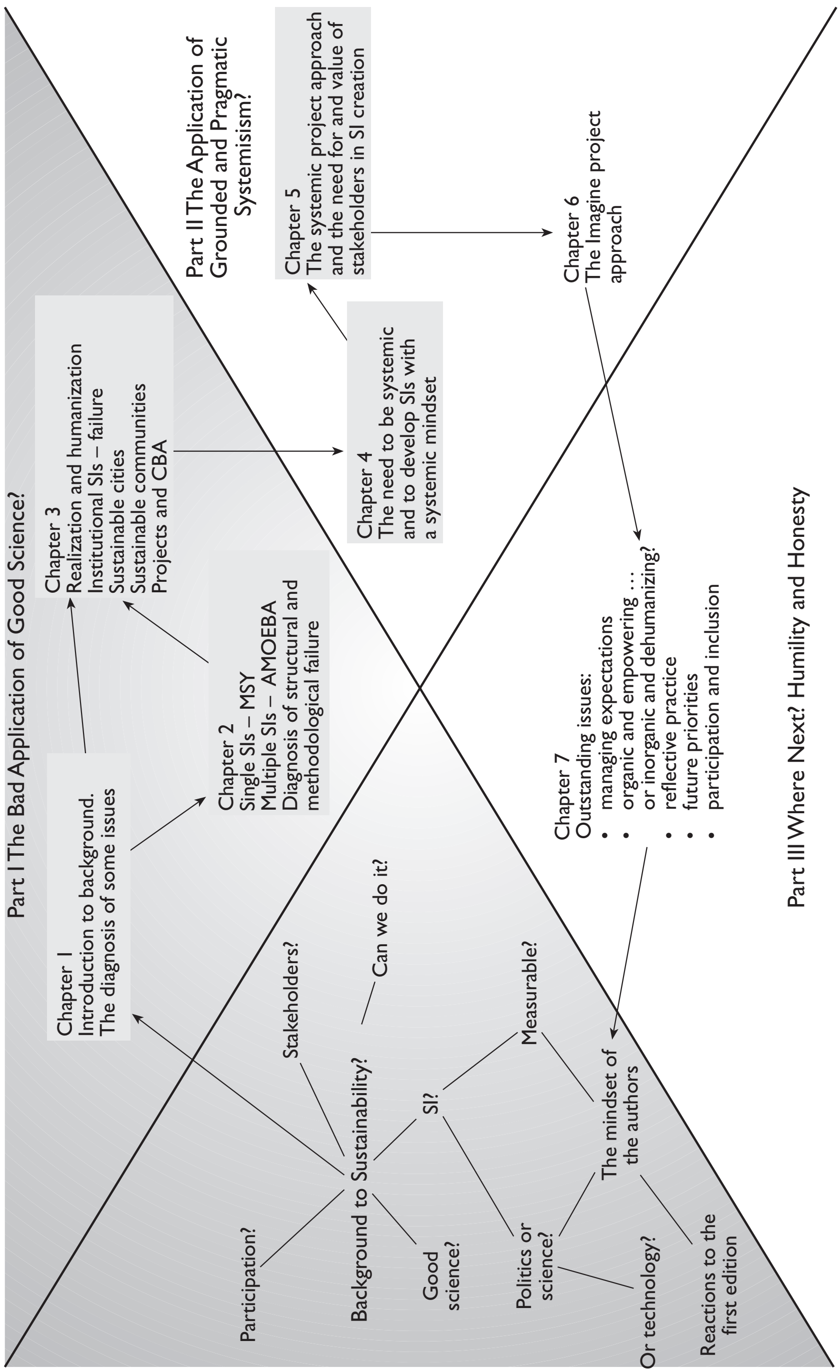


Figure C.5 *Chapter 5 in context*

	State	Pressure	Response	Impact	Drivers
What is happening right now – pre-project	✔	✔	—	—	—
Deliverable (project, implementation)	✔	✔	✔	✔	✔
Deliverer (institution)	✔	✔	✔	✔	✔
What is going to happen? Post-project	—	—	✔	✔	✔

Figure 5.1 *The use people make of sustainability indicators*

1 domain of 'what is';
2 domain of 'what could be';
3 domain of delivering a project;
4 domain of the deliverer of the project who is instituting sustainability.

These four are set out in Figure 5.1. The project context (the 'what is' prior to the project) can be reviewed for sustainability, and therefore SIs can be produced for it as can the domains of the projects deliverable and the delivering agencies themselves. The idea of seeking to measure how futures might develop and evolve is the domain of scenario planning or Prospective (as described in Chapter 4).

By keeping the context for the practice of SIs wide, we do not avoid difficult issues relating to where sustainability is of critical importance (the deliverer, the world as it is before the project, etc.). This quartet is linked closely to what the European Environment Agency has advocated (see the EEA internet site, www.eea.europa.eu/documents/berlin/proposal.pdf). These are described in Chapter 1 as SIs of driving force, pressure, state, impact and response (DPSIR); they could be loosely linked to our quartet as shown in Figure 5.1.

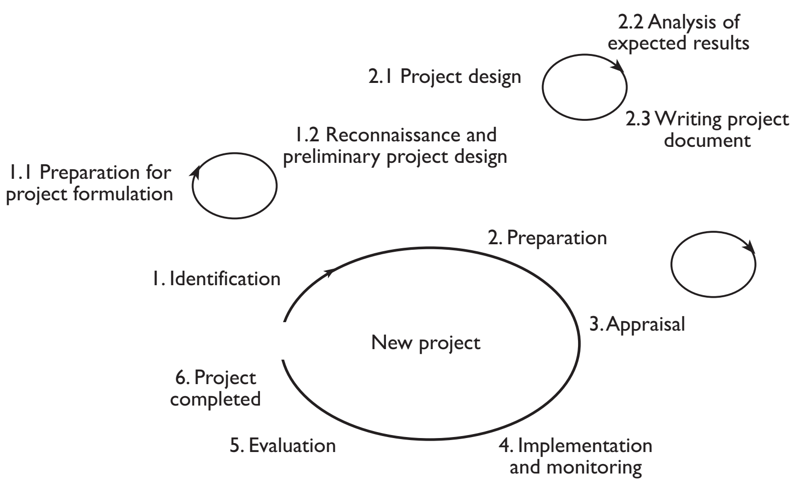
We will develop our use of these quartets in developing SIs in Chapter 6. One implication of the different types or forms of SI is that we need to briefly review the nature of the projects in the context in which SIs are implemented and what we have termed 'the projectified world order' (Bell and Morse, 2005a, c, 2007a, b). Different types of project format may be more or less sympathetic environments to different types of SI. Following this, we will review the idea of the stakeholder and where and how far this extends within the project. In Chapter 4 we described the importance of stakeholders participating in systemic practice. The inclusion of stakeholders will, in turn, have an impact upon the nature of the core participatory methods we use (focus groups, community interviews, key informant interviews, diagramming, teamworking, etc.).

The project scenario for SIs

There is considerable literature on the place and importance of projects in the development context (for a fairly random example of the range of literature on the subject, see Coleman, 1987b; Biggs, 1989; Rajakutty, 1991; Cusworth and Franks, 1993; Hulme, 1994; Bell, 1996a; Girma et al, 1996; Kumar and Corbridge, 2002). Projects can be defined in various ways; but here we employ the term to describe a set of activities to achieve desired and defined outputs, constrained by time and resources. Projects typically have a set start and end time and are monitored to ensure that they are on track to deliver within the resources that have been allocated. More recently, we have seen the rise of what is called the 'programmatic approach' where a programme comprised a group of linked projects. The time period for a programme may be longer than any one of the projects it contains, but the central features of a defined output, or set of outputs, to be achieved within a given amount of resource remains. We continue to use the term 'project' and ask the reader to bear in mind the caveat that a project may be the smallest unit of a larger planned activity.

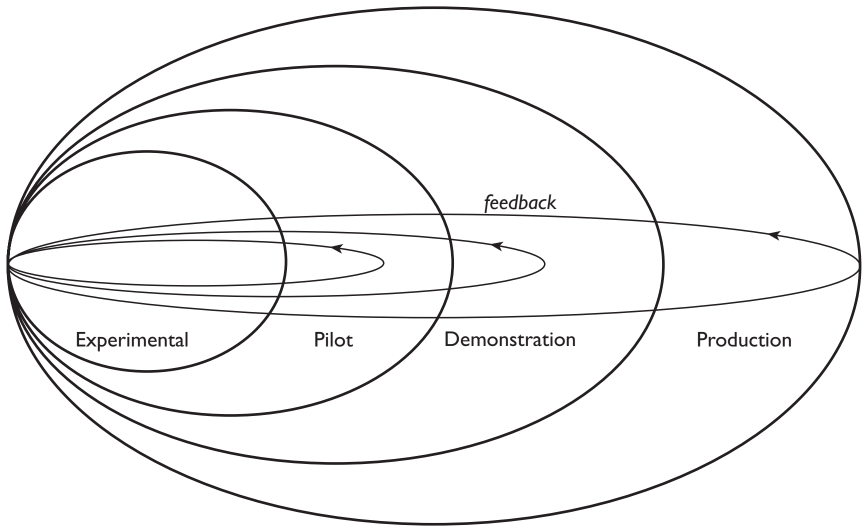
Central to our concern here is the rise in importance of projects, in general, as a resource-bound reflex response to problems of all kinds and, more specifically, of the process project over the traditional blueprint or project cycle approach. Figure 5.2 shows a traditional blueprint project approach; Figure 5.3 shows the main detail of the process project.

The traditional blueprint approach, while being cyclical in presentation, is not iterative or explicitly inclusive of stakeholders' views. It is arguable whether the cycle is really a cycle at all. There is no direct formal linkage between points



Source: adapted from FAO (1986)

Figure 5.2 *The blueprint project cycle(s): Relationship between the phases of project formulation and the traditional project cycle*



Source: adapted from Cusworth and Franks (1993, p9)

Figure 5.3 *The process or 'adaptive' project approach*

6 and 1 in Figure 5.2, nor any reason why the learning from one project should feed into another. Cusworth and Franks (1993, p9) argue:

> *The blueprint approach was too rigid and inflexible – that is, it placed too much reliance on prior comprehensive data gathering, planning and control (all of which often appeared as inadequate in developing countries) and did not give sufficient importance to the acceptability of the proposed intervention to the intended beneficiaries.* (Cusworth and Franks, 1993, p9)

They suggested an 'adaptive' model. This implies adaptive to the environment and able to change as the environment, in which the project system operates, changes. Building upon the systems view of Maturana (1997) and Maturana and Varela (1992) expressed in Chapter 4, the environment is seen as being an inclusive part of the project itself. At any stage the project may need to alter as it affects and is affected by the environment.

If we draw out the main themes of the two approaches or methodologies to project planning, we will see how they vary. Table 5.1 shows the major features of the two approaches.

Each approach has strengths and weaknesses. The blueprint approach is most specifically strong on control, accountability and forward planning (a reflection of the thinking in reductionism and first-order cybernetics, as discussed in Chapter 4). It is probably the best approach in situations where goals are clear and unambiguous and the project's objectives clearly formulated. The process–project approach is more flexible and able to accommodate

Table 5.1 *Project: Blueprint and process*

Traditional blueprint projects	*Process, adaptive projects*
Inputs and activities are specified at the outset.	Inputs and activities are only partially specified at the outset, generally only for the initial phase of the project.
Implementation is according to plans establishing during the formulation process.	Implementation is subject to continual re-planning on the basis of formative evaluation.
The stages of the project are distinct.	Formulation and evaluation are incorporated within the implementation stage of the project cycle.
Focus on efficient conversion of inputs into outputs.	Focus is on realization of project objectives rather than outputs.
Emphasis is on administration rather than management.	Emphasis is on management rather than on administration.

change and rethinking (second- and third-order cybernetics?). It would probably be best in situations where the goals of the project can only be semi-formulated at the outset, where stakeholders (including those providing the resources) in the project are unclear about the delivery they require and where there may even be a variety of views about the direction of the project and its expected outcome.

As we have said before, we are not arguing that one approach is wrong and the other right. We are indicating that projects come with their own mindsets and assumptions. If we were to think about the two approaches to project formulation in the same terms as we thought about approaches to problem-solving as set out in Figure 4.1, it might look like that in Figure 5.4 (for a similar but tabular breakdown on this point, see Chambers, 1997, p37).

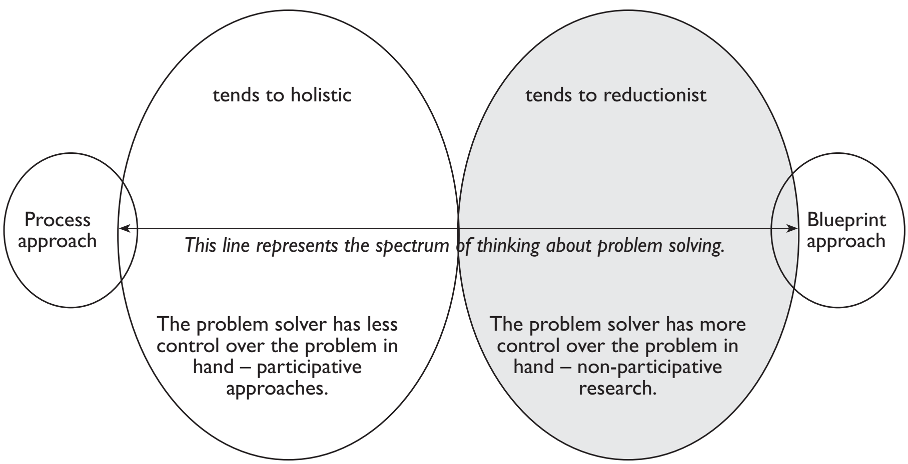


Figure 5.4 *Project approaches and the spectrum of thinking about problem-solving*

We have already argued in Chapter 4 that the holistic and systemic approaches to problem-solving are more consistent with the approach to sustainability analysis that we develop here. In the same vein, it is apparent that the process approach to project planning and management will be more consistent with the systemic approach, which we set out in the next chapter. With reference to the forms of SI that might be produced – what is and what could be (state), the deliverer (pressure and response) and the deliverable (drivers and impact) – it would seem that the reflective and learning process which is evident in the process–project approach would be more consistent with SIs reflecting upon processes within and outside the project context. On the other hand, the blueprint project approach is consistent with the necessarily more limited analysis of state. This does not mean that blueprint approaches cannot adopt sustainability measurement; but it does mean that the approach will make the analysis of sustainability relatively static, top down, expert driven and inconsistent with a participatory approach. Long and Long (1992, p9) has summed this difference up as follows:

> *Rather than viewing intervention as the implementation of a plan of action [blueprint], it should be visualized as an ongoing transformational process in which different actor interests and struggles are located.*

In this section we have reviewed the underlying assumptions of project approaches. Elsewhere we have commented:

> *There is no doubt that despite their limitations projects will continue to dominate the practice and, indeed, the research of sustainable development. While sustainability idealists may bemoan this reality, with its apparent obsession upon tangible outputs linked tightly to expenditure, it is difficult to imagine any change.* (Bell and Morse, 2005a, p50).

Whether we like it or not, sustainability will largely continue to be 'done' through projects. Thus, our concern is to consider and interpret sustainability within development projects. Process projects appear to offer the best chance of achieving this end. Working from this understanding and recognizing the importance of inclusion and participation in process projects, we need to develop our thinking a little further to consider the nature of participation and stake holding in projects.

The stakeholder scenario for SIs: Participation and coalition

The explicit inclusion of those who have a stake in a project scenario is now a development-project planning orthodoxy. Participation has become something of a holy grail in the development literature, and it is often portrayed as the solution to all ills without any acknowledgement of the difficulties that it poses in practice. As we saw in Chapter 4, Biggs (1995) has reservations about the orthodoxy and he has also indicated the range of approaches that are being applied:

> *Participatory process projects are being promoted by many donors, such as the World Bank and ODA [Overseas Development Administration, now the Department for International Development, or DfID], as well as many NGOs. Popular participation is seen as a 'process whereby those with legitimate interests in a project influence decisions which affect them' (Eyben and Ladbury, 1994). Stakeholder analysis, TeamUp, process documentation and monitoring and DELTA techniques are some of the methods being advocated.* (Biggs, 1995, p2)

Despite enthusiasm, there are considerable problems in achieving participation (as we saw briefly in Chapter 4). Hirschheim (1989) has discussed some of these in his research on participation in information systems development. He ran across a number of issues that are still relevant in a wide range of project contexts:

> *Participants still required the proactive input of a consultant to keep the design process running. Some participants felt that they did not have enough time to dedicate to the process. The group involved in the design process has to be the right size (an issue which varies between specific projects) otherwise it is non-representative or unwieldy.*
>
> - *Systems boundaries. Hirschheim notes that participants were unclear about the extent of the systems on which they were working and therefore the degree of responsibility they had for design outside their own specific location.*
> - *When to begin the participation.*
> - *Seniority of participatory staff. In the Hirschheim survey it was found that senior staff have more willingness and greater ability to participate. Junior staff do not have the same confidence to express their ownership of the system.* (Bell, 1996b, p130, adapted from Hirschheim, 1989, p194)

Hirschheim's concerns relate to the procedure of formulating participation. His areas of concern are practical and focus on teams of co-workers. Craig and Porter have other concerns about participation in the development project context, including the element of control that creeps into much project work which explicitly describes itself as participatory (Craig and Porter, 1997). Biggs (1995, pp9–10) takes a wider view and questions the mindset of participation itself, but also sees development opportunities. Specifically, he makes five 'practical suggestions' for those embarking on participatory project design:

1 Question and un-package the new participation orthodoxy.
2 Advocacy and influence: aim to teach these approaches and methods in such a way that historical, political, cultural and economic contexts can be fully appreciated.
3 Claims about efficacy and agency: be cautious with regard to two particular kinds of claims that tend to be made by those advocating any set of methods and techniques in development interventions: first, that such techniques and methods possess intrinsic value or efficacy; and, second, that advocates themselves have been the key agents in bringing about particular development outcomes.
4 Reflective analysis: encourage critical reflective writing by those who have been involved for many years in science technology development.
5 Coalitions and negotiations: recognize the involvement of contending coalitions in science and technology development.

Biggs (1995) advocates caution and critical reflection. His concern is that the method becomes the purpose and goal of the project, and that lessons of the past are not learned or that the value of past interventions in development is seen as being heretical. In all, the thrust of the five points is to encourage caution. The final two points are key to our argument in this book. We advocate reflective analysis elsewhere (see Bell, 1996b; Bell and Wood-Harper, 1998); but the notion of coalition requires further development.

Thus, while participation is an all too easy 'clarion call' or, more cynically, a means of providing apparent legitimacy to a project, the practice is rather more complex. How are stakeholders to be represented given that it is impractical to include everyone? How do we avoid 'capture' of issues by vociferous or powerful interests? The answer is usually to draw up a representative sample; but given that a community spans two sexes, many ages and occupations, let alone socio-economic status, the task is a daunting one.

Accommodating multiple views of sustainability

Participation and therefore inclusion in decision-making that will affect your life is a self-evident good; the devil really is in the detail. In any development intervention, competing interests will reside in the project constituents. A number of authors have indicated the problems of forming participation in projects (see Hirschheim, 1989; Biggs, 1995; Biggs and Smith, 1995; Mosse, 1995). More recently, a crop of papers have indicated problems with the orthodoxy of participatory approaches and have indicated the need for further thought (see Connell, 1997; Jackson, 1997; Khan and Ara Begum, 1997; Reckers, 1997).

The list of those groups which might be seen as participant stakeholders in a process project might appear to be fairly straightforward:

- donors;
- project managers;
- implementers;
- beneficiaries.

Nevertheless, this listing is simplistic and swiftly expands in complexity when we consider the subgroups in Table 5.2. As an example, for a Nigerian project that the authors worked on, the list would appear as shown in Table 5.3. The groups have diversified, but are these discrete groups? The Venn diagram in Figure 5.5 indicates the overlap of membership of the groups from the perspective of the consultants on the project.

Table 5.2 *Participant stakeholder groups*

Donors	*International donors: para-statal (e.g. World Bank and United Nations)*
	International donors: national and bi-national
	International donors, NGOs
	Local donors (state) (e.g. government)
	Local donors (private) (e.g. NGO)
	Local donors (private) (e.g. national and regional companies)
Project managers	International
	National
	Regional
	Local
Beneficiaries	Proximate explicitly intended
	Proximate implicitly intended
	Remote explicitly intended
	Remote implicitly intended

Table 5.3 *Participant stakeholder groups in a Nigerian project*

Donors	*International donors: European Union*
	International donors: ODA Local donors (state): federal government
Project managers	International: British Council National: higher education bodies Local: universities
Beneficiaries	Proximate explicitly intended: universities Proximate implicitly intended: students, lecturers, employers and local and international consultants Remote explicitly intended: European higher education institutions Remote implicitly intended: International higher education institutions

From Figure 5.5 it is possible to see that there is intense overlap: groups are neither discrete nor permanent. Groups' interests and membership change over time and so do the relationships between them. This ties in well with Biggs's (1995) ideas on coalitions, which borrow from the 'advocacy coalition framework' ideas of Sabatier (1988):

> … *while there may be great incentives and pressures to participate in a given coalition, it would not normally be appropriate to regard these as irresistible. Membership of a coalition is not, then, strictly determined by, for example, profession, class or gender, but typically involves some degree of choice*. (Biggs, 1995, p11)

Choice itself may be limited by events; but this does not detract from Biggs's core point:

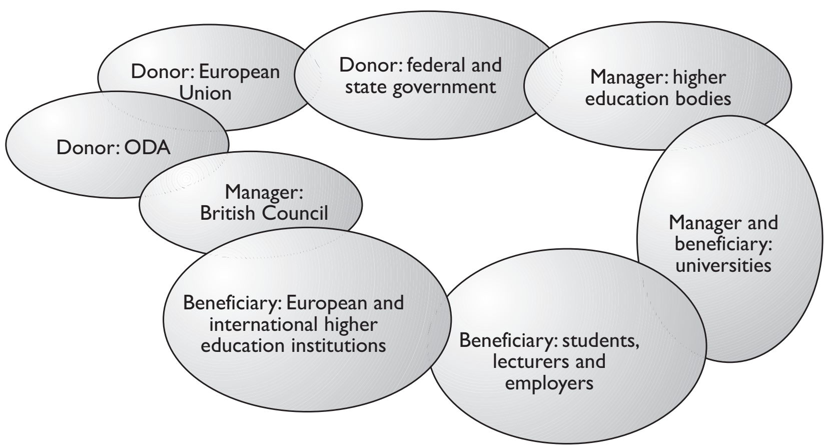


Figure 5.5 *Venn diagram of participant group overlap*

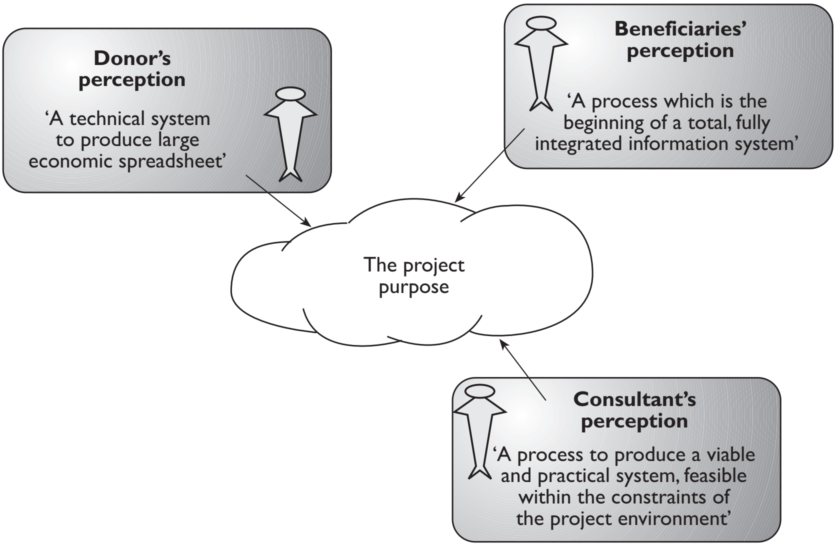


Figure 5.6 *Multiple views on a project's goal*

> … *it corresponds to the view commonly expressed by actors themselves that they have multiple identities and that different situations confront them with varying combinations of both opportunities and constraints.* (Biggs, 1995, p11)

Since there are coalitions of groups in any given context, and since these coalitions will merge and change over time and context, so the need for reflective practice is emphasized and re-emphasized; not only do the views of participating stakeholders change over time, their attitudes towards the core project context can also be at variance. The notion of coalitions and how discourse changes views and perspectives is the basis of the Advocacy Coalition Framework developed by Sabatier (1988).

On a project in China, the authors discovered the following breakdown in views on a project's core purpose between beneficiaries, donors and consultants (see Figure 5.6).

If the views between various participating groups in a project can vary on something as crucial and fundamental as the project goal, there is an even greater potential for differences of emphasis and comprehension on an idea as vague as sustainability. From the foregoing discussion it can be said that any system which models and interprets the meaning of sustainability across diverse groups needs to keep some key ideas in mind:

- Coalitions of participant stakeholders in the project context merge and vary with changes in the context.
- Individuals and groups within and between coalitions will have differing

perceptions of project goals and purposes and may well have a significantly different view on what constitutes sustainability.

Guidelines for including stakeholders effectively would be of value. Ison (1993a, pp47–48) has set out some principles for participation in projects:

- Projects have the potential for more mutually satisfying outcomes when an invitation is extended to participate, and the resultant communication is based on conversations that acknowledge each person's experience as unique and valid.
- It is important to understand that experience and knowledge are related to context, and that it is necessary to attempt to appreciate particular contexts.
- Enthusiasm, which may be triggered, appears to be an emotional state predisposing individuals to action that is meaningful to that individual. Matters that individuals are keen to take action on may or may not concur with 'experts' or institutional priorities. Pursuit of these matters in open, collaborative and critically informed ways can lead to locally meaningful and adaptive changes.
- Knowledge is both individually and socially constructed and because of this, processes are necessary to create learning networks. Pastoralist families and communities already do 'research' and 'extension' (share experience and knowledge – but they place importance on waiting to be asked).
- Diversity of experience, knowledge, research and 'extension' action is an asset of equal importance to the diversity of the biophysical environment.

These factors again indicate the vital importance of participation and dialogue between actors. From such dialogue emerges new understanding (McClintock and Ison, 1994, p6). This approach ties closely with the ideas relating to second- and third-order cybernetics, as discussed in Chapter 4.

If we link together our earlier ideas about systems thinking in Chapter 4 with these ideas of participation, then we need to change our thinking about how development intervention works at a systemic level. Figure 5.7 provides one view of this.

Actors in the world, and participants or stakeholders in a project, have separate or linked views of the reality in question. Such a reality can be seen as a system or wholeness of linked parts. Participation in a systemic sense is vital for us to understand and accommodate this range of views. Long and Long (1992, pp270–271) exemplifies the idea:

> *… planned intervention cannot be adequately comprehended in terms of a model based upon step-by-step linear or cyclical progression [blueprint or process projects?]. Rather, it must be seen for what it is – an ongoing, socially constructed and negotiated process with*

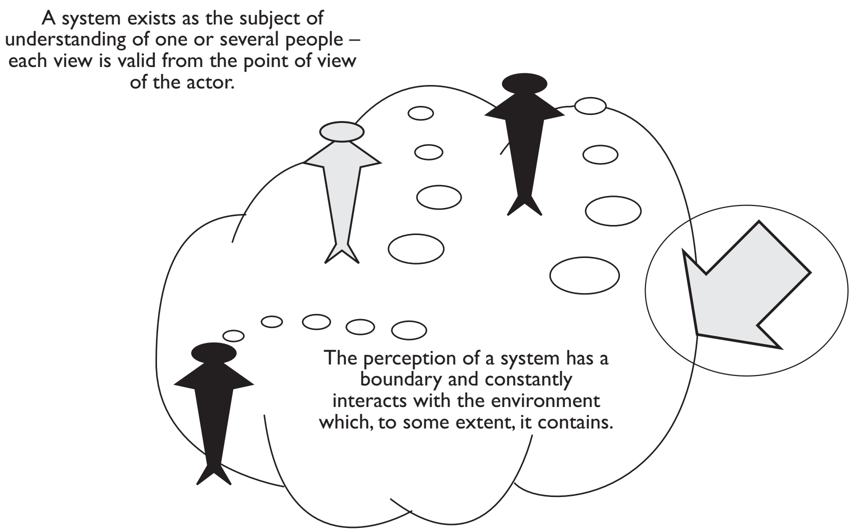


Figure 5.7 *A systems view of participation*

> *unintended consequences and side effects. Applying this insight to the understanding of development projects and the differential responses they provoke requires the deconstruction of orthodox views of policy and planning and their capacity for steering change. We need alternative, more open and less presumptuous … ways of thinking and acting. This task, we suggest, is best accomplished through the development of theory and methodology that is actor orientated.*

In this section we have introduced the context of projects and participation in developing countries. In arguing for participation and the inclusive use of tools such as logical frameworks, we echo the in-country experiences of other groups – most notably, see Hardi and Zdan (1997), where the development of participatory and reflective analytical mapping (PRAM) is described, including the use of logical frameworks. Participatory projects are the primary context for our discussion and analysis of sustainability. We have linked project approaches to more and less systemic forms of analysis. We have reviewed a range of problems that arise when thinking about discrete social groups within projects, and have shown that mindsets change among the groups. This is the context in which we develop our approach to systemic sustainability analysis. In the following section we briefly introduce the overview of the idea prior to developing one view of its application in Chapter 6.

Introducing the systemic sustainability analysis idea: The Imagine Approach

In Chapters 1, 2 and 3 we introduced the idea of the sustainability indicator and reviewed progress made so far in its development and application, and problems in practice. To get to this point we spent considerable time introducing the systems approach to thinking about complex issues and problems and reflecting on projects. We are not satisfied that narrow approaches to sustainability (such as SIs conceived in reductionistic frameworks) can work without reducing complexity, excluding valid and legitimate worldviews and reducing the area of concern to one that no longer represents the key issue of sustainability. Our belief is that participation, although difficult and problematic in itself, is preferable to projects that are determined top down. Our focus is subjective and systemic; but the tool for measuring SIs needs to be practical and useful. The key terms which we have used in defining the tool conform to principles of contemporary analysis in development studies (see Chambers, 1992; Cook, 1995; Slocum and Thomas-Slayter, 1995). For our purposes, it should be a rapid, participatory, qualitative, descriptive approach with a very clear explicit statement on what it is to be used for.

We refer to the embodiment of all we have said above as Systemic Sustainability Analysis (SSA), defined as the participatory deconstruction and negotiation of what sustainability means to a group of people, along with the identification and method of assessment of indicators to assess that vision of sustainability.

SSA is, thus, based on a number of fundamental assumptions:

- Sustainability is a subjective feature of any system; the subjectivity is inevitable and should not be regarded as a problem.
- Stakeholders have a right to be heard in any analysis of sustainability.
- While they may hold divergent views, what comprises sustainability can be negotiated amongst any group of stakeholders.
- A set of SIs can be identified with which to assess that agreed vision of sustainability.
- The SIs may be assessed either quantitatively or qualitatively in order to chart progress (or not) towards the goal or, indeed, to project 'what if' scenarios.
- 'Values' of SIs can be identified by the group which equate to what is desirable for sustainability. This can be thought of as a reference condition; but that term can imply a degree of objectivity which is absent from SSA. Instead, we prefer the term 'band of equilibrium', which we feel better encapsulates the subjectivity upon which the process is based.
- Care needs to be taken in the presentation of SIs, rather than just assuming that a tabulation is all that needs to be done. In order for SIs to be 'used' there needs to be a compromise between technical excellence and a form of presentation that allows for easy assimilation.

	State	Pressure	Response	Impact	Drivers
What is happening right now – pre-project	✔	✔	—	—	✔
Deliverable (project, implementation)	✔	✔	✔	✔	✔
Deliverer (institution)	✔	✔	✔	✔	✔
What is going to happen? Post-project	—	—	✔	✔	✔

Figure 5.8 *What are the main SIs that we will make use of?*

- SIs have no value in themselves unless they are used, either as a part of a learning exercise or to help influence policy/management.

In this book we will use the term 'SSA' to describe the philosophy which encompasses the above, rather than as a specific methodology. SSA may be achieved by employing a variety of specific participatory methods depending upon who the stakeholders are and the broad context of the analysis (research project, institutional sustainability, natural resource management, etc.). In this book we provide one illustration of how SSA can be achieved; but the reader should note that we are by no means implying that it is the only or, indeed, the best way of 'doing' SSA. What is important here are the assumptions upon which the process is undertaken.

In the first edition of this book we provided an example methodology for putting SSA into practice. Since then the methodology has evolved. In collaboration between Bell and the French environment and development agency – Plan Bleu (see www.planbleu.org) – the original methodology outlined in the first edition has now evolved into the 'Imagine' methodology for SIs (shown in Figure 5.1). The context of Imagine is very much 'projects' and even more specifically projects that deal with sustainability of coastal zone management in the Mediterranean and sustainable communities in the UK (these we describe in Figure 5.8). Imagine is thus a contextualized example of an SSA; but it does illustrate how the assumptions which underpin SSA can be addressed in practice; indeed, with some modification it could be readily applied in a variety of contexts.

To develop the Imagine approach a number of stages will need to be undertaken. We set out the steps here in general terms and develop the detail in Chapter 6.

Step 1

Identify the stakeholders and the system. The first point in the development of the approach is establishing the system to be measured. This would probably arise from a team of stakeholders. Tools for the development of such a team and the means of achieving cohesion and consensus are described elsewhere (see Thompson and Chudoba, 1994). The stakeholder group would identify the system to be reviewed with the approach, being careful to establish that the system is indeed a system and has systemic qualities. At this stage the system would probably refer to a task or main issue related to sustainability as a whole. A key concern here, as with any participatory methodology, is the identification of stakeholders to include in the process.

Step 2

Identify the main SIs. SIs are subjective and dependent upon the stakeholder group and the dominant viewpoint of that group. This needs to be affirmed and recognized by the group; but following this, in order to achieve a systems wide view of the item under analysis, SIs need to be drawn from a range of areas reflecting a holistic view. SIs should reflect items that need to be balanced in order for the system to be sustained.

Step 3

Identify the band of equilibrium (i.e. the reference condition). Measurement of SIs has dogged the literature. The focus of the approach advocated in this book is to provide a method which can be appreciated by a wide range of stakeholders without prior access to specialized measurement skills (as exemplified in some of the work undertaken in the Agenda 21 projects). In fact, the entire exercise can be undertaken by the stakeholder group, based upon the agreed views and opinions of that group. This is one of the empowering aspects of the approach overall.

Step 4

The development of the AMOEBA diagram: in Chapter 2 we first identified the AMOEBA approach of Ten Brink et al (1991). This was presented as a method to represent multiple SIs in one diagram and has since been developed in a systems manner (see Clayton and Radcliffe, 1996). However, in the Ten Brink et al (1991) presentation the AMOEBA was a fairly 'hard' and quantitative tool. Here we develop the AMOEBA, but in the light of the systemic, scenario-making and participative approaches detailed in Chapter

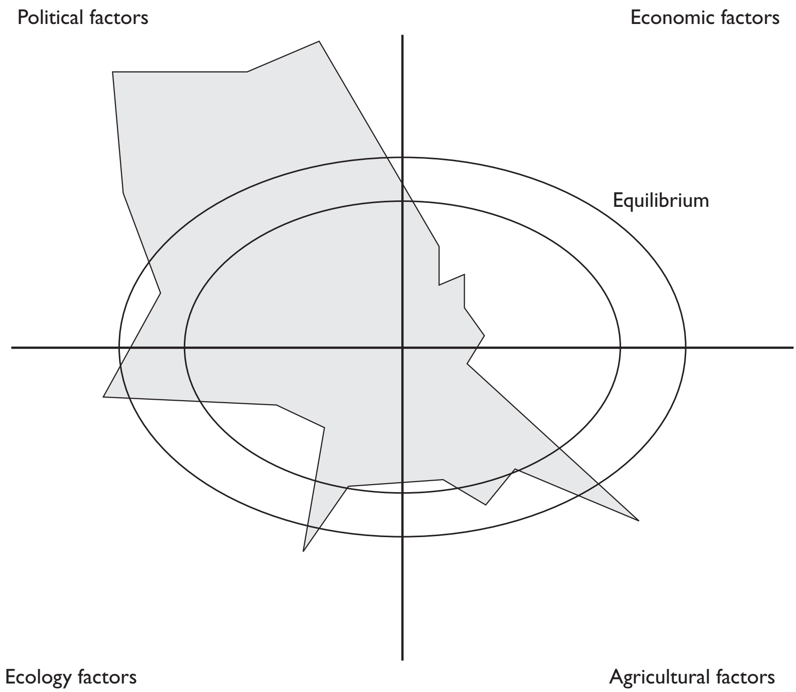


Figure 5.9 *A sustainability indicator AMOEBA*

4. The AMOEBA form of presentation is not the only such device that could be employed, but does provide a convenient form for summarization.

So far the description given here is distinguished from other work only in that it is based on a holistic and systemic approach to the factors which define the sustainability of a project, and upon an explicit recognition of the subjectivity of the analysis and the ownership of stakeholders within the context of the analysis as a tool for reflection. Figure 5.9 shows the development of the original model into the AMOEBA as first described in Chapter 2. The main function of the AMOEBA is to provide a relatively instant presentation of the project's state of health in terms of its sustainability.

Step 5

The extension of the AMOEBA over time: each time the AMOEBA is drawn from a project review by stakeholders, it gives a snapshot indication of the sustainability of a project; but sustainability is about how this has changed or might change with time. Linking this analysis to scenario-making allows a means of comparing current and potential future states of sustainability. The resulting 'AMOEBIC' analysis would provide two informing products:

1 the overall tendency over time of four major aspects of the project context; and
2 a rapid review of what is important now and in the future in terms of the stakeholder response to the information provided.

The AMOEBIC analysis set over time indicates continuance (or sustainability or equilibrium) within a given context from the standpoint of a stakeholder group. Of course, other groups might have other ideas and might be candidates for AMOEBIC analyses of their own. In all, the analysis would need to lead to informed discussion and action on items agreed to be in disequilibrium. This approach is described in more detail in Chapter 6.

The next chapter will seek to put more detail in our outline of the Imagine approach provided above. It should be reiterated that Imagine as an example of an SSA should not be seen as the only such approach that could be taken to introduce multiple perspectives to an analysis of sustainability. Neither are we saying that experts have no role here. There are benefits in experts engaging with other stakeholders, but not as a top-down 'let's tell you what to do' approach – rather, a 'what do you think?' mode. Imagine is given here as one possible approach, and the AMOEBA as one possible visual representation of SIs. Furthermore, what we are saying is that the assumptions that underpin SSA are important and should be the basis of *any* methodology which seeks to engage stakeholders in an analysis of sustainability. It's the sense of partnership, respect and application which represents the soul of SSA that is important and, in our view, non-negotiable.

6

Imagine: An Example of a Systemic Sustainability Analysis

Introduction and objectives

> *The knowledge of local people … has a comparative strength with what is local and observable by eye, changes over time, and matters to people. It has been undervalued and neglected. But recognizing and empowering it should not lead to an opposite neglect of scientific knowledge… The key is to know whether, where and how the two knowledges [sic] can be combined, with modern science as servant, not master, and serving not those who are central, rich and powerful, but those who are peripheral, poor and weak, so that all gain.* (Chambers, 1997, p205)

Taking a number of cases, we develop the use of the Imagine approach as an example of a Systemic Sustainability Analysis (SSA). In Chapters 1, 2 and 3 we discussed the range of approaches to sustainability indicators. In Chapter 4 we set out the problems with much of the 'top-down' approaches to analysing sustainability and the development of sustainability indicators (SIs). Building from this in Chapter 5, we set out what we think is an alternative approach that takes stakeholder participation as a non-negotiable starting point and suggests a set of principles that underpin what we refer to as a Systemic Sustainability Analysis. In Chapter 5 we also provided an outline of one SSA methodology developed in conjunction with Blue Plan (www.planbleu.org/planBleu/historiqueUk.html) – the Imagine approach.

In explaining the evolution of Imagine we work off the strengths and 'workable' elements that we have identified in these previous chapters (working with projects, clear boundaries and well-defined terms of reference). Based on this background and using systems approaches, we hope to demonstrate how sustainability indicators can be arrived at from within project contexts. Even more specifically, Imagine originally evolved from SSA within a project context

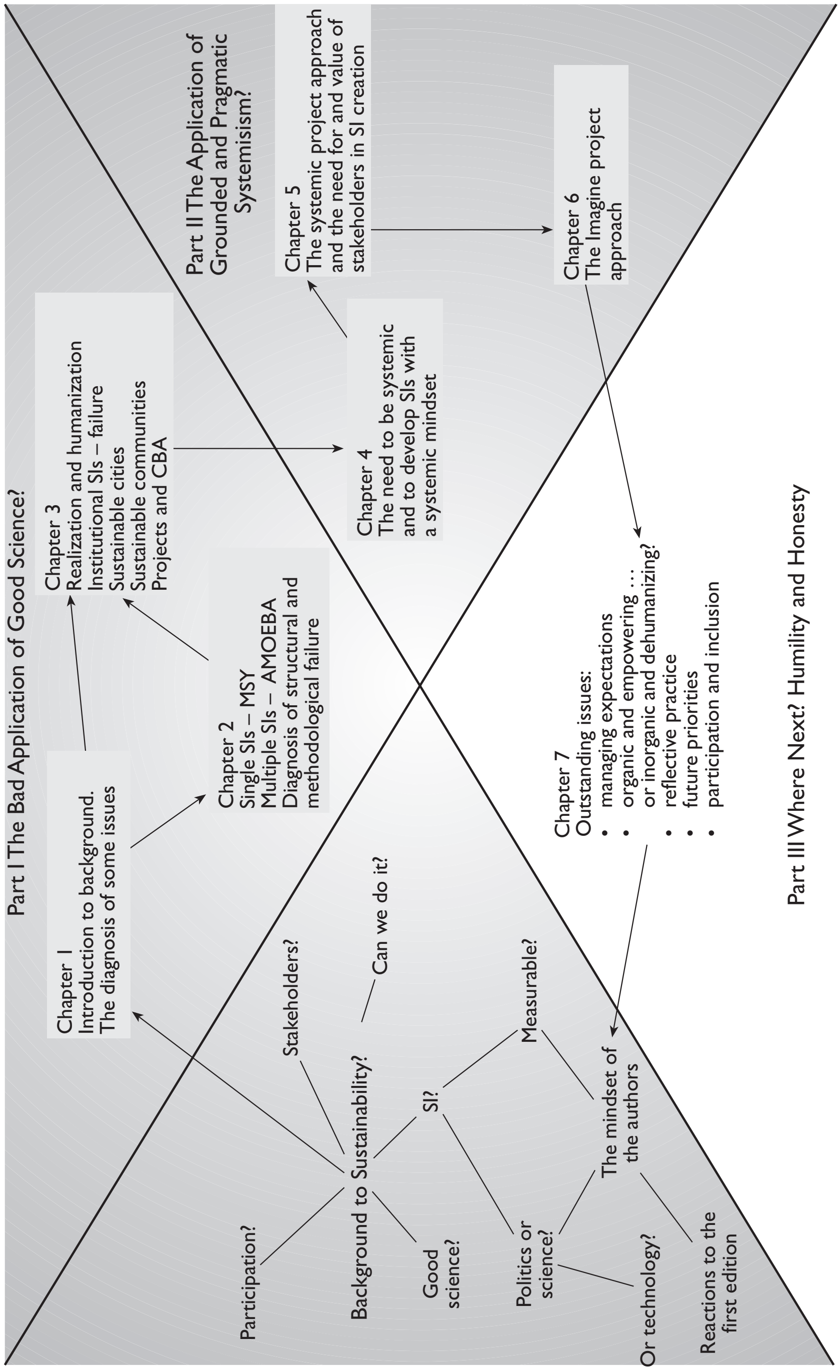


Figure C.6 *Chapter 6 in context*

focused on coastal zone management. Whether the SIs are ultimately useful and valuable in project work will be discussed further in the next chapter.

To reiterate from the previous chapter, the initial five-step procedure to the 'doing' of SSA as originally devised in 2000 was:

1 Identify the stakeholders with multiple views and the system in view.
2 Identify the main SIs. SIs are subjective and dependent upon the stakeholder group and the dominant viewpoint of that group.
3 Identify the band of equilibrium – the reference condition.
4 Develop the AMOEBA diagram as a means of representing the SIs. So far, the description given here is distinguished from other work only in that it is based on a holistic and systemic approach to the factors that define the sustainability of a project, upon an explicit recognition of the subjectivity of the analysis and the ownership of stakeholders within the context of the analysis as a tool for reflection.
5 Extend the AMOEBA over time by regular updating and by use of scenario-making of possible futures. Each time the AMOEBA is drawn from a project review by stakeholders, it indicates the sustainability of a project. Over a period of time the AMOEBA might be seen to move over the surface with each significant movement indicated by changes in the values of the SIs.

These five steps as first presented in the original edition of this book in 2000 are represented in Figure 6.1.

An updated and revised version of this which is the basis of the Imagine approach as developed in partnership with Blue Plan is shown in Figure 6.2. The steps are as follows:

1 Understand the context.

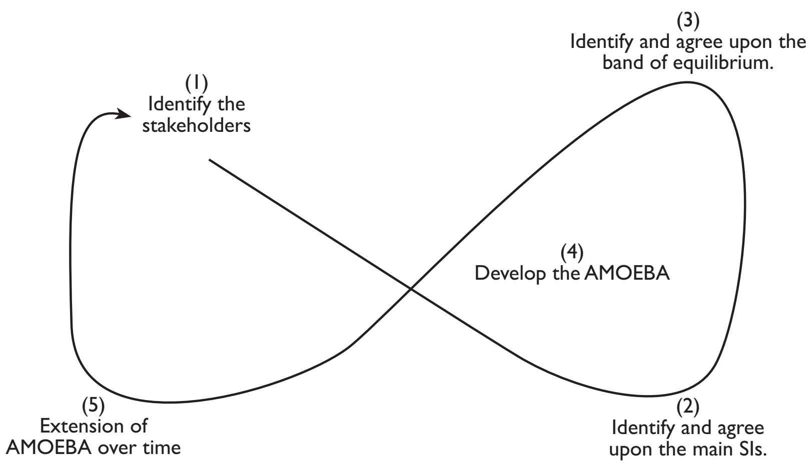
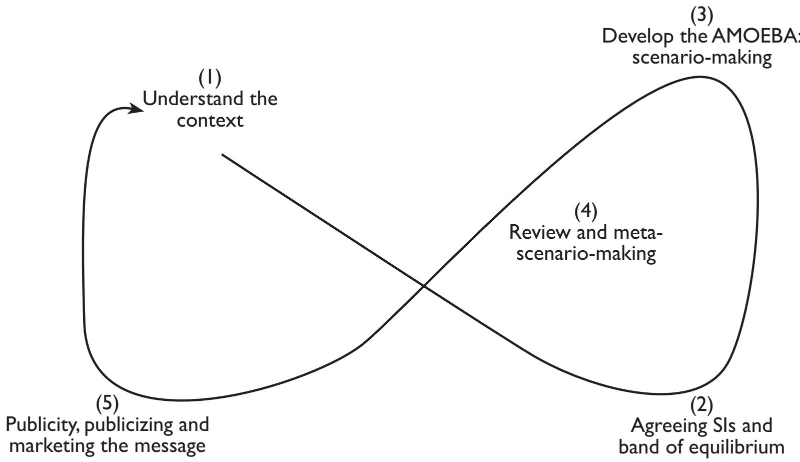


Figure 6.1 *The five steps of the Systemic Sustainability Analysis approach*



Source: adapted from Bell and Coudert (2005, p13)

Figure 6.2 *The five steps of the Imagine approach*

2 Agree upon sustainability indicators and bands of equilibrium.
3 Develop the AMOEBA approach and scenario-making.
4 Conduct a review and engage in meta-scenario-making.
5 Publicize and market the message.

As we explore the development of the Imagine approach from this basis we adopt an approach that is closely related in style to participatory studies (e.g. the use of tools such as focus groups and stakeholder analysis). While Imagine was developed for a specific context, it can be adapted to any context and, hence, we feel that the main elements of the approach can be applied in a number of ways (we include elements dealing with participatory approaches originating in rural development practice). The teams who make use of Imagine may well decide on their own tools for arriving at the outputs specified. As mentioned in the previous chapter, the authors do acknowledge that a range of 'variations on the participatory theme' are viable and our presentation of the Imagine approach is certainly not intended to imply that we feel it is the only possible approach to SSA. Instead, our prime intention is to use Imagine as a grounded framework that does have a track record, in practice, to illustrate what we feel are the essential elements of any participatory approach to sustainability. If we presented the SSA theory without tangible suggestions as to how it could be achieved, then it would be understandable if the reader responded with a 'well, that sounds nice but it can't be done'. On the other hand, if we present a suggestion as to how these issues can be addressed, then the alternative criticism emerges of: 'OK, but I think it can be done better.' We have no problem with this, and we can only repeat the invitation we made in the first edition of this book and stress that we would be interested to hear about methods used in different sustainability project contexts.

The dilemma of providing a grounded example is that the reader may regard it as only being relevant to that context. Coastal zones in the Mediterranean are important given the pressures that now exist on that body of water and the complexity of the political landscape involved. Imagine has evolved as a form of SSA to be applied within these specific contexts, and the reader might well ask how this could be relevant to their desire to analyse a micro-finance organization in Norwich or an agricultural development project in Zambia? This is a reasonable criticism; but we do not think that the approach should be limited in scope and therefore we expect it to be generic and have seen that it is applicable in a wide range of project contexts (such as rural development, initiatives for sustainable communities, information systems and organizational learning). This is borne out by the application of the Imagine approach by the Academy for Sustainable Communities in the UK. In this example the original Imagine approach has been developed into a formal generic teaching module that is being included in the teaching provision of higher education institutions in the UK, as well as being applied in a cut-down format for organizational sustainability. For more details on the course, see www.ascskills.org.uk/pages/learning-and-skills/generic-module.

Step 1: The beginning of the process – understand the context

Although the substantive aspect of this chapter which deals with the Imagine approach has been and remains, we believe, innovative and groundbreaking, the background to SIs or, indeed, participation is not new. Some of the reasons for focusing on projects within the sustainability context are discussed in Chapter 3. We assume that the tool will be applied by sustainability project planners and others in process or blueprint project contexts, but also by local communities, communities of practice and those engaging in undergraduate and postgraduate studies.

In this book, Imagine provides project planners and members of communities of all kinds with a rounder and more holistic view of the sustainability context.

The first stage of identifying sustainability as an objective for community projects consists of the project team (those entrusted with the development intervention) familiarizing themselves with the mood of the context. Mood is a highly subjective term, but this is a subjective business; it is important to understand if the context is one of historic hope and goodwill, or one of despair and anger, or if there is a mixture of both with neither predominating. We want to assess if the mood is positive or negative for future intervention. This is an analysis that can be done quickly in collaboration with local actors. It can be undertaken using some of the participatory rural appraisal (PRA) techniques listed in Chapter 4.

	Positive	Negative
Now	• Strengths: ability to raise finances at a departmental level, ability of faculty to buy time and resources, ability of department to set out true research picture (all income earned).	• Weaknesses: commercialization of the department? Current concentration on commercial ventures, problems with faculty operating as consultants, uneven distribution of rewards.
Later	• Opportunities: raise the profile of the department in the university, raise finances to develop projects and opportunities within the department, express the department as a practitioner as well as an academic unit increasing student interest in our courses.	• Threats: commercialism, divisive forces in the department (e.g. faculty unavailable for routine tasks in favour of more glamorous/interesting work), relative poverty and wealth among colleagues, academic work seen as being the poor relation.

Figure 6.3 *SWOT analysis of the mood of a university department concerning a project to develop consultancy within the department*

What follows is a series of tools and methods that can be applied all together or as a selection. The main point is to arrive at a sense of collective understanding among the various constituents of the team.

For example, for the purpose of aiding the clarification of thinking, resulting insights into participants' mood can be set out in a strengths, weaknesses, opportunities and threats (SWOT) table (see the example provided in Figure 6.3); more simply, thoughts can be put in a quadrant, as the example shown in Figure 6.4.

The intention of the SWOT or the quadrant analysis is to provide insight and to attune the research team to the prevailing mood of the organization acting within the context of the sustainability initiative (e.g. a project or an NGO initiative).

Under normal circumstances the review would remain a personal exploration, and it would not be necessary to circulate the results for wider

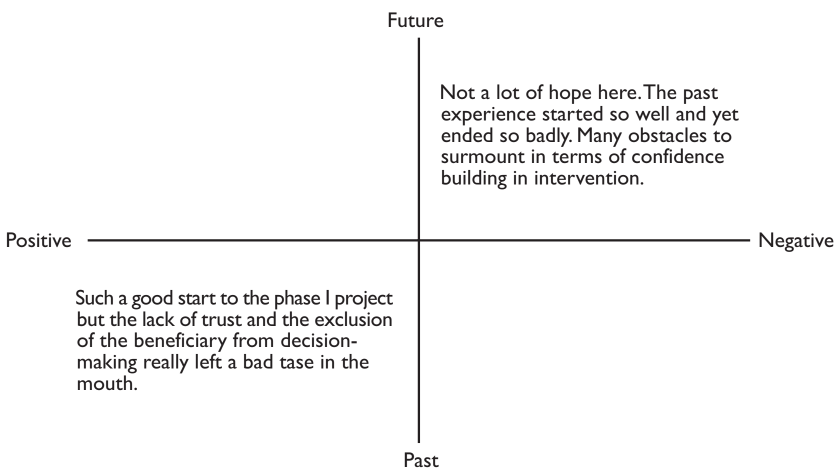


Figure 6.4 *Quadrants with notes*

consultation, although the resulting information may well be discussed openly with fellow participants in meetings at a later stage.

It should be kept in mind that 'mood' is a very volatile and changing phenomenon and variation relates to who is being approached and the 'baggage' of the person asking the questions. Therefore, understanding mood is an iterative process of drawing out major themes and recognizing that few assumptions should be made at this stage.

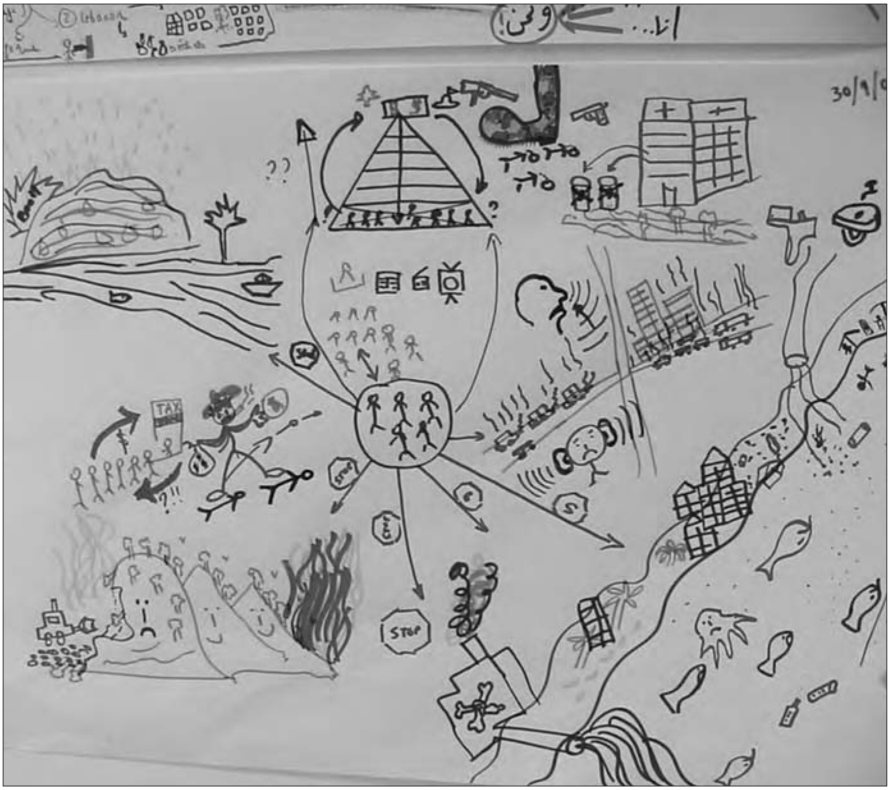
The outcome of this stage is insight into the potential for the people involved in the project intervention (some of whom may become actors and stakeholders) to deal with the issues and tasks which the context may throw up. It also provides an opportunity for emerging new themes and ideas. Mental traps and problems of perception will probably also arise. In the Norwich 21 example, participation and local involvement have been central planks of the sustainable cities approach and have been applied and valued from the outset of the project – so much so that the European Sustainable Towns and Cities Campaign invited delegates from Norwich to run a workshop on participation at a meeting in Brussels. Since then Norwich has made use of questionnaires, press releases, forums, conferences and roundtable discussions to develop understanding and participation in SI development. The experience of the Norwich 21 campaign is that the primary initial requirement for any project in sustainability is 'political will'; following this, participation and sharing ownership of the project idea are vital.

Understanding the mood of those involved in the project context helps the future planning of intervention and the resulting analysis of sustainability: the baseline condition of the context is better understood and therefore the range of possible and feasible interventions can be adjusted accordingly. It also attunes those engaged in the sustainability project to locally perceived and understood valuations of importance. By this means some potential conflicts between, for example, those with the quantitative data (such as planners) and those with life lessons and experiences may be averted.

Understanding the project context builds upon the understanding of mood; quite often, the two stages can be regarded as integrally linked or even indistinguishable. However, a different approach can be used to track the results of discussions with local people involved in the context – the 'rich picture'.

A word on rich pictures: the rich picture is a fairly unstructured tool for summarizing everything you know about a situation. It is used as a means to develop understanding of context in the soft systems approach set out briefly in Chapter 4. In the Open University course T301 – 'Complexity Management and Change', the rich picture is introduced as follows:

> *… the idea is to get from finding out to action by doing some systems thinking about the situation. To get started on this you need some efficient, economical and illuminating way of summarizing or representing the situation in all its complexity. You do this by building a*



Source: CAMP Lebanon, Systemic and Prospective Sustainability Analysis (SPSA), 30 September–1 October, Damour, Lebanon, p53

Figure 6.5 *Rich picture of a complex sustainability project context*

> *cartoon-type representation of it.* (Open University, 1987, Block IV, p21)

How the practitioner goes about this depends very much upon his or her tastes and preferences. Elsewhere (Bell and Wood-Harper, 1998), one way of undertaking the process of rich picture construction is an approach based on four items: hard and soft (these can be thought of as representing formal and informal), structures and processes (things and activities). These four elements need to be identified in terms of core tasks and issues (things to do and problems) that are of concern to the project in question. An element of a complex rich picture derived from a Blue Plan coastal zone project in the Lebanon is set out in Figure 6.5.

The picture can be the personal, subjective portrayal of the researcher or of a group of stakeholders in the project. It is the method used by researchers to express their understanding of the project. As a personal tool, it is a useful, heuristic device. For example, it would be wrong to present the rich picture to a

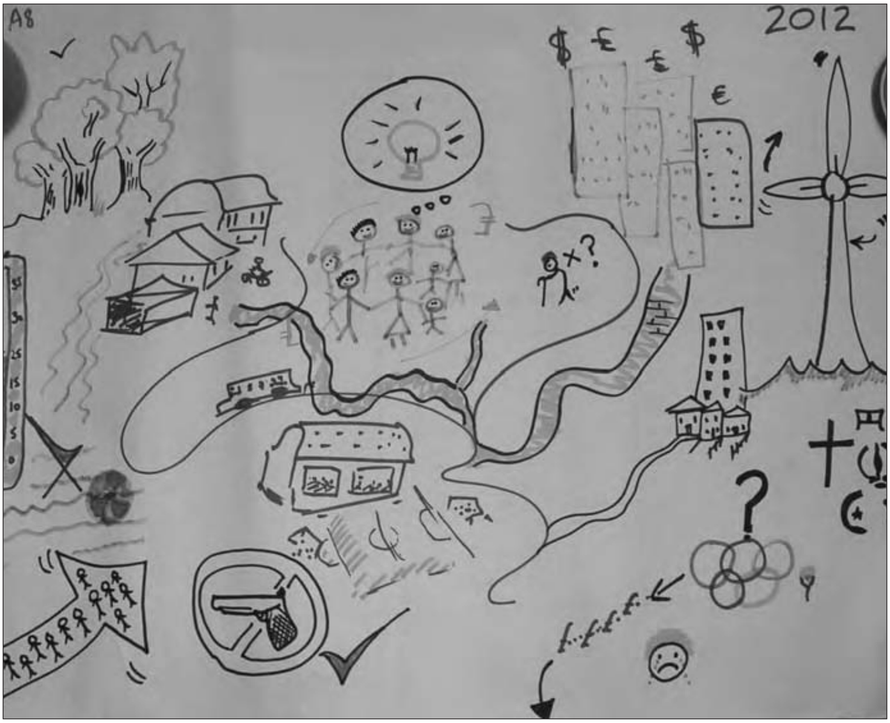


Figure 6.6 *A further rich picture of a complex sustainability project context*

group of project stakeholders as the reality of the project. It is a device to help in a researcher's understanding of that context.

The objective is to capture the richness of the context and to be sure that formal and informal elements are represented in future project developments. To demonstrate the variety and range of such pictures, a further rich picture, taken from a pilot use of the Imagine methodology is shown in Figure 6.6.

If SWOT and rich pictures have been applied, the researcher should have a view (limited and partial, but a starting point) of the prevailing states of mind of those in the context and of the complexities of the project context itself. It should not be forgotten that the knowledge is gained *with* those rather than *about* those in the context. Using the soft systems approach the researcher could (with stakeholders) draw out what might be major tasks and issues and provide a potential root definition or mission statement for the intervention (and transformation), which could be developed with all, or a representative sample of, actors; from this the researcher could generate a participatory view of an action plan (for more ideas on this, see Checkland and Poulter, 2006). In this book we do not go into such detail, but leave it open for readers to engage with the literature.

Once the researcher feels a degree of comfort and familiarity with the context and the mood of the actors, the analysis can go on to describe the range and type of stakeholders.

Identifying stakeholders

Participating, learning about and respecting the views of stakeholders is one of the most important aspects of SSA that we set out in this book. As with the two previous stages, this can be seen in terms of a personal process of subjective learning and recording.

Process

The usual formula for a gathering of stakeholders is a workshop. However, a workshop is a device arising from recent Western management science and is not necessarily in keeping with the needs of a diverse group, who might include:

- donors and their agents;
- project managers;
- agents for relevant ministries;
- international NGOs;
- local NGOs;
- academics and other non-academic experts;
- representatives of local rural populations (a diverse group who may well include a cross-section of the local hierarchy);
- representatives of local urban populations (ditto);
- representatives from local organizations of other types (such as industrialists).

When considering the diversity of interests and experiences of this group, to suggest that the gathering can produce a workable and consensual plan for action by waving a magic wand called a 'workshop' may be oversimplistic and even naive. We need to consider what a workshop is. Some of the major themes in terms of duration, format and outcome are set out in Box 6.1.

As an alternative to the workshop, an event can be organized. This might be in the format of a meeting conforming to local custom (such as the 'Jirga' of the peoples of North-West Frontier Province in Pakistan). At such a locally recognized event, the topic of the sustainability intervention itself can be set out and discussed in line with local custom.

The event format for developing the stakeholder grouping has a number of advantages over the more managerial workshop:

- The event is the known and expected context in which local people make communal decisions.
- The event is a statement of inclusiveness and should not be as likely to deter some groups and individuals from participating.
- Professionals in sustainability (such as donors and project managers) will

Box 6.1 Some major elements of a workshop

Duration

The term workshop can stand for a wide range of gatherings that can last from one to several days and can sometimes be 'rolling', leading to periodic meetings over several years.

Format

Workshops can include a wide range of devices to promote discussion and understanding, such as:

- presentations;
- small group work sessions;
- plenary sessions;
- visits;
- video/audio presentations;
- role play;
- discussion groups;
- soap boxing sessions (opportunities to provide a robust debate).

Outcome

The point of all these devices is to bring the group together on a given topic and to arrive at a joint understanding. In small, homogeneous groups (such as a workshop of project contract managers), the chances are that understanding can be rapidly developed. However, in large, heterogeneous groups there may be a need to develop sophisticated tools to gain a workable coalition of interests. In this type of situation it may be necessary to begin with separate smaller workshops (e.g. three or four groupings representing donors, managers and local and remote beneficiaries) and then for these workshops to develop their thinking in isolation, concerning major project topics, and to build towards a combined workshop at which nominated representatives for the diverse parties are to be included.

be more practised at conventional workshops and meetings than local people; therefore, it is appropriate that they, as the representatives of intervention, should meet the potential beneficiaries of intervention on their own ground.

Of course, the event also has some potential negative elements:

- ownership of the event by powerful groups and individuals;
- relegation of minority and disempowered groups (low caste groups and women) to the position of onlooker;
- the capacity for outcomes to be steered towards dominant interests.

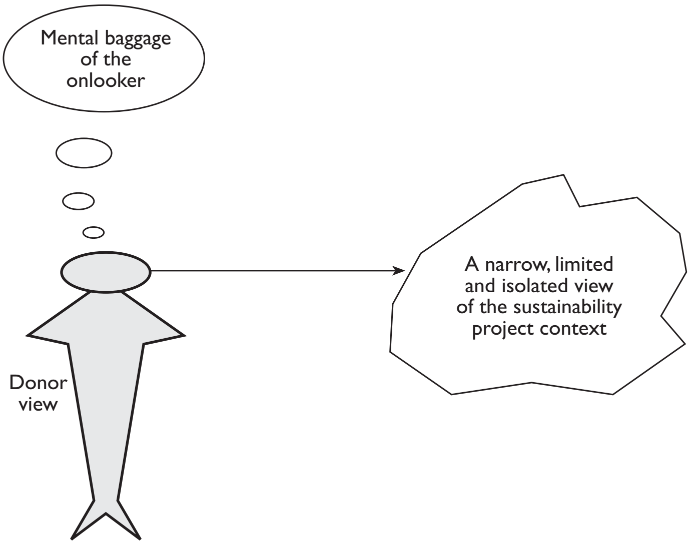


Figure 6.7 *Single view of sustainability*

Therefore, the design of the event and the individuals involved in that design process are of crucial importance for the integrity of the resulting stages. All formats have strengths and weaknesses; but in the case of the workshop or the event, these approaches include more views than can possibly be contained in the traditional top-down approach to project planning. The main outcome of the process of gathering stakeholders is to ensure that a sufficient and diverse range of views is provided for the sustainability analysis process. It cannot be expected that all views will be equally represented; but it must be evident that a representative set of views are provided. The objective is that single views of project sustainability as shown in Figure 6.7 are converted to multiple views as set out in Figure 6.8.

The most challenging aspect of this stage of developing multiple views on sustainability, and therefore the resulting indices, is to regard each stakeholder group's set of views as legitimate and worthy of respect. An anecdote from Liz Edwards, assistant chief executive officer of Norwich City Council and senior activist in the Norwich 21 sustainability campaign, gives an indication of the value of the participatory approach to action:

> *When considering the best way of promoting public awareness of sustainability, we were strongly influenced by the Seattle experience of developing sustainability indicators with the community. We suggested a similar approach to our Norwich 21 steering group, to community representatives and to officers of Norwich City Council, and had no difficulty in promoting the concept of a set of indicators which could be used to measure progress over time. The message which came back to us repeatedly was: 'Keep it simple; keep them short; use plain language*

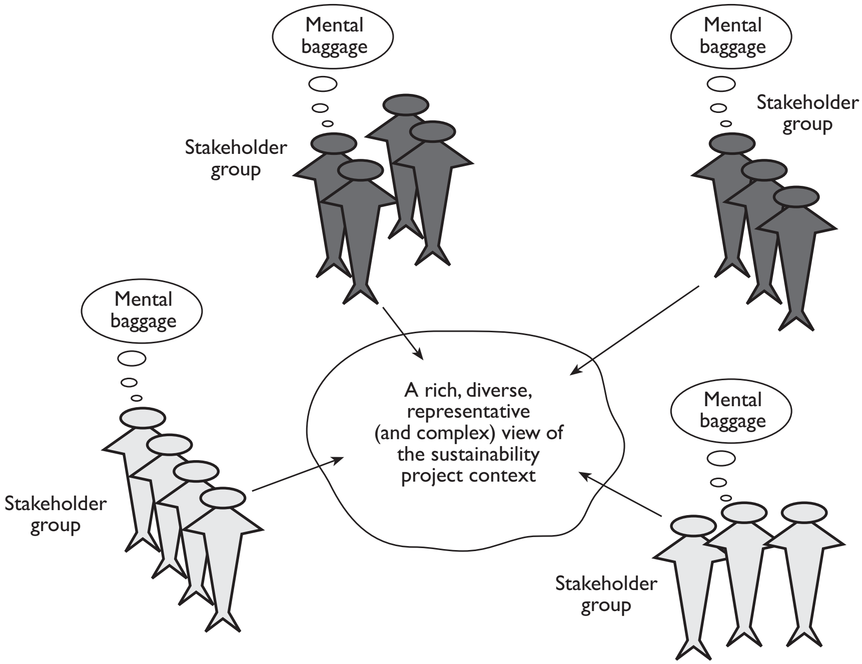


Figure 6.8 *Multiple views of sustainability*

> *and symbols wherever possible.' On this basis we pared down our original long list of indicators to a manageable list of 21 and presented them to a conference in April 1997. The list was warmly received, but we were specifically asked to add indicators for art and culture – which we duly did.* (Liz Edwards, pers comm, 17 December 1997)

In the case of Norwich 21 the conference was used as a means of sharing and developing understanding of the sustainability indicator concept. Further indicators arose from this, including a sense of ownership and responsibility over the resulting activity. We shall return to the theme of simple and short indicators later in this chapter.

When the views of all stakeholders have been gathered together, they can be included in an overall framework for reference, learning and reflection. The method described here is one that is relevant for consultant and management groups who are taking ownership of the overall project flow. The approach can be quite exclusive and 'expert driven'; but this does not have to be the case. Stakeholders can (and ideally should) provide their own assessment, although this can be time consuming. The approach set out is based on the work of Team Technologies (1995) and is described in the TeamUp methodology and software (for details see www.teamusa.com). Table 6.1 provides a view of a stakeholder analysis spreadsheet.

Table 6.1 *Stakeholder analysis spreadsheet*

Stakeholder	*Stake in the project*	*Overall effect on CFAA system (+, –, ? or n)*	*Value*	*Power*	*Impact**	*Activity which is required to assist the stakeholder in the M&E*
Donor						
Policy view	Donor to project – need to know impact	++	4	5	*20*	Include in all discussions. Use LF
Local officer for donor	Local interest in project impacts	+	3	3	9	Include in discussion on preliminary draft
Related donor agency						
Director	Sub-donor – interest in success	+	4	5	*20*	Include in discussion on preliminary draft
Project manager	Instrumental in project development	+	4	3	12	Include in drafting
Related Chinese agency						
Director	Financial performance indicators	+	4	5	*20*	Include some financial analysis, MS and National systems?
Sub-Director	Quarterly and monthly reports	+	4	5	*20*	Review possibilities of monthly more regular reports
Project staff						
Chief	Frustrated by data excess – need systems	+	5	5	*25*	Include focus, brevity and prioritized system
Staff 1	Will pick up implementation activities	++	5	4	*20*	System must be feasible
Staff 2	Co-worker in MIS – no training	+	3	3	9	Ditto – as co-worker
Staff 3	Frustrated but vital in participation	+	4	2	8	Valuable person to include in M&E set-up
Related agencies to CFAA						
Agency 1	Need proformas for collection + funds	++	3	3	9	Assist with proformas for data collection + assist with participation
Agency 2	Problems with participation	n	2	2	4	Use objective measures?
Beneficiaries of the system						
Beneficiary 1	Is the money being used for beneficiaries?	+?	2	5	10	Show that monitoring is active and project is fair
Beneficiary 2	Monitoring must be participative	+?	2	5	10	Demonstrate participative aspects
Beneficiary 3	Wants to participate in project	+	2	3	6	Include beneficiaries in impact analysis
Consultant						
Simon Bell	Helps to design the system	+	2	4	8	Need to include range of PIs – impact, financial, etc.

Notes: * Major stakeholder impact given in italics. Power is judged as follows: Impact = V × P. complete control = 6; significant control = 5; significant influence = 4; moderate influence = 3; low influence = 2; appreciation = 1. Value is judged as follows: critical = 5; essential = 4; necessary = 3; desirable = 2; non-essential = 1.

Although specific details are not required of this project, it is useful to describe the spreadsheet in outline:

- Stakeholders are given by name in column 1.
- A brief description of the stake which they hold is given in column 2.
- Column 3 contains a plus (+) or minus (–) depending upon whether the stake is positive or negative in terms of the success of the project by this organizing group ('n' means neutral).
- Column 4 is the value of the stakeholder. This is explained in the table notes; but 1 would indicate that the stakeholder was non-essential, whereas 5 would mean that the individual or group is critical. It should be noted that these are subjective values applied by the project managing group making use of the spreadsheet. They are not intended to be definitive evaluations, but guides for future actions and the assessment of behaviour, and in recognition of variation in the size of stakeholders and stakes.
- Column 5 is the power of the stakeholder and is assessed in much the same way as column 4. A score of 1 would indicate an 'appreciation' of the project, whereas 6 would indicate that the stakeholder has complete control.
- Column 6 provides a view of the overall impact for a stakeholder. This element of the stakeholder analysis approach is the most subjective and potentially misleading: it is produced by multiplying V (column 4) and P (column 5) together. Be wary of what the numbers tell you; but as a general rule of thumb, any stakeholder or stakeholder group with a score of over 20 points in terms of impact must be taken seriously. Major stakeholders are set out in italics.
- Column 7 is the activity set related to stakeholders to respond to their potential impact upon the project. This is a very important aspect of the table and should not be neglected. As any project develops over time, it will be seen that stakeholders vary in their scores and actions, and reactions to them will also vary.

Taken in this way the analysis provides a view of stakeholders (often not shown in the rich picture of subsequent analysis) and provides a means of developing an agenda of action to respond to needs.

By this stage of the process, the facilitator, or team encouraging the process, should have a fairly clear perception of the project context, the primary issues and tasks within the context, the range of stakeholders within the context, and their relative weighting (as well as insights into the various agendas). It is important that this information is not held back and used as a resource purely for the facilitator. The information is 'case history' and is valuable for all those involved in the exercise of arriving at sustainability indicators.

It is important within the project process to be sure that all members of the team who are to devise the sustainability analysis are clear on the range of methods and likely outcomes (in form, not content) that are expected. In this book we advocate a range of techniques, some of which may be well understood, many of which may be quite novel to the participants in the exercise. It is useful to spend some time in clarifying what is being done, why it is being done and what is the expected outcome of each stage. The participants may well have their own views on the manner in which techniques are applied or may be able to substitute or supplement techniques with ideas of their own. The process for the team is a learning one and depends upon the ability of all members to make contributions and to gain ownership of the overall process. Indicators themselves are often new and unclear and need introducing. SIs are the result of global processes and may appear irrelevant and alien to many stakeholders. The more that can be done to make their appearance relevant and useful at this stage, the more likely it is that the project will continue to be viable at a later date. While attempting to establish this process of SI development as a method that gains wide agreement, it should not be forgotten that the driving force behind the global SI phenomenon is the outcome of global political forces; this, in turn, is remote from most people's lives. Since the stage of developing awareness and insight of the background is now complete, the project can move on to the sustainability analysis process itself.

So far, the process we have been describing has developed our background understanding. This may have taken place in a single workshop (as with the current form of Imagine as applied in Mediterranean coastal zones and in the UK) or it may have been concluded over several days, weeks or months of meetings. However, no matter the nature of the format, it is important to identify and bring together the stakeholders in the project and to gain a clear vision of the sustainability system that is expected to emerge from the project process.

Processes for developing shared vision and learning teams are described elsewhere (this is dealt with in considerable depth by Senge et al, 1994, whose approach we described in Chapter 4). For the purposes of the approach that we set out here, the main factors to keep in mind are the following:

- In order to represent the diverse interests that are within any project scenario, stakeholders should ideally represent dominant and non-dominant mindsets within donor, manager, recipient and beneficiary groups (and the coalitions of these groups).
- It is beneficial to the work if stakeholders agree and 'vote into' the participatory group.
- There should be an explicit recognition by all stakeholders that the outcome of the project process is a sustainable system (no need for detail at this time, but plenty of need for a hands-on facilitation process in agreeing, first, on the group's understanding of what a sustainable system is and then agreeing to it in principle).

The gathered stakeholder group is the basis for all future decisions at this time (the group may change in future iterations of the process). The sustainable system, agreed to in principle, now needs to be developed as a root definition of the project process (see Checkland, 1981; Checkland and Scholes, 1990).

The term root definition has a specific meaning in systems terms and is derived from the soft systems approach described in Chapter 4. As we apply it here, the root definition is the 'vision' of the system that we wish to create (which, as described in some of the sustainability literature, can be thought of as the reference condition or target, but also contains the notion of transformation). Normally the root definition is contained in a paragraph which should have the following elements:

- The beneficiary or beneficiaries of the system: this can be multilayered. The beneficiary is usually the person for whom the system will provide some form of tangible benefits; however, it can also be the person who is paying for the transformation. This can be the donor who provides the capital and the beneficiary who provides the labour and will sustain disruption and change during the lifetime of the project. The team needs to be sure who is the beneficiary and what the beneficiary's expectations are.
- The implementers who will engage in the work of the project: these may include people who are also beneficiaries. For example, the implementers may be the project managers, but may also be members of the beneficiary group who will enact the change procedures upon which the sustainability project is focused.
- The third element of the root definition, the most critical for the purpose of the project, is the project's transformation. This will be the process or processes of change that are to arise and which we wish to understand and (to some extent) measure. Later we will describe what we mean by impact and process SIs.
- The fourth element is the worldview or set of assumptions behind the root definition. These are the underlying and working assumptions that are shared by the team. Assumptions might relate to the project's expected delivery, fears about the impact of certain aspects of the project, concerns over the boundary of the project, and its expected impact beyond the immediate project area.
- The owner of the transformation is the fifth element. Owners, beneficiaries and implementers can all be linked, depending upon the nature of the project. They are all stakeholders.
- The last element of the root definition is to set out the constraints under which the project must work. These may also be the first indication of the sustainability factors which the project team needs to address and agree upon.
- These six factors (beneficiaries, implementers, transformation, assumptions (or worldview), owner and constraints) combine to form the acronym

BITAOC. The BITAOC criteria should all be in the root definition statement. For example, this project is owned by this *owner* who deals with the *transformation*. The core agents involved in the project will be *implementers* and the underlying thinking behind the project is *assumptions*. The beneficiaries for the project are *beneficiaries* and the project will operate under the following sustainability issues and *constraints*.

By the end of this stage the team is gathered and the context is captured in rich pictures and a preliminary vision or reference condition of the project is agreed upon. The next task is to identify the main SIs and band of equilibrium that will measure the project's impact.

Step 2: Identify the main SIs and the band of equilibrium

SIs are subjective and dependent upon the stakeholder group and the dominant viewpoint of that group; but by including representatives across the project the intention is that the SIs conform to a holistic worldview. In Chapter 1 we discussed a range of quantitative approaches to SIs. These usually relate to the precise measurement of the project's features, which can be measured and which provide a view of long-term (anything from 5 to 20 years) sustainability. The International Institute for Sustainable Development (IISD) describe sustainability as:

> *Sustainable development is not a 'fixed state of harmony'. Rather, it is an ongoing process of evolution in which people take actions leading to development that meets their current needs without compromising the ability of future generations to meet their own needs.* (Hardi and Zdan, 1997, p9)

At this point it is important to describe what we expect an SI to indicate. In Chapters 2 and 5 we described the DPSIR, or drivers, pressure, state, impact and response SIs and explored the current interest in the development of pressures SIs, in particular, as a means of explaining sustainable or unsustainable activities and outcomes. Here we argue that state and impact SIs should largely describe project impacts, whereas driver, pressure and response SIs are more exploratory and analytical. Presenting state SIs without any understanding of what could be influencing them is of little use in practice, both in terms of policy or managerial intervention, but also in terms of learning and shared understanding. We suggest that SIs of impact, being largely descriptive, are relatively less difficult to agree upon and initiate. They provide the 'snapshot' of sustainable or unsustainable development. However, driver, pressure and response SIs, linked to SIs of state and impact, while being more complex and difficult to initiate, provide projects with more information

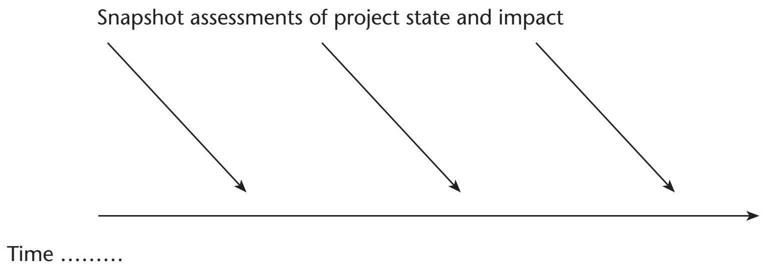


Figure 6.9 *State and impact SIs*

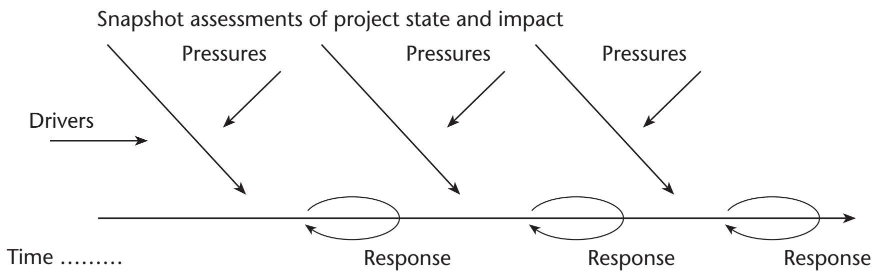


Figure 6.10 *DPSIR indicators*

about the factors affecting the achievement or non-achievement of sustainable development. The problem is that a state or impact SI can be influenced by a number of pressures. Figure 6.9 demonstrates the use of state SIs over time. Figure 6.10 indicates how driver, pressure and response SIs relate to state and impact SIs in our approach.

We therefore argue that impact and state SIs are the primary measure applied to sustainability projects, but that drivers, pressure and response (DPR) SIs may be developed at a later stage by the project team in order to help the team understand what the state SIs are describing – and thus to explain exactly what influences and drives the state and impact SIs.

Beyond DPSIR SIs, we could differentiate between internal and external process SIs (i.e. internal and external to the project boundary). Internal process SIs would necessarily be controlled by the project. External SIs would deal with factors beyond the project's direct control, as shown in Figure 6.11.

The project's ability to control DPR SIs will vary; in some cases, internal DPR SIs may be less controllable than external DPR SIs. We might represent the degree of control in terms of thickness of arrow, as shown in Figure 6.12.

This may all seem rather theoretical and abstract; to develop the concept Figure 6.13 shows the way in which state, internal and external SIs might be considered in terms of the River Cynon example discussed in Chapter 2. Note that in this example we set out SIs for the purpose of explanation only.

In terms of developing SIs, some practical issues need to be explored. As we have already mentioned, SIs of impact are relatively less difficult to develop,

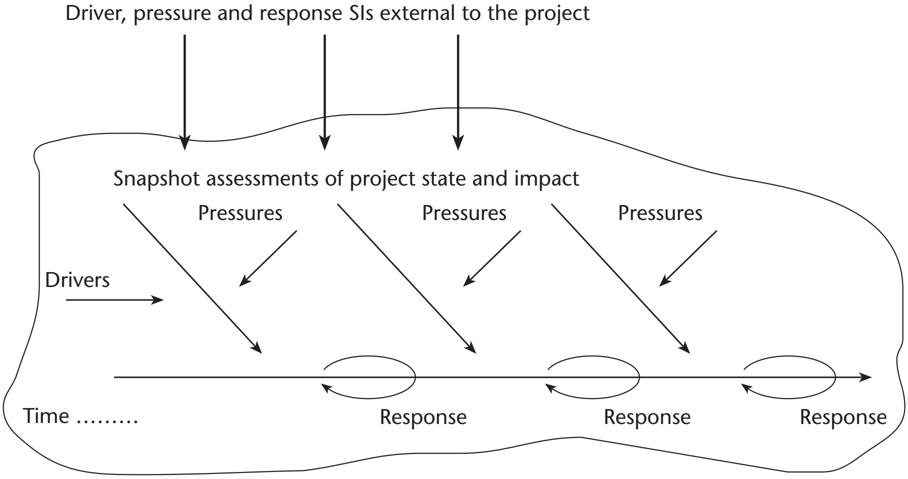


Figure 6.11 *Internal and external SIs*

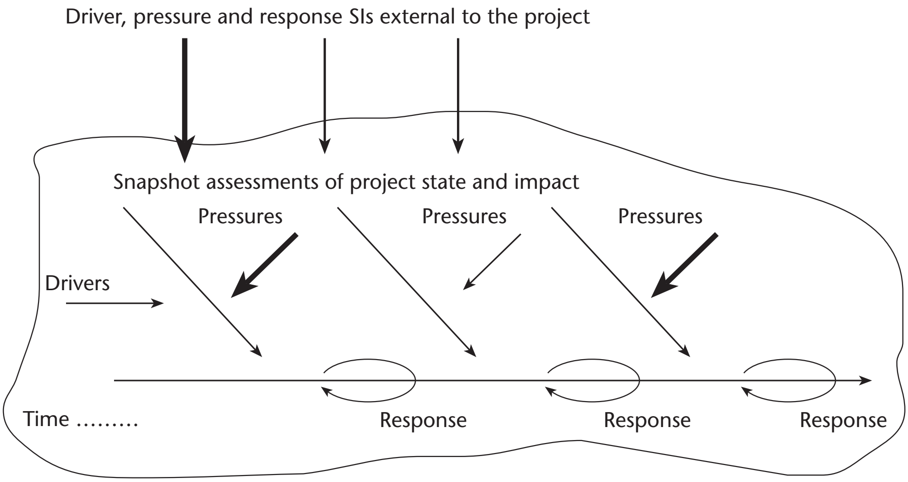


Figure 6.12 *Relative controllability of internal and external DPR SIs*

whereas external pressure SIs are more challenging. A project team might begin the SI development with impact SIs and then develop related pressure SIs as the team becomes well grounded, trust increases and clear insight in the project process correspondingly improves. Therefore, without being prescriptive, we would expect the range of SIs to develop over time, moving from SIs of impact to SIs that measure pressure, drivers and responses (PDR). The analysis of the team itself and its sustainability is an issue requiring the ability of the team to reflect and analyse its own behaviour. We shall return to PDR SIs in Chapter 7. The discussion relating to SIs, and taking the discussion forward from theory to practice, is shown in Figure 6.14.

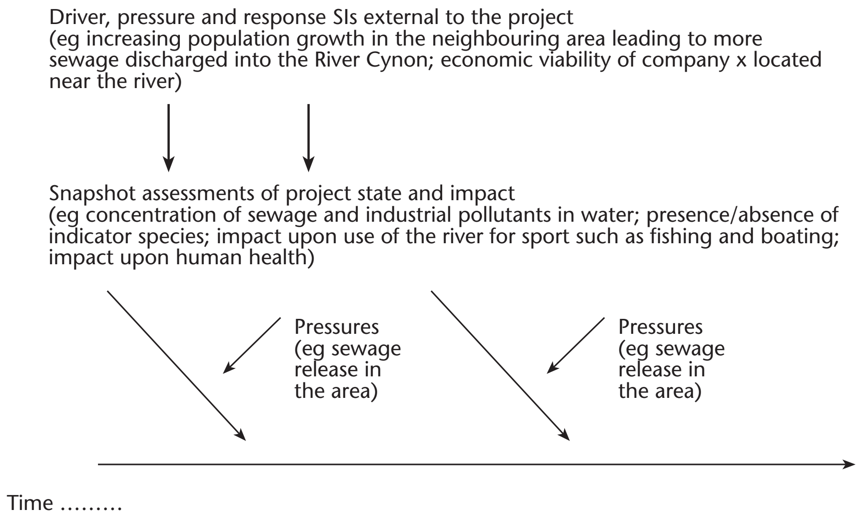


Figure 6.13 *The River Cynon project and SIs*

At the outset the indicators should gauge whether the project is meeting its impact criteria and is achieving the transformation as set out in the root definition, without – at the same time – leaving the resource for the project 'depleted or permanently damaged' (from a definition of sustainability taken from Webster's *New International Dictionary*).

To this end we need to clearly define SIs and to be aware that in so far as SIs comprise different types (as described in Chapters 1, 2, 3, 5 and above), they describe different things and indicate differences in the maturity of the project in question.

In line with the critique made in Chapter 3 of an overemphasis on institutional sustainability, we focus in this chapter on SIs of impact and pressure

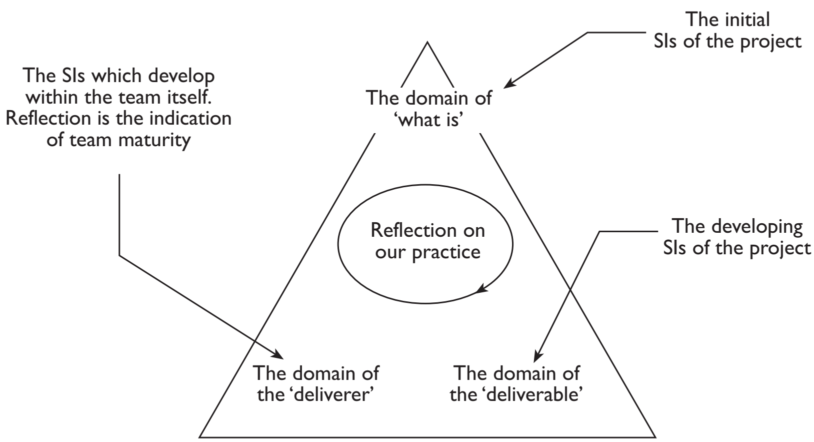


Figure 6.14 *Different types of SIs evolving in the project*

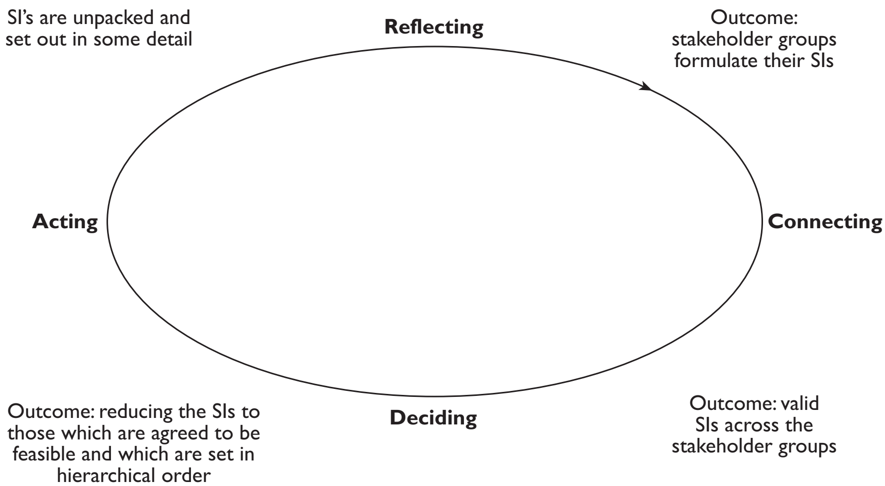


Figure 6.15 *The SI learning cycle*

relating to the deliverable: the actions and transformations of the project. Examples of state and pressure SIs are provided in Chapter 1. The means of achieving an understanding of the nature of SIs are many and varied and the reader may wish to make use of well-known approaches. In this book, based now on our practice in the Mediterranean and the UK, we have approached the process of identifying SIs by using an explicit 'Kolb' learning cycle. The cycle is shown in Figure 6.15.

The cycle is set out in the following sub-sections.

Reflecting

The team breaks up into groups, reflecting the different and, whenever possible, disparate stakeholder groups within the context. Each group reflects upon the initial SIs needed from their perspective. A group of scientists, social scientists and policy-makers might come up with the type of indicators that we identified within Chapters 1, 2 and 3. Local people usually come up with indicators related to conceptions of welfare and social improvement (quality of life) that are not strictly measurable in an absolute sense (see Chapter 1). Donors often come up with indicators of profitability or returns on loans (see Chapter 3). Each group has to keep in mind that despite subjective interest and personal bias, there needs to be a 'meshing' between the transformation and the identification of factors that would indicate permanent damage to resources within the project context. The question to be addressed is: 'What are we going to change and what might this impact upon?' In our experience it is often best if each group has the assistance of a facilitator who is responsible for keeping the conversation on track and acts as a neutral reporter for the next stage. The importance of the role of the facilitator is hard to overemphasize, as well as the skills needed to manage both the presenting issues and conversations, but also the 'music behind the words' (comment attributed to Harold Bridger). This idea of facilitating the explicit and implicit dynamics of the group or team is an important point. If the team is allowed to avoid its own issues, which are often subliminal, within the team conversation, then a good rate of progress may be made – but this will be at the price of dealing with the team's real concerns. Nevertheless, great care does need to be taken to avoid a facilitator driving the process in a particular direction. This is a point which is frequently unrecognized in participatory approaches. The facilitator is assumed to be an 'honest broker': someone who is only interested in the 'truth' and an altruistic seeking of consensus. But human beings are not like that and it is impossible for a facilitator to be removed from the process. Facilitators need to be clear about their position in the process. In the psycho-dynamic tradition, sensitivities regarding the consultant/facilitator are well understood and attention is paid to managing the role including issues pertaining to the dynamics between the group and the facilitator. Risks of the facilitator becoming the proxy group leader or, conversely, the group scapegoat need careful pre-planning, and contingencies need to be considered in advance of the group's engaging in collaboration. In the psycho-dynamic tradition much potential trouble is avoided by allocating time in advance of group work for the facilitator/consultant to 'internalize' the group membership – a process by which the various members of the group and their likely agendas and proclivities are considered in terms of the group and the role of the consultant.

The outcome of this stage is the development of a set of indicators. At this point in the process we are not concerned with their feasibility or contentiousness. The focus is on good indicators that tell us if the project's long-term sustainability is being achieved. The outcome is a set of indicators that are focused but may well be 'outrageous' (in the sense of reaction to them by other stakeholders). For example, in a project in higher education in West Africa, stakeholders suggested indicators that were plainly not feasible, which related to counting students in classrooms according to their use of the seating throughout each semester. However, although the method devised by the stakeholders was not practical (in terms of employing 'counters' and in verifying the results), raising the issue encouraged debate, which in turn resulted in feasible (if less ambitious) indicators being produced by the entire project team at a later date. We will deal with the notion of long-term sustainability shortly. Similarly, in a Blue Plan coastal project in Malta, different groups representing ecology, tourism and fishing interests came up with indicators that were clearly unacceptable to other stakeholders. But the very development of the indicators helped the team as a whole to become more mindful of the assumptions which they were making.

Connecting

At this stage the team makes connections between disparate aspects arrived at so far. The various groups come together and present the SIs that have arisen. The SIs should and often do represent a vast cross-section of views and counterviews. They include soft and hard methodologies and no methodology at all. There will be a range of thinking processes that cover the range of stakeholders in the project context. The project team has voiced its variations in approach and thinking during the opening stages; but it is at this stage that real differences of approach emerge and potential areas of conflict and outcome can and do often arise. This is to be expected, although as in the reflecting stage it also requires skilful facilitation to help keep the process going and to keep people involved. From a study made in Pakistan (Bell, 1996a), it was found that even highly diverse groups of stakeholders could be brought together to form useful focus groups, providing mutually satisfying insights. This experience was echoed and repeated in various locations when the Imagine approach was applied – for example, in the Lebanon and in the UK. The variations noted here are the real variations that exist within most projects and which are often not addressed. The connecting stage is a learning opportunity for all involved in the project to understand what development, transformation and sustainability mean to different people with different mindsets and different needs from the project effort.

There are few short ways of developing SIs. The facilitators need to map out (from past experience, we have found it useful to make use of 'post-it' pads) the core SIs (irrespective of feasibility and cost). The team then needs to agree on the following questions:

- Is the SI real? Does it exist for all the team or is it an idea which some of the team do not recognize? This is often a problem; therefore, this is the first question. The SIs as quantitative measures produced by subject specialists often mean nothing to local people and vice versa. An SI that is not perceived as realistic needs describing, discussing and explaining. At the end of this process it may well be real to all or it may need to be changed or dropped.
- Does the SI tell us something about the impact of the project upon the context?
- Does the SI, reviewed over time, tell us something about the sustainability of the context over history and possibly as projected into the future? This is an important point. Sustainability involves the maintenance or continuity of project outcomes over time. An SI can relate to a short-term gain (such as yield increases due to massive fertilizer input); but such an SI will quickly become redundant when the project ceases and fertilizer is no longer available. The focus of this stage in the Imagine process is to provide the project with SIs that will be collectable, viable and feasible for an indefinite period. If this is not the case, the SI itself is non-sustainable. Selected SIs should show little redundancy (ideally) and be robust in terms of long-

1	Public waste removal
2	Percentage of households connected to a public sewage system
3	Proportion of active working population
4	Daily migration/number of active working force
5	Ageing index
6	Education structure of inhabitants (percentage of higher education)
7	Number of arrivals and nights of tourists per 100 inhabitants
8	Number of tourist beds per 100 inhabitants
9	Gross income tax base per capita
10	Business – net profits/loss per employee

Source: adapted from Maher (2006, p14)

Figure 6.16 *A collection of 'valid' SIs*

term durability. To some extent, this means that SIs provide projects with continuity beyond their lifetime, and this in turn means that the SI encourages sustainability.

As each SI is discussed by the team it is either adopted – in which case it appears on a post-it on the wall – or it is changed so that it can be adopted, or it is dropped. The end of the connecting stage is for the team to learn about the whole project context, to develop wide-ranging state SIs and to agree on the validity (not yet feasibility) of these SIs. Therefore, the outcome is a set of 'valid' SIs. Figure 6.16 shows an example of a post-it collection of 'valid' SIs based on the experience of a team working in Slovenia.

Deciding

This is the third stage of the learning cycle. During this stage the issues of feasibility and hierarchy are dealt with by the team. It is agreed that the SIs are valid; now each SI is looked at in terms of the following:

- Can we get at or construct the information that we need for the SI? We do not necessarily need to know about data for quantitative SIs. We are not assuming that all SIs are quantitative. Instead, we need to know if we can get at data of a qualitative or quantitative format (e.g. yield data or conversations with farmers).
- What is the cost of getting at this information? Part of the issue of feasibility is cost. There are numerous ways of measuring a project for impact or sustainability, but they are of little use if the cost involved in getting the information is disproportionate to the value of the information gained.

- How important an SI is this? Does it rate a position in the top 10, 20 or 30? This may seem an arbitrary operation; but it is important. Part of the process of gaining clear and valuable SIs is to focus on the key sustainability issues which give the greatest insight into the project. Fifty or 60 SIs would require a considerable effort from a small project. As a rule of thumb, 20 to 30 should be adequate so long as they cross the full (whole) breadth of the project's concerns and stakeholder interests. In this sense we are ranking SIs in terms of importance (see the River Cynon example discussed in Chapter 2: should trout be seen as more important than a midge?; or Ten Brink et al's (1991) AMOEBA: are bottle-nosed dolphins more important than sea potatoes?). Because this analysis is explicitly subjective, we are building in the importance that the project team and wider stakeholders put upon the SIs.

At the end of this deciding stage the team should be confident that they have outlined the top 30 or so SIs which the project will use as its measures of sustainability in terms of impact (eventually this will include process).

Acting

This is the fourth element of the learning cycle – which in our approach is concerned with unpacking each of the selected and verified SIs in some detail. To be able to establish equilibrium, which is the main focus of the next stage, each of the agreed SIs needs to be taken back to the small stakeholder groups and worked through in detail. Core elements that should be worked out here are:

- What is the procedure for producing the SI?
- What is the expected band of output from the SI? This is vital. What does the subgroup expect the SI to produce? For example, for a yield-related SI, what would be the maximum and the minimum yields which one might expect? If it were a focus group of farmers discussing the uses of scrub land, what would be the extremes that such a group might produce? If it were a group of managers describing their responses to automation, what might be the extreme that the team would expect?

After the SIs have been identified, we can go on to attempt to identify the major processes that influence or 'drive' that SI. This can be an important element of the unpacking. With the unpacking of the SIs, this stage of the approach is completed. If the facilitator has managed to keep the team together through the workshop, then considerable progress may well have been made. For example:

- There should be a clear vision of the project and agreement on the basis for SIs.
- A representative stakeholder group has been formed.
- A view of the sustainable project transformation has been arrived at.
- Each set of stakeholders has agreed upon a common store of SIs related to the project transformation.
- The SIs have been explained to the team as a whole, and relevant and feasible SIs have been agreed upon as the basis for the SSA.
- The potential range of responses for each SI has been agreed upon.

The next stage is to consider what measures conform to being sustainable (the band of equilibrium for each indicator)

Identify the band of equilibrium/the reference position

We prefer to use the term 'band of equilibrium' instead of reference condition. Equilibrium is a contentious phrase with many applied meanings derived from academics and practitioners who work on the theme of sustainability. We take our definition from Webster: 'a: a state of intellectual or emotional balance; poise, b: a state of adjustment between opposing or divergent influences or elements' (Webster, 1995). The intention is to acknowledge different perspectives as to what is 'sustainable' and, hence, stress a sense of compromise. Reference condition is often used to imply an objective, scientifically derived point of sustainability. It suggests that 'science' knows what the target is and all the stakeholders can do is to help derive the best way of getting there. We go further than this and suggest that the power for setting the target also needs to be in the hands of stakeholders.

At the end of the last stage, the small groups of stakeholders were unpacking each of the SIs. During this process the range for each SI was established. For example, consider an SI which covers a local population's response to healthcare. The SI has been provided by local stakeholders from rural communities involved in a project focusing on infrastructure improvements in a developing country. The SI is centred on the perception of local focus groups establishing better health within their families. The continuum for the SI is agreed as taking in a range of related factors and processes, such as child mortality and prevalence of infant disease. The bottom of the continuum would indicate that local healthcare was as bad as ten years ago when the area was subject to prolonged drought. The top of the range for the SI would be to indicate that the factors were of little to no concern. The focus group would be senior women within the community. In this case the band of equilibrium, which would indicate a sustainable state of affairs, was a qualitative assessment (see Figure 6.17) with the focus group.

As we show in Figure 6.17, equilibrium is integrally related to the management of people's expectations. We deal with this issue more fully in Chapter 7.

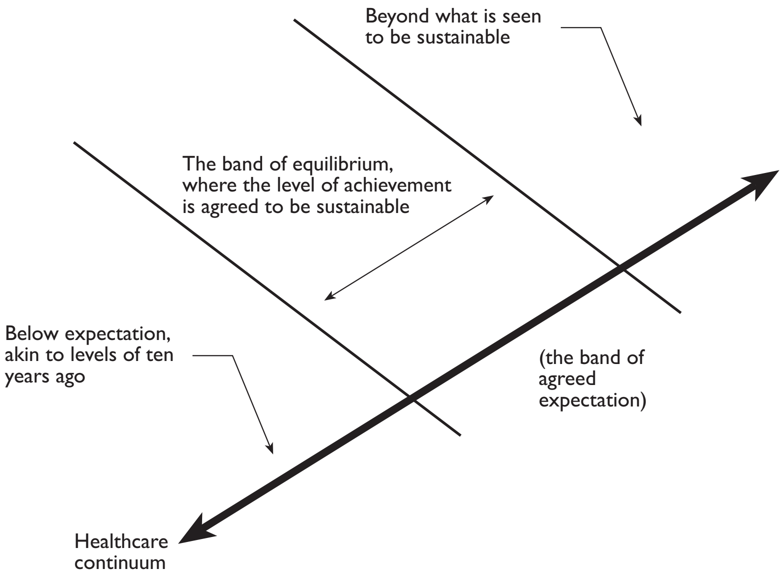


Figure 6.17 *The SI continuum*

The equilibrium band is reasonably well expressed in terms of its definition 'below expectation' range. It is not so easy to define equilibrium in terms of 'beyond the sustainable'. It will be the job of a facilitator working on the project to tease out this response from the group. The equilibrium band sets out the target or reference position for the project; but this band should be more realistic and useful than those used by Ten Brink et al (1991) and described in Chapter 2: it has been agreed upon and is known to be relevant to local people. It is an intrinsic target for the project and the indicator is thus defensible in encouraging the necessary behaviour for its achievement.

Another SI might relate to sustainable levels of education. This might be more quantitatively arrived at. Because statistics on attendance and achievement are readily available in the project area, the SI provides a quantitative measure of what is less than sustainable equilibrium in education. The process is very much one of expectation management. The figures are worked out with the local community who know what is possible (given the other callings on the children, such as farm labour and other forms of paid employment). A second continuum is produced for this new SI. The team needs to provide such a continuum for each state and process SI, indicating a broad band of responses (qualitative or quantitative) that indicates a sustainable level of progress. The team also needs to produce the outline of responses that are non-sustainable in terms of overachieving or underachieving from the band. Figure 6.18 shows the minimum and maximum points of the band of equilibrium for the Slovenian indicators that we have already described.

This can be a lengthy process with a great deal of discourse within the team about what is and is not the limit of the equilibrium (and, therefore,

		Band of equilibrium	
1	Public waste removal	12	20
2	Percentage of households connected to a public sewage system	80	90
3	Proportion of active working population	40	70
4	Daily migration/number of active working force	1500	2500
5	Ageing index	35	50
6	Education structure of inhabitants (percentage of higher education)	20	30
7	Number of arrivals and nights of tourists per 100 inhabitants	250	350
8	Number of tourist beds per 100 inhabitants	5	8
9	Gross income tax base per capita	105	130
10	Business – net profits/loss per employee	300	600

Source: Maher (2006, p14)

Figure 6.18 *Band of equilibrium for SIs*

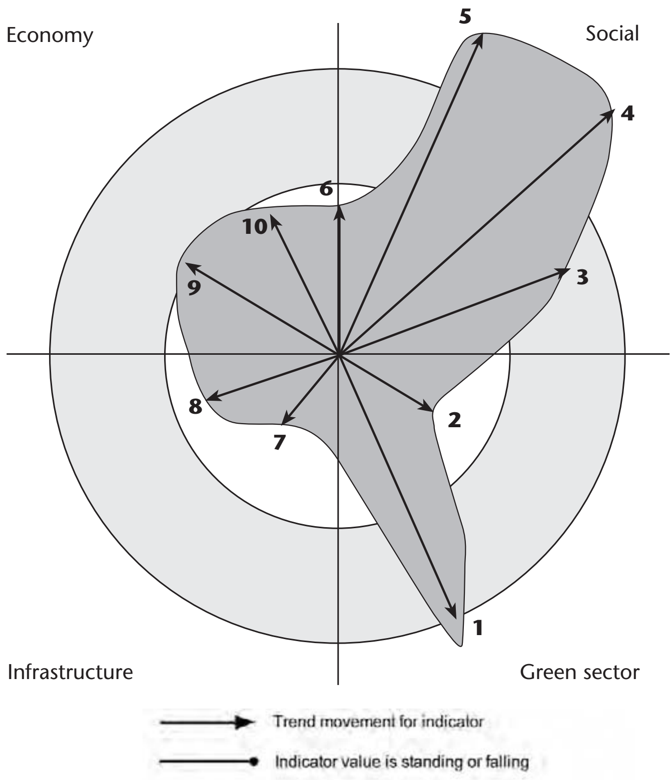
'sustainability') band. This is to be expected. While researching for and writing this book, and while exploring the use of the Imagine approach in the UK and in the Mediterranean, the authors have been struck by the difficulty that various academic and practitioner communities have had in coming to any agreement about what constitutes sustainability. This is not because of perverse pride on the side of the communities; rather, it is because sustainability is a difficult term to tie down. Nevertheless, time spent at this stage on this problem is time saved for the project as a whole. We suggest that understanding what each SI measures and what each SI means by sustainability will lead to insights into what is realistically achievable within the project context.

The output of this stage of the approach is substantial detail on, and ranking of, the state and process SIs and the establishment of the equilibrium band.

Step 3: The development of AMOEBA and scenario-making

The concept of AMOEBA as set out in Chapters 2 and 5 (and as extended and developed under a different label – for example, in the work of Clayton and Radcliffe, 1996) is relatively simple. We use it here as a device to map out the series of SIs as a simple graphic guide to the sustainability of outcomes of the project in question; but any similar device would equally do.

In the previous section we showed how, for each SI, a band of equilibrium was indicated on a continuum ranging from severely lower than equilibrium to substantially beyond equilibrium. The AMOEBA is used to represent these SIs



Note: grey belt indicates outer limits of the band of equilibrium.
Source: adapted from Maher (2006, p15)

Figure 6.19 *The equilibrium band: Drawing the SIs*

in their initial state (see Figure 6.19). The three general bands are: not sustainable by deficit; not sustainable by surfeit; and the equilibrium band itself. SIs can be placed anywhere in the circle; but in our example, which relates to a multi-sectoral sustainability project, the SIs are grouped in four categories of economic, social, tourism and environment. These sectors were decided upon by those attending the workshops.

In the example we can view an immediate, visual expression of the sustainability context of the project, with a clear view that tourism and social-sector SIs indicate that the project is not achieving sustainable outcomes – in the one case by being in deficit and in the other by largely being in excess. In contrast, the economic indicators show a tendency towards sustainability. The environmental indicators seem most confused.

AMOEBAE may well not be as neat as this one. It is often best to produce the diagram by hand in the first case, allowing those in the room to experience the figure coming together. This can result in some astonishingly revealing 'Ahaa!' moments for those drawing the picture. In this sense, the AMOEBA

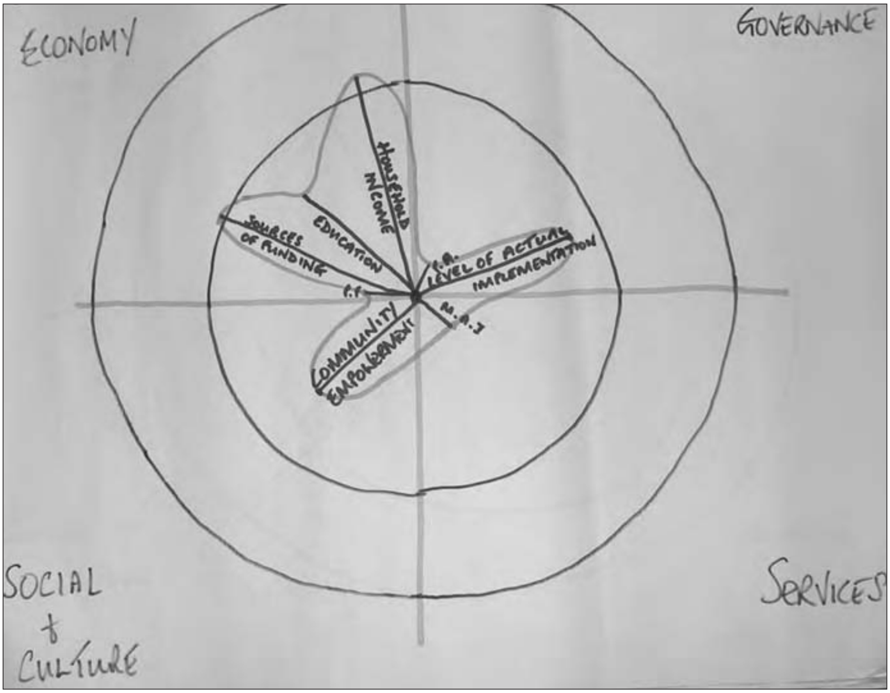


Figure 6.20 *Hand-drawn AMOEBA*

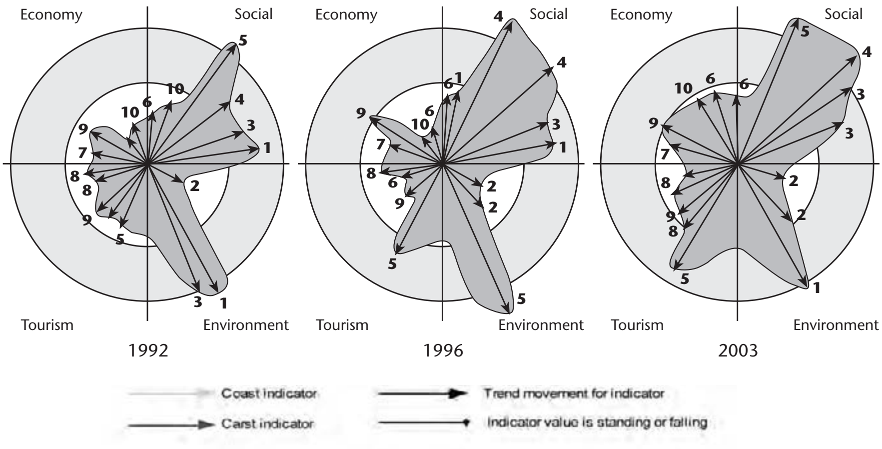
diagram is a revelatory tool, helping those attending the workshop to learn how sustainable or unsustainable their context is; for an example, see Figure 6.20 relating to a UK context.

The team now has an information product, the means to produce this, agreed SIs, agreed and verified feasible rules for the production of the SIs, and, most importantly, a team who will continue to produce the AMOEBA over time.

Snapshot by snapshot extension over time

Each time the AMOEBA is drawn from a project review by stakeholders, it gives an indication of the sustainability of a project in a snapshot. Over a period of time, the AMOEBA might move over the surface of the quadrants, with each significant movement indicated by the SIs. As the project progresses the AMOEBA can be drawn and redrawn, with attention paid to the indicators that are not in equilibrium. An example of three such AMOEBAE is shown in Figure 6.21.

AMOEBAE can change shape. Depending upon the context and the decision-making of the team, they can move over the quadrant surface as the project focus changes – for example, from tourism issues to environment and back. The more the AMOEBA imitates a perfect circle within the equilibrium



Note: grey belt indicates outer limits of the band of equilibrium.
Source: adapted from Maher (2006, p17)

Figure 6.21 *Extending the AMOEBA over time*

band, the more the context tends towards sustainability. We would, however, disagree with any tendency (such as that shown by Ten Brink et al, 1991, with the Ecological Dow Jones Index) to reduce the complexity of the AMOEBA to a single value: such as sustainability = 42, as illustrated in Chapter 2. This loses detail and could mean that vital indicators are ignored; thus, their reason for being produced in the first place is negated. The effective use of the AMOEBA as an indicator of moving towards or away from stakeholder understanding of sustainability is the basic theory behind the AMOEBA and the equilibrium band – it should be the informing principle behind the approach.

Assess the AMOEBA for its meaning

As with all presentational aids, AMOEBA does not tell the whole story about the project in question. It is a means of displaying how SIs are performing according to a common format. However, we intend the AMOEBA to be an informing device, the results of which will form future action. At a simplistic level, the ideal AMOEBA is a perfect circle within the equilibrium ring; but this is also a problematic point, as we shall see. The action arising from analysing AMOEBA can be preventative or corrective depending upon whether the SIs show an existing problem or a tendency towards a problem. It is important in all project developments to recognize that the AMOEBA is a device for presentation and not a representation of reality. We have tried, through including stakeholders and developing a wide range of SIs based upon all kinds of viewpoints, to make the AMOEBA represent a cross-section of sustainability issues within the project context – but this does not mean that the AMOEBA is anything more than an artificial gauge which will be more or less correct in each case. Use the results, but be wary. While Norwich 21 has not made use of AMOEBA at the time of writing, the experiences of the city are relevant and another anecdote from Norwich 21 is appropriate for inclusion here:

> *Our task will now be to retain the concept of simplicity in order to meet our main goal – that of engaging the general public in the concept of sustainability and giving them something concrete to measure it by. Already, certain interest groups are calling for sophistication with qualitative as well as quantitative data – despite the obvious difficulties. The key will be to remember our audience and to listen to what they have to say about the purpose and practicalities of developing measurements that chart the progress of their community over time.*
> (Liz Edwards, pers comm, 17 December 1997)

The authors would like to express their complete agreement with the sentiment of Liz Edwards' statement. The idea that local communities should own and develop their own view of sustainability via SIs is at the root of this book.

Scenario-making

At this stage in the Imagine process several prizes should have been gained:

- a functional and effective team or group;
- an agreed and shared view of the factors affecting sustainability in the group context;
- a set of indicators and bands of equilibrium that can be used to monitor this view of sustainability;
- present and past data and related AMOEBA diagrams.

The group can now start to develop their view of the possible futures that may arise from the current position. Scenario-making was introduced in Chapter 4 and its use in the Imagine approach is primarily to provide the sustainability analysis with the necessary tools to consider the long-term sustainability of the context in question. It is the observation of the authors that, despite good intentions and some evidence to the contrary, too much work in the sustainability domain is undertaken on mapping out the past and the trends of history, rather than in projecting these trends forward and considering their full implication. However, the scenario-making process is based upon the consideration of the import of the AMOEBA diagrams and the 'story' that they tell.

How to respond to good or bad news contained in the AMOEBA

Good news

An AMOEBA that shows a strong tendency towards equilibrium in all sectors indicates that the areas which we are monitoring appear to be progressing in a satisfactory way. However, this needs to be considered from at least two further standpoints – time and alternative view:

- In terms of time, an SI or a collection of SIs is a snapshot and nothing more. It is only when there is a selection of AMOEBA to make comparisons that the critical issue of change over time will be apparent.
- Alternative view: when all is well in most sectors, the right questions in the right areas are not always being asked. It is always sound to review the questions you are asking and the people and events you are focusing upon. A comfortable AMOEBA or a string of AMOEBA indicating that things are going well should prompt the question: 'What else might we look at or what might we look at differently?'

Bad news

A 'bad' AMOEBA can be seen as a good thing; the system is working and your question-asking process is throwing back problem areas where sustainability is not being achieved. If the measurement over time continues to highlight this, there will be a need for remedial action. Various lines of approach can be adopted; but we suggest that we make use again of the soft systems tools for developing an action plan. The checklist of responses to bad SIs can be set out as follows:

- Identify SIs that are 'poor' by deficit of surfeit.
- Identify tasks that the poor SIs indicate. An SI is not just a flag, marking some problem; it should also point the way to a course of action. A rich picture of the SI context might be useful, setting out the structures and processes which such a result would indicate – for example, an SI in an organization adopting new information technology. The SI measures the adoption of information products by staff. The sustainable level is not being achieved; staff are overwhelming the system with inquiries. The rich picture for such a scenario would include structures such as making use of the system, processes such as use rates, spread of knowledge about the new system, and training procedures in systems use. Identifying major tasks indicates the areas on which the project team need to focus in order to improve the function of the SI (presuming that we now have confirmed that the SI indicated a real problem and that it was not a case of a poor SI reporting badly).

- Following the identification of the major tasks, the team can produce a new root definition that sets out the transformation which should improve the functioning of the project in the light of the poor SI.
- The team can then set out an activity plan or conceptual model that describes the actions which are now required to bring about the transformation. For example, if the result of the root definition work is that the main problem is poor training of staff leading to overuse of the system, then the conceptual model might describe how the transformation of increased systems awareness, skills adoption and practical experience in the use of the information system can be achieved.

If the SI was seen to work well, to flag a real issue and to indicate a real problem for the sustainability of the project, then it can be switched on again and, following another cycle (three months, six months, or whatever), the SI can be tested to see if the remedial action has brought about an improvement in the state of affairs.

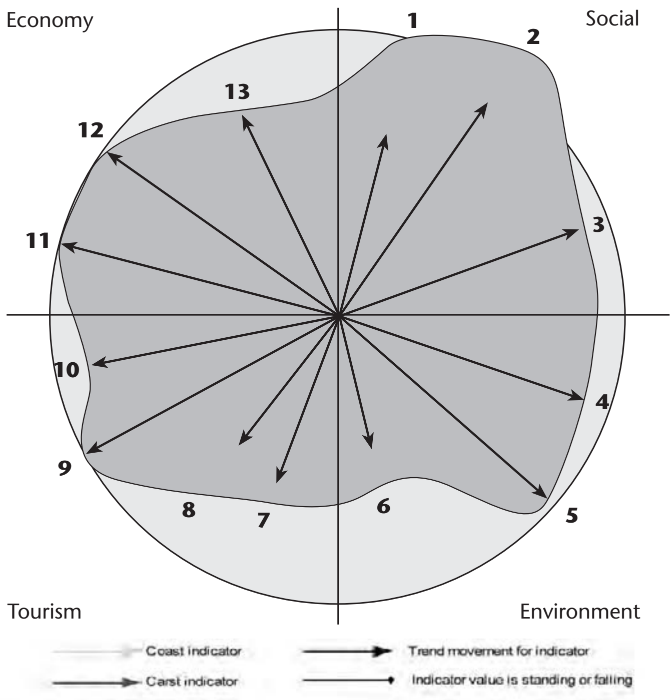
Following the assessment of the AMOEBA the team can engage in some preliminary scenario-making. The process as experienced in our work tends to follow along two lines.

First, the team is asked to draw a series of rich pictures based upon a 'catchy title'. The title may well capture some future condition based upon a trend in some or all of the indicators. The team engages in a detailed discussion concerning the outcome of existing and agreed trends on a 10- or 15-year time horizon. The rich pictures produced may represent a variety of different scenarios – some positive and some negative.

Second, those working on the pictures will be asked to represent the pictures by means of their suggested AMOEBA. By this means the indicators are reviewed and their values at the future time assessed. The new scenario AMOEBA will provide a vision of how things could be if certain trends prevail.

It should be noted that teams are encouraged to come up with multiple scenarios for the future depending upon their own experiences and expectations of trends. This is a valuable exercise in itself – it awakens a sense that the future is in the hands of those involved and change in behaviour can bring about either a worsening or an improvement. However, at this point the team may wish to select one specific scenario as the most likely. This will form an important conclusion for later discussion.

An example of a scenario AMOEBA taken from Slovenia is shown in Figure 6.22. This can instantly be seen as being a positive scenario with the arms of the AMOEBA generally residing in or near the band of equilibrium. However, such an AMOEBA will come with requirements for its attainment (or for its avoidance if it is a negative AMOEBA). The development of these requirements is the subject of the following two steps of the approach.



Note: grey belt indicates outer limits of the band of equilibrium.
Source: adapted from Maher (2006, p38)

Figure 6.22 *'Promising land' scenario AMOEBA from Slovenia*

Step 4: Review and meta-scenario-making

Within the Imagine approach the fourth step is an opportunity to take breath, assess the importance of what has been learned so far and provide some outreach to those outside the core team, but who would be interested in learning more about the findings to date. In this sense it is also an opportunity for the core team to consider the 'message' that they wish to share. This is the first step in considering the informational importance of the learning.

At this stage, two significant activities take place. First, a public meeting of some kind is organized to enable the team to present its findings and major learning. This process has a number of virtuous outcomes since it:

- requires the team to translate its understandings into a format which can be readily understood by the public at large;
- offers the opportunity to select the key outcomes;
- allows the public to comment on and criticize the process and outcomes;
- enables the team to better assess the importance of their work to date.

The team can benefit from this process of review and challenge and this will allow them to formalize their final 'position' on the Imagine process so far.

Following the public meeting, the team can reconsider the information and outcomes developed and arrive at a new 'meta-scenario' for the future. The meta-scenario is the agreed and overall scenario which the team believes to be the likely outcome from the current position; but, of course, the team may also wish to acknowledge that the 'confidence limits' of this scenario are wide – hence, confidence in this one projection might be fragile.

Step 5: Publicity, publicizing and marketing the message – influencing policy

The final step of the first iteration of Imagine is publicizing the outcomes of the approach and influencing policy following reflection on the learning. The Imagine approach is primarily a learning cycle, a means to co-understand and co-learn with others and come to agreed understandings of the past, present and possibly future conditions of sustainability for the context under consideration. However, this understanding is more or less of no value if the messages contained in the sustainability story are consigned to the vast archive of under-utilized reports on the subject. To join this 'lost library' may be academically interesting; but it is practically useless. The challenge of the fifth step is to get the message out and influence policy.

In step 5 the team identify:

- the preferred indicators and related scenarios;
- the potential consumers of this information;
- a suitable means for promoting the product to the customer.

In undertaking this work the team will build upon the lessons they learned from their experiences of step 4 when they first invited the public to review and comment on the work undertaken so far. Now in step 5 the message is refined and the process is established. Table 6.2 shows the top ten messages which the team in Slovenia wanted to broadcast to their identified customers. The team, in this case, has also prioritized the messages.

Step 5 should result in affirmative action towards the sustainable goals of the community. In this manner the approach allows a team not just to engage with the difficult and conflicting issues of sustainability that challenge them, but also to engage with the wider community in considering ways and means of arriving at a more sustainable future.

It is here, of course, that one of the central limitations of any participatory methodology begins to emerge – the power of stakeholders to actually help bring about change. All too often the process ends with a glossy report summarizing the findings of the process and photographs of the teams and their rich pictures. The funder is satisfied – the facilitators move onto the next project –

Table 6.2 *Developing the message for the customer*

	Messages	*Support Data*	*Priority*
1	Quality in 1/1000 of the Mediterranean	Rich pictures	2
2	Preservation of healthy environment	Environmental indicators Number of investments	1
3	Attracting potential investors for sustainable development goals	Scenarios AMOEBAs Rich pictures	5
4	Connecting Brkini, Coast and Carst (brand name BOK from Slovene language, also acronym for better environment and quality)	All statistical data for SIs	3
5	To preserve and sustain our own identity (cultural landscape and heritage, traditional products and services, multi-ethnic society, etc.)	Environmental indicators Rich pictures Investments in protected areas	6
6	University of Primorska – the mega market of knowledge (demand, exchange and offer of knowledge; meeting point between business, local population, government and professionals)	Scenarios AMOEBAs Rich pictures	4
7	Infrastructure is not just roads that connect people and places and their needs (traffic, energy management, drinking water supply, information link, etc.)	Presenting the negative scenario: we do not want that	7
8	Tourism involves people and the environment (natives, local business, natural and cultural landscape)	SIs and AMOEBAs	10
9	Agreement about the boundaries in such a way that our possibilities will be unlimited	Rich pictures Mission statement Spatial order of Slovenia	8
10	Sea – cradle of life and/or salt polygon	SIs AMOEBAs	9

Source: adapted from Maher (2006, p48)

and the stakeholders have had an interesting time and get back to their busy lives. But what change comes about from all of this? It's easy to say that many would have learned valuable lessons, and the learning potential of any participatory process should not be underestimated. Indeed, we have argued elsewhere that project donors often place far too little emphasis on stakeholder learning as a valid project outcome in itself. But the danger is that the circle closes and the process goes nowhere.

Step 5 is thus one of the most critical in the whole process; but the danger is that it is also the one that is most neglected. The circle needs to become a spiral of action, and we suggest the following:

- The group as a whole identifies clear tasks that need to be done and by whom. This can, for example, include meetings with politicians or other policy-makers to communicate the findings of the process. It is here that the scenarios under steps 3 and 4 would potentially have the most power.
- A timetable is set for the activities. Without a clear timetable, action may drift.
- An agreed time is set where the group reconvenes, without the facilitators, to discuss progress. At this point it may be decided to reconvene as the original teams and revisit the steps of the Imagine approach. It may be, for example, that the scenarios developed by the teams have been rejected by the policy-makers as unlikely or unrealistic. So, how would this new information impact upon the sustainability analysis?

There is evidence from the Mediterranean from past Imagine projects that this kind of subsequent activity has taken place; but it is not easy. Those involved in the analysis will have busy lives, and meeting to take the outcomes forward requires commitment. But we argue that the project cannot be complete until this aspect is taken into account. Some may see this as an agenda for sustainability activism, and we have no problem with this.

Conclusion: Renewing the cycle

We have deliberately attempted in this chapter to develop a modest and limited example of an SSA – that of the Imagine approach as implemented in a number of contexts, but most notably in the Blue Plan projects of the Mediterranean. We have indicated that SIs work well in well-defined projects with clear boundaries and agreed goals. Given this, we have set out how our approach works, basing our thinking on systems and learning models that develop wide-ranging and variable pictures of the project context. Working in a participatory manner and seeking to understand what is important to the stakeholders in the project, we have set out a learning process for SI development and implementation. The result of this is not a perfect SI device. We make use of all types of information and do not have a narrow scientific focus for the work. For this reason the tool becomes more unmanageable as the frame expands and conflicts of interest between stakeholder groups emerge. Nevertheless, although we think that the tool has the virtue of developing SIs to inform the discussion of the stakeholder team, we also feel that the very process of setting up SIs will inform the community of the deep sustainability of the context, and therefore may indicate if there are fundamental problems which might otherwise be missed. In this sense the process of developing SIs is part of a virtuous cycle, with the SI itself encouraging sustainable practices and reflecting the result of such practice. In this case the SI becomes the means to the end as well as a simplified description of the context end itself. We argue that this approach is organic and people focused and can be sustained into second and even third iterations, each building upon and developing from the previous one. In this way the approach itself is sustainable.

The AMOEBA is one way of presenting SIs so that they have an initial impact upon the stakeholders in the context of the sustainability process. They are also provocative, since change over time can be used to encourage stakeholders to discuss what is going on in the project context. To this extent, Ten Brink et al (1991) made an important contribution to the development of SIs. We invite the reader to compare the AMOEBAs set out here with the lists of SIs that are presented in Chapter 1.

Finally, what about variations on the theme? The Imagine approach is one way of putting SSA into practice and is, of course, adaptable to circumstances. For example, since publication of the first edition of this book a number of readers have asked about the possibility of adapting an SSA-based approach to research. In this case, the aim of the analysis may not be to directly influence policy but to help generate a better understanding of sustainability within a system or perhaps even to purposely compare the perspectives of different groups. Thus, Step 5 may not be all that important; but the process of Step 4 could well be replaced by a meta-analysis teasing out commonalities and differences between stakeholders separated across space and time and/or positions within the system. In Steps 1 to 3 there may also need to be changes with perhaps a greater aspect of teams conducting their own analysis in isolation and avoidance of plenary sessions where teams share insights.

In the next chapter we develop our discussion of the Imagine approach and draw some conclusions from the book as a whole.

Part III

Where Next?
Humility and Honesty

7

Sustainability Indicators: The Rhetoric and the Reality

Introduction and objectives

Throughout the review and rewriting of this book we have been chasing a moving shadow called sustainability. This is a term that has achieved Olympian proportions in all brands of ecology, rural development, institutional continuance, and city- and nation-building. It is one of the words that characterized much of the thinking and anxiety of the latter half of the century and has denoted much of the international dialogue of the new millennium. Unfortunately for those charged with the business of making the word mean something fixed, understandable and enforceable, there is no single meaning and there is no agreement on how it is measured and recognized in an objective sense. The situation appears to be that, at the end of the 20th century, a word was decided upon to conjure up the desirable outcome of social and political endeavours. Scientists and professionals took (or were given) the impossible task of achieving definitive measurement of this word. The impossible task was to measure what was never potentially measurable: the immeasurable 'sustainability'.

In Chapters 1 to 3 we looked at some representative samples of this endeavour. From single indicator to multiple indicator to institutional indicators, from reductionist science through to focus groups, from small research organizations to the United Nations, we have tried to describe the history of SIs and their understandable failure to achieve an objectively verifiable scientific measurement of sustainability. Following the review of progress to date, we have explicitly argued for a systemic, participatory and subjective approach to SI development; in Chapters 4 and 5 we described what systemic approaches have to offer and their value *vis-à-vis* projects. We encapsulated this theory, and the assumptions that underpin it, in the term Systemic Sustainability Analysis (SSA). In Chapter 6 we set out one approach to SSA that has resulted in the Imagine methodology and have described the main steps of the process of developing participatory and holistic analysis. We have not sought to present

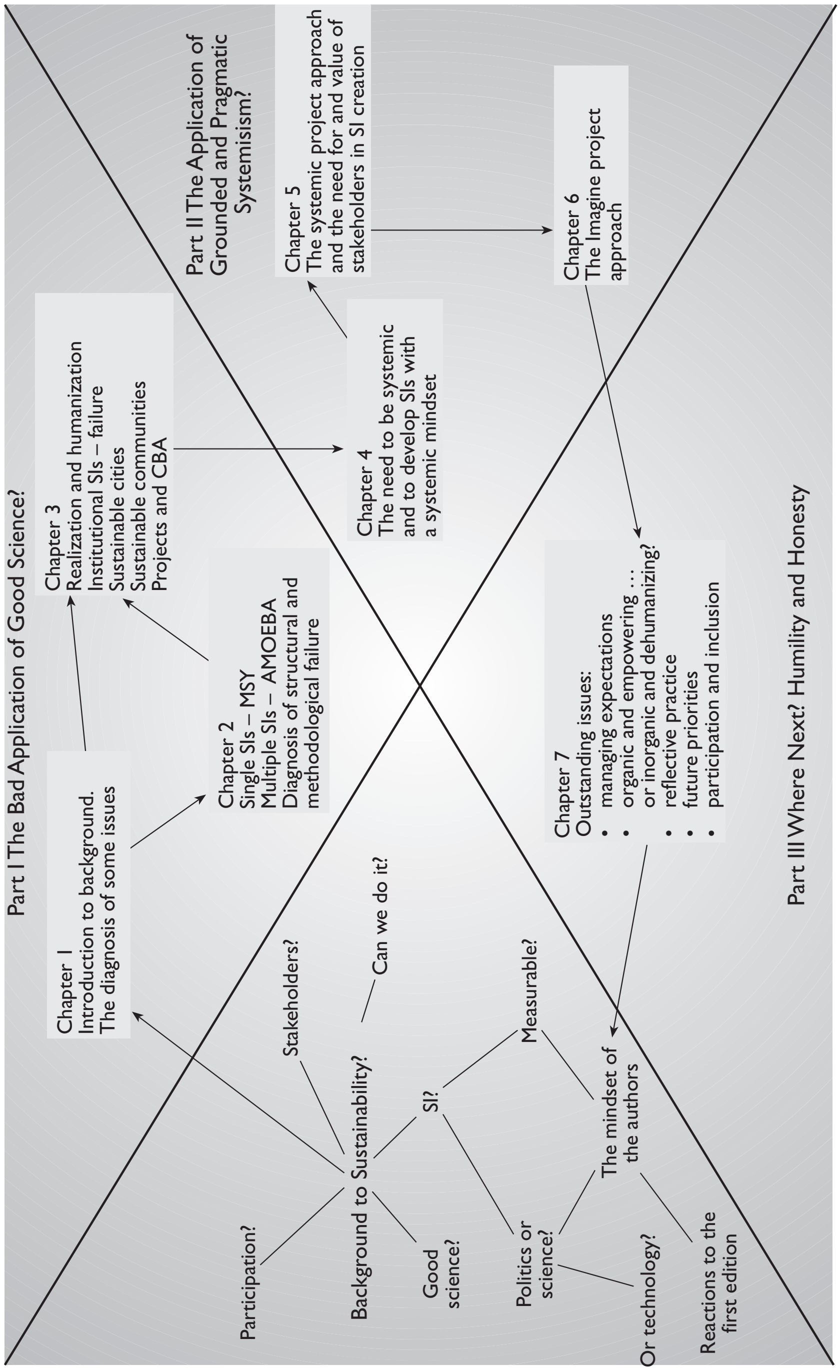


Figure C.7 *Chapter 7 in context*

Imagine as definitive or perfect, far from it. Rather, we have argued that it is an approach that has been shown to provide powerful outcomes, but is in need of still further application and development. SSA is the theory and Imagine is one important way of putting that theory into practice, and we readily acknowledge that Imagine was initially derived with one socio-spatial context in mind – coastal zone management in the Mediterranean. However, it is an approach that we believe will provide useful information to social groupings concerned with their own sustainability (as defined by these social groups), and this has been evidenced by the extension to Imagine to cover sustainable communities and organizations. We welcome further testing and further discussion.

So far, several items of interest have arisen and we wish to dedicate this last chapter to a review of those which we have found most provocative in our personal journey of discovery. The items we will deal with here are:

- managing expectation in the projectified world order;
- organic and empowering approaches compared to inorganic and dehumanizing approaches;
- culture change;
- the essential need for reflective practice;
- future research priorities.

Managing expectation in the projectified world order

In Chapter 6 we described a process for a group of stakeholders to arrive at a 'band of equilibrium'. In this chapter, Figure 6.17 appeared to be a culmination of this and we reproduce it again here with some additions (see Figure 7.1).

One addition to the diagram is the notion of a reasonable limit to expectation. We argue that one strength of SSA is that a stakeholder group has to agree to lower and upper limits to their expectations in terms of what can be achieved (in state and process terms). Both limits are problematic. Problems for the lower limit are mainly confined to defining an acceptable minimum. This idea has been represented in the UK with the political question of a minimum wage. What is the minimum wage below which UK workers are unable to sustain a reasonable standard of living, but which would not act as a disincentive for capital to invest in the UK economy or for labour to price itself out of work? Arriving at the sustainable figure could be the result of stakeholder discussion – in this case, government agencies, employers and employees as represented by the Confederation of British Industry (CBI) and the Trades Union Congress (TUC). The results of deliberation will hopefully be the 'agreed' figure, which will, by necessity, be a compromise. The non-participatory alternative would probably involve the appointment of a panel of experts to devise a figure to which stakeholder groups might or might not agree. In the participatory

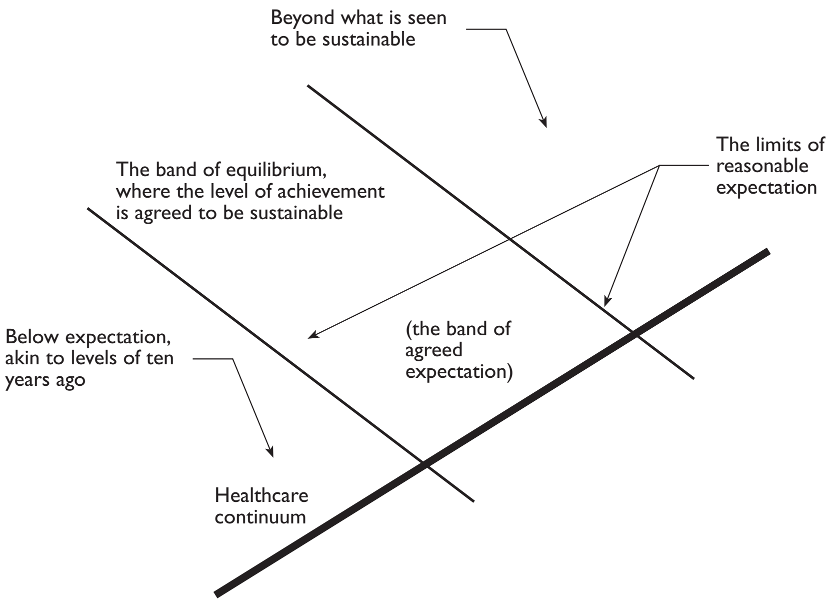


Figure 7.1 *Equilibrium and agreed expectations*

approach, expectation is explicit and to be bargained with. In the non-participatory approach, expectation is assumed to be known and discounted in deliberation by the expert panel. Governments across the world have caught onto this notion of inclusion and a number have embarked on 'conversations with the nation' on key policy points. Unfortunately, most of these conversations seem to have been strong on rhetoric and weak on evidence that the voice of the public has really been incorporated within, or is instrumental in, actual policy change. This is a common issue – just 'doing participation' does not mean that voices will eventually get listened to. At its worse, participation may be exploited as a means of strengthening a top-down vision of sustainability.

Upper-limit analysis is even more problematic in the view of the authors. To gain agreement on the upper limit is to gain insight into the preferences of social groupings, but while setting a reasonable limit to this expectation. A good example of an area that might profit from this type of approach is the UK Health Service. When it was originally set up shortly after World War II, the expectation was extremely limited in comparison to modern standards of what is possible in healthcare. The vision of most people was that the health service would patch up the individual in extreme illness, but that this would operate from 'cradle to grave'. Today, with mounting costs and expectations that are limitless (triple heart bypass, AIDS and cancer treatments), there is no agreed upper limit. The argument is not only financial, but moral and ethical, with a range of stakeholders from the government of the day, doctor and nurse representatives, patients and the general public. There needs to be an ongoing negotiation process comparing expectations in order to achieve sustainability.

What is the upper limit of expectation? This is a discussion that has proved too sensitive and has not yet been initiated in an open fashion in public forums other than those contained within a limited set of websites.

Sustainability indicators, as we have described them in Chapter 6, are intended to relate directly to issues such as these. The purpose of the SI exercise now becomes a discussion around the management of expectation. What is agreed to be sustainable? What effort can the health service sustain? What is the long-term cost of this sustainability? What is a viable system? We would argue that any participatory approach would have to deal with this thorny issue, and in Chapter 6 we have set out one way of arriving at this intensely subjective equilibrium band set within these limits.

Another question relates to the value of the project as a medium to achieve any sense of managed expectations. Expectations are as limitless as sustainability itself; but how are these concepts managed? In previous papers we have described the management of purposeful human activity as being contained and often constrained with the vehicle of the project. Projects fit the bill for human activity management from the donor or project funder perspective. Projects are contained, limited, time lined, risk assessed and assessed to a penny. But sustainability and expectation are uncontained, unlimited, eternal and without assessable cost. Thus, the projectified world order as we have labelled it (Bell and Morse, 2004, 2005a, b, c, 2007, a, b) brings the very basis of the sustainability activity into a milieu within which it is unlikely to be able to flourish. This takes us to our next theme.

Organic and empowering approaches compared to inorganic and dehumanizing approaches

While researching material for this book, it was noticeable how approaches to measuring sustainability often echo the use of indicators in economics, biology, environmental studies and social science. As we have pointed out, this is by no means unexpected given the complexity one is faced with; since sustainability has to be measured to be meaningful, what else can one do but use indicators? The fact that indicators by definition must simplify a complex entity is not ignored, and the question therefore becomes: what indicators will reflect an individual's vision of sustainability? The circularity rather than linearity of this process has already been described, as has its distinction from scientific derivation of indicators in ecology. We have no desire to labour this point any further. However, one interesting facet that emerges from a reading of the literature is how the use and development of SIs is itself an indicator of the very heart of the sustainability debate. Many seem to see sustainability as a property or target that is 'out there' in much the same way as the environment is an entity removed from ourselves. The argument appears to be that no one can define it clearly yet; but given the right SIs, it will enter the domain of being achievable and understandable. It is almost as if sustainability is a mountain to be climbed by those able to generate the 'right' knowledge.

Just what is the right knowledge and who is best suited to get it may well be a matter of serious contention. One only has to read a review in the *New Scientist* written by a scientist (Gribbin, 1998) of a book on research methods in the social sciences (Becker, 1997) to realize the gulf that exists between some members of the disciplines! Becker (1997) stresses the complexity of community and provides anecdotes as to how mistakes can be made during research if that complexity is ignored. Gribbin (1998), a physicist, on the other hand, is scathing about this perceived inability to reduce and generalize. The rhetoric emphasizing systems – a multi-disciplinary and all-embracing vision – sets the height of the mountain and stresses how difficult the climb will be; nevertheless, a flag will ultimately be placed on the summit, and we will know all there is to know about sustainability and how to get it. The fact that most of those trying to climb the mountain live in developed countries is noteworthy in terms of cultural mindsets and what could be called the imposition of 'sustainability imperialism'; but not in the context of agreeing upon the need for measurability. After all, search for knowledge is universal – the mountain is there for everyone to climb.

If our research has taught us nothing else, it is surely that sustainability is the mindset of those who are intimately entwined with its achievement, and not an entity that lies 'outside' of our heads. In other words, sustainability cannot be studied as we can study an ecosystem. Like the term environment, but far more so, sustainability is what we want it to be and can change as we change. It is an organic and evolving construct of our minds and not an inorganic and static entity that can be physically probed. Indeed, the very action of trying to implement what one thinks is sustainability may change one's vision of what it is. The best we can achieve is to acknowledge the centrality of people and to put participation and the narrative or story of sustainability at the very heart of implementation. The issue now becomes one of compromise between expectation and what is achievable without causing harm (as we have set out above). This may be vague; but it is the nature of the beast. Indicators can play a very useful role here, but only in terms of empowerment and not as precise measures.

The above is at the heart of our derivation of SSA as a theory, and much of it may sound very familiar. Other authors have been saying similar things about the environment (Ison, 1994; Blaikie, 1995; Ison et al, 1997) and medical science (Capra, 1982, 1996). The notion of an act of measurement changing the very thing that we are trying to measure is also very familiar to physicists and, indeed, to social scientists. This is not the most interesting facet of the sustainability debate; rather, what is important is that we still feel moved to have to repeat it here. Why has so much of the debate ignored what, to us, is a rather obvious conclusion? Why have we been so rooted in a mechanistic and inorganic vision of sustainability? Why have many tried to show that sustainability = 42? In part, the answer lies in a very human desire to understand and make sense of complexity, and this appears to arise with every new human vision of where we want to be. We want to achieve X, so let us first understand it, and to do this we need to measure it. An alternative and equally human approach would be: we want to achieve X, so let us first understand it by means of knowing how the story of it relates to the story of me or us; by knowing this story we relate and correlate the notion of X to our own self-notion. In this process the knower and the known are one – this is knowing beyond measurement.

We sincerely hope that this does not diminish what many people have put much time and effort into trying to understand. While we say that there is no mountain and only a mindset, we do not belittle those who wish to have something tangible rather than abstract. One can think of no greater challenge than trying to address organic visions. Nevertheless we believe we will never achieve a universal and unchanging set of sustainability indicators that provide a handle on sustainability, and the challenge is one of keeping pace with people's conceptions, ideas and dreams and trying to make them real. With sustainability, we (the whole of humankind) really are the creators.

Culture change

Much of the information and discussion that has been set out in this book relates to cross-referencing between apparently separate cultures or paradigms of understanding. The notion of different worldviews and paradigms is well established in the literature (for a catholic range of views on the matter, see Koestler, 1964; Checkland, 1981; Wilber, 1996). It appears that part of the problem of SIs is the inability of different agencies and individuals from different cultures, implicitly or explicitly, to espouse different worldviews and assumptions about the way in which the world works. The result of this is the development of antipathies and incomprehension between different stakeholder groups and the long-term development of conflict. There is a need to change one's culture to one that is more inclusive and tolerant of other beliefs. This is a challenge long set out in Koestler's work and elsewhere. It is a challenge to science and to all epistemologies (meaning 'the study or a theory of the nature and grounds of knowledge especially with reference to its limits and validity', Webster, 1995). The authors argue that such a change – a merging and toleration of worldviews and the assumptions of these worldviews – is also central to SSA and would bring about a number of virtuous corollaries:

- an appreciation that 'different' does not mean 'wrong';
- a recognition that variety is the basis for sustainability;
- an understanding that time spent in understanding other people's viewpoints is time saved later when the project starts.

Rather than being seen as a problem to be overcome, we argue that difference is at the heart of sustainability. In current and future work, the authors intend to develop the vision of culture change and to incorporate new ways of thinking in their analysis. This is a difficult and problematic area – we always tend to view our world from our own perspective, and to see things differently is to see through the lenses of our own prejudices and preconceptions. Nevertheless, recognizing that what has been done in the past with regard to the development of SIs is less than ideal and that multiple perspectives are vital for a rounder understanding, the authors are content to see their view of SI development evolve in practice. Culture change will mean tolerating and inviting different standpoints for a multi-perspective analysis of sustainability. But it does not mean that the expert has no contribution to make – far from it. The soul of what we are proposing is being inclusive in determining what sustainability means and how it is to be assessed. Widening the discourse to include many types of stakeholders does not imply that the expert is now unnecessary or unwelcome. We don't see this as a 'one or the other' issue; being inclusive means just that – inclusive to all stakeholders, whether they are an expert or not, male or female, old or young, etc. We do acknowledge that representation can be a problem, and we also agree with critics who say that there is scope for capture of the process by powerful individuals and groups, including the facilitator. All we can say is that no participatory process is perfect, and surely all we can ever hope for is something that moves power to a wider base.

The most difficult phase of the SSA theory that we propose in this book (in practice, it was the most difficult phase of the Imagine framework) is the breakout from discussion to action – in other words, the avoidance of creating just another 'talking shop' that can deconstruct sustainability *ad infinitum* (given the resources) and yet achieve nothing in practice. This issue is, of course, not unique to our attempt to realize SSA through Imagine. Participation is a nice-sounding term that makes for great theorizing; but practice is always far more sobering. In another book (Bell and Morse, 2003b) we stress how such participatory approaches can generate much learning about the perspectives of others, and given the contested nature of sustainability this is a valuable outcome in itself. We also point out how projects have tended to ignore these 'soft' outputs in favour of hard reports and listings of SIs. However, we do agree that learning in itself is not enough. The talk has to result in change, and while individuals may change their behaviour following what they have experienced in being part of an analysis such as Imagine, it is important for the outcomes to go somewhere and do something. One advantage of the participatory process is that by definition it can tap into a wealth of knowledge and networks, and these can be utilized to help influence those who can bring about change. Therefore, our methodology is not a closed circle of talk and navel gazing but a spur to collective activism. Thus, while Imagine does generate outcomes in itself (learning), it must also be a prelude to having an impact. That is not to say, of course, that those with power to bring about change will necessarily agree to being influenced.

The use of SIs within policy contexts has received remarkably little attention in the sustainability literature, although there are wider studies that have looked at how policy, in general, is influenced. The range conceivably spans the ignoring of SIs in favour of other priorities through to using SIs as 'spin' (i.e. to hide inaction), to complete adoption. It is, indeed, a rough world of policy outside the comfortable rooms employed for workshops. The danger for any participatory sustainability analysis is that those involved are simply left behind as the project and the world move on. Disenchantment can rapidly set in.

The essential need for reflective practice

An essential element for all future SI work must be reflective practice. The authors were surprised when they began this project to find a minimal literature that reflected upon lessons relating to SIs. The apparent absence of explicit learning about past problems and mistakes was also surprising. It appears that many authors cite those they wish to agree with and ignore the rest. On a related matter, one frightening element of this SI project was coming to grips with and reflecting upon the extreme wealth of literature in the area and the rapidity with which this literature is evolving and developing – but again, with minimal self-reflection on the part of authors. The avalanche of material was and remains incredible, so much so that there were times when both authors despaired at finding the time and space to 'stop' to write this book. We recognized that at the moment of our own pause, we could be sure in the knowledge that several new and interesting articles would be published somewhere. This contradiction – a voluminous literature on the 'doing' of SIs but little in-depth reflection on experience – continues to be a surprise to us. It seems that the derivation of SIs and the championing of a particular approach (such as Imagine) have been the main focus to date, with few attempting to stand back and set out an underlying theory upon which this should be based and even fewer reflecting upon what has been achieved as a means of testing that theory. We have acknowledged that Imagine is an imperfect attempt to put SSA into practice: it does suffer from weaknesses common to many participatory approaches. And in other places we have sought to analyse these gaps – but such literature is scant.

As with all issues, but most specifically in areas of fast and growing interest, there is a great need for all researchers and practitioners to reflect upon existing material, but also upon the reaction to that literature and research. This self-analysis is a vital element of understanding as the world changes and our reaction to that world also alters. We offer the following key to changing mindsets on the part of researchers and scientists who are involved in the process of SI formulation. Table 7.1 (taken from Bell, 1998) sets out in the left column nine problems with regard to unreflective practice in science.

These are some possible outcomes of the traditional scientific mindset. The last three are particularly important in terms of the scientist in the environmental context. When we read the books of, and listen to the lectures of, scientists, it may appear that they are splendidly confident creatures, comprehending and understanding the world in terms of their science. Yet, those of us who count scientists as our friends and know them personally know that, like the rest of us, they are often riddled with self-doubt and concern and anxiety about their work. There is often a mismatch between society's expectation of the scientist and the reality of what the scientist actually feels and knows. We believe – from our own experience – that in self-reflection the scientist comes to understand more about the issue of managing expectation *vis-à-vis* his or her own work and the nature of his or her own vulnerability. We argue that to recognize our vulnerability and to reflect upon our own ignorance provides prizes. However, with non-reflection we hide the reality. Reality is multifaceted; but it can often mean that we (as researchers) feel out of our depth and out of the context that we know and understand; we sometimes try to keep out the discrepancies (thus always measuring the world according to our long-term prejudices and presuppositions). We would argue that recognizing our vulnerability should develop certain prizes. For example, in accordance with Table 7.1 we could cite three recognitions:

1. A recognition (in humility) that we are all learning: the only human being who ceases to learn is a dead human being.
2. New contexts can be experienced and from this can follow understanding.
3. The object of our study is part of us; if we study and learn about it, we are engaged with it and have become part of it (no matter however slightly).

In this case all systems are linked together in growing and mutual comprehension.

Table 7.1 *Problems and prizes of vulnerability*

Problem of unreflective vulnerability	*Prize of self-reflective vulnerability*
Unrealistic quality standards	Realistic expectation
Paranoia	Tolerance
Doubt	Humility
Self-preservation	Self-giving
Incessant self-expression	Listening
Undue self-assertion	Self-containment
Out of my depth	But I can learn
Out of my context	But I can experience
Keep it out!	But I am already part of 'it' and 'it' is part of me.

Future research priorities

Upon completion of this book for the second time, the authors are re-engaging with the literature and with their own research in developing effective SIs

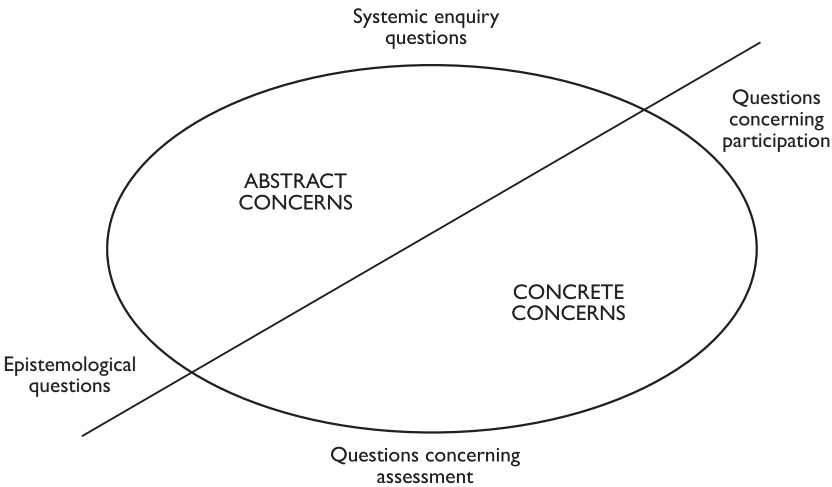


Figure 7.2 *A learning cycle of further questions*

from a holistic viewpoint, in collaboration with partners in government, local government, non-governmental organizations and private enterprise. Figure 7.2 provides a sketch of the research priorities that are derived from the work set out in this book and which we are now developing.

Epistemological questions

Our research has taken us into the theory of knowledge and understanding and has left some unanswered questions, such as how was the original development of SIs conceived? Why do serious-minded communities of decision-makers and theorists still believe sustainability can be measured in an objective sense? What were the epistemological assumptions that led to this view and are these views still determining policy? Briefly – what was the background thinking that got us into this mess? Putting it another way, where did the narrative arise that took us in this direction and what alternative narratives, both exoteric and occult, exist to take us in different directions? In fairness, it has to be said that 'measure to manage' has become something of a mantra these days and we see indicators and league tables covering a host of issues, from performance of schools to death rates in hospitals. The culture of 'name and shame' seems to become increasingly intertwined with a sense of us being 'consumers' of public services. Maybe we are also seen by those in power as placid consumers of the sustainability ethos, rather than drivers?

The systemic approach

The authors continue to develop, through action research practice, an Action Learning Cycle: a systemic approach to problem-solving that can be applied in a systemic manner, expanding on the ideas of second- and third-order cybernetics (as discussed briefly in Chapter 4). There are numerous systemic approaches to problem-solving (the soft systems approach or method, or SSM, in Chapter 4) and some of these are explicitly participatory (participatory rural appraisal, or PRA, in Chapter 4); but we remain unsure that any given approach is systemic in the sense of recognizing and developing the concept of multiple views of reality. In our presentation of SSA as a theory, we purposely embraced diversity of perspective as a necessity to sustainability, and the aim is to accommodate it rather than seek to remove it. Our objective might be to investigate and develop an approach that adapts to individual and social culture in a wide range of contexts. At the time of writing the authors are applying a psycho-analytic approach called the double task as a means of allowing groups of stakeholders to delve to deeper and more subconscious concerns in their understanding of sustainability.

Participatory SIs in social development projects and research

Related to the overtly systemic practice advocated above, we are also developing the Imagine approach to different contexts. In collaboration with others already engaged in SI monitoring (e.g. the Academy for Sustainable Communities, www.ascskills.org.uk/pages/home, in the UK and Blue Plan, www.planbleu.org/planBleu/historiqueUk.html). Questions we that engage in relate to empowerment and democratization of decision-making in the formulation of SIs with local people in double-tasked groups; we also address how SIs can contribute to empowerment. A further development is to modify the Imagine framework to accommodate an approach more geared towards research than activism. This is very much work in progress; but the goal is to build from SSA as a theory, while creating an approach that has elements of Imagine that allow for a much greater sense of understanding why differences in perspective occur, rather than accommodating them as a prelude to 'use'.

Assessment of SIs

We have been concerned throughout this book with the means and processes for SI assessment. We have seen in Chapters 1 to 3 that an overtly quantitative approach to SI assessment is often exclusive of the stakeholders involved in the sustainability project context. The AMOEBA set out in Chapter 6 is a fairly user-friendly means; but this can, we feel, be further developed and extended. How do we develop SI assessment in a holistic fashion?

In describing the history of information systems thinking, Peter Checkland and Sue Holwell describe the area as 'the anatomy of a confusion' (Checkland and Holwell, 1998, p31). The review of SIs set out in this book might also be thought of as an anatomy of confusion. However, while in the case of information systems the confusion lies essentially in blending technocratic and organizational mindsets, with SIs we see a frightening mix of mindsets where the technocratic element dominates. If this book has succeeded in nothing other than alerting the reader to the need for humility and understanding when dealing with different stakeholders with different mindsets, we will consider the exercise to have been a success.

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