

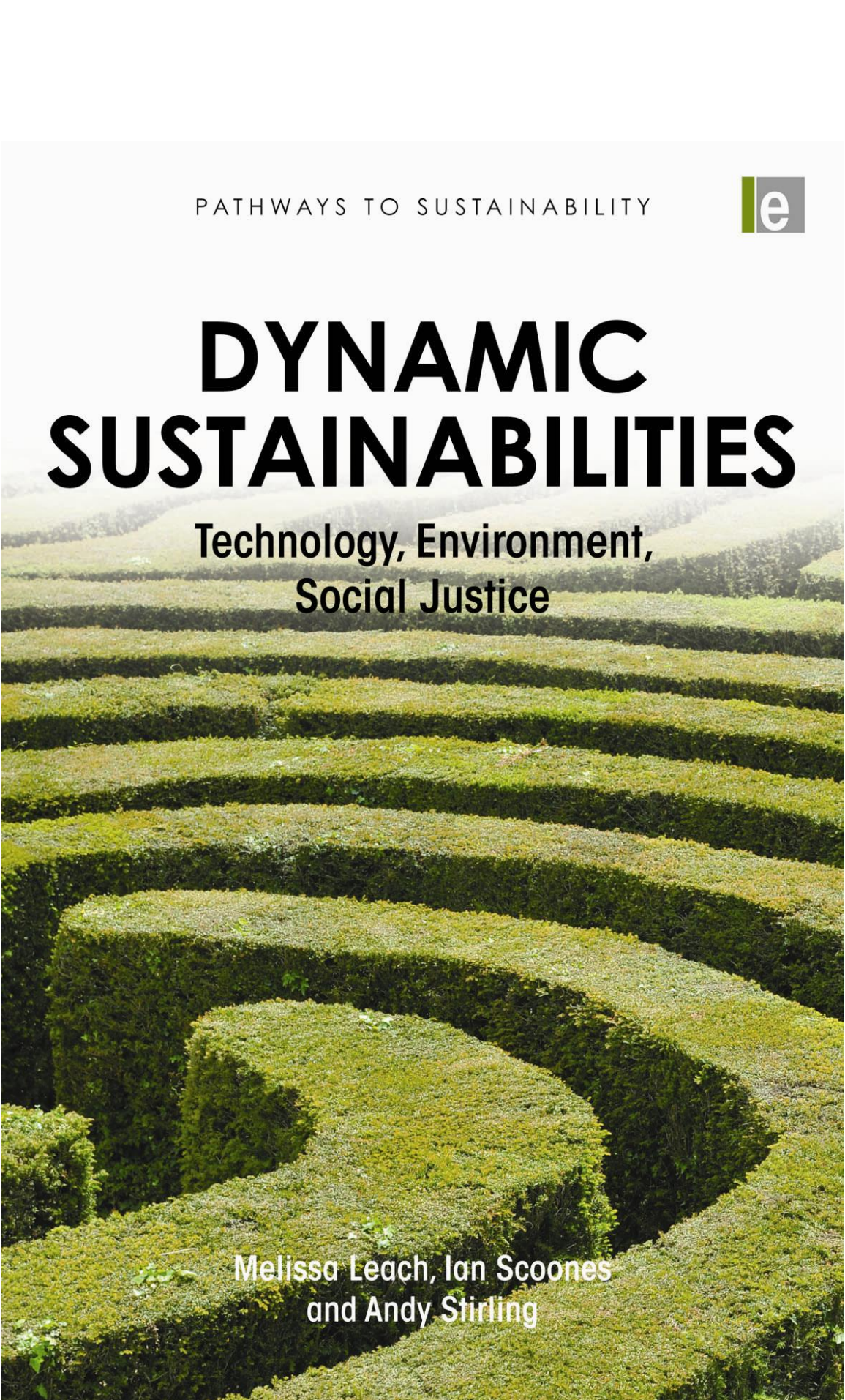
PATHWAYS TO SUSTAINABILITY



DYNAMIC SUSTAINABILITIES

**Technology, Environment,
Social Justice**

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Chapter 1

Sustainability Challenges in a Dynamic World

Today's world is highly complex and dynamic. Environmental conditions are changing fast as water, land and other ecological systems interact with climate change and new patterns of disease incidence. Developments in science and technology are proceeding faster than ever, with the spread of technologies shaped by new and often highly globalized patterns of investment and information. Social systems are changing rapidly too, linked to population growth, urbanization and market relationships. Such dynamics are, in turn, driven by shifting patterns of mobility – of people, practices, microbes, ideas and technologies – and globalized economic change, as some areas of the world transform, while others remain in deep poverty.

Yet the policies and institutions that have to deal with this new dynamic context are often premised on far more static views of the world. Where the rapidity of change is acknowledged, it is often seen to follow relatively clearly determined, single linear trajectories. Either way, assumptions of stability, equilibrium and predictable, controllable risks dominate. Yet the failures of such approaches to intervention and policy are everywhere to see. Simple blueprints, technological fixes or the transfer of technologies and regulations developed elsewhere frequently fail to work and create further problems. Standard approaches all too often betray their intended beneficiaries. Complex, dynamic contexts often undermine the neat assumptions of imported models. Emerging backlashes – from nature, from social movements, from politics – reveal this widening gap between standard policy approaches and dynamic systems.

Indeed, a major contradiction is emerging in contemporary responses to environment and development challenges. On the one hand, there is now a wide recognition of growing complexity and dynamism – evident across high science, popular media and the experiences of daily life. On the other hand, there appears to be an ever-more urgent search for big, technically driven managerial solutions – whether in the form of 'magic bullet' seeds and drugs, continent-wide roll-outs of high-impact solutions or top-down emergency-type responses aimed at shoring up stability and providing

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security. When such responses falter in the face of local dynamics and uncertainties, the response tends to be to implement with greater force or to blame locals or critics – rather than to question the underlying assumptions. The result can be a perpetuating cycle that narrows options, excludes alternative and dissenting voices, and fails to learn from mistakes and failures. This matters because it ultimately fails to tackle big problems of environment and development that affect us all, while often perpetuating inequalities and injustices.

All this raises some major policy and development challenges. For instance, how are shifting human–animal interactions and food production systems altering the likelihood of new global pandemics? How can the world respond to these interactions in ways that do not constrain poor people's livelihoods and freedom? What are the challenges of sustainability in rapidly growing Asian cities? As technology and economic growth bring wealth for some, how can the fall-out for those living on the margins – in overcrowding, pollution, ill-health and hazard – be addressed? How are farmers in dry parts of Africa coping with the challenges of climate change and disease? Can the potentials of new agricultural and health biotechnologies be harnessed to help, or will they provoke new uncertainties and missed opportunities to build on farmers' own adaptations? And how, in a world of rapidly advancing technologies and markets for drugs, seeds, energy and water use, can supply and regulatory arrangements be developed that suit the interests of the poor? How must global models of regulation be rethought to work in dynamic social and political settings? And how can these models respond to poorer and marginalized people's own perspectives on risk and uncertainty, grounded in their everyday lives and livelihoods?

Today, such questions are becoming ever more pressing. This book offers a way of thinking about these core relationships between ecology, technology, poverty and justice in a world of pervasive and growing inequality. Our starting point is that linking environmental sustainability with poverty reduction and social justice, and making science and technology work for people who are poor have become central practical, political and moral challenges of our times. We argue that meeting these challenges in a dynamic world requires an approach that embraces the dynamic interactions between social, technological and ecological processes; takes seriously the ways that diverse people and groups understand and value these; and acknowledges the role of economic and institutional power in shaping the resulting choices. In short, we need to recognize the essentially plural and political nature of our quest for pathways to sustainability.

Why are dynamics and complexity so important?

In meeting the challenges of sustainability, why is it so critical to take a perspective that treats dynamics and complexity seriously? Newspaper headlines across the world regularly highlight rapid rates of environmental and social change – and their threats and consequences. Even the World Bank acknowledges (Chen and Ravallion, 2008) that one and a half billion people are currently living ‘without sufficient means for human survival’ (Parsons, 2008). As disparities between rich and poor worsen (Worldwatch Institute, 2003), global environments are deteriorating (UNEP,¹ 2007). Carbon emissions are increasing (Met Office, 2009). Climate change is accelerating dangerously (Houghton, 2008). Multiple threats are posed to global food supplies (Beddington, 2009; Watson, 2009); and an array of other vulnerabilities are increasing (UNISDR, 2009).

Such reports and the dramatic statistics they cite can easily give the impression of impending catastrophe and disaster. While not diminishing the existence of serious environment and development problems, however, we argue that responding to these effectively requires a closer look at these dynamic systems and a deeper, more nuanced analytical approach that allows us to respond in effective ways. This requires looking at the interactions of different systems (social, ecological, technological) across multiple scales and as they play out in particular places with particular contexts. It also requires looking from the perspectives of different people with different views of these dynamics and their consequences. In particular this book argues that four major hurdles have to be addressed if more effective approaches to sustainable development are to be realized.

First, dynamics have often been ignored in conventional policy approaches for development and sustainability. Conventional approaches have often been rooted in standard equilibrium thinking, underlain by deeper-rooted notions of a ‘balance’ in nature. This tends to centre analyses – and so recommendations – on what are assumed to be aggregative, equilibrium patterns and on attempts to control variability, rather than adapt and respond to it. Equally, conventional methods often assume that models developed for one setting – usually the more controlled, managed contexts favoured by privileged interests – will work in others. This is so whether the export of models is from the developed to the developing world or from the laboratory or research station to the field. By contrast, this book recognizes the limits to planned intervention and argues for a more located, context-specific approach.

Second, governments and institutions are of course increasingly preoccupied with risk and with the insecurities that real and perceived threats seem to pose. However, as we argue in this book, dominant approaches

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involve a narrow focus on a particular (highly incomplete) notion of risk. This assumes that complex challenges can be calculated, controlled and managed – excluding other situations where understandings of possible future outcomes are more intractable. Some of these involve uncertainty, where the possible outcomes are known but there is no basis for assigning probabilities, and judgement must prevail. Other situations involve ambiguity, where there is disagreement over the nature of the outcomes, or different groups prioritize concerns that are incommensurable. Finally, some social, technological and ecological dynamics involve ignorance, where we don't know what we don't know, and the possibility of surprise is ever-present. Whereas conventional, expert-led approaches to analysis and policy are well-attuned to handling risk, they become highly inadequate in the increasingly common situations in which these other kinds of incomplete knowledge can be recognized to prevail. A wider appreciation of the dimensions of incomplete knowledge, this book argues, is essential if we are to avoid the dangers of creating illusory, control-based approaches to complex and dynamic realities.

Third, underlying such approaches are often wider assumptions about what constitutes the goals of 'development' or 'sustainability', often assuming a singular path to 'progress' and a singular, 'objective' view of what the problem might be. Yet of course different people and groups often understand system functions and dynamics in very different ways. They bring diverse kinds of knowledge and experience to bear – combining informal and more experiential ways of knowing with the disciplines and procedures associated with formal science. People also value particular goals and outcomes in very different ways. Rather than singular notions of 'progress' in relation to environment, technology or development, we can increasingly recognize situations in which there is a multiplicity of possible goals, which are often contested. Put another way, systems, and their goals and properties, are open to multiple 'framings'. Here, the concept of framing refers to the particular contextual assumptions, methods, forms of interpretation and values that different groups might bring to a problem, shaping how it is bounded and understood. In many situations, such understandings take the form of diverse narratives or storylines about a given problem: how it has arisen, why it matters and what to do about it. Paying serious attention to multiple, diverse framings and narratives, we argue, brings vital opportunities to advance debates about sustainability and connect them more firmly with questions of social justice.

Fourth, while debates about sustainability have become mainstream over the last two decades, they have also given rise to a great deal of confusion and fuzziness, in which easy rhetorical use masks lack of real change and commitment. In addition, ideas of sustainability have become co-opted into

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inappropriately managerial and bureaucratic attempts to ‘solve’ problems which are actually far more complex and political. This has led some to suggest abandoning the term ‘sustainability’ altogether. However, in this book we re-cast the notion of sustainability as a more explicitly normative (and so overtly political) concept. Rather than treat sustainability in a general, colloquial sense, implying the maintenance of (unspecified) features of systems over time, we are concerned with its specific normative implications. Thus sustainability refers to explicit qualities of human well-being, social equity and environmental integrity, and the particular system qualities that can sustain these. All these goals of sustainability are context-specific and inevitably contested. This makes it essential to recognize the roles of public deliberation and negotiation – both of the definition of what is to be sustained and of how to get there – in what must be seen as a highly political (rather than technical) process.

These are the reasons why we elaborate in this book an approach both to understanding sustainability and responding to challenges which we term a pathways approach. This addresses these four hurdles, highlighting the importance of ‘dynamics’, ‘incomplete knowledge’, ‘multiple framings’ and ‘normativity’. Our pathways approach is thus explicitly normative, focused on reductions in poverty and social injustice as defined by/for particular people in diverse settings. Particular narratives are produced by particular actors and so co-construct particular pathways of response. Some are dominant; shaped by powerful institutions and substantial financial backing – these are the ‘motorways’ that channel current mainstream environment and development efforts. But these can often obscure and overrun alternatives; the smaller by-ways and bush paths that define and respond to different goals, values and forms of knowledge. This is what we mean by ‘pathways’: alternative possible trajectories for knowledge, intervention and change which prioritize different goals, values and functions. These pathways may in turn envisage different strategies to deal with dynamics – to control or respond to shocks or stresses. And they envisage different ways of dealing with incomplete knowledge, highlighting and responding to the different aspects of risk, uncertainty, ambiguity and ignorance in radically different ways.

We argue in this book that there is a pervasive tendency – supported by professional, institutional and political pressures – for powerful actors and institutions to ‘close down’ around particular framings, committing to particular pathways that emphasize maintaining stability and control. In so doing, these often create universalizing and generalizing approaches. These can in turn obscure or deny the reality of alternatives. Yet addressing the full implications of dynamics and incomplete knowledge requires, we argue, ‘opening up’ to methods and practices that involve flexibility,

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diversity, adaptation, learning and reflexivity, and an alternative politics of sustainability that highlights and supports alternative pathways.

Some examples

So how might such an approach respond to some of the major environment and development challenges of our times? In this section we introduce a series of examples, drawn from a range of research from the STEPS Centre and beyond, which we return to throughout the book. These include a focus on water in dryland India, seeds in Africa, policymaking on epidemic disease and energy systems as responses to climate change. Across the book, these cases illustrate both the contradictions between dominant approaches and dynamic realities and how a pathways approach helps to pose questions, unpack problems and identify alternative ways forward.

Water in dryland India²

Solutions to the problems of drought, climate change and agricultural development in dryland India often rest on two competing narratives about water. Perhaps the longest running and most heavily backed narrative, politically and financially, is centred on aggregated notions of water scarcity which need to be addressed through large-scale technical and infrastructural solutions, such as large dams, river diversions and massive irrigation schemes. This is often set in the context of an impending water crisis, where violence and conflict might be the result unless urgent action is taken at scale. A competing narrative contests this vision and focuses instead on small-scale, often community-based solutions responding to a similar scarcity and water crisis narrative. Yet both of these offer planning-based technological solutions which assume that the need is to fill a scarcity gap. Yet, for example, farmers in the dry zones of Kutch in Gujarat, India, approach the issue of water scarcity in a different way. There are multiple scarcities – it depends on the place, the time and the purpose to which the water is being used. Water carries multiple meanings, with cultural values and symbolic importance interplaying with people's material needs. There is huge uncertainty and a number of ways of responding to the situation, some of which involve living with and responding to uncertainty in a more flexible way, adjusting cropping, livestock-grazing and domestic practices accordingly. There is thus not one solution, but many. And the issue is not so much one about absolute amounts of water, but its distribution. Who gets access, and when? Here, as well as for the small-scale irrigation tanks of southern India (Mosse, 2003), the dynamics of gender, caste and power –

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often deeply embedded in history and cultural context – shape patterns and inequalities in resource use in ways that confound comfortable assumptions that small-scale, community-based approaches will be sustainable, equitable or both. Hydrological solutions, at whatever scale, often fail to respond to inherent uncertainties and are not geared up to cope with surprises. Given the unfolding dynamics of climate change in dryland areas across the world, how might diverse pathways be built that respond to cross-scale water dynamics in ways that meet the needs and values of currently marginalized groups?

Seeds in Africa³

Debates about the global food crisis have re-energized green revolution narratives which were present in the 1960s and 1970s, which see technology-driven solutions as the core to any response. Thus investments in new seeds, genetic modification and breeding programmes, and associated packages of inputs (fertilizers etc) are seen by some advocates as the solution to Africa's food production problems and hunger more generally. Yet this supply-led, technology-push narrative is challenged by others. They argue that the challenge of hunger is less a question of production than of distribution and entitlement to food and that processes of market failure, social and power relations and the politics of access to resources influence who goes hungry. Others agree that production remains a challenge, but question both the appropriateness and efficacy of so-called modern seed technologies and systems. Instead, alternative technology pathways are suggested based on low external inputs, which are argued to be more ecologically and socially appropriate in the complex, diverse and uncertain settings in which farming happens. Another narrative focuses less on the technological end-products and more on the processes through which innovation occurs and who defines its proprieties. In particular, a 'farmer first' approach advocates a process of research and innovation in which farmers themselves are in the driving seat. Local social networks through which farmers exchange knowledge and seeds often enable them to respond to highly complex and embedded socio-ecological systems. Given the unfolding dynamics of environmental change, markets and politics that constitute the global food crisis, what pathways of innovation and mixes of technology make sense for poorer farmers as they live and work in diverse African settings?

Epidemics and health systems

Concerns about the emergence and re-emergence of infectious diseases and their capacity to spread rapidly in an interconnected world of mobile people

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and microbes have defined at least two major narratives guiding health policy and practice in recent years. The first focuses on the control of outbreaks through pervasive surveillance, rapid response, contingency planning and the timely delivery of medical technologies in outbreak settings. For example in recent years the response to highly pathogenic avian influenza has been characterized by a massive global effort directed at controlling the avian disease at source and so reducing the potential of pandemic spread. Responses to Ebola and other haemorrhagic fevers have focused on urgent control of outbreaks of these rapid-killing diseases, using a standard package of externally led responses. The second narrative responds to widespread endemic diseases of the poor (including malaria, HIV, tuberculosis and others) through technological solutions to be rolled out and applied at scale. Thus drugs, vaccines, bednets and associated therapeutic/educational/counselling packages (voluntary counselling and testing, direct observation systems to ensure drugs compliance, immunization information and education) are promoted as part of grand challenges to which donors, philanthropic organizations and public–private partnerships are now devoting major resources in the interests of global health. Yet other narratives point to the mixed effects and sometimes local resistance that such interventions encounter when they face the complex, diverse social, political and ecological settings in the developing world. Standardized programmes, whether in outbreak mode or technology roll-out mode, must confront highly diverse and dynamic disease–ecological settings, where uncertainty and surprise may rule – potentially confounding the best laid plans and models of health professionals. They confront diverse local social dynamics and cultural logics regarding how diseases and their ecologies and technologies operate; logics which alternative narratives see as valuable starting points for approaches to health which work in context. And they confront a diversity of institutional, political and market settings, involving diverse sources of authority and bureaucratic control, as well as diverse suppliers of knowledge and technology in health systems. Alternative narratives highlight a blossoming of innovative local governance arrangements and citizen responses which offer the potential to bring access to appropriate health technologies and services to poorer and marginalized people. Given the major health challenges, epidemic and endemic, facing the world, and given the particular disease challenges of poorer people, what pathways of response would ensure good health in an equitable, socially just and sustainable way?

Energy and climate

Debates about climate change have triggered a renewed series of debates about energy for development. In the past, debates about energy were

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framed in terms of narratives about energy ‘gaps’ (shortfalls and resources scarcity), whether of fossil fuel or woodfuel. Today attention has shifted to low-carbon alternatives as routes to achieving greenhouse gas reductions. However, approaches may still be centred on a single-fix technological solution to perceived energy security problems as dependence on fossil fuels is reduced. Thus for example, nuclear energy, biofuels and even some renewable sources are seen as the ‘solution’ to national energy requirements. Across the world, major controversies have arisen over the appropriateness of nuclear responses to energy problems, as in the case of India. Equally, biofuels have provoked controversy over the trade-offs around the use of land for food crops and the appropriation of land for large-scale biofuel plantations. Alternative narratives focus on the diverse energy needs of different people and places and the need to match these with a variety of technological and institutional options. They point out the way that energy technologies become part of socio-technical and political systems and thus transitions to low-carbon pathways must take account not only of technologies but also of broader social, political and governance settings. A shift is often advocated from a national energy planning and system mode to more decentralized approaches to technology and system design and the appraisal of different options, encompassing participatory, deliberative and community-based approaches. Given the imperative of a transition to a low-carbon economy, how might technological and energy system pathways emerge which respond to the diversity of both national and local demands?

Each of these cases thus generates a series of challenges and questions. We pick up on these throughout the book, exploring in more detail the particular examples and drawing in a variety of particular literatures on each. As we explore what a pathways approach means in practice, the cases are used to demonstrate and test the approach and the way it illuminates both the different implications of different narratives and the consequences of choices made on sustainability. In the concluding chapter, we return to the cases and revisit the challenges posed by each, asking how these might be addressed differently through the lens of a pathways approach. The pathways approach, as the book demonstrates, is not only a useful analytical tool, but one that highlights and makes clearer policy options and trade-offs and the real politics of sustainable development in ways that, we hope, will be useful to social movement activists as much as donor agencies and government policymakers.

Moving forward

The central questions of this book focus on how we might genuinely build pathways to sustainability in a complex, dynamic world – and the analytical,

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policy and appraisal approaches that can guide this. The chapters that follow combine an examination of existing approaches to understanding and intervention, addressing both their insights and shortcomings, with a forward-looking agenda that synthesizes elements of these into a new pathways approach.

This is an intrinsically collective and thoroughly interdisciplinary endeavour. Indeed, the book draws on and draws together a wide range of perspectives and analytical traditions that are rarely considered together – from development studies, science and technology studies, anthropology, political and policy sciences, to evolutionary economics, ecology and work on complexity in the natural sciences. Our aim is not to review any of these areas or their sub-fields comprehensively, but rather to distil key strands and convergences, including some unexpected and productive ones.

Drawing from this array of work, a core argument of this book is that we must define new ways of thinking and doing that take complex dynamics seriously. This is perhaps one of the major challenges for development in the 21st century. We are optimistic that there are new ways forward, however, and this optimism derives from three sources. First, that the failures of equilibrium approaches to intervention and policy are everywhere to see. The new dynamic contexts presented by a globalized, interconnected world make these all the more evident. There are emerging backlashes against the standard view which help encourage alternatives, opening up the chinks and spaces for a new politics of sustainability to flourish.

Second, despite the often confusing and contradictory debate about sustainability and sustainable development in particular, the broad, normative perspectives at the core of this discourse, highlighting the intersection of economic, social and environmental objectives, are now centre-stage and barely disputed across geographical location – North and South – and political persuasion – Left and Right. The widely recognized imperative of addressing climate change, for example, has brought global environmental change and development issues to the top of the political agenda internationally. This agenda – and the wider challenges of sustainability – are *par excellence* cases where social–ecological–economic–political dynamics must be at the core of any analysis. Public and political buy-in, it seems, has arrived and with it a more welcome context for what is currently lacking: clear thinking about how to conceptualize and address sustainability challenges in a dynamic world.

Third, there are many strands of work that can help in this thinking. There is an emergent yet rather remarkable convergence of thinking, across an array of fields of enquiry and disciplinary perspectives, which points towards the importance of dynamics, complexity, diversity, nonlinearity and uncertainty as critical to both understanding and, importantly, policy

and practice. Such areas of work are often rather nascent and certainly remain largely peripheral to the core disciplines to which they refer. But there are some important common themes – as well as interesting divergences and dissonances – between them. This book is about drawing these strands together and relating them to real-world dilemmas.

Signposts towards pathways to sustainability

In subsequent chapters we elaborate on these issues and concerns, illustrating them in relation to the case examples introduced in this chapter. The chapters introduce a set of simple diagrams to facilitate thinking around key concepts and their application to real-world problems.

The next chapter focuses in on the question of dynamics and how they have – and have not – been addressed in debates around sustainability and development. The chapter begins by illustrating how each of our four examples involves highly dynamic, complex and interacting socio-ecological-technological systems. Nonlinear dynamics create thresholds and tipping points, often unleashing deep uncertainty and the possibility of surprise. Indeed wherever one looks – in biological, social, economic or political systems and particularly in their interactions – complex dynamics are important and have long been so. Yet dynamics – both old and new – have often been ignored in conventional approaches to development. The chapter identifies a number of reasons for this, adding up to a problematic political economy of equilibrium thinking and practice. It then briefly reviews five fields in which equilibrium views have been challenged. It addresses the science and economics of complexity, drawing on wider work on complexity sciences, before turning to perspectives from non-equilibrium thinking in the ecological sciences. The third field explored draws on recent thinking in science, technology and innovation studies to address the dynamics of technical change and socio-technical transitions. The fourth field turns to policy, organizational and management responses to dynamic settings, highlighting perspectives from soft-systems approaches to management, nonlinear perspectives on policy processes and the rethinking of the role of expertise in a ‘post-normal’ science responsive to conditions of uncertainty. The final subsection, in turn, begins to look forward to a new dynamic systems approach for development.

Chapter 3 begins to construct a more integrated framework for addressing sustainability challenges in the dynamic contexts discussed in Chapter 2. Following a discussion of the notion of sustainability, establishing the need to treat this in normative and political terms, we introduce a set of building blocks of a pathways approach, using simple diagrams to assist

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explanation and illustration of key concepts. First, we discuss system framing and how different actors come to construct narratives about problems and solutions. We then explore how narratives differ in addressing the incomplete knowledge that pervades dynamic settings: whether narrow notions of risk are emphasized or whether uncertainty, ambiguity and ignorance/surprise are acknowledged. We go on to explore the kinds of intervention envisaged to address shocks and stresses – whether emphasizing stability or durability, resilience or robustness. The chapter argues that pathways to sustainability are thus constructed through decisions which must explicitly address contestation and trade-offs between such different dynamic system properties as seen under different framings and narratives. Negotiating pathways to sustainability is therefore necessarily a political process.

Then follow three chapters which, in different ways, explore the political processes around negotiating pathways to sustainability and offer ways forward. Chapter 4 focuses on governance. Which narratives come to prominence and which remain hidden, and which become powerful pathways and which remain marginalized depends heavily on governance, which we define here in a broad sense as political processes and institutions. The chapter begins by reviewing briefly a range of processes, styles and practices of governance in the contemporary world. These include an emphasis on networked, multi-scale governance processes, interacting with state institutions in various ways. Increasingly evident, too, are participatory processes and the power relations of these: the realities of politics and governance in practice, involving messy, day-to-day interactions and the locatedness of unfolding governance arrangements in particular cultural and historical contexts. Politics is today very much the politics of nature and technology, and the politics of knowledge. In the context of these aspects of governance, the chapter explores and illustrates how institutional, political and power/knowledge processes often interact to ‘close down’ around narrow notions of risk and stability. Other important dimensions of incomplete knowledge and of sustainability are thus ignored. Exposing the problems with this, the chapter also argues that it does not have to be this way. We consider how processes of networked, multi-level governance might enable alternative narratives and pathways to prevail, and how adaptive, deliberative and reflexive governance approaches offer prospects for addressing multiple dynamic properties of sustainability and multiple dimensions of incomplete knowledge.

Chapters 5 and 6 turn explicitly to ways of ‘opening up’ and ‘broadening out’ analysis and action. This, we argue, is essential if the narratives and potential pathways that attend to the full range of dynamic properties of sustainability, and to goals around reducing poverty and promoting social justice, are to be pursued. The focus in Chapter 5 is on ‘designs’, or

approaches and methods for appraisal. We explore what we term ‘empowering designs’: diverse ways of consciously engaging with the challenges of sustainability through broadening out the inputs to appraisal and opening up the outputs to decision-making and policy. Empowering designs aim at eliciting and exposing hidden narratives and pathways, and getting all potential pathways on the table – by being inclusive. Empowering designs also aim at facilitating processes of negotiation among narratives and potential pathways, through deliberation. The chapter focuses in on a potential array of methods and tools that can be used in the appraisal of sustainability issues. Following a discussion of what is meant by social appraisal, we examine a range of approaches which offer good prospects for broadening out and opening up complexity and addressing the diverse dimensions of incomplete knowledge and sustainability. The chapter then returns to the discussion of framing and looks in particular at the interaction between different methodological approaches and framing effects. In this context, it outlines four elements of effective appraisal for pathways to sustainability.

Chapter 6 asks what would it take for governance processes themselves to broaden out and open up – to receive and act on the outputs of appraisal, incorporating them into pathways to sustainability? What is taken up and acted upon is clearly influenced by power, politics and interests. In this chapter, we pursue further the argument that there are chinks and spaces in existing governance arrangements which, if opened up, might enable alternative narratives to be acknowledged, appreciated and become pathways; and for the adaptive and reflexive approaches needed to cope with dynamics and uncertainty to become real. The chapter outlines two key arenas and forms of engagement which offer prospects for opening up governance processes. First, we look at understanding and influencing policy processes. Second, we move to an exploration of the way citizen action and social movements can affect change. Finally, we address roles for researchers, public intellectuals and the media in seeking out and supporting pathways to sustainability.

In the concluding chapter, we summarize the book’s argument. We revisit the major contradiction it started with – the growing gulf between complex dynamics and approaches premised on a stable, manageable world – in this light. We return to the four case examples – of epidemics and health systems, water in dryland India, seeds in Africa, and energy and climate – and to the specific questions being asked by policymakers now. Systematically, the chapter considers how these might be addressed differently through the pathways approach. Finally, we draw together the potential ways forward outlined in earlier chapters and consider how these add up to a new agenda for thinking and action towards pathways to sustainability and social justice.

Chapter 3

Pathways to Sustainability: Responding to Dynamic Contexts

Debating sustainability

How does an understanding of complexity and dynamics influence our understanding of sustainability? The incorporation of an explicitly normative stance, as discussed in Chapter 1, together with a dynamic complexity perspective, discussed in Chapter 2, contrasts strikingly with more technocratic, managerial and equilibrium approaches to sustainability. An emphasis on pathways implies debates about politically contested goals and objectives. Given the way such pathways are constructed in highly dynamic, uncertain and complex settings, there is also a need for reflexivity in path-building, whereby destination, routes and directions are continuously reconsidered by multiple participants.

As discussed in Chapter 1, sustainability has become one of the most debated and contested terms of recent times.⁶ But, like all such terms, sustainability has a history. It did not always have such significant connotations. Several hundred years ago the term was first coined in an environmental context by a German forester, Hans Carl von Carlowitz in his 1712 text *Sylvicultura Oeconomica*, to prescribe how forests should be managed on a long-term basis. It was, however, not until the 1980s that 'sustainability' came into much wider currency. With the birth of the contemporary environmental movement in the late 1960s and 1970s, and debates about the 'limits to growth' (Meadows, 1972), environmentalists were keen to show how environmental issues could be linked to mainstream questions of development. The commission chaired by Gro Brundtland, former prime minister of Norway, became the focal point for this debate in the mid-1980s, culminating in the landmark report 'Our Common Future' in 1987 (Brundtland, 1987). This offered the now classic modern definition of sustainable development:

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1987, p43).

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The term ‘sustainability’, and more particularly ‘sustainable development’, drew on longer intellectual debates across disciplines (Scoones, 2007). From the 1980s there was an explosion of academic debate about these issues, as the terms were projected onto the centre stage of policy debates globally, particularly in the run-up to the World Conference on Environment and Development held in Rio in 1992.

As Chapter 2 has already discussed, ecologists have long been concerned with how ecosystems respond to shocks and stresses. In particular, mathematical ecology had blossomed through the 1980s, with important work on this issue from the likes of Buzz Holling and Robert May on the stability and resilience properties of both model and real biological systems (May, 1977; Holling, 1978). Sustainability could thus be defined in these terms as the ability of a system to bounce back from such shocks and stresses and adopt stable states (Holling, 1993; Ludwig et al, 1997; Folke et al, 2002). Neo-classical economists drew on theories of substitutable capital to define (weak) sustainability in terms of the constancy of human and natural capital in delivering constant consumption goods over time, with market failures due to externalities corrected. Within economics, debates raged over whether such a ‘weak’ definition of sustainability was adequate or whether a stronger definition highlighting the lack of substitutability of ‘critical natural capital’ was needed (Turner, 1992; Pearce and Atkinson, 1993; Goodland, 1995; Goodland and Daly, 1996).⁷ Ecological economics traces more concrete links with ecological systems, generating such fields as life-cycle analysis, ecological-footprint assessment and alternative national accounting systems (Common and Perrings, 1992; Common and Stagl, 2005). Building on these different debates, Herman Daly and others developed an economic vision of sustainable development which challenged standard growth models (Lele, 1991; Daly 1991, 1996). Elements of this were picked up by the business community and notions of the ‘triple bottom line’ emerged, where sustainability was seen as one among other more conventional business objectives, resulting in a whole plethora of new accounting and auditing measures which brought sustainability concerns into business planning and accounting practice (Welford, 1995; Elkington, 1997). The World Business Council for Sustainable Development was launched with much fanfare (Schmidheiny, 1992; Holliday et al, 2002), bringing on board some big corporate players. Drawing on wider popular political concerns about the relationships between environment, well-being and struggles for social justice, political scientists such as Andrew Dobson (1999) delineated political theories that incorporated a ‘green’ politics perspective and where sustainability concerns were put at the centre of a normative understanding of social and political change. Others offered integrative syntheses, linking the economic, environmental and socio-political

goals of sustainability into what Robert Kates and colleagues dubbed a 'sustainability science' (Kates et al, 2001).

By the 1990s, then, we had multiple versions of sustainability: broad and narrow, strong and weak, and more. Different technical meanings were constructed alongside different visions of how the wider project of sustainable development should be conceived. Each competed with each other in a vibrant, if confusing, debate. But how would all this intense debate translate into practical policy and action on the ground? The 1992 Rio conference, convened by the United Nations and attended by 178 governments, numerous heads of states and a veritable army of over a thousand NGOs, civil society and campaign groups, was perhaps the high point – the coming of age of sustainability and sustainable development. This was the moment when many hoped that sustainability would find its way to the top of the global political agenda and would become a permanent feature of the way development, both North and South, would be done (Holmberg et al, 1991).

The Rio conference launched a number of high-level convention processes – on climate change, biodiversity and desertification – all with the aim of realizing sustainable development ideals on key global environmental issues (Young, 1997, 1999). Commissions were established and national action planning processes set in train for a global reporting system against agreed objectives (Dalal-Clayton et al, 1994), and a whole plethora of economic valuation, indicator measurement and auditing/accounting techniques were elaborated. For example, David Pearce, Kerry Turner and colleagues at the ESRC Centre for Social and Economic Research on the Global Environment (CSERGE) developed approaches to environmental valuation as a means to ensure that environmental issues were taken into account in economic accounting and appraisal (Barbier et al, 1990; Pearce and Turner, 1990; Pearce and Warford, 1993; Turner et al, 1994),⁸ while others joined the growth industry in producing sustainable development indicators (Pearce et al, 1996; Rennings and Wiggering, 1997; Bell and Morse, 1999; Bossel, 1999; Pannell and Glenn, 2000). At the same time a more local-level, community-led process was conceived – Agenda 21 – which envisaged sustainability being built from the bottom up through local initiatives by local governments, community groups and citizens (Lafferty and Eckerberg, 1998; Selman, 1998). These were heady days indeed. But what did implementing sustainability mean? The result was an exponential growth in planning approaches, analysis frameworks, measurement indicators, audit systems and evaluation protocols which were to help governments, businesses, communities and individuals make sustainability real.

However, the simplistic managerialism of many initiatives labelled 'sustainable development' left much to be desired (Berkhout et al, 2003;



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Scoones, 2007; Jordan and Adger, 2009). Critiques focused on the lack of progress on major targets set in 1992, the endless repackaging of old initiatives as ‘sustainable’ this or that, and the lack of capacity and commitment within governments and international organizations genuinely to make the ideals of sustainability real in day-to-day practice (Vogler and Jordan, 2003). With the default bureaucratic mode of managerialism dominating – and its focus on action plans, indicators and the rest – the wider political economy of sustainable development was being ignored, with key elements of the sustainability debate being captured by powerful interest groups (Redclift, 1987, 1992; Meadowcroft, 1999). With mainstreaming and bureaucratization, the urgency and political vibrancy was lost, and with this came a dilution and loss of dynamism in a previously energetic and committed debate.

But all was not lost. Debates in recent years have refocused on some big issues which hit the headlines internationally, substituting for the emblematic issues – of the ozone hole, acidification, biodiversity loss and desertification – that dominated the run up to Rio. These have resulted in both public and, usually later, political reactions. For example, the controversy around genetically modified (GM) crops, which peaked in Europe in the late 1990s/early 2000s, had many political and policy reverberations internationally (GEC, 1999). This was a debate about, *inter alia*, the sustainability of farming systems, the future of food, human health and biodiversity and corporate control of the agri-food system (Thompson et al, 2007). In the same way, the climate change debate really only began to be taken seriously post-2000. No longer was this a discussion on the arcane specifics of global climate models but, as became clear, a real political and economic issue, which people and governments had to take seriously (Munasinghe and Swart, 2005; Roberts and Parks, 2007; Giddens, 2009). Concerns about the environment and development drivers of new global diseases and pandemics were also pitched into the public and political realm, first with severe acute respiratory syndrome (SARS) and then avian and H1N1 influenzas (Abraham, 2005; Greger, 2006; Bloom et al, 2007; Dry, 2008; Scoones and Forster, 2008). All of these issues – and the list could go on – are centred around classic ‘sustainability’ questions: they each involve complex and changing environmental dynamics having an impact on human livelihoods and well-being; they all have intersecting ecological, economic and socio-political dimensions; and, as with an increasing array of environment–development issues, they have both local and global dimensions.

But what is equally sure is that the existing ‘sustainable development’ institutional and policy machinery is incapable of dealing with them effectively. Options for a post-Kyoto climate change agreement, which involves

the USA, China and India, have yet to be elaborated. Questions of biosafety surrounding GM crops have not been resolved and nor does the UN Biosafety Protocol necessarily deal with these effectively. Also, recent disease scares have shown that neither global institutions nor local health systems are able to deal with a global pandemic.

So what of the future? Will sustainability become the unifying concept of the 21st century as many so boldly proclaimed just a few years ago? Certainly the 1990s managerialism and routinized bureaucratization has been shown to have its limits. While sustainability-related commissions, committees and processes persist in various guises, they have perhaps less political hold than before. But with climate change in particular – and wider risks associated with environmental change, whether in disease, biodiversity loss or water scarcity – now being seen as central to economic strategy and planning, there are clear opportunities for the insertion of sustainability agendas into policy discourse and practice in new ways.

What is required, this book argues, is a more concrete clarification of what is meant by ‘sustainability’. For example, the classic Brundtland definition of ‘sustainable development’ highlights notions of needs and limitations. Explaining these concepts, it defines ‘needs’ as ‘in particular the essential needs of the world’s poor, to which overriding priority should be given’, and limitations are seen in relation to ‘the state of technology and social organization on the environment’s ability to meet present and future needs’ (Brundtland, 1987, p43). However, we must ask whether, given the complex, uncertain and dynamic contexts in which negotiations of sustainability must take place, such static notions of needs and limits are appropriate. Colloquial usage of the term ‘sustainability’ simply refers to the general quality of being ‘capable of being maintained at a certain rate or level’ (OED, 1989) and is inherently conservative and not dynamic. What exactly is to be maintained is often not specified.

Towards a normative, politicized perspective on sustainability

In the post-Brundtland, post-Agenda 21 policy debates on sustainability, however, the usage is explicitly normative. Sustainability refers to a broadly identifiable, but often poorly specified, set of social, environmental and economic values. Although the details are often ambiguous, contested and context-dependent, the functions concerned include the securing of particular standards of social equity, economic well-being or environmental quality. In this policy context, then, structures – such as particular laws, technologies, infrastructures or institutions – are not ends

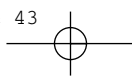
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in themselves, but means to the ends of delivering on these broad normative aims.

We share this spirit, but go further. We argue that it is useful to distinguish between different normative views of sustainability, recognizing that there are multiple sustainabilities which need to be defined quite precisely for particular issues and groups. Thus sustainability neither carries its colloquial connotations, implying the maintenance of system properties in a general sense, nor its broad normative connotations, in Brundtland's terms. Rather, we need to specify versions of sustainability in terms of the particular properties and flows of goods and services valued by particular social groups or in the pursuit of particular goals. Rhetorical appeals to sustainability can be, and often are, used to obscure complex or contested interpretations and interests around such particular versions of sustainability. Digging beneath such rhetoric and uncovering particular interpretations and their links with particular goals and interests is a key task.

It follows from this that the sustainability debate must shed its managerial pretensions. Rather, sustainability must become recognized as a contested, discursive resource – a boundary object (Gieryn, 1983) – that facilitates argument about diverse pathways to different futures. This brings sustainability firmly into the realm of the political, where debates around 'justice', 'democracy' and 'citizenship' have been for centuries.

Across our four case studies, it is thus not surprising that we find highly contested versions of sustainability. For example, in dryland India sustainable water management may be defined in relation to the sustained provision of urban water supply or the sustainability of irrigated farming – which might both be served through the building of large dams. In contrast, sustainability may be defined in relation to sustaining rain-fed farming livelihoods in particular dryland areas and the provision of groundwater-based village water supplies there. In the case of debates about the sustainability of seed systems, the focus may be on their contribution to national food security goals and sustaining overall aggregate production. Alternatively, the focus may be the ability to sustain the livelihoods of poorer farmers in the face of increasing shocks and stresses. Even within such a small-farmer focus, men and women, or elders and youth, might prioritize the sustainability of different crops or varieties. In the case of epidemics, the sustainability of the response system may be defined in terms of its ability to protect global populations from disease outbreaks. Yet in other versions sustainability may mean responding to the specific vulnerabilities and livelihood contexts of those confronting diseases on a day-to-day basis. In the case of energy systems, sustainability is routinely restricted – and not just in the industrialized world – to the single question of carbon intensity. Yet many of the alternatives to fossil fuels present their



own sustainability challenges, suggesting different versions of sustainability centred on, for instance, the toxicity and risks associated with nuclear materials, the resource implications of certain renewable strategies or the agronomic and land-use implications of wholesale shifts to biomass.

Across the cases, these versions – and indeed many others – are not just different, but are the subject of highly politicized contestation. This may occur at all scales, from disputes within and between households and communities to those between local, national and global priorities. Therefore what is defined as sustainable (or otherwise) and the indicators that are used must be subject to deliberation, with a clear and careful unpicking of the particular goals and their trade-offs.

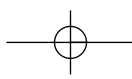
A systems perspective

Although the world is endlessly complex and dynamic, it is useful for analytical and practical purposes to think in terms of particular systems. Systems, as we consider them in this book, consist of social, institutional, ecological and technological elements interacting in dynamic ways.

Such systems need to be understood in relation to both their structures and their functions. Structures concern the ways in which the system and its boundaries are constituted, its internal and external relationships and the patterns in which its processes unfold. System functions, on the other hand, concern things such as services, outputs and consequences. These are the ‘outcomes’ that are held to be delivered by the system, as well as associated notions of purpose and meaning.

How these structures and functions are understood and prioritized can vary markedly, as the examples above indicate. Thus the ‘water management system’ of interest may be bounded at the regional or national level in relation to fulfilling water supply functions for irrigators or urban populations. Or it may be bounded and understood as a local water-agro-ecological system with very different functional qualities in terms of contributing to a flow of livelihood benefits. As in this example, systems might be bounded at very different scales, with different consequences for how structures and functions are defined. System-bounding can, however, also involve the same scale, but with different priority given to particular elements, relationships and functions. Thus, in the case of seed systems, a national system for research, innovation and supply of new seeds might be geared to high-value crops for high potential zones, or to crops and varieties suited to the circumstances of poorer farmers.

The ways that system structures and boundaries are understood and functions prioritized constitute central dimensions of what we term ‘framing’.



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This concern with framing, or the different ways of understanding or representing a system – drawing from the insights of methodological constructivism in the social sciences – is a central building block of our pathways approach. Thus we recognize that system boundaries, dynamics, functions and outcomes are always open to multiple, particular, contextual, positioned and subjective assumptions, methods, forms of interpretation, values and goals. These might be held, for instance, by diverse international organizations, technical agencies, sectoral ministries, professional disciplines, civil society or local actors, different community members or networks which connect members of these different groups (see Figure 3.1 and Box 3.1).

So whereas much systems thinking – including in debates about sustainability – seeks to reflect comprehensively a full range and diversity of elements, linkages and dynamics in a system and its environment, our pathways approach adds a reflexive dimension. This recognizes that all analysis of a system – whether by researchers, policy actors or different local people – involves framing. All framing involves not just choices about which elements to highlight, but also subjective and value judgements. Such framings are produced by particular actors and co-constituted with their particular institutional, political and life settings. Attention to the

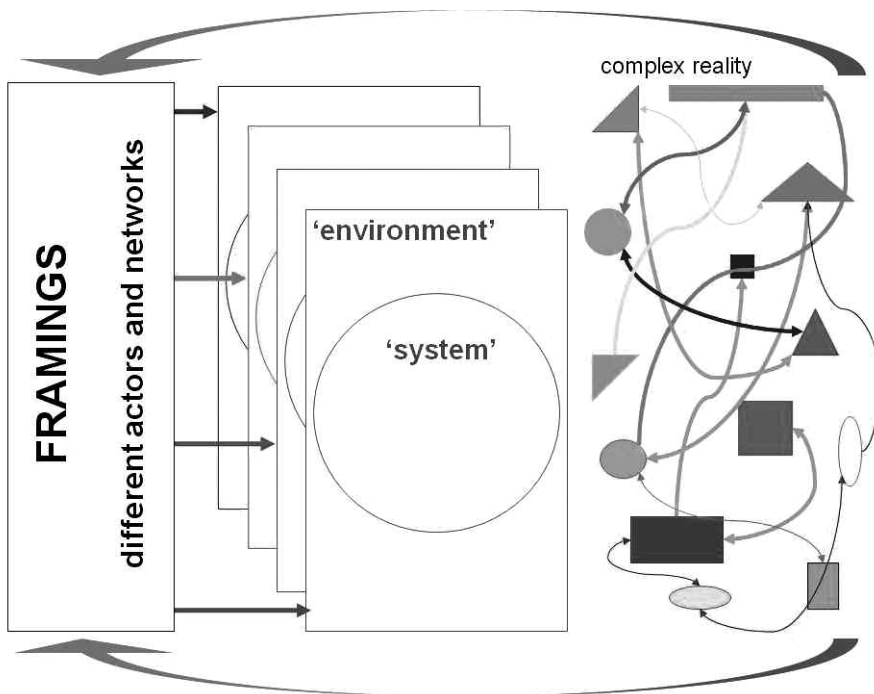


Figure 3.1 Multiple framings

Box 3.1 Dimensions of framing*Choice of elements:*

- Scale
- Boundaries
- Key elements and relationships
- Dynamics in play
- Outputs

Subjective judgements:

- Perspectives
- Interests
- Values
- Notions of relevant experience
- Goals

ways in which particular actors and networks produce – and sometimes seek to promote – particular framings is an important addition to systems perspectives which otherwise have a tendency to downplay the roles of particular actors and their agency.

Framing and narratives

Particular system-framings often become part of narratives about a problem or issue. These are simple stories with beginnings defining the problem, middles elaborating its consequences and ends outlining the solutions (Roe, 1994). Narratives often start with a particular framing of a system and its dynamics and suggest particular ways in which these should develop or transform to bring about a particular set of outcomes. Thus, in relation to the case of water in dryland India, an example of a mainstream policy narrative might be: ‘Major water scarcities are developing and undermining economic development; therefore the construction of large dams and investment in the infrastructure for water delivery must take place.’ In the case of epidemics, a frequently heard narrative holds that ‘the global threat of a pandemic and its consequences for massive mortalities and economic costs require substantial investments in surveillance, drug stockpiling and intervention in areas of the world where outbreaks originate, in order to protect us all.’ In the case of seeds in Africa, we often hear a narrative that ‘growing food deficits require massive boosts to agricultural productivity and only GM crops will provide the answer.’ In the case of energy, we often hear the narrative that ‘the challenges of dealing with climate change and energy security can only be dealt with through a centralized system including nuclear power generation.’

Table 3.1 highlights a number of ways by which narratives are formed, involving value judgements about what and who is included and excluded and what issues, questions and solutions are prioritized.

46 *Dynamic Sustainabilities***Table 3.1** *Creating narratives: Practices*

Stating goals	Defining problems	Including disciplines
Setting agendas	Prioritizing issues	Interpreting results
Posing questions	Setting baselines	Highlighting values
Deciding context	Choosing methods	Drawing boundaries
Discounting time	Recruiting expertise	Formulating criteria
Handling uncertainties	Characterizing options	
Constituting 'proof'	Exploring sensitivities	

Let us work through narratives related to two of our case examples in more detail, to consider how a system is framed, identify which actors are involved and consider the elements of system framing, as well as how these aspects are drawn into a particular narrative, through some of the practices highlighted in Table 3.1.

In the case of pandemic threats, an 'outbreak narrative' is often pushed by international agencies and governments in northern settings. As Wald (2008, p2) puts it:

[This] begins with the identification of an emerging infection, includes discussion of the global networks throughout which it travels, and chronicles the epidemiological work that ends with its containment. As epidemiologists trace the routes of the microbes, they catalogue the spaces and interactions of global modernity. Microbes, spaces and interactions blend together as they animate the landscape and motivate the plot of the outbreak narrative: a contradictory but compelling story of the perils of human interdependence and the triumph of human connection and co-operation, scientific authority and the evolutionary advantages of the microbe, ecological balance and impending disaster.

The narrative therefore defines and bounds the system in global terms. In terms of objective elements of system framing, it focuses on a particular interpretation of disease dynamics (sudden emergence, speedy, far-reaching, often global spread) and a particular version of response (universalized, generic emergency-oriented control, at source, aimed at eradication). More subjective dimensions include the value placed on protecting global populations, which often implies protecting particular populations in richer countries. Goals are defined in terms of impacts on human mortality and national economies and business viability. This narrative calls upon particular kinds of knowledge and expertise – notably formal science and epidemiology – in diagnosing and solving the problem.

Such an overall outbreak narrative has been typical of the international responses to highly pathogenic avian influenza (HPAI), for example, with

distinct versions associated with veterinary, human public health and pandemic preparedness strands of the response. The HPAI outbreak narrative in particular has been framed in terms of a globalized version of 'health security' (WHO, 2007; Scoones and Forster, 2008; Scoones, 2010). This, in turn, has given rise to a plethora of initiatives and associated institutional arrangements focused on early warning, risk assessment, intensive surveillance, outbreak monitoring, pandemic-preparedness planning, rapid response teams, contingency plans and so on. With disease-specific variations, dominant narratives around SARS and Ebola similarly emphasize short-term, acute outbreaks requiring rapid identification and control – to 'stamp out' the outbreak and prevent dangerous spread ultimately to global populations (Heymann et al, 1999; Crawford, 2007; Leach, 2008; Dry and Leach, 2010). Specific elements of the institutional response have included the creation by the WHO of a revised set of International Health Regulations in 2005 (WHO, 2005) and of the Global Outbreak Alert and Response Network (GOARN) (WHO, 2009) which mobilizes multiple agencies to respond to epidemic shocks as they arise.

Yet there are alternative narratives produced by different actors which frame the system in different ways. One alternative narrative, for instance, promoted by certain researchers, technical agencies and non-governmental organizations, emphasizes a local intervention model focused on reducing disease risk and exposure in a particular area. The system is thus bounded here in more local or regional terms. Relevant dynamics include the social, political and ecological processes which result in disease outbreaks and make particular people vulnerable to them. Variants of this narrative therefore embrace attention to long-term changes in human–animal–environment interactions (for example, trends in farming, livelihoods and land use in the context of climate change) as a focus for development and adaptation. These might include, for instance, land-use and ecosystem interventions such as integrated vector management, or the restructuring of market chains – for example in the poultry industry (Parkes et al, 2004; Waltner-Toews and Wall, 1997). In some versions, dynamic disease ecology comes to the fore, with attention to the often-unpredictable ways that viruses, social and environmental dynamics co-evolve in particular settings such as to render particular people and places vulnerable (Slingenbergh et al, 2004). Thus deforestation through agriculture and logging, and its political, economic and poverty-related causes, has been argued to contribute to viral haemorrhagic fevers, by bringing populations closer to their forest animal viral reservoirs and secondary vectors. Outbreaks of haemorrhagic fevers have often centred on the forest–savannah boundary zone, suggesting interactions with nonlinear forest–savannah dynamics and land use (Fairhead and Leach, 1998), and with agricultural and bushmeat-trading livelihoods

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(Hardin, 2008), which may themselves be influenced by the uncertain effects of climate change. Subjective goals and values in this alternative narrative focus more on addressing the underlying structural causes of inequity and disease vulnerability among particular populations (Farmer, 2003), and addressing the longer-term social justice and livelihood implications of disease and response.

In a related alternative narrative, advocated by some field practitioners with long experience of engagement with local populations, infectious diseases are seen as more endemic than epidemic; long present among local populations who have developed culturally embedded ways to live and deal with them, as with haemorrhagic fevers for example (Hewlett and Hewlett, 2008). Like the previous alternative narrative, the system is bounded in local terms. But here, the system relationships highlighted include local knowledge and social protocols which can, so this narrative argues, inform and be integrated into participatory surveillance and response strategies, helping to make these more context-specific, locally appropriate and acceptable.

Thus different actors and networks, framing system dynamics, boundaries and goals in different ways, produce very different narratives about what a response should be and what might make it effective. A similar array of contrasting narratives can be found across all our case examples. To take another, let us look at water in Western India.

The case of water-scarce Kutch, a region of Gujarat in Western India, has become iconic in the debate about water scarcity in India, particularly around the controversial Sardar Sarovar Project (SSP) (Mehta, 2005). Those promoting large-dam building as a solution to regional water scarcity, including certain state planners, water engineers and elite land owners with potential access to irrigation water, promote a narrative which sees the creation of a massive dam across the Narmada river as necessary to supply downstream irrigation and urban water needs. The system is bounded as a large, regional watershed, linking water supplies to a range of users. System dynamics are characterized in terms of declining water availability, portraying scarcity as natural – attributed to low and ever-decreasing rainfall and perennial droughts. As research by Mehta (2005) has shown, there is a widespread view in Kutch that due to the harsh climate, erratic water supply, declining groundwater sources and frequent droughts, the only solution is to get water from the rivers of Gujarat, with hopes pinned on the ambitious dam project SSP. These arguments have become incorporated into popular and media discourses, which have also become a way of expressing concerns about the political marginalization of the region. Kutchi identity is moulded around water or the lack of it. Villagers across the length and breadth of the district say in certain contexts that the lack of water is the cause of their

misery, the depopulated villages and mass migration out of Kutch (Mehta, 2005). Thus the subjective values and goals in this narrative include not just increasing physical water availability, but also the rescuing of the region from political marginality.

In contrast, farmers and pastoralists living in Kutch express in their everyday lives and practices a highly contrasting narrative. Their framings of the system focus on local dryland livelihoods and on the knowledge and livelihood strategies that allow them to adapt to the unpredictability and temporary scarcity of water. This narrative also draws attention to distributional issues and the social and political dynamics which enable some to access water while others do not. The water 'crisis' in Kutch in this view is largely human-induced and intensely political, and not simply 'natural' (Mehta, 2005). Emphasis is placed on the culpability of large farmers, bad water-management practices, misuse of water and the circumventing of legislation. Activists and researchers allied with this narrative, in turn, take a different view on the SSP. They argue that much of the water made available downstream will either be utilized by the industrial complex in southern Kutch or be diverted to meet the needs of big irrigation farmers whose use of water is neither economic nor judicious. They argue that, following present plans, SSP water will not help to recharge the groundwater aquifers of Kutch or reduce soil salinity; neither will it meet the water needs of poor dryland cultivators, women and pastoralists. Therefore with different subjective values and goals, as well as a different understanding of dynamics, the narrative emphasizes different solutions. These focus on learning lessons from history. In the past, even though rainfall was precarious and scanty, the region's water resources were managed either by local people or by the Raos of Bhuj, using principles and practices compatible with Kutch's needs: for example, earthen dams, tanks and other water-harvesting methods.

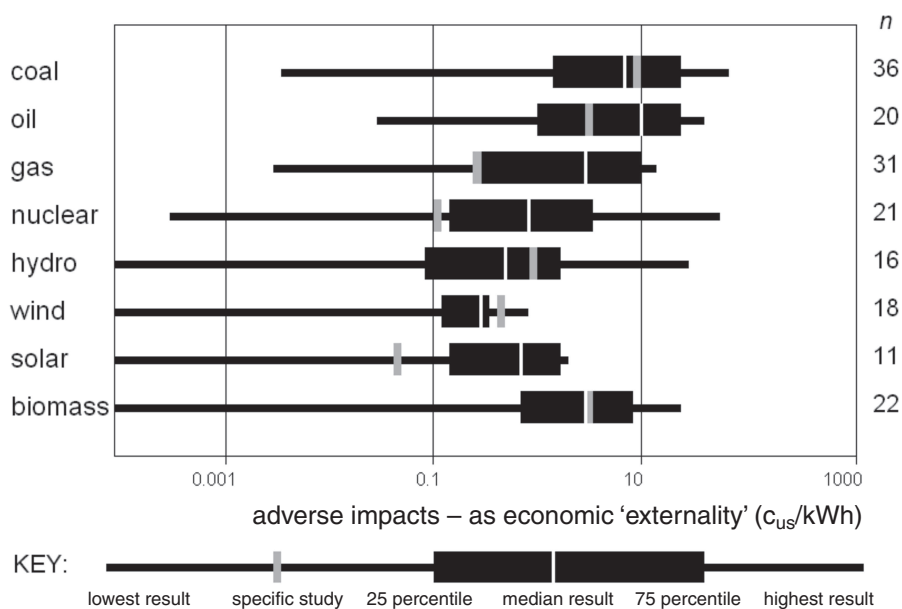
Thus, for any given issue, it is possible to identify a range of different narratives which link different system framings to particular goals and values. While narratives are produced by particular actors and networks, the same people may become allied with different narratives at different times and in different contexts. Thus, in the case of debates about water in Kutch, farmers may represent water scarcity as natural when they speak in popular, politicized terms about the region's marginalization, yet express very different perspectives as they live with water uncertainty in their day-to-day farming livelihoods.

As we see in these examples, different narratives lead to radically different assessments of policy options. Even among different actors in the policy field, different system framings are important and often lead to very different narratives around intervention and action. In the energy sector, for

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instance, great efforts have been expended to conduct comprehensive comparative assessments across a full range of policy options (CEC, 2004). Results have been influential in areas of policymaking such as climate change, nuclear power and utility regulation.

Figure 3.2 shows the results obtained across 63 international cost-benefit studies, looking at the adverse effects caused by a range of different electricity-generating options – from coal to biomass. Each study was conducted according to comparably stringent disciplinary principles and subject to similarly rigorous processes of expert accreditation or peer review. Not every study reviews every energy option, which is why the values of n on the right-hand side do not add up to 63. The impacts of energy technologies are expressed in this literature as ‘economic externalities’. This involves taking all the different kinds of environmental, health and wider social pros and cons of each energy option and calculating a monetary value to represent the relative magnitude of each. In Figure 3.2, the results are represented as the additional ‘external cost’ (in US cents at 1998 prices) that would have to be added to the existing market price of one unit of electricity (a kilowatt-hour, kWh) if this were to reflect the full ‘social cost’ of electricity production



Note: Results obtained across 63 detailed risk- and cost-benefit comparative studies (n).

Source: Adapted from Sundqvist et al, 2004

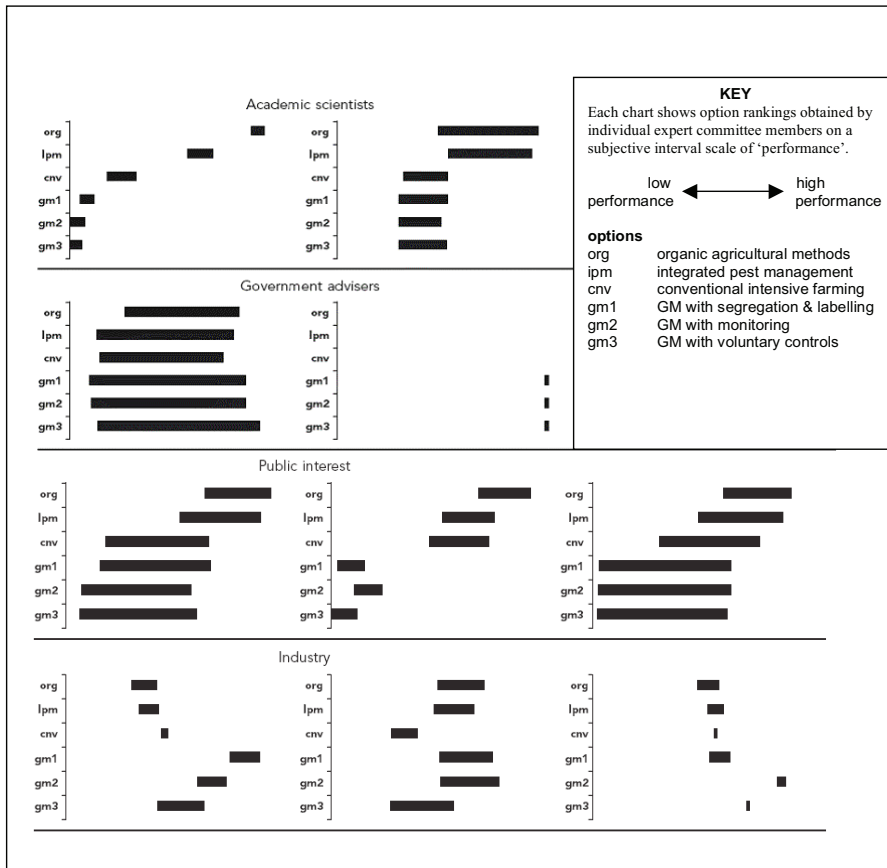
Figure 3.2 Variability in assessment of policy options for electricity supply

by each means (Sundqvist et al, 2004). Although the expression of these results in terms of monetary values is controversial (Stirling, 1997), it is standard procedure in this energy-assessment literature, as across other areas of technology assessment such as chemicals, agriculture and transport (Amendola, 1992; Saltelli, 2008). Whereas individual studies typically express their results as very precise, there is enormous variability in the literature as a whole, extending to several orders of magnitude around the median values for each range in Figure 3.2. Thus, depending which result is chosen from within the range associated with each option, contending energy supply technologies could be ranked very differently. These contrasts between the results obtained by different studies are due to the divergent framings of their analyses. Although privately well known to analysts, this importance of subjective judgement is rarely reflected in the presentation of results, let alone policy discussions, which routinely refer to this kind of 'science based' analysis as offering clear prescription for choice among alternative technology options (Stirling, 2008).

In the same way, Figure 3.3 displays the variety of judgements exercised by different experts involved in advising the UK government on the regulation of GM crops in the late 1990s. Using an elicitation method called 'multicriteria mapping' (MCM) (Stirling, 1997; Stirling and Mayer, 1999), each individual expert explored their own understandings of the options, evaluation criteria, policy priorities and technical uncertainties. The result in each case included an individual picture of the relative performance rankings for a series of different agricultural strategies. Each chart in Figure 3.3 summarizes these individual pictures for six agricultural strategies that were comparable across all experts. The results reveal large uncertainties within individual views (shown by the lengths of the bars) and stark ambiguities across different perspectives (shown by the contrasting rankings across individual charts). The detailed picture of the underlying framings provided by MCM contrasts strongly with the typically quite precise prescriptive collective findings expressed by the advisory committees on which these same experts sit. Each framing is similarly 'expert' and 'legitimate', yet yields radically divergent implications for policymaking. Conventional unified recommendations 'close down' these uncertainties and ambiguities and obscure the importance for policymaking of divergent 'expert' framings.

The reason that expert assessment procedures such as these can yield such contrasting pictures is that the answers that are derived typically depend on the framing of analysis (Goffman, 1975). As Chapter 5 illustrates further, framing effects such as these shape the application of appraisal tools, methods and procedures of all kinds.

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Source: After Stirling and Gee, 2003

Figure 3.3 Variation in policy judgements on alternative agricultural policy options

As we now go on to explore, narratives differ not just in how they frame systems and prioritize particular goals, they also differ in how they address risk and uncertainty, and in the particular dynamic properties of sustainability that they emphasize. We now deal with these themes in turn.

Addressing risk and uncertainty

As seen from these examples from the field energy policy and agriculture, the world involves both complex dynamics and radical differences in framings of them. For our understandings (and policymaking) to be as effective

as possible, attention must therefore focus very directly on the risks, uncertainties and ambiguities which result.

Yet there are many ways of thinking about risk and uncertainty. These can be illustrated by building on the two basic dimensions that constitute the mainstream policy concept of 'risk'. First, there are the things that might happen: 'hazards', 'possibilities', 'benefits' or 'costs' – which can be referred to as 'outcomes'. A second dimension is the likelihood of each outcome happening – conventionally represented as a numerical probability between zero and one. Routine economic and policy analysis represents 'risk' as the simple product of these two parameters. But what is neglected in this kind of approach is that either of these dimensions may itself be subject to variously incomplete or problematic knowledge.

As Figure 3.4 shows, this conventional definition of 'risk' actually implies three other idealized possible states of knowledge about likelihoods and outcomes (Stirling, 1999). In naming these, Figure 3.4 employs terms in a sense that reflects both their colloquial meanings and their strict (and original) technical definitions. The crucial point here, however, lies not in terminology or taxonomy. The four distinguished aspects of incomplete knowledge are 'ideal types', reflecting different facets of incomplete knowledge that typically occur together in varying degrees. The value of this

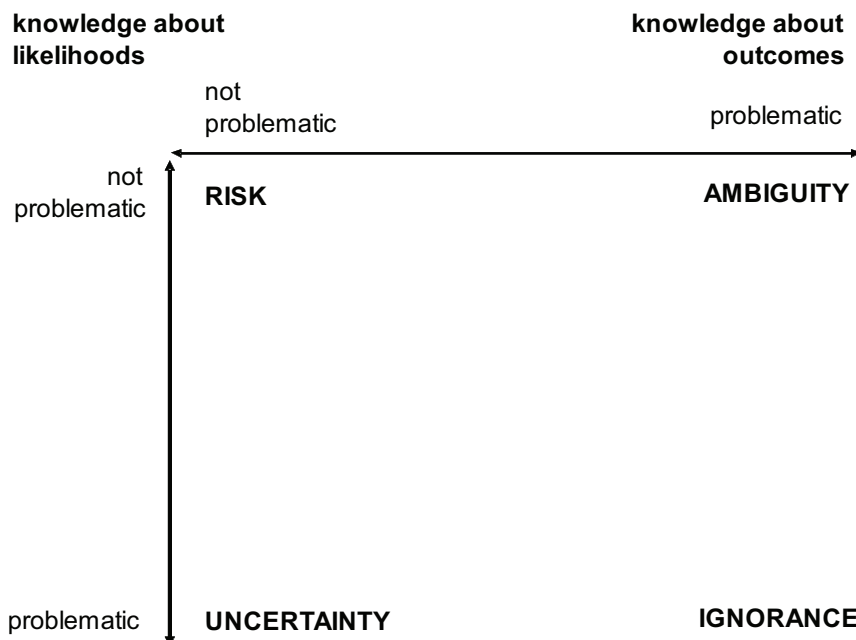


Figure 3.4 Dimensions of incomplete knowledge

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picture lies rather in the substance of the distinctions, highlighting their very different implications for practical and policy responses. By recognizing the different properties of these contrasting states of knowledge, we can gain important insights into the challenges for sustainability.

The top left-hand quadrant defines risk in the strict sense of the term. This refers to a situation where there is confidence that probabilities can be calculated across a range of known outcomes. However, the three other dimensions of incomplete knowledge are situations where these conditions do not apply: uncertainty, ambiguity and ignorance. These describe a range of circumstances under which reductive, analytic methods – such as risk assessment – are, even in their own terms, quite simply not applicable.

Under the strict definition of uncertainty in Figure 3.4 (lower left quadrant), we can be confident in our characterization of the different possible outcomes, but the available empirical information or analytical models do not present a definitive basis for assigning probabilities (Keynes, 1921; Knight, 1921; Rowe, 1994). It is under these conditions – in the words of the celebrated probability theorist de Finetti – that ‘probability does not exist’ (1974). Of course, we can still exercise subjective judgements and treat these as a basis for systematic analysis (Luce and Raiffa, 1957; Morgan et al, 1990). However, the challenge of uncertainty is that such judgements may take a number of different – equally plausible – forms (Wynne, 1992). Rather than reducing these to a single expected value or prescriptive recommendation, the rigorous approach is therefore to acknowledge the open nature of a variety of possible interpretations.

Under the condition of ambiguity (upper right quadrant), it is not the probabilities but the characterization of the outcomes themselves that is problematic. This may be the case even for events that are certain or have occurred already. Disagreements may exist, for instance, over the selection, partitioning, bounding, measurement, prioritization or interpretation of outcomes (Wynne, 2002; Stirling, 2003). Examples may be found in decisions over the right questions to pose in regulation: ‘Is this safe?’, ‘sustainable?’, ‘sustainable enough?’, ‘acceptable?’ or ‘the most sustainable option?’. For instance, in the regulation of genetically modified seeds, ambiguities arise over contending ecological, agronomic, safety, economic or social criteria of harm (Grove-White et al, 1997; Levidow et al, 1998; Stirling and Mayer, 1999). Similar ambiguities emerge when we are forced to compare ‘apples and oranges’. These might be qualitatively different forms of damage; impacts on different people (e.g. workers or the public; children or adults); consequences over different time-frames (e.g. present or future generations) or on different life-forms (e.g. humans or nonhumans). When faced with such questions over ‘contradictory certainties’ (Thompson and Warburton, 1985), Nobel prize-winning work in rational

choice theory has shown that analysis alone is unable to guarantee definitive answers (Arrow, 1963; Kelly, 1978; MacKay, 1980). Where there is ambiguity, then, reductions to a single 'sound scientific' picture are also neither rigorous nor rational (Collingridge, 1982; Bonner, 1986).

Finally, there is the condition of ignorance (lower right quadrant). Here, neither probabilities nor outcomes can be fully characterized (Keynes, 1921; Loasby, 1976; Collingridge, 1980). Where 'we don't know what we don't know' (Wynne, 1992, 2002), we face the ever-present prospect of 'surprise' (Brooks, 1986; Rosenberg, 1996). This differs from uncertainty, which focuses on agreed known parameters (such as carcinogenicity or flood damage). It differs from ambiguity, in that the parameters are not just contestable but are acknowledged to be at least partly unknown. Some of the most important challenges of sustainability involve issues that were – at least at their outset – of just this kind (Funtowicz and Ravetz, 1990). In the early histories of stratospheric ozone depletion (Farman, 2001), novel zoonotic diseases such as bovine spongiform encephalopathy (BSE) (van Zwanenberg and Millstone, 2001) or highly pathogenic avian influenza (Stirling and Scoones, 2010), and the recognition of new mechanisms of chemical toxicity such as endocrine disruption (Thornton, 2000), for instance, the initial problem was not so much divergent expert views or mistakes over probability; rather, it was straightforward ignorance over the possibilities themselves.

Returning to the case example of seed systems in Africa, one of the hottest debates of recent years has been over the potential role of GM food crops. At the heart of this has been an intense discussion about multiple dimensions of risk and uncertainty, with different actors articulating different narratives with different emphases. Perhaps the most dominant of these has focused on the classic, narrow definition of risk. Here the potential toxicity or biosafety risks of GM food and crops are assessed in controlled conditions or through extrapolating from experiences in the USA and Europe. Principles such as 'substantial equivalence' (Millstone et al, 1999) are deployed, which not only assume the appropriateness and completeness of risk assessment, but seek to elevate these assumptions to the status of a global regulatory principle. On this basis, it becomes an institutional imperative to confine attention to 'risk based' assessments of the probabilities of a set of specific forms of harm to people and environments. However, both potential consequences and associated probabilities may be viewed very differently. Take the emergence of 'superweeds' or the toxic effects of GM food, for instance. The consequences of superweeds depend on assumptions about the efficacy, accessibility and affordability of management techniques, which can look very different for different groups. Toxic effects appear differently depending on whether they are understood as aggregate statistical effects over large populations or as specific impacts on genetically

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susceptible sub-populations. In either case, the probabilities of such outcomes occurring in particular places or conditions are typically deeply uncertain. This applies in particular to agro-ecological and social settings in Africa, for example, where standard experimental models designed for other contexts may not apply. In many situations, furthermore, conditions of ignorance may arise – where we simply don't know what we don't know. The synergistic impacts of GM foods on immune-suppressed populations, for example, may result in very different and wholly unforeseen toxicity reactions. Or the impacts of shifts in climate and agro-ecology may interact with crop weed genetic dynamics in ways that cannot be foreseen, particularly in biodiverse areas. Finally, the GM debate has been fraught with conditions of ambiguity, where different views on potential outcomes and why they matter prevail. Thus for example, GM may be discussed in terms of its potential for boosting crop productivity, disease and pest resistance and nutritional value. However, it may also be discussed in quite different terms in relation to the political economy of corporate control of agriculture and the implications this has for autonomy, dependence and livelihood options for the future (Scoones, 2005; Glover, 2009). Such different categories of incomplete knowledge in relation to GM crops are illustrated in Figure 3.5.

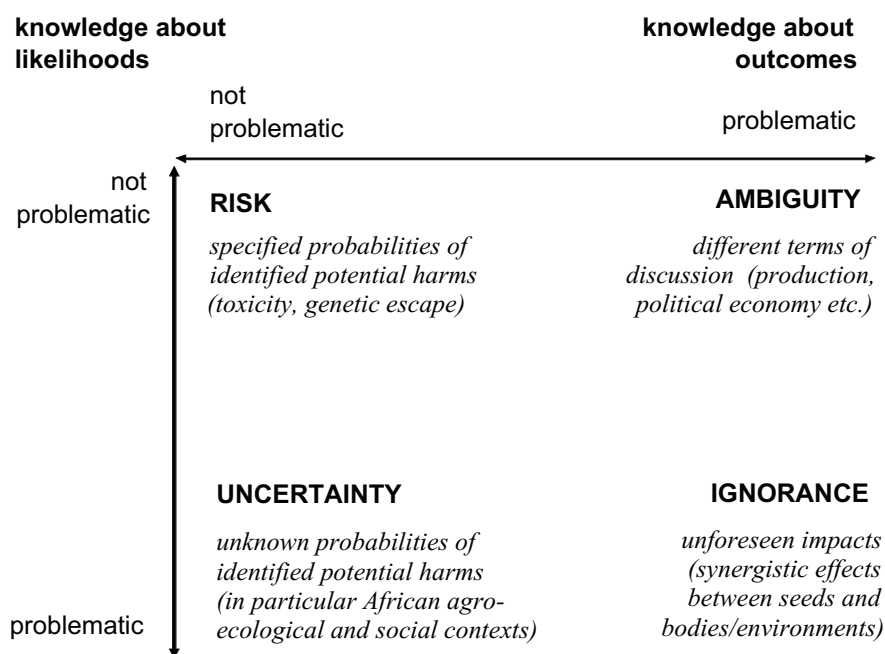


Figure 3.5 GM foods and crops: Dimensions of incomplete knowledge in African settings

Let us take another of our examples and look at how different dimensions of incomplete knowledge are invoked in the debate on avian influenza (Figure 3.6). Much of the debate has been dominated by quantitative probabilistic models of risk which sometimes present information about outcomes and likelihoods in far more definitive terms than is warranted. In 2005, for example, two models were presented in the journals *Nature* (Ferguson et al, 2005) and *Science* (Longini et al, 2005) which together had a huge influence in framing the response as one that needed to be focused on containment at the source of the outbreak. But of course a wide range of uncertainties exist – from the big uncertainty (will a devastating pandemic happen at all, and if so when?) to more specific uncertainties (about the impacts of veterinary control measures, about vaccination and drug efficacy, about behaviour change in situations of crisis and so on) (Scoones and Forster, 2008; Scoones, 2010). Thus, for example, the interplay between viral ecology and genetics (such as patterns of antigenic shift and drift), transmission mechanisms (such as the role of wild birds or poultry, backyard chickens or large factory units) and impacts (such as the consequences in immuno-compromised individuals and populations) are highly complex and contingent. There are also ambiguities: How do we define an ‘outbreak’? What different perspectives are there on the potential distributional consequences and associated implications for the ‘fairness’ of different possible interventions? Outcomes can be defined, for example, in terms of potential impacts of pandemic influenza on human mortality. Up to 150 million deaths may occur in a major global pandemic according to some estimates (although there are huge variations in the numbers quoted). Human mortality impacts may also be more tightly defined, in relation to particular groups at risk – for example, women or children handling poultry. Potential economic impacts of a global pandemic are also quoted, with some estimating the cost at US\$3 trillion. Yet cast in a different way, outcomes may be seen in terms of lost livelihoods and impacts on poverty and well-being. These outcomes may emerge from the response itself, as culling campaigns have resulted in around two billion chickens being slaughtered, many of which were backyard birds owned by poor families in developing countries (Scoones and Forster, 2008).

The condition of ignorance has also characterized debates over avian and pandemic influenza. The possible importance of hitherto unknown further mutations means that no one knows whether sustained human–human transmission will arise from the H5N1 virus or not. The possibility of as-yet undocumented transmission mechanisms and vectors means, further, that no one knows whether (if this occurs) it will result in rapid, global transmission with huge mortalities or not. And the possible importance of unexplored determinants of efficacy and wider consequences of response

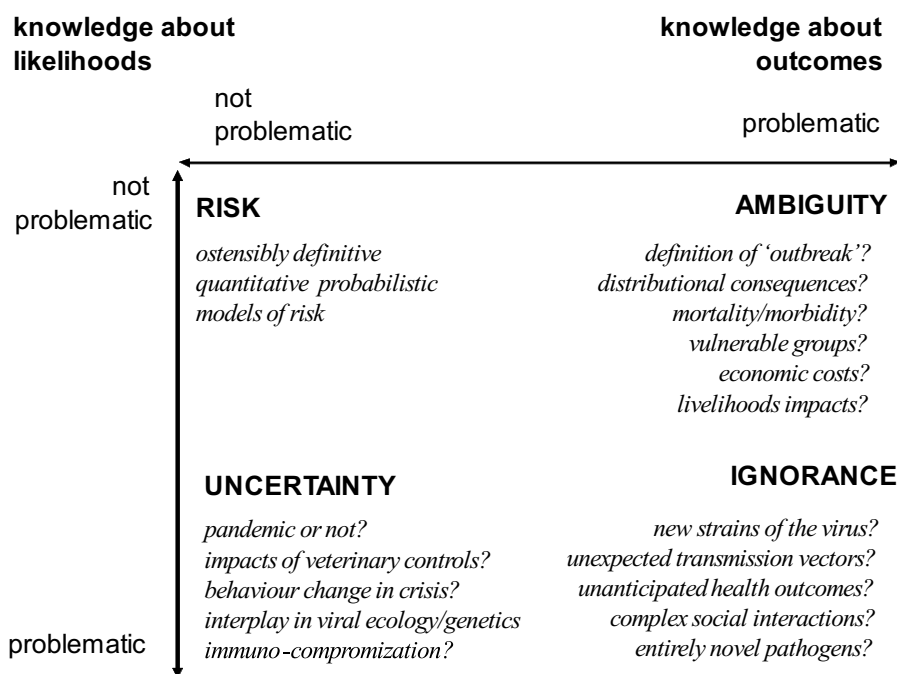


Figure 3.6 Avian and human pandemic influenza: Dimensions of incomplete knowledge

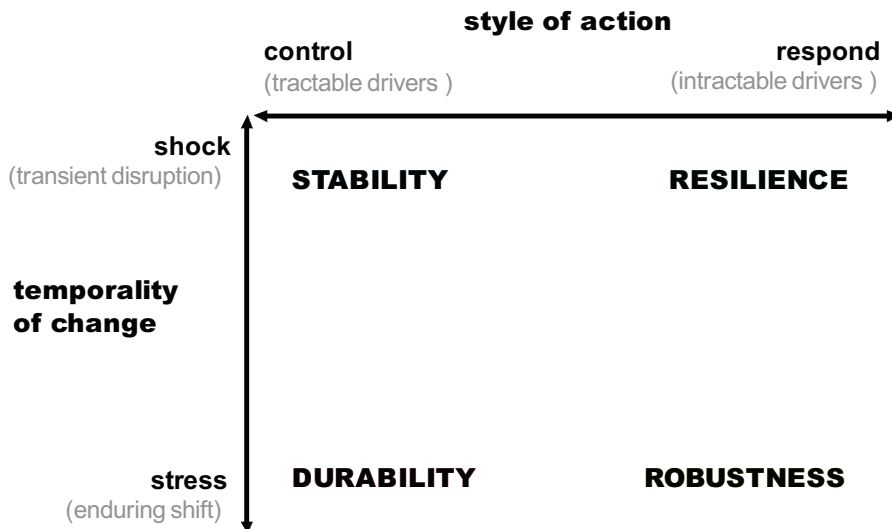
measures (e.g. containment, anti-viral drugs, vaccination) further compound the unknown implications for the spread of a pandemic. Of course, it is inherent in the nature of surprise that it is difficult to give possible examples of ignorance *ex ante*. However, possible surprises may plausibly be anticipated around the emergence of radically new strains of the virus (such as new combinations of avian and swine flu viruses), unexpected transmission mechanisms or unanticipated health outcomes, including those arising in complex interactions with other health/social conditions. Beyond this, there is always the broader possibility of the emergence of entirely novel pathogens; indeed more than 70 per cent of new infectious diseases affecting humans that have emerged over the last 30 years have emerged unexpectedly from non-human animal populations (Woolhouse and Gaunt, 2007; Jones et al, 2008).

Addressing dynamic properties of sustainability

Narratives about actions aiming to promote sustainability also involve assumptions about the nature, or 'temporalities', of the changes these

actions are intended to counter. Are changes seen as short-term shocks or long-term stresses? And these narratives also differ strongly in terms of the styles of actions that are envisaged. Is the aim to control the causes or drivers of change, or to respond to them? These are important practical distinctions that are often elided or ignored in existing analysis for policy-making on sustainability. Figure 3.7 maps out these further distinctions and the dynamic properties of sustainability associated with them. The vertical axis rests on a distinction between temporalities of change – the dynamics of the system in question. If changes are characterized mainly as shocks, then disruptions are seen as transient under otherwise continuous trajectories. On the other hand, if changes are seen as stresses, then we are talking of enduring, long-run shifts to the directions of the trajectories themselves. The horizontal axis rests on the distinction between different kinds of strategic action or intervention. If sources or drivers of disruption are seen as tractable to control, then relatively ambitious measures of control may be held justifiable. If the driving causes of change are more intractable, then it may be that only relatively modest forms of response are appropriate. Such styles of action reflect the distinction between more conventional, control-oriented management and responsive, adaptive management.

Thus we might ask, within any given policy narrative: Are intervention strategies aimed at exercising control in order to resist disturbance or shocks to what is otherwise assumed to be an essentially unchanging trajectory



Source: From Stirling, 2007b

Figure 3.7 Dynamic properties of sustainability

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(stability)? Or is there an acknowledgement that there may be limits to control, and thus that interventions should resist shocks in a more responsive fashion (resilience)? In other circumstances, the system may be subject to important stresses, driving long-run shifts. In this case, interventions might attempt to control the potential changes – aiming at durability. Alternatively, embracing both the limits to control and an openness to enduring shifts would suggest strategies aimed at robustness.

In dealing with epidemics, an emphasis on stability is the case for many outbreak narratives, which, as we have seen, emphasize ‘stamping out’ short-term disease shocks to return to a previous status quo. Thus control-oriented responses to outbreaks of Ebola in East and Central Africa, involving rapid response, containment and public health measures to limit contact and spread, have often proved highly effective (Heymann et al, 1999). This is a classic case of a control response to a short-term shock, with the aim of ensuring stability. However, in thinking about a sustainable disease response system over wider areas and longer time frames, there is a need to respond to outbreaks as they arise in a more flexible manner. A flexible response network that can be mobilized as and when needed can, in this context, be seen as a strategy for resilience. The WHO’s Global Outbreak Alert and Response Network (GOARN) (WHO, 2009) is a potential example, although most of its activities focus on control responses to immediate shocks. The responses thus mobilized emphasize one-off, short-term disease-eradication efforts, often with little attention to longer-term stresses. For instance, in the case of Ebola, there are questions over how response infrastructures might respond to longer-term evolutionary changes in viruses and their ecological interactions (Pinzon et al, 2004; Walsh et al, 2005). Yet existing strategies are conventionally built on assumptions of internal stability, in which the fundamental dynamics are assumed to stay the same. In this way the property of durability is downplayed at the expense of stability.

Finally, there is the property of robustness – a conjunction of challenges both of intervention and change as represented in the bottom right of Figure 3.7. Like durability, this requires consideration of possible stresses towards secular long run shifts in conditions. But in this case these are recognized to lie beyond the ready reach of control. In dealing with Ebola, there exist numerous examples which point to this latter challenge of robustness (Leach, 2008): changes in viral susceptibility in different populations; long-term shifts in forest–savannah dynamics and their effects on the populations of rats that are the main vectors for the disease (Denys et al, 2005); ecological shifts and stresses resulting in more human–animal contact and the effects of climate change on these. These issues have not been addressed at a fundamental level in mainstream policy narratives.

There is an argument (usually geared to funders), that investment in epidemic responses and infrastructure networks at a global level will proof the system against future outbreaks by improving capacity (surveillance, diagnosis and so on) – and so ensuring, in our language, durability and robustness. Yet there is very little attention to the specific challenges presented by long-term, external changes which are not amenable to prediction and control.

In the case of water management – in India as elsewhere – short-term shocks creating variability in water supply have been responded to through engineering systems with an emphasis on water control through dams, pipes and pumps. The definition of sustainability therefore is centred on the maintenance of stability of supply. However, increasingly, water supply engineers and managers are having to confront long-term secular shifts in rainfall and hydrological patterns as a result of climate change. Again, control-oriented strategies are linking engineering solutions to long-term predictions of climate-related stresses. So, for example, dam infrastructures are built with margins to accommodate extra water or to operate with less. Thus, conceptions of sustainability extend from stability to durability, but still remain within a control-oriented paradigm.

In many instances, though, the tractability of the drivers of future environmental shocks and stresses affecting water supply and hydrology is understood to be limited. Here, more response-oriented strategies are essential in assuring sustainability. Thus, in cases of short-term shocks such as droughts or sharp, high rainfall episodes leading to floods, strategies for resilience are required. This involves moving beyond a control-oriented engineering approach to consider a diversity of response strategies and management interventions. In the Indian case, this might include building on local understandings, techniques and technologies – such as tank systems, water harvesting and so on, or strategies for pastoral mobility or inter-annual shifts in crop mixes. Water engineering for resilience requires inbuilt flexibility and an ability to manage flows in a responsive and adaptive manner.

However, given long-term stresses associated with climate change in places such as Kutch in Western India, acting in conjunction with other long-term stresses linked to population shifts, economic change and alterations of land use, adaptation to short-term shocks may be insufficient. Strategies to ensure robustness of water supply for users would need to respond not just to inter-annual variability or episodes of infrastructure failure, but to long-term changes in water supply and its use. This might involve longer-term shifts in land use, in agricultural practices, in crop types and varieties, and in the overall dependence on rain-fed agriculture in people's livelihoods. The suite of technologies and management practices required for sustainability focused on robustness will look different. Again,

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engineering solutions will be important but might, for instance, focus on a variegated system of smaller dams which can be adjusted more flexibly in response to long-term shifts in water availability. There are no simple answers; indeed debate and experimentation around strategies for responding to shocks, stresses and their less tractable causes in the Indian context, as elsewhere in South Asia, is live and ongoing (Moench and Dixit, 2004).

Sustainability is about the maintenance of qualities of human well-being, social equity and environmental integrity over time. This inherently encompasses both shocks and shifts (as the kinds of change against which qualities are maintained) and control and response actions (as the kinds of intervention that might be adopted to achieve these ends). The four properties mapped out in Figure 3.7 may therefore be seen as individually necessary and collectively sufficient elements of sustainability (see Figure 3.8). ‘Sustainable solutions’ are thus those that offer stability, durability, resilience and robustness in specified qualities of human well-being, social equity and environmental quality. Defined in this way, these dynamic properties of sustainability relate to benefits and flows delivered in any particular system, as framed in a particular way.

These quite fundamental conceptual distinctions give rise to some very practical policy implications. For instance, rather than speaking about some particular policy aim in terms of undifferentiated ‘strategies for sustainability’, we cannot assume that particular strategies fostering one aspect of the dynamics of sustainability will necessarily promote others. Thus, in the case of an epidemic response system, a sustainable system would combine not

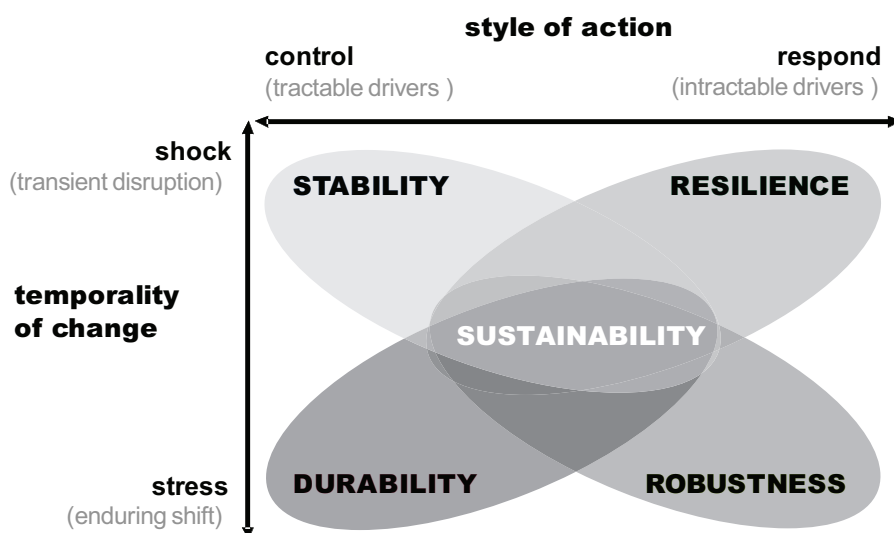
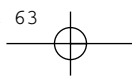


Figure 3.8 Combining dynamic properties of sustainability



only measures to control outbreaks at source as they arise, but also be positioned to respond adaptively to emergent outbreaks, thus conferring resilience and to identify, track and respond to longer-term shifts in disease incidence linked to changes in ecological and demographic conditions – both those that can be relatively easily controlled (durability) and those that require more adaptive responses (robustness). The relative emphasis on each of these dynamic properties of sustainability will depend on how the system is framed (its structures, elements and relationships) and on the associated policy goals and objectives. Thus narratives aimed at controlling global outbreaks of avian influenza, and those focused on more localized livelihood goals of Asian farmers affected by this as a long-term poultry disease, would highlight different dynamic properties and different goals of sustainability.

A new science for sustainability?

Following the discussion above, the task faced in thinking about and appraising issues of sustainability involves more than just a technical assessment of the dynamic properties of stability, durability, resilience and robustness. We must ask: What is the system? What are its purposes, functions and meanings? What is to be sustained and for whom? Who is to define each of these things and how? All such aspects are inevitably contested.

Drawing together the various sets of distinctions discussed above, for any issue we might therefore identify an array of narratives – different stories about the nature of a problem and potential solution. For each particular narrative we might ask:

- Who are the actors and networks articulating the narrative?
- What is the specific framing of ‘the system’ and its dynamics – including the treatment of different notions of bounding and spatial and temporal scale, and the goals and values prioritized for system change (Figure 3.1)?
- How is incomplete knowledge dealt with? To what extent does the narrative address the issue in terms of risk, uncertainty, ambiguity or ignorance (Figure 3.4)?
- Which dynamic properties of sustainability are prioritized? In particular, to what extent is the narrative focused on shocks or stresses, control or response (Figures 3.7 and 3.8)?

Narratives are important not just as stories about the world. Some of them, at least, justify and become entwined with particular pathways of intervention and system change. As we have discussed above, for any particular issue it is

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often possible to identify multiple narratives, each suggesting different pathways to different sustainabilities. Some exist, some are hidden and some are, currently, only imagined. But all must be subject to analysis, consideration and debate.

Pathways to sustainability are thus constructed through decisions which must explicitly address contestation and trade-offs between different dynamic system properties as seen under different framings and narratives. Critically, this requires a reflexive process, whereby assessments become necessarily positioned and partial, constructed in relation to the social-economic-political subjectivities of the analyst.

A new science for sustainability thus requires a joining together of now well elaborated non-equilibrium perspectives from the natural sciences (see Chapter 2) with social science perspectives which take the issue of framing seriously in an integrated manner. With Holling (1998) we agree that a positivist, sometimes reductionist analytic is needed alongside more integrative, holistic sciences. This requires greater dialogue and interaction across disciplines, sectors and policy debates. As Holling (1998, p5) notes, even ‘Those more comfortable in exercising only one of these have the responsibility to understand the other.’

Central to the approach that we have developed in this chapter is what we might call a ‘reflexive turn’, by which we mean taking account of how analysis and understanding always depend on the position and assumptions of the analyst. This derives from a position on understanding systems, their structures, properties and functions, in relation to particular, normative goals and values. Any negotiation of pathways to sustainability in dynamic, complex systems must therefore be centrally about focusing on framings of systems and their properties – recognizing divergent epistemological (ways of knowing) and ontological (ways of being) positions, associated with different actors and interests. It must also involve negotiating the trade-offs across diverse pathways (actual, potential and imagined) in relation to the political-normative positions, goals and values of diverse actors.

Negotiating pathways to sustainability is therefore necessarily a political process. It can be informed by scientific analyses of contexts, systems and their properties but fundamentally requires an opening up of debate, through a diversification of knowledge bases and processes of inclusive deliberation at all steps. This needs to be supported by reflexive institutional frameworks and governance systems – and perhaps above all an increased humility and attention to power relations in processes of appraisal and decision-making. Just how this might come about – and often why it does not – both in terms of wider governance issues and particular appraisal designs – is the subject of the next three chapters.