



**Governing long-term social-ecological change: What
can the adaptive management and transition
management approaches learn from each other?**

Timothy J. Foxon, Mark S. Reed and
Lindsay C. Stringer

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Sustainability Research Institute (SRI), School of Earth and Environment,
The University of Leeds, Leeds, LS2 9JT, United Kingdom

Tel: +44 (0)113 3436461

Fax: +44 (0)113 3436716

Email: SRI-papers@see.leeds.ac.uk

Web-site: <http://www.see.leeds.ac.uk/sri>

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Governing long-term social-ecological change: What can the adaptive management and transition management approaches learn from each other?

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Email: t.j.foxon@leeds.ac.uk

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Abstract

Maintaining social welfare and opportunity in the face of severe ecological pressures requires frameworks for managing and governing long-term social-ecological change. This paper analyses two recent frameworks, outlining what they could learn from each other. The first aims to understand transitions in socio-technical systems, by analysing dynamic interactions between three levels: *niches*, *socio-technical regimes* and *landscape*. This has led to the concept of transition management as a process of shaping or modulating socio-technical regimes towards long-term sustainability goals. The second focuses on *resilience* and *adaptive capacity*, by considering wider social-ecological systems in terms of their ability to absorb disturbance, self-organise and build and increase the capacity for learning and adaptation. This approach views management as experiments from which successive interventions can be adapted to more effectively manage social-ecological systems.

Though usually applied in different domains, the two conceptual frameworks aim to integrate bottom-up and top-down approaches and share a focus on the ability of systems to learn and develop adaptive capacity whilst facing external shocks and long-term pressures. Both also emphasise learning from experimentation in complex systems, but transition management focuses more on the ability to steer long-term changes in system functions, whilst adaptive management emphasises the maintenance of system functions in the face of external change. The combination of iterative learning and stakeholder participation from adaptive management has the potential to incorporate vital feedbacks into transitions management, which in turn offers a longer-term perspective from which to learn about and manage socio-technical and social-ecological change. It is argued that by combining insights from both frameworks, it may be possible to foster more robust and resilient governance of social-ecological systems, than could be achieved by either approach alone. The paper concludes by illustrating how elements of each approach are being combined in the methodology of a research project investigating social-ecological change in UK uplands.

Key words: Adaptive management; transition management; social-ecological change; socio-technical change.

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About the Authors

Dr Tim Foxon joined the Sustainability Research Institute in September 2007 as a Research Councils UK Academic Fellow, exploring the conditions for the up-take of new energy technologies. His position is linked to the University's Earth, Energy and Environment Interdisciplinary Institute. His research focuses on innovation systems and processes for a transition to a low carbon economy. He is particularly interested in how path dependency arises through co-evolution of technologies and institutions (social rule systems), how this can lead to lock-in of particular paths, and how policies to promote diversity of options and long-term thinking can help to overcome such lock-in. He was previously a Research Associate in the Cambridge Centre for Climate Change Mitigation Research (4CMR) at the University of Cambridge, and a Research Lecturer at Imperial College London, where he co-ordinated research on

policy drivers and barriers for sustainable innovation, under the ESRC Sustainable Technologies Programme, leading to a number of journal papers and a report for policy-makers, launched at the DTI in April 2005. He was also lead or co-author of three reports for the DTI on UK renewables innovation systems, as well as a report for the Carbon Trust on 'Inducing innovation for a low-carbon future', which has been widely cited.

Dr Mark Reed is a Senior Lecturer in Participatory Conservation in the School of Earth and Environment. Mark's expertise in participatory conservation focuses on land degradation, sustainability indicators and participatory processes. Over the last 10 years, he has applied these skills in a range of interdisciplinary projects in the UK and Africa. He has published over 20 articles in international peer-reviewed journals since finishing his PhD in 2005, and his work has been covered by BBC Radio 4, the Guardian and southern Africa newspapers. He has led research proposals that have secured over £1 million from organizations such as the European Union, Global Environment Facility, the Royal Society, the Royal Geographical Society and the UK Government's Research Councils. He gained his PhD working on land degradation assessment with communities in the Kalahari, Botswana. The methodological framework from this research has been adapted for use in UK uplands and is being applied internationally through a 9 million euro EU-funded land degradation remediation project, working with communities in southern, northern and Sahelian Africa, southern Europe, China & S America.

Dr Lindsay C. Stringer is a Lecturer in Environmental Social Sciences at the School of Earth and Environment, University of Leeds, UK. Her research examines environmental change, focusing in particular on land use and land degradation in semi-arid areas of Africa and Europe. She draws on a range of conventional, participatory and adaptive approaches and integrates methods from both the natural and social sciences in her research. Lindsay has published a number of papers in international journals such as *Ambio* and *Frontiers in Ecology and the Environment*. She is the book reviews editor for *Land Degradation and Development* and a member of the Science-Policy Working Group of European Desertnet.

1 Introduction

Over recent years, policymakers and researchers have focussed increasing attention on the capacity of human systems to continue functioning in the face of severe and rapid ecological disturbances (for example hurricane Katrina (2005), extensive summer flooding in the UK (2007), and disease outbreaks such as bluetongue virus and avian influenza). Such systems are characterised as social-ecological systems to emphasise that human and natural elements are closely interacting and mutually constituting (Folke et al., 2005). Both theory and unfortunate empirical evidence emphasise the vulnerability of society to such disturbances (Janssen and Ostrom, 2006). At the same time, researchers and policymakers have increasingly accepted the threat to social-ecological systems posed by anthropogenic climate change and hence the need to achieve a transition to low carbon systems for delivering energy, food and other essential services. This will require radical changes over a long period in order to maintain and enhance service delivery whilst achieving reductions in global greenhouse gas (GHG) emissions of the order of 50-80% by 2050 (IPCC, 2007). Similarly, such systems are characterised as socio-technical systems to emphasise that the social and technological elements are closely interacting and mutually constituting (Rip and Kemp, 1998; Geels, 2002, 2005).

Maintaining social welfare and opportunity in the face of these kinds of pressures requires the ongoing development of appropriate frameworks for both managing and governing long-term change in social-ecological and socio-technical systems. While no single governance or management framework is likely to be appropriate under all circumstances (Nagendra, 2007), there is currently a tendency for single, generalised solutions to be prescribed based on simple system models (Ostrom et al., 2007; Ostrom, 2007). These often neglect to look more broadly across sectors and can lead to the adoption of so-called blue-print or “panacea” policy instruments (Brock and Carpenter, 2007).

Social-ecological policy has drawn on several frameworks, for example: OECD’s (1993) Pressure-State-Impact-Response framework; Scoones’ (1998) Sustainable Livelihoods Framework; and Bossel’s (1998, 2001) Orientation Theory. However, these frameworks have tended to remain restricted to the theory, discipline and problem base in which they were originally conceived. This results in narrow application and limits opportunities for one approach to inform the development or evolution of another in relation to different policy sectors or management areas. Similarly, management of change in socio-technical systems is generally addressed within mainstream economics. Often this involves the use of tools such as cost-benefit analysis, which has been criticised for failing to address issues relating to ethics, plural values and distributional inequities (Stern, 2007; Spash, 2007). In addition, these long-term challenges are characterised by high levels of risk and uncertainty about future social, technical and economic possibilities and outcomes, and governance approaches need to take these into account.

Two recent approaches, relating to *adaptive management* (AM) of social-ecological systems and *transition management* (TM) of socio-technical systems, have begun to address key aspects of these challenges. Nevertheless, they have largely developed independently and, until very recently, without significant mutual interaction. It has been suggested that there exists huge potential for learning between the AM and TM

approaches (van der Brugge and van Raak, 2007; Pahl-Wostl, 2007). This paper aims to add to a potentially fruitful dialogue in this area.

The first approach we consider (Section 2) aims to understand transitions in socio-technical systems, by analysing dynamic interactions between three levels: *niches*, *socio-technical regimes* and *landscapes*. This has led to the concept of transition management as a process of shaping or modulating socio-technical regimes towards long-term sustainability goals. The second approach (Section 3) focuses on *resilience* and *adaptive capacity*, by analysing wider social-ecological systems in terms of their ability to absorb disturbance, self-organise and build and increase the capacity for learning and adaptation. This approach views management interventions as experiments from which successive interventions can be adapted to more effectively manage social-ecological systems. Although both approaches broadly stem from complex adaptive system theory (van der Brugge and van Raak, 2007), their domains of application to date have largely differed. We argue (Section 4) that, by combining insights from both adaptive management and transition management, it may be possible to foster more robust and resilient governance of complex social-ecological and socio-technical systems than could be achieved by either approach alone. Indeed, managing for resilience may enhance the possibility of sustaining desirable pathways under conditions of future uncertainty (cf. Walker et al., 2004; Adger et al., 2005). Finally, the paper uses ongoing case study research to show how elements of the two approaches can be combined in practice. This is achieved through presentation of a methodology for investigating social-ecological change in UK uplands (Section 5).

2 Transitions and the transition management approach

The ideas of transition management arose out of work on understanding long-term transitions in socio-technical systems, building on insights from a range of literatures on innovation systems, evolutionary economics and social shaping/construction of technological systems (Geels, 2002, 2005). A key theoretical step was the formulation of a multi-level framework for understanding such transitions, which analyses dynamic interactions between three levels: *niches*, *socio-technical regimes* and *landscapes* (Rip and Kemp, 1998). In response to demands from policy-makers in the Netherlands, *transition management* was proposed as a useful approach to help shape or modulate socio-technical regimes towards long-term sustainability goals. In this framework, a *socio-technical regime* arises through the interaction between the actors and institutions involved in creating and reinforcing a particular technological system and acquires a social stability and resistance to change. As described by Rip and Kemp (1998): “A socio-technical regime is the rule-set or grammar embedded in a complex of engineering practices; production process technologies; product characteristics, skills and procedures; ways of handling relevant artefacts and persons; ways of defining problems; all of them embedded in institutions and infrastructures.” *Landscapes* represent the broader political, social and cultural values and institutions that form the deep structural relationships of a society, and so are even more resistant to change than regimes. Whereas the existing regime generates incremental innovation, radical innovations are generated in *niches*. As a regime will usually not be totally homogeneous, niches provide spaces that at are least partially insulated from ‘normal’ selection processes in the

regime, for example, specialised sectors of the market, or locations where a slightly different institutional rule-set applies.

Transition management was adopted as a policymaking process in the Netherlands, as part of the 4th Netherlands Environmental Policy Plan (NMP4), published in 2000 (see Rotmans et al., 2001; Kemp and Rotmans, 2005). This Plan argued that there remains a set of persistent environmental problems to be addressed: climate change, biodiversity issues, depletion of resources, threats to human health, and that these require a systems approach to policy making in order to stimulate *transitions* towards sustainable energy, transport, resource use and agriculture. Following the publication of the NMP4, transition management programmes have been initiated for these areas by the four Ministries responsible. The 'Energy Transition' programme is following a public-private partnership approach, facilitated by the Ministry of Economic Affairs (Ministry of Economic Affairs, 2006). This has so far involved the formulation of 26 transition paths, from four transition platforms (with the themes 'sustainable mobility', 'new gas and clean fossil fuels', 'green raw materials' and 'chain efficiency'). These paths are based on their contribution to reducing CO₂ emissions, the opportunities they offer to Dutch companies and their technological feasibility, as assessed by stakeholders brought together in a 'transition arena'. To facilitate learning-by-doing and to assess these transition paths, a large number of practical transition experiments are being undertaken. These typically involve collaboration between technology developers, industrial partners, local authorities and community groups, and are designed to test the social and technological feasibility as well as the acceptability of the transition paths.

Transition management has also been applied to the social and economic development of Dutch regions and to issues of water management and waste management (Loorbach, 2007; van der Brugge and Rotmans, 2007; Kemp et al., 2007). In this context, it is viewed as a form of participatory policy-making based on complex systems thinking. A key concept here is that of a 'transition arena', defined as "a group of people that reach consensus with each other about the need and opportunity for systemic change, and co-ordinate amongst themselves to promote and develop an alternative" (van der Brugge and van Raak, 2007, p.33). The transition arena enables a relatively small group of innovation-oriented stakeholders to come together to engage in a process of social learning about future possibilities and opportunities. As van der Brugge and van Raak suggest, the transition arena idea forms a natural bridge between transition management and similar iterative, participatory approaches to adaptive management described below.

Transition management is thus envisioned as a process-oriented and goal-seeking approach designed to deal with complexity and uncertainty in a constructive way. Kemp et al. (2007) argue that it forms an example of 'goal-oriented modulation', which represents a 'third way' approach to governance, combining the advantages of incrementalism (based on mutual adaptation) with the advantages of planning (based on long-term objectives). They also argue that it can be seen as a specific form of multi-level governance (Hooghe and Marks, 2001), involving interactions between multiple actors at *strategic* (vision development and strategic goal-formulation), *tactical* (agenda building and networking) and *operational* (experimenting and implementing) levels. Key elements within transition management, according to Loorbach and Rotmans (2006), are:

- systems-thinking in terms of a range of actors and sectors interacting at multiple levels;
- long-term thinking (over a period of at least 25 years) as a framework for shaping short-term policy;
- back- and fore-casting: setting of short-term and longer-term goals based on long-term sustainability visions, scenario-studies, trend-analyses and short-term possibilities;
- a focus on learning-by-doing;
- an orientation towards system innovation and experiments;
- learning about a variety of options;
- participation of and interaction between stakeholders.

The forward-looking and iterative, learning-based approach of transition management is illustrated in Figures 1 and 2.

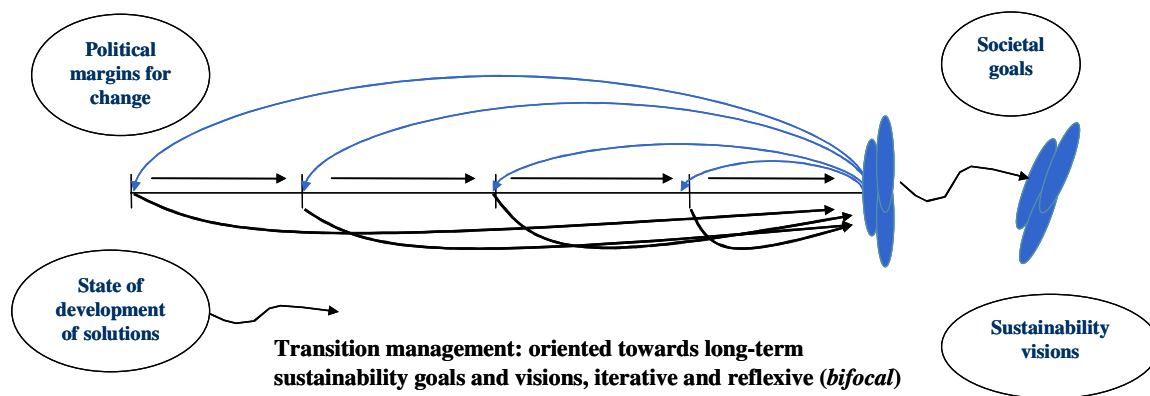


Figure 1. Feedback from long-term sustainability goals and visions to current decision-making (Source: Kemp and Loorbach, 2005)

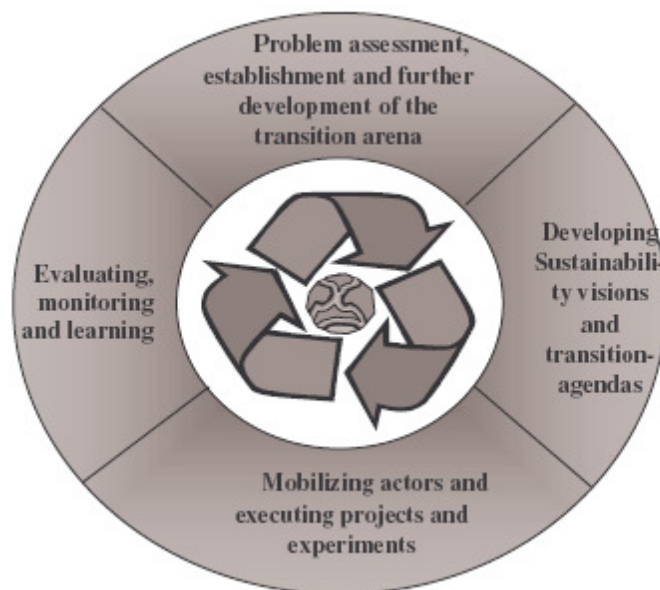


Figure 2. Iterative process of transition management (Source: Loorbach and Rotmans, 2006)

Although it has intuitive appeal, the transition management approach has been criticised from a theoretical viewpoint for offering an overly functionalist and structural explanation, for example: "... the tendency to treat regime transformation as a monolithic process dominated by rational action and neglecting important differences in context" (Smith et al., 2005, p.1492). It has also been criticised for downplaying the role of power-relations and agenda-setting (Smith and Stirling, 2008). In the practical application of transition management in the Netherlands, this has led to concerns that the transitions approach risks capture by the incumbent energy regime, thereby undermining the original NMP4 ambition for radical innovation of the energy system. This is exemplified by the fact that the energy transition taskforce, set up in 2005 to oversee the transition process and identify strategic directions, is chaired by the CEO of Shell Netherlands (Kern and Smith, 2007).

3 The adaptive management and resilience approach

Adaptive management is an approach that has rapidly expanded in its application over recent years (e.g. Berkes and Folke, 1998; Lee, 1999; Milestad and Hadatsch, 2003; Olsson et al., 2004). It has been used across a wide range of environmental contexts to inform the management of social-ecological systems including fisheries (McDaniels and Gregory, 2004; Pinkerton, 1999), agriculture (Tress and Tress, 2003), grasslands (Salwasser, 1999), forests (McGinley and Finnegan, 2003; Gray, 2000) and rangeland grazing (e.g. Clements, 2004). Rooted in Holling's studies of structural change and ecosystem functioning in the 1970s, early adaptive management initiated a trend away from theories of equilibrium within the ecological sciences, towards an understanding of nature as a dynamic, self-organising complex system (Levin, 1992; Bavington, 2002). As this complexity has been more widely accepted, it has gradually led to the emergence of an adaptive management paradigm in which managers acknowledge the limits to predictability (Levin, 1999), and accept that knowledge about social and ecological systems is both uncertain and pluralistic (Carpenter and Gunderson, 2001). This in turn, has caused an emphasis to be placed on *learning*, as interventions are strategically designed to allow hypotheses about the functioning of a system to be tested through experimentation (Holling, 1978; Walters, 1986; Clark et al., 2001). In this way, the results from one generation of experimentation and study inform subsequent decisions (Stringer et al., 2006). Adaptive management processes for a particular system thus start with the identification of system boundaries and system context, as well as both problems and the desired goal(s). Hypotheses and goals are then developed and tested. This leads to the implementation of policy strategies and monitoring of results (often using empirically tested indicators), after which the problem and goals are re-visited, and the cycle starts again. Figure 3 provides a graphical illustration of this cycle (see Reed et al., 2006).

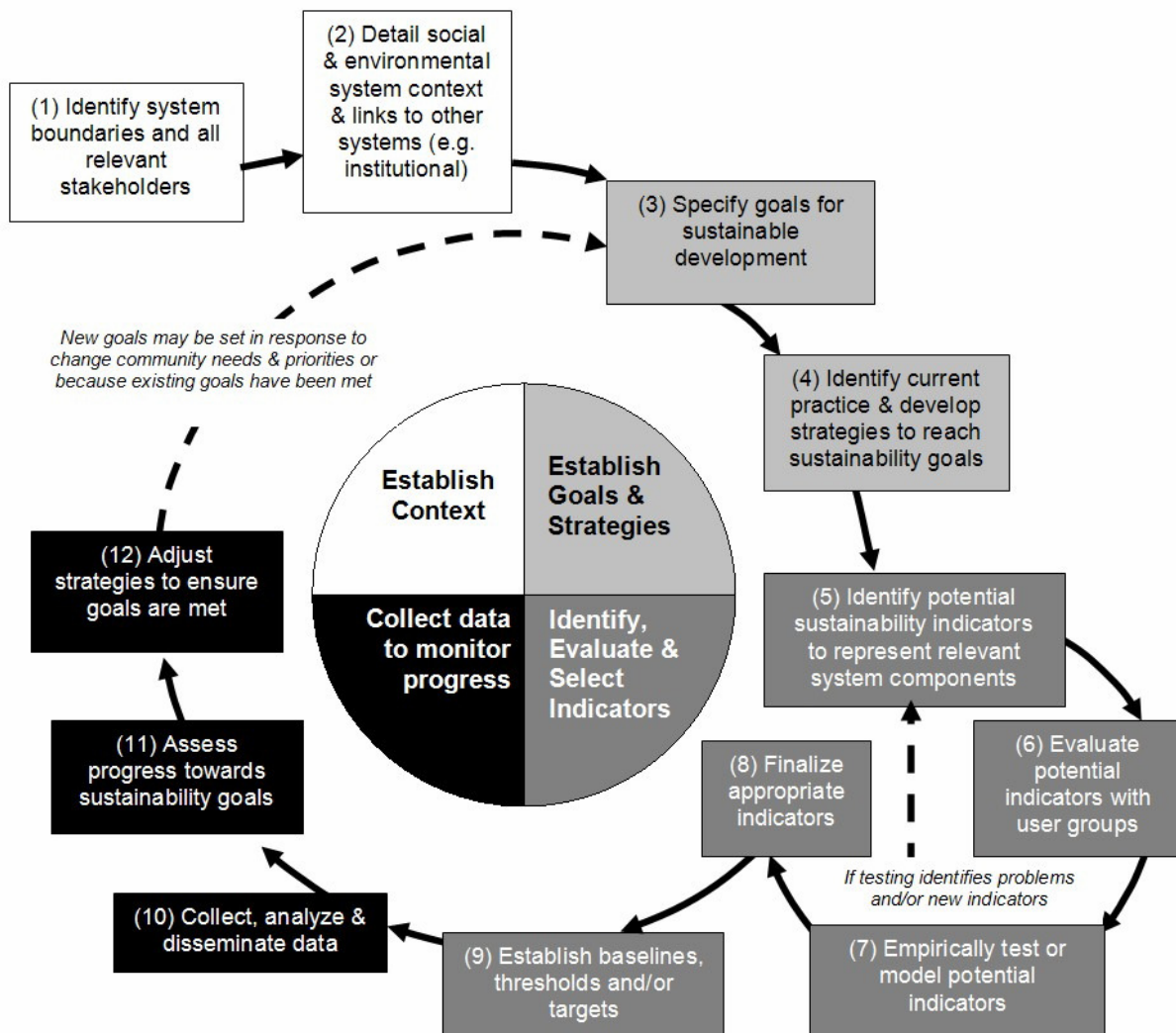


Figure 3. Illustrative adaptive management process, as followed by Reed et al. (2006) to help stakeholders manage and monitor progress towards sustainability in the Kalahari, Botswana.

In an adaptive management approach, system boundaries are often defined as a delineated spatial area (for example, a watershed, forest or river catchment). Drawing boundaries in this way can simultaneously encompass multiple spatial scales of operation of both social and ecological processes. Within those boundaries, a variety of stakeholders may be engaged, to help ensure policy reflects many different values and viewpoints (scientific, local and indigenous), not only in the exploration of a management ‘problem’, but also in goal setting, experimentation and management planning (McLain and Lee 1996; Johannes 1998, Ludwig et al., 2001; Folke, 2003). Recently, increasing critical attention has been paid to the social system boundaries and nature of stakeholder selection and involvement (e.g. Prell et al., in press), as well as the ways in which participatory processes and information flows can enhance social learning and build adaptive capacity (see Stringer et al., 2006). This can lead adaptive management to be conceptualised as a polycentric style of governance, which does not have a single centre (Hooghe and Marks, 2003; Ostrom et al., 1961). Instead, a process of multi-level governance can be allowed to evolve within the

system boundaries (Gatzweiler, 2005), permitting flexibility and interplay across scales. This approach takes into consideration ecological niches, economies of scale and stakeholder preferences across different, vertically-integrated levels of the system (Marks and Hooghe, 2005). However, in general, adaptive management remains tied to the operational level (Pahl-Wostl, 2007).

Similarly, time-scales play an important role within the adaptive management approach, largely because policies and goals are established over a particular time-horizon, with monitoring and assessment and re-evaluation continuously taking place. The iterative nature of the adaptive cycle means that each stage offers the potential to involve different stakeholder groups as appropriate, and provides an opportunity for them to learn from each other (Walters, 1986). This results in the development of a social as well as a scientific process, as communication and information can pass in multiple directions between multiple stakeholders at different times. In taking such an iterative, cyclical approach, management processes, institutions and policies can be adapted, as circumstances change, knowledge about the system is accrued and learning takes place. This shifts the emphasis from 'objective science' towards 'learning over time whilst managing'. Even if a system collapses, time remains important. Social-ecological memory (i.e. legacy) of the previous system state can persist, acting as a point of growth for renewal and reorganisation. Social memory endures in the individuals and institutions that store and use various practices and knowledges and hold different values and worldviews (Adger et al., 2005), while ecological memory refers to the environmental legacies following collapse, including the landscapes, colonising species and habitats that develop on disturbed sites (Berkes et al., 2003).

Closely linked to the adaptive management process is the concept of resilience. Holling originally introduced the notion of ecological resilience as a concept for understanding regime shift in the 1960s and 70s (Scheffer et al., 2001), through studies of predator-prey relationships in relation to ecological stability theories (Holling, 1961). Initial work on resilience focused on the buffering capacity of ecosystems to absorb shocks without collapsing into a different state, structure or function, controlled by a different suite of processes. The resilience of an ecosystem therefore refers to its ability to withstand shocks, maintain stability during disturbances and rebuild itself when required (Carpenter and Gunderson, 2001). In social systems, this is extended to consider the social system's capability to self-organise and build capacity for learning and adaptation. Resilience can thus be retained by maintaining diversity, be it biological diversity or multi-stakeholder involvement. For example, there is evidence that multi-stakeholder participation in environmental decision-making enhances the quality and durability of decisions and potentially leads to better informed policy options, by drawing on a wider knowledge base (Reed, in press). Used in this sense, concepts of resilience draw upon human capacities to iteratively experiment, learn, anticipate, plan for the future and manage risk. Nevertheless, it is not always possible to return a system to a previous (desired) state, particularly if threshold levels have been surpassed.

4 Discussion: comparison of the two approaches

Despite the use of different terminology and jargon, a number of similarities are present between the two approaches. For example, adaptive management (AM) and transition management (TM) both have their roots in thinking which recognises the complexity of, and interactions between, social, economic and ecological systems (Holling, 1978; Hughes, 1983). This has close links to more recent ideas on complex adaptive systems (Rammel et al., 2007) which analyse how systems of diverse, interacting elements give rise to emergent, structural properties, though much of that work has focussed more on building computational models of such systems (Holland, 1995). The approaches emphasise the evolutionary, path-dependent nature of change, and hence that the future dynamics of such systems are subject to risk and uncertainty. Although it may be possible to identify tendencies for system change, they remain highly unpredictable in practice. This implies that detailed control and management of these systems is impossible and so more flexible and responsive approaches are needed. This is in contrast to more reductionist approaches which seek to assess the optimal course of action based on an assessment of the estimated costs and benefits of future options, assuming quantifiable assessments of uncertainties.

The alternative philosophy proposed by both AM and TM is an iterative, learning-based approach to managing complex systems, characterised as “learning to manage by managing to learn” (Bormann et al., 1994; Pahl-Wostl, 2007). This is achieved through the application of repeated experimentation and revision of future directions based on learning from these experiments. They also both emphasise the involvement of a wide range of stakeholders and the need for institutional changes to provide arenas for learning and adaptive decision-making. Both approaches seek to reach sustainability goals that have been negotiated with stakeholders, though these goals tend to be longer-term aspirations in TM compared to the often shorter-term operational goals of AM. In both approaches, goals can be revised and refined as stakeholders learn about the system through the process of experimentation. Despite these areas of common ground, there are nevertheless some important differences of emphasis and context between the two approaches. This suggests the potential for mutual learning, particularly in relation to six key factors:

1. Goal-setting
2. Increasing participation in decision-making
3. Understanding the role of diversity
4. Addressing spatial and time-scales for change
5. Analysing governance processes
6. Stimulating institutional change.

Goal-setting

The AM approach starts from the need to build adaptive capacity within a social-ecological system to enable maintenance of system functions and allay the risk of large-scale collapse, whereas TM focuses on developing the ability to *steer* long-term changes in functioning of socio-technical systems. In TM, innovation therefore acts as an important driver of regime change, particularly through the development of radical innovation in niches, which then challenge the existing regime. However,

innovation is also able to enhance adaptive capacity, and there is evidence that the combination of scientific and local knowledges that often occurs in AM projects can facilitate the development of innovative options for adaptive management (Reed *et al.*, 2007; in press). In general though, the AM approach relies on the accretion of adaptive capacity in order to absorb and manage rather than to *direct* change. TM also largely works at a sectoral level (e.g. energy, water etc), and seeks to modulate change towards systems that fulfil societal functions, such as providing heating, lighting or clean water services, in more sustainable ways, for example, by moving from current high-carbon energy regimes to future low-carbon energy regimes. This focus on long-term modulation of change could help to enhance the AM approach by considering not only resilience in the face of transitory external shocks, but also in response to more gradual changes in external environments and internal preferences. For instance, this could include the involvement of stakeholders in thinking about desired futures states of social-ecological systems and what steps or paths would be needed to achieve these.

Participation

Evidence from AM processes suggests that multi-stakeholder input and participatory processes are crucial in building system resilience. The issue of costs and risks in AM is interesting however, and one that sits centrally in critiques of the AM approach (Pahl-Wostl, 2007). While short-term (substantial) investments are often needed to support experimentation and the participation of diverse interest groups, the returns from these investments may only be seen over the long-term. Where experimentation and opportunities for participation are restricted due to this tension, the costs of lost-learning are rarely accounted for. Despite these tensions, there is an increasingly rich tradition of stakeholder participation in AM. Drawing on collaborative management approaches, the more participatory approach to AM is often referred to as “adaptive co-management” (Ruitenbeek and Cartier, 2001; Olsson *et al.*, 2004; Plummer and Armitage, 2006). Among the many claims for adaptive co-management, it is argued that participatory processes lead to higher quality decisions, as they can be based on more complete information, anticipating and ameliorating unexpected negative outcomes before they occur (Beierle, 2002). There is evidence to support this claim from a number of case studies (e.g. Brody, 2003; Koontz, 2005; Sultana and Abeyasekera, 2007). Stakeholder Analysis is also gaining prominence in adaptive co-management as a way of systematically representing those relevant to environmental decision-making processes (Prell *et al.*, in press; Reed *et al.*, submitted). Though TM aims to involve a wide range of stakeholders, as we saw above in the case of the Netherlands, it has been criticised for risking capture by dominant actors within existing regimes. More explicit and discerning use of multi-stakeholder and participatory processes within TM could help to avoid this outcome, by better managing stakeholder relationships and power dynamics and giving more weight to those advocating the feasibility and desirability of different futures that threaten current interests.

Diversity

AM emphasises the role of diversity in building and maintaining the capacity to manage risks. Though TM suggests that the development of multiple niches is required to challenge the existing regime, there has been little direct emphasis on the

importance of diversity. Recent work on the role of diversity in maintaining and enhancing resilience within socio-technical systems for supplying energy services (Stirling, 2007) suggests that this could be an important area for future research. This therefore represents an important area in which AM could potentially inform TM.

Scale

Scale is an important consideration within AM, particularly when the social-ecological system of interest crosses multiple scales. The experimental element of the AM approach means that it remains vulnerable to the inherent scale issues faced by experimental scientific research. For example, large-scale systems may exhibit properties that cannot be detected or perhaps do not even take place at smaller scales. Similarly, while some effects are too small to observe at the laboratory scale, they may nevertheless cause adverse effects when taking place in a larger system (Lee, 1993). This means that despite experimentation, managers taking an AM approach must recognise that experimental outcomes are closely linked to other scales and that the potential for experimental uncertainties remains high. There is also a time dimension to consider when thinking about scale. In AM, it is the results of past and present experiments which provide the basis on which learning can take place. In TM, there is more emphasis on the longer term and the future. Additionally, the scale of focus is usually sector-specific in TM (e.g. energy, water etc), and the future goal is to move society as a whole towards a more sustainable energy or water system. This means that less consideration is given to scale overall. Nevertheless, it is still important in the context of the extent to which experiments that are successful in niches can be scaled up to challenge dominant regimes, as demonstrated by the difficulties faced by attempts to diffuse local experiments in sustainable transport solutions (Hoogma et al., 2002).

Governance

Perhaps the most interesting comparisons and contrasts between the two approaches come in relation to governance processes and institutional changes. As noted above, AM can be conceptualised as a polycentric, multi-level style of governance that can evolve within system boundaries. However, the extent to which this can occur depends on political systems that are open to public participation in environmental decision-making, which form part of the landscape context in TM. TM makes use of a specific macro-meso-micro level framework, based on landscapes, regimes and niches. This could be seen as constraining but it has proved useful in analyzing a range of different transitions, and so its application to AM processes could be usefully investigated (Pahl-Wostl, 2007).

Institutional change

Finally, both AM and TM approaches recognise the need for changes to current institutions so that they are able to facilitate the type of long-term, iterative, learning-based and participatory approaches needed for the sustainable management of complex systems. Both approaches support the view that neither top-down command-and-control management, nor bottom-up market-orientated processes, are adequate in the face of short-term and long-term challenges to sustainability. Both AM and TM can thus be seen as attempts to create institutional frameworks to

achieve positive change in complex multi-level and multi-stakeholder systems, in the face of severe risks and uncertainties. Despite the positive advances achieved by both approaches, creating such institutional frameworks remains elusive in practice. This may be because the requirements of both AM and TM processes are at variance with many of the institutional structures of the organisations charged with implementing environmental policy. For example, decision-makers may feel uncomfortable committing themselves to implement and resource the as-yet unknown outcome of an AM or TM process. In many cases, to do so would represent a radical shift in the organisational culture of government agencies and other institutions and stakeholders.

5 Combining approaches in practice: UK upland case study

So far, the discussion in this paper has been largely theoretical. This final section therefore outlines a methodology that combines ideas from the adaptive management and transition management frameworks to show how elements of each may be combined in practice. The case study we present combines knowledge from local stakeholders, policy-makers and social and natural scientists to anticipate, monitor and sustainably manage social-ecological change in UK uplands (for detailed overviews see: Dougill *et al.*, 2006 and Prell *et al.*, 2007). The project has study sites in the Peak District National Park, Yorkshire Dales and Galloway.

The iterative process used in the case study combines experience and new ideas from stakeholders with natural and social science to develop a range of options to deal with future challenges and exploit potential opportunities. First, participatory methods are used to identify the concerns and aspirations of local stakeholders. Next, computer models incorporating drivers of future change are used to build up a detailed picture of possible future social, economic and environmental scenarios. Innovative ideas are then sought from local people, policy makers and researchers about how people might adapt to these conditions. Suggestions are then fed back into the models to evaluate how they might affect future society, economy and environment, and enable participants to revise their ideas to avoid unintended and previously unexpected consequences. This iterative process operates on at least two different levels of governance, aiming to help identify appropriate ways for people to adapt in each area, as well as ways that policy-makers can support adaptation at a broader scale. The following paragraphs elaborate on this process in more detail, and show how it has been informed by both adaptive management and transition management frameworks.

Having defined the system boundaries and institutional context, the starting point for setting goals for long-term management in this case study was to identify the current needs and aspirations of local stakeholders and to explore the challenges and opportunities they faced in future. This was done through in-depth, semi-structured interviews with a cross-section of stakeholders, to elucidate their conceptualisation of system structure and function. Grounded Theory Analysis (Strauss and Corbin, 1990) was used to identify how stakeholders think that current and future drivers of change are likely to affect the evolution of different system components. This raised the challenge of how to represent pathways to possible future social, economic and environmental states. Both AM and TM frameworks emphasise the need to understand the complexity of social-ecological systems and interactions and

feedbacks between system components, in order to understand the evolutionary, path-dependant nature of change in such systems. To explore the complex, interconnectedness of social-ecological systems, a conceptual modelling approach was used to integrate both local and scientific knowledge of linkages, processes and relationships between system components. In combination with local knowledge, scientific knowledge can contribute to a more comprehensive understanding of complex and dynamic natural systems and processes (Stringer and Reed, 2007; Reed, in press). By triangulating different local and scientific knowledge sources, it may be possible to investigate uncertainties and assumptions in addition to developing a more rigorous understanding of the system (Johnson et al., 2004). Scientific conceptualisations were elicited from researchers during a systems modelling workshop, and supplemented with information from a literature review (Holden et al., 2007). Local and scientific conceptualisations were then integrated in a conceptual model of the system.

Inherent in the exploration of system dynamics, both frameworks emphasise the uncertainty and unpredictability of change in dynamic social-ecological systems. In response to this, scenario development is increasingly being used to help decision-makers better understand, anticipate and respond to the sorts of dynamic and uncertain changes that are likely to happen in future (Berkhout et al., 2001; Hubacek and Rothman, 2006; Rothman et al., 2000). Unlike forecasts or predictions, scenarios are images of the future or alternative futures that present us with situations for which we may need to prepare. Unpredictability may be addressed by introducing surprise scenarios that are deemed unlikely but that would have a significant impact if they occurred. The case study developed qualitative scenarios on the basis of data collected for the conceptual systems model (above), which are being further developed using outputs from integrated biophysical and socio-economic computational models to elucidate detailed likely effects and important feedbacks. By using an Agent-Based Model of human behaviour based on decision-rules derived from interviews with resource managers, policy-makers will be able to evaluate how land managers might respond to potential future policies. It is hoped that this will be able to inform policy-making designed to steer long-term change. As proposed in TM (Loorbach, 2007), scenarios may be used to stimulate future-oriented thinking by identifying elements of future 'visions' of sustainability.

Both AM and TM emphasise the role of real-world experiments to provide a setting for learning to take place. However, we argue that there may be a constructive role for simulation modelling to inform the choice and specification of experiments. Although models can only approximate real-world system dynamics, it is possible to use them to qualitatively test adaptive strategies, identifying potential feedbacks and unintended consequences. By feeding this information back to stakeholders in successive workshops or other such interactive settings, it should be possible to evaluate and refine a far wider range of adaptive strategies than would be possible using conventional experimental approaches, and to do so under a range of potential future conditions. With appropriate model validation, such an approach also has the potential to overcome the scale limitations usually associated with experimentation in AM, providing results for much larger areas than would otherwise be feasible. By taking this approach, it is also possible to consider far longer temporal scales than would normally be possible with experimentation, considering the sort of time horizons (e.g. 20-30 years) that are normally the domain of TM.

It is important to engage with stakeholders at a number of different levels and through a number of different mechanisms. In the case study, this has ranged from consultation during interviews and focus groups and dissemination of outputs via stakeholder meetings, to two-way communication and joint knowledge production in small group work, often in the field (cf. Rowe and Frewer, 2000). At this highest level of engagement, interaction with a small, but representative and influential group of stakeholders may facilitate both group and social learning, as emerging ideas diffuse to the wide social networks to which participants have access. Individuals deemed to be both influential and have access to large social networks were identified and selected through Social Network Analysis (Prell *et al.*, in press). Combined with stakeholder analysis (Reed *et al.*, submitted), this technique helped ensure that the group was broadly representative and included those typically marginalised in environmental decision-making. This is analogous to the selection of small groups of innovators to create transition arenas in TM (Rotmans *et al.*, 2001). Van der Brugge and van Raak (2007) describe these as a “participatory network of innovators” selected on the basis of capabilities including the ability to abstract and work creatively, work beyond their field of expertise, and propagate ideas within their social network. This approach also has parallels with Nooteboom’s (2006) “adaptive networks”, defined by van der Brugge and van Raak (2007) as “informal groups, which seek solutions outside the formal day-to-day machinery and participate in informal networks to reflect on the workings of the system”.

Our experience from the Sustainable Uplands project is that a range of innovative ideas emerges from these groups. Many focus on enhancing resilience by maintaining system structure and function in the face of future change (for example, increasing the sustainability of management of the use of fire in the case of the UK uplands). However some innovations have the potential to drive regime change, for example shifting towards managing uplands for carbon storage through large-scale ecological restoration (Worrall *et al.*, 2003). Following the TM multi-level framework, resilience is considered not only in the face of transitory external shocks (e.g. Foot and Mouth Disease), but also in response to more gradual changes in external environments (e.g. climate change) and internal preferences (e.g. cultural shifts leading to grouse shooting bans).

The final step in our methodology is to consider the alterations to current governance structures that may be needed to bring about the proposed changes. This may take place through use of a combination of bottom-up activities involving experimentation with new management processes by groups of stakeholders and managers, as well as more top-down changes to wider institutional structures. These activities may be informed by the participatory visioning process and conceptual modelling, and by the use of the multi-level framework to specify potential transition pathways based on past experiences. They are likely to involve innovations in changing current and future management regimes at a range of spatial and temporal scales.

6 Conclusion

This paper has presented an analysis of two approaches that may be used to inform the development of strategies to manage change. Though usually applied in different domains, AM and TM share a number of similarities but also exhibit a number of

differences. By exploring what the two frameworks can learn from each other and illustrating a methodology by which this may take place, the ideas presented here contribute to a fruitful ongoing dialogue. The methodology described here is being applied in the Sustainable Uplands project, and further papers will assess and evaluate the effectiveness of the methodology in practice. It is also informing the development of an 'analytical-deliberative' approach being pursued in new research examining the technical feasibility and social acceptability of transition pathways to a low carbon energy system in the UK (Foxon *et al.*, 2008). Further exchanges between AM and TM in the future may foster more resilient and robust processes of governance to enhance the sustainability of social-ecological and socio-technical systems.

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