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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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ABSTRACT
Maintaining social welfare and opportunity in the face of severe ecological pressures requires frameworks for managing and governing long-term social–ecological change. In this paper we analyse two recent frameworks, adaptive management and transition management, outlining what they could learn from each other. 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 emphasize 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 emphasizes 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 transition 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 critically reflecting upon the challenges and benefits of combining elements of each approach, as has been attempted in the methodology of a research project investigating social–ecological change in UK uplands. Copyright © 2009 John Wiley & Sons, Ltd and ERP Environment.

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Introduction

OVER RECENT YEARS, POLICY-MAKERS 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 characterized as social–ecological systems to emphasize that human and natural elements are closely interacting and mutually constituting (Folke *et al.*, 2005). Both theory and unfortunate empirical evidence emphasize the vulnerability of society to such disturbances (Janssen and Ostrom, 2006). At the same time, researchers and policy-makers 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 characterized as socio-technical systems to emphasize 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 pressure 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, generalized solutions to be prescribed based on simple system models, which do not consider diversity or context specificities (see, e.g., Booth, 1994). 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; Roe, 1991; Ostrom *et al.*, 2007; Ostrom, 2007).

Socio-ecological policy has drawn on several frameworks, for example OECD's (1993) driving force–pressure–state–impact–response (DPSIR) framework, Scoones' (1998) sustainable livelihoods framework and Bossel's (1998, 2001) orientation theory. However, each of these frameworks has limitations (e.g. the focus of DPSIR on categorizing indicators for monitoring progress towards sustainability goals), and they 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 criticized for failing to address issues relating to ethics, plural values and distributional inequities (Stern, 2007; Spash, 2007). In addition, these long-term challenges are characterized 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.

This paper examines two recent approaches to managing and governing long-term social–ecological change. First, *transition management* (TM), relating to socio-technical systems, has been proposed as a process of shaping or modulating socio-technical regimes towards long-term sustainability goals. Second, *adaptive management* (AM) seeks to analyse social–ecological systems in terms of their ability to absorb disturbance, self-organize and build and increase the capacity for learning and adaptation. This paper aims to compare these two approaches and facilitate mutual learning, by identifying key factors that the two approaches consider in complementary ways. Rather than seeking to establish a blueprint for a combined methodology, we illustrate this mutual learning by showing how it has informed an ongoing research project, in which two of the authors are involved. The paper thus builds on previous initial attempts to compare and contrast the two approaches (van der Brugge and van Raak, 2007; Pahl-Wostl, 2007).

The paper is structured as follows. The following section examines work on understanding transitions in socio-technical systems, which analyses dynamic interactions between three levels: *niches*, *socio-technical regimes* and *landscapes*. This work has led to the concept of *transition management* as a process of shaping or modulating socio-technical regimes towards long-term sustainability goals. The next section examines work on *resilience* and *adaptive capacity* in social–ecological systems. This work has led to the idea of *adaptive management*, in which management interventions are viewed as experiments from which successive interventions can be adapted to more effectively

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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. The fourth section establishes key areas for mutual learning between the two approaches. The fifth section illustrates how these insights have been applied in the context of an ongoing research project investigating social–ecological change in UK uplands. The paper seeks to demonstrate that, by combining insights from both AM and TM, 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, we claim that 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).

Transitions and the Transition Management Approach

The ideas of TM 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, p. 338), '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 not usually be totally homogeneous, niches provide spaces that at are least partially insulated from 'normal' selection processes in the regime, for example specialized sectors of the market, or locations where a slightly different institutional rule-set applies.

Transition management was adopted as a policy-making process in The Netherlands as part of the Fourth 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 NMP4, TM 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 (2006). This has so far involved the formulation of 26 transition paths, from four transition platforms (with the themes of 'sustainable mobility', 'new gas and clean fossil fuels', 'green raw materials' and 'chain efficiency'). These paths are based on their contribution to reducing CO_2 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

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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 TM and similar iterative, participatory approaches to AM 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, 2003) 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 TM, 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-casting and forecasting – 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 and
- participation of and interaction between stakeholders.

The forward-looking and iterative, learning-based approach of TM is illustrated in Figures 1 and 2. These figures aim to illustrate how practitioners of TM seek to incorporate processes of engaging with, and learning from, a range of societal stakeholders.

Although it has intuitive appeal, the TM approach has been criticized 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 criticized for downplaying the role of power-relations and agenda-setting (Smith and Stirling, 2008). In the practical application of TM in The Netherlands, this has led to concerns that the transition 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, 2008).

The Adaptive Management and Resilience Approach

Adaptive management is an approach that has rapidly expanded in its application over recent years (see, 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 different locations and 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 (see, e.g., Clements, 2004). Rooted in Holling's studies of structural change and ecosystem functioning in the 1970s, early AM initiated a trend away from theories of equilibrium within the ecological sciences towards an understanding of nature as a dynamic, self-organizing complex system (Levin, 1992; Bavington, 2002). As this complexity has been more widely accepted, it has gradually led to the emergence of an AM 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 the more passive forms of AM, models and predictions may be used to determine the hypotheses to be tested (see, for example, the work of

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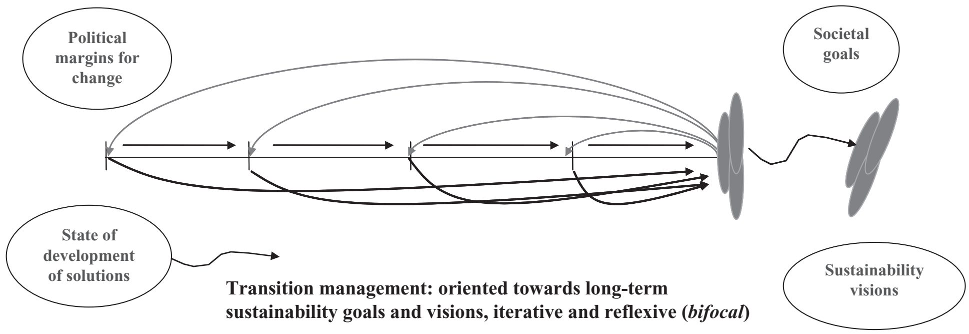

Figure 1. Feedback from long-term sustainability goals and visions to current decision-making (source: Kemp and Loorbach, 2005)

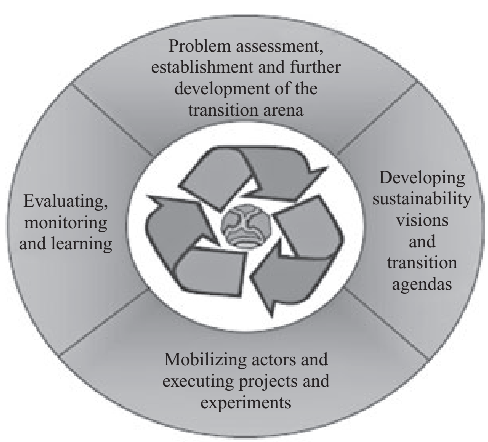

Figure 2. Iterative process of TM (source: Loorbach and Rotmans, 2006)

Nichols *et al.* (2007), who consider the use of mallard population models to inform the AM of wildfowl harvests), whereas more active AM changes management strategies in order to test completely new hypotheses. In both active and passive AM, 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 the 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).

In an AM 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 these boundaries, a variety of stakeholders may be engaged, to help ensure that 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 (see, e.g., Prell *et al.*, in press), as well as the ways in which participatory processes and information flows can enhance

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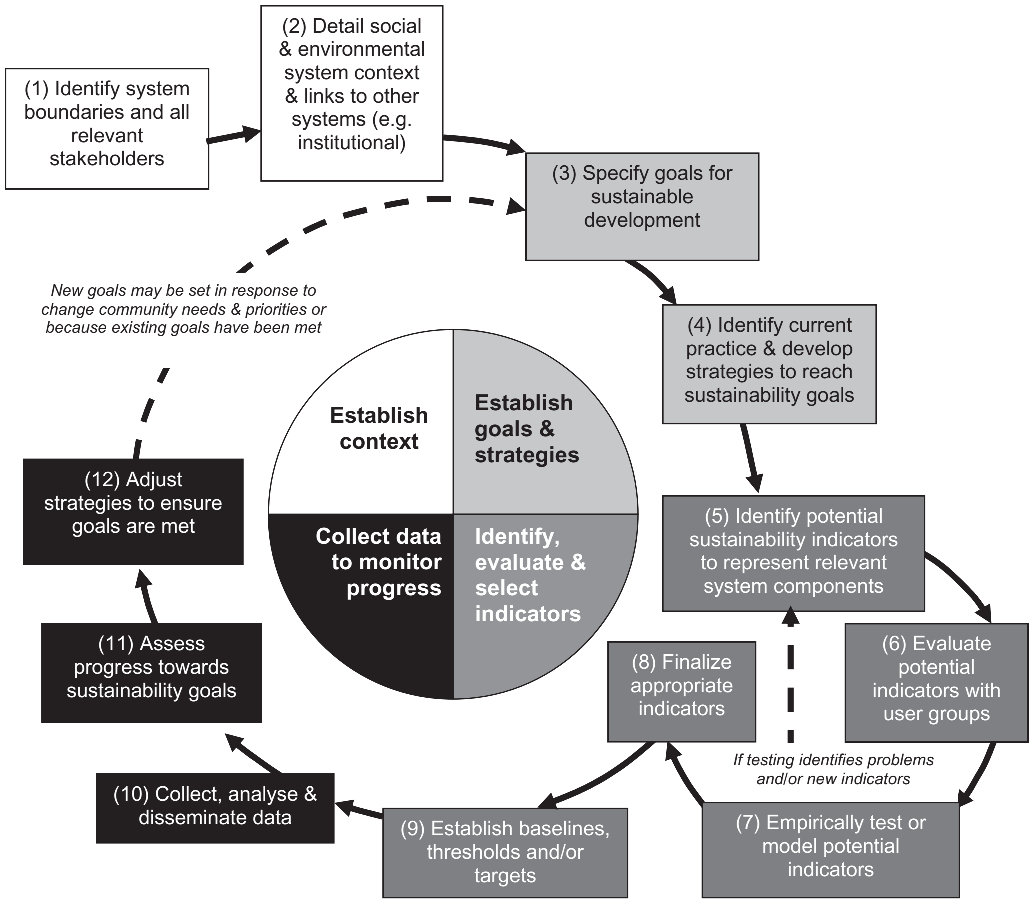

Figure 3. Illustrative AM process, as followed by Reed *et al.* (2006) to help stakeholders manage and monitor progress towards sustainability in the Kalahari, Botswana

social learning and build adaptive capacity (see Stringer *et al.*, 2006). This can lead AM to be conceptualized 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, AM remains tied to the operational level (Pahl-Wostl, 2007).

Similarly, timescales play an important role within the AM 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 reorganization. Social

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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, colonizing species and habitats that develop on disturbed sites (Berkes *et al.*, 2003).

Closely linked to the AM 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 1970s (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-organize 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 the participation of multiple stakeholders in environmental decision-making can enhance the quality and durability of decisions and potentially lead to better informed policy options, by drawing on a more diverse knowledge base (Reed, 2008). 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.

Comparison of the Two Approaches

The following section analyses AM and TM, identifying similarities and differences, to establish key areas for mutual learning between the two approaches. Given the different theoretical bases upon which these approaches are based, we do not attempt to integrate these into a combined framework. Instead, we focus on identifying lessons for the management of socio-ecological systems that emerge from the cross-fertilization of ideas between these two approaches.

Despite the use of different terminology and jargon, a number of similarities are present between the two approaches. For example, AM and TM both have their roots in thinking that recognizes 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 emphasize 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, characterized 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 emphasize 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:

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(1) goal-setting
(2) increasing participation in decision-making
(3) understanding the role of diversity
(4) addressing spatial scales and timescales for change
(5) analysing governance processes
(6) stimulating institutional change.

Some of these factors relate to the framing of the process (2, 4); others concern different stages or elements of the approaches (1, 2, 6), while others still concern the process of evaluation (3, 5). The potential for mutual learning is now considered for each of these factors.

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 AM (Reed *et al.*, 2007, 2008). 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. in energy, water management sectors, 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 resilience not only 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 future states of social–ecological systems and the steps or paths that would need to be taken to achieve these.

Increasing Participation in Decision-Making

Evidence from AM processes suggests that multi-stakeholder input and participatory processes are crucial in building system resilience. However, this raises the issue of who bears the costs and risks, which is raised in critiques of the AM approach (Pahl-Wostl, 2007). Neglect of this issue can often lead to the reinforcement of existing power imbalances. 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.*, in press). Though TM aims to involve a wide range of stakeholders, as we saw above in the case of The Netherlands, it has been criticized for risking capture by dominant actors within existing regimes. This can sometimes be due to the framing or management and facilitation of the process (i.e. a result of the context in which TM is typically applied). 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.

Understanding the Role of Diversity

AM emphasizes the role of diversity in systems and structures as a means of 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 of energy sources 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.

Addressing Spatial Scales and Timescales for Change

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 recognize 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 that 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).

Analysing Governance Processes

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 conceptualized as a polycentric and 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 analysing a range of different transitions, and so its application to AM processes could be usefully investigated (Pahl-Wostl, 2007).

Stimulating Institutional Change

Finally, both AM and TM approaches recognize 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 (e.g. command-and-control), nor bottom-up (e.g. 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. The key difference, however, lies in the approach that is taken towards achieving this. In TM, the modulation towards sustainability is goal oriented, and stimulates institutional change based on the results of experimentation combined with consensus achieved within the transitions arena. In AM, the stimulation for institutional change is based more upon the results of hypothesis testing and learning. Despite the positive advances, creating such institutional frameworks remains elusive in practice for both approaches. This may be because the requirements of both AM and TM processes are at variance with many of the institutional structures of the

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organizations 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 organizational culture of government agencies and other institutions and stakeholders. This implies that neither AM or TM alone can currently offer such radical transformation in the absence of a flexible wider institutional context.

Combining Approaches in Practice: UK Upland Case Study

Given the differences between the AM and TM approaches highlighted above, we do not claim that a single unified approach would be either valuable or desirable. Nevertheless, we argue that the areas for mutual learning highlighted in the previous section are not merely of academic interest, but that valuable lessons may be drawn for practitioners of AM or TM. In order to illustrate this, we describe how insights relating to the six areas for mutual learning are being applied to an ongoing research project to inform the management of social–ecological change in the UK uplands. Two of the authors are members of the project team and have been directly involved in the development of the methodological approach.

The case study is part of a project which seeks to 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; Prell *et al.*, 2007). The project has study sites in the Peak District National Park, Yorkshire Dales and Galloway. The project is following an iterative process combining experience and new ideas from local people with natural and social science expertise to develop a range of options to deal with future challenges and exploit potential opportunities. As well as seeking to inform shorter-term management of change through adaptive processes, the project also aims to inform how stakeholders may wish to steer local social–ecological systems towards greater sustainability in the longer term. Thus, in doing so, it draws on elements of both TM and AM, as well as exploring appropriate ways forward when dealing with the differences between the two approaches.

The approach being applied in the project is pursuing the following steps.

- Stakeholder priorities and their relationships are explored through a process of stakeholder analysis and social network analysis, with a small working group selected to represent a cross-section of stakeholders (including local people, policy-makers and researchers). This working group is analogous to a ‘transition arena’, and the group has worked with many of the participatory methods now widely used to stimulate learning within more active forms of AM.
- With this working group, semi-structured interviews and focus group discussions in the field were used to explore stakeholders’ current goals and likely future challenges/opportunities, with stakeholders and researchers working together to share and co-generate knowledge. This process was designed to capture the goals towards which different stakeholders wished to steer the system (as in TM), in addition to identifying likely future changes to which they may need to adapt (as in AM).
- Building on the focus on complex systems in both AM and TM, a conceptual model of the upland system was developed based on a grounded theory analysis of interview transcripts, field-based discussions and literature review. To assess potential future development of this social–ecological system, the model was used to create scenarios by tracing the effects of different drivers on successive system components. These scenarios were refined and prioritized through stakeholder focus groups.
- Computer models incorporating drivers of future change were used to build up a detailed picture of possible future social, economic and environmental scenarios. Innovative ideas are currently being sought from stakeholders about ways in which they might adapt to these conditions. Suggestions will then be 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 final step uses models in place of experiments in AM and TM to test the technical feasibility of innovations that could stimulate different transition pathways, and by working with stakeholders throughout their development

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assesses their social acceptability. Although these models can only be used as heuristics to support learning and decision-making by stakeholders, this approach is able to evaluate likely futures and innovations/adaptations at far broader scales than is usually possible through the experimental approaches of AM, and at the sort of temporal scales commonly addressed by TM. This iterative process operates across different governance levels, 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 AM and TM frameworks, in relation to the six areas for mutual learning identified in the previous section.

Goal-Setting

Having defined the stakeholders, 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 conceptualization of system structure and function. A grounded theory approach (Strauss and Corbin, 1990) was taken to identify the key ways in which stakeholders thought current and future drivers of change were likely to affect the evolution of different system components. This drew on elements of AM in that it sought to elucidate preliminary perspectives that would later be drawn upon to lay the foundations for enhancing adaptive capacity and resilience. It also, however, raised the challenge of how to represent pathways to possible future social, economic and environmental states, building on the TM tradition of steering change.

Both AM and TM frameworks emphasize the need to understand the complexity of social–ecological systems and interactions and feedbacks between system components, in order to understand the evolutionary, path-dependent nature of change in such systems. In order 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, 2008). By triangulating different local and scientific knowledge sources, this enabled the investigation of the uncertainties and assumptions of different groups (cf. Johnson *et al.*, 2004). Scientific conceptualizations were thus elicited from researchers during a systems modelling workshop, and supplemented with information from a literature review (Holden *et al.*, 2007). Local and scientific conceptualizations were then integrated in a conceptual model of the system. In this stage of the research, TM's focus on long-term modulation was therefore used to enhance the traditional AM approach. Attention shifted away from building resilience in the face of external shocks towards developing an understanding of how the social–ecological system could be steered to respond to more gradual changes, eventually leading towards a more desirable future state.

Increasing Participation in Decision-Making

It is important to consider engaging with stakeholders at a number of different levels and through a number of different mechanisms in order for participation to be both meaningful and useful (Reed, 2008). In the process employed in this project, stakeholder involvement 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). This is an important consideration in more participatory forms of AM (e.g. adaptive co-management – see Armitage *et al.*, 2007), because, at the deepest level of engagement, interaction with a small but representative and influential group of stakeholders can help to facilitate both group and social learning, as emerging ideas diffuse to the wide social networks to which participants have access. It also helps to identify the distribution of costs and risks. In our project, individuals deemed both to be influential and to 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.*, in press), this technique helped ensure that the group was broadly representative and included those typically marginalized in environmental decision-making.

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Participatory model building was attempted unsuccessfully in an initial multi-stakeholder workshop at Site 1 (Dougill *et al.*, 2006). Although this workshop formed a foundation for future collaboration, the attempt to build conceptual models with stakeholders in this workshop was not successful due to the highly heterogeneous composition of the group in terms of their views/interests and formal education level, coupled with inadequate facilitation. First, the professional facilitator was not sufficiently familiar with the local issues and stakeholders to be able to adequately follow and hence facilitate discussion. In addition, the wide range of educational backgrounds, ranging from those who were less literate to those with PhDs, presented significant facilitation challenges. The lack of alternative, more appropriate facilitation tools that could be used by the less literate participants led to a power dynamic where more educated participants felt more comfortable and authoritative, and less formally educated participants felt marginalized and disempowered. As a result, very little constructive progress was made during this workshop (Reed *et al.*, under review).

Learning from this experience and building on suggestions from stakeholders, a series of site visits was developed to initially replace workshop activities, using the landscape as a visual aid. Investment was made in professional facilitation training for two project members. Site visits were designed to bring stakeholders with different interests and backgrounds together with researchers as equal partners to discuss the upland management issues that were perceived to be most important. The outdoor context and facilitation style significantly reduced the discrepancies in power that were witnessed in the initial workshop, with all participants feeling comfortable engaging in discussion (Reed *et al.*, under review).

While more obviously standard practice in the adaptive co-management approach, this process may also be considered 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, p. 42) 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'. Combining insights from both AM and TM at this stage of the research helped us to learn from the experiences of others, as well as from the less successful multi-stakeholder workshop. As such, we were able to mediate some of the problems reported in the literature. For example, the use of social network analysis and stakeholder analysis reduced the risk of capture by dominant actors, which is mentioned as a problem in the TM approach used in The Netherlands.

Understanding the Role of Diversity

Rather than seeking consensus among stakeholders about 'optimal' responses to future scenarios, this study emphasizes the value of identifying, evaluating and refining a diverse range of options that could be used by different stakeholders in different contexts to address the challenges identified in each future scenario. In this way, the project aims to equip different stakeholders with ideas for policy and practice that will be relevant under a range of dynamic futures. In accordance with AM experiences, this will help to build and maintain the capacity to manage risks, whereas bringing TM experience to this stage of the research shows us the importance of developing diversity through multiple niches. Indeed, experience to date shows that diverse and innovative ideas can emerge from the group work described in the previous section. Many of these innovations 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). As such, this has allowed us to put into practice some of the ways in which AM and TM approaches can inform each other, as identified earlier on in our review.

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Addressing Spatial Scales and Timescales for Change

Both AM and TM emphasize the role of real-world experiments to provide a setting for learning to take place, often at very different scales. In this study we have found that there may also be a constructive role for simulation modelling to inform the choice and specification of experiments, and overcome the scale limitations of experimental approaches. Although models can only approximate real-world system dynamics, we are using them to qualitatively test adaptive strategies, identifying potential feedbacks and unintended consequences. In summary, this includes the use of Agent-Based Model outputs to estimate the likely levels of burning, grazing and/or labour under each scenario (e.g. what level of destocking CAP reform is likely to produce), and a range of more detailed knock-on biophysical effects for each scenario (e.g. effects of a certain level of destocking on water quality or biodiversity). Likely feedbacks will be investigated including potential interactions between scenarios that could occur concurrently. Outputs from this process relating to the scenarios short-listed in each study area will then be communicated to stakeholders using short films, as a basis for discussion with the modelling team to unpack the model's 'black box' of assumptions. This will then form the basis for discussion to identify innovative adaptation options that could help maintain livelihoods and the ecosystem services upon which they depend under each scenario. In this way the ultimate goal is to inform future decision-making that could enable effective adaptation to upland change (Reed *et al.*, under review).

By developing these models in collaboration with stakeholders (often referred to as a process of 'mediated modelling'), it is possible to capture diverse knowledges that may facilitate a more holistic conceptualization of the system that is being modelled (Prell *et al.*, 2007). By feeding back this information 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. This combines elements of both active and passive AM. 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. This combines some of the strengths of both AM and TM, and the potential remains to extend this even further. For example, it may be possible to expand the role of models as heuristics to support learning and decision-making among stakeholders and researchers, to highlight possible decision outcomes, feedbacks and surprises. This is particularly useful in contexts where the relevant spatial and temporal scales preclude the use of experimental approaches. Although models can never replace real world experience, by involving stakeholders in the modelling process, it may be possible to combine the experience and expertise of modellers with those who manage the land on a day-to-day basis, and in doing so allow us to address both temporal and spatial scales of change.

Analysing Governance Processes

The final step in the research process was to consider the alterations to current governance structures that may be needed to bring about the proposed changes. This can 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 (as per the AM approach), and by the use of the multi-level framework to specify potential transition pathways based on past experiences (drawing on the TM framework). Both approaches are able to promote innovation in changing current and future management regimes at a range of spatial and temporal scales.

Both AM and TM frameworks emphasize the need for environmental governance to account for 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 change that are likely to happen in future (Berkhout *et al.*, 2001; Hubacek and Rothman, 2006; Rothman *et al.*, 2000; IPCC, 2007). Unlike forecasts or predictions, scenarios are images of the future or alternative

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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. Our research process developed qualitative scenarios on the basis of data collected for the conceptual systems model (above), which are now being further developed using outputs from integrated biophysical and socio-economic computational models to elucidate detailed likely effects and important feedbacks. By employing an agent-based model of human behaviour using 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 and development of governance structures that are well positioned to steer long-term change. As proposed in the TM approach (Loorbach, 2007), the results from this part of the study indicate that scenarios can stimulate future-oriented thinking by identifying elements of future 'visions' of sustainability.

Stimulating Institutional Change

The final area for mutual learning – that of stimulating institutional change – is obviously more difficult to achieve within the context of a single project. Nevertheless, this study has illustrated an approach to overcoming some of the problems faced by more participatory and adaptive approaches to managing social–ecological change, which arise from existing institutional structures. Many widely used institutional structures and management tools, such as quantitative risk assessment, consensus building approaches and cost–benefit analysis, put a premium on converting uncertainties about the future into manageable risks and integrating different values held by different stakeholders into a common framework for decision-making (Warner, 1997; Stirling *et al.*, 2007). The approach followed here, stimulated by AM and TM thinking, is to develop a framework for exploring the consequences of these uncertainties and differing values to help stakeholders make informed choices. The participatory framework adopted by this study brings together stakeholders working in a variety of institutional settings, and offers a methodological framework for decision-making that could be adopted beyond the uplands context. For example, the study has led the UK Department for Environment and Rural Affairs (DEFRA) to consider adopting elements of this methodological framework for its proposed Soil Strategy for England and Wales. Furthermore, the significantly wider spatial and temporal scales over which TM tends to operate may make institutionalization possible at higher levels than typically occurs with AM. As shown above, bottom-up, participatory decision-making processes, facilitated by 'transition arenas' of innovation-oriented stakeholders, can contribute to higher-level learning processes by acting as 'experiments' along potential transition pathways.

Increasingly, government agencies and other organizations are seeking to apply more participatory approaches to environmental decision-making as part of a wider institutional change towards more inclusive decision-making. For example, in the UK, policy consultations now often involve stakeholder workshops, and these increasingly take place in the regions rather than just in the capital city. However, there is a danger of growing disillusionment among policy-makers and practitioners who have been involved in such processes that participatory processes are used to reinforce decisions already made, and so fail to realize many of the benefits that have been claimed for participation (Reed, 2008). Our study illustrates that there are benefits to genuine participatory processes, and informs the development of best practices for engaging stakeholders in effectively designed participatory processes (Reed, 2008). In this light, institutionalizing participatory governance takes some power away from central decision-makers and gives it back to stakeholders. Though this may be perceived as risky, it has the potential to give rise to more effective as well as more inclusive decision-making.

Conclusion

This paper has presented an analysis of two approaches – AM and TM – 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 methodological approach drawing on elements of each, the ideas presented here should contribute to a fruitful ongoing dialogue. In particular, we have identified six key areas in which there

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is potential for each approach to learn from the other: (1) goal-setting; (2) increasing participation in decision-making; (3) understanding the role of diversity; (4) addressing spatial scales and timescales for change; (5) analysing governance processes and (6) stimulating institutional change. We argue that it would be fruitful for future studies to reflect on these areas in developing methodologies for managing social–ecological and socio-technical change. In this way, it may be possible to overcome some of the limitations inherent in each approach, through, for example, showing how each approach may be operationalized at different spatial and temporal scales than in previous applications.

The paper has used a case study to illustrate how the insights that emerge as each approach learns from the other can inform research practice. It has explored the development of a methodological approach aiming to enhance the management of socio-ecological systems by both building resilience (cf. AM) and steering change (cf. TM). Participatory scenario development and mediated modelling were used to engage stakeholders in a process that developed a diverse range of responses to future change across spatial and temporal scales that are not normally possible to investigate using experimental approaches alone. Future papers will further assess and critically evaluate the effectiveness of this methodology in practice. Nevertheless, the case study has demonstrated some of the theoretical and practical problems faced when seeking to develop and apply a methodology combining insights from different approaches, as well as identifying some of the benefits that are to be gained. The insights described in this paper are 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). We hope that this paper stimulates further fruitful exchanges between AM and TM in the future and that it may contribute towards the development of more resilient and robust processes of governance to enhance the sustainability of social–ecological and socio-technical systems.

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