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Participatory scenario development for environmental management

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Participatory scenario development for environmental management: A methodological framework illustrated with experience from the UK uplands



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ABSTRACT

A methodological framework is proposed for participatory scenario development on the basis of evidence from the literature, and is tested and refined through the development of scenarios for the future of UK uplands. The paper uses a review of previous work to justify a framework based around the following steps: i) define context and establish whether there is a basis for stakeholder engagement in scenario development; ii) systematically identify and represent relevant stakeholders in the process; iii) define clear objectives for scenario development with stakeholders including spatial and temporal boundaries; iv) select relevant participatory methods for scenario development, during initial scenario construction, evaluation and to support decision-making based on scenarios; and v) integrate local and scientific knowledge throughout the process. The application of this framework in case study research suggests that participatory scenario development has the potential to: i) make scenarios more relevant to stakeholder needs and priorities; ii) extend the range of scenarios developed; iii) develop more detailed and precise scenarios through the integration of local and scientific knowledge; and iv) move beyond scenario development to facilitate adaptation to future change. It is argued that participatory scenario development can empower stakeholders and lead to more consistent and robust scenarios that can help people prepare more effectively for future change.

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1. Introduction

Where do we come from? What are we? Where are we going? These questions, from the title of Gauguin's famous painting, have been asked in many guises through the ages, by people seeking to better understand their world and prepare for their future. Throughout history, humans have tried to predict what will happen to them. But despite replacing crystal balls with computer models we are still largely groping in the dark, due to the complexity and unpredictability of the socio-ecological systems that we belong to

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(Sarewitz et al., 2000; Walz et al., 2007). If we are prepared to use our imagination however, it may still be possible to prepare for what lies ahead: “the best way to predict the future is to invent it” (Kay, 1989: 1). By telling stories about what the future might hold, it is possible to build up plausible scenarios that we can prepare for (Kahn and Weiner, 1967; Heugens and van Oosterhout, 2001). Although we can all dream of the future environment we want to live in (e.g. using techniques such as visioning (Wilson, 1992) and backcasting (Dreborg, 1996; Manning et al., 2006)), few of us have the capacity to make our dreams come true. However, by developing scenarios, we can explore what different people’s visions might be like, and be prepared for whoever’s dream comes true. We can also prepare for possible “nightmare” scenarios and the surprises that are an inevitable part of life. By being prepared, we don’t simply have to cope with whatever happens; we may be in a much stronger position to potentially exploit and harness future change.

Given the dynamic complexity and unpredictability of socio-ecological systems as they respond to drivers such as climate change, scenarios are increasingly being developed at various temporal and spatial scales to help people prepare for change (e.g. Georgopoulou et al., 1997; Nakicenovic et al., 1998; IPCC, 2000; Eames, 2002). However, if scenarios are to serve this purpose, it is essential that the people whose futures are being discussed are part of the scenario development process. Although there is growing awareness that stakeholder¹ participation² can improve the relevance, consistency and hence usefulness of scenarios, the level of engagement varies considerably between studies. Limitations and drawbacks of stakeholder participation in scenario development are also becoming evident e.g. practicalities associated with involving stakeholders in the development of international scenarios. To date there have been few analyses of experiences with stakeholder participation in scenario development. This article therefore aims to:

- Review literature on scenario development and the participatory methods that have been used to engage stakeholders to date;
- Build on emerging understandings of best practice stakeholder participation (Reed, 2008; de Vente et al., 2013), to synthesise a novel methodological framework that engages stakeholders at every stage of scenario development and application; and
- Apply, evaluate and refine this methodological framework using UK uplands as a case study.

2. Literature review

2.1. What are scenarios?

Heugens and van Oosterhout (2001: 863) define scenarios as “stories about the future”. Rather than attempting to predict the future, scenarios are plausible descriptions of what the future *might* hold (Kahn and Weiner, 1967). Scenario development (or scenario “analysis” or “planning”) is a systematic method for thinking creatively about dynamic, complex and uncertain futures, and identifying strategies to prepare for a range of possible outcomes (c.f. Peterson et al., 2003; Madlener et al., 2007). Scenarios may focus on identifying desirable futures towards which people want to work (e.g. using backcasting to work backwards through the steps necessary to reach a desired state). They may also include

undesirable futures that people may wish to avoid. Rather than attempting to reduce uncertainty through ever more accurate prediction, scenarios can flexibly incorporate potential feedbacks and surprises, to investigate and prepare for the uncertainties that are fundamental to complex systems (Kok et al., 2007; Walz et al., 2007). Scenarios can be entirely qualitative “storylines” or may include significant levels of quantification, for example incorporating findings from process-based mathematical models. Scenarios may serve a number of functions, for example: i) supporting research; ii) facilitating public learning and discussion; and 3) political decision-making support. With all three modes can come different degrees of stakeholder participation (ranging from consultation to co-decision-making) (Zurek and Henrichs, 2007; Volkery et al., 2008). For these reasons, scenarios are particularly useful in systems that are highly complex and unpredictable and/or where it is not possible to experimentally manipulate the system to see how structure and function changes in response to relevant drivers (e.g. due to the long time-frames involved) (Peterson et al., 2003).

To be plausible, scenarios must be logical, i.e. they must rest on a set of internally consistent assumptions about the way drivers of change and system components are interconnected (IPCC, 2000; Tietje, 2005). Having said this, although internally logical in their representation of processes, they may appear illogical in their representation of future issues and challenges that should be prepared for. To be useful for decision-making, a small range of significantly different scenarios is considered most effective, as there is a limit to the amount of information people can take in and process at once (Heugens and van Oosterhout, 2001), while small differences between scenarios generally make little difference to decisions and limit creativity (Brauers and Weber, 1988; Scholz and Tietje, 2002). Scenarios may be purely qualitative stories or may contain quantitative elements (Swart et al., 2004). Quantification may come from extrapolation of current trends (e.g. Schonwiese, 1994), or from (sometimes dynamic) systems models that may have predictive (or forecasting) capabilities (e.g. Vested et al., 1992; Brabec et al., 2001). Since Kahn and Weiner (1967) first abandoned forecasts for the use of scenarios, they have been used in a wide variety of contexts, including corporate planning (e.g. MacNulty, 1977; Wack, 1985; Schwartz, 1991), economics (Madlener et al., 2007; Kowalski et al., 2013) and energy generation (Nakicenovic et al., 1998). They have been used at a variety of temporal and spatial scales, from local, mid-term scenarios (e.g. Georgopoulou et al., 1997) to national and international long-term scenarios (e.g. IPCC, 2000; Nakicenovic et al., 1998; Eames, 2002; Millennium Ecosystem Assessment, 2005).

The limitations of scenario studies are well documented (e.g. Berkhout et al. 2001; Dockerty, 2002; Hubacek and Rothman, 2005). For example, there is a danger that decisions based on scenario development may be biased by scenarios that lack a sufficient evidence base, downplay uncertainty, or that do not consider sufficiently different time horizons or perspectives. Scenarios may also lack transparency if they do not make their assumptions explicit. For example, users may fail to differentiate between different habitats and regions, assuming that a scenario may have similar effects across both. The choice of criteria against which scenarios are evaluated may also bias the outcome of any decision-making process upon which they are based.

It may also be difficult to effectively communicate the levels of uncertainty associated with different scenarios, for example due to their dependence on links with external systems e.g. global food markets. The Millennium Ecosystem Assessment’s (2005) desertification synthesis indicates attempts to do this by estimating certainty for some of the statements they make. This is based on the collective opinion of the authors, using observational evidence, modelling results, and theory to develop categories of “very certain” (98% or more probability); “high certainty” (85–98%);

¹ We define stakeholders as those who are affected by or can affect a decision or action (after Freeman, 1984).

² We define participation as a process where individuals, groups and organisations choose to take an active role in making decisions that affect them (Reed, 2008).

“medium certainty” (65–85%); “low certainty” (52–65%); and “very uncertain” (50–52% probability). A range of other qualitative scales are also used, for example to describe the level of scientific understanding relating to a particular topic (such as “well established”; “established but incomplete”; “competing explanations”; and “speculative”).

However, it is often challenging to combine qualitative storylines with quantitative modelling and to weigh different types of knowledge. Quantitative scenarios appear more scientific and hence pose less risk in review processes. Even when users want to see qualitative descriptions of uncertainty, the needs, capabilities and mores of scenario producers, which tend to be quantitatively-oriented analysts and modellers, often dominate (Parson, 2008).

2.2. Why engage stakeholders in scenario development?

There are many very successful and high-profile scenarios that have been developed with little participation from stakeholders (e.g. IPCC, 2000; Millennium Ecosystem Assessment, 2005). However, given their capacity to influence decisions that may have wide-reaching implications for a range of stakeholders, there are normative arguments that people have a democratic right to participate in any analysis concerning their own futures. Such arguments focus on benefits for democratic society, citizenship and equity (Reed, 2008). For example, it is argued that stakeholder participation reduces the likelihood that those on the periphery of the decision-making context or society are marginalised. In this way, more relevant stakeholders can be included in decisions that affect them and active citizenship can be promoted, with benefits for wider society (Martin and Sherington, 1997).

Kok et al. (2007) and Walz et al. (2007) argue that stakeholder engagement in scenario development may empower those involved, through the co-generation of knowledge with researchers and increasing participants' capacity to use this knowledge. Scenarios can communicate complex information about socio-ecological change in ways that can be easily understood by stakeholders from a variety of backgrounds, giving people the opportunity to use this information to shape their future or adapt to changing conditions.

Given the inherently subjective and value-laden nature of scenario development, the process of elaborating scenarios needs to involve a wide range of perspectives, including both local and scientific knowledge (Berkhout et al., 2002). Stakeholder involvement can provide a wealth of relevant local knowledge that might otherwise be missed, and this information may also lead to more pragmatic benefits.

Pragmatic arguments for involving stakeholders in scenario development focus on participation as a means to an end, which can deliver higher quality scenarios. Walz et al. (2007) show how stakeholder engagement can ensure the relevance of scenarios for local decision-making. Kok et al. (2007) suggest that stakeholders are likely to bring different perspectives to the table at different scales, thereby expanding the range of scenarios that can be developed, particularly where there are highly conflicting viewpoints between different stakeholders. Similarly, Reed et al. (2009a) compared eight scenario studies conducted in UK uplands and suggested that more extensive participation from stakeholders broadened the scope of the scenarios developed. Local knowledge can be invaluable in understanding how socio-ecological systems function, to determine how drivers are likely to influence different system components (Kok et al., 2004). This can lead to the development of qualitative conceptual models from which more quantitative models and scenarios may be developed (e.g. Walz et al., 2007). In their study of agricultural change in the Swiss Alps,

Walz et al. (2007) argued that local knowledge was able to validate and deepen researcher understanding of system dynamics, and enhance the logic, internal consistency and validity of the scenarios they developed. In a context where Danish citizens were rather cynical about the planning authorities, Tress and Tress (2003) argued that participatory scenario development had the capacity to build trust and increase the acceptance of planning decisions by local residents (Luz, 2000; Bryner, 2001) whilst also giving planners access to community knowledge that enabled them to produce better plans.

2.3. How can stakeholders get involved in scenario development?

A wide range of qualitative and quantitative participatory methods have been used to facilitate engagement of stakeholders in scenario development. These include: future workshops (e.g. Jungk, 1994); scenario-based stakeholder engagement, based around facilitated discussion and ranking (Tompkins et al., 2008); cooperative discourse (e.g. Renn, 2006); Multi-Criteria Evaluation (e.g. Madlener et al., 2007; Kowalski et al., 2013); conceptual system modelling (e.g. Magnuszewski et al., 2005); and mediated or dynamic systems modelling (Bousquet et al., 2002; van den Belt, 2004; Castella et al., 2005). A range of visualisation techniques have been used to communicate scenarios to stakeholders (e.g. Bullock and Kay, 1997; Tress and Tress, 2003; Sheppard and Meitner, 2005; Soliva et al., 2008; Sheate et al., 2008).

Having said this, the level of stakeholder engagement still varies significantly between studies. Stakeholder engagement in scenario development may take place during initial scenario development (e.g. Biggs et al., 2004; Morris et al., 2005, 2006; Eftic, 2006). Stakeholders may also evaluate and prioritise scenarios emerging from prior engagement for further study (Bullock and Kay, 1997; IEEP and GHK Consultants, 2004; Soliva et al., 2008; Sheate et al., 2008). Alternatively, they may evaluate scenarios developed by researchers and make them relevant to local contexts (e.g. Kok et al., 2006; Kok and van Delden, 2004; Patel et al., 2007). The depth of consultation may vary from a single workshop (e.g. Cumulus et al., 2005; Morris et al., 2005, 2006) to a combination of workshops and in-depth interviews (e.g. Jessel and Jacobs, 2005; Kowalski et al., 2013). Less participatory (one-way, consultative) approaches range from using participatory mapping as an input to land cover maps in quantitative scenario development (Soares et al., 2004) and using computational model outputs as a basis for negotiation with stakeholders (Stolte et al., 2005), to eliciting “reactions from an audience to scenario images” (Dockerty et al., 2006: 103).

A number of drawbacks and limitations of stakeholder participation in scenario development have been identified. For example, local knowledge is not always sufficiently robust or detailed enough to provide information about relationships between system components, necessary for scenario quantification (Walz et al., 2007). A number of studies noted the significant time necessary to engage meaningfully with stakeholders, and did not have enough time to achieve all their aims (e.g. Walz et al., 2007; Kok et al., 2007; Kowalski et al., 2013). However, many of the limitations identified in the literature may simply reflect poorly practiced participatory methods. For example, the choice of stakeholders who are involved has the potential to significantly affect the outcome of scenario studies; however, there are few examples of scenario studies that systematically identify and select stakeholders for engagement (Tress and Tress, 2003; Sheppard and Meitner, 2005; Tompkins et al., 2008 are exceptions). This is particularly relevant when stakeholders are involved in both initial scenario development and the evaluation/selection of scenarios. Hence, without systematic and representative stakeholder selection, there is a danger that participation may bias results (Prell et al., 2009). Reed et al. (2009a)

illustrated how in the lack of systematic procedures for identifying and selecting stakeholders for engagement, eight scenario studies working in the same context (UK uplands) worked with significantly different groups. Although all the studies identified farmers as a key stakeholder, no individual study identified all the categories of upland stakeholder (10 key groups were identified between all the studies, but studies only worked with an average of 4.5 groups). The omitted stakeholders included water companies (who play a significant economic role as uplands as the main source of potable water for the UK) and grouse moor managers (who are principally responsible for maintaining heather moorland habitats through rotational burning that are valued for conservation and landscape aesthetics in many uplands). For a review of “stakeholder analysis” methods designed to help identify and prioritise stakeholders for involvement in scenario development, see Reed et al. (2009b).

3. Methodological framework for participatory scenario development

A number of approaches to participatory scenario development have been developed. The following section analyses procedural overlaps and differences between the methodological frameworks that have been used to date, in the light of emerging best practice in participation processes (Reed, 2008). In summary, this analysis suggests that the following steps are necessary to facilitate effective stakeholder participation in scenario development:

1. Define context (biophysical, socio-economic and political) and establish whether there is a basis for stakeholder engagement in scenario development;
2. Systematically identify and represent relevant stakeholders in the process;
3. Define clear objectives for scenario development with stakeholders including spatial and temporal boundaries;
4. Select relevant participatory methods for scenario development:
 - a. During initial construction of scenarios;
 - b. To evaluate and select scenarios for further investigation;
 - c. To support decision-making based on scenarios.

The following sections elaborate and justify each of these steps. Throughout these steps, there are many opportunities for local and scientific knowledge to be integrated, for example linking conceptual system models to dynamic computational models. The need for scientific information and analysis to inform stakeholder deliberation has been identified by many authors as an essential ingredient in any participatory process (e.g. Chess et al., 1998; Johnson et al., 2004; Chase et al., 2004; Webler and Tuler, 2006; Fischer and Young, 2007; Tippett et al., 2007; Reed et al., 2008). In highly technical decision-making contexts this may serve an educational purpose (Section 3.1). However, there is also a danger that unless carefully balanced, such information may bias decisions. In combination with local knowledge, scientific knowledge can contribute to a more comprehensive understanding of complex and dynamic natural systems and processes (Reed, 2008). By triangulating different local and scientific knowledge sources, it may be possible to investigate uncertainties and assumptions and develop a more rigorous understanding about the future (Johnson et al., 2004). Following from this, it is argued that decisions based on such knowledge are likely to be more robust than decisions based purely on either scientific or local knowledge alone (Reed, 2008). At the same time, such integration enhances the relevance of the scenarios in particular, and the research in general, for the stakeholders.

3.1. Define context and establish basis for stakeholder engagement

First, although there are many pragmatic and normative reasons for engaging stakeholders in scenario development (Section 2.2), it should not be assumed that stakeholder participation is always necessary or even advisable. For example, if stakeholders do not have the capacity or power to respond to scenarios then engagement is likely to raise unrealistic expectations, resulting in disillusionment (Fiorino, 1990; Laird, 1993; Chase et al., 2004; Tippett et al., 2007). For example, Broad et al. (2007) describe participatory Water Allocation Committees in Brazil that had to choose between a narrow range of water allocation scenarios developed by a risk-averse Governmental agency who had the power to overturn any of the decisions the committees made. This case illustrated the need for stakeholder involvement to have political backing, including a commitment to take the outcomes of the process seriously in decision-making.

Consideration may need to be given to ways that participants can be empowered through the scenario development process, for example ensuring participants have the technical capability to engage effectively with the information involved (Richards et al., 2004). It may also be necessary to identify and address power inequalities between group members. When material is highly technical, this may involve educating participants, developing the knowledge and confidence that is necessary for them to meaningfully engage in the process from the outset. Alternatively, a number of studies have used visualisation techniques to present complex information to stakeholders from different backgrounds (e.g. Bullock and Kay, 1997; Tress and Tress, 2003; Sheppard and Meitner, 2005; Soliva et al., 2008; Sheate et al., 2008 – see Section 3.4.2 for more details).

3.2. Systematically identify and represent relevant stakeholders in the process

If it is deemed appropriate to engage stakeholders in scenario development, then it is necessary to consider how to systematically identify relevant stakeholders for inclusion in the process. This is a step that is rarely taken,³ although there is evidence that choice of stakeholders can significantly alter the outcomes of participatory scenario development (Reed et al., 2009a; Stanghellini, 2010; Cuppen, 2012). Stakeholder analysis is a process that: i) defines aspects of a social and/or natural system affected by a decision or action, ii) identifies individuals and groups who are affected by or can affect those parts of the system (this may include non-human and non-living entities and future generations); and iii) prioritises these individuals and groups for involvement in the decision-making process (Reed et al., 2009b). A wide variety of tools and approaches have been used for stakeholder analysis in these disciplines and in different contexts. These can be categorised as methods used for: i) identifying stakeholders; ii) differentiating between and categorising stakeholders; and iii) investigating relationships between stakeholders (Reed et al., 2009b). In the context of scenario development, stakeholders may include organisations, groups of people (e.g. farmers) and specific individuals.

3.3. Define clear objectives for scenario development with stakeholders

In order to select the most appropriate methods for engaging stakeholders in scenario development, it is essential to define the

³ A notable exception is that this is now routinely done as part of the UK planning process through Regional Spatial Strategies.

objectives of scenario development and the role of stakeholders within this process (Rauschmayer and Wittmer, 2006; van den Belt, 2004; Wiek et al., 2006; Walz et al., 2007). More efficient and effective answers are likely to follow from well-developed questions (Lynam et al., 2007), and Dunn (1988) suggests that the way a problem is constructed by stakeholders often already points to perceived solutions. For example, Walz et al. (2007) found that outputs from stakeholder engagement in scenario development lacked focus and depth due to poor specification of the problems the scenarios were meant to address. If the goals of scenario development are negotiated through dialogue between participants (making trade-offs where necessary), they are more likely to take ownership of the process. In turn, partnership building will be more likely, and the outcomes are likely to be more relevant to stakeholder needs and priorities, motivating their ongoing active engagement (Johnson et al., 2004; Lynam et al., 2007).

3.4. Select relevant participatory methods for scenario development

Only after objectives have been established with relevant stakeholders can relevant participatory methods be selected and tailored to scenario development. The choice of methods needs to consider the objectives, type of participants (including local socio-cultural norms), and appropriate level of engagement. Highly skilled facilitation is essential for successful participatory scenario development and should not be overlooked. Indeed, there is evidence that the outcome of any participatory process is far more sensitive to the manner in which it is conducted than the specific tools that are used (Chess and Purcell, 1999; Richards et al., 2004; de Vente et al., 2013). Power inequalities within groups can represent an equally important barrier to meaningful engagement (Williams et al., 2003). It is therefore also necessary to consider how inequalities in age, gender and background (e.g. socio-economic status) can be overcome to enable stakeholders to participate on a level playing field.

Stakeholder participation typically takes place at three points during scenario development: i) during initial construction of scenarios; ii) evaluating and selecting scenarios for further investigation; and iii) supporting decision-making based on scenarios (and potentially monitoring decision outcomes).

3.4.1. Stakeholder participation in initial construction of scenarios

A number of methods have been used to engage stakeholders in the initial construction of scenarios. First, there are different approaches to identify drivers of change, likely impacts and key assumptions and uncertainties. For example, Bohensky et al. (2004) conducted a Sustainable Livelihoods Analysis with South African stakeholders to identify key drivers of change and their likely future effects. They then developed these into qualitative storylines, which they presented to stakeholders for further discussion and elaboration using theatrical plays.

Second, there are various more structured methods that can be used to develop conceptual models of system structure and function. For example, Soft Systems Analysis (Checkland, 1981) starts by expressing the “problem situation” with stakeholders. Using informal and unstructured discussions about people’s daily routines, as well as structured questionnaires, the approach attempts to understand the scale, scope and nature of problems in the context of the community’s organisational structure and the processes and transformations that occur within it. The methods used in Soft Systems Analysis have considerable overlap with other tools from development studies that are often used to describe livelihood systems, such as transect walks, participatory mapping, activity calendars, oral histories, daily time use analysis and participatory video making (e.g. Chambers, 1994). Most of these methods result

in a single conceptual model of the system, and there is a danger that this may not adequately capture diverse and potentially conflicting perspectives on system structure and function. For this reason Nainggolan et al. (2013) developed Visual Discourse Analysis to display graphically how the conceptual models of different stakeholder groups overlap and differ from each other.

Another approach is co-evolutionary scenario development (Lorenzoni et al., 2000). A co-evolutionary approach focuses on the complex reciprocal relationship between human and environmental systems: social structures shape the environment but environmental change also drives changes in and adaptation by social systems. For example, Lorenzoni et al. (2000) developed interlinked climate impact scenarios and scenarios of social–economic change. This recognised that society would evolve drastically irrespective of climatic change. The approach also linked top–down projections of climate and social change based on expert knowledge with local, bottom–up, adaptation scenarios developed by stakeholders.

Increasingly, researchers and stakeholders are working together to build conceptual models, using local knowledge to capture the sort of complexities and details that are rarely represented in computational models (referred to as participatory or mediated modelling e.g. Bousquet et al., 2002; Castella et al., 2005; van den Belt, 2004). For example, Walz et al. (2007) developed qualitative system models with different groups of stakeholders focussing on different themes e.g. agriculture and tourism. Stakeholders identified the most important “factors, actors or sectors... they considered most relevant for the development of the region”, put these in a pair-wise matrix and rated the impact of each element on every other, to determine the overall importance of each element in the regional system (Walz et al., 2007: 118). This information was then used to construct “system graphs” that showed how each component linked to the others. However, such methods necessarily involve significant simplifications of system structure and function e.g. ignoring feedbacks.

3.4.2. Participatory evaluation and selection of scenarios for further investigation

Stakeholder participation in many scenario studies starts when stakeholders are invited to evaluate scenarios developed previously by researchers. This may lead to the refinement of scenarios or the selection of a smaller sub-set of scenarios for further investigation, often by research teams using computation models. This is a step that is also common in studies that construct initial scenarios with stakeholders, but that want to further refine or short-list scenarios. Short-listing may be done against a range of criteria, including for example: likelihood, potential impact, perceived levels of uncertainty or desirability.

Visualisation techniques are often used to communicate scenarios at this stage. For example, Soliva et al. (2008) used digitally manipulated photographs to communicate the effects of varying EU farming subsidy levels on ecological succession and biodiversity. However, visualisation techniques pose the risk of visual bias. Aspects of scenarios that can easily be represented visually (e.g. land cover change) may receive more attention from focus group participants than other aspects (such as cultural or demographic change). Taking advantage of the more sophisticated tools that GIS and digital image processing have to offer, scenarios can be further translated into a *virtual landscape* following the approach used by Ball et al. (2008). Alternatively 3D models may be built and theatrical plays have been used to communicate scenarios to stakeholders in Africa (Bohensky et al., 2004; Burt and Copteros, 2004).

A number of participatory methods exist for evaluating scenarios including participatory indicator development (e.g. Reed et al., 2006, 2008), deliberative choice experiments (e.g. Kenter

et al., 2011) and Multi-Criteria Evaluation (e.g. Stagl, 2007). For example, Madlener et al. (2007) and Kowalski et al. (2013) used Multi-Criteria Evaluation with stakeholders to select five out of 16 exploratory scenarios developed by researchers for further development. Many Multi-Criteria Evaluation techniques have been criticised for their lack of transparency to stakeholders who have to accept results from a black box of complex algorithms (Messner et al., 2004). However, more participatory, often qualitative approaches exist e.g. in Reed et al. (2008) stakeholders used stones to rank options against criteria and used the results to stimulate discussion rather than produce rankings. Alternatively, Sheppard and Meitner (2005) developed stakeholder-derived sustainability indicators to evaluate the sustainability of different scenarios. Sheate et al. (2008) used a similar approach to conduct a “sustainability analysis” of scenarios, developing indicators with stakeholders to assess the extent to which different scenarios met sustainability objectives. Similarly, Tress and Tress (2003) gave stakeholders questionnaires in which they assessed the desirability of landscape elements (positive, neutral or negative, with room for comments) in a series of visualised scenarios. The use of indicators is not straightforward, as the choice of indicators can be subjective and significantly influence outcomes (Reed et al., 2006).

3.4.3. Participatory decision-making based on scenarios

Finally, the systematic evaluation of scenarios above can be used as an input to decision-making with stakeholders. This may be focussed around choosing sustainable scenarios or sustainable futures (e.g. using Multi-Criteria Evaluation), towards which stakeholders would like to work (e.g. Soliva et al., 2008; Sheate et al., 2008). Back-casting⁴ techniques may then be used to work back from a future scenario to the present day, for example using system models to better understand how such a future could be achieved (e.g. Kok et al., 2007). Alternatively, the use of scenarios may focus on preparing for a range of possible futures (e.g. Jessel and Jacobs, 2005; Prell et al., 2007). A key issue at this stage is the perceived legitimacy of the process and the decision-making power of the participants. This emphasises the importance of the earlier stages, especially stakeholder selection.

4. Applying the methodological framework to the UK uplands

The following section shows how the methodological framework (Section 3) was applied in three UK upland sites by the authors between 2005 and 2012: the Dark Peak of the Peak District National Park (Site 1); Nidderdale Area of Outstanding Natural Beauty in the Yorkshire Dales, North Pennines (Site 2); and in Cairnmore of Fleet and the Luce, Bladnoch, Cree, Dee and Ken catchments in Galloway, Scotland (Site 3). These sites were selected to represent a range of biophysical, socio-economic and regulatory upland contexts. A more detailed description of this context is provided by Reed et al. (2013).

4.1. Defining the context and establishing the basis for stakeholder engagement

Stakeholder participation was deemed appropriate given high levels of interest among a number of stakeholder groups in the future of the uplands. For example, Natural England (a Government agency) and the National Trust (a charity) both independently

embarked on the development of upland scenarios to inform the development of their future work, during the course of the project. At the same time, a number of stakeholder groups felt their voices were not being heard by those taking high-level decisions about the future of upland landscapes. This project therefore aimed to bring these different groups together to investigate possible upland futures and identify strategies for policy and practice that could help different stakeholders prepare for what might lay ahead (Dougill et al., 2006).

The upland case study context was explored through scoping interviews with stakeholder representatives in each site, who were selected through stakeholder analysis (see Section 4.2). These participants helped refine the focus of the research in each site and suggested other relevant stakeholders (see 4.2 and 4.3).

To ensure that all participants started with a similar level of understanding about key issues and to prevent technical barriers to effective discussion, preparatory material was developed in collaboration with stakeholders who discussed the scope and reviewed content prior to the workshops in which the materials were used (Section 4.4.1).

4.2. Systematically identifying and representing relevant stakeholders in the process

Dougill et al. (2006) describe the results of the stakeholder analysis. To summarise, this resulted in the following stakeholder group categories in all sites: water companies; recreational groups; agriculture; conservationists; grouse moor interests (consisting of owners/managers and game keepers); tourism-related enterprises; and statutory bodies. In Site 3, forestry and fisheries stakeholders were also identified. It was recognised that residents were involved indirectly through representatives of some of the stakeholder groups such as parish councils, neighbourhood groups and ‘single-issue’ interest groups. Individuals were selected to represent each of these groups, initially identified via snowball sampling within each stakeholder category, and then selected for participation in workshops in collaboration with the project’s stakeholder steering group (comprising representatives of the two Non-Governmental Organisations who were formal partners on the research project, Moors for the Future and the Heather Trust and others selected during the stakeholder analysis) and where possible with additional information from a Social Network Analysis of stakeholders (sites 1 and 2) (Prell et al., 2008, 2009). In this way, it was possible to include stakeholders that were deemed by a cross-section of stakeholders on the project’s steering group to be broadly representative of each stakeholder category. Using SNA findings, it was possible to prioritise stakeholders who were well respected by their peers and connected to a significant number of other stakeholders, so that ideas emerging from the workshops would be more likely to diffuse through a wider social network of interested stakeholders. The SNA findings were also used to ensure that groups who are typically marginalised in decision-making processes and generally disconnected from the wider stakeholder network (e.g. recreation and tourism groups) could be prioritised for inclusion too.

4.3. Defining clear objectives for scenario development with stakeholders

Objectives were developed on two levels. First, objectives for scenario development were developed during the stakeholder analysis. The results of this work are described by Dougill et al. (2006). In Site 1, stakeholders developed objectives for the preliminary stages of the research focussed on issues relating to managed burning in the uplands, so that the results could feed into the then highly contentious Government review of the Heather and

⁴ Backcasting is “a method in which the future desired conditions are envisioned and steps are then defined to attain those conditions, rather than taking steps that are merely a continuation of present methods extrapolated into the future” (Holmberg and Robèrt, 2000: 291).

Grass Burning Code (this resulted in a multi-stakeholder response submitted by the project to this consultation). In its next phase, the project broadened its scope, but retained a focus on future challenges for upland management. This broader scope was retained in the other sites, but with different emphases. In Site 2, there was particular interest in objectives relating to carbon management, and on contributing to the next management plan being developed for a local Area of Outstanding Natural Beauty (AONB).⁵ In Site 3, there was particular emphasis on objectives relating to land use tradeoffs between forestry and conservation, hill sheep and fisheries. For all sites, it was decided to develop scenarios up to 2030, a temporal scale at which the effects of climate change were likely to be evident, but which was relevant to the time horizons considered by most land owners and managers in their decision-making.

Second, stakeholders proposed sustainability goals for the upland system, and suggested indicators that could monitor progress towards these goals. Sustainability goals were grouped around the UK Government priorities as part of its Sustainable Development Strategy (DEFRA, 2005): sustaining upland communities; protecting and enhancing the environment; mitigating and adapting to climate change; and promoting sustainable upland production and consumption. For example in Site 1, specific goals included: i) having restored all badly damaged peats, maintain vegetation cover and move towards more natural species assemblages; ii) maintain sheep stocks to levels that do not threaten (or that may in fact positively enhance) ecosystem services; and iii) provide sufficient clean water to surrounding population and meet demand and an economic and acceptable price.

4.4. Selecting relevant participatory methods for scenario development

4.4.1. Stakeholder participation in initial construction of scenarios

Information about drivers of change and their potential effects on system dynamics was obtained from three sources: i) individual semi-structured interviews; ii) group site visits between stakeholders and researchers; and iii) scientific knowledge based on conceptual modelling workshops with researchers and literature review. This included a range of socio-economic drivers (e.g. Common Agricultural Policy reform and demographic change) and environmental drivers (e.g. climate change). This information was then used to develop preliminary scenarios.

First, potential future drivers of change and their effects on upland system components were identified through Grounded Theory Analysis (Strauss and Corbin, 1998) of transcripts from in-depth semi-structured interviews with a cross-section of stakeholders identified through stakeholder analysis and snowball sampling in each site (Section 4.2). The themes that emerged from this analysis were constructed into an initial conceptual model using Vensim dynamic systems modelling software.

Second, workshops were held to explore possible futures with a broadly representative sub-set of the stakeholders who had been interviewed in each site. This sub-set of stakeholders was selected using a combination of: i) findings from Social Network Analysis of the stakeholder network; and ii) guidance from the project's stakeholder steering group (see Section 4.2). An initial multi-stakeholder workshop was conducted unsuccessfully in 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 did not work successfully due to the highly heterogeneous composition of the group in terms of their views/interests and formal education level, coupled with inadequate facilitation. First, although experienced in facilitating workshops with high-level stakeholders in Hungary and Poland, the professional facilitator was not sufficiently familiar with the local issues and stakeholders (or their accents) to be able to adequately follow and hence facilitate discussion. In addition, the wide range of formal educational backgrounds, ranging from those who were illiterate to those with PhDs, presented significant facilitation challenges and methods based on reading and writing had to be abandoned. The lack of alternative, more appropriate facilitation tools that could be used by illiterate participants, led to a power dynamic where more educated participants felt more comfortable and authoritative, and less formally educated participants felt marginalised and disempowered. As a result, very little constructive progress was made during this workshop.

Learning from this experience and building on suggestions from stakeholders, a series of site visits was developed to initially replace workshop activities. Investment was made in professional facilitation training for two project members, who then shadowed a UK-based professional facilitator on site visits in Sites 1 and 2, and then led site visits under observation before conducting facilitation unaided. The site visit programme was designed by a stakeholder project steering group who selected the issues to be covered and the most appropriate sites to stimulate discussion. The steering group suggested the development of information sheets about each issue, to ensure all participants had similar levels of information about each issue and could engage in debate at a similar level with one another. The scope of each information sheet was decided through discussion with stakeholders, and drafts were peer-reviewed by stakeholders prior to distribution. 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.

A total of three site visits were conducted in site 1, and two site visits were held in site 2. One site visit was planned for site 3, but due to time/weather constraints, it was held inside. Discussion during these site visits focussed around future drivers of change in the different landscapes that were visited, how these might play out in the upland system, and how stakeholders might be able to adapt to these changes. Two scribes took notes to capture the discussion and summarised key points at the end to provide participants with an opportunity to correct misinterpretations and/or add important missing points.

Third, two conceptual modelling workshops were held with researchers from the team, to map out their understanding of system structure and function in relation to key drivers. This was further enriched through literature review. Additional insights from this work and the site visits were then integrated with the initial conceptual model (developed from semi-structured interviews) to derive a rigorous conceptual system model. Fig. 1 shows a sub-model from this work in Site 1 (the full model is significantly more complicated).

Finally, the conceptual model that emerged from the integration of these different knowledge bases was used to trace the likely effects of different drivers through the upland system, to develop preliminary scenarios. 10, 11 and 8 preliminary scenarios were developed in this way in sites 1, 2 and 3 respectively. These are described in Tables 1 and 2.

⁵ AONB is a conservation designation in England, Wales and Northern Ireland for areas of countryside considered to have significant landscape value. Unlike national parks, AONBs do not have their own authority or dedicated measures to stop unsympathetic development within their boundaries. 1.

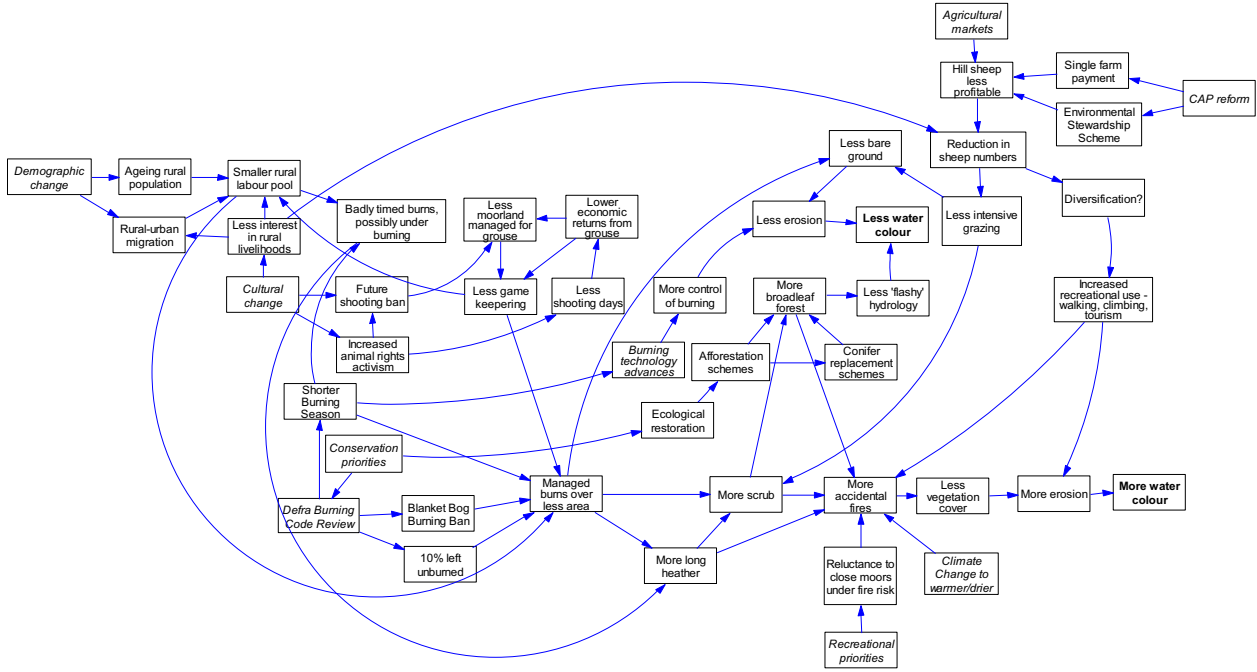


Fig. 1. Conceptual sub-model of socioeconomic and biophysical processes related to burning management in the uplands of the Peak District National Park (Site 1) (from Prell et al., 2007).

4.4.2. Participatory evaluation and selection of scenarios for further investigation

Preliminary scenarios were evaluated by a cross-section of stakeholders in each site (selected via stakeholder analysis, as described in Section 4.2). This was done in two steps: first, the relative likelihood and magnitude of impact of each individual component of a scenario was assessed (e.g. “reduced numbers of hill sheep”), with highly unlikely components removed and additional components added where deemed necessary to make the scenario more realistic or detailed; and second, components were integrated to form scenarios (e.g. “farmers as ecosystem service providers”), and these scenarios were themselves evaluated in terms of their relative likelihood and the magnitude of their impact, if they were to occur. These criteria were chosen for two reasons. First, the scenario development literature reviewed in Section 3 emphasises the need for scenarios to be plausible – there are an infinite number of highly unlikely scenarios that are simply not deemed plausible by stakeholders, and hence are of little value for decision-making. Second, although perhaps interesting, there is no need to invest resources in preparing adaptations to scenarios that are likely to have very little impact on business as usual.

The title of each scenario was written on a sheet of flip chart paper, with a graph in the centre that had two axes crossing in the centre: likelihood of occurrence and magnitude of impact (Fig. 2). This created four quadrants to categorise scenarios that were: i) highly likely to occur and that would have a high impact; ii) highly likely but low impact; iii) unlikely to occur, but if they did they would have a significant impact; and iv) unlikely to occur and low impact if they were to occur. Beside each flip chart sheet were a series of printed cards, each with different components of the scenario (e.g. agricultural support is significantly reduced, sheep numbers decline significantly/slightly/do not decline etc.). There were also blank cards for participants to add additional components if deemed necessary. Participants then allocated scenario components to quadrants through facilitated discussion. Where agreement was not possible within the group, additional scenario

components representing the opposite viewpoint were created and placed in the relevant place to represent the diversity of views in the group. Participants then had an opportunity to view other groups’ work and suggest changes or add opposite components to represent their views through the facilitator (Fig. 2). Additional and refined components from the Peak District group were added to the scenarios evaluated by the Nidderdale group due to the comparability of these sites, who further refined and added to the scenarios. Galloway scenarios differed considerably from both of the English sites, due to the importance of forestry and fisheries in the study area. Tables 1 and 2 show the components that made up each of the proposed scenarios (showing new components (red), components that were deemed to be both unlikely and low impact (grey) and components that were deemed to be both likely and high impact (bold)). It is assumed that it would not be necessary to model components that were unlikely and low impact, and participants were told not to consider these aspects of the scenarios in their final categorisation. Table 1 shows that there was broad agreement between stakeholders in Nidderdale and the Peak District National Park about which scenario components should be included and excluded from further analysis. Table 2 shows the qualitatively different scenarios developed in Galloway.

Next, the likelihood and impact of each full scenario (consisting of all the components discussed in the first part of the exercise) was then evaluated by the group, by placing numbers representing each scenario on a large likelihood/impact matrix (Fig. 2). Scenarios were then prioritised and ranked by counting the number of times each was classified as high impact and highly likely to happen. Finally, the group discussed this overall ranking, and alternative scenarios that had not been evaluated were elicited and discussed. Tables 3–5 show the ranking of full scenarios (integrating the components of each scenario) in relation to their likelihood and impact for the Peak District National Park, Nidderdale AONB and Galloway respectively. This assumes that stakeholders are interested in prioritising the most likely, high impact scenarios for further exploration. The assumption that “highly likely” and “high

Table 1

Upland scenarios evaluated by Peak District and Nidderdale stakeholders, showing components that emerged from analysis of semi-structured interviews and site visits with stakeholders combined with evidence from academic literature (black), new components suggested by stakeholders during scenario development workshops (red) and components deemed unlikely and low impact by stakeholders during scenario development workshops (grey).

Peak District Stakeholders	Nidderdale Stakeholders
<p>1. Farmers as ecosystem providers</p> <p><i>Description: a decline in levels of agricultural support (based on cross-compliance with environmental measures) leads to a significant loss (50% current levels) of hill sheep from the Peak District (levels and nature of managed burning remains relatively constant)</i></p> <ul style="list-style-type: none"> • Ecological recovery and increased biodiversity in currently over-grazed moorland fringe habitats • Little change in plant species composition and structure in lightly grazed blanket bog habitats • Increased dominance of heather in place of grass in dry heath habitats • Increased amount of mature and degenerate phase heather and scrub in dry heath habitats • Increased amount of mature and degenerate phase heather and scrub across the whole upland landscape, including many blanket bogs • A reduction in the number of farms and farmers, some amalgamation of existing farms into larger units, and an associated fall in demand for agricultural inputs and services (e.g. feed and vets) • The loss of farms is limited by increased reliance on alternative and off-farm incomes, and any fall in demand for agricultural inputs and services offset to some extent by demand for alternative inputs and services associated with new enterprises • Reduction in the pool of available rural labour • Increase in number and severity of wildfires due to increased fuel-load and/or recreational use 	<p><i>Description: a decline in levels of agricultural support (based on cross-compliance with environmental measures) leads to a significant loss (50% current levels) of hill sheep from Nidderdale AONB (levels and nature of managed burning remains relatively constant)</i></p> <ul style="list-style-type: none"> • Ecological recovery and increased biodiversity in currently over-grazed moorland fringe habitats • Little change in plant species composition and structure in lightly grazed blanket bog habitats • Increased dominance of heather in place of grass in dry heath habitats • Increased amount of mature and degenerate phase heather and scrub in dry heath habitats • Increased amount of mature and degenerate phase heather and scrub across the whole upland landscape, including many blanket bogs • A reduction in the number of farms and farmers, some amalgamation of existing farms into larger units, and an associated fall in demand for agricultural inputs and services (e.g. feed and vets) • The loss of farms is limited by increased reliance on alternative and off-farm incomes, and any fall in demand for agricultural inputs and services offset to some extent by demand for alternative inputs and services associated with new enterprises • Reduction in the short-term availability of rural jobs • Increase in number and severity of wildfires due to increased fuel-load and/or recreational use
<p>2. Hill farming collapse</p> <p><i>Description: removal of agricultural support with no alternative Government funding leads to a cessation of hill farming (but levels of managed burning remain relatively constant)</i></p> <ul style="list-style-type: none"> • Short-term ecological recovery and increased biodiversity in currently over-grazed moorland fringe habitats followed by loss of biodiversity due to under-grazing • Slow change in plant species composition and structure in lightly grazed blanket bog habitats • Increased dominance of heather in place of grass in dry heath habitats • Increased amount of mature and degenerate phase heather and scrub in dry heath habitats • Increased amount of mature and degenerate phase heather and scrub across the whole upland landscape, including many blanket bogs • Dramatic reduction in the number of farms and farmers, amalgamation of existing farms into larger units, and an associated fall in demand for agricultural inputs and services (e.g. feed and vets) • Almost complete loss of available rural labour • Increase in number and severity of wildfires on dry heath due to increased fuel-load • Less land managed for grouse due to the additional cost of maintaining sheep for purpose of grouse management, increasing the area of land burned or introducing heather cutting • Change in job content for those still employed 	<p><i>Description: removal of agricultural support with no alternative Government funding leads to a cessation of hill farming (but levels of managed burning remain relatively constant)</i></p> <ul style="list-style-type: none"> • Short-term ecological recovery and increased biodiversity in currently over-grazed moorland fringe habitats followed by loss of biodiversity due to under-grazing • Slow change in plant species composition and structure in lightly grazed blanket bog habitats • Increased dominance of heather in place of grass in dry heath habitats • Increased amount of mature and degenerate phase heather and scrub in dry heath habitats • Increased amount of mature and degenerate phase heather and scrub across the whole upland landscape, including many blanket bogs • Dramatic reduction in the number of farms and farmers, amalgamation of existing farms into larger units, and an associated fall in demand for agricultural inputs and services (e.g. feed and vets) • Almost complete loss of available rural labour • Increase in number and severity of wildfires on dry heath due to increased fuel-load • Less land managed for grouse due to the additional cost of maintaining sheep for purpose of grouse management, increasing the area of land burned or introducing heather cutting • Change in job content for those still employed • Increased farm diversification
<p>3. Rural-Urban Migration</p> <p><i>Description: ageing rural population and young people working in cities reduces labour availability, which reduces the area of moorland that can be burned each year by 50% (hill farming and predator control continues at current levels)</i></p> <ul style="list-style-type: none"> • Slight increase in the amount of mature and degenerate phase heather and scrub in dry heath, inactive blanket bog and moorland fringe habitats • Slight increase in number and severity of wildfires due to increased fuel-load • Increased biodiversity in regularly burned blanket bog habitats that are no longer burned • Retention of head keepers, but shortage of under keepers and extra help during burning season • Increase in abundance of birds of prey and other predators of ground-nesting birds in areas that are not burned (or burned much less frequently) • Increase in number of different species of birds of prey and other predators of ground-nesting birds in areas that are not burned (or burned much less frequently) • Decrease in the abundance of ground nesting birds in areas that are not burned (or burned much less frequently) • Decrease in the number of different ground nesting bird species nesting in areas that are not burned (or burned much less frequently) 	<p><i>Description: ageing rural population and young people working in cities reduces labour availability, which reduces the area of moorland that can be burned each year by 50% (hill farming and predator control continues at current levels)</i></p> <ul style="list-style-type: none"> • Slight increase in the amount of mature and degenerate phase heather and scrub in dry heath, inactive blanket bog and moorland fringe habitats • Slight increase in number and severity of wildfires due to increased fuel-load • Increased biodiversity in regularly burned blanket bog habitats that are no longer burned • Retention of head keepers, but shortage of under keepers and extra help during burning season • Increase in abundance of birds of prey and other predators of ground-nesting birds in areas that are not burned (or burned much less frequently) • Increase in number of different species of birds of prey and other predators of ground-nesting birds in areas that are not burned (or burned much less frequently) • Decrease in the abundance of ground nesting birds in areas that are not burned (or burned much less frequently) • Decrease in the number of different ground nesting bird species nesting in areas that are not burned (or burned much less frequently) • Increase in species diversity of ground-nesting birds e.g. dunlin and plover are replaced by black grouse, willow warblers and lapwing etc. • Increase in house prices due to purchase of second homes • Increase in farm prices due to lifestyle farmers from city
<p>4. Blanket Bog Burning Ban</p> <p><i>Description: a ban on burning blanket bogs means that managed burning is restricted mainly to dry heath habitats (assuming the Natural England definition of blanket bog, and that inactive blanket bog acts like dry heath)</i></p> <ul style="list-style-type: none"> • Increase in the amount of mature and degenerate phase heather and scrub on inactive blanket bogs • Increase in number and severity of wildfires on inactive blanket bog due to 	<p><i>Description: a ban on burning blanket bogs means that managed burning is restricted mainly to dry heath habitats (assuming the Natural England definition of blanket bog, and that inactive blanket bog acts like dry heath)</i></p> <ul style="list-style-type: none"> • Increase in the amount of mature and degenerate phase heather and scrub on inactive blanket bogs • Increase in number and severity of wildfires on inactive blanket bog due to

<p>increased fuel-load</p> <ul style="list-style-type: none"> Increased biodiversity in blanket bog habitats that were previously regularly burned Loss of game keepers from estates that are predominantly blanket bog Increase in abundance of birds of prey and other predators of ground-nesting birds in areas that are not burned (or burned much less frequently) Increase in number of different species of birds of prey and other predators of ground-nesting birds in areas that are not burned (or burned much less frequently) Decrease in the abundance of ground nesting birds in areas that are not burned (or burned much less frequently) Decrease in the number of different ground nesting bird species nesting in areas that are not burned (or burned much less frequently) Improvement in water quality with reduced burning Improvement in local air quality in villages and towns 	<p>increased fuel-load</p> <ul style="list-style-type: none"> Increased biodiversity in blanket bog habitats that were previously regularly burned Loss of game keepers from estates that are predominantly blanket bog Increase in abundance of birds of prey and other predators of ground-nesting birds in areas that are not burned (or burned much less frequently) Increase in number of different species of birds of prey and other predators of ground-nesting birds in areas that are not burned (or burned much less frequently) Decrease in the abundance of ground nesting birds in areas that are not burned (or burned much less frequently) Decrease in the number of different ground nesting bird species nesting in areas that are not burned (or burned much less frequently) Improvement in water quality with reduced burning Improvement in local air quality in villages and towns
<p>5. Shooting Ban</p>	
<p><i>Description: a grouse shooting ban leads to the end of grouse moor management in the Peak District (hill farming continues at current levels)</i></p>	<p><i>Description: a grouse shooting ban leads to the end of grouse moor management in Nidderdale AONB (hill farming continues at current levels)</i></p>
<ul style="list-style-type: none"> Significant increase in the amount of mature and degenerate phase heather and scrub in dry heath, inactive blanket bog and moorland fringe habitats Significant increase in number and severity of wildfires due to increased fuel-load Increased biodiversity in regularly burned blanket bog habitats Loss of game keepers, and associated fall in demand for inputs and services (e.g. pesticides and pellets) Reduction in the pool of available rural labour Increase in abundance of birds of prey and other predators of ground-nesting birds Increase in number of different species of birds of prey and other predators of ground-nesting birds Decrease in the abundance of ground nesting birds, but viable populations of each population would be maintained Decrease in the number of different ground nesting bird species nesting ESA/other money pays rural labour to provide services for game keepers 	<ul style="list-style-type: none"> Significant increase in the amount of mature and degenerate phase heather and scrub in dry heath, inactive blanket bog and moorland fringe habitats Significant increase in number and severity of wildfires due to increased fuel-load Increased biodiversity in regularly burned blanket bog habitats Loss of game keepers, and associated fall in demand for inputs and services (e.g. pesticides and pellets) Reduction in the pool of available rural labour Increase in abundance of birds of prey and other predators of ground-nesting birds Increase in number of different species of birds of prey and other predators of ground-nesting birds Decrease in the abundance of ground nesting birds, but viable populations of each population would be maintained Decrease in the number of different ground nesting bird species nesting ESA/other money pays rural labour to provide services for game keepers Increased impact on neighbouring habitats (e.g. due to increase in bird of prey) Increase in "undesirable uses" of the moors (e.g. 4x4 use)
<p>6. Bird Disease</p>	
<p><i>Description: Major disease outbreak without cure leads to long-term decimation of grouse populations and the complete collapse of grouse moor management nationally (hill farming continues at current levels)</i></p>	<p><i>Description: Major disease outbreak without cure leads to long-term decimation of grouse populations and the complete collapse of grouse moor management nationally (hill farming continues at current levels)</i></p>
<ul style="list-style-type: none"> Significant increase in the amount of mature and degenerate phase heather and scrub in dry heath, inactive blanket bog and moorland fringe habitats Significant increase in number and severity of wildfires due to increased fuel-load Increased biodiversity in regularly burned blanket bog habitats Loss of game keepers, and associated fall in demand for inputs and services (e.g. pesticides and pellets) Reduction in the pool of available rural labour Increase in abundance of birds of prey and other predators of ground-nesting birds Increase in number of different species of birds of prey and other predators of ground-nesting birds Decrease in the abundance of ground nesting birds, but viable populations of each population would be maintained Decrease in the number of different ground nesting bird species nesting Long term implication loss of knowledge and skills for grouse moor management Decrease in number of different species of ground-nesting birds nesting 	<ul style="list-style-type: none"> Significant increase in the amount of mature and degenerate phase heather and scrub in dry heath, inactive blanket bog and moorland fringe habitats Significant increase in number and severity of wildfires due to increased fuel-load Increased biodiversity in regularly burned blanket bog habitats Loss of game keepers, and associated fall in demand for inputs and services (e.g. pesticides and pellets) Reduction in the pool of available rural labour Increase in abundance of birds of prey and other predators of ground-nesting birds Increase in number of different species of birds of prey and other predators of ground-nesting birds Decrease in the abundance of ground nesting birds, but viable populations of each population would be maintained Decrease in the number of different ground nesting bird species nesting Long term implication loss of knowledge and skills for grouse moor management Decrease in number of different species of ground-nesting birds nesting Increased impact on neighbouring habitats (e.g. due to increase in bird of prey) Increase in "undesirable uses" of the moors (e.g. 4x4 use)
<p>7. Managed Retreat</p>	
<p><i>Description: a policy of "managed retreat" from uplands provides funds to maintain fire breaks but leads to the end of hill farming and grouse management</i></p>	<p><i>Description: a policy of "managed retreat" from uplands provides funds to maintain fire breaks but leads to the end of hill farming and grouse management</i></p>
<ul style="list-style-type: none"> Significant increase in amount of mature and degenerate phase heather and scrub in dry heath and moorland fringe habitats Significant increase in amount of mature and degenerate phase heather and scrub across the whole upland landscape, including blanket bogs Significant increase in number and severity of wildfires due to increased fuel-load and/or increased recreational access, but limited in extent by firebreaks Increased biodiversity in regularly burned blanket bog habitats Loss of all farms and farmers and an associated loss of demand for agricultural inputs and services (e.g. feed and vets) Loss of game keepers, and associated fall in demand for inputs and services (e.g. pesticides and pellets) Almost complete loss of available rural labour Increase in abundance of birds of prey and other predators of ground-nesting birds 	<ul style="list-style-type: none"> Significant increase in amount of mature and degenerate phase heather and scrub in dry heath and moorland fringe habitats Significant increase in amount of mature and degenerate phase heather and scrub across the whole upland landscape, including blanket bogs Significant increase in number and severity of wildfires due to increased fuel-load and/or increased recreational access, but limited in extent by firebreaks Increased biodiversity in regularly burned blanket bog habitats Loss of all farms and farmers and an associated loss of demand for agricultural inputs and services (e.g. feed and vets) Loss of game keepers, and associated fall in demand for inputs and services (e.g. pesticides and pellets) Almost complete loss of available rural labour Increase in abundance of birds of prey and other predators of ground-nesting birds

<ul style="list-style-type: none"> • Increase in number of different species of birds of prey and other predators of ground-nesting birds • Decrease in the abundance of ground nesting birds • Decrease in the number of different ground nesting bird species nesting • Progressive loss of dry heath specialists 	<ul style="list-style-type: none"> • Increase in number of different species of birds of prey and other predators of ground-nesting birds • Decrease in the abundance of ground nesting birds • Decrease in the number of different ground nesting bird species nesting • Progressive loss of dry heath specialists • Economic loss from end of shooting
<p>8. Post-Peat World</p> <p><i>Description: With a global population of around 8 million by 2030, climate change, the marginality of peat in the Peak District and cost of restoration, and increasing demand for energy and land, energy crops are planted across wide tracts of upland</i></p>	<p>8. Arable Uplands</p> <p><i>Description: With a global population of around 8 million by 2030, climate change, sea level rise, expansion of biofuel crops and increasing demand for food and land, arable crops are planted across wide tracts of upland valleys and in-by land. This scenario assumes industrial agriculture and periods of low vegetation cover</i></p>
<ul style="list-style-type: none"> • Loss of peat soils due to increased erosion and oxidization • Increased sediment load and water colouration downstream, assuming industrial agriculture and low vegetation cover • Increased depth to water table • Increased likelihood of flooding downstream, when harvested, assuming low vegetation cover • Soil compaction • Loss of existing upland species, habitats and biodiversity • Loss of game keepers, and associated fall in demand for inputs and services (e.g. pesticides and pellets) • A reduction in the number of farms and farmers, and amalgamation of existing farms into larger units • Change of skills in rural labour force • Fall in demand for existing agricultural inputs and services (e.g. feed and vets) replaced by demand for inputs and services associated with biofuel production <ul style="list-style-type: none"> • Mechanisation reduces need for rural labour force, which continues to shrink • Increased demand for rural labour force, which will grow 	<ul style="list-style-type: none"> • Loss of peat soils due to increased erosion and oxidization (turning into carbon dioxide) • Increased sediment load and water colouration downstream • Decreasing water table • Increased likelihood of flooding downstream, when crops harvested • Soil compaction • Loss of existing upland species, habitats and biodiversity • Loss of game keepers, and associated fall in demand for inputs and services (e.g. pesticides and pellets) • Increased demand for rural labour force, which will grow <ul style="list-style-type: none"> • Change of skills in rural labour force • Fall in demand for livestock inputs and services (e.g. feed and vets) replaced by demand for inputs and services associated with arable production • Increased water pollution from fertilisers
<p>9. Restoration</p> <p><i>Description: Carbon offsetting leads to gullies and grips being blocked and bare ground re-vegetated across the majority of uplands</i></p>	<p><i>Description: Carbon offsetting leads to gullies and grips being blocked and bare ground re-vegetated across the majority of uplands</i></p>
<ul style="list-style-type: none"> • Majority of active gullies and grips are blocked • The water table is raised and there are more bog pools • Increased biodiversity in blanket bog habitats • Reduction in severity of wildfires due to water table depth • Flooding downstream is less likely • Water colour is reduced • Less sediment in fish spawning beds and reservoirs • Afforestation of upland valleys with native species through natural regeneration and planting 	<ul style="list-style-type: none"> • Majority of active gullies and grips are blocked • The water table is raised and there are more bog pools • Increased biodiversity in blanket bog habitats • Reduction in severity of wildfires due to water table depth • Flooding downstream is less likely • Water colour is reduced • Less sediment in fish spawning beds and reservoirs • Afforestation of upland valleys with native species through natural regeneration and planting • Increased run-off from uplands
<p>10. Climate Change</p> <p><i>Description: Summers have become significantly warmer and drier, and winters have become significantly warmer and wetter with rain concentrated in high intensity events, due to climate change by 2030</i></p>	<p><i>Description: Summers have become significantly warmer and drier, and winters have become significantly warmer and wetter with rain concentrated in high intensity events, due to climate change by 2030</i></p>
<ul style="list-style-type: none"> • Wetter winters lead to a reduction in the area of moorland being regularly burned by approximately 25% • Increase in number and severity of summer wildfires due to increased fuel-load (as a result of reduced managed burning), increased summer temperatures and more droughts • Contraction of active blanket bog area • Loss of upland species that are at the edge of their geographical range in the Peak District • Increased flash flooding downstream from gripped or gullied uplands • Increased depth to water tables with associated emissions of methane from peat • More heavy rainfall events lead to reduction in burning • Increased flooding from moorlands due to heavy rainfall events 	<ul style="list-style-type: none"> • Wetter winters lead to a reduction in the area of moorland being regularly burned by approximately 25% • Increase in number and severity of summer wildfires due to increased fuel-load (as a result of reduced managed burning), increased summer temperatures and more droughts • Contraction of active blanket bog area • Loss of upland species that are at the edge of their geographical range in the Peak District • Increased flash flooding downstream from gripped or gullied uplands • Increased depth to water tables with associated emissions of methane from peat • More heavy rainfall events lead to reduction in burning • Increased flooding from moorlands due to heavy rainfall events

impact” scenarios were of most interest/relevance to stakeholders was unpacked during discussion at the end of each workshop.

Climate change was mentioned as potentially a significant driver of change in all the sites and interest was expressed in the potential for peatland restoration. In the Peak District, although most agreed with the proposed list of possible scenarios, there was a desire to see more “surprise” scenarios that were unlikely to happen, but that would have a major impact if they did occur. To this end, the expansion of arable agriculture into uplands was suggested as a surprise scenario that was more likely than the expansion of biofuel crops. Although an increase in wind farms was discussed by participants, the research team deemed this outside their expertise to

model effectively. The scenarios were considered to be quite general in nature, and participants requested more site-specific, spatially explicit components. Participants also suggested that there should be more socio-economic scenario components. A number of such components were added by participants in both workshops and by the research team (between workshops) in response to this.

The desire to prioritise “surprise” scenarios was echoed by participants in Nidderdale, who despite the low ranking of the “arable uplands” scenario (9th), wanted to see this short-listed, due to its potentially high impact. It was suggested that the “bird disease” scenario could be combined with the “shooting ban” scenario,

Table 2
Upland scenarios evaluated by Galloway stakeholders, showing components that emerged from analysis of semi-structured interviews and an initial workshop with stakeholders combined with evidence from academic literature (black), new components suggested by stakeholders during a subsequent scenario development workshop (red) and components deemed unlikely and low impact by stakeholders during the scenario development workshop (grey). Components in bold were considered to be both very likely and have high impact.

<p>1. Upland farming collapse</p> <p><i>Description: Support for agriculture is withdrawn due to competing priorities for funding in other areas such as health and education</i></p> <ul style="list-style-type: none"> • Upland farms abandoned and not managed for agriculture • Forestry expands onto previously farmed areas <ul style="list-style-type: none"> • New forestry planting confined to marginal arable land • Rural to urban migration for work increases • Trend for consolidation of farm holdings continues • Loss of biodiversity • Loss of landscape diversity • Loss of recreational infrastructure (wild walking)
<p>2. Energy production in uplands</p> <p><i>Description: The demand for sustainable energy and changes in planning legislation lead to the widespread approval of wind and biomass energy generation projects</i></p> <ul style="list-style-type: none"> • Grazing management continues at current levels in conjunction with new wind farms • Peat degradation increases under wind farm developments, depending on location • Forestry management changes to increase production of forest residues for biofuel power plants • Mainly Sitka spruce planting and clear felling management • Rate of new plantings increases • Forestry employment increases • Increased acidification problems in upland rivers • Reduction in important fish species (salmon and trout) • Increased soil erosion on clear felled sites • Increased number of windfarms in the uplands • Community windfarm developments – local involvement in purchasing turbines • Detrimental impact of windfarms on tourism • Planting of forests on more productive lowlands • Windfarm impacts on upland birds, depending on species, heights and migration • No impact of windfarms on local employment
<p>3. Expansion of Tourism</p> <p><i>Description: Tourism and recreation become the major income providers and drivers for the local economy</i></p> <ul style="list-style-type: none"> • Farming diversifies into conservation and nature trails reducing management for sheep if profitable • Forestry management changes to create more open areas through rotation (felling and planting at different stages to reduce areas of closed canopy) • More jobs available, less out-migration • New tourist route through Galloway • Tourism season extended e.g. marketing Burn's Night etc. • More and better accommodation becomes available • Roadsides cleared more effectively to make views visible
<p>4. Rural retirement</p> <p><i>Description: The rural population is increased by retirees from urban areas while young workers and their families migrate to urban centres for better paid jobs</i></p> <ul style="list-style-type: none"> • Upland farming reduces and farms are sold for redevelopment e.g. for family dwellings • Trend for consolidation of farm holdings continues • Availability of workers for the agriculture and forestry sectors is reduced • Out-migration slowed by introduction of broadband
<p>5. Conservation future</p> <p><i>Description: Policy drives management (particularly forest management) to focus on conservation goals</i></p> <ul style="list-style-type: none"> • Forestry management changes to create more open areas through rotation (felling and planting at different stages to reduce areas of closed canopy) • Moorland fringe habitat increased through felling and selective planting • Mix of native deciduous trees in current plantations is increased • Conifer diversity increased to improve habitat for red squirrels • Forestry fallow periods are increased • No planting boundary on water courses increases (for conifers) • All forestry removed from areas with major acidification problems • Small Scale peatland restoration instead of replanting becomes widespread (especially clearing scrub. Natural regeneration more likely) • Limits placed on the amount of forest planting allowed in each catchment • Farming diversifies into conservation and nature trails reducing the management for sheep • New planting and re-planting are of native species (especially around streams) • Smaller clear fell areas and greater maturation allowed • More deciduous trees lead to more birds and more diversity of birds and other species (e.g. fungi, invertebrates) • Increase in carbon storage • More money available for bracken control • Adapt forest management plans to suit wildlife species of relevance to each area
<p>6. Forested future</p> <p><i>Description: Increases in timber prices and the demand for sustainable wood maintains or increases the amount of forested areas</i></p> <ul style="list-style-type: none"> • Mainly Sitka spruce planting and clear felling management • Rate of new planting increases • Forestry employment increases • Increased acidification problems in upland rivers • Reduction in important fish species (salmon and trout) • Increased soil erosion on clear felled sites • Loss of traditional rural skills • Loss of biodiversity • Loss of variety in landscape
<p>7. World food shortages</p> <p><i>Description: Population increases around the world and the demand for food grows</i></p> <ul style="list-style-type: none"> • More cattle grazed in the uplands (assumes policy change) • Land abandoned by forestry turned over to farming • More intensive sheep farming introduced • Increase in year round grazing as feed prices increase • Forests cleared to allow sheep and cattle farming expansion • More people are able to make a living in the uplands on viable farms



Fig. 2. Likelihood/impact matrix showing examples of the categorisation of scenario components by Nidderdale stakeholders (top left) and Peak District stakeholders (top right); and likelihood/impact matrix showing the categorisation of full scenarios by Nidderdale (bottom left) and Peak District stakeholders (bottom right).

since these were caused by different drivers, with similar effects. Neither of these scenarios were short-listed in the Peak District.

Both Peak District and Nidderdale stakeholders short-listed the same scenarios, with one exception. Nidderdale stakeholders prioritised “bird disease” (which could be combined with “shooting ban”), whereas Peak District stakeholders prioritised “blanket bog burning ban”. One reason for this may have been that the Peak District workshop was held very shortly after the consultation on the Heather & Grass Burning Code had been published, ruling out a blanket bog burning ban, which until then had been widely anticipated (it was published during the month that the workshop was held).

In Galloway, there was general agreement about the list of scenarios presented and none were deemed inappropriate for Galloway. There was also general agreement about the scenarios short-listed through the categorisation process, although it was decided through discussion that a “collapse in upland farming”, while only ranked 5th, should still be included in the Galloway short-list because although this scenario was considered by some as less likely to happen, the impact of this scenario was deemed to be significant enough to warrant consideration.

Given that the climate change can be integrated with each of the other scenarios and the restoration scenario can be turned “on” and

“off” in each scenario, the final short-listing for each site is as follows. In the Peak District, the short-list was: i) blanket bog burning ban; ii) farmers as ecosystem providers; iii) hill farming collapse; and iv) arable uplands. In Nidderdale AONB, the short-list was: i) hill farming collapse; ii) farmers as ecosystem providers; iii) bird disease/shooting ban; iv) arable uplands. In Galloway, the short-list was: i) expansion of tourism; ii) energy production; iii) rural retirement; iv) conservation future; and v) upland farming collapse. For details of each scenario, see Tables 1 and 2; for full ranking see Tables 3–5.

Although these workshops were held inside, compared to the initial workshop that was held in Site 1, power dynamics were not a problem in these workshops due to the level of trust that had been built between participants (there was significant overlap between participants from the initial site visits and the workshops to develop and short-list scenarios) and due to the higher standard of workshop facilitation.

4.4.3. Participatory decision-making based on scenarios

More detailed likely implications of each scenario were explored using a number of linked, process-based computational models (see Reed et al. (2013) for details). In summary, this included the use of a spatially explicit Agent-Based Model of land owner/manager

Table 3
Scenarios ranked by likelihood and impact by Peak District stakeholders.

Rank	Scenario	Votes
1	Blanket bog burning ban	11
2=	Restoration	10
2=	Climate change	10
3	Farmers as ecosystem service providers	9
4	Hill farming collapse	6
5	Managed retreat	5
6=	Rural labour pool dries up	4
6=	Bird disease	4
7=	Shooting ban	1
7=	Post-peat world	1

Table 4
Scenarios ranked by likelihood and impact by Nidderdale stakeholders.

Rank	Scenario	Votes
1	Climate change	16
2	Hill farming collapse	14
3	Farmers as ecosystem providers	12
4	Restoration	8
5	Bird disease	7
6	Blanket bog burning ban	6
7	Rural labour pool dries up	5
8	Managed retreat	4
9	Arable uplands	3
10	Shooting ban	1

Table 5
Scenarios ranked by likelihood and impact by Galloway stakeholders.

Rank	Scenario	Votes
1	Expansion of tourism	12
2=	Energy production	10
2=	Rural retirement	10
4	Conservation future	9
5	Upland farming collapse	8
6	Forested future	6
7	World food shortage	1

decision-making behaviour based on the analysis of interviews with decision-makers across sites 1 and 2. This was used 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). These changes were then linked to changes in land cover, which in turn were linked to models describing how land management decisions would affect the distribution of key habitats and species, hydrology and carbon dynamics. This made it possible to consider the likely biophysical effects of each scenario in some detail (e.g. effects of a certain level of destocking on water quality, carbon dynamics, the dominance of heather or abundance of red grouse).

Model outputs were integrated with qualitative findings in narratives, which were communicated to stakeholders via short films (see Reed et al., 2013 for details). These films were then used as a basis for discussion with the modelling team to unpack the model's "black box" of assumptions. This then formed the basis for a discussion to identify innovative adaptation options that could help maintain livelihoods and the ecosystem services upon which they depend under each scenario. The ultimate goal was to inform future decision-making that could enable effective adaptation to upland change.

5. Discussion

This paper has proposed a methodological framework for participatory scenario development, which has been applied in a UK upland case study using three study sites. Each of the scenarios developed are likely to have a series of complex implications for the upland environment, economy and society. These are likely to include feedbacks and hence some implications may not be readily anticipated. Some of these scenarios may take place together – most obviously in combination with climate change. This means it is also necessary to be prepared for the interactions that may occur between certain elements of these scenarios.

The modelling that was undertaken as part of this project was designed to help elucidate some of these implications and interactions. Full findings from the modelling work are reported in more detail in Reed et al. (2013). Model outputs provided further evidence to support the likelihood of some aspects of the scenarios, and helped the team incorporate more detail and spatial resolution, which provided greater realism to the scenarios. However, given the significant time and resources that were required to construct, validate and calibrate these models, model outputs did not significantly alter any of the scenarios they were integrated with. It may therefore be possible to argue that basing scenarios on local knowledge and secondary data alone would have been more efficient. However, a number of important insights were gained from the development of process-based mathematical models that would not have been possible to incorporate otherwise, for example, about the spatial distribution and types of management that led to changes in carbon dynamics, which have subsequently contributed towards an evidence base upon which a UK Peatland Code is being proposed in a subsequent UK Government funded

research project. If successful, such a Code may be used to facilitate peatland restoration via private investment, making one of the scenarios explored in this research become reality.

By combining local and scientific knowledge in this way, stakeholders were able to gain insights into possible future system dynamics that they would not have been able to gain without collaborating with researchers. At the same time, it is clear that the scenarios would be far less rich in detail, meaning and relevance without engaging stakeholders. This integration of local and scientific knowledge is a key theme running through each of the steps in the proposed methodological framework. First, site visits provided researchers and stakeholders with the opportunity to exchange knowledge about the upland system as equals, and to integrate this knowledge through face-to-face discussion. Second, conceptual models of system structure and function were developed from local knowledge through Grounded Theory Analysis of interview transcripts, and integrated with scientific knowledge by adding insights from research literature and the conceptual model developed by researchers (see Section 4.4.1). Third, stakeholders reviewed and provided inputs to information sheets that had been developed from published literature. Finally, the qualitative scenarios that emerged from the process described above were supplemented by outputs from process-based computational models (see Reed et al., 2013). Stakeholders then had an opportunity to evaluate and discuss model outputs, modifying the resulting scenarios where relevant in response to discussions between stakeholders and modellers (Reed et al., 2013). In this way, local knowledge was evaluated using the computer models, and scientific knowledge was evaluated against the knowledge and experience of stakeholders.

It could be argued that the results of this sort of work may lack replicability due to their dependence on the balance of stakeholders attending workshops; a different mix of participants could lead to alternative outcomes. The approach proposed in this paper addressed this by selecting a broadly representative group through a combination of stakeholder analysis and Social Network Analysis. Although this should lead to a replicable identification of participants, it is difficult to predict who will be able to attend. Stakeholders in the Galloway workshop for example, commented on a number of prominent organisations that had been invited but did not attend the workshop. This was addressed through follow-up interviews with representatives of these organisations, to supplement the information collected in the workshop.

The following discussion draws four conclusions from this application of the proposed methodological framework for participatory scenario development.

5.1. Stakeholder participation in scenario development has the potential to make scenarios more relevant to stakeholder needs and priorities

The proposed framework emphasises the need for representative stakeholder involvement, where relevant, from the outset and throughout scenario development. A well designed participatory process has the capacity to enhance the relevance of scenarios to stakeholders by incorporating and building on their preferences, and enabling stakeholders to direct the scenario development process, and hence its outputs.

In the case study, stakeholder participation led to the development of scenarios based on topical issues of immediate concern to stakeholders, such as bird flu and global food shortages. Due to the limited capacity for people to engage with a large number of scenarios, most scenario studies set out to develop a maximum of four scenarios (e.g. Berkhout et al., 2001; Kok and van Delden, 2004; Bohensky et al., 2006; Kok et al., 2006; Caille et al., 2007; Patel et al.,

2007; Tompkins et al., 2008). However, by short-listing the four highest impact and most likely scenarios from a longer list of options, the case study research was able to further increase the relevance of the selected scenarios for stakeholders.

5.2. Representative participation from diverse stakeholders has the potential to extend the range of scenarios developed

Reed et al. (2009a) show how, with few exceptions, all seven previous UK upland scenario studies converged around four key scenarios based on economic drivers: i) continuation of hill farming (at reduced levels) based on cross-compliance with environmental measures; ii) significantly reduced levels of hill farming based on cross-compliance with environmental measures; iii) withdrawal of agricultural management and re-wilding; and iv) significantly reduced levels of hill farming supported by diversification. This occurred despite the studies being conducted at different times, in different parts of the country, with the participation of different stakeholders. Despite overlapping geographically with a number of these previous studies and consulting many of the same stakeholder groups, the case study derived a number of qualitatively very different scenarios, in addition to those identified in previous studies (as reported by Reed et al., 2009a). These included scenarios based on cultural and policy drivers (e.g. the possibility of a future game shooting ban or regulations to stop the management of blanket bog for game), demographics (e.g. the effects of rural–urban migration limiting the availability of rural labour), disease (e.g. a major disease outbreak without cure that would decimate grouse populations), emerging economic incentives to restore degraded peatland for carbon storage, and climate change.

The qualitatively different and more diverse scenarios that emerged from the case study may in part be due to the significantly different methods that were used, compared to previous studies. Indeed, Metzger et al. (2010) suggest that the engagement of stakeholders with divergent worldviews is likely to lead to the development of a wider range of scenarios, due to differences in the way scenarios are interpreted. The case study research involved a wider range of stakeholders in a more participatory research design. This involved a far greater degree of integration between local and scientific knowledge, for example through site visits between researchers and stakeholders, the integration of conceptual models from both groups, and the capacity for both groups to evaluate each other's contributions to scenario development. Instead of relying solely on focus groups for stakeholder engagement, as is common in scenario development, the case study used focus groups (which we refer to as workshops in this paper) to evaluate and refine in-depth material collected in semi-structured interviews. This ensured the initial scenarios were based primarily on stakeholder perceptions of system structure, function and likely futures. Semi-structured interviews are particularly well suited to in-depth discussion and the elucidation of different views, whereas the dynamics of focus groups can shut down diversity of opinion and are unable to explore issues in the same depth (Powell et al., 1996; Scott, 2011). Given the history of conflict and existing power dynamics between stakeholders in this case study, where focus groups were used, where possible they were designed as site visits to reduce power disparities and encourage all participants to express their views openly.

5.3. Stakeholder participation provides an opportunity to develop more detailed and precise scenarios through the integration of local and scientific knowledge

The framework we have presented and applied emphasises the need to combine local and scientific knowledge. It is argued that the integration of information from stakeholders with evidence from

research has the potential to empower stakeholders, and develop more consistent, detailed and precise (though of course, not necessarily accurate) scenarios than could be developed from local or scientific knowledge alone. Metzger et al. (2010) suggest that this is particularly important for scenarios or elements of scenarios that are not well understood or possible to quantify, and hence more reliant on personal judgement and interpretation.

This can be illustrated by the level of detail and precision contained in scenarios from the case study, compared to those published previously for UK uplands (Reed et al., 2009a). The scenario, “farmers as ecosystem providers” is analogous to the scenario developed by previous studies, summarised by Reed et al. (2009a) as “significantly reduced levels of hill farming based on cross-compliance with environmental measures”. However, significant involvement from land managers and conservationists, combined with information from researchers and literature review in the case study research, led to the incorporation of far more precise details about what such a scenario would entail. For example, it was possible to differentiate between the ways this scenario would play out for specific species in different upland habitats. The more detailed and precise information arising from the integration of local and scientific knowledge, is likely to be more useful for those who need to prepare for new ways of managing the land in future.

5.4. Involving stakeholders requires moving beyond scenario development to facilitate adaptation to future change

To engage stakeholders effectively, there must be rewards (or perceived benefits) for those who participate (Sultana et al., 2008). In market research, participants are usually paid for attendance. However, this is unlikely to attract high-level stakeholders and may lead to biases in group composition. Few stakeholders are likely to invest the necessary time in a process that only leads to scenarios. The reason they are likely to be interested in scenarios is because they want to be able to prepare for the future. Hence, working with participants to prepare for the futures depicted in the scenarios that have been developed is an important, but often neglected, final step.

Monetary compensation and expenses were available for participants in the case study, and during the invitation process it became clear that many became motivated to attend when they found out who else was attending (e.g. as they wanted to provide balance or to get access to decision-makers). Nonetheless, interest in preserving the future upland environment and local livelihoods appeared to be a primary motivation for those who took part. For this reason, the last step in the case study research design is for stakeholders and researchers to discuss finalised scenarios (that in this case incorporated model outputs) and identify potential adaptations that could support key aspects of the upland environment and the livelihoods that depend upon it under a range of future conditions. Although there is not enough time to experiment or conduct field trials to test the adaptations that are suggested, computational models may be used heuristically to evaluate potential effects of proposed adaptations. Where feedbacks and unintended consequences are identified, it should be possible to discuss and evaluate refinements, and develop adaptations that are more likely to be effective in response to future conditions.

Most of this paper has been concerned with viewing stakeholder participation in scenario development as a way of improving the quality or validity of scenarios, and possibly increasing the extent to which participants accept the end results. This views participation as a means to an end, rather than as a process that has value in itself. Following best practice in stakeholder participation (e.g. Reed, 2008), participatory scenario development may be able

to help people learn about the issues being addressed and how they can work together to deal with them (de Vente et al., 2013). As such, carefully conducted participatory scenario planning may go beyond identifying adaptations, to build adaptive capacity among stakeholders to implement change. By increasing ownership over the process, participation may enhance the likelihood that stakeholders accept responsibility for acting on what they learn. As Koontz and Bodine (2008) suggest, political will is the main roadblock to change, not knowledge, and a participatory approach has the potential to address both.

Given the central role of stakeholder participation and associated power dynamics to the proposed methodological framework, its transferability to other contexts is likely to depend upon the quality of participatory process that is used to develop scenarios. The academic literature is littered with examples of participatory processes that did not achieve their intended goals or that led to unintended consequences (see Cooke and Kothari (2001) and Reed (2008) for reviews). de Vente et al. (2013) reviewed a number of participatory processes internationally and concluded that contextual factors were relatively unimportant, whereas the most important factors associated with success or failure were associated with process design and participant selection, in particular: i) the systematic representation of stakeholders prior to starting a participatory process; ii) professional facilitation including structured methods for eliciting and aggregating information from participants, and balancing power dynamics between participants; and iii) the provision of information (ideally via face-to-face contact) and decision-making power to participants. A number of these lessons identified by de Vente et al. (2013) pertain to the management of power dynamics, which emerged as an important limitation in the case study reported in the current paper. It suggests that although the transferability of the proposed framework may be limited the quality of the participatory process, it should be possible to achieve most of the benefits of participatory scenario development, by following good practice in participatory process design.

6. Conclusion

This paper has outlined a methodological framework for participatory scenario development on the basis of evidence from the literature. It has applied the framework to three case study regions in which a series of qualitative scenarios were developed to depict different futures for UK uplands. With effective stakeholder participation, the transferability of the methodology between the case studies suggests the methodological framework proposed in this paper could have broader applications in other UK uplands and similar regions elsewhere. A number of arguments from the literature were played out in the case study research, suggesting that participatory scenario development has the potential to: i) make scenarios more relevant to stakeholder needs and priorities; ii) extend the range of scenarios developed; iii) develop more detailed and precise scenarios through the integration of local and scientific knowledge; and iv) move beyond scenario development to facilitate adaptation to future change. Environmental scenarios cannot be developed without reference to the people who use, value and shape the environment. They can be developed without their involvement, and often are. Effective stakeholder participation in scenario development is likely to take extra time and resources, and the success of this participation is likely to depend on the quality of the process design and effective representation of stakeholder interests. However, this paper has argued that involving stakeholders in scenario development can bring significant benefits to both stakeholders and researchers, leading to the development of more consistent and robust scenarios that can better prepare people for

the future. To quote Malcolm X (1925–1965), “the future belongs to those who prepare for it today”.

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