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Engaging Communities and Climate Change Futures with Multi-Scale, Iterative Scenario Building (MISB) in the Western United States

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Current projections of future climate change foretell potentially transformative ecological changes that threaten communities globally. Using two case studies from the United States Intermountain West, this article highlights the ways in which a better articulation between theory and methods in research design can generate proactive applied tools that enable locally grounded dialogue about the future, including key vulnerabilities and potential adaptive pathways. Moreover, anthropological knowledge and methods, we find, are well-suited to the complexities and uncertainties that surround future climate change. In this article, we outline a narrative-driven assessment methodology we call multi-scale, iterative scenario building (MISB) that adheres to four key principles: (1) meaningful integration of socioecological interactions, (2) engagement with uncertainty, (3) awareness and incorporation of dynamic spatial and temporal scales, and (4) inclusion of diverse knowledge(s) from both social and natural sciences as well as from communities, including skeptics and deniers. The research found that MISB illuminated the complex, relational nature of vulnerability and adaptation and provided significant insight into potential, and sometimes surprising, future conflicts, synergies, and opportunities. We also found that MISB engendered a deep appreciation among participants, even skeptics and deniers, about the numerous, multi-scaled feedbacks and path dependencies generated by interacting drivers of social and ecological change. In conclusion, we argue this approach provides substantial space for the reflexive learning needed to create the "critical emancipatory knowledge" required in the face of transformational threats like climate change, and as such, we suggest potential avenues to support planning and decision making in the face of uncertain futures.

Key words: climate change, adaptation, vulnerability, narrative, scenarios, uncertainty

Introduction

Using two case studies from the United States Intermountain West, one from the Big Hole Valley, Montana, and the other from Grand County, Colorado, this article highlights the ways a stronger articulation between theory and methods can generate proactive applied tools to aid researchers and communities in exploring climate change-related vulnerabilities and adaption while also enabling locally grounded dialogue about the future.[1] Unlike other social scientists, anthropologists are often uneasy applying theoretical knowledge to such future concerns. In contrast, following Barnes et al. (2013), we argue that by combining theories of practice with critical concerns in theoretical anthropology (and other influences from the social sciences and humanities), anthropological knowledge and expertise, however partial, is of considerable value in uncertain conditions such as those presented by climate change.[2] An anthropological perspective is also vital as various social science investigators increasingly discover "culture" as a key to understanding human-environment relations in the context of climate change (Adger et al. 2012; Castree et al. 2014)[3]. In light of this uncertainty and the "turn" towards culture,

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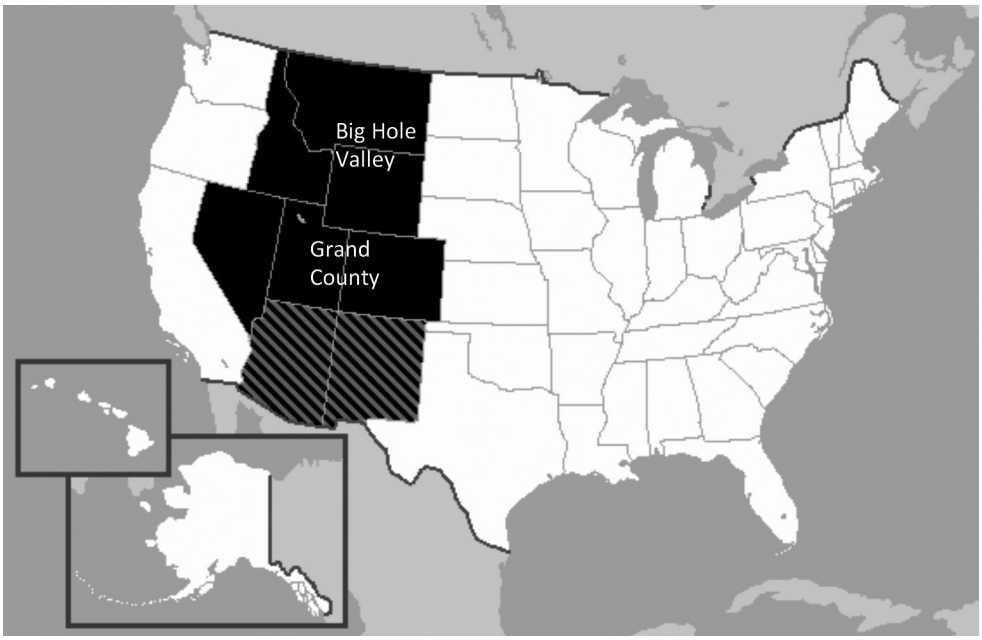
Map 1. Locations of Research Sites in the Intermountain West Region (Shaded)



we find narrative and storymaking/telling to be key practices for illuminating the role of anthropology and anthropological knowledge in uncovering vulnerabilities and facilitating adaptation. As Hulme (2011:178) notes, "The importance of storytelling around climate change needs elevating alongside that of fact finding [as] stories are the way that humans make sense of change."

The methodology and data we present here demonstrate how narrative-driven approaches can help us map the contours and margins of our knowledge about climate change-related vulnerabilities and adaptive capacities. For that reason, the research is guided by three key principles. First, considerations of vulnerability and adaptation in the context of climate change require, methodologically, greater *social-ecological integration*; in particular, attention must be paid to the deeply interwoven, mutually constitutive, and emergent relationships between social and ecological processes. This requires intense interdisciplinary engagement between the natural and social sciences (Casagrande et al. 2007) and, in particular, grounding in local knowledge (Sherpa 2014), even when that "knowledge" comes from self-avowed skeptics and deniers. Second, research should orient assessments toward future climate change impacts, as solely relying on past experience can eschew the uniqueness of future threats. Thus, a future orientation requires recognition of continuing *uncertainty* regarding how future impacts will manifest on the ground. Third, the drivers of social and ecological changes operate on different spatial and temporal scales, requiring close attention to the cross-scale interactions shaping vulnerability and adaptive pathways in particular *places*, represented here by the Big Hole Valley, Montana, and Grand County, Colorado (see Map 1).

Anthropology provides a holistic perspective that is well-suited to work that crosses scales and incorporates multiple stakeholders in collaborative processes (Crate 2011; Fiske et al. 2014). This article outlines an anthropologically-inspired methodology that we call "multi-scale, iterative scenario building" (MISB) that integrates these principles and explores data that illuminate them. We find that by utilizing diverse socioecological scenarios as dynamic narrative threads, "climate futures" can be multi-authored in ways that permit conflicts as well as synergies and opportunities to emerge and/or subside, without succumbing to climate reductionism (Hulme 2011). This approach also provides space for the reflexive learning needed to create the "critical emancipatory knowledge" required in the face of transformational threats like climate change (Castree et al. 2014:765).[4] Finally, we evaluate the method's strengths and potential to support planning and decision making for an uncertain future.

From Theory to Method

Many current vulnerability and adaptive capacity assessments are marred by poor articulations of the linkages between the theoretical and methodological assumptions underlying research design (O'Brien et al. 2007; Wise et al. 2014). Past approaches, we argue, have been problematic for three reasons: (1) minimizing the potential for social-ecological transformation, (2) theorizing "units" and "events" in reductive ways, and (3) ignoring the considerable uncer-

tainty that surrounds future climate change. We argue that explicit illustration of these linkages is critical to understand how certain epistemological and theoretical stances lead to different conceptual and methodological frames, such as a focus on narrative, and subsequently, to different results and potential utility.

In this vein, we begin by moving beyond a hazards model where climate change (Fussel and Klein 2006) is largely conceived through discrete, objective "threats" (e.g., fire, drought, flooding, etc.) that are treated as synchronic, bounded events in which there is a distinct before, during, and after. Rather, climate change represents not a hazard or event per se but a saturating, pervasive (though uneven) threat, a potentially fundamental and transformational realignment of social-ecological relationships (Nelson, Adger, and Brown 2007). In reframing and situating climate change in this frame, vulnerability and adaptation evolve in the *relational* and *emergent* nature of social-ecological process. Climate change is simultaneously produced and "grounded," shaped by a dynamic set of material and discursive linkages that interact in particular contexts (Jasanoff 2010). In other words, if climate change is made "real" through dynamic social-ecological relationships, then understanding vulnerability and adaptation requires attending to these relations and not necessarily the distinct "units" and "events" themselves. These insights illustrate how social process is equally pervasive and constitutive, rather than a secondary driver of change, an effect, or a structural element that either limits or constrains adaptation (Castree et al. 2014; Pelling 2010; Thornton and Manasfi 2010). They also allow us to consider the manifold social-ecological relations at stake and how they might disassemble and reassemble in new ways.

This reframing of climate change also has implications for how we theorize "actors." In MISB, we seek to move beyond a focus on actors as "exposed units" defined narrowly as discrete, unified, and oftentimes, rational agents. By essentializing actors in such ways, inadequate attention is paid to agency, power, and the social relations and webs of meaning that constitute them (Klein and Juhola 2014). Consequently, such frameworks are largely depoliticized, decontextualized, and acultural. In the face of such shortcomings, we draw instead on scholars who call attention to the political and contextualized aspects of climate change, particularly focusing on scalar, spatial, and temporal dynamics (Adger et al. 2009; Eakin, Wendel, and Sendzimir 2009; Leichenko and O'Brien 2008). We also draw on work that recognizes the dense social and cultural dynamics that constitute "actors" and thereby shape vulnerability and adaptation (Crate and Nuttal 2009; Hulme 2009; Norgaard 2011). Moreover, we privilege the idea that learning and knowledge processes considered fundamental to adaptive dynamics are deeply rooted in place and mediate the actions required to adapt (Pelling et al. 2008; Tschakert and Dietrich 2010; Van Aalst, Cannon, and Burton 2008).

Given how we theorize both "climate change" and "actors," and despite advances in climate science, climate futures are inherently uncertain.[5] This sense of uncertainty is only made deeper given the scale of such forces, which, for better or worse, pose pervasive, transformational threats (Stafford Smith et al. 2011). Ignoring the fundamental uncertainty of the future gives the impression that climate change can be converted to specific risks which cannot adequately characterize the potential transformations wrought by climate change nor the vulnerability of human communities to them. Research on climate change vulnerability and adaptation must embrace and explicitly articulate diverse and interacting uncertainties to better understand adaptation in the context of partial and competing knowledge.

These theoretical considerations form the basis of our methodology (MISB). Scenarios are qualitative descriptions of alternative sets of future conditions; consequently, to orient the method towards future vulnerabilities and adaptive capacities, we explored the potential uses of scenario-planning (Amer, Daim, and Jetter 2013; Peterson, Cumming, and Carpenter 2003; Soliva 2008), scenario-building (Aligica 2005; Hallegatte, Pryzluski, and Vogt-Schlib 2011; Ozkaynak and Rodriguez-Labajos 2010; Sheppard et al. 2011; Wilkinson and Eidinow 2008), participatory scenario analysis (Gidley et al. 2009; Ravera et al. 2011; Tompkins, Few, and Brown 2008; Vervoort et al. 2010), and other kinds of narrative analysis (Paschen and Ison 2014) and scenario-based "futures" studies (Borjeson et al. 2006; Ebi et al. 2014; Kaltenborn, Thomassen, and Linnel 2012) particularly in the context of climate change (Hallegatte 2009; Roscoe 2014). We drew on scenarios for a number of reasons. Most generally, scenarios are not bound by probabilities, and consequently they permit participants to engage potential future(s) and uncertainties by embracing a wide range of "knowns" and "unknowns" through alternative pathways. More specifically, the multi-dimensional and "simulatory" aspect of scenario methods (Aligica 2005; Vervoort et al. 2010), allows the relational dynamics and socioecological interactions that underlie vulnerability and adaptive capacity to emerge. Finally, the narrative and dialogic structure of scenario-building permits the inclusion of multiple, diverse voices and sets of knowledge in crafting what are in effect collaborative stories and visions of the future.

Scenario methods range from formal, scenario modeling at global scales (Roscoe 2014), to local, narrative forms of community visioning. The latter use scenario methods to work across diverse social groups and scales (Ozkaynak and Rodriguez-Labajos 2010) to envision possible future vulnerabilities and adaptive capacities in the context of climate change (Gidley et al. 2009). Most scenario methods are focused on the end goal or product of the scenario process which typically defines a goal and a set of alternative pathways to reach that goal (i.e., solution or problem-orientation). In contrast, Wilkinson and Eidinow (2008) argue for the use of scenarios as reflexive tools to develop strategic practices of social learning. These distinctions are key, as scenario narratives can become "fetishized" as objects of contestation rather than a means to reveal new knowledge because they convey the sense that the scenario itself (as well as "outcomes,"

Table 1. Base Climate Descriptions

Scenario	Climate Description	Shorthand
"Some Like it Hot"	Warmer and drier across all seasons with perennial drought	"hot and dry"
"The Seasons are a Changin"	Warmer across all seasons, earlier snowmelt, with more winter precipitation (as snow and/or rain)	"seasonal change"
"Feast or Famine"	High inter-annual climate variability with hot, dry years followed by cool, wet years (increasing the frequency of extreme events such as floods or droughts)	"increased variability"

"plans," "goals," or "actions") is the desired end. Moreover, these kinds of approaches can also diminish differences and disputes between participants, not necessarily by resolving them but by silencing them, which in turn could limit our ability to produce new knowledge. Consequently, MISB represents a move away from a traditional outcome-oriented use of scenarios but without avoiding the interactive tensions that may cause dispute or conflict (or opportunities and synergy) in future decision making contexts. Our intention was to allow participants to more freely explore the range of possible futures without the pressure to get "something"—that is, a plan, product, or goal. As Castree et al. (2014) argue, we intended to "throw it wide open."

Study Sites

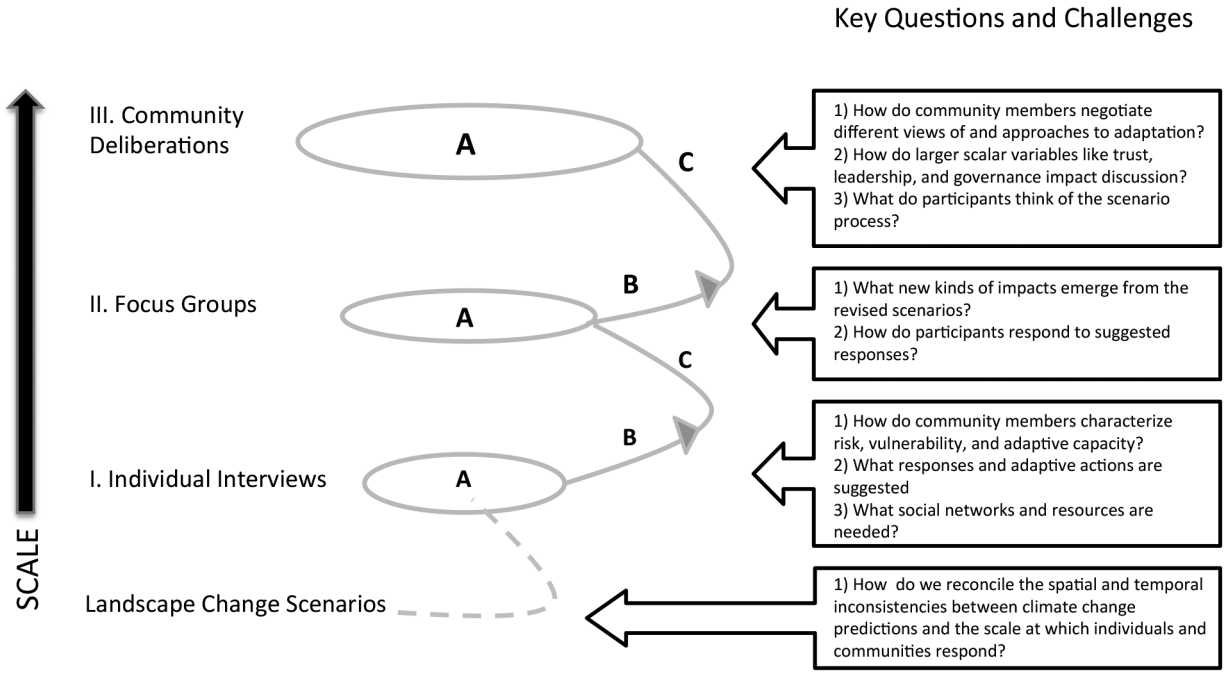
In order to develop and deploy MISB (described in detail below), we focused on selecting sites in high altitude ecosystems and mountain communities in the intermountain West since they are believed to be particularly vulnerable to climate change (Archie 2013; IPCC 2013; USGCRP 2014). Consequently, we selected two watersheds in the region: the upper Big Hole Valley in Montana (p<346) and Grand County in Colorado (p >14,000). Despite the differences in population, both the Big Hole and Grand County typify the intermountain West. Given the high altitude of Grand County and the higher latitude of the upper Big Hole, climatologically and ecologically they are quite similar, and both landscapes include important federal holdings, managed by the Forest Service, Park Service, and Bureau of Land Management. Economically, historic livelihoods such as ranching and forestry exist alongside amenity-based activities such as recreation and tourism, though the latter are significantly more important in Grand County which has three ski resorts and a large number of tourists during both winter and summer. In the Big Hole, there is a small recreation economy centered largely around fishing and to some extent hunting. Working family ranches dominate private lands in the Big Hole, while amenity migration and parcelization is much more significant in Grand County, where more than 60 percent of the homes are owned by absentee owners. Both landscapes are struggling with water availability. Seventy percent of the water in Grand County is diverted over the continental divide to Denver and surrounding cities, and in the Big Hole, ongoing concerns about the arctic grayling (*Thymallus arcticus*), a candidate for endangered species listing, have inspired pre-emptory conservation efforts. Given the natural resource base of each community's economy and current conservation efforts, these sites proved effective places to employ the MISB methodology outlined below.

Multi-scaled Iterative Scenario Building

Building on the theoretical insights described above, our interdisciplinary team started by developing initial qualitative scenarios of landscape-scale ecological change at an approximately twenty-year time horizon for each of these study sites. This was chosen because it corresponds to a timescale within which human communities and individuals observe, decide, and act, and is within generational change. Twenty years is within the imaginative capacity of participants, yet allows sufficient time for certain biophysical changes to occur and accumulate in a particular landscape. While climate models are typically run out to 2100 to understand changes from greenhouse gas forcing, they do not provide the meaningful time-evolving predictions of the natural decadal variability that we sought (Meehl et al. 2009). Consequently, the climate basis for the scenarios highlighted certain aspects of our current predictive capacity, in particular, the increased uncertainty due to natural variability as you narrow from global to local scales and the greater uncertainties surrounding projections of precipitation than temperature (Deser et al. 2012). These considerations formed the basis of three qualitative scenario frames representing a range of climate futures for each of the two sites (see Table 1).[6]

Ecological impacts were developed using peer-reviewed literature and published reports to make predictions for the terrestrial and aquatic ecosystems, including changes to fire regimes, recent drought measures, rangeland productivity, forest insect, and disease dynamics, as well as impacts to water resources as they apply to the particular ecological landscapes of the two study sites. After combining each description of climate-driven ecological change into three consistent narrative-style scenarios for each study site, all

Figure 1. MISB Process. The figure below graphically depicts the MISB process as it unfolds over several rounds. After developing the basic scenarios of landscape change, MISB progressively moves to larger and wider **scales** of decision making from individuals to communities (**I-III**), including actors at scales such as state or federal land management agencies. In each round, the research team conducts qualitative data collection (**A**), interdisciplinary rapid analysis (**B**), and revision of scenarios based on social data and anticipated ecological impacts of recommended actions (**C**), to be utilized in the following round. This process ensures that the scenario-building process iterates as spatial and jurisdictional scale increases. In each round, data collection focuses on a key questions regarding adaptation challenges.



six were reviewed by scientists with regional expertise. The three resulting landscape change scenarios for each study site then represent tightly linked narratives of ecological and climate change as well as local uniqueness and a range of probable futures.

We utilized these site-specific sets of landscape change scenarios to engage research participants over three rounds of scenario building including: (I) in-depth, semi-structured interviews with single participants representing diverse ownership types, livelihoods, and political positions; (II) focus groups with multiple participants stratified by "livelihood"; and (III) a community-level meeting with a wide range of representative stakeholders, community members, and local officials (Figure 1 depicts these scales I-III). Between each round, as will be described below, responses to each scenario were analyzed, evaluated, and built back into the scenario description. This iterative element draws on aspects of expert review from Delphi methodologies as a mechanism for building each scenario narrative. Moreover, drawing on Ozkaynak and Rodriguez-Labajos (2010), the multi-scaled approach (from individual to focus group to community) allowed us to "progressively contextualize" (Vayda 1983) participant responses within a greater range of networks, institutions, and social relationships across scales.

For the first round (I.A., Figure 1), the initial three landscape change scenarios described above were utilized first for in-depth, semi-structured interviews with twenty-two individual community members in the Big Hole and twenty-six in Grand County where we elicited views on vulnerability and adaptive capacity relative to each alternative future. Participants were selected through a purposive sample stratified according to dominant occupational and livelihood categories such as ranchers, small business owners, agency employees, residents, and recreational outfitters/operators.[7] The lead researchers visited ranches, restaurants, bars, groceries, and other locations to sit down one-on-one with each participant. Interviews began with basic background on each participant and current perceptions of social, economic, and ecological change in the study sites. Then the researchers presented each landscape change scenario to the participant, working through them consecutively. In response to each scenario, individuals were asked to discuss: (1) how they and their community would be impacted by specific changes they recognized in the description, (2) how they imagined responding to these

impacts (both as individuals and as a community), and (3) what resources, networks, and knowledge they would draw upon for different responses or actions. Participants across the sites discussed impacts ranging from the effect of reduced water flows on irrigation to the effect of higher temperatures on tourism as well as responses to each.

Beginning the process with individual interviews runs counter to most applications of scenario methods, but we found it valuable: it allowed us to contend with participants' views on climate change in a relaxed, one-on-one setting, and to walk them through each scenario. The setting also allowed each participant to have equal say, whereas in focus group or community-based scenario approaches, less dominant but no less consequential voices can often be drowned out. As we explain below, each of these elements provided considerable contextual relevance, exploring potential "shadow spaces" (Pelling et al. 2008) of knowledge, and engaging climate skeptics, all of which are keys to social learning in the context of climate change. Each interview was recorded, transcribed verbatim, and coded in NVIVO 9.2.

From our analysis of the individual interviews, the research team conducted (I.B., Figure 1) a revision of the scenarios, taking into account individual responses as well as "likely" human actions and their possible ecological impacts (I.C., Figure 1). The team assessed proposed actions based on the scale at which they would occur, the resources necessary to implement them, and the frequency with which they were mentioned. We defined actions that seemed to find traction across individuals but required minimal resources and had few institutional barriers as highly likely. Actions that required greater resources or confronted significant institutional barriers, such as dams or re-adjudication of water rights, were labeled as "under consideration" or as "proposed," and their impacts were considered "possible." Ecological scientists on the research team also assessed the possible environmental impacts of each proposed response action. All six landscape change scenarios (three from each site) were then expanded to include commonly expressed themes as well as the various actions and their impacts while also maintaining coherent and consistent narratives of social-ecological interactions and base descriptions of climate and ecological change. Each scenario, in short, expanded in length and grew in scope and complexity.

For the second round, these revised and expanded scenarios were then presented to focus groups of three to seven members of key community constituencies (four in the Big Hole, five in Grand County), including private landowners; small business owners; recreation operators; and federal, state, and non-governmental agency representatives (II.A., Figure 1). Participants from the first round were included in the focus groups, though some new participants were also added and briefed on the previous round.[8] These group discussions centered on vulnerabilities and adaptation options in the context of the various responses, differences between how individuals and groups respond to the potential "adaptive" actions suggested by others, and the kinds of vulnerabilities and capacities that are important in each scenario. We found that the group interviews provided participants an opportunity to review, revise, and reflect on the diversity of ideas and actions from across the different groups in targeted ways. Focus group data, as we discuss below, revealed potential opportunities and conflicts related to institutional responsibilities and authorities, decision making processes, and governance arrangements. After the focus group interviews were completed, the research team rapidly analyzed the interviews, reviewed the responses, and revised and expanded each scenario to further reflect this additional participant discussion (II. B.-C.).

For the third round, the revised and expanded scenarios were presented in a final, community-scale meeting that engaged a range of participants in each study site (eight in the Big Hole, seventeen in Grand County) (III.A., Figure 1). First and second round participants were invited to participate in this round along with new participants. New participants were briefed on the previous rounds and their results. Discussion in this round allowed participants to speak across diverse individual and group concerns, including the various kinds of opportunities, constraints, potential frictions, and surprises that arose through the scenario-building process.

To give a simplified example of how this process unfolds through rounds, we explore briefly the emergence of irrigation as a key focal point for adaptation. In discussing scenario one during individual interviews, ranchers identified significant impacts on rangeland productivity and responded in a variety of ways, including changing hay reserve use, improved irrigation, dam installation, use of grazing allotments, and tighter herd management. Agency participants discussed impacts on aquatic species and rangeland and forest ecosystems, suggesting that allotments might need to be reduced under the discussed conditions. In the second round, ranchers were dismayed to find that allotments might be reduced but understood the rationale and so considered other possible responses, particularly improved irrigation efficiencies through conservation programs. Conversely, in the second round, agency participants downplayed the possibility of dam installation given that it would have to be erected on Forest Service land and argued that the key for improved water availability resided primarily in irrigation efficiencies. By the third round, there was a synergistic overlap regarding improved irrigation as a potential adaptation to reduced rangeland productivity and water availability. Participants could see that conservation programs, in particular, represented a possible pathway for supplementing such improvements rather than an impediment (as they previously considered them). This synergy, compared to other possible pathways, also benefited outfitters and small business owners. The emergence of this kind of trajectory demonstrates how the iterative process unfolds.

Lastly, as most participants were thoroughly familiar with the scenarios and the process that generated them, the community meeting provided time to reflect on the process as a whole; more abstract qualities of vulnerability and adaptive capacity like trust, leadership, and governance; and some of the preliminary findings. We feel that the prior rounds set the stage for considerable discussion and ensured the inclusion of

a diversity of voices that would not have been included without them. This final stage could serve as a jumping off point for collaborative decision making. Below, we discuss the nature of the results and the insights generated by the MISB method.

Findings

In each study site, the MISB process resulted in three distinct narratives of interwoven social, cultural, economic, climatic, and ecological change with each leading to distinct sets of outcomes for individuals, groups, and the community as a whole. Moreover, the process resulted in considerable knowledge about how each narrative was constructed and the various dynamics that shaped their respective trajectories. In the Big Hole, for instance, the cascading set of impacts and responses flowing from the conditions described in the first scenario resulted in clear sets of winners and losers; yet, for the community as a whole, the resulting outcomes in total were catastrophic, leading to what they saw, in the final iteration, as community collapse. However, rather than presenting an exhaustive description of each scenario trajectory for each site and the resulting vulnerabilities and adaptive capacities, in this section, we present qualitative data and findings that exemplify and illustrate how MISB uncovered and integrated the key principles outlined above: (1) complexities of socioecological interactions; (2) diverse and interacting uncertainties; and (3) spatial and temporal scale.

Socioecological Interactions

MISB generated a rich data set describing the socioecological systems shaping these different landscapes. By exploring the relationships between ecological change and the actors, activities, and processes, the scenarios quickly elicited a broad landscape view of key interactions that produce vulnerability. In responding to the initial scenarios, the Big Hole participants evoked deep connections between ranching, irrigation, river health, aquatic species, angling, and conservation, and the multiple drivers of vulnerability. In response to the "hot and dry" scenario, one rancher stated:

> [For] an irrigated pasture situation…this is going to reduce the production quite a bit. It won't put us out of business; probably, just reduce stocking rates and all the habitat stuff. Then you get the grayling [candidate for endangered species listing] starting to go down again quickly and then, they are going to make us start irrigating less and we are already irrigating less because the flow regimes have changed. (Ranhcer, Big Hole)

Similarly, a federal land manager in Grand County highlighted connections between water and economic development, illuminating the implications of historical decisions about the flow of water for tourism, ranching, and forestry operations:

> We rely on water in the man-made reservoirs to promote recreation. The reservoirs support the water flow through the year. If this was a natural system, we wouldn't have anything like what we have now. We would have high stream flows or river flows in the spring and then very little to nothing throughout the rest of the year. But this [scenario] is gonna impact that. And that impacts everybody in the county. The tourism industry impacts everybody, including us, even though we don't work in that industry. (Agency, Grand County)

Data also illuminate the critical linkages between community identity, sense of place, and livelihood in each socioecological system. Referring to the way ranching livelihoods intersect with landscape aesthetics to foster angling tourism, one fishing outfitter from the Big Hole explained:

> The bottom line is, if we make it so tough for the ranchers to make a living, and force them to sell out and it becomes developed through large real estate sales that subdivide into smaller plots, it's going to look like any other watershed in the state or in the country. (Outfitter, Big Hole)

Likewise, in Grand County, participants discussed the ways that widespread tree mortality from mountain pine beetle altered landscape aesthetics and, in turn, impacted community morale and tourism.

But unlike synchronic, snapshot views of socioecological systems, the iterative process revealed the ways that social actors and ecological changes interact to produce the feedbacks and path dependencies that shape trajectories of socioecological change. For example, in Grand County, participants discussed the less obvious social and economic implications of reduced snowpack:

> If you've got more folks but a shorter time to make your dollars, then that's going to have an effect on the community as a whole. And it goes from there to how many sales, what the sales tax is collected in the communities, and what they're able to afford. There is a chain of things that is affected by whether you get snow over a long period. (Agency, Grand County)

Accordingly, MISB illuminated how vulnerabilities and adaptations might unfold in particular places and how key relationships might unravel and reassemble in new, and sometimes unexpected, ways. Related to the example cited above in the methods section, in the Big Hole, ranchers suggested that, if climate change resulted in the extirpation of the arctic grayling, they would continue to engage in riparian and aquatic restoration efforts:

> We have improved our grasslands…we have made the improvements to wildlife, for our cattle. Anytime we can improve and enhance our grasslands, it is helping us out… we are killing two or three birds with one stone here… we are helping the public and tourism…we are all going to benefit. Whether the grayling is here or not, we will benefit. (Rancher, Big Hole)

The multiple iterations also revealed the ways that the three alternative ecological futures differentially affected

the unfolding of the socioecological system, sometimes producing contrasting outcomes for certain sets of relationships. The "hot and dry" scenario, for instance, threatens the viability of most family ranches in the Big Hole. The loss of these ranches, which comprise the majority of private acres in the valley, would impact other local businesses and potentially drive further depopulation. Conversely, in the "seasonal change" scenario, ranchers believed they would be able to sustain their operations. Local business owners, learning of the ranchers' responses in the focus groups, subsequently saw a hopeful future for their communities under this scenario. In Grand County, the combined warmer temperatures and less precipitation in the "hot and dry" scenario posed challenges for all, particularly participants dependent on winter tourism. However, this scenario also presented opportunities for expanding summer recreation, and over the rounds, participants increasingly focused on this as a possible adaptive pathway. Conversely, the heavy winter precipitation of the "seasonal change" scenario and even the promise of some very good snow years in the "increased variability" scenario, instilled confidence in future winter tourism and muted interest in expanding summer tourism. However, many believed the high variability of the latter scenario would significantly undermine the capacity of the tourism economy to continue in its current form, driving countywide economic decline. Consequently, residents called for new industries, such as biomass energy, which would result in major changes to social-ecological relationships in Grand County.

The findings revealed radically different social-ecological futures across the scenarios in both study sites, despite ostensibly similar climate trends. But the iterations within each site consistently unfolded around key tensions and fundamental sources of community anxiety. For Grand County, concerns about water diversions tended to dominate, whereas in the Big Hole, concerns revolved around flood irrigation. Across scales and groups, singular concerns tended to dominate, exerting a disproportionate effect on the direction of the scenarios such that other concerns were, at times, subsumed by these key foci.

Engaging Uncertainty

By engaging participants in a dialogue about plausible yet qualitatively different futures, we explicitly sought to understand how people respond to uncertainty. Participants across both sites recognized multiple types of uncertainty in the scenarios. In Grand County, participants described uncertainty about how human communities will respond to fast-paced environmental change:

> We're watching changes that took millennia…happening in a short amount of time. I don't know how the world will react. I don't know. It's kind of disconcerting to the general person because they don't know what to do. They just don't know what to do. (Agency, Grand County)

Responses also revealed different perceptions of uncertainty and risk in relation to the different futures. For example, many participants saw the "hot and dry" and "seasonal change" scenarios as "more of a predictable pattern." For some, this predictability introduced a clear set of conclusions, while for others it forced them to confront a set of unknown possibilities. Interestingly, across both sites, the "increased variability" scenario was perceived as having a greater degree of uncertainty, making it "hard to plan" from year to year. However, responses to this scenario also illuminated different capacities to make decisions and execute desired actions in the context of uncertainty. This occurred because the variation, for some, described conditions that had partial historical analogues that they were able to draw on in characterizing their responses. Consequently, some participants managed the variation by perceiving it in terms of *risk*. Ranchers in the Big Hole envisioned variability as a sufficiently probable array of risks and responded with a series of coping strategies (such as tighter control of hay storage, shifting herd composition, grass banks, or grazing cooperatives). Similarly, in Grand County, small business owners discussed adopting year-to-year risk management strategies to manage the long-term uncertainty of inter-annual variability. As this small business tourism operator explained:

> I'm not thinking five years down the road. There's just too much that can happen…. This feast or famine scenario is one of them. I think if you're conservative most of the time, with the way that you spend at least early on in the season, making sure that it's gonna work…then you start making some improvements…new water lines, sewer lines, whatever. But if you're not gonna make it, you can hold back the improvement as well. (Small Business, Grand County)

By contrast, agency staff in both sites articulated the challenges that extreme variability presents to building public support, as they are unable to convey the probable effectiveness of a particular management strategy. The differing nature of the decision making context is apparent: small business owners and ranchers have greater control over their actions and the consequences, whereas agency staff are required to undertake public consultation for planning and management.

The process also enabled participants to envisage how different the future could look under multiple and interacting sources of social, climatic, and ecological uncertainty. As a Grand County resident explained, "So many of these things are kind of interconnected so that you think about one effect but then you totally disregard another one and it's right there as well" (Agency, Grand County). In the Big Hole, seemingly mundane economic and institutional uncertainties, such as fluctuating gas prices and continued postal services, influenced participant responses across the three scenarios. In both sites, participants expressed concerns about "a real influx of people" "looking for somewhere else to live," with migrants fleeing changing conditions such as heat waves in other parts of the country, recognizing that climate change impacts in other locations could affect local communities in unpredictable ways. Participants from the Big Hole

consistently highlighted the multiple, interacting sources of uncertainty stemming from price fluctuations in global commodities such as beef that might be influenced by conditions in countries as far away as Brazil. Other participants such as outfitters discussed uncertainty about generational shifts in hunting and fishing interest, and small business owners voiced uncertainty about access to state and local services with declining budgets.

Despite these complex and somewhat overwhelming uncertainties, participants were still able to articulate impacts and imagine responses, though to varying degrees. This, we believe, is because the initial narratives of ecological change translated uncertain climate projections from abstract and politicized science into local, tangible, and therefore meaningful landscape-scale changes, creating a platform for dialogue. As this Grand County resident explains:

> But when it comes down to looking at these different scenarios and asking the question what we should do about them, I don't know that there's a single right answer, but I think part of the underlying theme is having some dialogue among a broader audience about what that long range vision is. (Resident, Grand County)

In this sense, even in the context of uncertainty, MISB enabled participants to engage in a dialogue about plausible implications of different social-ecological interactions. Additionally, the revised scenarios, from the researchers' perspective, introduced a greater degree of uncertainty due to the speculation required to create social and ecological interactions based on the interview data. Paradoxically, focus groups in both sites engaged in deep and meaningful ways with these revisions, possibly because they became more locally relevant as the descriptions became more contextualized through details about local responses and social-ecological interactions. This is critical because when asked to consider possible adaptation strategies in the interviews, many participants in Grand County found the initial uncertainty paralyzing. However, as they moved through the iterative process in the focus groups and the community-scale meeting, they were able to identify possible responses to the scenarios. We suspect that as the revised scenarios become more locally meaningful, the focus group setting allowed participants to build off each others' responses, helping them move beyond overwhelming uncertainties to imagine possible futures. Therefore, as we argue in detail below, the scenarios have utility even without being precise or accurate predictions of future change.

Spatial and Temporal Scale

Building on the complexities of uncertainty, MISB also permitted us to explore problems of spatial and temporal scale. In the Big Hole, ranchers discussed the scalar implications of the de-synchronization of run-off and irrigation start dates caused by early spring warming and low snowpack as predicted in the "hot and dry" and "seasonal change" scenarios (e.g., impacts to downstream users and water rights adjudication). Participants from both sites recognized the role of national media in constructing images that influence broad-scale tourism demands and, in turn, local tourism livelihoods. In Grand County, for instance, residents talked about the negative impacts of media reports about fire danger, whereas in the Big Hole, outfitters worried that premature predictions about drought would dissuade anglers from visiting.

Participants also invoked scale in ways that illuminated how various institutions and processes might create barriers, constraints, and conflicts as well as opportunities and synergies. For instance, in both sites, individual choices could accrete and pose larger problems at bigger scales, fostering a "tyranny of small decisions" (Odum 1982), just as decisions at larger scales can impinge on local adaptation and individual decision making. For example, in the Big Hole larger ranchers, particularly under the "hot and dry" scenario, were attracted to the efficiencies of center-pivot as opposed to flood irrigation. As smaller ranches failed and arctic grayling were extirpated, the political pressures that currently prevent center pivot investments might disappear. Even small-scale shifts to center-pivot irrigation could negatively impact invasive weeds, stream flow, and landscape aesthetics. Individual decisions about irrigation, such as shirking on shutdown calls or irrigating early, could also produce larger, more deleterious outcomes for conservation.

We also uncovered a number of key findings regarding temporal scale. Most evident, we found a distinct difference across the two sites in the capacities of participants to consider the temporal horizons presented in the scenarios. For some participants, twenty years exceeded their ability to imagine and respond to the conditions presented in each narrative, whereas for others it did not. Extending from our previous discussion of uncertainty, it was also clear that this capacity differed depending on the scenario and the variability, trajectory, and frequency of ecological impacts that were described.

For instance, the Big Hole residents were, in large part, more capable and willing to think on a twenty-year time scale compared to residents in Grand County. We attribute this to the relatively deep historical roots of communities and the continuity of family businesses over multiple generations in the Big Hole as opposed to Grand County, which has experienced a large influx of new residents over the past fifty years. More specifically, we found that certain occupations permitted longer-term thinking. In the Big Hole, ranchers already think in terms of scenarios and develop multiple contingency plans over the course of the year given the risks and uncertainties they face in a highly variable environment. In Grand County, small businesses think on shorter time frames given the variable economic conditions and the influence of existing climate variability on tourism. For agency participants, capacity to engage the future was highly dependent on the scenario. The challenges presented by the "increased variability" scenario invoked generic calls for better science. In contrast, the "hot and dry" scenario, though more problematic over the long run, appeared more certain in its trajectory, allowing agency participants to envisage possible responses.

Many participants saw the scenarios as descriptions of past experiences, permitting us to see how people draw on the past to conceptualize the future. Participants used the past to recognize change, make sense of uncertainty, articulate coping strategies based on past adaptations, and to dismiss or justify the climate science in the scenarios. In the Big Hole, for instance, participants recalled periods of drought that matched descriptions in the "hot and dry" scenario, years in which late spring rains saved their hay crop as described in the "seasonal change" scenario, and in Grand County, participants recognized the "increased variability" scenario as an approximation of the last decade. They drew on their ability to cope with past experiences to suggest that the people and ecosystems in the county are "resilient" and "adaptable."

However, experiencing a scenario in a particular year is different from that scenario being the "new normal" every year. Comparing the broader climate conditions in which past hazards occurred to the transformational changes described in the scenarios revealed that past coping was not entirely relevant. Though participants frequently referred to the past in the individual interviews, during the focus groups, participants were looking toward the future and recognizing the limits of past adaptations. In Grand County, participants cited the failure of culverts during a high snowpack, high runoff year to suggest that, if the "seasonal change" scenario were the new normal, the county would need to invest in infrastructure to upgrade roads and culverts. Additionally, this recognition became increasingly evident when looking across the scenarios. For example, though the third scenario was highly variable, many in Big Hole could respond and adapt to the ups and downs; however, the sustained trajectory of the "hot and dry" scenario towards a drier, less productive ranching landscape meant that past coping strategies and risk management practices would no longer be effective.

Discussion

The methodology described above exhibits many of the strengths of anthropological approaches to climate change. These include a focus on a "landscape of change" rather than single hazards, a deep appreciation of social and community dynamics, the role of meaning and identity in place-making, attention to scalar issues of governance and global markets, engagement with a diverse array of participants, and an emphasis on how these forces affect and are affected by perception of risk and uncertainty at a local scale. Applying these strengths to the assessment of future climate change vulnerabilities and adaptive capacities, MISB engendered appreciation among participants, including the researchers, of the dynamic, multi-scaled feedbacks between various drivers of change and the ways in which different climate futures may unfold even within the same landscape. By knitting partial perspectives into each narrative thread, participants could build, horizontally and vertically as well as spatially and temporally, a shared understanding of the situation the scenarios represent. This overall strength is exhibited by reactions to the resulting three narratives in each site. By the final community round focus group, each of the three scenario narratives, in both the Big Hole and in Grand County, described distinct but holistic sets of conditions, each of which clearly implies very different outcomes for individuals and communities. This was most evident in the Big Hole, where the resulting conditions for scenario one described community collapse. In contrast, scenario two appeared hopeful and in some ways provided better conditions than current ones as increased and extended spring precipitation relaxed the need to start irrigation earlier and reduced total irrigation needs, thereby extending flows throughout the summer months. For ranchers, this meant better hay yields, and for outfitters and agency participants this meant reduced stress on fish. The outcomes of scenario three were uncertain, but at a minimum and of most concern to the community, small-scale ranching would survive by employing current risk management strategies and tactics more frequently, such as tighter management of hay reserves and herd size. Working through these sorts of implications, though daunting and at times depressing, also serves as an opportunity to reflect on the links between decisions and their consequences as well as vulnerabilities and adaptive capacities. In this vein, participants also felt the process helped elicit a sense of what was important and worthy of their collective focus in forging an adaptive future for each community as a whole.

More pointedly, and at a smaller but no less important a scale, both groups gained nuanced, and at times surprising, insight into potential future conflicts, synergies, and opportunities. Consequently, in this kind of process both participants and researchers are able to question initial assumptions, find unlikely connections, and potentially locate previously unconsidered vulnerabilities and adaptive capacities (Wyborn et al. 2014). In other words, the process generated the kind of critical emancipatory knowledge and social learning essential for climate change adaptation. For instance, in first-round interviews, several rancher participants from the Big Hole assumed that interest in center-pivot irrigation was absent in the valley. However, other ranchers and participants in the first round argued that interest in center-pivot irrigation, albeit at a limited scale, would grow as land consolidation by larger ranching interests increased. In the second round focus group with ranchers, participants were surprised to hear this response and began to consider the implications of such a shift as well as opportunities to prevent it from occurring given the potential impact on flood irrigation and river health. Fishing outfitters, a key economic cog in the valley economy, found themselves particularly vulnerable to such actions and began considering ways to prevent this development, such as through the watershed council or by reconsidering dams which they currently do not support. Not all surprises were potential conflicts though. In the first round interviews, key agency participants argued that under the first scenario's conditions, grazing allotments would certainly be reduced, but they were resistant to engage the community in any discussion of such actions. Interestingly, when ranchers

heard this in the second round focus groups, they were not surprised and acknowledged that given the grave conditions described, they would begrudgingly expect such reductions to occur. Conversely, agency participants discussed the possibility of collaboration around grass banks as a way to alleviate small-rancher vulnerability.

In exploring participant reactions to the scenarios, it is important to recognize that the scenario narratives themselves are not the "result" or end goal of the process. Rather, they serve best as a heuristic to support dialogue while generating new knowledge about possible future vulnerabilities and adaptation in an interactive, participatory, and emergent way. As such, MISB allowed participants to articulate these issues in their own language without being guided by a preconceived framing around predefined targets or impacts. This approach enabled participants to learn about others' responses and the potential feedbacks, synergies, and conflicts between responses thereby supporting the type of reflexive and relational dialogue foundational to the social learning required to meet the challenges of an uncertain future (Pelling 2010; Tschakert and Dietrich 2010). And it is in this vein that we feel MISB could also be integrated into planning and decision making in ways that foster and deepen mutual understanding in a decision context and help identify points of shared concern. For instance, agency representatives frequently expressed concern about finding sufficient public support for adaptation and future planning efforts given the high degree of uncertainty involved and, as a result, often simply called for better science rather than action in response to the scenario conditions. They felt that the inevitably incomplete and uncertain knowledge of future manifestations of climate change in combination with competing values and potential for controversy posed considerable barriers to community engagement and ultimately action. This "risk-and-uncertainty" averse attitude shortens decision frames and potentially delays action, both of which can have serious consequences given the potential for climate change to force social-ecological systems to cross transformational thresholds and tipping points.

A key example of this from the Big Hole concerns watershed management and endangered species conservation. For nearly a decade, United States federal and Montana state agencies have been working with landowners in the Big Hole Valley and with the Big Hole Watershed Council to ensure the conservation of arctic grayling, much of which depends on river health. Through Candidate Conservation Agreements with Assurances (CCAA) coordinated by the United States Fish and Wildlife Service, agencies worked with landowners to ensure flood irrigation practices reduced grayling mortality and improved habitat conditions. However, these hard-won collaborations do not take into account the impact of other pressures such as climate change on relevant ecological indicators and ultimately on the possibility of listing grayling as an endangered species. Given that the scenario process does not just permit but actually fosters this kind of thinking, agency participants were reluctant to discuss such issues, finding the openness and possibility for surprise to be a potential threat to their collaborations. Yet, in first and second interviews with ranchers and other landowners, we found that participants in the CCAA and other programs would seek to continue collaboration beyond the possibility of listing because of the beneficial impact of these programs to habitat overall and the possibility that such measures would synergistically assist their own adaptations to reduced water availability. Agency participants, fearing backlash and reluctant to engage communities in these sorts of questions, were shocked to find that such consensus and opportunity already existed. These findings illustrate that such knowledge and social learning can open up and clear the way for previously unconsidered, yet critical adaptive pathways (see also Wyborn et al 2014).

In each study site, participants found synergies across both scale and landscape because MISB permitted emergence, surprise, and a willingness to engage uncertainty, much of which is enabled by the way the research iterates from individual to community. This we feel is evidence that such methodological tools can move past constraints and barriers that limit planning horizons and community engagement to achieve consensus and legitimacy without scientific certainty. We find this particularly crucial for agencies such as the United States Forest Service that have a mission to ensure multiple use and in concert with more recent multi-agency efforts towards "all lands" approaches to resource management. Though we recognize that a decision or planning focus shifts or attenuates some of the benefits and strengths by "re-fetishizing" the scenarios as an object of contestation, the ability to engage diverse participants in structured forms of social learning at different scales across a landscape could be extremely valuable to decision making processes by facilitating the potential for increased mutual understanding. Such efforts have the potential to not only craft better outcomes but also enhance the credibility and legitimacy of resulting decisions and actions.

Lastly, but no less importantly, MISB also addressed concerns that climate change communication is vague and distant (Shome and Marx 2009). When climate change is depicted as an abstract, global-scale temperature increase, people struggle to envision the implications of such change on their livelihoods and local landscapes. The scenarios provided detailed, localized descriptions of change, creating a platform for even self-identified skeptics to discuss vulnerabilities and potential adaptations. This is no small feat in the American West, where climate change denial and skepticism are the norm. Inviting participants to respond to recognizable and tangibly relevant narratives of local change legitimized their knowledge and experiences, providing space for them to move beyond dominant discourses about climate change and attach their own meanings and values to the construction of the future. Ultimately, the degree of creativity exhibited by participants in both the Big Hole Valley and Grand County convinced us that attempting to reduce uncertainty may not only be illusory but also be counterproductive. Consequently, rather than fixating on the challenge of identifying probabilities, we suggest that a more fruitful approach to facilitate adaptation

is to acknowledge and embrace uncertainty, recognize the mutability of the future, and focus on dialogue, process, and learning rather than scenario accuracy. Anthropologists are well suited to address these challenges.

Conclusion

The iterative scenario process described in this article demonstrates the power of narrative-based methodologies. This approach deepens our understanding of interacting social and ecological vulnerabilities, uncertainties, and capacities in the context of climate change while also providing a platform for the type of collaborative reflection necessary to enable social learning. Of particular concern to anthropologists, it does so in ways that illuminate the place of culture in the complexities of social-ecological change. This is critical because as Adger et al. (2012:116) point out, "If the cultural dimensions of climate change are ignored, it is likely that both adaptation and mitigation responses will fail to be effective because they simply do not connect with what matters to individual and communities." Additionally, the "use-inspired focus" of adaptation research has resulted in the neglect of theoretical considerations, which Swart (2014) argues undermines the quality of policy recommendations and practice. In support of this, we argue that MISB is effective not in spite of theoretical concerns, but because it is partly driven by them. Theoretical abstraction within contemporary social science is sometimes seen as a distraction by many in interdisciplinary applied research settings; yet, here we have tried to demonstrate how it can become an effective strength without impeding the exigencies of practical concerns. In short, narrative-based methodologies like MISB are key tools for working across diverse sets of voices and in the face of uncertainty they can produce the kind of critical emancipatory knowledge needed to foster continued action in a "plural world" (Castree et al. 2014).

Notes

[1]In order to ensure some consistency and transparency for the reader's sake but without getting mired in definitional debates, we define adaptation very loosely as some change affected to address fit between sets of social and ecological relationships and adaptive capacity as the agency to affect such change. Adaptive pathways are the possibilities of adaptation, as they might occur in and through actual space-time. When pathways become manifest, they are subject to adaptive dynamics which include the interacting agents, structures, and historical processes through which "real" adaptation unfolds.

[2]See also Oliver-Smith (2013) for a similar argument regarding disaster risk reduction in the context of climate change adaptation.

[3]See also Strauss (2012) for anthropological efforts to engage culture in interdisciplinary ways.

[4]We define critical emancipatory knowledge as knowledge derived from self-reflection through critical inquiry, similar to Pelling et al.'s (2008) conception of "reflexive adaptation." In this sense, scenario processes allow participants to reflect on the implications of their own being and acting in the world, including its fundamental, often unquestioned assumptions and its consequences.

[5]Climate scientists are still uncertain how shifting precipitation will interact with upward, but uneven, shifts in temperatures at the local scale (and ultimately how local ecosystems will change under these conditions) (IPCC 2013).

[6]Due to the high elevation of Grand County, the localized climate descriptions were the same for both sites. The ecological impacts of those changes, however, were different for each landscape.

[7]Employee representation from federal agencies included the United States Forest Service, United States Fish and Wildlife, National Park Service, state wildlife and resource management agencies in Montana and Colorado, and non-government land managers such as The Nature Conservancy.

[8]Because of the time constraints of ranching and the distances agency participants often had to travel, participant attrition posed a minor problem, particularly in the Big Hole. However, in the second and third round, additional participants were invited to join continuing participants and were briefed on the previous rounds. Given the overall continuity of the sample, on the whole, this attrition did not seem to affect research outcomes.

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