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Review article

Climate change adaptation in the world's best places: A wicked problem in need of immediate attention

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HIGHLIGHTS

- Climate change adaptation at natural World Heritage (WH) sites is a wicked problem.
- I review the refereed literature relevant to adaptation at natural WH sites.
- Clumsy solutions are broadly embracing, allowing conflict and incorporating widely disparate alternatives.
- Clumsy solutions are the future of effective adaptation at natural WH sites.

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ABSTRACT

Natural World Heritage (WH) sites are globally recognized as having universal value, providing society with critical ecosystem services like biodiversity, clean water, and recreational opportunity. Every natural WH site is at risk from climate change, but the scope and nature of that risk varies widely. Climate change adaptation is a wicked problem; that is, there are no clear-cut solutions and stakeholders at each site disagree on values, norms and first steps, making adaptation difficult. Yet, delaying action poses more risks than taking action under uncertainty. I synthesize the refereed literature relevant to climate adaptation for natural WH sites. I argue that adaptation should be ecosystem based. It should begin by understanding linkages among site attributes and the surrounding landscape, and asking how off-site and on-site practices might reduce risk of negative effects of climate change on those attributes. Adaptation responses are tiered. Fine-scale, on-site responses are less expensive and easier but will have less impact than coarse-scale responses involving the surrounding community. We cannot precisely predict future conditions so we must act adaptively, designing responses, acting, evaluating results, re-designing and trying again. Action is constrained by institutional mandates focused on preserving existing conditions rather than recognizing a dynamic future. Climate change adaptation at natural WH sites should be Adaptive, Participatory and Transformative, deployed through clumsy solutions. Such solutions will require strong leadership and excellent communication, drawing together widely disparate views and iterative practices focusing on resilience. That requirement establishes the need for capacity development for climate change adaptation.

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1. Climate change at natural World Heritage sites

World Heritage (WH) represents society's highest conservation designation (Rao, 2010; UNESCO, 2008b). A natural WH site has 'universal' value (Tucker & Carnegie, 2014) and is to be conserved for all humankind, in perpetuity. "Heritage is our legacy from the past, what we live with today, and what we pass on to future generations" (UNESCO, 2008b). Yet, that heritage is at risk. Ecosystems evolved over millennia to their present condition. The rate of change today is unprecedented in human history. 21st Century ecosystems and their component species are faced simultaneously with fragmented landscapes and climate change, not allowing species to adapt to new conditions (Hoegh-Guldberg, 2012; Stein et al., 2013). Climate change-induced losses to biodiversity will exceed those of habitat destruction (Pounds & Puschendorf, 2004) or invasive species, and climate change exacerbates other stresses (e.g., pollution, habitat loss and fragmentation) that society already places on ecosystems (Anonymous, 2008). The legacy we pass to future generations is changing rapidly.

An ecosystem exists in a geophysical landscape. Climate dictates the species and communities that occupy that space (De'ath, Fabricius, Sweatman, & Puotinen, 2012). As climatic conditions evolve, so too does the complex of species on the site (Lawler et al., 2009), and the range of goods and services human society can expect from that landscape (Higgins, Bryer, Khoury, & Fitzhugh, 2005). WH sites are designated as globally significant because they have specific attributes that are a function of the interaction among biophysical and climatic conditions (Perry, 2011). Yet, fundamental changes in those conditions are inevitable as climates evolve (Baron et al., 2009). Our goals for biodiversity and other site values must be dynamic as changes occur (Groves et al., 2012). Although site boundaries may be static, new species distributions will require a dynamic view of site qualities (Bagchi et al., 2013). WH sites are managed to protect an "Outstanding Universal Value", one or more attributes intended to persist through time (UNESCO, 2008b). That is a relatively static definition. New climates and species configurations are causing changes that require dynamic definitions if societal goals are to be met (Pettersson & Keskitalo, 2013).

Climate change adaptation involves developing and implementing policies and practices to reduce negative impacts of, or adapt to new conditions posed by an altered climate (IPCC, 2007). Adaptive capacity is the aspect of vulnerability most amenable to influence (Marshall, Tobin, Marshall, Gooch, & Hobday, 2013). Adapting now is much more effective than adapting after changes have occurred (Lemieux & Scott, 2011), and is most successful when stakeholders feel a place-based affinity (Schweizer, Davis, & Thompson, 2013). As such, climate change adaptation at a natural WH site can draw together interested parties and mobilize action. However, the increased visibility of a WH site may make managers hesitant to try innovative approaches (Terrill, 2008).

Several recent authors have described global and regional climate changes and expected impacts to biodiversity (e.g., Hannah et al., 2013; Lawler et al., 2009). Those broad-scale analyses serve to contextualize what might be expected in a region or a local site, and can lead to the conceptual frameworks and case studies essential for society to act on "... the sea of adaptation ideas" (Heller & Zavaleta, 2009). However, new species configurations will be site-specific, and will require site-specific adaptation strategies.

The climate change adaptation literature is growing at a rate of several hundred papers per year. In spite of the growth of scholarship, society remains ill-equipped to understand and adapt to climate change impacts. Political institutions function within the constraints of short- term pressures. Laws and policies are designed explicitly such that they do not constrain future decisions. Yet, climate change adaptation specifically requires policies that constrain the present to benefit the future (Lazarus, 2009). Adaptation also is limited by professional capacity. Lemieux, Beechey, and Gray (2011) interviewed protected area managers in Canada, which has a strong conservation momentum and where resources are relatively available. Nearly all (94%) felt that climate change impacts would substantially alter policy and planning within 25 years. Yet, a similar percentage (91%) felt that they did not have resources to adequately respond to those changes. Resource constraints included financial capacity, understanding of anticipated impact, skill, and awareness of specific adaptation practices Managers view most climate change adaptation literature as too generic and/or infeasible for actual implementation (Scott & Lemieux, 2005; Welch, 2005).

There are 211 natural and mixed WH sites. Climate change will affect each of those sites, some more rapidly and more extensively than others. In this review, I synthesize the literature most relevant to climate change adaptation at those WH sites, intending to empower future management. There are many guidance manuals and agency reports intended to guide climate change adaptation, including a recent UNESCO document intended specifically to offer guidance to WH site mangers (Perry & Falzon, 2014). My primary focus here is on the refereed literature that guides and supports those applied documents. I suggest that the problem is wicked (Rittel & Weber, 1973) and that Ecosystem based Adaptation (EbA) (Mercer, Kelman, Alfthan, & Kurvits, 2012; Naumann et al., n.d.) implemented through clumsy solutions (Khan & Neis, 2010) provides the most appropriate conceptual framework for natural WH site climate change planning.

2. This is a wicked problem

"Some problems are so complex that you have to be highly intelligent and well informed just to be undecided about them" (Peter, 1982). Social system problems that are ill-formulated, based on conflicting information, faced with stakeholder groups which disagree on norms and values and goals are widely known as "wicked" (Xiang, 2013). Wicked problems have several common characteristics (Conklin, 2005; Hoppe, Wesseliink, & Cairns, 2013; Rittel & Webber, 1973; Sharman & Mlambo, 2012). Some of those include (a) values of the stakeholders involved conflict among groups and through time, (b) the problem and its solutions are not determinate, (c) wicked problems can be suppressed or managed, but not solved (Xiang, 2013). Wicked problems are