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Baselines of acceptability and generational change on the Mactaquac hydroelectric dam headpond (New Brunswick, Canada)

Kristina Keilty[a], Thomas M. Beckley[b], Kate Sherren[a,*]

[a] School for Resource and Environmental Studies, Suite 5010, 6100 University Avenue, Dalhousie University, Halifax, NS B3H 4R2, Canada
[b] Faculty of Forestry and Environmental Management, 2 Bailey Drive, University of New Brunswick, Fredericton, NB E3B 5A3, Canada

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ABSTRACT

Hydroelectricity is an old yet reliable form of renewable energy, with acknowledged social and ecological impacts. A tension currently exists between such concerns and energy needs, with dam construction and removal ongoing around the world. It is critical to better understand the implications of both on local citizens. We performed map elicitation interviews with 20 locals around the prematurely-aging Mactaquac Dam and headpond, in New Brunswick, Canada, to understand if and how they came to accept the dam landscape, and what they want for its future. A Baselines of Acceptability conceptual framework was developed to guide the interpretation. Respondents demonstrated attachment to the dam-in-place landscape, even those initially disadvantaged by its construction, and a preference for keeping the headpond intact. Despite this demonstrated adaptability, the paper calls for improved transparency, scope and justice in energy landscape decision-making, as well as further testing of the framework with different demographics, infrastructure case studies and over time.

1. Introduction

People can grow attached to their home landscapes regardless of the aesthetic, ecological, or cultural value of those landscapes to a non-resident observer. A landscape is after all more than a physical location in the environment; it is a culturally significant place, with historical, spiritual, personal and community meaning (Antrop, 2005, 2006; Glover et al., 2008). Sense of place (Jorgensen and Stedman, 2006; Stedman, 2003; Tuan, 1974) is often used to describe the person-place relationship, incorporating the ideas of place attachment and place meaning (Brehm et al., 2013). Thus, attachment and emotional connection to place means that potential changes are often seen as a threat to one's meaning of place (Greider and Garkovich, 1994; Stedman, 2003).

Infrastructure associated with tackling climate change presents substantial challenges to the place meanings of host communities (Adger et al., 2013). Climate mitigation focusses on carbon, while adaptation focusses on water (Ramsar Convention on Wetlands, 2010), and the infrastructure to manage both can change landscapes. Urgent calls for transitions in carbon (thus energy) and water management, and commensurate policies and targets, are forcing a deeper look at the drivers of community acceptance of such infrastructure (Batel et al., 2013; Cohen et al., 2014; Stigka et al., 2014). Similarly, the justice implications of the resulting actions (e.g. land expropriations) have not been as well conceptualized in climate mitigation or adaptation as in those displaced by climate change impacts (Displacement Solutions, 2013; Sovacool et al., 2016). Hydroelectric dams are addressed here in the context of renewable energy, although they have considerable overlaps with the use of water impoundments for the purposes of agricultural irrigation, flood control, and drinking water in areas becoming more arid or unpredictable (despite frequent criticism of dams for exacerbating water scarcity as a result of increased evaporation (e.g. Sauri and del Moral, 2001)).

Community acceptance of renewable energy infrastructure is not a new challenge in resource decision-making. Citizens often support the idea of renewable energy in general, but specific acceptance is always conditional upon a project suiting the specific landscape and its community (Aitken, 2010). Opposition to local infrastructure siting and implementation decisions is thus commonly framed in aesthetic, health and landscape terms (Fernandez-Jimenez et al., 2015; Wolsink, 2007; Wüstenhagen et al., 2007). Yet hydroelectricity is clearly a special case among renewable energy options.

First, hydroelectric dams are unusual among non-carbon emitting renewable energy options for their scale. Compared with non-renewable energy infrastructure such as nuclear or coal plants, most renewable energy generation infrastructure is smaller scale and uses technology with a lower net energy gain. This can

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* Corresponding author.
E-mail addresses: kkeilty@dal.ca (K. Keilty), Beckley@unb.ca (T.M. Beckley), kate.sherren@dal.ca (K. Sherren).

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result in a larger number of required physical infrastructure "units" (e.g. wind turbines, solar panels) needed to produce sufficient energy, affecting more people and more landscapes (Firestone et al., 2015; Nadaï and van der Horst, 2010; Wolsink, 2012). While many dams are small, they can also sometimes operate on a scale similar to centralized fossil fuel and nuclear plants (i.e. mega dams), with a large single piece of infrastructure (i.e. dam and associated spillways and powerhouses), though the footprint typically extends to large reservoirs or 'headponds' as well as downstream effects from changed hydrologic conditions (e.g. sediment load) and engineered flow regimes.

Second, hydroelectric dams are also unusual among renewable energy options for the nature of their landscape impacts. Renewable energy production uses above-ground, dispersed and generally non-transportable natural resources (e.g. sun, wind, flowing water), so generation occurs at the site of the resource. Such sites mean renewable energy infrastructure is generally more visually apparent (e.g. line of sight for sun, prominent ridges for wind, or populated valleys for natural running water) (Fernandez-Jimenez et al., 2015; Wüstenhagen et al., 2007). Such distributed visual impact is why renewable energy is often studied for its impact on connections to place and how it inspires place protective behaviour (Bell et al., 2013; Devine-Wright, 2009, 2011; Selman, 2010; van der Horst and Vermeylen, 2012; Warren, 2014). Vorkinn and Riese (2001) did groundbreaking work on how place attachment to the impacted areas drove negative attitudes towards a hydroelectricity proposal in Norway. Yet dams are arguably the only renewable energy option whose drastic landscape implications: (a) can (far enough upstream) be mentally dissociated from the cause; and, (b) appreciated for the new amenity value, at least over the longer term, despite initial fear of threats they represent to river landscapes (Davenport and Anderson, 2005).

Third, hydroelectricity is unusual among renewable energy technologies for its maturity and its stage of adoption. The oldest renewable technology for electricity generation is hydropower. Hydropower dam construction grew in popularity in the 20th century, peaking in the 1970s when it was estimated that 2–3 large dams were commissioned every day worldwide (The World Commission on Dams, 2000). Kingdon (2001) would have considered many such constructions a solution in search of a problem: justifications have included electricity, economic modernization, flood control, irrigation and general 'nation-building'. In general, dam building represents a pathological 'command and control' approach to nature and its resources (Holling and Meffe, 1996). Dam construction projects have been seen to have devastating environmental (Namy, 2007; The World Commission on Dams, 2000), ecological (Sauri and del Moral, 2001; Mims and Olden, 2013; Namy, 2007; Zarfl et al., 2015), and societal consequences (Nüsser, 2003; The World Commission on Dams, 2000; Vorkinn and Riese, 2001). Dams are believed to be responsible for diverting 60% of the world's rivers and displacing 40–80 million people (The World Commission on Dams, 2000), yet may simply be techno-fixes (*sensu*. Fazey et al., 2010) that reduce system resilience. Due to these consequences, as well as aging infrastructure and industrial changes, the social movement around dam decommissioning and removal is gaining legitimacy (Box 1). Despite a decline in the past two decades in hydroelectric energy and increasing numbers of dams being removed in North America (The World Commission on Dams, 2000), a decade ago worldwide impoundments were estimated to cover 260,000 km^2 (Downing et al., 2006), approximately the land mass of New Zealand. Hydropower dams are still being planned and built around the world for reasons as diverse as rural electrification, drought management and climate mitigation (Ansar et al., 2014; Zarfl et al., 2015). Large dams seem particularly characteristic of the approaches (control, symbolism) of centralized and/or autocratic regimes (e.g. Sauri and del Moral, 2001).

Box 1 A brief history of dam removal.

There is a substantial movement in North America in support of dam removal for reasons of ecological, economic, and safety concerns (Babbitt, 2002; Born et al., 1998; Pohl, 2002; Prowse et al., 2013). To date, in the United States, it is estimated that approximately 1000 small dams (<30 MW of power, <6 m in height) have been removed and only a few medium or large dams (>30 MW of power, >15 m in height) have been removed (American Rivers, 2014), such as the Elwha and Glines Canyon Dams on the Elwha river in Washington (Witze, 2015) and the Condit Dam on the White Salmon River in Washington (Pohl, 2002). Canada has similarly seen small dam removal (such as the barrage removal at Petitcodiac in New Brunswick (The Atlantic Salmon Conservation Foundation, 2013)) but large dam removal has not yet taken place. The USGS maintains a Dam Removal Science Database that thus far covers studies monitoring the biotic and abiotic implications of 130 dam removals worldwide (USGS, 2015). Despite the positive intentions associated with dam removal (e.g. free flowing rivers, increase of fish quantity and quality, natural ecosystem restoration, etc.) there are negative social consequences that need to be acknowledged (e.g. Fox et al., 2016).

We do not set out to resolve the many arguments for and against hydroelectric dams, large or small, but to begin to understand how local communities view dam construction and the prospect of dam removal. For reasons explained above we cannot rely entirely on insights from other renewable or conventional technologies. We use the prematurely aging, 653 MW Mactaquac dam and its associated 96 km-long headpond in New Brunswick, Canada, as a case study of dam construction and potential removal. Most large-scale hydro projects are intended to last many human generations. The case study area presents a unique setting where the lifespan of the original dam will be well within the lifespan of some local residents (Sherren et al., 2016a). Specifically, we seek to answer three questions:

1. How do communities near the Mactaquac dam perceive their landscape over time?
2. How do community members perceive the subsequent prospect of the removal of the Mactaquac dam?
3. What do (1) and (2) mean for the establishment and malleability of landscape baselines in the Mactaquac region?

We developed a conceptual 'baselines of acceptability' framework with which to structure our search for the source and flexibility of landscape expectations emerging from interviews with 20 current Mactaquac locals across a range of ages and experience with the landscape. We draw out the implications of our resulting understanding for the future of the Mactaquac dam (to be decided in late 2016), and cautiously step beyond the case to present potential implications for dam construction and removal decisions generally, and similar landscape changes associated with renewable energy transitions or climate adaptation.

2. Conceptual framework

Our Baselines of Acceptability framework (Fig. 1) organizes various theories of how landscape acceptability is established and how it might change. The framework is based on two axes, based on scale (individual to social/species-level sources) and