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## From climax thinking toward a non-equilibrium approach to public good landscape change

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### Abstract

Many of us, when facing landscape change such as energy infrastructure development, often demonstrate a belief that we inhabit a 'climax' landscape. In successional terms, a climax landscape is defined here as one that is perceived by those who live in and use it to have reached a stable and ideal state after various stages of socio-cultural progress, from 'pioneers' on up, as humans met their needs through landscape modification. This chapter defines a new concept, climax thinking, that is making it difficult to adapt landscapes to new needs: e.g. renewable energy, climate adaptation, urban densification. Understanding and easing climax thinking could smooth the way for numerous sustainability transitions. While we often believe we will not be able to adapt to change in our landscapes, the opposite has been repeatedly demonstrated. Not only do our expectations and norms slowly change as generations replace one another, but landscape expectations and preferences can evolve even within the generation that has witnessed quick and dramatic change. Ecologists have debunked the idea of equilibrium in natural systems, and a similar development is needed in public perceptions of lived landscapes. This chapter describes climax thinking as a powerful illusion. It describes the pathology of climax thinking, and the need for a non-equilibrium model for managing public good change in lived landscapes, mapping to related theories and ideas in other fields. Finally, it proposes a cross-disciplinary research and action agenda to help avoid casting landscape futures around old needs and old solutions while maintaining sense of place, identity and cultural heritage.

### Key take-aways

- Landscapes must change in line with new societal needs, but such change is politically difficult.
- Climax thinking is fallacious thinking, but near ubiquitous in Western settings.
- Climax thinking is the privileged mobilization of ignorance and hubris across time and space.
- Forcing landscape stasis despite changing conditions and needs pushes impacts to those less able to resist.
- Leverage points to reduce climax thinking may include improving awareness of past landscape changes and landscape changes elsewhere that our decisions may cause.
- As in succession theory, climax thinking should be challenged by a non-equilibrium approach to thinking about landscapes that acknowledges a range of viable futures exist beyond the status quo

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## Introduction

This book is dedicated to exploring the opportunities to coordinate across scales, sources, and social science subfields toward better understanding of energy impacts. One such barrier to coordination has been theory to understand public resistance to landscape change. Current global challenges necessitate wide-spread transitions that will have significant impacts for landscape appearance, function and meaning and are thus subject to local opposition. Public good landscape changes discussed here include those required for sustainability transitions: renewable energy but also urban densification and climate adaptation. Explanations for this opposition has thus far been fragmented, but may have common roots.

In recent years it has become common to apply ecological concepts to society (e.g. adaptation, resilience). Many of these instances develop into rich interdisciplinary fields of study and application. The application of ecological concepts to society is often initiated by ecologists recognizing familiar patterns. It is less common for a social scientist to reach into ecology, especially given the range of social theories that capture specific phenomena as well or better. For instance, resilience has had a strong uptake among social scientists engaged in team social-ecological research led by ecologists, as well as by policy-makers, but has been critiqued for its lack of attention to social dimensions and human subjectivity (Cretney, 2014; Davidson, 2010; Olsson, Jerneck, Thoren, Persson, & O'Byrne, 2015; Stedman, 2016). I thus use ecological analogies here cautiously. Scholars have also applied succession to other aspects of human communities, similarly not without controversy (Rudel, 2009). Yet I will build on succession concepts to 1) describe a new concept of climax thinking in relation to a range of parallel literatures and theories, 2) deconstruct its pathology and implications for managing landscape change in lived landscapes; and, 3) suggest an action and research agenda to ease the process of transformation.

## What is climax thinking?

We are all, from time to time, climax thinkers. That is, we seem to believe that the landscape we currently have is the one that is the *intended* end point for our given context. This recalls Frederick Clements' concept of succession, developed in rangelands (Sayre, 2017), where a climax plant community was defined as a stable one that dominates in a given site and set of conditions after a series of predictable and progressive stages. In Clements' thinking this equilibrium state is inevitable, almost fated, and will be reliably returned to after disturbance such as grazing if that grazing is properly done. Indeed, that return was an indication of the plant community's vitality. We often perceive our lived landscapes similarly as progressing from 'pioneers' on up to what is seen locally as a mature or 'climax' state. In ecology, equilibrium theories such as succession have been surpassed by non-equilibrium concepts such as panarchy and resilience, and multiple potential stable states for given social ecological systems (Elmqvist et al., 2003). This sequence of climax to non-equilibrium theories is an important one for us to follow in the context of landscape change as well. This chapter suggests that in lived landscapes, climax is only an illusion. Though ecologists have stepped away from climax thinking, it seems that social thinking is often stuck with notions of climax (steady state landscapes of place and attachment) that are unhelpful in the face of new challenges. Here I describe the phenomenon of climax thinking and its implications more thoroughly, focussing not on the ways that climax thinking may arrest negative landscape change (Hager & Haddad, 2015), but on how such thinking can be a barrier to the landscape transformations we need to meet new societal and planetary needs, such as de-carbonization

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or climate adaptation. I recognize how much nuance such a focus excludes—not all change is good, and not all stasis is bad—but such decisions are sometimes critical for generating useful theory (Healy, 2017).

First, however, it is important to note that it is harder than it might seem to identify what is a public good landscape change. In a context of climate change, landscape changes for decarbonization and climate regulation create public benefits that by economic classification are non-excludable and non-rival. Such public goods are under-provided in part because they also impose at least short-term negative externalities on people living nearby (Stokes, 2016), driving opposition to such proposals that increases the cost and reduces the likelihood of transition. In general it should be a good thing to have “interest ... coincident with duty” (Brennan, 1996, p. 256, citing James Madison c. 1788), but it complicates such proposals that they do not *exclusively* represent public goods, but also economic benefits to developers and town councils, both variously trusted (Hess, 2018; Parkins et al., 2017). Those with the power to judge that something is in the public good may not reflect the demographics (class, race) of those affected by the decision (Pasternak, 2010; Reed & George, 2011). There is very real peril in this situation, though I largely set it aside in what follows. Exemplars of integrated landscape planning and transitions are needed that include close attention to power and justice (Newell & Mulvaney, 2013; Stenseke, 2016).

The idea of climax thinking has repeatedly emerged from my recent social science case study work, as well as more informal readings of local events, bringing explanatory value to observed public responses to proposed landscape change. Residents around a failing hydroelectric dam recently protested its removal, as they protested its construction less than 50 years earlier (Sherren, Beckley, et al., 2016). Many locals disagreed with the dyke realignment and wetland restoration necessary to protect coasts from climate-related risks, although most of the agricultural land the dykes protect is no longer actively farmed (Sherren, Loik, & Debner, 2016). It is manifest in resistance to landscape change of all kinds, but particularly explored here in relation to public good landscape change, whether a landscape addition, replacement or removal (Magilligan, Sneddon, & Fox, 2017). It is also manifest in debates over reconstruction after ‘natural disasters’ like hurricanes, where to rebuild as it was (rather than in preparation for what will be) is seen as most heroic (Birch & Wachter, 2006). Sometimes climax thinking seems to emerge as result of ‘sunk costs’, where past effort or investment by our selves or ancestors to build (farm, log) the current landscape makes the possibility of changing that landscape feel like an invalidation. This kind of emotional ‘lock-in’ becomes a sort of social infrastructure that rejects change to retain identity and honour past generations (Sherren, Beckley, Greenland-Smith, & Comeau, 2017).

Climax thinking is easiest to visualize at an individual scale, with that individual in a bubble: while we stand on a layered landscape, we may be only dimly aware of this history (Figure 1). This drives our ignorance, inability or lack of willingness to perceive the current landscape as only one in an ongoing sequence. Instead we see it as the culmination of a sequence, its persistence privileged. We may assume current solutions will meet future needs, when in fact aggregate resistance to change will inevitably cause degradation of fit for all. Climax thinking is a luxury, afforded the socially, politically or economically powerful who can maintain their own climax landscape at the expense of others. Such resistance to accepting change in lived landscape to meet new public needs pushes the provision of those needs and the implications of that provision onto to those more spatially or socially distant. In

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disaster contexts it also often pushes the cost of landscape stasis (or restoration/rebuilding) onto governments, who are forced for political ends to prolong current uses.

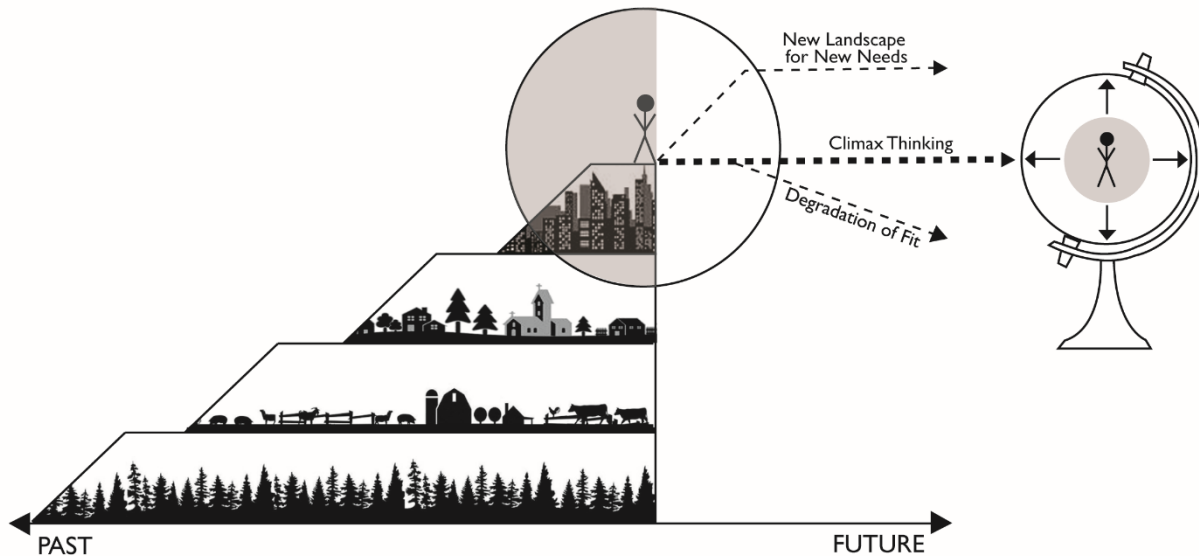


Figure 1 Climax thinking, illustrated

Climax thinking is a significant problem given the scope of land use change that is required to meet current climate challenges: climate adaptation and decarbonisation of the economy, our lifestyles and energy sector. New landscapes need to be written into this crowded space, such as renewable energies, new urban forms, restoring ecosystem services and finding space for sea level rise. This is sometimes described as landscape transformation, a step-change rather than incremental change (Pelling, O'Brien, & Matyas, 2015). Instead, climax thinkers pick a winner, a particular time period and 'strategy' (Shepherd, 1997), in which to arrest the lived landscape and its meaning. This subjects new land uses to former needs, much as those who seek to maintain landscapes in specific conditions, such as the sheep-managed Cotswolds, rather than re-wilding abandoned agricultural land (Monbiot, 2014). Silvia Crowe summarized it best sixty years ago in *Landscape of Power* (1958, p. 38):

*The superficial approach to a landscape, seeing only its appearance at the moment, without realizing its past, its essential character or its potential future, can have a stultifying effect at the time we need a broad-minded vision. The humanized landscape is a constantly changing pattern, and cannot be arrested at one point in history.*

In conservation settings the idea of historical fidelity is being discarded (Higgs et al., 2014), perhaps because it is increasingly clear that future conditions are unlikely to easily support past ecosystems, , although the public still prefers for instance to support native species conservation than immigrant species following shifting climate bands (Lundhede et al., 2014).

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## Lived landscapes are layered landscapes

There are few if any places on earth where the hand of humans cannot be seen, but we do not have good descriptors for such places. It is now widely acknowledged that we live in the Anthropocene, the geological time period in which human forces have dominated natural processes, but that term refers to time rather than landscape (Robin & Steffen, 2007). The term ‘landscape’ itself is widely acknowledged to encompass the combined outcome of both cultural and natural forces, but these are more commonly referred to as ‘cultural’ landscapes (Council of Europe (CoE), 2000). I introduce here the term ‘lived landscape’ to encompass the range of places where we live, work and extract natural resources. Most lived landscapes are mundane, yet are no less the combined effort of humans and nature: farms, mill towns, suburbs, hydroelectricity reservoirs, working forests (through fire suppression and plantation forestry). Lived landscapes may well be the most mature available representations of a given culture as it is currently practiced, but they often do not meet established definitions of cultural landscapes (Box 1). It frankly doesn’t seem that they’re ‘making’ any more cultural landscapes as defined by some, but lived landscapes are ubiquitous as we meet our needs for food and fuel, shelter and community, beauty and inspiration. While the idea of lived landscapes emerges from the ‘working’ landscapes of resource management (Abrams & Bliss, 2013), it includes sites of resource consumption as well as production.

Box 1 about here

Lived landscapes represent a significant planning challenge (Plieninger et al., 2015). This is in part because of the subjectivity in how they are experienced and interpreted by individuals, which may not be directly connected to the physical meanings or affordances of the place or typical demographic characteristics (Stedman, 2016). Individuals in the same physical place may effectively ‘read’ a different landscape ‘text’, depending on any number of personal variables and experiences. Within this diversity, however, there may be clusters, some of which may become dominant, normalized, depending on the power dynamics within the place (Cresswell, 1996; Stokowski, 2002).

Decades of scholarship has described landscape as palimpsest (Drenthen, 2015): a reused surface upon which a story of current livelihoods is legible, at the same time as evidence of past ones remains visible. Landscapes have many constituencies and thus many ways of being read and thus meaningful (Widgren, 2004). D.W. Meinig’s famous essay, *The Beholding Eye*, enumerated ten ways to read landscape: as nature, habitat, artifact, system, problem, wealth, ideology, history, place, and aesthetic (Meinig, 1979). Cosgrove and Daniels (1988) made a smaller list: landscape as scenery/spectacle, institution/rules, and resource. Architect Paul Shephard (1997) would counter these with legible landscape ‘strategies’—e.g. reason, defense, economic exploitation, restoration—that play out at large scales. Shephard also reminds us that a lack of coherent landscape strategy does not arrest landscape change, it just makes it more emergent, fragmented and potentially maladaptive: “Incremental changes happen all the time, [and] ... accrue to big changes in what there is in the world, and whatever you are up to, you will be involved in these already. ... be aware of the strategy that governs what you do.” (Shephard, 1997, p. 233).

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Box 1: Lived landscapes are not the same as cultural landscapes

There is a rich vein of research in specifically cultural landscapes. The European Landscape Convention definition of cultural landscapes is oft-cited: an “area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Council of Europe (CoE), 2000, p. 2). The cultural landscapes protected since 1992 under the UNESCO World Heritage system are “combined works of nature and humankind” (UNESCO World Heritage Convention), typically examples of human landscape modifications for the purposes of aesthetics, spirituality or livelihood. These are usually but not always representing land uses, meanings and practices that are now archaic or at least quaint. These landscapes are manifestations of past resource, lifestyle or spiritual problem-solving. Their protection by UNESCO has often come as a result of having fallen into disuse or use being somehow ruptured (Kasemets, 2015), and thus ‘paused’ at a specific stage of cultural problem-solving. By contrast, many former cultural landscapes in areas of high pressure for development such as river deltas may be long buried under layers of newer landscape solutions. Any such landscape artefacts serve, as described Dutch writer Willem van Toorn (translated by Martin Drenthen), to “remind us ... that there is a past, that people who lived in that past had to deal with the world just as we have to; that they had to protect themselves against nature and use its resources” (Drenthen, 2015, p. 66). UNESCO cultural landscapes are thus archetypal and rare, exemplars and celebrations of localized problem-solving.

Lived landscape overcomes limitations of cultural landscape as a concept for the purposes of this chapter.

- First, balance between human and nature is generally a characteristic of cultural landscapes. In lived landscapes such as cities, however, human forces and technologies have sought to overtake nature. This happens despite the fact that many cities today seek to mimic, if not (re)integrate, ecosystems in order to ensure and leverage ecosystem service supply (Depietri, Renaud, & Kallis, 2012).
- Second, scale is also an important variable. Cultural landscapes often function as symbols of smaller scale and arguably more sustainable human endeavour, encompassing discrete complexes of human habitation, resource exploitation and cultural identity. Lived landscapes are more difficult to delineate, representing multiple connections across sometimes large distances for livelihoods, relationships, resources and meaning.
- Finally, cultural landscapes typically have meaning beyond their boundaries, for instance representing a cultural group and its traditions, even with ‘associative’ UNESCO category landscapes where there is no material evidence of human use. By contrast, many lived landscapes may seem aesthetically compromised or culturally bereft to an outsider, while for locals they may inspire strong (and likely diverse) senses of personal attachment and cultural identity (Stobbelaar & Pedroli, 2011). These lived landscapes are not cultural by most definitions, but they are made by humans of nature and even if they are utilitarian and industrialized, they are variously inhabited, used, perceived and cherished.

The shared nature of lived landscapes, albeit with their many constituencies over place and time, make them useful to conceptualize as containers for—as well as outputs of—multiple and overlapping rules

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and behavioural regimes. Institutions are simply “structures for exchange” (Hotimsky, Cobb, & Bond, 2006, p. 42), and generally refer to the intangible social inventions such as law, education, markets, more than their physical manifestations (courthouses, schools, banks). Turner (1997, p. 6), however, described institutions in a way that anchors them to problem-solving and resource use:

*[as] a complex of positions, roles, norms and values lodged in particular types of social structures and organising relatively stable patterns of human activity with respect to fundamental problems in producing life-sustaining resources, in reproducing individuals, and in sustaining viable societal structures within a given environment.*

Goodin’s thinking on institutions echoes Shephard’s, earlier: “[they] can be the product of intentional action without ... having been literally the intentional product of anyone’s action” (Goodin, 1998, p. 28). Giddens (1979) described structuration cycles that drive and reinforce behaviours. Landscape is thus a physical manifestation of those norms and the way we solve problems in a particular place, and the landscape in turn enables and thus recursively reproduces those patterns. Others have called these sociotechnical landscapes, stable “taken-for-granted backdrop[s]” that do not drive action but “[exert] power and influence ... provid[ing] deep-structural ‘gradients of force’ that make some actions easier than others” (Geels & Schot, 2007, p. 403). Changing society means changing landscapes, and vice versa.

Thinking of the interactions between landscapes and institutions is instructive to understanding how change and perhaps transformation should be approached (Pelling et al., 2015). If we can agree that landscapes are institutions in the sense of being commonly held, and reproduced by humans playing out rules and regimes to sustain viable communities in a changing environment (to paraphrase Turner, 1997, above), we can more easily see that succession beyond any perceived current ‘climax’ is an obvious outcome. Handmer and Dovers identified four approaches to institutional change that can be applied to landscape planning (Handmer & Dovers, 1996): stability, where the goal is the status quo; incremental or superficial change, often marginal or symbolic; adaptability, where the goal is resilience amidst change; and, flexibility, with the concomitant risk of maladaptation. Given the tendency of future options to be narrowed by past choices (so-called lock-in, or path-dependency (Simmie, 2012)), it is appropriate for landscape change processes to face interrogation, as well as some rigidity or resistance. We must balance rigidity and flexibility, consider how much cost or benefit accrues to whom, and find ways to avoid widespread grief and loss from imposed change (Marris, 2014; Mels, 2016) as well as the solastalgia that results from environmental degradation in cherished places (Albrecht et al., 2007).

## A pathology of climax thinking

The attenuation of time and space operate powerfully on us to create climax thinking. Blindnesses or lapses of empathy across temporal and spatial dimensions seem to drive the problem, though whether these emerge as a result of hubris, exceptionalism, ignorance or uncertainty is unclear (Table 1). First, climax thinking manifests as an apparent belief that current landscapes are how they are meant to be. This may be linked by genuine ignorance of former land uses, or to a sense that former generations (and their land uses) were more primitive. Second, climax thinking suggests a failure to imagine alternative future landscapes that are equivalently viable and desirable. This might be caused by an assumption that

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current landscapes will continue to meet the needs of current and future generations, or simply a sense that future people matter less: temporal discounting of generations to come. Third, climax thinking may arise from a lack of willingness or ability to adapt to landscape change. Fourth, climax thinking could be linked to the belief that forcing local landscape stasis harms no one, i.e. there are no losers. This could be either spatial discounting of distant individuals, or a true ignorance of our ability to impact faraway places and their people by our landscape decisions. Each dimension is described more fully below.

Table 1 A multi-dimensional pathology of climax thinking.

<b>Dimension</b>	<b>Pole</b>	<b>Hubris/exceptionalism</b>	<b>Ignorance/uncertainty</b>
<i>Time</i>	<i>Past</i>	Previous generations and land uses were paving the way for this one.	There were no previous land uses.
	<i>Future</i>	Future generations matter less than this one.	Current solutions will continue to work in future.
<i>Space</i>	<i>Self</i>	I should not need to accept landscape change.	I am not able to adapt to landscape change.
	<i>Other</i>	People in other places matter less.	Local landscape decisions do not have implications elsewhere.

Specific aspects of this proposed pathology of climax thinking overlaps with others that have been advanced to explain mired public processes about landscape change, in the years since such processes became commonplace. Most of these have emerged from social science, and explain defaults to the *status quo* rather than leverage points for alternatives. Here I try to include links to a wide range of literature that touches upon this concept, without pretences of being exhaustive. The closest concepts I have found in the literature to date are: *immortality*, what Pasqualetti (2011, p. 914) described as “the expectation of landscape permanence” in his quest to understand drivers of opposition to wind energy; and, *continuity*, where adaptive capacity depends in part whether “places remain continuous and provide same attributes and meet certain needs, giving continuity to identity” (Fresque-Baxter & Armitage, 2012, p. 254). These concepts, however, suggest that of landscape is stable-state, i.e. no change has yet occurred or been experienced.

### Past

One driver of climax thinking is a limited awareness of past landscapes. Any individual’s time in a given place is limited, and so also are their experiences of it. As Simon Schama described, “landscape is the work of the mind. It’s scenery is built up from strata of memory as much as from layers of rock” (Schama, 1996, pp. 6-7). That time-in-place may cover periods of slow incremental change such as suburbanization, as well as potentially faster, more significant changes such as hydroelectricity inundation. Changes often involve layering the landscape, from one use to another and consequently one memory to another, as new needs are met. Artefacts of past uses are sometimes still visible to those who know how to see them, but can be equally easily ignored by those who do not (Hirsh & Jones, 2014). Individuals often demonstrate *post hoc* adaptability to both kinds of change (e.g. ‘shifting baselines’ with subsequent generations (Keilty, Beckley, & Sherren, 2016; Pauly, 1995)). Before this can



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happen, however, opposition to public good proposals manifests as efforts to keep the current landscape 'solution' intact.

The palimpsest of lived landscapes implies some level of erasure, and this can make the past somewhat illegible to those who did not directly experience it. Paul Shephard draws a parallel between domesticated dogs, who are happy with their lot without understanding it, and humans: "How many humans are simply domesticated? Living in our civilization – our cultivation – without knowing why it exists?" (Shephard, 1997, p. 19). He goes on later to explain,

*"As you retreat in time, the evidence [of past lives] becomes so scanty and so contaminated by the process of being passed down the generations that you can be sure about nothing." (p. 30)... "If it's hard to perceive the ancient, simple landscapes, it's harder still to see the ground beneath the clutter of the modern world" (p. 49).*

Our resistance to change in our lived landscapes may thus come in part from simple ignorance of not only *what* has come before but *that* something came before. Our perception that our lived landscape is somehow fated might be weakened by awareness that previous decision-makers or inhabitants may have chosen to overwrite previous versions of the same place to fill erstwhile needs.

Better awareness of past landscapes will not necessarily combat climax thinking, however, because of what Carl Sagan (1997) called temporal chauvinism, or what C. S. Lewis (1955) called chronological snobbery: past landscape change being dismissed as irrelevant to present day occupants because of a sense that earlier generations were lesser or primitive. In either instance this past blindness or current hubris serves as a very real barrier to sustainability transitions. This is a failure of local historical knowledge, as well as demonstrating ignorance of the broad strokes of human civilization, and our place in it, indigenous and settler. There is a good link to this in succession theory, as Clements defined it. He viewed early successional plant communities as laying the groundwork for later ones, thus facilitating them while clearly less desirable.

## Future

Individuals cannot be faulted for the bias introduced by the 'ordinality' of time: simply not knowing what is to come. As Barbara Kingsolver (2009, p. 240 ) wrote in *The Lacuna*, "The past is all we know of the future". But it does seem that we are guilty of a kind of paternalistic presentism: assuming that what we have built for current generations will serve future generations. Two fallacies may be associated with this kind of thinking: that current solutions will continue to work in future, e.g. in a context of climate change; and that future humans are less important than today's if their needs differ. Futurist Jim Dator has described this phenomenon as temporal crackpot realism: the "fully understandable but quite misleading belief that the world of the present will dominate the future" (Candy, 2010, p. 68). Such thinking is a failure of the sociological imaginary (Castoriadis, 1987), in that what we collectively hold as possible and desirable is often limited by what already exists. It is also, however, a failure of our capacity to fully consider future generations as equally important to our own (Karlsson, 2006). Such temporal discounting is a persistent challenge to implementing the full intentions of sustainable development, that which meets "the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development (WCED), 1987).

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Intergenerational equity is thus a cognitive challenge as well as a challenge to hubris. Pop culture commentator Chuck Klosterman explores the limitations of the “informed imagination” (2016, p. 259) in *What if we’re wrong? Thinking about the present as if it were the past* (p. 30):

*Before we can argue that something we currently appreciate deserves inclusion in the world of tomorrow, we must build that future world within our mind. This is not easy (even with drugs). But it’s not even the hardest part. The hardest part is accepting that we’re building something with parts that don’t yet exist.*

Uncertainty lies at the heart of some of these concepts. For instance, prospect theory is sometimes used to explain resistance to landscape change: the tendency for loss aversion to outweigh the uncertain possibility of future gain (Holtorf, 2015; Rogge, Dessein, & Gulinck, 2011). For instance, Kate Reilly and others recently found that locals around a hydroelectric dam headpond were able to map current ecosystem service provision, but could not imagine those that would follow scenarios such as dam removal (Reilly, Adamowski, & John, 2018). Such uncertainty is generally associated with fear (of change or the unknown) or flawed logic (cognitive dissonance, status quo bias). Some conceptualizations come with implied opprobrium for those said to hold them, so-called NIMBY (not in my backyard), or the more awkward NOOMBY (not out of my backyard) (Fox, Magilligan, & Sneddon, 2016), with their echoes of the deficit model (Burningham, Barnett, & Walker, 2015). In renewable energy settings these have been superseded by place-protection, which builds on a significant literature of sense-of-place and place attachment (Devine-Wright, 2009). More informal and perhaps mean-spirited conceptualizations of climax thinking include “last one in, close the door”, also called the ‘gangplank’ or ‘last-settler’ syndrome (Graber, 1974; Voss, 1980).

Ecology gives us numerous analogies for this phenomenon. In resilience terms, climax thinking relates to the desire to unnaturally prolong the ‘fore loop’ of current landscape settings (Allen, Angeler, Garmestani, Gunderson, & Holling, 2014). A frequent analogy is fire-suppression in a forest, which otherwise would naturally recycle nutrients and initiate secondary succession, leading to increased risk of catastrophic fire. In social systems also, extending the fore loop can lead to a more brittle and maladaptive system (Slight, Adams, & Sherren, 2016). This is an excellent corollary for climax thinking – the desire to hold in stasis, or force stasis, despite changing conditions and the need to re-use some of the various capitals otherwise locked-up. Repeatedly rebuilding after disaster may be another example: a political decision but a poor collective investment. Clements used the ability of a rangeland to return to its identified climax state after disturbance as a critical diagnostic for the health of that system. A non-equilibrium model sees it differently.

### Space and Place

Our desire to hold our lived landscape in stasis can force those of others to change. Thanks to a highly interconnected society and economy, local decisions can have far-flung landscape and livelihood implications. The decision to reject hydraulic fracturing for shale gas in one place, for instance, may mean a continued reliance on conventional fuels produced elsewhere, perhaps in places with weaker safety and environmental regulations, and may exacerbate sea level rise in yet another. This is a failure of intragenerational equity—concern for other members of the same generation elsewhere in the globe—which is another persistent challenge to sustainable development (WCED, 1987). To some

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degree this explains why climax thinking is characteristic of developed nations. It is a privileged form of buffering against environmental signals that only those with capital can undertake (Meyfroidt, 2013), particularly those with livelihoods outside the primary and secondary economic sectors and thus decoupled from nearby siting and land use decisions.

The scholarship of place has been particularly concerned with the multiplex relationships between people and landscapes, and how those can best be sustained. While useful here for how it explains place-attachment, in terms of subjective meanings (Brehm, Eisenhauer, & Stedman, 2013; Stedman, 2016) and time in place (Smaldone, Harris, & Sanyal, 2008; Vorkinn & Riese, 2001), though place theory makes reference to iteration, in practice it seems to validate stasis. The difference may simply be semantics; place attachment is positively framed climax thinking. It has been shown, for instance, that place attachment and identity can reduce transformational capacity, such as in changing commodities in the face of climate change in Australia (Marshall, Park, Adger, Brown, & Howden, 2012). While we may believe we will not be able to adapt to change in our lived landscapes, the opposite has been repeatedly demonstrated as today's landscapes have emerged. Indeed, landscape expectations and preferences can evolve even within the generation that has witnessed quick and dramatic change (e.g. hydroelectricity development) (Keilty et al., 2016). Even if current settings or features are perceived as irreplaceable in terms of place attachment or other ecosystem service supply, there may be significant elasticity in the sources of values derived from landscape (Daw et al., 2016).

## Leverage points for landscape transition

We need to develop our knowledge, imagination and empathy to change our landscapes and perhaps our cultural infrastructure in the face of new challenges. Most importantly, we must do this without cultural obliteration, environmental degradation and rupture in human-environment relationships (Hourdequin & Havlick, 2015). This section proposes three key leverage points to tackle climax thinking, illustrating with examples of research gaps across a range of fields, including social science, environmental assessment, spatial science, Big Data and digital technologies (Table 2). Importantly, none of these leverage points, or specific suggested directions to action them, would have the outcome of disempowering valid resistance in the face of development proposals which did were not seen to represent a public good; arguably, they would help in identifying such instances.

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Table 2 A cross-disciplinary research and action agenda for climax thinking.

<b>Field</b>	<b>Past</b>	<b>Future</b>	<b>Self and Other</b>
<i>Spatial Science</i>	Expose past layers and trajectories	Show challenges and viable scenarios	Reveal how our energy choices propagate globally
<i>Big Data and Digital Technology</i>	Track cultural trajectories through landscape change	Digitally conserve past solutions to make space for new ones	Reach outside online bubbles to develop empathy
<i>Environmental Assessment</i>	Convey past trajectory	Interrogate 'public good' and incorporate end-of-life planning	Document inter- and intra-generational implications of status quo and proposal
<i>Social Science</i>	Do tools to reveal past and possible trajectories ease climax thinking?	How does place re-attachment occur and how can it be facilitated?	How does knowing where your energy comes from, perhaps locally, affect attitudes and consumption?

### Heal our link with the past, without anchoring there

What the above makes clear is that landscape is not ever completed. We need to reveal the fact that landscape is an ongoing trajectory of problem-solving, without somehow getting stuck in those past visions. If a blindness to past landscapes drives climax thinking, this is in part because of their erasure. New media may have a role to play. Thanks to archives and online and mobile mapping, improved transparency is well within our ability. We need a better sense of how many times, and in how many ways, our lived landscapes have already been written and re-written (Hanson, 2012). Archival photos and maps can reveal many different versions of a place over time, but their display is limited by cartographic convention. Instead such resources can be brought to life using online applications such as storymaps to remind viewers of past occupants and some of the past viable landscapes they created and/or overwrote as needs changed. Digital archives and social media can also be used to help us track cultural trajectory alongside landscape change, including that resulting from energy transitions (Sherren, Parkins, Smit, Holmlund, & Chen, 2017). Such insight on past land uses at sites facing land use change could be co-created as well as shared with the public via dialogue in more collaborative environmental assessment and stakeholder engagement processes (Eaton, Burnham, Hinrichs, & Selfa, 2017). Further research is needed to explore whether exposure to site-specific trajectories of past and current landscape solutions eases transitions to new ones. There is some evidence for the former: in research on changing woodland cover in the UK, exposure to maps of past woodland arrangements (as well as literary perceptions of the same) made survey respondents significantly less likely to opt for status quo scenarios (Hanley et al., 2009).

### Learn layering: we can't keep everything

Transition will require learning how to negotiate the editing of lived landscapes. This chapter does not endorse replacing landscape preservation with layering: it is critical that some cultural landscapes are maintained as records of past landscape solutions and associated cultures, but we cannot keep everything. Heritage experts have been grappling with questions about the risk of cultural erasure (Holtorf, 2015), as well as the practical need for controlled forgetting (Harrison, 2013; Holtorf &

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Kristensen, 2015) to leave space for new culture (e.g. nuclear domes (Holtorf & Högberg, 2014)). Landscape planners may have things to learn from archaeologists and heritage specialists. Those fields are developing an increasingly wide range of opportunities for ‘conservation by record’ thanks to 3D and immersive technologies (Champion, 2017; De Reu et al., 2013; Seif, 2009). Techniques like this have already been used in many landscape change settings to simulate scenarios of future conditions, but rarely to conserve or reconstruct those becoming past. Tools such as digital globes and phone apps can also augment our understanding of current landscape values and challenges such as sea level rise to public stakeholders (Bishop, 2015; Harwood, Lovett, & Turner, 2015). Research is required to understand how such immersive digital archives or renderings might be experienced and perceived by those who see landscapes-at-risk as entangled with their own or ancestors’ efforts and identities. Moreover, we need to better understand how to facilitate processes of place re-attachment after place disruption (Keilty et al., 2016).

Collaborative planning processes could perhaps also be improved with more transparent end-of-life planning discussions at the proposal stage. It is important to emphasize to local populations the reasonable lifespan of new infrastructure and what might follow. A proposed dam, for instance, has a limited lifespan, so proponents and affected landowners should be able to consider its implications at the outset of the project. We should also be more willing to remove old uses as well as add new ones, which in the context of energy Martin Pasqualetti has called “recycling” landscapes, consistent with nutrient cycling in forests, given the varying permanence and ‘temporal qualification’ of energy landscapes (Pasqualetti & Stremke, 2018). More research is needed on whether early and transparent end-of-life planning can ease transition related to specific infrastructure, by casting it as temporary, or whether the spectre of future disruption in fact increases resistance. It may also be that certain kinds of baselines (*status quo* landscapes) operate differently, for instance in terms of expectations of permanence, or perceptions of naturalness, desirability or ‘blank slate’.

Climax thinking is in part a failure of imagination (Ingold, 2012). We may need to reconsider our landscape strategy (*sensu* Shephard, 1997) to recast landscape to meet new challenges. One alternative landscape strategy, for the purposes of illustration only, could be ‘local energy’. Unlike with ‘local food’, in North America there seems a lack of interest in taking similar ownership of and responsibility for energy use, generation choices and their carry-on effects. Europe is ahead on such thinking, perhaps because of the need to ‘overwrite’ their smaller landmass earlier (e.g. de Waal & Stremke, 2014). Rejection of renewable energy proposals for instance may prolong reliance on imported fuels and electricity with remote negative externalities. A local energy ethic would expose energy consumers to environmental signals, and thus might inspire energy conservation. It might also reduce opposition to local renewable energy infrastructure in contexts where local alternatives (e.g. fracked natural gas) may represent environmental or health risk. The negotiation and implementation of such new landscape strategies may be able to ease landscape transition and give meaning to disruption, but must be informed by more research. A local energy strategy raises important hypotheses that need testing, for instance, to establish if people generally know where their energy currently comes from, and whether places currently supplied with locally produced energy consume less of it. Moreover, we may be able to reduce the impacts of climax thinking if we shift our thinking about renewable energy as a

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commodity no different than forestry or agriculture; why should opportunities for export be anathema and drive so much resistance to development?

### Build empathy for other lives and our impacts on them

Climax thinking is also in part a failure of empathy. Again, new media has an important role to play in building empathy and system knowledge. So far it has not. As Marshall McLuhan is oft-quoted as saying, “We shape our tools and afterwards they shape us”. Cosmopolitanism is a philosophy that emphasizes our duty to consider the global community of humans in our actions. Cosmopolitanism is typically associated with calls for wider education in the humanities (Fischer et al., 2007; Sherren, 2008), for instance literature to develop a sense of empathy and the capacity to envision the experience of other lives (Nussbaum, 2002). More ubiquitous than literature is that other potential ‘empathy machine’, the internet. Ethan Zuckerman (2013) observes that ready access to global media and culture is making us think we are worldly, despite the fact that we tread relatively worn, familiar paths when we visit there. Such paths delineate the echo chamber, which reinforces prejudices through news feeds fed by algorithms and social networks (Jasny, Waggle, & Fisher, 2015). International news coverage in American media has declined with the rise of access to online sources, but our bubbles make sure we do not become exposed to such coverage (Zuckerman, 2013). So what might it look like to ‘do internet differently’? We could learn about what life is like where our energy sources currently come from. Faced with a landscape change, we could seek out a vicarious experience from someone who has faced similar landscape changes. More substantively than recreational internet use, it may be possible to integrate intragenerational considerations into environmental assessment processes (Gibson, 2006; Winfield, Gibson, Markvart, Gaudreau, & Taylor, 2010)? Climax thinking may be reduced by understanding how needs (e.g. energy) are currently met, and the impact of that provision on others, as well as how those impacts of new proposals might be distributed.

## Conclusion

This chapter draws on the ecological concept of succession to present a new concept, climax thinking, uniting and adding to ideas related to public resistance to landscape change emerging from a range of disciplines. Public good landscape transitions are hampered due to climax thinking, our erroneous perception that our lived landscape is in its peak state. Any perceived summit is only a powerful illusion: land uses must continue to change and layer as new needs and priorities are encountered. That said, this contribution is not meant to provide ammunition to those endorsing unexamined opportunities for large-scale landscape change. This chapter describes lived landscapes as layered landscapes that present us with challenges to adapt for new needs. A multi-dimensional pathology of climax thinking is proposed that covers time and space, including hubris or ignorance as potential drivers. Three broad leverage points are proposed to help us ease transitions across those dimensions: 1) healing our link with the past, 2) learning layering, and 3) building empathy. A cross-disciplinary mix of directions are proposed to make progress across those leverage points. This research and action agenda should only be a starting point as we learn how to adapt our shared landscapes in the face of significant local and global challenges.

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## Summary

In the absence of strong political will, public resistance to landscape change is a significant challenge to the kinds of transitions needed to make to achieve long-term sustainability. Such resistance happens across the urban-rural gradient: from protesting the condo development next door that will house more people in a smaller area and reduce our need for cars, to residents opposing a large-scale wind farm to reduce our dependency on fossil fuels. Such arguably public good landscape changes are always challenged by those living nearby, a phenomenon well explored in energy research. This chapter draws upon succession theory to describe the phenomenon of ‘climax thinking’, the sense we have that the landscape we currently live in is in its ideal, perhaps even intended, state. The pathology of climax thinking is dissected into temporal and spatial dimensions of ignorance or egotism. The past dimension is being unaware of any previous land uses or, if aware, seeing those past landscapes as lesser, along with past residents who had to suffer change for today’s landscape to emerge. The future dimension is assuming current land uses will continue to work in future, or feeling that we have no duty to anticipate the needs of future residents. The spatial dimensions are anchored in the self—our feeling that we should not need to, or cannot, accept change—towards incomprehensible others, elsewhere, whose landscapes change precisely because we seek to hold ours static. The pathology, once described, is tackled by outlining a potential set of leverage points for easing each dimension: healing our link with the past, learning layering, and building empathy for other lives. Returning to succession theory, the chapter advocates for a multi-disciplinary research and action agenda across the social and computational sciences to facilitate a non-equilibrium way of thinking about landscapes in the face of sustainability transitions.

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## References

- Abrams, J., & Bliss, J. C. (2013). Amenity Landownership, Land Use Change, and the Re-Creation of "Working Landscapes". *Society & Natural Resources*, 26(7), 845-859.  
doi:10.1080/08941920.2012.719587
- Albrecht, G., Sartore, G.-M., Connor, L., Higginbotham, N., Freeman, S., Kelly, B., . . . Pollard, G. (2007). Solastalgia: the distress caused by environmental change. *Australasian Psychiatry*, 15(sup1), S95-S98. doi:10.1080/10398560701701288
- Allen, C. R., Angeler, D. G., Garmestani, A. S., Gunderson, L. H., & Holling, C. S. (2014). Panarchy: Theory and Application. *Ecosystems*, 17(4), 578-589. doi:10.1007/s10021-013-9744-2
- Birch, E., & Wachter, S. (2006). *Rebuilding urban places after disaster: lessons from Hurricane Katrina*: University of Pennsylvania Press.
- Bishop, I. D. (2015). Location based information to support understanding of landscape futures. *Landscape and Urban Planning*, 142, 120-131.  
doi:<https://doi.org/10.1016/j.landurbplan.2014.06.001>
- Brehm, J. M., Eisenhauer, B. W., & Stedman, R. C. (2013). Environmental Concern: Examining the Role of Place Meaning and Place Attachment. *Society & Natural Resources*, 26(5), 522-538.  
doi:10.1080/08941920.2012.715726
- Brennan, G. (1996). Selection and the currency of reward. In R. E. Goodin (Ed.), *The Theory of Institutional Design*. Cambridge, UK: Cambridge University Press.
- Burningham, K., Barnett, J., & Walker, G. (2015). An Array of Deficits: Unpacking NIMBY Discourses in Wind Energy Developers' Conceptualizations of Their Local Opponents. *Society & Natural Resources*, 28(3), 246-260. doi:10.1080/08941920.2014.933923
- Candy, S. (2010). *The futures of everyday life: politics and the design of experiential scenarios*. (PhD ), UNIVERSITY OF HAWAI'I AT MĀNOA.
- Castoriadis, C. (1987). *The imaginary institution of society* (K. Blamey, Trans.). Cambridge, UK: Policy Press.
- Champion, E. (2017). The role of 3D models in virtual heritage infrastructures. In A. Benardou, E. Champion, C. Dallas, & L. Hughes (Eds.), *Cultural Heritage Infrastructures in Digital Humanities*: Routledge.
- Cosgrove, D., & Daniels, S. (1988). *The iconography of landscape: essays on the symbolic representation, design and use of past environments* (Vol. 9): Cambridge University Press.
- Council of Europe (CoE). (2000). *European Landscape Convention*. CETS No. 176. Florence and Strasbourg and online at <https://rm.coe.int/1680080621>: Council of Europe.
- Cresswell, T. (1996). *In place/out of place : geography, ideology, and transgression*. Minneapolis: Minneapolis : University of Minnesota Press.
- Cretney, R. (2014). Resilience for Whom? Emerging Critical Geographies of Socio-ecological Resilience. *Geography Compass*, 8(9), 627-640. doi:10.1111/gec3.12154
- Crowe, S. (1958). *Landscape of power*. London, UK: Architectural Press.
- Davidson, D. J. (2010). The applicability of the concept of resilience to social systems: some sources of optimism and nagging doubts. *Society and Natural Resources*, 23(12), 1135-1149.
- Daw, T. M., Hicks, C. C., Brown, K., Chaigneau, T., Januchowski-Hartley, F. A., Cheung, W. W. L., . . . McClanahan, T. R. (2016). Elasticity in ecosystem services: exploring the variable relationship between ecosystems and human well-being. *Ecology and Society*, 21(2). doi:10.5751/ES-08173-210211



- Sherren, K. (in press), From climax thinking toward a non-equilibrium approach to public good landscape change. Forthcoming in *Energy Impacts: A Multidisciplinary Exploration of North American Energy Development*, co-edited by Jeffrey Jacquet, Julia Haggerty and Gene Theodori (Social Ecology Press & Utah State University Press)
- De Reu, J., Plets, G., Verhoeven, G., De Smedt, P., Bats, M., Cherretté, B., . . . De Clercq, W. (2013). Towards a three-dimensional cost-effective registration of the archaeological heritage. *Journal of Archaeological Science*, 40(2), 1108-1121. doi:<https://doi.org/10.1016/j.jas.2012.08.040>
- de Waal, R., & Stremke, S. (2014). Energy Transition: Missed Opportunities and Emerging Challenges for Landscape Planning and Designing. *Sustainability*, 6(7), 4386.
- Depietri, Y., Renaud, F. G., & Kallis, G. (2012). Heat waves and floods in urban areas: a policy-oriented review of ecosystem services. *Sustainability Science*, 7(1), 95-107. doi:10.1007/s11625-011-0142-4
- Devine-Wright, P. (2009). Rethinking NIMBYism: The role of place attachment and place identity in explaining place-protective action. *Journal of Community & Applied Social Psychology*, 19(6), 426-441. doi:10.1002/casp.1004
- Drenthen, M. (2015). Layered Landscapes, Conflicting Narratives, and Environmental Art: Dealing with Painful Memories and Embarrassing Histories of Place. In M. Hourdequin & D. G. Havlick (Eds.), *Restoring Layered Landscapes: History, Ecology, and Culture* (pp. 239-262): OUP Us.
- Eaton, W. M., Burnham, M., Hinrichs, C. C., & Selfa, T. (2017). Bioenergy experts and their imagined “obligatory publics” in the United States: Implications for public engagement and participation. *Energy Research & Social Science*, 25, 65-75. doi:<https://doi.org/10.1016/j.erss.2016.12.003>
- Elmqvist, T., Folke, C., Nyström, M., Peterson, G., Bengtsson, J., Walker, B., & Norberg, J. (2003). Response diversity, ecosystem change, and resilience. *Frontiers in Ecology and the Environment*, 1(9), 488-494. doi:10.1890/1540-9295(2003)001[0488:RDECAR]2.0.CO;2
- Fischer, J., Manning, A. D., Steffen, W., Rose, D. B., Daniell, K., Felton, A., . . . Wade, A. (2007). Mind the sustainability gap. *Trends in Ecology & Evolution*, 22(12), 621-624. doi:<https://doi.org/10.1016/j.tree.2007.08.016>
- Fox, C. A., Magilligan, F. J., & Sneddon, C. S. (2016). “You kill the dam, you are killing a part of me”: Dam removal and the environmental politics of river restoration. *Geoforum*, 70, 93-104. doi:<http://dx.doi.org/10.1016/j.geoforum.2016.02.013>
- Fresque-Baxter, J. A., & Armitage, D. (2012). Place identity and climate change adaptation: a synthesis and framework for understanding. *Wiley Interdisciplinary Reviews: Climate Change*, 3(3), 251-266. doi:10.1002/wcc.164
- Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, 36(3), 399-417. doi:<http://dx.doi.org/10.1016/j.respol.2007.01.003>
- Gibson, R. B. (2006). Sustainability assessment: basic components of a practical approach. *Impact Assessment and Project Appraisal*, 24(3), 170-182. doi:10.3152/147154606781765147
- Giddens, A. (1979). *Central problems in social theory: Action, structure, and contradiction in social analysis* (Vol. 241): Univ of California Press.
- Goodin, R. E. (1998). *The theory of institutional design*: Cambridge University Press.
- Graber, E. E. (1974). Newcomers and oldtimers: growth and change in a mountain town. *Rural Sociology*, 39(4), 504.
- Hager, C., & Haddad, M. A. (2015). *NIMBY is beautiful: Cases of local activism and environmental innovation around the world*: Berghahn Books.
- Handmer, J. W., & Dovers, S. R. (1996). A typology of resilience: rethinking institutions for sustainable development. *Organization & Environment*, 9(4), 482-511.
- Hanley, N., Ready, R., Colombo, S., Watson, F., Stewart, M., & Bergmann, E. A. (2009). The impacts of knowledge of the past on preferences for future landscape change. *Journal of Environmental Management*, 90(3), 1404-1412. doi:<https://doi.org/10.1016/j.jenvman.2008.08.008>

- Sherren, K. (in press), From climax thinking toward a non-equilibrium approach to public good landscape change. Forthcoming in *Energy Impacts: A Multidisciplinary Exploration of North American Energy Development*, co-edited by Jeffrey Jacquet, Julia Haggerty and Gene Theodori (Social Ecology Press & Utah State University Press)
- Hanson, L. L. (2012). *Changes in the social imaginings of the landscape: The management of Alberta's rural public lands*: UBC Press Vancouver, BC.
- Harrison, R. (2013). Forgetting to remember, remembering to forget: late modern heritage practices, sustainability and the 'crisis' of accumulation of the past. *International Journal of Heritage Studies*, 19(6), 579-595. doi:10.1080/13527258.2012.678371
- Harwood, A. R., Lovett, A. A., & Turner, J. A. (2015). Customising virtual globe tours to enhance community awareness of local landscape benefits. *Landscape and Urban Planning*, 142, 106-119. doi:<https://doi.org/10.1016/j.landurbplan.2015.08.008>
- Healy, K. (2017). Fuck Nuance. *Sociological Theory*, 35(2), 118-127. doi:10.1177/0735275117709046
- Hess, D. J. (2018). Energy democracy and social movements: A multi-coalition perspective on the politics of sustainability transitions. *Energy Research & Social Science*, 40, 177-189. doi:<https://doi.org/10.1016/j.erss.2018.01.003>
- Higgs, E., Falk, D. A., Guerrini, A., Hall, M., Harris, J., Hobbs, R. J., . . . Throop, W. (2014). The changing role of history in restoration ecology. *Frontiers in Ecology and the Environment*, 12(9), 499-506. doi:10.1890/110267
- Hirsh, R. F., & Jones, C. F. (2014). History's contributions to energy research and policy. *Energy Research & Social Science*, 1, 106-111. doi:<https://doi.org/10.1016/j.erss.2014.02.010>
- Holtorf, C. (2015). Averting loss aversion in cultural heritage. *International Journal of Heritage Studies*, 21(4), 405-421. doi:10.1080/13527258.2014.938766
- Holtorf, C., & Högberg, A. (2014). Communicating with future generations: what are the benefits of preserving for future generations? Nuclear power and beyond. *The European Journal of Post-Classical Archaeologies*, 4, 315-330.
- Holtorf, C., & Kristensen, T. M. (2015). Heritage erasure: rethinking 'protection' and 'preservation'. *International Journal of Heritage Studies*, 21(4), 313-317. doi:10.1080/13527258.2014.982687
- Hotimsky, S., Cobb, R., & Bond, A. (2006). Contracts or scripts? A critical review of the application of institutional theories to the study of environmental change. *Ecology and Society*, 11(1).
- Hourdequin, M., & Havlick, D. G. (2015). *Restoring Layered Landscapes: History, Ecology, and Culture*: OUP Us.
- Ingold, T. (2012). Introduction. In M. Janowski & T. Ingold (Eds.), *Imagining Landscapes : Past, Present and Future*. Farnham: Routledge.
- Jasny, L., Waggle, J., & Fisher, D. R. (2015). An empirical examination of echo chambers in US climate policy networks. *Nature Clim. Change*, 5(8), 782-786. doi:10.1038/nclimate2666  
<http://www.nature.com/nclimate/journal/v5/n8/abs/nclimate2666.html#supplementary-information>
- Karlsson, R. (2006). Reducing Asymmetries in Intergenerational Justice. *Organization & Environment*, 19(2), 233-250. doi:10.1177/1086026606288227
- Kasemets, K. (2015). Affect, Rupture and Heritage on Hashima Island, Japan. In H. Sooväli-Sepping, H. Reinert, & J. Miles-Watson (Eds.), *Ruptured Landscapes: Landscape, Identity and Social Change* (pp. 97-109). Dordrecht: Springer Netherlands.
- Keilty, K., Beckley, T. M., & Sherren, K. (2016). Baselines of acceptability and generational change on the Mactaquac hydroelectric dam headpond (New Brunswick, Canada). *Geoforum*, 75, 234-248.
- Kingsolver, B. (2009). *The Lacuna*. New York:: HarperCollins.
- Klosterman, C. (2016). *What if we're wrong? Thinking about the present as if it were the past*. New York, NY: Blue Rider Press.
- Lewis, C. S. (1955). *Surprised by joy: The shape of my early life* (Vol. 320): Houghton Mifflin Harcourt.

- Sherren, K. (in press), From climax thinking toward a non-equilibrium approach to public good landscape change. Forthcoming in *Energy Impacts: A Multidisciplinary Exploration of North American Energy Development*, co-edited by Jeffrey Jacquet, Julia Haggerty and Gene Theodori (Social Ecology Press & Utah State University Press)
- Lundhede, T. H., Jacobsen, J. B., Hanley, N., Fjeldså, J., Rahbek, C., Strange, N., & Thorsen, B. J. (2014). Public Support for Conserving Bird Species Runs Counter to Climate Change Impacts on Their Distributions. *PLOS ONE*, 9(7), e101281. doi:10.1371/journal.pone.0101281
- Magilligan, F. J., Sneddon, C. S., & Fox, C. A. (2017). The Social, Historical, and Institutional Contingencies of Dam Removal. *Environmental Management*, 59(6), 982-994. doi:10.1007/s00267-017-0835-2
- Marris, P. (2014). *Loss and Change (Psychology Revivals): Revised Edition*: Routledge.
- Marshall, N., Park, S., Adger, W., Brown, K., & Howden, S. (2012). Transformational capacity and the influence of place and identity. *Environmental Research Letters*, 7(3), 034022.
- Meinig, D. W. (1979). The Beholding Eye: Ten Versions of the Same Scene. In D. W. Meinig (Ed.), *The Interpretation of Ordinary Landscapes: Geographical Essays* (pp. 33-50). New York, NY: Oxford University Press.
- Mels, T. (2016). The trouble with representation: landscape and environmental justice. *Landscape Research*, 41(4), 417-424. doi:10.1080/01426397.2016.1156071
- Meyfroidt, P. (2013). Environmental cognitions, land change, and social–ecological feedbacks: an overview. *Journal of Land Use Science*, 8(3), 341-367. doi:10.1080/1747423X.2012.667452
- Monbiot, G. (2014). *Feral: Rewilding the land, the sea, and human life*: University of Chicago Press.
- Newell, P., & Mulvaney, D. (2013). The political economy of the ‘just transition’. *The Geographical Journal*, 179(2), 132-140.
- Nussbaum, M. (2002). Education for Citizenship in an Era of Global Connection. *Studies in Philosophy and Education*, 21(4), 289-303. doi:10.1023/a:1019837105053
- Olsson, L., Jerneck, A., Thoren, H., Persson, J., & O’Byrne, D. (2015). Why resilience is unappealing to social science: Theoretical and empirical investigations of the scientific use of resilience. *Science Advances*, 1(4). doi:10.1126/sciadv.1400217
- Parkins, J. R., Beckley, T., Comeau, L., Stedman, R. C., Rollins, C. L., & Kessler, A. (2017). Can Distrust Enhance Public Engagement? Insights From a National Survey on Energy Issues in Canada. *Society & Natural Resources*, 30(8), 934-948. doi:10.1080/08941920.2017.1283076
- Pasqualetti, M. J. (2011). Opposing Wind Energy Landscapes: A Search for Common Cause. *Annals of the Association of American Geographers*, 101(4), 907-917. doi:10.1080/00045608.2011.568879
- Pasqualetti, M. J., & Stremke, S. (2018). Energy landscapes in a crowded world: A first typology of origins and expressions. *Energy Research & Social Science*, 36, 94-105. doi:<https://doi.org/10.1016/j.erss.2017.09.030>
- Pasternak, J. (2010). *Yellow dirt: an American story of a poisoned land and a people betrayed*: Simon and Schuster.
- Pauly, D. (1995). Anecdotes and the shifting baseline syndrome of fisheries. *Trends in ecology and evolution*, 10(10), 430.
- Pelling, M., O’Brien, K., & Matyas, D. (2015). Adaptation and transformation. *Climatic Change*, 133(1), 113-127. doi:10.1007/s10584-014-1303-0
- Plieninger, T., Kizos, T., Bieling, C., Le Dû-Blayo, L., Budniok, M.-A., Bürgi, M., . . . Kolen, J. (2015). Exploring ecosystem-change and society through a landscape lens: recent progress in European landscape research. *Ecology and Society*, 20(2), 5.
- Reed, M. G., & George, C. (2011). Where in the world is environmental justice? *Progress in Human Geography*, 35(6), 835-842. doi:doi:10.1177/0309132510388384
- Reilly, K., Adamowski, J., & John, K. (2018). Participatory mapping of ecosystem services to understand stakeholders’ perceptions of the future of the Mactaquac Dam, Canada. *Ecosystem Services*, 30, 107-123. doi:<https://doi.org/10.1016/j.ecoser.2018.01.002>

- Sherren, K. (in press). From climax thinking toward a non-equilibrium approach to public good landscape change. Forthcoming in *Energy Impacts: A Multidisciplinary Exploration of North American Energy Development*, co-edited by Jeffrey Jacquet, Julia Haggerty and Gene Theodori (Social Ecology Press & Utah State University Press)
- Robin, L., & Steffen, W. (2007). History for the Anthropocene. *History Compass*, 5(5), 1694-1719. doi:10.1111/j.1478-0542.2007.00459.x
- Rogge, E., Desein, J., & Gulinck, H. (2011). Stakeholders perception of attitudes towards major landscape changes held by the public: The case of greenhouse clusters in Flanders. *Land Use Policy*, 28(1), 334-342. doi:<https://doi.org/10.1016/j.landusepol.2010.06.014>
- Rudel, T. K. (2009). Succession theory: reassessing a neglected meta-narrative about environment and development. *Human Ecology Review*, 16(1), 84.
- Sagan, C. (1997). *Pale blue dot: a vision of the human future in space*: Random House Digital, Inc.
- Sayre, N. F. (2017). *The politics of scale: A history of rangeland science*: University of Chicago Press.
- Schama, S. (1996). *Landscape and Memory*. New York: Knopf.
- Seif, A. (2009). Conceiving the Past: Fluctuations in a Multi-value System. *Conservation and Management of Archaeological Sites*, 11(3-4), 282-295. doi:10.1179/175355210X12747818485484
- Shepherd, P. (1997). *The Cultivated Wilderness, Or, What is Landscape?* : Mit Press.
- Sherren, K. (2008). A history of the future of higher education for sustainable development. *Environmental Education Research*, 14(3), 238-256. doi:10.1080/13504620802148873
- Sherren, K., Beckley, T. M., Greenland-Smith, S., & Comeau, L. (2017). How provincial and local discourses aligned against the prospect of dam removal in New Brunswick, Canada. *Water Alternatives*, 10(3).
- Sherren, K., Beckley, T. M., Parkins, J. R., Stedman, R. C., Keilty, K., & Morin, I. (2016). Learning (or living) to love the landscapes of hydroelectricity in Canada: Eliciting local perspectives on the Mactaquac Dam via headpond boat tours. *Energy Research & Social Science*, 14, 102-110.
- Sherren, K., Loik, L., & Debner, J. A. (2016). Climate adaptation in 'new world' cultural landscapes: The case of Bay of Fundy agricultural dykelands (Nova Scotia, Canada). *Land Use Policy*, 51, 267-280.
- Sherren, K., Parkins, J. R., Smit, M., Holmlund, M., & Chen, Y. (2017). Digital archives, big data and image-based culturomics for social impact assessment: Opportunities and challenges. *Environmental Impact Assessment Review*, 67, 23-30. doi:<https://doi.org/10.1016/j.eiar.2017.08.002>
- Simmie, J. (2012). Path Dependence and New Technological Path Creation in the Danish Wind Power Industry. *European Planning Studies*, 20(5), 753-772. doi:10.1080/09654313.2012.667924
- Slight, P., Adams, M., & Sherren, K. (2016). Policy support for rural economic development based on Holling's ecological concept of panarchy. *International Journal of Sustainable Development & World Ecology*, 23(1), 1-14. doi:10.1080/13504509.2015.1103801
- Smaldone, D., Harris, C., & Sanyal, N. (2008). The role of time in developing place meanings. *Journal of Leisure Research*, 40(4), 479.
- Stedman, R. C. (2016). Subjectivity and social-ecological systems: a rigidity trap (and sense of place as a way out). *Sustainability Science*, 11(6), 891-901.
- Stenseke, M. (2016). Integrated landscape management and the complicating issue of temporality. *Landscape Research*, 41(2), 199-211. doi:10.1080/01426397.2015.1135316
- Stobbelaar, D. J., & Pedroli, B. (2011). Perspectives on Landscape Identity: A Conceptual Challenge. *Landscape Research*, 36(3), 321-339. doi:10.1080/01426397.2011.564860
- Stokes, L. C. (2016). Electoral Backlash against Climate Policy: A Natural Experiment on Retrospective Voting and Local Resistance to Public Policy. *American Journal of Political Science*, 60(4), 958-974. doi:10.1111/ajps.12220

- Sherren, K. (in press), From climax thinking toward a non-equilibrium approach to public good landscape change. Forthcoming in *Energy Impacts: A Multidisciplinary Exploration of North American Energy Development*, co-edited by Jeffrey Jacquet, Julia Haggerty and Gene Theodori (Social Ecology Press & Utah State University Press)
- Stokowski, P. A. (2002). Languages of place and discourses of power: Constructing new senses of place. *Journal of Leisure Research*, 34(4), 368-382.
- Turner, J. H. (1997). *The Institutional Order: Economy, Kinship, Religion, Policy, Law, and Education in Evolutionary and Comparative*: Longman, New York.
- UNESCO World Heritage Convention. Cultural Landscapes.
- Vorkinn, M., & Riese, H. (2001). Environmental Concern in a Local Context. *Environment and Behavior*, 33(2), 249-263. doi:doi:10.1177/00139160121972972
- Voss, P. R. (1980). A test of the "Gangplank Syndrome" among recent migrants to the Upper Great Lakes Region. *Community Development*, 11(1), 95-111.
- Widgren, M. (2004). Can landscapes be read? *European rural landscapes: persistence and change in a globalising environment*, 455-465.
- Winfield, M., Gibson, R. B., Markvart, T., Gaudreau, K., & Taylor, J. (2010). Implications of sustainability assessment for electricity system design: The case of the Ontario Power Authority's integrated power system plan. *Energy Policy*, 38(8), 4115-4126.  
doi:<http://dx.doi.org/10.1016/j.enpol.2010.03.038>
- World Commission on Environment and Development (WCED). (1987). *Our Common Future ('The Brundtland Report')*. New York, NY: Oxford University Press,.
- Zuckerman, E. (2013). *Digital cosmopolitans: Why we think the internet connects us, why it doesn't, and how to rewire it*: WW Norton & Company.