

# Dwelling in the biosphere: exploring an embodied human–environment connection in resilience thinking

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**Abstract** Resilience has emerged as a prominent paradigm for interpreting and shaping human–environment connections in the context of global environmental change. Resilience emphasizes dynamic spatial and temporal change in social–ecological systems where humans are inextricably interwoven with the environment. While influential, resilience thinking has been critiqued for an under-theorized framing of socio-cultural dynamics. In this paper, we examine how the resilience concepts of planetary boundaries and reconnecting to the biosphere frame human–environment connection in terms of mental representations and biophysical realities. We argue that focusing solely on mental reconnection limits further integration between the social and the ecological, thus countering a foundational commitment in resilience thinking to social–ecological interconnectedness. To address this susceptibility we use Tim Ingold’s ‘dwelling perspective’ to outline an embodied form of human–environment (re)connection. Through dwelling, connections are not solely produced in the mind, but through the ongoing interactivity of mind, body and environment through time. Using this perspective, we position the biosphere as an assemblage that is constantly in the making through the active cohabitation of humans and nonhumans. To illustrate insights that may emerge from

this perspective we bring an embodied connection to earth stewardship, given its growing popularity for forging local to global sustainability transformations.

**Keywords** Resilience thinking · Social–ecological systems · Dwelling · Stewardship · Temporality · Biosphere

## Introduction

Resilience thinking has emerged over the past decade as a prominent paradigm in sustainability research. Resilience thinking is built upon an understanding that humans are inextricably linked with their environment, and that any “delineation between social and natural systems is artificial and arbitrary” (Berkes et al. 2003: 3). The proposition of this inextricable link has generated a significant body of research analyzing interactions between social systems and biophysical processes with special focus on ecological non-linearities, regime shifts and tipping points (Scheffer et al. 2001; Scheffer and Carpenter 2003; Biggs et al. 2011; Lade et al. 2013), the notion of fit between ecosystems and institutions (Olsson et al. 2007; Folke et al. 2007), and adaptive forms of environmental management and governance (Folke et al. 2005; Olsson et al. 2007; Galaz 2014). The concepts of planetary boundaries (Rockström et al. 2009a) and reconnecting to the biosphere (Folke et al. 2011) have recently generated much interest in sustainability circles and are prominent vehicles for resilience thinking in research, policy and public debates (Biermann et al. 2012; Hajer et al. 2015). Both concepts also support a narrative of desirable global social–ecological transformation under the banner of earth stewardship (Chapin et al. 2011; Folke et al. 2011; Steffen et al. 2011).

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Despite its emphasis on the inextricability of social and ecological connection, resilience thinking has been critiqued for undertheorizing the social and cultural dimensions of social–ecological complexity, such as practice, cognition, agency, power and institutional diversity (Nadasdy 2007; Hornborg 2009; Meadowcroft 2009; Smith and Stirling 2007; Brown and Westaway 2011; Pelling and Manuel-Navarrete 2011; Watts 2011; Cote and Nightingale 2011). Indeed, while non-equilibrium ecological theory provides a coherent base for the ecological dimensions of resilience thinking, the human and social conceptions are rather thinly distributed over a wide range of disciplinary traditions—including management, economics, anthropology, psychology, political science and sociology (Scoones 1999; Folke 2006; Martin-Breen and Anderies 2011). This diversity of social theory engagement is in many respects a strong point of resilience thinking, encouraging experimentation and avoiding dogma. However, as the processes of social–ecological connection have not been explicitly or uniformly theorized, it is important to scrutinize the ontological and epistemological assumptions of particular framings. We suggest that current attempts to scale up resilience to the global level through planetary boundaries and reconnection to the biosphere may have inadvertently embraced a philosophical position that contradicts foundational resilience commitments to the inextricability of social and ecological dimensions.

At the root of resilience framings of human–environment connection in the planetary boundaries and reconnecting to the biosphere concepts is the idea that humans depend on a non-negotiable biophysical substrate for their existence, but that humans as a species generally fail to mentally recognize this (West et al. 2014). Planetary boundaries and reconnecting to the biosphere depict our transgression (or approaching transgression) of this biophysical substrate as a consequence of a mental disconnection between people and the biosphere, which will require a “mind shift” to overcome (Folke et al. 2011: 719). As we will demonstrate in this paper, the framing of social–ecological relationships as mental has important implications for the way we represent and respond to global sustainability challenges (Ingold 2000). We posit that juxtaposing mental connections with biophysical realities actually risks continuing a dichotomy between mind and matter that reinforces the separation of the social and ecological components that resilience seeks to remedy (Ingold 2000; Berkes et al. 2003).

To address this paradox, we explore how human–environment (dis)connection can alternatively be framed as an ‘embodied’ relationship. This framing reflects that humans are not just mentally but also materially and physically immersed in their immediate environments. By positioning

people as tangibly immersed “being(s)-in-the-world” (Ingold 2011: 11), whose understanding and experience is indivisible from sensory engagement in that world, we advocate for diverse forms of social–ecological connection. We use Ingold’s (2001) ‘dwelling perspective’ (outlined below) to conceptualize this embodied connection and argue that it complements the ‘mental’ framings of human–environment connection that are currently dominant in resilience thinking. We are prompted to pursue this work in line with recent calls for greater cross-fertilization between the environmental humanities and social sciences (EHSS) and global environmental change (GEC) research (Palsson et al. 2013; ISSC and UNESCO 2013; Castree et al. 2014).

This paper proceeds by introducing the dwelling perspective and how it informs an embodied human–environment connection. We then outline the concepts of planetary boundaries and reconnecting to the biosphere, before exploring the current human–environment connection they present. Following this we operationalize dwelling as a form of embodied connection for two specific purposes: (1) as a means to tease out the implicit complexity and temporality of human–environment connections that produce planetary boundaries, with a specific focus on the biodiversity boundary, and (2) as a conduit for complementing the mental framing of human–environment connection in reconnecting to the biosphere. To conclude, we integrate an embodied connection with the nascent concept of earth stewardship, to show how a sense of embodied stewardship can broaden the trajectory of responses to global environmental change.

### **An embodied human–environment connection for resilience**

The framing of a mental connection between people and the environment suggests an inherent interactional philosophical underpinning for planetary boundaries and reconnecting to the biosphere. This philosophy appears to align most closely with an interactional worldview in psychology, which treats human and the environment as independent and contained domains which “act and react” to one another over time. Here, time appears as a “location”, and the phenomenon is examined as a series of snapshots, “with time locating the phenomenon in two or more places” (Altman and Rogoff 1987: 9, 17). This perspective is grounded in modernist social theory, which also influences the behavioral studies approach in sociology (Burton 2004). The associated focus on attitudes, values and beliefs that accompanies this perspective tends to construct the ‘human’ around the mind rather than the body. Subsequently, an interactional philosophy positions the environment as an independent biophysical reality that humans act *upon*, rather than a

world where humans are acting *in concert* with nonhumans.

We suggest that an uncritical adoption of an interactional perspective in resilience thinking risks reinforcing the “separateness” of social and ecological elements (Kasper 2009: 313). Separating social and ecological reinforces the idea of a neutral realm of knowledge about a uniform biophysical reality. In governance terms, there is a danger that this perspective may unduly prioritize knowledge (of a biophysical reality) that is produced by experts and implemented through technological fixes and centralized solutions (Stirling 2010). The implications here are quite different from the broad participation, diverse knowledge, and co-production processes celebrated in much resilience literature (Berkes and Folke 1998; Berkes et al. 2003; Folke et al. 2005). Given the increasing adoption and deployment of resilience concepts in research and public debate, examination of their theoretical assumptions is important, as the assumptions of such theorizing also become embodied—they shape “ontologies of action” (Cairns and Stirling 2014: 26). With this in mind, we aim to disrupt the implicit association of social–ecological relationships with mental perceptions and biophysical realities through an embodied human–environment connection for resilience thinking. This embodied connection positions people as tangible inhabitants of a biosphere that they are actively co-producing as part of a multi-species assemblage.

To complement the interactional perspective we present a relational/transactional understanding of human–environment connection (Gibson 1979; Altman and Rogoff 1987; Heft 2001; Whatmore 2002; Thrift 2008). While encompassing multiple disciplines, the transactional perspective (psychology) and relational turn (geography, anthropology, and sociology) depict a world of mutually constituted aspects (humans and nonhumans) that coexist as a holistic achievement. In this way, the research emphasis focuses on the *relations* between aspects as a way to break down the human–nature divide, as opposed to positioning people and nature as discrete and independent of one another. This contextual holism also treats temporal dimensions as inherent to aspects and their relations rather than as an external backdrop to events (Altman and Rogoff 1987; Ingold 2011).

With its focus on holism, a transactional/relational perspective provides an ideal vehicle for bringing attention to the body in resilience thinking. Countering mental connections with an emphasis on the body reinforces that humans are “organisms among organisms” (Adams 2016: 55), engaging with other nonhuman bodies in the making of the biosphere. In eliciting an embodied connection, we aim to directly address the ontological separation of mind and matter, positing instead that to be human is to be tangibly embedded in the world that we inhabit (Ingold

2011). Thus, human involvement with the biosphere is not simply of the mind, but engagement of mind-in-body. As Tilley (2004: 79) notes, “We do not just interpret (the world) with our minds in a distanced way, but through our sensing bodies”. This perspective has important implications for sustainability research, as “it is not enough to know sustainability. We have to literally be able to *feel* it” (Carolan 2014: 317).

Constructing an embodied connection does not constitute a radical shift for resilience thinking, but rather a re-energizing of formative theoretical development (Berkes and Folke 1998; Berkes et al. 2003). We extend our work from Davidson-Hunt and Berkes’ (2003) efforts to elicit a ‘human-in-ecosystem’ approach to resilience; sensitive to people’s enduring interactions with their environment. Together with Davidson-Hunt and Berkes (2003), we see *temporality* as central to exploring an embodied connection that captures an ongoing relationship between people and their environment. As such, we reprise Davidson-Hunt and Berkes’ adoption of Ingold’s (2000) dwelling perspective to exemplify an embodied connection. Dwelling positions the environment as an “array of features” that have come into being through an ongoing “pattern of activities” conducted by human beings and other living and non-living entities (Ingold 2000: 198). As a result, dwelling paints people as active participants in the making of the biosphere, while also recognizing that people’s tangible experience of the biosphere will shape their understanding of it (Cloke and Jones 2004; Ingold 1993, 2000; Macnaghten and Urry 1998). To act in the world is, therefore, to be interwoven with other material elements, rather than to inscribe pre-determined ideas onto the biophysical environment (Ingold 2011). Dwelling helps to define the ‘environment’ in broad terms as the biophysical landscape, in an effort to avoid the separation of cultural (urban, rural) and natural (ecosystems) spaces. Dwelling’s co-constitution of the environment and the making of space for tangible, bodily activity can help to re-assert resilience’s foundational principle of indivisibility between the social and ecological (Berkes et al. 2003).

### Human–environment connection and time in resilience thinking

The concept of social–ecological resilience emerged from the work of C. S. Holling in the 1970s, marking an ontological shift from traditional ecological thinking that emphasized stable states towards understanding dynamic change and the co-evolution of social and ecological systems (Folke 2006). The acknowledgement of dynamic and non-linear change prompted also a epistemological shift that recognized scientific uncertainty and incompleteness,

and prioritized ongoing learning, participation and multiple sources of knowledge and understanding (scientific, local, experiential and traditional) in environmental management (Berkes et al. 2003). Recognizing diverse knowledge and multiple ways of knowing is indicative of the space within resilience thinking for plural forms of human–environment connection.

Moreover, the emphasis in social–ecological systems research on dynamic temporal change draws attention to history as a causal factor of both material social–ecological configurations and our understanding of them (Boonstra and de Boer 2014). Indeed, early work exploring the implications of these ontological and epistemological shifts for the social sciences highlighted historical contingency as vital point for understanding intersecting human and ecological processes (Scoones 1999; Berkes et al. 2003). Some classic resilience heuristics, such as panarchy and the adaptive cycle, aim to represent these dynamic spatio-temporal processes (Gunderson and Holling 2002). However, this temporal sensitivity to human–environment connection does not appear to have become explicitly entrenched in planetary boundaries and reconnecting to the biosphere, two concepts that have in recent years become influential exemplars of resilience thinking as applied to the global scale. While planetary boundaries form the current public scientific centerpiece of resilience thinking by defining the problem of unsustainability, reconnecting to the biosphere forms the position statement for moving towards the solution.

### Planetary boundaries

The planetary boundaries concept (Rockström et al. 2009a; updated by Steffen et al. 2015) attempts to identify critical values for nine biophysical processes, beyond which the Earth is more likely to experience global scale regime shifts, destabilized system processes and the erosion of resilience, and will no longer support stable, Holocene-like conditions (Fig. 1). The boundaries have been framed in popular discourse as the “non-negotiable planetary pre-conditions that humanity needs to respect” (Rockström 2010). According to Rockström et al. (2009a: 475) the boundaries circumscribe “a safe operating space for humanity” in which people have “the freedom to pursue long-term social and economic development”. This safe operating space is linked temporally to the age of the Holocene, consisting of the past ~10,000 years, which Rockström et al. (2009a: 472) note has been an “unusually stable” period in the Earth’s history and has allowed human civilizations to “arise, develop and thrive”.

While human–environment connection is not explicitly discussed in the papers setting out planetary boundaries, Rockström et al. (2009b) note that boundaries are “human

determined values ... [that involve] normative judgments of how societies choose to deal with risk and uncertainty”. This recognition of the normativity embedded within planetary boundaries has been echoed by calls for an “environmentally safe and socially just space”, where the biogeophysical boundaries are complemented by the so-called “social foundation” (Raworth 2013: 4; see also Leach et al. 2013).

### Reconnecting to the biosphere

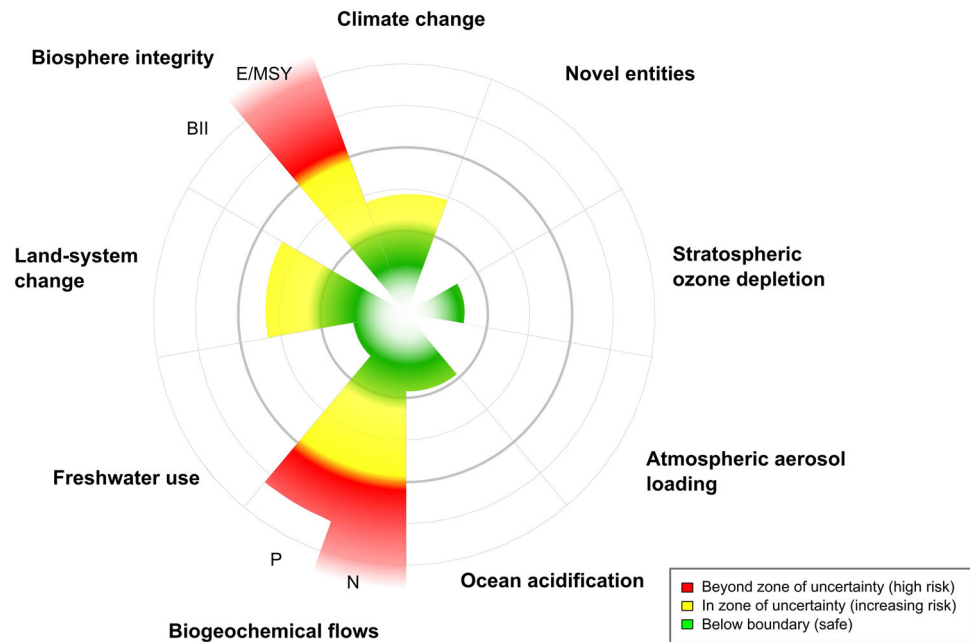
In 2011, a special section of the journal *Ambio* featured a resilience perspective on the response to the challenges posed by planetary boundaries. In the first paper of the special section, ‘Reconnecting to the Biosphere’, Folke et al. (2011) state that the “continuation of civilization requires us to stay within certain thresholds; some are moral imperatives and others are biogeophysical boundaries” (721). Folke and colleagues subsequently discuss these new moral imperatives, arguing that a “shift in mind set” is needed to reorient how we understand our relationship to the biosphere.

Folke et al. (2011: 719) begin by emphasizing the inexorable connections between humans and the biosphere, declaring “people and societies are integrated parts of the biosphere, depending on its functioning and life support while also shaping it globally”. These connections are characterized by dynamic change, interconnections across spatial scales, and gradual and abrupt temporal transformations. Folke et al. then locate present sustainability challenges in a *mental* disconnection between humans and the biosphere—“current perspectives and worldviews mentally disconnect human progress and economic growth from the biosphere”—and present this mental disconnection as a primary cause of ecological degradation (Folke et al. 2011: 270). “Reconnecting humanity to the biosphere” is, therefore, considered to be a prerequisite for staying within planetary boundaries and encouraging planetary (or earth) stewardship.

### Earth stewardship

Folke et al. (2011) provide several examples of how reconnection may take place, including natural capital investment in China and the emergence of adaptive ecosystem governance. They suggest integrative multi-level approaches to situate local initiatives within broader regional, national and international processes and contexts (Folke et al. 2011). Indeed, the authors propose harnessing local to global interconnections to enable the emergence of a new “social contract for global sustainability” under the banner of planetary/earth stewardship (Folke et al. 2011: 731). Earth stewardship is defined as “the active shaping of

**Fig. 1** The nine different planetary boundaries that, if transgressed, may threaten global biogeophysical stability and human wellbeing (adapted from Steffen et al. (2015), Copyright (2015), with permission from The American Association for the Advancement of Science)



trajectories of change in coupled social–ecological systems at local to global scales to enhance ecosystem resilience and promote human wellbeing” (Chapin et al. 2011: 45). It is suggested that the social contract underpinning earth stewardship will need to outline, “the reciprocal rights, obligations, and responsibilities between states and citizens” in relation to global sustainability (Folke et al. 2011: 731). Given that promoting earth stewardship will presumably involve identifying desirable connections between people and environment, it is vital that earth stewardship creates space for multiple types of human–environment connection.

### Re-engaging embodiment and temporality in human–environment connection

Planetary boundaries and reconnecting to the biosphere do not appear to explicitly develop the dynamic temporal perspectives on human–environment connection initially articulated by complex social–ecological systems research. Temporalities are implicit in the science of historically important global tipping points and interactions between slow and fast global change variables (Rockström et al. 2009a). But the visual representation of planetary boundaries does not explicitly consider complex interactions between variables in time that produce particular ecological assemblages, and the temporalities of the complex human practices that produce the harmful dynamics.

On the other hand, Folke et al. (2011) do directly refer to changing human–environmental relationships through

time—citing the Industrial Revolution and the ‘Great Acceleration’ of the last 50 years as important moments. Perhaps most suggestively, the selection of the prefix ‘re’ in ‘reconnecting’ suggests a past time in which humans were more connected than they are today, while the active tense suggests an ongoing process of change and co-evolution. While we do not suggest a deliberate intent in resilience thinking to advocate for a return to a past ecological state, we do think that the language of reconnecting may risk looking back uncritically to a previous ‘optimal’ biosphere condition (Head 2011; Ellis 2013).

We suggest that neglecting the temporalities that shape the different dimensions of human–environment connection risks portraying connection as a static phenomenon, rather than a heterogeneous, dynamic quality. By overlooking the biosphere’s continual temporal emergence, we risk creating a false impression that a return to an idealized (spatial) social–ecological arrangement is required (Castree 2014; Ellis 2013). Moreover, extending ‘reconnection’ from reference to the interdependence of ecological, economic and social systems, to individual or communal human relationships with the biosphere, may suggest a universal form of connection. This contrasts with earlier complex social–ecological systems literature that has framed human–environment connection as a product of historically contingent factors converging in particular contexts (e.g. Barthel et al. 2010; Davidson-Hunt and Berkes 2003).

The risks involved in conceiving of human–environment connection unitarily are illustrated in the example of Chinese natural capital investments, identified by Folke et al.

(2011) as an opportunity for reconnection. The Chinese government has, in the process of identifying and preserving natural capital, implemented a range of policies designed to change local land management practices, such as paddy farming and timber harvesting to activities like dry farming and revegetation (Liu et al. 2009; Yin and Yin 2009). These policies have been largely top-down. Xu et al. (2006: 604) point out that the local farmers had little option to choose which plots and how much of their land was retired, nor had they the right to select the tree or grass species planted. Meanwhile Chen et al. (2009) found that local cultural factors, such as social norms, were an important factor conditioning community acceptance of the government initiatives. Finally, Zheng et al. (2013) reveal the complex effects of the Paddy Land-to-Dry Land scheme on the livelihoods of participating families (an increased reliance on migrant earnings from cities) and on the environment (increased nutrient application in dry farming methods, improved water provision to downstream actors).

This example demonstrates that connection to the biosphere does not necessarily scale easily through space (between local communities, and from local communities to cities and national governments) or through time (considering the range of land use practices that have existed in these areas). An embodied sensibility may open up exploration of the different types of ‘(dis)connection’ that have developed among various actors at multiple scales, and how various human–nature connections have produced different types of landscape through time (Xu et al. 2006; Marks 2012). We see room to enhance planetary boundaries and reconnecting to the biosphere with more attention to the diverse and historically contingent processes of habituation and culture in shaping human–environment relationships and future sustainability priorities.

### Dwelling and the taskscape—operationalizing resilience

Early research into complex social–ecological systems saw the value of a dwelling perspective for operationalising resilience thinking in particular contexts (Davidson-Hunt and Berkes 2003). This engagement with dwelling focused largely on how we learn through the “practical and perceptual engagement of humans with others of the dwelt-in-ecosystem” (Davidson-Hunt and Berkes 2003: 68); dwelling’s spotlight on tangible and active processes of human–environment connection provided a useful entry point for extending the social scientific theorisation of resilience thinking. Following from the earlier introduction to dwelling, we turn to a famous application of the concept by Ingold (1993) to demonstrate how dwelling might help

us to unsettle the dominant framing of mental connection to the biosphere.

To capture the co-production and temporality of the environment (or landscape, in this case), Ingold uses the idea of the ‘taskscape’. The taskscape is the active component of dwelling that is evidenced in the landscape—the processes, movement, and ‘doing’ of people and nature that continually makes and re-makes the world. In other words, the landscape is the physical embodiment of the taskscape. Of importance here is that the taskscape does not consist of patterns of activity in isolation, but ongoing “interactivity” between human and nonhuman agents (Ingold 1993: 163). Ingold explains these processes in his discussion of Pieter Bruegel’s *The Harvesters* (Fig. 2).

Ingold (1993) pays particular attention to Bruegel’s portrayal of the pear tree that affords shelter to the harvesters. The very form of the tree—tended over time, picked of fruit and situated amidst a field that has been cultivated—reveals how the life of the tree is deeply entangled with the life of the people. Moreover, as a site of shade and rest, the tree has become a ‘place’; a place that was not pre-given, but that has materialized with the maturation of the tree. The relationship between the people and tree is not static or defined by a particular point in time. Nor is this relationship characterized only by a mental connection or reconnection between people and nature—it is also an intimate, physical and bodily relationship.

Capturing the historic and culturally dynamic dwelling together of humans and nonhumans in a twenty-first century biosphere can help to facilitate a diversity of responses to the transgression of planetary boundaries (Cloke and Jones 2004; Lien and Davison 2010; Raymond et al. 2013).



**Fig. 2** Ingold (1993) suggests that the landscape depicted in the *The Harvesters*, by Pieter Bruegel, captures how the ongoing togetherness of people and environment structures our practices, movement and understanding of that space

## What can dwelling offer to the planetary boundaries concept?

The concept of dwelling as a local scale process may seem diametrically opposed to the representation of global, planetary boundaries. Indeed, in the essay ‘Globes and Spheres’ Ingold (2000: 211) examines how the representation of the environment as a globe has drawn “‘the world’, as we are taught it exists [...] ever further from the matrix of our lived experience”. For Ingold, the ontology of a global environment places humans outside nature: “a distinction is commonly made between the real environment that is given independent of the senses, and the perceived environment as it is reconstructed in the mind... The starting point of all such accounts is an imagined separation between the perceiver and the world, in the mind, prior to any meaningful engagement with it” (Ingold 2000: 178).

While planetary boundaries are framed by Rockström and Klum (2012: 31) as a “move away from the prevailing societal paradigm in which we perceive ourselves as being apart from the planet to being a part of the planet”, the distinction made between human perceptions and a non-negotiable biophysical substrate resembles the representation that Ingold critiques. As Rockström and Klum write, the proposed solution is “a mind shift at the scale of a ‘Copernican revolution’ in the long-term, to put our minds in harmony with the earth system we depend on” (Rockström and Klum 2012: 49). This suggests a paradox where the social and ecological are presented as inseparable in resilience thinking, while at the same time, dominant framings work to ontologically separate mind from matter and, consequently, people from their surrounding environment.

In a dwelling perspective, knowing and acting are not distinctly separable but rather co-constituted. Following Ingold and Davidson-Hunt and Berkes, becoming part of our planet requires a discussion of the ways in which people relate to and engage in their social–ecological context materially and culturally. A dwelling perspective encourages operationalizing planetary boundaries in conjunction with people’s everyday lifeworld, which can then be used as local entry points into global sustainability challenges.

Global perspectives, such as planetary boundaries, have the potential to detach people from their immediate lifeworld. While dwelling emphatically locates people in this world, it does not connect to global flows of social–ecological relations in the manner achieved by planetary boundaries. As Ingold (2000: 216) suggests: “we could say that both perspectives are caught up in the dialectical interplay between engagement and detachment, between

human beings’ involvement in the world and their separation from it [...]” The dialectical interplay of globally represented concepts like planetary boundaries, and EHSS concepts like dwelling, can create room for other ways of understanding human–environment connection. In this section, we explore this room by discussing one of the nine planetary boundaries—the biodiversity boundary.

### Biodiversity from a planetary boundary and dwelling perspective

Rockström et al. (2009a) present biodiversity as one of three boundaries that have already been transgressed. They note, however, that because biodiversity is a slow process without known global level thresholds, and because there is incomplete knowledge about the role of ecosystem functioning across scales, setting the position of the boundary is highly uncertain. Moreover, as Mace et al. (2014: 290) point out, the very characterization of the relationships between biodiversity, ecosystems and human wellbeing in terms of boundaries has prompted scientific controversy (e.g. Brook et al. 2013; Hughes et al. 2013). In this section we take a brief look at some of the conceptual difficulties of conceiving of human–biodiversity relations in terms of boundaries. We use dwelling to indicate an alternative framing of planetary boundaries, away from non-negotiability, that maintains space for diverse forms of human–environment connection.

Planetary boundaries researchers have encountered two closely interrelated challenges in constructing a biodiversity boundary. First, how to consistently and meaningfully scale the effects of biodiversity change on ecosystems and human wellbeing from local to global (and vice versa). Cornell (2012) notes that planetary boundaries include “systemic processes that manifest themselves at the global scale”, such as climate change and stratospheric ozone depletion, and “environmental issues that become critical global problems when they are aggregated from the regional and local scale”, such as land use and biodiversity change. Aggregation from local to global scales works well for systemic processes, “because local inputs or changes make a predictable contribution to global processes with known thresholds” (Mace et al. 2014: 290). But for environmental issues, such as biodiversity change, recognized as “complex human–system–ecosystem processes not easily associated with known global or continental thresholds”, aggregation from local to global is far less straightforward (Mace et al. 2014: 290). This is because the multiple dynamic elements of biodiversity—including species richness, phylogenetic species variability and functional diversity—interact to affect ecosystems and human wellbeing in complex and uneven ways across spatial and temporal scales.

This complex picture of biodiversity change and accompanying effects on human wellbeing brings the second problem into view—how to identify a control and response variable for a global level biodiversity boundary. Indeed, Pereira et al. (2013) have suggested a minimum of 22 important variables for monitoring and managing biodiversity change. Rockström et al. (2009a) initially constructed a boundary with global species extinction rate as the control variable and ecosystem functioning as the response variable. However, a number of problems with this approach were identified (e.g. Cornell 2012; Brook et al. 2013) not least because it is unclear how global species loss will affect ecosystem functioning “at scales relevant to the safe operating space” (Mace et al. 2014: 290). For instance, species’ roles in ecosystem change over time; while species are being lost at the global scale, this does not always translate to corresponding declines in local species richness or in ecosystem function (e.g. Ellis et al. 2012; Thomas 2013). Steffen et al. (2015) have subsequently attempted to address these issues in a revised biodiversity boundary, now labeled “biosphere integrity”. The control variable for the revised boundary is split in two—genetic diversity, provisionally measured by extinctions per million species-years (E/MSY) at the global scale (until global measures of phylogenetic species variability are available), and functional diversity measured at the large ecosystem or biome scale by the biodiversity intactness index (BII). Currently, there is little evidence of a relationship between the change measured by the BII and global scale effects (Steffen et al. 2015).

A dwelling perspective helps to articulate the difficulties faced by the planetary boundaries researchers in constructing the biodiversity boundary, by (a) highlighting the importance of time to changing relationships between biodiversity, ecosystems and human wellbeing across scales, and (b) emphasizing the relational nature of boundaries. This may complement planetary boundaries thinking (Steffen et al. 2015) in dealing with the challenge of rapid biodiversity change. Existing work on dwelling tends to refer to biodiversity in the broad sense of interrelationships between nonhuman species and between humans and nonhumans (e.g. Ingold 2000). In this context, dwelling differs to dominant approaches in the biological sciences that characterize biodiversity in terms of form (genetic make-up or functional role of species), rather focusing attention on the “patterns of activity” that give rise to particular ecological forms (Ingold 2000: 185).

First, by framing the relationships between humans and nonhumans as an ongoing pattern of activities, dwelling draws attention to the importance of time in describing the relationships between biodiversity, ecosystems and human wellbeing. For instance, as species diversity, abundance and function change in an ecosystem, so do human abilities

to benefit from such functions and the potential risks of losing them. From a dwelling perspective, any boundary constructed in this context will carry embedded temporalities. As Mace et al. (2014) observe, existing metrics of biodiversity hold relevance for human wellbeing at differing timescales. The benefits accrued by humans from genetic diversity become apparent over tens of thousands of years, the benefits obtained from biome resilience are expressed over thousands of years, whereas measures based on functional traits refer to the traits known to benefit human wellbeing today. By not being explicit about the embedded temporal dimensions of metrics used to construct global level boundaries like biodiversity, we risk oversimplifying their application at national, regional or local scales.

Second, through a dwelling perspective, a biodiversity boundary appears as relational: not an inherent feature of ecological processes, nor a human construct, but emergent from each. As Ingold (1993: 156) writes about the more familiar landscape boundaries of hedgerows and fences: “[...] no feature of the landscape is, of itself, a boundary. It can only become a boundary or the indicator of a boundary, in relation to the activities of the people (or animals) for whom it is recognized or experienced as such”. Recognition of the relational aspect of boundaries is increasingly acknowledged in the planetary boundaries literature. Rather than representing non-negotiable biophysical preconditions, Mace et al. (2014) and Steffen et al. (2015) emphasize that planetary boundaries represent values for control variables that are set at a safe distance from potential thresholds *relevant for humans*. Boundaries are, therefore, products of ecological change, the potential or perceived effects of ecological change on human wellbeing, the level of (un)acceptable risk associated with these potential effects, and our inherently uncertain knowledge about all of these dimensions. As such, setting a particular boundary entails “normative judgments of how societies choose to deal with risk and uncertainty” (Rockström et al. 2009a). It follows that setting a boundary in any particular context requires identification of the relations and interactions between human practices and processes of biogeophysical change.

Evidently, in response to the complexity of such an endeavor, Steffen et al. (2015) state that planetary boundaries are not designed to be scaled down to regional and national levels. Nevertheless, the authors acknowledge that ‘planetary boundaries thinking’ has captured the imagination of “policy, business, and governance sectors”, and researchers have already begun to apply the framework at national scales (Nykqvist et al. 2013; Cole et al. 2014). The planetary boundary concept is, therefore, likely to have a significant effect on actions designed to shape and stimulate national and local environmental engagement. Given



this, we think it is important to recognize the relational nature and temporal contingency of planetary boundaries to maintain space for plural enactments of human–environment connection. Dwelling shifts the framings of human–environment connection in resilience thinking from becoming cognitively aware of non-negotiable biogeophysical realities, to the interactivity between our actions, our knowledge, and environmental processes over time. Acknowledging the relational nature of planetary boundaries does not preclude the value of the planetary boundaries framework for illuminating potentially dangerous biogeophysical change (particularly in global policy arenas). However, we do seek to draw out the ways in which boundaries are co-constituted from a plurality of human perceptions, practices and environmental processes, in ways that may accommodate the use of the concept at regional and local scales.

### What can dwelling offer reconnecting to the biosphere and earth stewardship?

The way we construct the biosphere and our relationship to it through sustainability concepts will shape a specific trajectory of future actions and possibilities in the Anthropocene (Rickards et al. 2014). In framing sustainability responses, we find it useful to think about enacting the biosphere, rather than reconnecting to it. Our current biosphere relationship may be problematic but our inextricable connection to it cannot be severed. Therefore, the framing for resilience shifts from simply reconnecting to the biosphere through a change in mindset, to the ways we are enacting our relationship to the biosphere through everyday life. Dwelling can help to make us more conscious of the myriad ways in which we are already connected through time and space. Thus, the conversation turns to exploring how we can foster, augment or dwell in the biosphere in a way that recognizes historical and cultural contingency, and with greater care for the nonhumans with which we dwell (van Dooren 2014). We now consider how the notion of earth stewardship could be adapted as a vehicle for enacting the biosphere.

### From reconnecting to enacting the biosphere: embodied stewardship

As resilience thinking and complex adaptive systems thinking are foundational to the notion of earth stewardship, it holds potential for advancing bodily human–environment connection. Earth stewardship has been noted as an “action-orientated” heuristic for change in resilience thinking (Chapin et al. 2011: 45), evoking the language of bodily engagement. As such, we can use dwelling to

interpret earth stewardship in a way that retains its attentiveness to global processes, whilst shedding light on active and temporal social–ecological processes at the local scale.

At present, resilience interpretations of earth stewardship have been bound up with the mental connection we have identified (Folke et al. 2011; Chapin et al. 2011). Formulated this way, stewardship emerges in the mind and is then applied to the world; first comes thinking, followed by doing. In contrast, when formulated from a dwelling perspective where thinking and doing are entwined, stewardship develops from a change in one’s direct engagement with everyday surroundings (Cooke and Lane 2015; Ingold 2000). The starting point in a dwelling perspective is consequently not the global but the local. A dwelling perspective also suggests that earth stewardship has to come, in part, from people’s involvement and experience of their lifeworld. To conceptualize earth stewardship from a dwelling perspective we must conceive of a world “given in experience” (Ingold 2000: 161).

So, what might embodied stewardship look like with people as active cohabitants of the biosphere? With 80 % of the world population predicted to live in cities within 20 years (Chapin et al. 2011), cities provide a relevant context for exploring this question. Indeed, Folke et al. (2011) identify rapid urbanization as a clear source of our disconnection from nature. We suggest that practices like urban greening, urban agriculture and foraging for edible plants in an urban landscape can exemplify types of embodied earth stewardship (Fig. 3).

For example, weeds are generally considered to be flora outside of a historical range—species that have been transported from elsewhere, often through global processes of trade, transportation and exchange. As a ‘non-native’



**Fig. 3** Foraging for edible weeds in an urban environment represents a type of enacting of the biosphere in a way that encourages an embodied form of earth stewardship (photo courtesy of Adam Grubb, Very Edible Gardens™)

form of biodiversity, they afford us the opportunity to enact biosphere connections in the spaces where we live. The practice of foraging for edible weeds (a hands-on process in the most literal sense) is a form of environment interaction that is not orientated towards restoring past ecologies, but towards a willingness to be “transformed by the world in which we find ourselves” (Graham and Roelvink 2010: 322). Foraging is an urban interaction that embraces the interactivity of people and environment (Macnaghten 2008). Rather than seeking to re-connect with a form of biodiversity that exists outside the urban environment, or to recreate an ecological arrangement that existed prior to the social–ecological transformations of the Anthropocene, practices like urban foraging capture an operationalization of resilience at a local scale.

Instead of identifying the need for a new social contract for sustainability, as advocated through earth stewardship, Davidson-Hunt and Berkes (2003) used a dwelling perspective to propose the creation of “learning contexts to reconnect [people] to the land... and building their own memories and skills in relationship with the land” (75). The creation of memories and development of skills and practices in urban environments must be drawn alongside efforts to shift mindsets (e.g. Barthel et al. 2010). The process of “learning or enskilling” through which people “can build his or her own perceptual skills in relation to the total environment, biophysical and social” (Davidson-Hunt and Berkes 2003: 69) needs to be folded into an expanded conception of earth stewardship. This type of enskilling can be fostered by the “experience of conducting one’s life in a particular environment” (Ingold 2000: 25). Or to put it in Davidson-Hunt and Berkes’ words: dwelling captures the ways in which people are “attentive to humans, other animals, and life processes of the landscape in which they dwell” (Davidson-Hunt and Berkes 2003: 75).

An embodied sense of stewardship can also help to foster an ethic of care about the nonhumans with which we share the biosphere (Suchet-Pearson et al. 2013). While dwelling locates people as an element of an emerging biosphere, this notion of moving along with the world as it transforms itself does not abdicate us of responsibility for the character and form of that movement (Boonstra 2016). As stewards and participants in the making of the world, an ethical engagement with nonhuman actors is a necessary precondition for a hopeful trajectory of planetary change.

Of course, a focus on dwelling does not deny the importance of global environmental processes, but highlights that these need to be operationalized in relation to people’s experiences. Stewardship’s potential to emerge at the local level through everyday experience is more than a point of common interest—it has direct relevance for scientists and policy makers engaging with global governance discourses. The failure to connect processes of global

environmental change to local contexts runs the risk of only aligning stewardship with global responses, rather than making room for local opportunities for action (Beilin and Bohnet 2015). Moreover, the disconnection between local and global process can leave unchallenged the kind of technical fixes that are so often triggered from global or planetary perspectives (Ingold 2000: 216–217).

However, connecting GEC research like resilience with dwelling will not always be a harmonious endeavor that meets the needs and intentions of GEC objectives. Stewardship emergent from dwelling may not align with, and in some cases may openly conflict with framings of stewardship deployed at regional and global scales. Ogden et al. (2013), for example, draw attention to the ways that deployments of stewardship by global actors such as the United Nations may conflict with place-based social movements around the world. They argue, consequently, “Earth Stewardship requires a willingness to recognize the politics of the Anthropocene and the socioecological consequences of such politics” (Ogden et al. 2013: 346). Yet, it is these very tensions and challenges that make the dialog between dwelling and the resilience literature vital, as it helps us to see the plurality of human–environment connections and the ways that they are temporally and spatially contingent.

## Conclusion

In this paper, we have developed an embodied human–environment connection by placing the prominent resilience concepts of planetary boundaries, reconnecting to the biosphere and earth stewardship in dialog with a dwelling perspective. While ambitious in scope, involving inevitable simplifications, this approach is valuable for illuminating the dominant framing of resilience, while also highlighting the value of complementing this framing with different perspectives. In developing an embodied connection, we have re-ignited formative engagements between resilience and dwelling first developed by Davidson-Hunt and Berkes (2003). An embodied connection has encouraged a stronger temporal framing of human–environment relations in contemporary resilience thinking. It has enabled us to present the biosphere as constituted of the ongoing interactivity of people with the environment, reinforcing the formative resilience commitment that separation between the social and the ecological is arbitrary. In this sense, dwelling materializes our relationship to the biosphere—the making of the biosphere through time gives a tangible sense to this relationship—and reminds us that human–environment connection is “of the mind, and of the hands, of neither alone” (Berry 1981: 275).

Framings of prominent resilience concepts which juxtapose mindsets with biophysical realities can run the risk of reinforcing the ontological separation of the social and ecological elements they seek to connect. Using transactional/relational EHSS concepts like dwelling to emphasize the ways that human–environment connections evolve through habituation, culture, and everyday practice, we can discuss the emergent ways in which human–environment relations develop (Carolan 2014). Moreover, examining the mutually constitutive relations between knowing and acting is one way of opening up resilience concepts to questions of agency, justice and power (Boonstra 2016) in ways that may stimulate exciting new research. Note that we do not advocate a grand integration or reconciliation of resilience and dwelling perspectives—but rather hope that we have contributed to an opening up of plural trajectories for resilience research while demonstrating how linkages between GEC and EHSS can be pursued. We conclude with some insights of relevance for sustainability science researchers who are interested in such a pursuit (Box 1).

### Box 1: Insights from the cross-fertilization of dwelling and contemporary framings of resilience

Dwelling does not readily translate into a definition with fixed and specific attributes or benchmarks. Consequently, it does not lend itself to the formulation of, for instance, a new resilience principle. Rather, EHSS ideas like dwelling constitute a “sensitizing concept” that can give a “general sense of reference and guidance in approaching empirical instances [and] suggests directions along which to look” (Blumer 1954: 7). As a way of “seeing, organizing, and understanding experience” (Charmaz 2003: 259) we believe that EHSS concepts like dwelling can provide useful insights for future resilience research that engages with human–environment connection.

- **From components to holism:** While starting from a holistic perspective in theory, resilience thinking from an interactional perspective tends to break the ‘social–ecological’ into ‘social’ and ‘ecological’ components for the purpose of analysis. Rather than identifying social–ecological components (e.g. boxes in systems diagrams), relational/transactional worldviews can help researchers examine emergent processes and change (e.g. the arrows between the boxes in systems diagrams) (Feldman and Orlikowski 2011). This shift highlights the actions and practices through which things adapt, develop or break down as part of a holistic process.
- **Conceptual underpinnings:** Engaging with human–environment connection in resilience thinking means

putting to work social theory. This paper suggests the importance of ensuring this is a conscious engagement with theoretical underpinnings and their implications, which reflects the policy or research problem at hand. The presence of interactional perspectives in currently prominent resilience concepts suggests great potential for new insights by embracing a wider range of EHSS theories and perspectives.

- **Mental and embodied connection:** Recognizing that connections between humans and nonhumans in the biosphere have both a mental and embodied character means being attentive to bodily interactions. For example, engaging with transactional/relational theories can help to make sense of discrepancies that emerge between conscious desires and human action. Exploring how sustainability practices materialize through everyday experience can reveal unanticipated challenges, constraints and opportunities for sustainability initiatives.
- **Temporality:** Relational/transactional worldviews offer sustainability researchers the opportunity to think about the biosphere as an ongoing relationship between people and environment. A broader engagement with social theory may help complement the current emphasis on spatial representations of sustainability challenges (like planetary boundaries) by reinvigorating a much needed emphasis on temporality in resilience thinking.

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### References

- Adams PC (2016) Placing the Anthropocene: a day in the life of an enviro-organism. *Trans Inst Br Geogr* 41(1):54–65. doi:10.1111/tran.12103
- Altman I, Rogoff B (1987) World views in psychology: trait, interactional, organismic and transactional perspectives. In: Stokols D, Altman I (eds) *Handbook of environmental psychology*, vol 1. Wiley, New York, pp 1–40
- Barthel S, Folke C, Colding J (2010) Social–ecological memory in urban gardens—retaining the capacity for management of ecosystem services. *Global Environ Change* 20(2):255–265. doi:10.1016/j.gloenvcha.2010.01.001
- Beilin R, Bohnet IC (2015) Culture–production–place and nature: the landscapes of somewhere. *Sustain Sci* 10(2):195–205. doi:10.1007/s11625-015-0289-5

- Berkes F, Folke C (eds) (1998) Linking social and ecological systems: management practices and social mechanisms for building resilience. Cambridge University Press, Cambridge, pp 1–27
- Berkes F, Colding J, Folke C (2003) Navigating social-ecological systems: building resilience for complexity and change. Cambridge University Press, Cambridge, UK
- Berry W (1981) The gift of good land: further essays cultural and agricultural. North Point Press, San Francisco
- Biermann F, Abbott K, Andresen S, Bäckstrand K, Bernstein S, Betsill MM, Bulkeley H, Cashore B, Clapp J, Folke C et al (2012) Navigating the Anthropocene: improving earth system governance. *Science* 335(6074):1306–1307. doi:[10.1126/science.1217255](https://doi.org/10.1126/science.1217255)
- Biggs D, Abel N, Knight AT, Leitch A, Langston A, Ban NC (2011) The implementation crisis in conservation planning: could “mental models” help? *Conserv Lett* 4:169–183. doi:[10.1111/j.1755-263X.2011.00170.x](https://doi.org/10.1111/j.1755-263X.2011.00170.x)
- Blumer H (1954) What is wrong with social theory? *Am Sociol Rev* 18:3–10
- Boonstra WJ (2016) Conceptualizing power to analyze social-ecological interactions. *Ecol Soc* 21(1):21
- Boonstra WJ, de Boer FW (2014) The historical dynamics of social-ecological traps. *Ambio* 43(3):260–274
- Brook BW, Ellis EC, Perring MP, Mackay AW, Blomqvist L (2013) Does the terrestrial biosphere have planetary tipping points? *Trends Ecol Evol* 28(7):396–401
- Brown K, Westaway E (2011) Agency, capacity, and resilience to environmental change: lessons from human development, well-being, and disasters. *Annu Rev Environ Resour* 36:321–342
- Burton R (2004) Reconceptualising the ‘behavioural approach’ in agricultural studies: a socio-psychological perspective. *J Rural Stud* 20(3):359–371. doi:[10.1016/j.jrurstud.2003.12.001](https://doi.org/10.1016/j.jrurstud.2003.12.001)
- Cairns R, Stirling A (2014) Maintaining planetary systems’ or ‘concentrating global power? High stakes in contending framings of climate geoengineering. *Global Environ Change* 28:25–38
- Carolan M (2014) Affective sustainable landscapes and care ecologies: getting a real feel for alternative food communities. *Sustain Sci* 10(2):317–329. doi:[10.1007/s11625-014-0280-6](https://doi.org/10.1007/s11625-014-0280-6)
- Castree N (2014) The Anthropocene and the environmental humanities: extending the conversation. *Environ Hum* 5:233–260
- Castree N, Adams WM, Barry J, Brockington D, Büscher B, Corbera E, Wynne B (2014) Changing the intellectual climate. *Nat Clim Change* 4(9):763–768. doi:[10.1038/nclimate2339](https://doi.org/10.1038/nclimate2339)
- Chapin FS, Pickett ST, Power ME, Jackson RB, Carter DM, Duke C (2011) Earth stewardship: a strategy for social-ecological transformation to reverse planetary degradation. *J Environ Stud Sci* 1(1):44–53. doi:[10.1007/s13412-011-0010-7](https://doi.org/10.1007/s13412-011-0010-7)
- Charmaz K (2003) Grounded theory: objectivist and constructivist methods. In: Denzin NK, Lincoln YS (eds) *Strategies for qualitative inquiry*, 2nd edn. Sage, Thousand Oaks, pp 249–291
- Chen X, Lupi F, He G, Liu J (2009) Linking social norms to efficient conservation investment in payments for ecosystem services. *PNAS* 106(28):11812–11817
- Cloke P, Jones O (2004) Turning in the graveyard: trees and the hybrid geographies of dwelling, monitoring and resistance in a Bristol cemetery. *Cult Geogr* 11(3):313–341. doi:[10.1191/1474474004eu3000a](https://doi.org/10.1191/1474474004eu3000a)
- Cole M, Bailey RM, New G (2014) Tracking sustainable development with a national barometer for South Africa using a downscaled “safe and just space space” framework. *PNAS* 111(42):E4399–E4408
- Cooke B, Lane R (2015) How do amenity migrants learn to be environmental stewards of rural landscapes? *Landsc Urban Plan* 134:43–52. doi:[10.1016/j.landurbplan.2014.10.006](https://doi.org/10.1016/j.landurbplan.2014.10.006)
- Cornell S (2012) On the system properties of the planetary boundaries. *Ecol Soc* 17(1):r2. doi:[10.5751/ES-04731-1701r02](https://doi.org/10.5751/ES-04731-1701r02)
- Cote M, Nightingale AJ (2011) Resilience thinking meets social theory: situating change in socio-ecological systems (SES) research. *Prog Hum Geogr* 36(4):475–489. doi:[10.1177/0309132511425708](https://doi.org/10.1177/0309132511425708)
- Davidson-Hunt I, Berkes F (2003) Nature and society through the lens of resilience: toward a human-in-ecosystem perspective. In: Berkes F, Folke C (eds) *Navigating social-ecological systems: building resilience for complexity and change*. Cambridge University Press, Cambridge, pp 33–52
- Ellis EC (2013) Sustaining biodiversity and people in the world’s anthropogenic biomes. *Curr Opin Environ Sustain* 5(3–4):368–372. doi:[10.1016/j.cosust.2013.07.002](https://doi.org/10.1016/j.cosust.2013.07.002)
- Ellis EC, Antill EC, Kreft H (2012) All is not loss: plant diversity in the Anthropocene. *PLoS One* 7(1):1–9
- Feldman MS, Orlikowski WL (2011) Theorizing practice and practicing theory. *Organ Sci* 22(5):1240–1253
- Folke C (2006) Resilience: the emergence of a perspective for social-ecological systems analyses. *Global Environ Change* 16(3):253–267. doi:[10.1016/j.gloenvcha.2006.04.002](https://doi.org/10.1016/j.gloenvcha.2006.04.002)
- Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of social-ecological systems. *Annu Rev Environ Resour* 30:441–473
- Folke C, Pritchard L, Berkes F, Colding J, Svedin U (2007) The problem of fit between ecosystems and institutions: ten years later. *Ecol Soc* 12(1):30
- Folke C, Jansson Å, Rockström J, Olsson P, Carpenter SR, Chapin FS, Westley F (2011) Reconnecting to the biosphere. *Ambio* 40(7):719–738. doi:[10.1007/s13280-011-0184-y](https://doi.org/10.1007/s13280-011-0184-y)
- Galaz V (2014) *Global environmental governance, technology and politics: the Anthropocene gap*. Edgar Elgar Publishing, Northampton
- Gibson J (1979) *The ecological approach to visual perception*. Houghton Mifflin, Boston
- Graham JKG, Roelvink G (2010) An economic ethics for the Anthropocene. *Antipode* 41:320–346. doi:[10.1111/j.1467-8330.2009.00728.x](https://doi.org/10.1111/j.1467-8330.2009.00728.x)
- Gunderson LH, Holling CS (eds) (2002) *Panarchy: understanding transformations in human and natural systems*. Island Press, Washington, DC
- Hajer M, Nilsson M, Raworth K, Bakker P, Berkhout F, de Boer Y, Rockström J, Ludwig K, Kok M (2015) Beyond cockpitism: four insights to enhance the transformative potential of the sustainable development goals. *Sustainability* 7(2):1651–1660
- Head L (2011) Decentering 1788: beyond biotic nativeness. *Geogr Res*. doi:[10.1111/j.1745-5871.2011.00746.x](https://doi.org/10.1111/j.1745-5871.2011.00746.x)
- Heft H (2001) *Ecological psychology in context: James Gibson, Roger Barker and William James’s radical empiricism*. Lawrence Erlbaum Associates, New Jersey
- Hornborg A (2009) Zero-sum world: challenges in conceptualizing environmental load displacement and ecologically unequal exchange in the world-System. *Int J Comp Sociol* 50(3–4):237–262
- Hughes TP, Carpenter S, Rockstrom J, Scheffer M, Walker B (2013) Multiscale regime shifts and planetary boundaries. *Trends Ecol Evol* 28:389–395
- Ingold T (1993) The temporality of the landscape. *World Archaeol* 25(2):152–174. doi:[10.1080/00438243.1993.9980235](https://doi.org/10.1080/00438243.1993.9980235)
- Ingold T (2000) *The perception of the environment: essays on livelihood, dwelling and skill*. Routledge, London and New York
- Ingold T (2011) *Being alive: essays on movement, knowledge and description*. Routledge, New York
- ISSC and UNESCO (2013) *World Social Science Report 2013. Changing global environments*. OECD Publishing and UNESCO Publishing, Paris

- Kasper DVS (2009) Ecological habitus: toward a better understanding of socio-ecological relations. *Organ Environ* 22(3):311–326. doi:10.1177/1086026609343098
- Lade SJ, Tavoni A, Levin SA, Schlüter M (2013) Regime shifts in a social–ecological system. *Theor Ecol* 6:359–372. doi:10.1007/s12080-013-0187-3
- Leach M, Raworth K, Rockström J (2013) Between social and planetary boundaries: navigating pathways in the safe and just space for humanity. In: ISSC/UNESCO, World Social Science Report 2013: changing global environments. OECD Publishing and Unesco Publishing, Paris. doi:10.1787/9789264203419-10-en
- Lien ME, Davison A (2010) Roots, rupture and remembrance: the Tasmanian lives of the Monterey Pine. *J Mater Cult* 15(2):233–253. doi:10.1177/1359183510364078
- Liu J, Li S, Ouyang Z, Tam C, Chen X (2009) Ecological and socioeconomic effects of China's policies for ecosystem services. *PNAS* 105(28):9477–9482
- Mace GM et al (2014) Approaches to defining a planetary boundary for biodiversity. *Global Environ Change* 28:289–297
- Macnaghten P (2008) Embodying the environment in everyday life practices. *Sociol Rev* 51(1):63–84. doi:10.1111/1467-954X.00408
- Macnaghten P, Urry J (1998) *Contested natures*. Sage, London
- Marks RB (2012) *China: its environment and history*. Rowman & Littlefield Publishers, Plymouth
- Martin-Breen P, Anderies JM (2011) Resilience: a literature review. The Rockefeller Foundation. <http://www.rockefellerfoundation.org/blog/resilience-literature-review>
- Meadowcroft J (2009) What about the politics? Sustainable development, transition management, and long term energy transitions. *Policy Sci* 42(4):323–340
- Nadasdy P (2007) The gift in the animal: the ontology of hunting and human–animal sociality. *Am Ethnol* 31(4):27–43
- Nykqvist B et al (2013) National environmental performance on planetary boundaries: a study for the Swedish Environmental Protection Agency. Stockholm Environment Institute, Stockholm
- Ogden L, Heynen N, Oslender U, West P, Kassam K-A, Robbins P (2013) Global assemblages, resilience, and Earth Stewardship in the Anthropocene. *Front Ecol Environ* 11(7):341–347. doi:10.1890/120327
- Olsson P, Folke C, Galaz V, Hahn T, Schultz L (2007) Enhancing the fit through adaptive comanagement: creating and maintaining bridging functions for matching scales in the Kristianstads Vattenrike Biosphere Reserve Sweden. *Ecol Soc* 12(1):28
- Palsson G, Szerszynski B, Sörlin S, Marks J, Avril B, Crumley C, Hackmann H, Holm P, Ingram J, Kirman A, Buendía BP, Weehuizen R (2013) Reconceptualizing the “Anthropos” in the Anthropocene: integrating the social sciences and humanities in global environmental change research. *Environ Sci Policy* 28:3–13
- Pelling M, Manuel-Navarrete D (2011) From resilience to transformation: the adaptive cycle in two Mexican urban centers. *Ecol Soc* 16(2):11
- Pereira HM, Ferrier S, Walters M, Geller GN, Jongman RHG, Scholes RJ, Bruford MW, Brummitt N, Butchart SHM, Cardoso AC, Coops NC, Dulloo E, Faith DP, Freyhof J, Gregory RD, Heip C, Höft R, Hurr G, Jetz W, Karp DS, McGeoch MA, Obura D, Onoda Y, Pettorelli N, Reyers B, Sayre R, Scharlemann JPW, Stuart SN, Turak E, Walpole M, Wegmann M (2013) Essential biodiversity variables. *Science* 339:277–278
- Raworth K (2013) A safe and just space for humanity: can we live within the doughnut? Oxfam Discussion Paper. <https://www.oxfam.org/sites/www.oxfam.org/files/dp-a-safe-and-just-space-for-humanity-130212-en.pdf>
- Raymond CM, Singh G, Benessaiah K, Bernhard JR, Levine J, Nelson H, Turner NJ, Norton B, Tam J, Chan K (2013) Ecosystem services and beyond: using multiple metaphors to understand human–environment relationships. *Bioscience* 63(7):536–546
- Rickards L, Ison R, Funfgeld H, Wiseman J (2014) Opening and closing the future: climate change, adaptation, and scenario planning. *Environ Plan C Gov Policy* 32(4):587–602. doi:10.1068/c3204ed
- Rockström J (2010) Let the environment guide our development. [http://www.ted.com/talks/johan\\_rockstrom\\_let\\_the\\_environment\\_guide\\_our\\_development.html](http://www.ted.com/talks/johan_rockstrom_let_the_environment_guide_our_development.html) (retrieved 19 May 2015)
- Rockström J, Klum M (2012) *The human quest: prospering within planetary boundaries*. Bokforlaget Max Strom, Stockholm
- Rockström J et al (2009a) A safe operating space for humanity. *Nature* 461:472–475
- Rockström J et al (2009b) Planetary boundaries: exploring the safe operating space for humanity. *Ecol Soc* 14(2):32
- Scheffer M, Carpenter SR (2003) Catastrophic regime shifts in ecosystems: linking theory to observation. *Trends Ecol Evol* 18:648–656
- Scheffer M, Carpenter S, Foley JA, Folke C, Walker B (2001) Catastrophic shifts in ecosystems. *Nature* 413:591–596
- Scoones I (1999) New ecology and the social sciences: what prospects for a fruitful engagement? *Annu Rev Anthropol* 28:479–507
- Smith A, Stirling A (2007) Moving outside or inside? Objectification and reflexivity in the governance of socio-technical systems. *J Environ Plan Policy Manage* 9(3–4):351–373
- Steffen W, Persson A, Deutsch L, Zalasiewicz J, Williams M, Richardson K, Crumley C, Crutzen P et al (2011) The Anthropocene: from global change to planetary stewardship. *Ambio*. doi:10.1007/s13280-011-0185-x
- Steffen W et al (2015) Planetary boundaries: guiding human development on a changing planet. *Sci* 347(736):1259855
- Stirling A (2010) Keep it complex. *Nature* 468:1029–1031. <http://www.nature.com/nature/journal/v468/n7327/abs/4681029a.html>
- Suchet-Pearson S, Wright S, Lloyd K, Burarrwanga L (2013) Caring as country: towards an ontology of co-becoming in natural resource management. *Asia Pac Viewpoint* 54(2):185–197. doi:10.1111/apv.12018
- Thomas CD (2013) Local diversity stays about the same, regional diversity increases, and global diversity declines. *PNAS* 110:19187–19188
- Thrift N (2008) *Non-representational theory: space, politics, affect*. Routledge, New York
- Tilley C (2004) Mind and body in landscape research. *Camb Archaeol J* 14(1):77–80. doi:10.1017/S0959774304240057
- van Dooren T (2014) *Flight ways: life and loss at the edge of extinction*. Columbia University Press, New York
- Watts M (2011) On confluences and divergences. *Dialogues Hum Geogr* 1(1):84–89
- West S, Haider J, Sinare H, Karpouzoglou (2014) Beyond divides: prospects for synergy between resilience and pathways approaches to sustainability. STEPS Working Paper 65. STEPS Centre, Brighton
- Whatmore S (2002) *Hybrid geographies: natures, cultures, spaces*. Sage, London
- Xu J, Yin R, Li Z, Liu C (2006) China's ecological rehabilitation: unprecedented efforts, dramatic impacts, and requisite policies. *Ecol Econ* 57:595–607
- Yin R, Yin G (2009) China's ecological restoration programs: initiation, implementation, and challenges. In: Yin R (ed) *An integrated assessment of China's ecological restoration programs*. Springer, Dordrecht, pp 1–19
- Zheng H et al (2013) Benefits, costs, and livelihood implications of a regional payment for ecosystem service program. *PNAS* 110(41):11681–11686