



Transformational responses to climate change: beyond a systems perspective of social change in mitigation and adaptation

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There is a growing imperative for responses to climate change to go beyond incremental adjustments, aiming instead for society-wide transformation. In this context, sociotechnical (ST) transitions and social–ecological (SE) resilience are two prominent normative agendas. Reviewing these literatures reveals how both share a complex-systems epistemology with inherent limitations, often producing managerial governance recommendations and foregrounding material over social drivers of change. Further interdisciplinary dialogue with social theory is essential if these frameworks are to become more theoretically robust and capable of informing effective, let alone transformational, climate change governance. To illustrate this potential, ideas from Deleuze and Guattari’s political writing as well as other approaches that utilize the notion social fields (as opposed to socio-systems) are combined to more fully theorize the origins and enactment of social change. First, the logic of systems is replaced with the contingency of assemblages to reveal how pluralism, not elitism, can produce more ambitious and politicized visions of the future. In particular, this view encourages us to see social and ecological tensions as opportunities for thinking and acting differently rather than as mere technical problems to be solved. Secondly, the setting of social fields is introduced to situate and explain the power of ideas and the role of agency in times of uncertainty. The potential of such insights is already visible in some strands of climate change mitigation and adaptation research, but more needs to be done to advance this field and to bring it into dialogue with the mainstream systems based literature. © 2016 The Authors. *WIREs Climate Change* published by Wiley Periodicals, Inc.

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INTRODUCTION

The policy implications of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change¹ (IPCC) are both deep and wide ranging. In particular, the contribution of Working Group II² calls for timely and significant society-wide transformational change. Such an undertaking will

need to secure broad scientific, political, and civic input and support in order to maximize the diversity of, and buy-in for, multiple pathways of change toward a climate compatible future. Whether through the IPCC or any other social institution, the way climate and society relations are conceptualized greatly influences the way their coevolution is interpreted and responded to.³ Thus, when such large-scale and deliberate (not emergent) transformations of society are invoked questions of representation, ethics and sustainability immediately arise.^{4,5} Whose envisioned future are we pursuing and along which pathways? Who bears the cost of the transformation and who reaps the benefits? What weighting is given to environmental, social, and economic priorities? Interdisciplinary social science that draws on insights from social, political, economic, and behavioral research is well placed to help answer such questions.^{5–8}

Within the climate change literature transformational responses to environmental change are generally defined by their scale, novelty, and/or spatial reach compared to incremental or retrenchment strategies.^{9–11} Such significant levels of change that affect fundamental aspects of society are likely to involve multiple social processes. Based on reviews of the global environmental change literature, these processes can be grouped into a typology of: *practical* innovations in technology, management strategies, and behavior, *political* contests between incumbents and challengers over the rules of the game (i.e., how society functions) and *personal* explorations of individual and collective beliefs, values, and worldviews.^{5,12,13} One of the greatest challenges for environmental social science is to address these interrelated aspects of social change in a balanced and interwoven way.

Climate change mitigation—the act of reducing anthropogenic greenhouse gas emissions—is often characterized as a social and technological problem with social and technological solutions, for example, involving overconsumption and polluting infrastructure that can be directly remedied through behavior change and low-carbon technology. Accordingly, the sociotechnical (ST) systems framework explores the interrelated social and technological processes through which sustainability innovations emerge and are consolidated.^{14,15} Climate change adaptation—the act of responding to anticipated and present impacts of climate change—has been guided more by social–ecological (SE) systems research, which emphasizes the interdependence of society and ecosystems, stressing that successful responses to a changing climate will require high levels of adaptive

capacity in both.^{16,17} As these frameworks share a common foundation in ‘complex systems’ thinking there have been attempts to draw theoretical and applied lessons between the two.^{11,18,19} However, conceptual blind spots remain (most notably around issues of power and politics), suggesting that the systems epistemology itself may well be the barrier to a fuller understanding of social change. Ultimately, both frameworks could benefit from extradisciplinary considerations reaching beyond the boundaries of systems thinking to engage with more explicitly sociological and political modes of thought.^{20–23} Reviewing and expanding on these claims, this article presents two examples of such interdisciplinary endeavors that could inform transformational climate change research and practice.

ST TRANSITIONS AND CLIMATE CHANGE MITIGATION

The notion of a ST system emerged from the technology-oriented field of innovations studies. Through a series of perspective widening turns, the influence of social institutions and practices was further integrated into the framework. Much of this influence coincided with the emergence of Science and Technology Studies, which problematized linear understandings of scientific and technological innovation by drawing attention to the values, intentions, meaning-making, and subversive involvement of humans at all stages of research and practice.^{14,24} Examples ranged from the small scale to the large; solar panels being used to dry laundry or mosquito nets used for fishing through to low-carbon energy options that either decentralize or consolidate existing supply chains and their associated web of power relations. Social theory too benefited from a closer focus on human and nonhuman (technological/ecological) relations by breaking down such conceptual dichotomies to reveal their effect on socially embedded processes of domination and power.^{25,26} The extent to which this more radical work has fed into ST systems research varies greatly across the literature but overall is minimal. At its most social, the ST system is an interdisciplinary construct encapsulating the prevailing *modus operandi* of a given (sector of) society and its embedded technological artifacts. Typically, it is toward the normative goal of sustainability that this work points, prescribing transition pathways toward new and more desirable relationships between society and technology. More historical ST research has addressed technological

development over longer periods of time, drawing useful insights about the (often slow or disjointed) coevolution of their attendant social institutions.^{27–29}

This work has been a timely reminder for innovations studies and sustainability transitions enthusiasts to heed the power of embedded interests and ideas,³⁰ but it features less prominently in the climate change area of this field.

Much of the ST transitions literature presents a multilevel perspective of change. Therein, desirable change toward sustainability is understood to result from the modulation of three simultaneous scalar pressures: instability within, and competition among, ST regimes (meso level), successful innovations from smaller niches (micro level), and changes in the broader social and material landscape (macro level).^{14,31} Whilst this may sound inclusive the main focus is on practical issues (e.g., behavior change, technology, and management strategies) with only limited consideration of the institutional context and even less sensitivity to the interpretations, values, and intentions of actors. With regards to climate change mitigation ST transitions seek potential social (e.g., low-carbon lifestyle choices) and technical (e.g., deploying low-carbon technology) ‘solutions,’ often presenting them as desirable recommendations for any given sector or strata of society.^{32–35} Granted, flexibility in implementation is advised but the socio-cultural context and political implications of adopting certain solutions over others is rarely considered in great depth.

The potentially technocratic narrative of a ST transition leaves little room for exploring more personal and political drivers of change such as agency,^{13,36–38} contestation,^{22,39,40} and discursive diversity.^{8,41} Whilst some ST research, such as the historical strand cited above, does include political institutional and actor-oriented elements attempts to include them in contemporary climate change research is hampered by a pervasive tendency toward reductive methodologies that quantify, model, and control their effects.^{42,43} The mediating role of these dynamic social factors on the very practical innovations described in most ST studies is often underacknowledged. Thus, it may be this very blind spot that prevents applied ST transitions initiatives from achieving the transformational changes they seek and which are demanded of them by the urgency of mitigating dangerous climate change.^{44–46} Consequently, the potential of adopting concepts and/or theorizing in conjunction with nonsystem based perspectives has been recognized.⁴⁷ Initial responses from ST scholars have suggested fruitful theoretical developments^{44,47} leading to several meta-reviews that call

for a much more politicized and interdisciplinary research agenda going forward.^{20,21,23,48,49}

TRANSITION MANAGEMENT

The shortcomings of a predominantly behavioral and technical view of social change are particularly pertinent to the part of ST systems literature that deals with governance, also known as transition management (TM). Following the multilevel narrative outlined above, TM seeks to simultaneously destabilize the existing regime whilst fostering, and upscaling, niche-level innovation.²³ The very idea of governing or purposively managing change in complex systems would appear paradoxical to first-generation systems theorists who adopted the term ‘complex’ precisely to describe the unpredictable and nonlinear nature of cause and effect in certain systems.⁵⁰ Despite their apolitical overtones, processes such as emergence, coevolution, and self-organization have been built into the lexicon of ST governance.^{51,52} For example, the undesirable attributes of a given system (e.g., high levels of emissions from the transport sector) are targeted through changes to the constituent elements (e.g., transportation technology) and their functions (e.g., nonessential and inexpensive aviation). Combining this strategy with principles from the wider governance literature, TM seeks to produce fundamental change in the attributes and functions of ST systems through the following levers:

- Strategic—envisioning of futures, pathways, and long-term goals
- Tactical—setting agendas through negotiating and coalition building
- Operational—experimenting with and implementing projects
- Reflexive—monitoring, evaluating and learning from feedback

Whilst this governance toolkit is based on the theoretical foundations of a complex systems view of the world that is favored by environmental social sciences and other fields working on ‘wicked problems’ its practical applications run into significant problems. This is not because ST systems truly are unpredictable or random but because they are subject to a range of sociopolitical processes that are largely absent from a systems epistemology. In other words, the institutionalized ideas and power relations that provoke/mediate/resist social change are grossly underappreciated by a governance style that breaks society down into broadly consensual,

experimental, and self-organizing systems. This appears particularly problematic in governance contexts with weak accountability (e.g., fossil fuel extraction in undemocratic countries), where political institutions are entrenched in a dominant logic (e.g., economic growth at all costs) and wherever hegemonic power is exercised (e.g., global capitalism). It is acknowledged even in TM itself that ‘only a relatively small number of actors will be involved in strategic and tactical activities’ (Ref 51, p. 156), suggesting that already influential actors are most likely to secure a presence at the crucial envisioning stage. Who defines the parameters and pathways of the transition is a fundamental yet underexplored question. As a result, some TM initiatives may not be achieving their desired transformational ends because the steering committee is made up of dominant members of society who have a vested interest retaining or only partially reforming the status quo.⁴⁶ Furthermore, should a momentum for change begin to accelerate too quickly then these actors are in a position to protect their own interests—possibly at the expense of the already marginalized⁵³—during an unavoidable period of transition.⁴⁶ However, it would not suffice to merely replace those responsible for steering the transition with the marginalized and disaffected. Common to both scenarios is the problem of a relatively small number of actors without either the will or the power to unite and govern something as fragmented and diverse as human society toward one consensual vision of a sustainable future.

This particular limitation stems in part from the system perspective’s use of the ecological concept of isomorphism⁵⁴—the idea that systems have a tendency to develop a similarity in structure or shape as they evolve. This is illustrated succinctly by the ST transitions narrative of a more sustainable niche ‘up scaling,’ that is, converting and absorbing resistance as it develops until a critical mass is reached and the whole system tips toward this new configuration. Two key assumptions underpinning this view of social change are objectionable. First, whilst it may sound like a story of bottom-up innovation, and triumph, the practice of TM described above depends on benevolent top-down intervention and guidance. It is up to a privileged few to select, incubate, and then mainstream their preferred low-carbon technologies and behaviors. Secondly, TM generally rejects the possibility of abrupt and disjointed change. Its narrow view of power as an entrenched and static force to be chipped away at leads to the counterintuitive principle of radical change in incremental steps expressed by the mantra of ‘more evolution than

revolution.’⁵⁵ It is a short step from here to the assumption that fundamental change can only avoid causing catastrophic collapse or inducing insurmountable resistance in an incumbent regime if it emerges through an isomorphic process choreographed by an elite vanguard (Ref 51, p. 145). Such managerialist forms of governance overlook the way existing power relations can be reproduced through the very political institutions and social arrangements responsible for pursuing sustainability.²² This failure to acknowledge the variety of discursive and ideational motives behind decision-making at multiple levels by multiple actors downplays the daily struggle of strategists and practitioners to either accelerate or resist transformational change.^{37,41,56} It is worth noting here that this democratic tension—which is a recurring theme within the field of sustainable development—is by no means peculiar to TM. As the imperative for wide-spread social action on sustainability grows it is vital that accountability and democratic process is not simply assumed, made implicit or even put on hold,⁵⁷ but is instead ‘opened up.’⁸

Partly because of these shortcomings many climate change mitigation initiatives guided by elite driven variations of TM will continue to fall short of the transformational imperative for rapid and drastic emissions reductions targets. For instance, in many high-emitting countries long-term policy goals (such as the UK’s 80% reduction in emissions by 2050) are at odds with short-term political cycles.⁵⁸ Not only is there an incentive for policymakers to delay strong action until after they are reelected or are no longer in power,⁵⁹ but there is ample opportunity for doing so through institutionalized political processes (reviews, debates, vetoes, etc.) that are difficult to circumvent.⁶⁰ Here we can expect to see more conservative climate policymaking, for example, labeling existing actions as pro-climate rather than novel or innovative actions capable of accelerating low-carbon trajectories.^{59,61,62} Despite the seemingly global allure of transition discourses TM may be equally problematic if applied by emerging emitters and low-income countries where its implicit assumption—or outright ignorance—of democratic procedure could be easily exploited by ruling elites and unaccountable institutions.^{63,64} Ultimately, the ST systems framework favors a process of innovation based on hard to reach consensus over more contentious politics and pluralistic pathways.^{8,41,65} Describing, as well as prescribing, society-wide transformations capable of unprecedented emissions reductions will require a much greater awareness of how competing world-views and political processes govern the pursuit of sustainability transitions.

SE RESILIENCE AND CLIMATE CHANGE ADAPTATION

Placing society within, alongside or before its natural environment entails different ontological and epistemological commitments that can lead to very different forms of politics and governance.^{18,26,66} The 1960s and 1970s were a key era for the idea of ecological limits to economic growth and the emergence of a holistic ‘complex systems’ approach to studying society–environment interactions.^{66,67} The study of SE systems places the interdependence of societies and ecosystems in the spotlight; it is broadly applied in the (social) environmental sciences and has a great deal to say about process of change. Drawing heavily on systems theory and ecology, the influential book *Panarchy*⁶⁸ developed an adaptive cycle conceptualization of change arguing that social systems, in conjunction with the ecosystems they depend on, can maintain their vital functions through cycles of creative destruction and recourse to multiple states of equilibrium. According to this view, the direction of travel in times of change is determined by the presence and interaction of three attributes:

- Potential—utilizing sources of capital for strategic action
- Connectivity—regulating practices and mediating shocks
- Resilience—maintaining vital functions through recourse to multiple states

In the context of adapting to the impacts of climate change this theoretical framework has been criticized for lacking empirical validity and for paying insufficient attention to human livelihoods and their institutionalized contexts.^{69,70} Its applications appear almost exclusively concerned with management strategies and contain minimal consideration of how these are situated within wider political structures or how they might be interpreted—and thus responded to in discourse and practice—by actors with differing values and worldviews.^{71–73} These limitations become more profound as climatic uncertainty increases across time and space, putting pressure on SE systems to be prepared for the worst.⁷⁴ In these instances, where preemptive and transformational actions are called for, a much more politicized theory of change will need to be evoked.¹⁰ Questions around why certain SE system states appear more viable than others cannot be adequately answered using the descriptive terminology of multiple equilibrium and creative destruction. As with ST transitions,

what is missing from the SE system theory of change is a dynamic understanding of power, that is, how and why do these system attributes and processes serve the interests of some whilst inhibiting those of others?

ADAPTIVE COMANAGEMENT OF RESOURCES

Following the adaptive cycle theory, SE systems research often advocates a form of multiactor governance using networks to increase resource pools, connectivity, and opportunities for social learning.¹⁷ Based on studies of natural resource management practices, this process of ‘adaptive comanagement’ pursues SE resilience through polycentric, participatory, and accountable processes—thereby achieving a diversity of input, good compatibility between knowledge and context and a safeguard against overlooking issues of social justice.^{75,76} However, as with TM, in practice this approach faces significant barriers, not least because the theoretical assumptions and practical traditions upon which it is based were developed for small-scale resource management without the multilevel complexity of globalized social and political institutions. Reflexivity and learning through experimentation are laudable—although never purely technical—governance principles but generalizing lessons and prescribing ideal type processes should be done with caution. Numerous attempts to impose ‘good governance’ on the way societies adapt to ecological variability have suffered from an underappreciation of power relations and cultural difference, or, in other words, from institutional incompatibility.^{19,23,76} For instance, when international institutions such as the UNFCCC or the World Bank propose various market-driven adaptation initiatives such as ‘payments for ecosystem services’ or natural disaster insurance schemes, they rely on the smooth translation of a set of neoclassical economic assumptions that are often fundamentally at odds with the sociocultural norms of their intended destination.^{77–79} Whilst these assumptions may be deeply embedded within the functioning of advanced liberal democracies, it is not so the world over. Fully recognizing and expressing the social, cultural, and political peculiarities of other societies—who often happen to be the ones most at risk of dangerous climate change impacts—is a task that may well be beyond the aggregated discourses of mainstream international forms of climate governance,^{40,63,78} especially those that perceive environmental problems through a decontextualized SE systems lens.

Climate change adaptation research that does not solely rely on a SE system perspective has engaged with some of these issues, for example, culture, perception, and behavior.^{80–82} Insights from this work, particularly around power and agency, can be productively incorporated into the SE systems perspective. However as with many interdisciplinary dialogues there are epistemological and normative limitations. For example, the notion of an institutional entrepreneur—which has striking similarities to the niche innovators found in ST transitions—has gained conceptual currency in SE systems research. This idea builds in part on Folke et al.¹⁷ emphasizing social learning and leadership in adaptive governance, but also in part as a response to the criticisms leveled against climate policies that cast individuals as mere respondents to, rather than carriers of, transformational change.^{83,84} Seen as the harbingers of disruptive innovation these individuals can guide systems in the desired direction of adaptation depending on their levels of resources, power and positioning within a network.^{83,84} However, as Rickards et al.³⁷ illustrate, even senior decision makers who support strong action on climate change are constrained by their social milieu, often to the extent that transformational society-wide change is moot. One encouraging aspect of this research is the acknowledgement of actors' capacities for agitation, that is, for proactively opening windows of opportunity to drive social and political change.^{84,85} Bringing the discourses, practices, strategies, and (most of all) the interactions of various influential actors (e.g., social movement leaders, boundary organizations, local activists, social entrepreneurs, and policy-makers) into sharper focus may reveal undercurrents of discontent and conduits for innovation.

Many climate change adaptation initiatives based on the SE systems perspective aim to increase a society's levels of potential, connectivity, and especially resilience. Yet, to derive a policy or governance mandate from the assumption that resilience in the short-term leads to adaptation in the long-term runs directly into criticisms of reactionary conservatism, deterministic thinking, and political naivety.⁸⁶ For instance, the capacity to maintain the vital functions of a given social system may not always be exercised in a progressive or desirable manner, particularly from the viewpoint of the oppressed and marginalized who would rather see more radical change. In this form, resilience may be seen as an apology for incrementalism similar to that of the isomorphism of TM where restorative stability is preferred to disruptive alternatives. For this reason, human geographers

and other scholars working on international development and security have been particularly critical of the rise of resilience as a new interdisciplinary norm. Some see this conservative form of resilience as depoliticizing climate change and reinforcing a neoliberal form of governing that is responsible for escalating socioeconomic inequality and vulnerability.^{87–90} In response to such rebuttals, the transformational potential of the concept has become increasingly discussed and much empirical work has been carried out to track exactly how SE systems enact and achieve their resilience in times of crisis and evolution. For instance, in relation to climate change adaptation Pelling (Ref 89, p. 79)⁹¹ proposes the following typology:

- Resilience—functional persistence in a changing environment. Change in technology, management practice and organization.
- Transition—realize the full potential through the exercise of rights within the established regime. Change in practices of governance to secure procedural justice; this can in turn lead to incremental change in the governance system.
- Transformation—reconfigure the structures of development. Change overarching political-economy regime.

As societal responses to climate change move toward the transformational end of this continuum issues of justice, legitimacy, authority, and representation will need to be foregrounded.^{10,91} However, this may prove impossible—both in theory and in practice—from within the confines of a SE systems discourse that defines resilience as an apolitical property, characteristic, or function. If transformational social change is to be achieved in an empowering and pro-poor way then a more politicized view of climate change adaptation is needed^{87,90,92} to expose, problematize, and resist the ongoing reproduction of harmful power relations. Although it should be noted, this is not to suggest that transformation itself should become another new uncritical normative goal—every norm should have its critique. As some research has shown, stability and security may sometimes be preferable in order to avoid maladaptation to climate change.^{93,94} Ultimately, responding to climate change should be seen not as a technical problem to be managed away but as an *opportunity* to radically rethink and rebuild social, ecological, and economic relations.³⁹

POLITICS AND POWER IN SYSTEMS: FURTHERING AN INTERDISCIPLINARY RESEARCH AGENDA

The above review has outlined considerable gaps in the explanatory power of ST and SE frameworks, especially when applied to contexts of society-wide transformational change, for example, those associated with climate change mitigation and adaptation. In particular, the enabling/constraining effects of political structures and socially embedded power relations are undertheorized. Without examining the mediating role of politics and power in times of uncertainty and change these perspectives will only offer partial explanations for why truly transformational responses to climate change are still so rare. Before illustrating how social theory may improve our understanding of the origins of transformational agendas and their agitation for expression, a brief survey of existing interdisciplinary work in this vein is necessary.

In addition to highlighting the hegemony of neoliberal ideas about unrestricted markets and individualism,^{40,77,88} critics of the mainstream climate change and systems research agenda have suggested importing concepts from other disciplines as well as combining them with completely different perspectives. For instance, in order to get at the ‘politics behind policy,’ to (re)politicize TM and adaptive governance, Meadowcroft²¹ and Kern³⁰ suggest turning to political science for guidance in three crucial areas of analysis: interests, institutions and ideas. Resonating with the work of O’Brien and Sygna¹² and Shove and Walker¹³ on practical, political, and personal aspects of responding to global environmental change, this way of dividing up (but not disconnecting) a given context for mitigation or adaptation immediately opens socially oriented lines of questioning: whose interests do practical changes in technology and behavior serve, how are political institutions constraining or enabling transformations in society, which ideas are shaping the process of change and inspiring personal engagement?

In addition, Scrase and Smith²² offer a fairly blunt and politically realist view; without a fundamental redistribution of power and resources the diaspora of existing niche level innovations and social movements pursuing a low-carbon future will never flourish. However, the types of power (instrumental, discursive, material, etc.) that are to be addressed will vary depending on researchers’ and practitioners’ epistemologies. Pertinent to all of these

suggestions is the thorny issue of cost and benefit distribution, especially given the high demand on political capital/feasibility entailed in any transformational change.²³ The need to be explicit and transparent when discussing and calculating distributive processes and outcomes is of central concern to climate change and social change researchers alike. This is just one reminder of the need to reinterpret how and why technical information about ST and SE systems is being presented as a rationale for pursuing reformist rather than radical responses to climate change.

Addressing some of these applied issues common to both systems theory and social science more broadly requires good interdisciplinary research. As Bailey and Wilson’s⁴¹ note, much work on ST transitions and SE resilience does not actually theorize, instead it presents a framework that tries to identify and describe system processes through a technocentric or eco-centric lens, neglecting a host of social theory insights and predictions about human agency and power in times of change. But they also point out that this need not be a permanent limitation; it may in fact enable creative dialogue. Previous interdisciplinary interventions have explored the applicability of different power concepts within a transitions framework,⁴⁴ opened a dialogue between ST and SE systems,^{11,18,19} and sought to deepen the description of social processes^{95,96} all with the aim of improving on-the-ground governance efficacy. However, in varying degrees, conceptual blind spots (e.g., ideas and agency) remain, as does a problematic tendency toward technical rather than political forms of governance. Several reviews have noted this limitation and proposed a more politicized direction for research.^{20,21,64} This cross-fertilization has expanded the scope and ambition of some applied transitions work,¹⁵ but its influence on the theoretical foundations of systems theory—as applied to sustainability and climate change—has been limited.^{45,47} Despite these efforts, there may still be fundamental limitations to adopting a systems based view of social change. Social processes such as interpersonal relations, ideas, discourse, and strategic action are capable of generating and enacting transformational change but they cannot be implicitly assumed or partially and clumsily bolted on to what is at heart a functionalist epistemology. A more comprehensive engagement with concepts from social theory can help to critically examine these processes as well as demonstrate their influential role in shaping social responses to climate change.

THE SEEDS OF CHANGE

The writings of Gilles Deleuze and Felix Guattari contain numerous concepts of relevance to ecological thought and environmental politics.^{97–100} Collaborating after the 1968 social movements in Paris, they combined philosophy and psychology to propose an approach to political activism that emphasized subjects over systems, that is, agency over structure.¹⁰¹ Their work shares some ontological and epistemological assumptions with ‘complex systems’ thinking, inasmuch as they view society as made up of networked connections among actors evolving in unpredictable nonlinear ways. However, by describing this as a spatially and temporally contingent ‘assemblage’ rather than as a definable system they emphasized the creative potential of ever-changing, and often conflicting, relations between actors (human and nonhuman alike). Accordingly, the discord and instability of micropolitics as opposed to the consensus and isomorphism of management are seen as the most potent opportunities for innovation and change to emerge.¹⁰²

In practice, this position supports recent calls for more pluralistic and positive environmental politics that can bring conflicting worldviews together in search of an adequate response to the threats of global climate change.^{8,63,66} However, inclusivity alone is not enough, as the repeated shortcomings of international climate negotiations attest. Genuinely participatory and novel interactions will have to take place in less aggregated arenas, that is, not just multi-actor governance dancing to the tune of top-down prescriptions or the seemingly unassailable logic of globalized economic markets.³⁹ Social, cultural, and political *différence* ought to be celebrated for its provocations (differing) not its legitimizing (deferring) effects. As political theories of learning suggest, in the context of environmental policy we can expect macropolitical structures (e.g., institutions and paradigms) to produce incremental or ‘of a kind’ change^{41,60} and the micropolitical (e.g., personal networks and social movements) to produce radically alternative discourses and practices.^{17,41,91} To illustrate, the governments and industries of most wealthy countries—and the international institutions they dominate—have predominantly sought to reform rather than rethink the social and economic arrangements responsible for anthropogenic climate change, for example, through ecological modernization and green capitalism. Yet, however hegemonic such discourses of global capitalism may appear there are always cracks in the system to be found and exploited. Contradicting Lukes’¹⁰³ notion of a

totalizing cognitive form of power, Deleuze and Guattari remind us of the creative potential of intersubjectivity,¹⁰¹ of the destabilizing effect of actors’ expressive and material capacities when they come together and collide with each other and with the status quo. Whether in the economic degrowth road to emissions reductions or the postdevelopment approach to climate change adaptation, there are numerous transformational discourses and practices that reject the very foundations of more reformist agendas.⁶³

So what does all this add to the ST and SE narratives of change? One major advantage is that it affords actors a latent capacity—or agency potential—that is obscured by the systems perspectives, that is, a potential to be and to act in a multiplicity of ways in relation to other actors or systems and across time and space. It thereby makes the *contingency* rather than the *functionality* of systems more analytically important¹⁰⁴ or, in simpler words, the who and why rather than the how and when. In practice, this prompts us to look more closely at a given individual’s or a society’s low-carbon initiatives; are they temporary commitments? Contradicting their espoused values? Or are these efforts potentially transformative inasmuch as they seek to replace the framing of industrial growth with one of human–environment wellbeing? Similarly, as vulnerable societies seek to build resilience and preemptively adapt to climate change, are they prioritizing economic functions, communal ways of life or ecosystem integrity? Which actors and institutions are responsible for governing the transformation and why might they seek to steer it in a certain direction? Answering such questions will require consideration of different actors’ ideas and interests but also the sociocultural peculiarities of their interactions with one another. Without such micropolitical detail descriptions of social change will always tend toward the aggregate, eliding the daily creative conflict of actors, networks, and worldviews in favor of broad conclusions about structure, management, and hegemony. Perhaps, the biggest challenge this poses to ST and SE frameworks is the need to look beyond the system. Dissolving the discrete levels and borders of the multilevel perspective or the SE system might open up their actors and institutions to potentially transformational engagement with fundamentally alien discourses and practices.

Beyond the theoretical benefit of bringing forth novel responses to climate change—which should not be understated given the current reformist agenda’s protracted failure and the growing appetite for transformational alternatives—this perspective may also

provide concrete lessons for improving mitigation and adaptation outcomes. For example, energy and climate change researchers mobilizing this sort of conceptual lens have produced interesting readings of supply–demand instability^{105,106} as well as insights into the political-ethical issues of energy distribution and justice.^{53,107} In both instances, disruptive actors problematize the technical assumptions of low-carbon transition narratives, offering vital lessons about unintended consequences, the mutability of technology and the nuances of the social context. Similarly, in terms of public engagement with the environmental policy process, differences in rationales (e.g., instrumental, legalistic, technocratic, or subversive) abound due to the way participation is defined and enacted in different political institutional contexts.⁵⁶ On the one hand, these potentially conflicting discursive practices may produce creative friction and radical alternatives but they also pose serious problems to the successful functioning of climate policy and governance. Vital to all of these accounts is the possibility for more relational and interpretivist descriptions of power to be made available.^{65,108} Such approaches are arguably well suited to the pursuit of transformational outcomes that necessarily involve changes in worldviews, values, and beliefs.^{39,44,109} As Jørgensen³⁶ and Shove³⁸ both point out, such a detailed and ideational view of agency is largely omitted by the structural emphasis of systems frameworks. This oversight will need to be remedied, particularly as more complex and networked forms of climate change governance (e.g., transnational low-carbon cities initiatives and multi-regional ecosystem management) continue to proliferate, placing greater stress on social institutions to accommodate and articulate the desired outcomes of very different types of actors.^{78,110,111} Paying attention to these dynamics may facilitate novel responses to climate change, it may enable more reflexive and inclusive forms of governance but it may also throw light on the fundamental incompatibility or limited reach of generalized mitigation and adaptation initiatives.

SOCIAL FIELDS

If the notion of micropolitics encourages us to consider more closely the origins of social change, then we still need to explore how it gets enacted. For social theories explicitly concerned with the creative dualism of structure and agency, transformational strategies are usually described as being both constrained and enabled by the existing rules of the

game but also as having the capacity to shape the structures of the social fields in which they are enacted.^{112–115} Fligstein and McAdam¹¹⁴ describe these social fields as ‘socially constructed arenas within which actors with varying resource endowments vie for advantage’ (Ref 112, p. 10) and where there are ‘shared (which is not to say consensual) understandings about the purpose of the field, relationships to others in the field (including who has power and why), and the rules governing legitimate action’ (Ref 112, p. 9, parentheses in original). Crucially the role of agency is foregrounded in a way that links actors’ intentions and influence to the personal—or ideational—realm.

To some extent, the ST and SE frameworks have incorporated similar insights from institutionalist theory addressing agency-structure dynamics in their analyses through the concepts of path dependency and vested interests. However, this has mostly produced research on instances of continuity or processes of long-term change,^{14,116,117} neglecting the more sociological strands of this discipline that are capable of accounting for values, worldviews, discourses, and power relations in more detail.^{85,118,119} The important role of institutions or, more broadly speaking, social fields in steering responses to climate change and environmental crises cannot be understated. For instance, much research on adaptation has learnt from the well-rehearsed critiques of international development by acknowledging the dangers of overriding or ignoring locally situated practices often associated with public goods, biodiversity, and social action.^{69,116,120,121} This is precisely why we need to pay greater attention to the micropolitical struggles to resist, rethink and replace those institutions that continue to fail to articulate the plural values and priorities of society.

Characterizing climate change as an amplifier of existing social, economic and ecological problematics can be particularly instructive here. Rather than a stand-alone problem with a technical solution, climate change imperatives combine with the already present agitations of marginalized groups or issues to call into question the current rules of the game, presenting a highly visible opportunity to negotiate alternatives.³ In social movements, this is often referred to as an episode of contention¹¹⁴ and in political science as a window of opportunity.¹²² What both point to is the influential power of ideas and agency in shaping the transformation of a social field.⁸⁵ More precisely, it is their power to problematize; the moment when social ills are diagnosed and remedies prescribed through recourse to scientific, economic, moral, and/or political discourses.¹²³ Such moments

can be pivotal as they are never politically neutral or technically impartial and can have long lasting consequences. For instance, defining greenhouse gases as a market failure that could be internalized has produced dysfunctional emissions trading schemes that favor the already powerful and continue to fall short of their own modest objectives. So too with adaptation, seeing vulnerability as simply an information/expertise deficit produces knowledge and technology transfer initiatives that may be incompatible with, or even harmful to, their recipients' ways of life. For actors concerned with countering these top-down discourses it is not sufficient just to have access to resources (e.g., varieties of capital; economic, social, and political), it is their entrepreneurial and innovative utilization—creating uncertainty and offering compelling critiques and alternatives—that matters.^{124,125} Some strands of SE resilience research have begun to include such considerations in their framework via the notion of transformational agency;⁸⁴ something that is carried by certain individuals involved in adaptive ecosystem management. The scope for developing this work is promising and certainly reaches beyond localized natural resource management practices. Examples where this line of research has proved insightful include: climate policy-making that favors low-carbon energy,¹²⁶ innovative policy processes,⁶² and integration of climate goals into economic trade rules.¹²⁷ Vitaly, and in correspondence to the above section on the seeds of change, this focus on the interpretive aspects of agency-structure dynamics before, during and after moments of crisis has helped to explain how seemingly marginal ideas can gain influence within and across social fields.

In social fields where shared interests and understandings exist between actors, there is more at stake than mere instrumental power or rational competition. There exists a microcosm of cognitive and communicative relations, a multiplicity of values and the potential for creative, but also troublesome, conflict. If these sociological and ideational dimensions are made explicit—for example, through more representative and deliberative forms of governance^{128,129}—then not only will our understanding of how they affect transformational climate change mitigation and adaptation be improved but they may be harnessed toward producing more significant outcomes.^{130–132} Assessing the influence of cognitive–communicative exchanges between certain actors, particularly during periods of uncertainty and crisis, has certainly enriched our understanding of how political institutions change or persist over longer periods of time,^{133,134} but what is required

now is an expansion of this type of research, to address more informal and sprawling social fields. Granted, the borders of social fields are permeable and overlapping, capable of crossing multiple levels, territories and temporalities (especially where climate change is concerned), but this flexibility is both a challenge to practitioners and scholars to remain attuned to their dynamic relational qualities and an opportunity for those same qualities to produce and enact genuinely transformational change.

CONCLUSION

Transformational social change can be said to involve a broad set of interrelated processes: practical, political and personal in nature. In the context of climate change mitigation and adaptation, two prominent agendas (ST transitions and SE resilience) both utilize a systems perspective to address some of these issues. However, certain conceptual blind spots (particularly regarding politics, power, agency, and ideas) have not only limited the scope of their analyses but have also led to problematic governance prescriptions. Whilst some strands of TM and adaptive comanagement do acknowledge the existence of competing visions for a climate compatible future, in general there is a tendency to try to control this potentially creative force through a process of isomorphism, managerialist steering and consensus building. Reflexivity and social learning are encouraged by both approaches but little is said of how ideas and influences mediate this process and to what extent this reinforces a incremental rather than transformational trajectory. Such an approach will not only favor technical and behavioral solutions to climate change but it may do so in a politically naïve way that struggles to challenge the dominant ideas and institutional inertia of societies with high/rising emissions and large swathes of vulnerable communities.

In response, we may turn to social theories—where power, politics, and social relations are of central concern—for insights and provocations. If ST and SE systems are to become more productive interdisciplinary frameworks capable of politically contextualized climate governance prescriptions then they will need more socially oriented theories of change. First, focusing on the contingent relations between various actors (human and nonhuman) and their assemblages (e.g., an industry or a community) instantly opens up possibilities for more radical innovation and adaptability beyond the discursive

confines of a functionalist system perspective. Second, the interpretive and strategic actions of influential actors before, during, and after moments of crisis and agitation have to be made explicit. Tracking these processes across space and time exposes both the creative potential of social interactions and the institutionalized rules of the game that enable or

constrain them. Immediately, critical questions emerge around why some mitigation and adaptation actions are successful or not and to what extent they are capable of driving transformational change. Or in other words, whose vision of a climate compatible future is being pursued and along which pathways?

FURTHER READING

DeLanda M. *A New Philosophy of Society: Assemblage Theory and Social Complexity*. New York: Continuum; 2006.

Ong A, Collier SJ. *Global Assemblages: Technology, Politics, and Ethics As Anthropological Problems*. Oxford, UK: John Wiley & Sons; 2008.

Snow DA. Framing processes, ideology, and discursive fields. In: Snow DA, Soule SA, Kriesi H, eds. *The Blackwell Companion to Social Movements*. Oxford: Blackwell Publishing Ltd; 2003, 380–412.

REFERENCES

- IPCC. Summary for policymakers. In: Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, et al., eds. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press; 2014, 1–32.
- IPCC. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press; 2014.
- Hulme M. *Why We Disagree about Climate Change*. Cambridge: Cambridge University Press; 2010.
- O'Brien K. Global environmental change II From adaptation to deliberate transformation. *Prog Hum Geogr* 2012, 36:667–676.
- Feola G. Societal transformation in response to global environmental change: a review of emerging concepts. *Ambio* 2015, 44:376–390.
- ISSC/UNESCO. *World Social Science Report 2013: Changing Global Environments*. Paris: OECD Publishing and UNESCO Publishing; 2013.
- Sovacool BK. What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda. *Energy Res Soc Sci* 2014, 1:1–29.
- Stirling A. Pluralising progress: from integrative transitions to transformative diversity. *Environ Innov Soc Trans* 2011, 1:82–88.
- Burch S, Shaw A, Dale A, Robinson J. Triggering transformative change: a development path approach to climate change response in communities. *Clim Policy* 2014, 14:467–487.
- Kates RW, Travis WR, Wilbanks TJ. Transformational adaptation when incremental adaptations to climate change are insufficient. *Proc Natl Acad Sci USA* 2012, 109:7156–7161.
- Park SE, Marshall NA, Jakku E, Dowd A-M, Howden SM, Mendham E, Fleming A. Informing adaptation responses to climate change through theories of transformation. *Glob Environ Change* 2012, 22:115–126.
- O'Brien K, Sygna L. Responding to climate change: the three spheres of transformation. In: *Proceedings of Transformation in a Changing Climate*, Oslo, Norway, 19–21 June, 2013.
- Shove E, Walker G. Governing transitions in the sustainability of everyday life. *Res Policy* 2010, 39:471–476.
- Geels FW. From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory. *Res Policy* 2004, 33:897–920.
- Haxeltine A, Avelino F, Wittmayer J, Kemp R, Weaver P, Backhaus J, O'Riordan T. *Transformative Social Innovation: A Sustainability Transitions Perspective on Social Innovation. Social Frontiers: The Next Edge of Social Innovation Research*. London: NESTA; 2013.
- Adger WN, Brown K, Nelson DR, Berkes F, Eakin H, Folke C, Galvin K, Gunderson L, Goulden M, O'Brien K. Resilience implications of policy responses

- to climate change. *WIREs Clim Change* 2011, 2:757–766.
17. Folke C, Hahn T, Olsson P, Norberg J. Adaptive governance of social–ecological systems. *Annu Rev Environ Resour* 2005, 30:441–473.
 18. Fischer-Kowalski M, Rotmans J. Conceptualizing, observing, and influencing social-ecological transitions. *Ecol Soc* 2009, 14:3 [online]. Available at: <http://www.ecologyandsociety.org/vol14/iss2/art3/>.
 19. Foxon TJ, Reed MS, Stringer LC. Governing long-term social–ecological change: what can the adaptive management and transition management approaches learn from each other? *Environ Policy Gov* 2009, 19:3–20.
 20. Markard J, Raven R, Truffer B. Sustainability transitions: an emerging field of research and its prospects. *Res Policy* 2012, 41:955–967.
 21. Meadowcroft J. Engaging with the politics of sustainability transitions. *Environ Innov Soc Trans* 2011, 1:70–75.
 22. Scrase I, Smith A. The (non-) politics of managing low carbon socio-technical transitions. *Environ Polit* 2009, 18:707–726.
 23. Smith A, Stirling A. The politics of social-ecological resilience and sustainable socio-technical transitions. *Ecol Soc* 2010, 15:11 [online]. Available at: <http://www.ecologyandsociety.org/vol15/iss1/art11/>.
 24. Smith A, Voß J-P, Grin J. Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges. *Res Policy* 2010, 39:435–448.
 25. Latour B. Technology is society made durable. *Sociol Rev* 1990, 38:103–131.
 26. Latour B. *Politics of Nature*. London: Harvard University Press; 2009.
 27. Bijker WE. *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*. Cambridge, MA: MIT Press; 1997.
 28. Geels FW. The dynamics of transitions in socio-technical systems: a multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930). *Technol Anal Strat Manage* 2005, 17:445–476.
 29. Sovacool BK. Rejecting renewables: the socio-technical impediments to renewable electricity in the United States. *Energy Policy* 2009, 37:4500–4513.
 30. Kern F. Ideas, institutions, and interests: explaining policy divergence in fostering ‘system innovations’ towards sustainability. *Environ Plann C* 2011, 29:1117.
 31. Geels FW, Schot J. Typology of sociotechnical transition pathways. *Res Policy* 2007, 36:399–417.
 32. Bergman N, Eyre N. What role for microgeneration in a shift to a low carbon domestic energy sector in the UK? *Energy Effic* 2011, 4:335–353.
 33. Foxon TJ. A coevolutionary framework for analysing a transition to a sustainable low carbon economy. *Ecol Econ* 2011, 70:2258–2267.
 34. Heiskanen E, Johnson M, Robinson S, Vadovics E, Saastamoinen M. Low-carbon communities as a context for individual behavioural change. *Energy Policy* 2010, 38:7586–7595.
 35. Moloney S, Horne RE, Fien J. Transitioning to low carbon communities—from behaviour change to systemic change: Lessons from Australia. *Energy Policy* 2010, 38:7614–7623.
 36. Jørgensen U. Mapping and navigating transitions—the multi-level perspective compared with arenas of development. *Res Policy* 2012, 41:996–1010.
 37. Rickards L, Wiseman J, Kashima Y. Barriers to effective climate change mitigation: the case of senior government and business decision makers. *WIREs Clim Change* 2014, 5:753–773.
 38. Shove E. Beyond the ABC: climate change policy and theories of social change. *Environ Plann A* 2010, 42:1273.
 39. Manuel-Navarrete D. Power, realism, and the ideal of human emancipation in a climate of change. *WIREs Clim Change* 2010, 1:781–785.
 40. Swyngedouw E. The non-political politics of climate change. *ACME* 2013, 12:1–8.
 41. Bailey I, Wilson GA. Theorising transitional pathways in response to climate change: technocentrism, ecocentrism, and the carbon economy. *Environ Plann A* 2009, 41:2324.
 42. Ruth M, Kalnay E, Zeng N, Franklin RS, Rivas J, Miralles-Wilhelm F. Sustainable prosperity and societal transitions: long-term modeling for anticipatory management. *Environ Innov Soc Trans* 2011, 1:160–165.
 43. Wangel J. Exploring social structures and agency in backcasting studies for sustainable development. *Technol Forecast Soc Change* 2011, 78:872–882.
 44. Avelino F, Rotmans J. Power in transition: an interdisciplinary framework to study power in relation to structural change. *Eur J Soc Theory* 2009, 12:543–569.
 45. Geels FW. Regime resistance against low-carbon transitions: Introducing politics and power into the multi-level perspective. *Theory Cult Soc* 2014, 21–40. doi: 10.1177/0263276414531627.
 46. Kern F, Smith A. Restructuring energy systems for sustainability? Energy transition policy in the Netherlands. *Energy Policy* 2008, 36:4093–4103.
 47. Geels FW. The multi-level perspective on sustainability transitions: responses to seven criticisms. *Environ Innov Soc Trans* 2011, 1:24–40.
 48. Stirling A. Transforming power: social science and the politics of energy choices. *Energy Res Soc Sci* 2014, 1:83–95.

49. van den Bergh JC, Truffer B, Kallis G. Environmental innovation and societal transitions: Introduction and overview. *Environ Innov Soc Trans* 2011, 1:1–23.
50. Ropohl G. Philosophy of socio-technical systems. *Techné* 1999, 4:186–194.
51. Grin J, Rotmans J, Schot J. *Transitions to Sustainable Development: New Directions in the Study of Long-Term Transformative Change*. Oxon: Routledge; 2010.
52. Loorbach D. Transition management for sustainable development: a prescriptive, complexity-based governance framework. *Governance* 2010, 23:161–183.
53. Eames M, Hunt M. Energy justice in sustainability transitions research. In: Bickerstaff K, Walker G, Bulkeley H, eds. *Energy Justice in a Changing Climate: Social Equity and Low-Carbon Energy*. London: Zed Books; 2013.
54. Holling CS. Understanding the complexity of economic, ecological, and social systems. *Ecosystems* 2001, 4:390–405.
55. Rotmans J, Kemp R, Van Asselt M. More evolution than revolution: transition management in public policy. *Foresight* 2001, 3:15–31.
56. Wesselink A, Paavola J, Fritsch O, Renn O. Rationales for public participation in environmental policy and governance: practitioners' perspectives. *Environ Plann A* 2011, 43:2688.
57. Hendriks CM. Policy design without democracy? Making democratic sense of transition management. *Policy Sci* 2009, 42:341–368.
58. Voß J-P, Smith A, Grin J. Designing long-term policy: rethinking transition management. *Policy Sci* 2009, 42:275–302.
59. Howlett M. Why are policy innovations rare and so often negative? Blame avoidance and problem denial in climate change policy-making. *Glob Environ Change* 2014, 29:395–403.
60. Munck af Rosenschöld J, Rozema JG, Frye-Levine LA. Institutional inertia and climate change: a review of the new institutionalist literature. *WIREs Clim Change* 2014, 5:639–648.
61. Jordan A, Huitema D. Innovations in climate policy: the politics of invention, diffusion, and evaluation. *Environ Polit* 2014, 23:1–20.
62. Upham P, Kivimaa P, Mickwitz P, Åstrand K. Climate policy innovation: a sociotechnical transitions perspective. *Environ Polit* 2014, 23:774–794.
63. Escobar A. Degrowth, postdevelopment, and transitions: a preliminary conversation. *Sustain Sci* 2015, 10:451–462.
64. Lawhon M, Murphy JT. Socio-technical regimes and sustainability transitions: insights from political ecology. *Prog Hum Geogr* 2012, 36:354–378.
65. McFarlane C. Translocal assemblages: space, power and social movements. *Geoforum* 2009, 40:561–567.
66. Nordhaus T, Shellenberger M. *Break Through: From the Death of Environmentalism to the Politics of Possibility*. Houghton Mifflin Harcourt: Boston, MA; 2007.
67. Röpke I. The early history of modern ecological economics. *Ecol Econ* 2004, 50:293–314.
68. Gunderson LH, Holling CS. *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, DC: Island Press; 2001.
69. Berman R, Quinn C, Paavola J. The role of institutions in the transformation of coping capacity to sustainable adaptive capacity. *Environ Dev* 2012, 2:86–100.
70. Plummer R, Armitage D. A resilience-based framework for evaluating adaptive co-management: linking ecology, economics and society in a complex world. *Ecol Econ* 2007, 61:62–74.
71. Berkes F, Jolly D. Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. *Conserv Ecol* 2002, 5:18.
72. Folke C. Resilience: the emergence of a perspective for social-ecological systems analyses. *Glob Environ Change* 2006, 16:253–267.
73. Nelson DR, Adger WN, Brown K. Adaptation to environmental change: contributions of a resilience framework. *Annu Rev Environ Resour* 2007, 32:395.
74. Vermeulen SJ, Challinor AJ, Thornton PK, Campbell BM, Eriyagama N, Vervoort JM, Kinyangi J, Jarvis A, Läderach P, Ramirez-Villegas J, et al. Addressing uncertainty in adaptation planning for agriculture. *Proc Natl Acad Sci USA* 2013, 110:8357–8362.
75. Armitage DR, Plummer R, Berkes F, Arthur RI, Charles AT, Davidson-Hunt IJ, Diduck AP, Doubleday NC, Johnson DS, Marschke M. Adaptive co-management for social-ecological complexity. *Front Ecol Environ* 2008, 7:95–102.
76. Lebel L, Anderies JM, Campbell B, Folke C, Hatfield-Dodds S, Hughes TP, Wilson J. Governance and the capacity to manage resilience in regional social-ecological systems. *Ecol Soc* 2006, 11:19 [online]. Available at: <http://www.ecologyandsociety.org/vol11/iss1/art19/>.
77. Methmann C, Rothe D, Stephan B, eds. *Deconstructing the Greenhouse: Interpretative Approaches to Global Climate Governance*. Oxon: Routledge; 2013.
78. Okereke C, Bulkeley H, Schroeder H. Conceptualizing climate governance beyond the international regime. *Glob Environ Polit* 2009, 9:58–78.
79. Schipper ELF. Conceptual history of adaptation in the UNFCCC process. *Rev Eur Commun Int Environ Law* 2006, 15:82–92.
80. Adger WN, Dessai S, Goulden M, Hulme M, Lorenzoni I, Nelson DR, Naess LO, Wolf J, Wreford A. Are there social limits to adaptation to climate change? *Clim Change* 2009, 93:335–354.

81. Grothmann T, Patt A. Adaptive capacity and human cognition: the process of individual adaptation to climate change. *Glob Environ Change* 2005, 15:199–213.
82. Lorenzoni I, Nicholson-Cole S, Whitmarsh L. Barriers perceived to engaging with climate change among the UK public and their policy implications. *Glob Environ Change* 2007, 17:445–459.
83. Westley F, Olsson P, Folke C, Homer-Dixon T, Vredenburg H, Looibach D, Thompson J, Nilsson M, Lambin E, Sendzimir J. Tipping toward sustainability: emerging pathways of transformation. *Ambio* 2011, 40:762–780.
84. Westley FR, Tjornbo O, Schultz L, Olsson P, Folke C, Crona B, Bodin Ö. A theory of transformative agency in linked social–ecological systems. *Ecol Soc* 2013, 18:27. doi: 10.5751/ES-05072-180327.
85. Blyth M. *Great Transformations: Economic Ideas and Institutional Change in the Twentieth Century*. Cambridge: Cambridge University Press; 2002.
86. Rose A. Resilience and sustainability in the face of disasters. *Environ Innov Soc Trans* 2011, 1:96–100.
87. Evans B, Reid J. *Resilient Life: The Art of Living Dangerously*. Cambridge: Polity Press; 2014.
88. Joseph J. Resilience as embedded neoliberalism: a governmentality approach. *Resilience* 2013, 1:38–52.
89. Swyngedouw E. Apocalypse forever? Post-political populism and the spectre of climate change. *Theory Cult Soc* 2010, 27:213–232.
90. Walker J, Cooper M. Genealogies of resilience from systems ecology to the political economy of crisis adaptation. *Secur Dialog* 2011, 42:143–160.
91. Pelling M. *Adaptation to Climate Change: From Resilience to Transformation*. Oxon: Routledge; 2010.
92. Béné C, Newsham A, Davies M, Ulrichs M, Godfrey-Wood R. Resilience, poverty and development. *J Int Dev* 2014, 26:598–623.
93. Fazey I, Gamarra JG, Fischer J, Reed MS, Stringer LC, Christie M. Adaptation strategies for reducing vulnerability to future environmental change. *Front Ecol Environ* 2009, 8:414–422.
94. Wise R, Fazey I, Smith MS, Park S, Eakin H, Van Garderen EA, Campbell B. Reconceptualising adaptation to climate change as part of pathways of change and response. *Glob Environ Change* 2014, 28:325–336.
95. Rauschmayer F, Bauler T, Schöpke N. Towards a thick understanding of sustainability transitions—linking transition management, capabilities and social practices. *Ecol Econ* 2015, 109:211–221.
96. Armitage D, Béné C, Charles AT, Johnson D, Allison EH. The interplay of well-being and resilience in applying a social–ecological perspective. *Ecol Soc* 2012, 17:15.
97. Buchanan I, Thoburn N. *Deleuze and Politics*. Edinburgh: Edinburgh University Press; 2008.
98. Deleuze G. *Difference and Repetition*. New York: Columbia University Press; 1994.
99. Guattari F. *The Three Ecologies*. London: Bloomsbury Publishing; 2005.
100. Herzogenrath B. *Deleuze/Guattari & Ecology*. New York: Palgrave Macmillan; 2009.
101. Goodchild P. *Deleuze and Guattari: An Introduction to the Politics of Desire*, vol. 44. London: Sage; 1996.
102. Scott-Cato M, Hillier J. How could we study climate-related social innovation? Applying Deleuzian philosophy to Transition Towns. *Environ Polit* 2010, 19:869–887.
103. Lukes S. *Power: A Radical View*. London: Macmillan; 1974.
104. DeLanda M. *A New Philosophy of Society: Assemblage Theory and Social Complexity*. New York: Continuum; 2006.
105. Bennett J. The agency of assemblages and the North American blackout. *Publ Cult* 2005, 17:445.
106. Strengers Y, Nicholls L, Maller C. Curious energy consumers: humans and nonhumans in assemblages of household practice. *J Consum Cult* 2014. In press. doi: 10.1177/1469540514536194.
107. Walker G, Day R. Household energy vulnerability as 'assemblage'. In: Bickerstaff K, Walker G, Bulkeley H, eds. *Energy Justice in a Changing Climate: Social Equity and Low-Carbon Energy*. London: Zed Books; 2013.
108. Allen J. *Lost Geographies of Power*. London: John Wiley & Sons; 2008.
109. Smith A, Stirling A, Berkhout F. The governance of sustainable socio-technical transitions. *Res Policy* 2005, 34:1491–1510.
110. Hoffmann MJ. *Climate Governance at the Crossroads: Experimenting with a Global Response after Kyoto*. Oxford: Oxford University Press; 2011.
111. Jordan A. The governance of sustainable development: taking stock and looking forwards. *Environ Plann C Gov Policy* 2008, 26:17.
112. Bourdieu P. *Outline of a Theory of Practice*, vol. 16. Cambridge: Cambridge University Press; 1977.
113. Bourdieu P. *The Field of Cultural Production: Essays on Art and Literature*. New York: Columbia University Press; 1993.
114. Fligstein N, McAdam D. *A Theory of Fields*. Oxford: Oxford University Press; 2012.
115. Giddens A. *The Constitution of Society: Outline of the Theory of Structuration*. Cambridge: Polity Press; 1984.
116. Hoffman AJ, Ventresca MJ. *Organizations, Policy and the Natural Environment: Institutional and*

- Strategic Perspectives*. Redwood City, CA: Stanford University Press; 2002.
117. Thornton PH, Ocasio W, Lounsbury M. *The Institutional Logics Perspective: A New Approach to Culture, Structure, and Process*. Oxford: Oxford University Press; 2012.
 118. Cleaver F. Reinventing institutions: bricolage and the social embeddedness of natural resource management. *Eur J Dev Res* 2002, 14:11–30.
 119. Vatn A. Rationality, institutions and environmental policy. *Ecol Econ* 2005, 55:203–217.
 120. Young OR. *The Institutional Dimensions of Environmental Change: Fit, Interplay, and Scale*. Cambridge, MA: MIT Press; 2002.
 121. Paavola J, Gouldson A, Kluvánková-Oravská T. Interplay of actors, scales, frameworks and regimes in the governance of biodiversity. *Environ Policy Gov* 2009, 19:148–158.
 122. Zahariadis N. The multiple streams framework: structure, limitations, prospects. In: Sabatier PA, ed. *Theories of the Policy Process*. 2nd ed. Boulder, CO: Westview Press; 2007, 65–92.
 123. Rabinow P, Rose N. Introduction: Foucault today. In: Rabinow P, Rose N, eds. *The Essential Foucault: Selections from Essential Works of Foucault*. New York: New Press; 2003.
 124. Paavola J, Adger WN. Institutional ecological economics. *Ecol Econ* 2005, 53:353–368.
 125. Phillips N, Tracey P. Opportunity recognition, entrepreneurial capabilities and bricolage: connecting institutional theory and entrepreneurship in strategic organization. *Strat Org* 2007, 5:313–320.
 126. Hess DJ. Industrial fields and countervailing power: the transformation of distributed solar energy in the United States. *Glob Environ Change* 2013, 23:847–855.
 127. Evans R, Kay T. How environmentalists “greened” trade policy: strategic action and the architecture of field overlap. *Am Sociol Rev* 2008, 73:970–991.
 128. Dryzek JS. *Foundations and Frontiers of Deliberative Governance*. Oxford: Oxford University Press; 2010.
 129. Fischer F. *Reframing Public Policy: Discursive Politics and Deliberative Practices*. Oxford: Oxford University Press; 2003.
 130. Dryzek JS, Lo AY. Reason and rhetoric in climate communication. *Environ Polit* 2014, 24:1–16.
 131. Few R, Brown K, Tompkins EL. Public participation and climate change adaptation: avoiding the illusion of inclusion. *Clim Policy* 2007, 7:46–59.
 132. Fisher DR. COP-15 in Copenhagen: how the merging of movements left civil society out in the cold. *Glob Environ Polit* 2010, 10:11–17.
 133. Lorenzoni I, Benson D. Radical institutional change in environmental governance: explaining the origins of the UK Climate Change Act 2008 through discursive and streams perspectives. *Glob Environ Change* 2014, 29:10–21.
 134. Schmidt VA. Taking ideas and discourse seriously: explaining change through discursive institutionalism as the fourth ‘new institutionalism’. *Eur Polit Sci Rev* 2010, 2:1–25.