

Societal transformation in response to global environmental change: A review of emerging concepts

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Abstract The study of societal transformation in response to environmental change has become established, yet little consensus exists regarding the conceptual basis of transformation. This paper aims to provide structure to the dialog on transformation, and to reflect on the challenges of social research in this area. Concepts of transformation are identified through a literature review, and examined using four analytical criteria. It is found that the term ‘transformation’ is frequently used merely as a metaphor. When transformation is not used as a metaphor, eight concepts are most frequently employed. They differ with respect to (i) system conceptualization, (ii) notions of social consciousness (deliberate/emergent), and (iii) outcome (prescriptive/descriptive). Problem-based research tends to adopt concepts of deliberate transformation with prescriptive outcome, while concepts of emergent transformation with no prescriptive outcome tend to inform descriptive-analytical research. Dialog around the complementarities of different concepts and their empirical testing are priorities for future research.

Keywords Environmental change · Transformation · Sustainability · Social science

GLOBAL ENVIRONMENTAL CHANGE AND SOCIETAL TRANSFORMATION

There is mounting evidence that human activities drive global environmental change (GEC) in what has been come to be called the ‘Anthropocene’ Era (Steffen et al. 2007;

IPCC 2014). Modern societies have engaged in increasingly disruptive modes of interaction with the biophysical environment, and this is widely perceived as not simply a side effect, but a characterizing trait of modern societies (Jackson 2009). There is, therefore, a growing consensus not only that ‘business as usual’ is not an option (e.g., Jackson 2009), but also that given the pace and magnitude of GEC, a fundamental, radical, and possibly rapid change toward sustainability is needed (Nelson 2009; Westley et al. 2011; DeFries et al. 2012; ISSC 2012; Shove et al. 2012).

While a variety of terms have been used to describe this fundamental shift, the term ‘transformation’ is gradually becoming institutionalized in the vocabulary of the scientific and policy communities, particularly as exhibited through global collaborative initiatives such as Future Earth (www.futureearth.info), the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2012), and the latest World Social Science Report (ISSC/UNESCO 2013).

Particularly, research on GEC is shifting its focus from simply “understanding and explaining environmental problems to addressing them quickly and effectively” (O’Brien 2011, p. 110), which indicates that social sciences are progressively claiming their space in the field of research on GEC. Inputs from the social sciences and humanities are increasingly recognized as essential to understanding and responding to global environmental change by both research funding agencies and natural scientists (O’Brien 2011, see also International Social Science Council/United Nations Educational, Scientific and Cultural Organization (ISSC/UNESCO) 2013). The social sciences are called to take the lead in integrative, interdisciplinary research: on the one hand to help understand human–environment interactions, particularly the persistence and change of human activities that are cause

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of, or emerge in response to, environmental change, and, on the other, to contribute in identifying human responses to GEC (International Social Science Council (ISSC) 2012; International Social Science Council/United Nations Educational, Scientific and Cultural Organization (ISSC/UNESCO) 2013).

The general idea of transformation as a major, fundamental change, as opposed to minor, marginal, or incremental change, appears to be widely agreed upon in both research and policy (Kapoor 2007; O'Brien 2012). However, there is little consensus regarding the features that make change in human–environment systems 'transformational,' and therefore qualitatively different from 'non-transformational' shifts, and in fact, as some have noted (Berkhout 2013; Brown et al. 2013; Mustelin and Handmer 2013), the wider conceptual bases of transformation, notions of its forms, and processes have been the subject of debate. Some scholars have identified important contrasts between the concepts of 'transformational adaptation' and 'societal transformation' (O'Brien and Barnett 2013), whereby the former tends to denote reactive change in spatially or functionally delimited systems and the latter may refer to the redesign of modern societies as a whole, a redirection of civilization that recalls the advent of market economies described by Polanyi in *The Great Transformation* (1944; Haberl et al. 2011; Leggewie and Messner 2012).

Similarly, disagreements have arisen regarding the desirability of transformation. Transformation is seen by some scholars as the consequence of societal collapse, and therefore considered a negative outcome (e.g., Butzer 2012), while others see the capacity to actively transform (i.e., transformability) as an essential property of long-lasting functioning systems (Folke et al. 2010), and concomitantly view transformation as an effective means of promoting ecological sustainability and social prosperity (Beddoe et al. 2009; Jackson 2009). The latter perspective has been influenced by debates in Marxist and post-Marxist theory, with some scholars defining societal transformation as change within the frame of the capitalist economic system (WBGU 2011), while others viewing transformation as a radical change of the social structures (e.g., world views and power relations) underpinning a capitalist economy (e.g., Brooks et al. 2009).

Transformation has significant overlaps with other concepts, such as resilience, adaptation, transition, critical transition, and sustainable development (Sheffer 2009; Pelling 2011; Park et al. 2012), and the relationships among these are interpreted from a range of perspectives. Some strongly delineate transformation from transition (Pelling 2011; Brown et al. 2012), while for others (e.g., Griffith et al. 2010; De Haan and Rotmans 2011), the former is seen as a building block or particular type of the

latter. Similarly, some scholars draw sharp distinctions between the ideas of 'transformation' and 'resilience' (e.g., Pelling 2011), while for others, transformability is a fundamental characteristic of a resilient system (Walker et al. 2004; Folke et al. 2010).

To be sure, this plurality signals the vitality of this field of research and is typical of the social sciences, where multiple paradigms coexist (e.g., Sunderlin 1995). Furthermore, it has been shown that concepts with 'loose' meanings that also benefit from a strong metaphoric power can be highly effective to stimulate research and action, and to create a much needed common ground for scholars from different disciplines, as well as among scientists and stakeholders, which facilitates inter- and transdisciplinarity (Thompson 2007; Newell 2012; Strunz 2012; Angelstam et al. 2013). Inter- and transdisciplinarity are, in effect, pillars of some of the most recent developments in research on GEC and sustainable development, including Future Earth and the IPCC.

Yet, while it is recognized that the process of transformational change is not well understood (Nelson 2009; International Social Science Council (ISSC) 2012), and that there is not yet a solid theory of transformation (Shove 2010b; O'Brien 2012; O'Brien and Sygna 2013), conceptual plurality and lack of consensus can also have significant drawbacks, particularly when it is time to apply research to the implementation of effective actions. It has been argued that the high conceptual elasticity and lack of empirical grounding of the concept of transformation generate the risk of voiding the term of meaning, and consequently easily co-opted by actors who aim to defend the status quo rather than promoting radical societal change (Tanner and Bahadur 2013). This can be seen in cases where the idea of transformation is applied purely metaphorically. When powerful metaphors become fashionable buzzwords, there is the risk that diversity is accompanied by vagueness, i.e., the phenomenon of a term that has several meanings which "have so much in common that it is difficult to separate them" (Strunz 2012:113). Vagueness may also hinder the development of understandings of the social processes and mechanisms involved in transformational change (Thompson 2007; Strunz 2012). As noted by Agrawal et al. with reference to the process of adaptation to climate change, "precision in language and understanding can translate into more useful and targeted analyses and interventions" (2012, p. 330).

Therefore, it is important to clarify whether and in what ways transformation is a useful concept. Does the value of transformation reside in primarily being a powerful metaphor to inspire research and action, or does the concept also have an analytical value that can support the understanding societal transformation in response to GEC?

Theoretical and methodological debate around transformation is in its infancy (e.g., Shove 2010a, b; Brown

et al. 2012; Kates et al. 2012; O'Brien 2012; Park et al. 2012; Wiek et al. 2012; Brown et al. 2013; Mustelin 2013; O'Brien and Sygna 2013), and to the best of the author's knowledge, no attempt to systematically characterize the concept has been made so far. This paper aims to make some first steps in that direction. It renders and critically analyzes the diversity of concepts of transformation being used in current research by addressing four main questions: (i) what concepts of transformation are emerging in the literature? (ii) what are the differences and similarities among these concepts? (iii) are some concepts particularly associated with, or considered more suitable for specific research approaches? and (iv) what does this imply for the challenges of understanding and promoting transformative processes?

It is not the aim of this paper to advocate a specific concept of transformation, nor to develop a theory of transformation. Rather, this paper provides a critical perspective of transformation by mapping its conceptual and methodological diversity. This study suggests a way to provide structure to the dialog on transformation, and proposes some critical reflections on the challenges and directions of integrative social scientific research regarding societal transformation in response to GEC.

The paper is structured as follows. In section two, I present the methods used to select the works of literature reviewed and the framework adopted for their analysis, while the results of the analysis are presented in the three sections that follow. Section three identifies some emerging concepts of transformation, which are then dissected through the lenses of the analytical framework. In section five, I discuss relationships between different concepts of transformation and particular research paradigms. Finally, I sum up and briefly discuss the main findings, before concluding with some thoughts on the challenges and directions of integrative social scientific research on societal transformation in response to GEC.

RESEARCH METHOD AND ANALYTICAL FRAMEWORK

This study entailed three main phases, namely (i) the selection of relevant literature on societal transformation in response to GEC, (ii) the identification of concepts of transformation, and (iii) the analysis of these concepts in the light of the theoretical framework.

Literature selection and identification of concepts of transformation

I selected relevant literature on transformation by running a query in the Thomson Reuters Web of Science as a

keyword search (“transform*” AND “environmental change” OR “transform*” AND “climate change”) for publications in the social sciences (Social Sciences Citation Index, Conference Proceedings Citation Index- Social Science & Humanities, Book Citation Index—Social Sciences & Humanities) between 1990 and 2013. I then scanned the titles and abstracts of the 706 queried articles in order to filter the results, excluding the following types of research from the subsequent analysis: (i) articles in which the concept of transformation referred exclusively to biophysical systems, either as a consequence of man-induced processes or not (e.g., transformation of ecosystems or landscapes); (ii) articles in which the need for a societal transformation represented a general background motivation of the study rather than the object of study (e.g., some studies of natural resource management or consumer behavior); (iii) articles that investigated forms of societal transformations occurred exclusively in the past (i.e., archeological research); and (iv) articles that dealt with transformative change within a specific organization (i.e., organizational change). The selected articles were complemented with relevant reports and publications not indexed in the Web of Science (Appendix S2). Finally, I identified the concepts of transformation adopted in the 138 selected publications by analyzing their content and identifying the key academic works that informed the conceptualization of societal transformation adopted in those articles. The number of concepts identified was not predetermined, and the concepts of transformation included in the analysis emerged from the selected literature. The review was not meant as an extensive survey of all available literature on the theme, which is beyond the scope of this paper. Instead, it aimed to reveal what concepts of societal transformation in response to GEC are most often used, in order to systematically analyze them and reflect on their implications.

The analytical framework: Anatomy of transformation

In order to uncover differences and commonalities among the concepts of transformation used in the literature, it is useful to rely on analytically relevant categories. Following Sztompka (1993), I adopted four cross-cutting general criteria to classify social change processes (Table 1): (i) system model, (ii) form and temporal range, (iii) seat of causality and social consciousness, and (iv) outcome. These criteria together represent an ‘anatomy’ of social change, which I used as an analytical framework to systematically characterize concepts of transformation. The criteria are described in detail in Appendix S1 (Electronic Supplementary Material).

Table 1 Analytical framework (elaborated from Sztompka 1993)

Criterion	Descriptors
System model	The system definition Elements, interrelations, functions, boundaries, subsystems, environment Structure, function Patterns, units Level (micro, meso, macro)
Form and temporal range	The form and time span the change process takes Directional or non-directional Short to long term Continuity, time lags, ruptures
Seat of causality and social consciousness	The moving force behind the change process and the awareness human agents have of the results that the change process brings about Endogenous or exogenous forces Dominant cause or distributed human agency Social consciousness
Outcome	The end result of the change process Morphogenesis, transmutation or reproduction Qualitative or quantitative change Functional or structural change

CONCEPTS OF TRANSFORMATION

The literature review uncovered a growing scholarship on societal transformation in response to GEC, as shown both by the increasing number of publications and by the international research programs and events employing any of the existing versions of this concept (Appendix S2; Table S1 in Electronic Supplementary Material).

I found that for about fifty percent of the reviewed articles ‘transformation’ was a prominent theme, but no clear conceptual basis was provided for its use, and the term was not defined at all in many cases (e.g., Kristjanson et al. 2012; Pearson and Foxon 2012; van Vuuren et al. 2012; Ferguson et al. 2013). Transformation is rather used as a metaphor to convey the idea of fundamental, systemic, or radical change, e.g., in livelihoods (Huang et al. 2012), finance (Gomez-Echeverri 2013), governance (Biermann et al. 2013), energy markets (Aylett 2013), or agriculture (Reganold et al. 2011). These articles employ the term ‘transformation’ in connection with a range of issues related to societal change (e.g., cultural or technical innovation adaptation to climate change), but do not rely upon nor develop a specific theoretical basis of transformation.

The literature on societal transformation in response to GEC most frequently employed in the remaining articles are illustrated in Table 2.

It is sometimes the case that research on societal transformation in response to GEC is informed by more than one concept of transformation. Figure 1 shows which concepts are more often employed together. This figure highlights the relative proximity or distance of scholarly traditions in which different concepts of transformation have their intellectual roots (Table 2).

It is important to note that the simple frequency of reference to these concepts does not fully capture their consolidation in the literature. First and foremost, in such a recent and rapidly growing field of research, many concepts of transformation have only been recently introduced and for this reason are not yet necessarily considered in other studies. Second, some citations may be more influential than others on account, among others, of their international visibility and authority. For example, the IPCC special report on *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (2012) builds heavily on Pelling (2011) and O’Brien (2012) while virtually ignoring other concepts of transformation in Table 2. Moreover, the figures reported in Table 2 do not take into account that some scholarly traditions developed independently of the issues of societal transformation specifically in response to GEC and have only relatively recently been connected to this area of research, as is the case with Social Metabolism (SM), which has an established tradition of study of societal transformations (e.g., Fischer-Kowalski and Haberl 2007; Haberl et al. 2011), or Social Practices Approach (SP), whose relevance and potential contribution to societal transformation in the face of GEC have only recently been explored (Shove et al. 2012). Thus, Fig. 1 and Table 2 illustrate the emerging conceptual diversity, rather than their relative weight in the literature, which is the basis for further theoretical and methodological analysis carried out in the next two sections of this paper.

ANALYSIS OF CONCEPTS OF TRANSFORMATION

In this section, I use the analytical framework (Table 1) to identify differences and similarities among the concepts of transformation that are emerging in the literature on societal responses to GEC (Table 2).

System model

Most of the concepts of transformation define the systems of analysis as an integration of interacting human and

Table 2 Emerging concepts of societal transformation in response to global environmental change

Concept	Short description	Key references	Scholarly tradition
Deliberate transformation (DT)	“Transformation can be defined as physical and/or qualitative changes in form, structure or meaning-making. It can also be understood as a psycho-social process involving the unleashing of human potential to commit, care, and effect change for a better life” (O’Brien 2012, p. 4)	O’Brien (2012)	Various
(Progressive) transformation (PT)	“For adaptation to be transformative and progressive it must provide scope for the revision and reform or replacement of existing social contracts and the meaning of security and modes of development, as well as defending social gains already won. [Transformation tackles] the causes of vulnerability at their roots” (Pelling 2011, p. 171)	Pelling (2011)	Human security
Regime shift (RS)	Active transformation is the “deliberate initiation of a phased introduction of one or more new state variables (a new way of making a living) at lower scales, while maintaining the resilience of the system at higher scales as transformational change proceeds.” Forced transformation is an “An imposed transformation of a social–ecological system that is not introduced deliberately by the actors” (Folke et al. 2010, p. 20)	Walker et al. (2004) Folke et al. (2010)	Resilience
Societal transition (SoT)*	“Transitions are co-evolution processes that require multiple changes in socio-technical systems and configurations.” [...] They are “multi-actor processes, [...] radical shifts from one system or configuration to another. The term ‘radical’ refers to the scope of change. [...] Transitions are long-term processes” and “macroscopic” (Grin and Schot 2010, p. 9)	Grin and Schot (2010)	Transition theory
Social practice (SP)	Transformation is a reconfiguration of practices: the elements (i.e., materials, meanings, and competencies) that define practices, practices themselves, and practice complexes	Shove et al. (2012)	Social practices
Transformational adaptation 1 (TA1)	“There are at least three classes of adaptations that we describe as transformational: those that are adopted at a much larger scale or intensity, those that are truly new to a particular region or resource system, and those that transform places and shift locations” (Kates et al. 2012, p. 7156).	Kates et al. (2012)	–
Transformational adaptation 2 (TA2)	“[Transformation is] a discrete process that fundamentally (but not necessarily irreversibly) results in change in the biophysical, social, or economic components of a system from one form, function or location (state) to another, thereby enhancing the capacity for desired values to be achieved given perceived or real changes in the present or future environment” (Park et al. 2012, p. 119)	Park et al. (2012)	Builds on resilience and transition theory
Socioecological transition (SeT)	“A socioecological transition [...] is a transition from a socioecological regime to another. [...] A socioecological regime is a specific fundamental pattern of interaction between (human) society and natural systems” (Fischer-Kowalski and Haberl 2007, p. 8). A socioecological regime is associated to a social metabolic profile, i.e., the throughput of energy and material in the system	Fischer-Kowalski and Haberl (2007)	Social metabolism

* In the transition theory literature, the terms transition and transformation are not always distinguished (Grin and Schot 2010; Leggewie and Messner 2012), although the former is largely preferred. Only recently, De Haan and Rotmans have proposed that transformation is a particular type of transition process (De Haan and Rotmans 2011)

biophysical or technological components. However, different system conceptualizations are found in the literature, i.e., in terms of fundamental system elements and their interactions. Societal transition (SoT) refers to Socio-Technical Systems (STS), while regime shifts (RS) and usually deliberate transformation (DT) and progressive transformation (PT) refer to Social–Ecological Systems (SES). SM conceptualizes systems as coupled communication and biophysical compartments (Fischer-Kowalski and Haberl 2007), with roots in Luhmann’s System Theory (Luhmann 1995). SP has an established theoretical basis in social practice theory proposed by Shove et al. (2012),

which draws from a tradition of social thought which includes Giddens’ Structuration Theory (Giddens 1984).

Some system conceptualizations adopted in distinct concepts of transformation share a common theoretical ground. Importantly, all concepts of transformation involve structural change, i.e., a qualitative change of system. Additionally, Transformational adaptation (TA2) builds on resilience and transition theory, from which RS and SoT concepts derive; SP and socioecological transition (SeT) are compatible with transition theory (Shove and Walker 2007; Fischer-Kowalski and Rotmans 2009; Shove 2010a); and DT and PT build on resilience thinking, although with

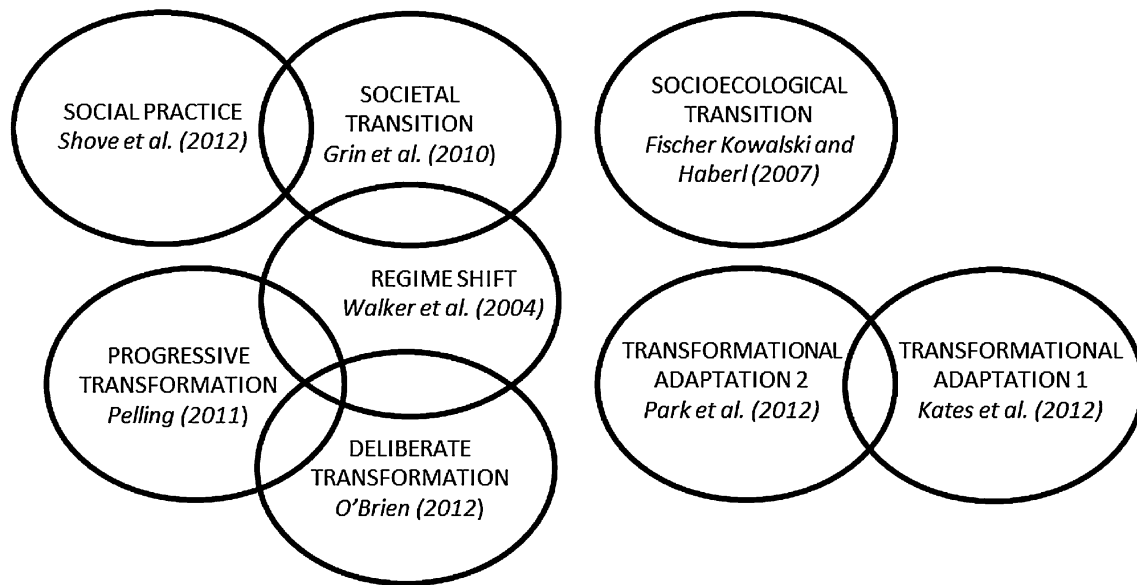


Fig. 1 Concepts of transformation most often employed in the literature. Overlaps denote concepts that at times are found to be employed concomitantly

a stronger emphasis on political ecology and individual dimension of transformation (O'Brien and Barnett 2013; Tschakert and Clair 2013).

All concepts of transformation refer to system models that are conceptualized as complex, dynamic, and multi-level entities. Consequently, transformation is conceptualized as a process involving the interaction of units at different levels, although what levels are identified in a system depends on the system model adopted. In particular, some concepts of transformation adopt system models that explicitly include an examination of the individual level (DT, PT, TA2, and SP) while others regard only the meso and macro levels (SoT, RS, and SeT). In transformational adaptation (TA1) only, the level at which change is observed is considered a defining characteristic of transformation, whereby the adaptive change is classified as 'transformative' when it is scaled up, e.g., from the local to the regional level (Kates et al. 2012).

Concepts of transformation also draw different system boundaries. Some bodies of thought, i.e., SeT, SP, and PT, refer to transformation as a process entailing a whole society, whether the society be global, national, or local. Others, i.e., DT, RS, SoT, TA1, and TA2, are applied to a wider range of systems, from societies on the largest scale, down to functionally, biophysically, or socially more delimited systems (e.g., ecosystems and productive sectors).

Form and temporal range

Concepts of transformation converge on approaching transformational change as a non-linear, non-teleological process. This is consistent with the common

conceptualization of systems as complex adaptive entities characterized by, among others, feedback processes, emergence, lock-in effects, and path dependence. Some concepts of transformation propose that transformative change follows a sequence of general phases. For example, SoT is a process comprising four phases (i.e., predevelopment, take off, acceleration, and stabilization), for which pathways of transition, e.g., reform, reconfiguration, substitution, and transformation, have been identified (e.g., Geels and Schot 2007; De Haan and Rotmans 2011). RS entails three phases, namely being prepared for or actively preparing the social–ecological systems for change; navigating change by making use of a crisis as a window of opportunity; and building resilience of the new social–ecological regime (Olsson et al. 2006; Folke et al. 2010). TA2 involves a cycle with three stages: problem structuring and establishing the adaptation arena developing the adaptation agenda, vision, and pathway; implementing adaptation actions; and evaluating, monitoring, and learning. Nevertheless, all concepts of transformation recognize that transformative processes are characterized by discontinuities, ruptures, or thresholds, and do not generally proceed smoothly, and therefore these 'cycles' or 'phases' represent attempts to make sense of the complex behavior of systems rather than strictly defining features of transformation.

With the exception of TA2, concepts of transformation depict it as a historical process, i.e., one that cannot be undone and whose effects are persistent, although subject itself to further change due to the dynamic nature of complex systems. TA2, however, contemplates the possibility that transformation is a reversible process (Park et al.

2012). Ideas of transformation also vary in scalar approach; for example, SeT entails long-term transformations (e.g., the transformation of hunter-gatherer societies into agricultural societies or the outbreak of the industrial revolution) (Fischer-Kowalski and Haberl 2007), while SoT is limited to a multi-decadal time frame of 40–50 years (Grin et al. 2010). Other concepts of transformation, however, do not bind the process to specific time frames. In fact, some concepts of transformation, particularly RS and those that to some extent build on resilience theory, such as DT, PT, and TA2, stress that the existence of unknown social and biophysical thresholds blurs the distinction between long- and short-term time ranges, as incremental change may result in transformational change if one such threshold is passed (Nelson et al. 2007; Sheffer 2009; Preston et al. 2013). TA1 appears to distinguish even more markedly between transformative and incremental change (e.g., Kates et al. 2012).

Seat of causality and social consciousness

A consensus in the literature classifies transformation as a change that proceeds via a combination of endogenous and exogenous processes, involving both emergent, inadvertent, unintended consequences and intended, deliberate ones. This is consistent with the understanding of STS, SES, and other system conceptualizations of integrated human and biophysical components as complex adaptive systems (“[System model](#)” section), characterized by emergence and self-organization and by inherent limits to human control (e.g., Shove and Walker 2007).

While recognizing the complex nature of systems, concepts of transformation may differ in whether they emphasize either emergent or deliberate processes. These distinctions may be represented by dichotomies such as those drawn between ‘active’ vs. ‘forced’ (Folke et al. 2010), or between anticipatory versus reactive transformation (Kates et al. 2012).

SP and SeT are emergent processes, whereas DT, PT, RS, SoT, TA1, and TA2 emphasize deliberate change process, i.e., they include possibility of steering or navigating, if not fully managing the process of change. Transition management (Grin and Schot 2010), adaptive management and collective action (Olsson et al. 2006; Folke et al. 2010; Ernstson 2011), consensus building through visioning (Beddoe et al. 2009), and social learning (Park et al. 2012) are common approaches to deliberate transformation. Such concepts highlight the fundamental role of agency (Nelson et al. 2007; Brown and Westaway 2011; Pelling 2011; O’Brien 2012), and identify types of key agents such as innovators (e.g., Westley et al. 2011) and leaders (Olsson et al. 2006). Concepts of deliberate transformation also open

up a ground for scientists to directly engage with change processes, which is discussed in “[Concepts of transformation and research approaches](#)” section.

Outcome

The concepts of transformation reviewed herein are employed in research that aims to contribute to the understanding of and foster socially and ecologically effective responses to GEC, i.e., to achieve change that will generate sustainable modes of societal interaction with the natural environment.

It is widely agreed that transformation is a process of structural change, i.e., a change of fundamental patterns, elements, and interrelations in the system, and that pursuing sustainability requires the involvement of social, symbolic, physical, and material changes, that is, fundamental alterations in e.g., sense-making, worldviews, political and power relations, social networks, and ecosystems, physical infrastructure, and technology, respectively. However, there are important differences with respect to the extent to which a socially and ecologically sustainable outcome is a defining feature of transformative change; that is, the extent to which a sustainable outcome of change is necessary to identify observed changes as transformational.

On this basis, concepts of transformation can be broadly divided into two categories based on whether they employ descriptive and prescriptive concepts of transformation. The former identifies patterns that are considered definitive of transformation, but does not attach value to any specific—e.g., sustainable—configuration of these patterns. These perspectives, which include RS, SoT, SeT, and SP, encompass distinct pathways and outcomes of transformation (Geels and Schot 2007; De Haan and Rotmans 2011), including potentially ‘non-desirable’ consequences (Marshall et al. 2012), such as changes resulting in greater social inequality or increases in carbon consumption and emissions. On the other hand, prescriptive concepts of transformation, which include DT, PT, and TA2, define transformative change not only as entailing structural change, but also as going specifically in desirable directions, which are differently determined on the basis of such benefits as “substantial and widely distributed benefits [to] both society and ecosystems” (Marshall et al. 2012:2), increased adaptive capacity (e.g., Park et al. 2012), or empowerment and agency (O’Brien 2012). Transformation can be contested, as the particular performance of the evaluated system depends on given values. It is notable that such perspectives tend to inform a particular problem-based transdisciplinary research approach, which manages this issue through various forms of consensus building and participatory processes, as discussed in “[Concepts of transformation and research approaches](#)” section.

Example: Peasants in the Colombian Andes

In order to illustrate how concepts of transformation differ in practice, along with some possible blind spots and policy implications, I will use the example of peasants in the Colombian Andes, which are responding to GEC and the simultaneous pressures of trade liberalization and violent conflict.

Colombian agriculture is facing multiple pressures, to which peasants and smallholders are considered especially vulnerable. On the backdrop of decades of violent conflict, the country is experiencing the increasing effects of climate change and variability, exacerbated by pressures from global markets; the latter being increased by a recent round of trade liberalization agreements between Colombia and such major global players in the agriculture sector as the European Union and the United States of America (Feola et al. 2014). Smallholding farms dominate the rural Andes, where they employ up to 95% of the agricultural workforce, and they provide a substantial proportion of the food consumed in rural and urban areas alike. It is unclear whether these farming communities have the capacity to adapt to the magnitude and pace of the aforementioned pressures, despite the centuries-long history in the area of adaptation to such difficult environments (Feola et al. 2014).

By and large, two types of responses are being pursued to these pressures, namely, agricultural modernization and community, or alternative, development. Agricultural modernization—which is embraced by the government, governmental agencies and sectors of the agro-industry and agricultural producer associations—entails moving the agricultural sector in Colombia toward more mechanized, economically efficient agriculture. The changes triggered by this policy strategy have been particularly catastrophic among traditional peasant communities in the Andes, as well as among afro-Colombian and indigenous communities across the country. In effect, with the exception of a minority of peasants who manage to successfully integrate into the new economic conditions, these communities are largely being disenfranchised from their traditional lands and means of subsistence, forced to abandon traditional agriculture and move to urban areas, or to offer their labor to agricultural enterprises or take on other activities (e.g., mining) in the rural areas. Similar to what has been observed in other Latin American countries, Colombian liberalization policies have favored the supply of cheap food to the growing urban middle class, but have been largely based on neoclassical economic models that do not account for the diversity and specificity of local agricultural systems, ignore the social and cultural value—as opposed to purely economic benefits—of particular farming systems, and leave little space for practices that are not compatible with an imposed integration into the global market economy.

Agricultural modernization is accompanied by top-down adaptations to climate change that are mostly based on investment in technology and technology transfer, external inputs, and information (Feola 2013). Such strategies hardly recognize the diversity of the Colombian cultural and environmental landscapes, and they ignore the root causes of smallholder vulnerability, which do not necessarily lie in a lack of information or technology, but rather in the lack of access to credit and land (Colombia has one of the most inequitable land distributions in the world), uncertain land property rights, weak social networks (especially in rural areas as a legacy of violent conflict), and social, political, and geographical exclusion of rural communities whose contributions to the country's food security, economy, and identity have been underplayed for decades (Feola 2013; Feola et al. 2014).

A second response to the multiple exposures threatening Colombian peasants is that which emerges largely from the civil society, particularly members of farming communities themselves, as well as Colombian and international non-governmental organizations. It involves inclusive participation, alternative epistemologies, and the empowerment and self-organization of local communities to respond to climate change through innovation that builds on, rather than abandons, cultural traditions, and local knowledge systems (e.g., Barkin 2011). Such type of community development often involves the creation of cooperatives that institutionalize and foster interaction and collective action between farmers and other actors, such as scientists and activists. It is a model of development that aims to be endogenous, i.e., to be locally generated, to rely on local knowledge, resources (e.g., native seeds) and technical inputs, and consequently to reject exploitative extractive economies. Community development therefore results not only in an alternative pathway to local rural development, but also often in alternatives *to* development itself (e.g., Escobar 1995).

The example of the Colombian Andes illustrates two important points with respect to the understanding and pursuit of societal transformation in response to GEC. First, as long as transformation is employed as a metaphor, it can be used to indicate either of the two above-mentioned responses to GEC and multiple exposures. Both responses generate some form of radical reconfiguration of those units (e.g., farm households and farm businesses) and patterns (e.g., institutions and social networks) that characterize traditional farming communities. In addition to technological changes, agricultural modernization calls for a deep integration of peasant economies into the market, a change that is cultural before being economic, requiring them to abandon non-utilitarian in favor of utilitarian rationality, and reconfigure the structures of traditional household economies, social roles, and informal

institutions (Gudeman 2012). Yet, community development also calls for radical change, albeit different from that generated by agricultural modernization—in the form of livelihood diversification, increased association, and community participation in a territory traditionally characterized by an ethos of passivity and social reserve (Fals-Borda 1955), as well as new institutional arrangements and forms of exchange such as local and farmers' markets.

In this example, transformation as a metaphor helps convey the idea that fundamental change is occurring and needed, but does not help identify what processes are transformational in what manner and to what extent. It is apparent that both responses entail changes to fundamental structures, but that these changes are radically different. In other words, transformation as a metaphor could be employed—and is in fact employed in the contested narratives of rural change in Colombia—to indicate pathways that refer to very different visions of rural development, and have roots in distinct worldviews of human–environment relations, concepts of social prosperity, and values of social justice.

This example also illustrates how observed processes of fundamental change can be understood as transformative. For example, the type of fundamental change spurred through top-down policies to pursue agricultural modernization does not entail empowerment, deliberative processes, or increased equity, nor does it tackle some of the structural inequality issues (e.g., land distribution and access to credit), which would be recognized as essential elements of transformative change according to some concepts (e.g., DT and PT). More specifically, regarding GEC, agricultural modernization pursues a societal response that imposes fundamental structural changes to certain parts of society (e.g., peasant and smallholding farmers), but does not challenge others (e.g., models of development) that are at the roots of existing vulnerability to GEC (Feola 2013). On the other hand, while community development would generate transformative change according to DT and PT, it may also be identified as incremental change with regards to TA1, as it is hardly scaled up and does not entail a shift of location; it requires innovation but is firmly rooted in traditional knowledge systems and cultural practices. Therefore, while scholars recognize that peasant and smallholding communities are exposed to pressures, including climate change, which will likely induce change, not all concepts of transformation would inform an analysis that recognizes transformative processes in this change.

CONCEPTS OF TRANSFORMATION AND RESEARCH APPROACHES

The differences highlighted in section four with respect to the criteria of causality, social consciousness, and outcome

suggest that varying concepts of transformation may inform different types of research approaches. Following Wiek et al. (2012), there are two fundamental challenges to which the social sciences are called: on the one hand to help understand human–environment interactions, particularly the persistence and change of human activities that are the cause of, or emerge in response to, environmental change, and, on the other hand, to contribute to identifying transformative human responses to GEC (International Social Science Council (ISSC) 2012; International Social Science Council/United Nations Educational, Scientific and Cultural Organization (ISSC/UNESCO) 2013; O'Brien and Sygna 2013). These issues can be said to correspond to two broad research approaches, one of which being descriptive-analytical in nature, the other being more solutions-oriented.

The descriptive-analytical approach aims to describe and understand the complexity of human–environment interactions, and thus provide the knowledge that would ultimately translate into practical solutions. Social and social-ecological change is viewed as a research problem that is often investigated interdisciplinarily and with a balance between fundamental understanding and considerations of use. The goal, at times naively, but increasingly critically intended (Shove et al. 2012; Turnpenny 2012), usually lies toward informing policymaking or other forms of action by key decision-makers, and this may, but does not necessarily, imply the achievement of 'objective' knowledge produced by testing rigorous theories following a normal science paradigm (Strunz 2012). According to this model, the researcher's positionality and values are usually made explicit (Strunz 2012), and it is considered important to distinguish between the knowledge base and the political decision.

The solution-oriented or 'transformational social science' (International Social Science Council (ISSC) 2012) perspective calls on the social sciences to take a more strategic and operational approach to issues of change. It refers to a 'post-normal' science epistemology (Turnpenny 2012), and privileges transdisciplinary and action research methodologies (Angelstam et al. 2013; Seidl et al. 2013), while also calling for a more active social role for science in the process of social change by directly bringing about change in society, such as in scientist–activist–practitioner networks (Evans 2011).

Overall, the descriptive-analytical perspective calls for descriptive approaches to the issue of transformation, and leaves open ground for the understanding of change as a result of inadvertent or deliberate processes. There appears to be little compatibility between this approach and concepts of transformation that are prescriptive and place emphasis on deliberate processes of change. The concepts of transformation adopted in solution-oriented approaches

tend to assume the possibility of deliberate action and systemic change management (e.g., transition or adaptive management), and particularly to claim the role of academia as an active player in this processes. Furthermore, this research approach is more comfortable with prescriptive concepts of transformation, which are often seen as a result of the processes of knowledge co-production carried out in the in-specific systems, as opposed to descriptive perspectives that place little emphasis on deliberate processes of change (Fig. 2).

DISCUSSION

This paper suggests a way to provide structure to dialogs regarding societal transformation in response to GEC. This effort is inevitably subject to some limitations, not least due to the highly dynamic nature and diversity of this growing scholarship, and the on-going conversations within and across academic communities. Nevertheless, this study provides input to the current debate. For one, it is among the first to identify and map existing concepts of transformation and to analyze their similarities and differences based on a given set of analytically relevant categories.

In this section, I sum up the main findings of this analysis and outline their implications for current and future research.

Transformation as a metaphor or analytical concept, and the advantages of rigor

I have shown that transformation is often used simply as a general metaphor to convey the idea of a radical and fundamental change in a given system. In these cases, transformation is often not defined at all, and the systemic patterns, units, forms, causality, and outcome of transformation are hardly conceptualized. Thus, transformation is used as an umbrella term under which diverse fields of research dealing with responses to GEC—e.g., from studies of natural resource management to livelihood, behavioral, or organizational change, and to energy or water infrastructure innovation—may find space and some common ground and purpose. To be sure, this is an important condition to facilitate interdisciplinary (Newell 2012; Strunz 2012) and transdisciplinary research (Angelstam et al. 2013); however, I argue that this is not the most powerful use of the concept. In fact, a second fundamental condition to enable interdisciplinary dialog is precision in identifying the conceptual borders of what transformation means in different studies (Berkhout 2013). Evidence suggests that conceptual rigor is important independently of the specific research approach adopted, i.e., analytic-descriptive or solution-oriented. The analytic-descriptive approach requires precise, substantive, non-prescriptive and theoretically grounded concepts (Thompson 2007; Strunz 2012) of transformation which identify patterns and units and their relationships. Without a

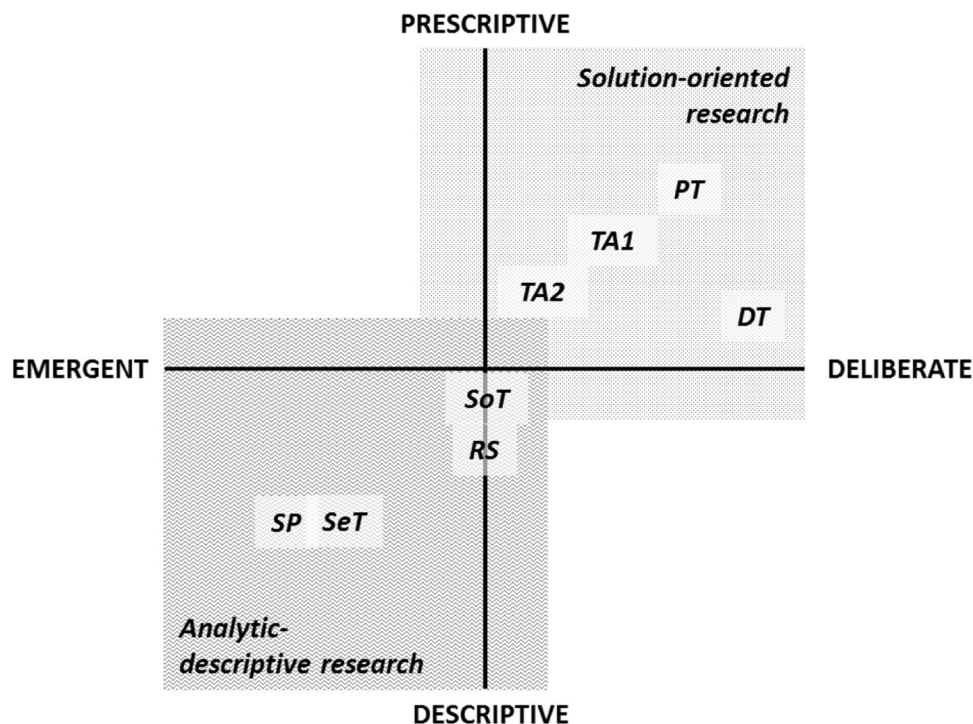


Fig. 2 Research approaches and characteristics of concepts of transformation

rigorous conceptualization of the term, scholars can hardly distinguish among its different usages and are, therefore, prevented from engaging in potentially fruitful discussions regarding how different interpretations relate to one another, how each interpretation may contribute to understanding observed phenomena, or what theoretical or methodological development may be needed to improve such understanding. This approach does not overlook the importance of factors such as values and power relations, but aims to understand their role in the process of change rather than to shape them directly and actively in the research enterprise.

The solution-oriented perspective can, in principle, accommodate a looser, non-substantive definition of concepts than can be encompassed by descriptive-analytical approaches. This approach values creativity and problem-solving, and prioritizes the wide applicability of concepts—which favors the wide involvement of actors in the participatory (e.g., social learning) process, and in general accepts that some concepts have ‘families of meanings’ rather than one single meaning (Strunz 2012). A vague definition of transformation allows for recognition of the different meanings that the concept might have for different social actors. In addition, prescriptive and value-laden interpretations might be accepted and actually favored as a basis for negotiations and the construction of a common ground for participation (Thompson 2007; Strunz 2012; Angelstam et al. 2013). In fact, looseness may be preferred based on the assumption that a precise system representation might imply a level of complexity that is not manageable by decision-makers and consequently discourages action (Thompson 2007).

However, the solution-oriented approach may suffer, in practice, from the serious drawback of a lack of rigorous conceptualization of transformation. Vagueness can be a barrier to successful transdisciplinary processes (Lang et al. 2012), and rigor is not necessarily a barrier to problem-solving research approaches (Strunz 2012). The major risk in this respect is of co-opting powerful actors to impose their own definition of transformation, and potentially to legitimize vested interests to serve different discourses, including those against radical change of the status quo (Tanner and Bahadur 2013). Several authors have shown how a similar phenomenon has occurred regarding the concepts of sustainable development (Lele 1991; Robinson 2004; Redclift 2005) and sustainable agriculture (Thompson 2007).

Conceptual diversity mapped

It is important to note that calling for rigorous concepts of transformation does not imply advocating for any specific concept, nor for limiting conceptual plurality. On the

contrary, it has been argued that pursuing a one suits-all definition of transformation might not be a fruitful research endeavor (Kapoor 2007).

I propose that if acknowledging conceptual diversity is vital, then it is equally important to characterize and articulate it in forms that can facilitate scientific dialog, empirical testing, and application of concepts and theories and, ultimately, theoretical development. Sztompka’s categories, which I have used in this paper as an anatomy of transformation, provide a structure for the systematic description of the concept of transformation adopted in research, and thus serve the purpose of comparing different concepts in the future.

Through an exploration of the existing literature employing the term ‘transformation,’ I have identified the range of emerging concepts and proposed a map of their relations, similarities, and differences. I have highlighted how different concepts tend to follow the boundaries of scholarly traditions, and consequently to refer to resilience thinking, transition theory, social metabolism, social practices, or human security approaches, or to fall within an area that, following O’Brien and Barnett (2013), may be termed ‘transformational adaptation’ (Fig. 1; Table 2).

Emerging concepts of transformation mostly differ in respect to system model, social consciousness, and outcome, while they share important similarities in respect to form and temporal range. Differences in system model are not surprising, given the diverse scholarly traditions and the diverse conceptualizations of human–environment systems, from which the concepts of transformation are emerging. While other studies have highlighted the diversity of concepts of transformation in literature (Park et al. 2012; Brown and Fabricius 2013; O’Brien and Sygna 2013; Tanner and Bahadur 2013), this is the first study to map this diversity along analytically relevant categories. In so doing, this exercise offers a basis for future dialog on theories of societal transformation in response to GEC.

Conceptual diversity and research approaches: Implications

In this article, I used one detailed example to illustrate how concepts of transformation differ in practice and, most importantly, their possible blind spots and policy implications. Firstly, it has been shown that how distinct political programs, even those aiming at maintaining the status quo, can adopt the metaphor of societal transformation. Second, different conceptualizations of transformation matter in that they can equip us to understand the same processes of social change in response to GEC differently, or even lead to not qualifying some particular processes as transformational but rather as incremental change. In other words, the

concepts of transformation adopted in research make an important difference to what changes are defined as transformational, and what processes and mechanisms of transformation may be better understood through a given concept of transformation. The example of Colombian peasants is not exceptional. For example, programs that are focused on green growth, green economy, or low-carbon development all aim at changing the current models of development, mostly measured in terms of environmental performance, particularly the emission of greenhouse gases. However, these have generated controversy (Bowen and Fankhauser 2011; Bina 2013), as they are often defined within given economic models based on economic growth that overlook issues of social justice, which can in fact be considered to be at the root of GEC (Unmüßig et al. 2012; Bina 2013). It is apparent that the characterization of green growth, green economics, or low-carbon development as transformational change depends on the conceptualization of transformation (i.e., system boundaries, form and temporal range, seat of causality and social consciousness, and outcome), which reinforces the call for rigorous conceptualizations, by which important differences and similarities can be exposed and challenged.

This article has also showed that different concepts of transformation tend to inform different research approaches. This has important implications for research policy in support of societal transformation in response to GEC, especially as the solution-oriented perspective is gaining favor in the scientific community (e.g., DeFries et al. 2012; International Social Science Council (ISSC) 2012; O'Brien 2012; Wiek et al. 2012). The growing quest for impactful research pursued by funding bodies and public opinion in the context of scarce financial resources and the sense of urgency to respond to incumbent GEC have contributed to the solution-oriented approach establishing itself in several global initiatives (e.g., Future Earth). Because solution-oriented approaches tend to be compatible with some concepts of transformation but not with others, there is the risk that these initiatives may in fact be indirectly restricting the space for alternative concepts of transformation, and that this, in turn, may limit the ability to overcome the blind spots associated with specific concepts of transformation.

CONCLUSIONS: IS TRANSFORMATION A USEFUL CONCEPT?

There is no need to further demonstrate the urgent need for fundamental changes in the way societies interact with the biophysical environment. However, what constitutes a fundamental change, and how this comes about, is the topic of research and debate in the social sciences and beyond.

What does change in a transformational process entail? How deep, how radical does change need to be to be transformational? In other words, when is it *transformation*?

In this paper, I have addressed these questions through a review of emerging concepts of societal transformation in both reactive and active responses to GEC. This view obviously leaves other takes on transformation temporarily aside. Yet, even by restricting the analysis to such relatively recently emerging scholarship and policy priority, a plurality of understandings regarding the notion of transformation has been uncovered, although this is not surprising considering the typical co-existence of different paradigms in the social sciences.

How can common ground for a fruitful dialog on societal transformation be established? I have identified two broad alternatives: use the term transformation as a loose metaphor, or apply it as an analytically relevant concept. The first approach relies on facilitating dialog using the term 'transformation' to simply indicate a fundamental change, without a specific, theoretically founded identification of the patterns, units, and characteristics of such transformative change. This, in principle, allows for joining forces within and across research and action under the banner of transformation. The second approach relies on the recognition of the differences that exist between different concepts of transformation, and in a rigorous engagement in a theoretically and empirically informed dialog, that is, to appreciate the potential of conceptual plurality and harness it to understand the complexity of transformative change from a variety of angles.

I have argued in this paper that there is more to gain than to lose in taking a rigorous, substantial use of transformation as an analytical concept. When transformation becomes a buzzword that is needed to be funded or published, coupled with a situation where any process of change can be labeled as transformative, the usefulness of the term becomes diluted. There is a need to resist the fashion of transformation, i.e., the temptation of attributing a transformative character to any instance of social change.

Thus, I have not advocated for one specific concept of transformation, nor have I attempted to identify which of the emerging concepts may be best suited to advance this scholarship further. On the contrary, I have endeavored to set the basis for a structured engagement with different traditions of thought. One of the important directions for future research on societal responses to GEC will be to find creative and fruitful ways to foster a dialog around the potential and complementarities of different concepts: what concepts can be applied to study different types of systems, what prescriptive assumptions inform them, what concepts connect with what research paradigm, and what processes of change are ruled out from the analysis if a particular

concept of transformation is employed. Another important direction for future research will be to fuel the dialog by testing different concepts and theories of transformation in empirical research. Dealing with the complexity of societal transformation and with conceptual plurality simultaneously is challenging, but a rigorous engagement with these traditions can contribute to understanding current and future societal transformation.

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REFERENCES

- Agrawal, A., M.C. Lemos, B. Orlove, and J. Ribot. 2012. Cool heads for a hot world—Social sciences under a changing sky. *Global Environmental Change* 22: 329–331.
- Angelstam, P., K. Andersson, M. Annerstedt, R. Axelsson, M. Elbakidze, P. Garrido, P. Grahn, K.I. Jönsson, S. Pedersen, P. Schlyter, E. Skärbäck, M. Smith, and I. Stjernquist. 2013. Solving problems in social–ecological systems: Definition, practice and barriers of transdisciplinary research. *AMBIO* 42: 254–265.
- Aylett, A. 2013. Networked urban climate governance: Neighborhood-scale residential solar energy systems and the example of Solarize Portland. *Environment and Planning C: Government and Policy* 31: 858–875.
- Barkin, D. 2011. Communities constructing their own alternatives in the face of crisis. *Mountain Research and Development* 32: 12–22.
- Beddoe, R., R. Costanza, J. Farley, E. Garza, J. Kent, I. Kubiszewski, L. Martinez, T. McCowen, et al. 2009. Overcoming systemic roadblocks to sustainability: The evolutionary redesign of worldviews, institutions, and technologies. *Proceedings of the National Academy of Sciences* 106: 2483–2489.
- Berkhout, F. 2013. Speed, scope and depth: What counts as a socio-transformation? Paper presented at the *International Conference Transformation in a Changing Climate*, 19–21 June, 2013, University of Oslo, Norway
- Bina, O. 2013. The green economy and sustainable development: An uneasy balance? *Environment and Planning C: Government and Policy* 31: 1023–1047.
- Bowen, A., and S. Fankhauser. 2011. The green growth narrative: Paradigm shift or just spin? *Global Environmental Change* 21: 1157–1159.
- Brooks, N., N. Grist, and K. Brown. 2009. Development futures in the context of climate change: Challenging the present and learning from the past. *Development Policy Review* 27: 741–765.
- Brown, K., and E. Westaway. 2011. Agency, capacity, and resilience to environmental change: Lessons from human development, well-being, and disasters. *Annual Review of Environment and Resources* 36: 321–342.
- Brown, G., P. Kraftl, J. Pickerill, and C. Upton. 2012. Holding the future together: Towards a theorisation of the spaces and times of transition. *Environment and Planning A* 44: 1607–1623.
- Brown K., S. O’Neill, and C. Fabricius. 2013 Social science understanding of transformation. In: *International Social Science Council/United Nations Educational, Scientific and Cultural Organization (ISSC/UNESCO). 2013. The World Social Science Report 2013: Changing Global Environments*. OECD Publishing/UNESCO Publishing.
- Butzer, K.W. 2012. Collapse, environment, and society. *Proceedings of the National Academy of Sciences* 109: 3632–3639.
- De Haan, J., and J. Rotmans. 2011. Patterns in transitions: Understanding complex chains of change. *Technological Forecasting and Social Change* 78: 90–102.
- DeFries, R.S., E.C. Ellis, F. Stuart Chapin, P.A. Matson, B.L. Turner, A. Agrawal, P.J. Crutzen, C. Field, et al. 2012. Planetary opportunities: A social contract for global change science to contribute to a sustainable future. *BioScience* 62: 603–606.
- Ernstson, Henrik. 2011. Transformative collective action: A network approach to transformative change in ecosystem-based management. In *Social networks and natural resource management: Uncovering the social fabric of environmental governance*, ed. Ö. Bodin, and C. Prell, 255–287. Cambridge: Cambridge University Press.
- Escobar, A. 1995. *Encountering development. The making and unmaking of the Third World*. Princeton: Princeton University Press.
- Evans, J.P. 2011. Resilience, ecology and adaptation in the experimental city. *Transactions of the Institute of British Geographers* 36: 223–237.
- Fals-Borda, O. 1955. *Peasant society in the Colombian Andes: A sociological study of Saucó*. Gainesville: University of Florida Press.
- Feola, G. 2013. What (science for) adaptation to climate change in Colombian agriculture? A commentary on “A way forward on adaptation to climate change in Colombian agriculture: perspectives towards 2050” by J. Ramirez-Villegas, M. Salazar, A. Jarvis, and C. E. Navarro-Valcines. *Climatic Change* 119: 565–574
- Feola, G., L.A. Agudelo, and B.C. Bamón. 2014. Colombian agriculture under multiple exposures: a review and research agenda. *Climate and Development*. doi:10.1080/17565529.2014.934776.
- Ferguson, B.C., R.R. Brown, and A. Deletic. 2013. Diagnosing transformative change in urban water systems: Theories and frameworks. *Global Environmental Change* 23: 264–280.
- Fischer-Kowalski, M., and H. Haberl. 2007. *Socioecological transitions and global change: Trajectories of social metabolism and land use*. Cheltenham: Elgar.
- Fischer-Kowalski, M., and J. Rotmans. 2009. Conceptualizing, observing, and influencing social–ecological transitions. *Ecology and Society* 14: 3.
- Folke, C., S. Carpenter, B. Walker, M. Scheffer, T. Chapin, and J. Rockström. 2010. Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society* 15: 20.
- Geels, F., and J. Schot. 2007. Typology of sociotechnical transition pathways. *Research Policy* 36: 399–417.
- German Advisory Council on Global Change (WBGU). 2011. *World in transition. A social contract for sustainability*. Berlin: WBGU.
- Giddens, A. 1984. *The constitution of society*. Polity: Cambridge.
- Gomez-Echeverri, L. 2013. The changing geopolitics of climate change finance. *Climate Policy* 13: 632–648.
- Griffith, R., M. Mitchell, G. Walkerden, V. Brown, and B. Walker. 2010. Building a framework for transformative action in the Wakool Shire Transformation for resilient landscapes and communities project. Institute for Land, Water and Society, Report 61, Charles Sturt University.
- Grin, J. J. Rotmans and J. Schot. 2010. *Transitions to sustainable development. New directions in the study of long term transformative change*. New York/London: Routledge.
- Gudeman, S. 2012. Vital energy. The current of relations. *Social Analysis* 56: 1–17.

- Haberl, H., M. Fischer-Kowalski, F. Krausmann, J. Martinez-Alier, and V. Winiwarter. 2011. A socio-metabolic transition towards sustainability? Challenges for another great transformation. *Sustainable Development* 19: 1–14.
- Huang, Y., F. Li, X. Bai, and S. Cui. 2012. Comparing vulnerability of coastal communities to land use change: Analytical framework and a case study in China. *Environmental Science & Policy* 23: 133–143.
- International Social Science Council (ISSC). 2012. *Transformative cornerstones of social science research for global change*. Paris: ISSC.
- IPCC, 2012: Summary for policymakers. In *Managing the risks of extreme events and disasters to advance climate change adaptation*, eds. Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, et al. A special report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge, UK, and New York, NY, USA: Cambridge University Press, pp. 3–21.
- International Social Science Council/United Nations Educational, Scientific and Cultural Organization (ISSC/UNESCO). 2013. *The world social science report 2013: Changing global environments*. OECD Publishing/UNESCO Publishing.
- Intergovernmental Panel on Climate Change (IPCC). 2014. *Climate change 2014: Impacts, adaptation and vulnerability*. Geneva: IPCC.
- Jackson, T. 2009. *Prosperity without growth: Economics of a finite planet*. London: Earthscan.
- Kapoor, R. 2007. Transforming self and society: Plural paths to human emancipation. *Futures* 39: 475–486.
- Kates, R.W., W.R. Travis, and T.J. Wilbanks. 2012. Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences* 109: 7156–7161.
- Kristjanson, P., H. Neufeldt, A. Gassner, J. Mango, F.B. Kyazze, S. Desta, G. Sayula, B. Thiede, W. Förch, and P.K. Thornton. 2012. Are food insecure smallholder households making changes in their farming practices? Evidence from East Africa. *Food Security* 4: 381–397.
- Lang, D., A. Wiek, M. Bergmann, M. Stauffacher, P. Martens, P. Moll, M. Swilling, and C. Thomas. 2012. Transdisciplinary research in sustainability science: Practice, principles, and challenges. *Sustainability Science* 7: 25–43.
- Leggiewie, C., and D. Messner. 2012. The low-carbon transformation—A social science perspective. *Journal of Renewable and Sustainable Energy* 4: 041404.
- Lele, S.M. 1991. Sustainable development: A critical review. *World Development* 19: 607–621.
- Luhmann, N. 1995. *Social systems*. Stanford: Stanford University Press.
- Marshall, N.A., S.E. Park, W.N. Adger, K. Brown, and S.M. Howden. 2012. Transformational capacity and the influence of place and identity. *Environmental Research Letters* 7: 034022.
- Mustelin J., and J. Handmer. 2013. Triggering transformation: Managing resilience or invoking real change? In: *Proceedings of Transformation in a Changing Climate*, 19–21 June 2013, Oslo: University of Oslo.
- Nelson, D.R. 2009. Conclusions: Transforming the world. In *Adapting to climate change. Thresholds, values, governance*, ed. W.N. Adger, I. Lorenzoni, and K.L. O'Brien, 514 pp. Cambridge: Cambridge University Press.
- Nelson, D.R., W.N. Adger, and K. Brown. 2007. Adaptation to environmental change: Contributions of a resilience framework. *Annual Review of Environment and Resources* 32: 395–419.
- Newell, B. 2012. Simple models, powerful ideas: Towards effective integrative practice. *Global Environmental Change* 22: 776–783.
- O'Brien, K. 2011. Responding to environmental change: A new age for human geography? *Progress in Human Geography* 35: 542–549.
- O'Brien, K. 2012. Global environmental change II: From adaptation to deliberate transformation. *Progress in Human Geography* 36: 667–676.
- O'Brien, K., and J. Barnett. 2013. Global environmental change and human security. *Annual Review of Environment and Resources* 38: 373–391.
- O'Brien, K., and L. Sygna. 2013. Responding to climate change: The three spheres of transformation In: *Proceedings of Transformation in a Changing Climate*, 19–21 June 2013, Oslo: University of Oslo.
- Olsson, P., L.H. Gunderson, S.R. Carpenter, P. Ryan, L. Lebel, C. Folke, and C.S. Holling. 2006. Shooting the rapids: Navigating transitions to adaptive governance of social–ecological systems. *Ecology and Society* 11: 18.
- Park, S.E., N.A. Marshall, E. Jakku, A.M. Dowd, S.M. Howden, E. Mendham, and A. Fleming. 2012. Informing adaptation responses to climate change through theories of transformation. *Global Environmental Change* 22: 115–126.
- Pearson, P.J., and T.J. Foxon. 2012. A low carbon industrial revolution? Insights and challenges from past technological and economic transformations. *Energy Policy* 50: 117–127.
- Pelling, M. 2011. *Adaptation to climate change. From resilience to transformation*. Oxford: Routledge.
- Polanyi, K. 1944. *The great transformation*. New York: Rinehart.
- Preston, B.L., K. Dow, and F. Berkhout. 2013. The climate adaptation frontier. *Sustainability* 5: 1011–1035.
- Redclift, M. 2005. Sustainable development (1987–2005): An oxymoron comes of age. *Sustainable Development* 13: 212–227.
- Reganold, J.P., D. Jackson-Smith, S.S. Batie, R.R. Harwood, J.L. Kornegay, D. Bucks, C.B. Flora, J.C. Hanson, et al. 2011. Transforming U.S. agriculture. *Science* 332: 670–671.
- Robinson, J. 2004. Squaring the circle? Some thoughts on the idea of sustainable development. *Ecological Economics* 48: 369–384.
- Seidl, R., F. Brand, M. Stauffacher, P. Krütli, Q. Le, A. Spörri, G. Meylan, C. Moser, et al. 2013. Science with society in the Anthropocene. *AMBIO* 42: 5–12.
- Sheffer, M. 2009. *Critical transitions in nature and society*. Princeton: Princeton University Press.
- Shove, E. 2010a. Beyond the ABC: Climate change policy and theories of social change. *Environment and Planning A* 42: 1273–1285.
- Shove, E. 2010b. Social theory and climate change: Questions often, sometimes and not yet asked. *Theory, Culture & Society* 27: 277–288.
- Shove, E., and G. Walker. 2007. CAUTION! Transitions ahead: Politics, practice and sustainable transition management. *Environment and Planning A* 39: 763–770.
- Shove, E., M. Pantzar, and M. Watson. 2012. *The dynamics of social practice: Everyday life and how it changes*. London: Sage.
- Steffen, W., P.J. Crutzen, and J.R. McNeil. 2007. The anthropocene: Are humans now overwhelming the great forces of nature? *Ambio* 36: 614–621.
- Strunz, S. 2012. Is conceptual vagueness an asset? Arguments from philosophy of science applied to the concept of resilience. *Ecological Economics* 76: 112–118.
- Sunderlin, W.D. 1995. Global environmental change, sociology, and paradigm isolation. *Global Environmental Change* 5: 211–220.
- Sztompka, P. 1993. *The sociology of social change*. Oxford: Blackwell.
- Tanner, T., and A.V. Bahadur. 2013. Distilling the characteristics of transformational change in a changing climate. Paper presented at the *International Conference Transformation in a Changing Climate*, 19–21 June, 2013, University of Oslo.

- Thompson, P.B. 2007. Agricultural sustainability: What it is and what it is not. *International Journal of Agricultural Sustainability* 5: 5–16.
- Tschakert, P., and A.L. St. Clair. 2013. Conditions for transformative change: The role of responsibility, solidarity, and care in climate change research. Paper presented at the *International Conference Transformation in a Changing Climate*, 19–21 June, 2013, University of Oslo.
- Turnpenny, J.R. 2012. Lessons from post-normal science for climate science-sceptic debates. *Wiley Interdisciplinary Reviews: Climate Change* 3: 397–407.
- Unmüßig, B., W. Sachs, and T. Fatheuer. 2012. *Critique of the green economy. Publication series on ecology*. Berlin: Heinrich Böll Foundation.
- Van Vuuren, D., N. Nakicenovic, K. Riahi, A. Brew-Hammond, D. Kammen, V. Modi, M. Nilsson, and K. Smith. 2012. An energy vision: the transformation towards sustainability—Interconnected challenges and solutions. *Current Opinion in Environmental Sustainability* 4: 18–34.
- Walker, B.H., C.S. Holling, S.R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society* 9: 5.
- Westley, F., P. Olsson, C. Folke, T. Homer-Dixon, H. Vredenburg, D. Loorbach, J. Thompson, M. Nilsson, et al. 2011. Tipping toward sustainability: Emerging pathways of transformation. *Ambio* 40: 762–780.
- Wiek, A., B. Ness, P. Schweizer-Ries, F. Brand, and F. Farioli. 2012. From complex systems analysis to transformational change: A comparative appraisal of sustainability science projects. *Sustainability Science* 7: 5–24.

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