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Survey

Exploring the governance and politics of transformations towards sustainability

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ABSTRACT

The notion of 'transformations towards sustainability' takes an increasingly central position in global sustainability research and policy discourse in recent years. Governance and politics are central to understanding and analysing transformations towards sustainability. However, despite receiving growing attention in recent years, the governance and politics aspects of transformations remain arguably under-developed in the global sustainability literature. A variety of conceptual approaches have been developed to understand and analyse societal transition or transformation processes, including: socio-technical transitions, social-ecological systems, sustainability pathways, and transformative adaptation. This paper critically surveys these four approaches, and reflects on them through the lens of the Earth System Governance framework (Biermann et al., 2009). This contributes to appreciating existing insights on transformations, and to identifying key research challenges and opportunities. Overall, the paper brings together diverse perspectives, that have so far remained largely fragmented, in order to strengthen the foundation for future research on transformations towards sustainability.

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1. Introduction

The notion of 'transformations towards sustainability' takes an increasingly central position in global sustainability research and policy discourse in recent years. For example, it is one of three core themes of the global sustainability research platform Future Earth (Future Earth, 2014a), and frequently employed in discussions on the Global Goals for Sustainable Development (e.g. HLPEP, 2013; Hajer et al., 2015). Interest in transformations reflects enthusiasm within global sustainability discourse for moving from 'describing problems' to 'identifying solutions', and for better understanding possible pathways of sustainable environmental and societal change within the looming Anthropocene (Rockström et al., 2009; Raworth, 2012; Bai et al., 2015). Governance and politics are central to understanding, analysing, and shaping transformations towards sustainability. This is because: (1) governance is inherently implicated in any intentional effort to shape 'transformations towards sustainability', and (2) transformations towards sustainability are deeply and unavoidably political, and need to be recognised as such. However, despite receiving growing attention in recent years, ways of understanding and analysing governance and politics remain under-developed in academic literature on transformations.

The notion of transformation appears increasingly attractive to articulate aspirations for significant and enduring change in human society towards more sustainable and equitable global futures (Future Earth, 2014a,b).'Transformations towards sustainability' refer to fundamental changes in structural, functional, relational, and cognitive aspects of socio-technical-ecological systems that lead to new patterns of interactions and outcomes (drawing on de Haan and Rotmans, 2011; Hackmann and St. Clair, 2012; O'Brien, 2012; Feola, 2014). It places an explicit focus on the processes of change in human society involved in moving towards more sustainable and equitable futures, which can be approached in both a normative way (e.g. as a good/desirable thing to do) as well as an analytical way (e.g. what actually 'happens', and how and why). Efforts to bring about transformations towards sustainability however, are likely to be deeply political and contested because different actors will be affected in different ways, and may stand to gain or lose as a result of change (Meadowcroft, 2011; van den Bergh et al., 2011). Moreover, framings and narratives of transformation processes are socially constructed and may be viewed differently, due to differing judgments about problem boundaries, perceptions of change processes, contested uncertainties and ambiguities, and sometimes incommensurable value sets (Stirling, 2011; O'Brien, 2012). For example, the need for urgent decarbonisation of energy systems in society is framed, promoted and resisted by different actors in a wide variety of ways, and continues to prove extremely complex and challenging to bring about at a societal level (WBGU, 2011; Hilldingsson, 2014).

Research interest in sustainability transformations[1] is growing across a range of problem domains and (inter) disciplinary perspectives. For example, sustainability transformations are explored in diverse problem domains such as energy systems (Loorbach and Rotmans, 2010; WBGU, 2011), water systems (Pahl-Wostl et al., 2010; Ferguson et al., 2013), food systems (Vermeulen et al., 2013; Gliessman, 2015), urban systems (McCormick et al., 2013; Revi et al., 2014), and green jobs (Fischer-Kowalski et al., 2012). A variety of approaches to conceptualising transformations towards sustainability have been developed in the literature, including socio-technical transitions (e.g. Geels, 2002; Geels and Schot, 2007), and transitions management (Kemp et al., 2007; Loorbach, 2009), social-ecological transformations (e.g. Olsson et al., 2006, 2014; Westley et al., 2011), transformative pathways to sustainability (e.g. Leach et al., 2012, 2013; Stirling, 2014), and transformative adaptation (e.g. Pelling, 2011; O'Brien and Selboe, 2015). There is often overlap between these approaches, but they are also distinct and somewhat divergent in how they conceptualise transformations. This burgeoning interest and conceptual experimentation provides a rich landscape for the study of transformations towards sustainability. However, while the fundamental importance of governance and politics is increasingly recognised, these aspects arguably remain under-developed, particularly in light of their fundamental importance to understanding and analysing transformations.

There is a need to place governance and politics at the centre of research on transformations towards sustainability (Smith et al., 2005; Smith and Stirling, 2010; O'Brien, 2012; Olsson et al., 2014; Scoones et al., 2015). This paper aims to explore the governance and politics of transformations towards sustainability by applying a conceptual lens that takes a political perspective of governance for sustainability: the Earth System Governance (ESG) framework (Biermann et al., 2009). This framework is useful because it articulates a high-level set of dimensions and themes that are essential to understanding and analysing the governance and politics of global sustainability issues. It has been widely peer-reviewed and is the organising principle for the largest global network of social scientists in environmental governance (the 'Earth System Governance Project'). The paper first considers the relationship between governance and transformations towards sustainability (Section 2), and then critically surveys several prominent conceptual approaches to transformations in the global sustainability literature (Section 3). These approaches are then compared through the lens of the ESG framework in order to identify key insights and the existing state of knowledge on transformations regarding governance and politics (Section 4). Research challenges and opportunities are identified discussed by collectively considering the four approaches in the context of the

[1] We use the term 'sustainability transformations' as an umbrella term to encompass diverse perspectives on transitions and transformations in the global sustainability literature, including those addressed in this paper but potentially also others. Debates about these terms are ongoing, and we follow Stirling (2014), in using 'transformation' as a broad encompassing term. Nonetheless, 'the utility of this distinction [between transition and transformation] is heuristic . . . rather than formal or definitive. The real value lies in considering implications on a concrete case by case basis, by reference to real-world examples and settings. . . . the point here is not to insist on particular definitions for specific words . . . [and] Much existing usage of either term, often legitimately also implies the other'(Stirling, 2014, p.13).

broader notion of transformations towards sustainability (Section 5). The paper concludes with critical reflections on the potential of the notion of transformations towards sustainability, and of the ESG framework as a lens for understanding and analysing transformations (Section 6).

The paper contributes to building on rich but fragmented existing literature in order to lay a foundation for progressing research on the governance and politics of transformations towards sustainability. It compares and assessesses multiple different perspectives on transition and transformation within the global sustainability literature. This is important because a broad range of scholars, policymakers and practitioners are increasingly looking to better understand the diverse range of perspectives on transition and transformation present in the literature. However, this can be confusing, especially to people not deeply familiar with the research traditions, theoretical conceptualizations, and key arguments put forward by various different schools of thought. We aim to contribute to 'making sense' of the multiple, sometimes overlapping, perspectives in the literature by stepping back to compare and assess different approaches and their views on how processes of transition/transformation in society operate, with a particular focus on governance and politics.

2. Governance and transformations

2.1. The notion of transformations

While the notion of transformations is only recently being taken up as a specific focus within global sustainability discourse, it has a longer (although sporadic) background across several bodies of literature. An early use of the notion of transformations in the context of societal systems was by the political economist Polanyi, who examined political economic transformation in the emergence of the modern 'market state'. Polanyi (1944) described transformation as a fundamental altering of humankind's mentalities which creates new institutions reconstructing the state, the economy, and relations of distribution. Over later decades, public policy researchers tended to focus on explanations of 'punctuated equilibrium' to explain radical institutional change, which involves periods of stability and occasional abrupt change when the distribution of power among dominant actors changes significantly (Baumgartner and Jones, 1993). However, a focus on punctuated equilibrium is incomplete for understanding the many gradual ways in which institutional change and societal transformation can occur (Thelen, 2009; Mahoney and Thelen, 2010). More broadly, Norgaard (1995, 2006) argues that patterns of human development and societal change are coevolutionary and emerge from ongoing mutual interaction between human systems (e.g., values, knowledge, organisation, technology) and environment systems.

Collectively this prior scholarship offers several significant insights for understanding and analysing transformations towards sustainability. First, transformations are complex, dynamic, political, and involve change in multiple systems (e.g., social, institutional, cultural, political, economic, technological, ecological) (van den Bergh et al., 2011). Second, trajectories of transformative change are likely to emerge from coevolutionary interactions between multiple systems, and thus cannot be viewed in a narrow disciplinary-bounded or deterministic way. Taken together, this raises major questions about what 'governing' transformations towards sustainability might involve. For example, how can governance contribute to shaping or steering transformations, particularly within the real-world constraints of actual governance contexts (e.g., fragmented institutional arrangements, contested policy processes, and tightly constrained or poorly delineated roles and capabilities of policymakers and administrators), and given the complex, contested and coevolutionary nature of societal change? Which governance systems support societal transformations, and when do societal transformations require or enforce transformations in governance? Finally, it cannot be assumed that change will not be met with resistance, especially when deeply held norms and values are questioned—indeed, transformations may involve 'battles of institutional change' (Chhotray and Stoker, 2009), but the processes and implications of such disruptive change are little understood.

2.2. The role of governance

Governance refers to the structures, processes, rules and traditions that determine how people in societies make decisions and share power, exercise responsibility and ensure accountability (Folke et al., 2005; Lebel et al., 2006; Cundill and Fabricius, 2010). This includes multiple possible modes of policy and decision making (e.g., hierarchical, market, network), and multiple possible actors (e.g., government, industry, research, civil society). We draw on the definition of the Earth System Governance Project, that governance refers to "the interrelated and increasingly integrated system of formal and informal rules, rule-making systems, and actor-networks at all levels of human society (from local to global) that are set up to steer societies towards preventing, mitigating, and adapting to global and local environmental change and, in particular, earth system transformation, within the normative context of sustainable development" (Biermann et al., 2009). Governance can be seen in several ways, including: as a scientific concept employed to conceptualise and empirically trace transformations and institutionalised interventions in societies; as a normative program based on the ambition to realise and manage political change; and as a critical societal discourse linked to wider debates on global change (Eguavoen et al., 2015).

It is important to think critically about the notion of transformations, and the value it can potentially add to the existing business of environmental policy and governance. For example, is the notion of transformations useful for purposefully steering society towards sustainability, or is it largely confined to an *ex-post* role to describe change processes after they occur?

This raises questions about the role of governance in shaping transformations towards sustainability. Several sometimes-overlapping views on governance and transformation are reflected in the global sustainability literature:

- governance for transformations i.e., governance that creates the conditions for transformation to emerge from complex dynamics in socio-technical-ecological systems,
- governance of transformations i.e., governance to actively trigger and steer a transformation process, and
- transformations in governance i.e., transformative change in governance regimes.

For example, social-ecological systems scholars have focused on understanding how adaptive governance can facilitate adaptability and transformability in social-ecological systems (Walker et al., 2004; Folke et al., 2005; Olsson et al., 2006). This has included proposals that 'governance for navigating change' requires a dual focus on both 'adapting' (i.e. "short and long-term responses and strategies to buffer perturbations and provide capacity to deal with change and uncertainty"), and 'transforming' (i.e. "strategies to create a fundamentally new system when current conditions make the existing system untenable") (Armitage and Plummer, 2010). Transitions scholars have explored the governance of transitions in socio-technical systems (e.g., Smith et al., 2005; Foxon et al., 2009; Loorbach, 2009), assuming that whilst change cannot be controlled it can nevertheless be steered through 'goal-oriented modulation' of co-evolutionary change processes (Kemp et al., 2007). Development scholars have argued vigorously for the need to focus on the socially-embedded and power-laden nature of sustainability governance contexts, placing a central focus on marginalised groups (Leach et al., 2007a,b), and to "culture plural [forms of] radical progress" through recognising democratic struggle as a fundamental force for societal transformation (Stirling, 2014). More broadly, political scientists have long emphasised the deeply political and normative aspects of governance for sustainability (Meadowcroft, 2007) such as the dominance of (neo)liberal environmental norms in global environmental governance (Bernstein, 2002), and the importance of pluralism and democratic debate as a basis for sustainability agendas (Meadowcroft, 1997). These different approaches have different kinds of implications for understanding governance in regard to transformations towards sustainability.

Under a normative view of transformation, it is important to consider how and the extent to which it is possible for governance to purposefully foster transformations. For example, in discussing governance for global environmental change, Duit et al. (2010) invoke Lindblom's (1959) concept of policy making as a process of 'muddling through', stating that: "at the end of the day, governance solutions for many of those problems rooted in complex systems dynamics will, as always, consist in incrementally implemented, heterogenic, and piecemeal mixes of policy instruments, institutions, networks and organizations". However, it is also important to recognise when incremental change is insufficient for meeting desired goals, and thus when transformative change must be pursued (Kenny and Meadowcroft, 1999; Kates et al., 2012). Other scholars have tried to bridge the gap between either incrementalism or transformative change, to find a more fruitful middle ground. Weiss and Woodhouse (1992) respond to key critiques of 'incrementalism' (i.e. lack of goal orientation, conservatism, limited applicability, unconduciveness to analysis), arguing that not only are these critiques overblown, they also largely reflect a deeper anxiety about "the deep and troubling questions raised for political organization and action by the sharp constraints on human capacities for understanding policy problems and options" (Weiss and Woodhouse, 1992, p.270). This anxiety is unlikely to have disappeared in the period since this work was published. Hence Weick's (1984) suggestion remains timely, that responding to complex societal policy problems could benefit from an approach focusing on "small wins", which refers to "concrete, complete outcomes of moderate importance" that can create momentum for larger-scale change. Interestingly, Weick (1984, pp. 43–44) states that "careful plotting of a series of wins to achieve a major change is impossible because conditions do not remain constant", and therefore what matters most is "identifying, gathering, and labeling several small changes that are present but [largely] unnoticed", and creating new narratives that link up small changes in multiple as-yet unconnected areas. Therefore while particular interventions may be incremental or piecemeal, small to moderate changes could have the potential to cumulate into more substantial transformation over time.

Hence perhaps governance for sustainability transformations entails a dual focus on high-level, longer-term transformation combined with an honest recognition of the realities of near-term incrementalism at the same time. That is, a strategy of *incremental change with a transformative agenda*, where a normative focus on sustainability transformations helps to orient incremental efforts (such as policy change) within a broader narrative of transformative change. This aligns with Levin et al. (2012) who call for a focus on 'progressive incremental' change, where policy-makers focus on relatively small yet cumulative incremental steps that contribute to creating new path-dependencies towards more desirable futures, and also Grunwald's (2007) notion of 'directed incrementalism' that aims to connect long-term normative sustainability goals with the realities of incremental decisions in the present. It also aligns with emerging ideas from institutional literature on the often gradual nature of institutional change (Streeck and Thelen, 2005; Mahoney and Thelen, 2010), which explores "how transformative changes can happen one step at a time" (Streeck and Thelen, 2005, preface). It also resonates with the idea of a planning modality of 'mutual adjustment' where "planning for sustainable development implies a degree of forward-oriented thought and action by government [but] does not require directing society towards some comprehensively pre-determined social end state" (Kenny and Meadowcroft, 1999, p. 18).

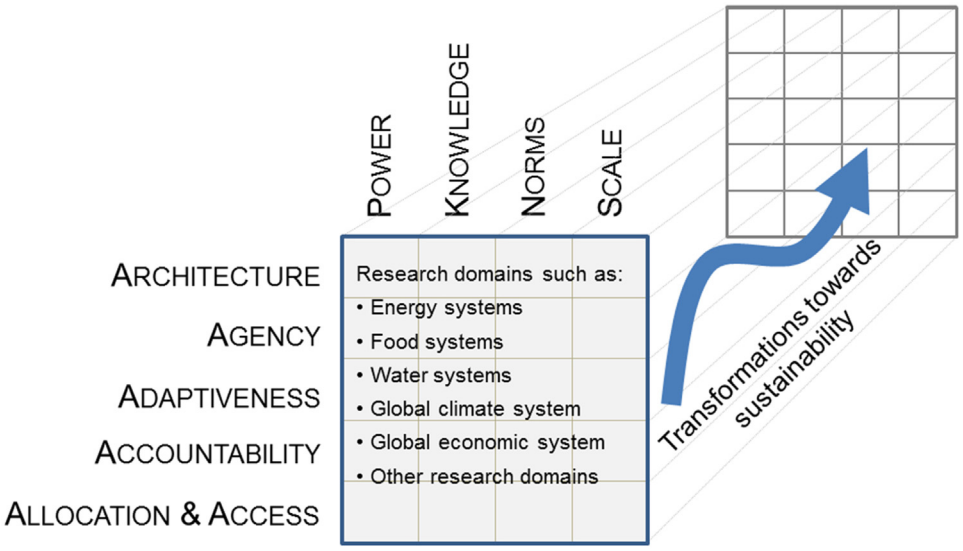

Fig. 1. Applying the existing ESG framework (Biermann et al., 2009) to the challenge of understanding and analysing transformations towards sustainability.

2.3. The Earth System Governance framework

The Earth System Governance (ESG) framework (Biermann et al., 2009) is highly relevant to the challenge of understanding and analysing the governance and politics of transformations towards sustainability. It comprises a matrix of key governance problems, and cross-cutting themes that are inherent to dealing with global sustainability problems. Key governance challenges are caputured under "five A's" of: architecture, agency, adaptiveness, accountability, and allocation and access. Architecture refers to "the overarching system of public or private institutions, principles, norms, regulations, decision-making procedures and organizations that are valid or active" in [a particular] issue area" (Biermann et al., 2010). Agency is constituted by the actions of actors (e.g., individuals, organizations, states), which interact with social and institutional structures (Archer, 2000) to shape change in socio-technical-ecological dynamics (Biermann et al., 2010). Adaptiveness describes "changes made by social groups in response to, or in anticipation of, challenges created through environmental change . . . [and] includes the governance of adaptation to social-ecological change, as well as the processes of change and adaptation within governance systems" (Biermann et al., 2010). Accountability and legitimacy are key concerns in regard to democratic governance and also in influencing institutional effectiveness (Biermann et al., 2010). Allocation and access entails issues relating to mechanisms for addressing questions of "who gets what, when, where and how" which "is a key question of politics" that fundamentally involves moral and ethical issues (Biermann et al., 2010). The cross-cutting themes of power, knowledge, norms, and scale further highlight politically-laden governance challenges. At the centre of the ESG framework are particular problem domains (i.e. energy, food, water, climate, and economic systems), which are likely to be the focus of efforts to bring about transformations towards sustainability. The ESG framework has been extensively peer-reviewed (e.g., see: Biermann et al., 2009, 2010, 2012) and is the organising principle for the largest global network of social scientists in environmental governance (the 'Earth System Governance network').

We extend the ESG framework to include an explicit temporal dimension when applying the framework in the context of transformations towards sustainability, as shown in Fig. 1. This is useful in bringing to attention the kinds of governance dimensions that need to be considered in understanding and analysing transformations towards sustainability, especially because different conceptual approaches (e.g. socio-technical transitions, social-ecological transformations, sustainability pathways, transformative adaptation) may emphasise different subsets of these governance dimensions. The framework does not prescribe or make judgements about the nature of transformation processes, nor does it privilege any particular conceptual approach. In this way, it provides a meta-framework for systematically considering key aspects of the governance and politics of transformations, which is flexible enough to accommodate a multiplicity of specific conceptual approaches. This is beneficial for allowing structured reflection and cross-case analysis (even when differing conceptual approaches to transformations are applied) that can inform theory-building over time. The framework also provides a boundary concept for researchers from diverse disciplines to appreciate the diverse governance and political aspects of transformations towards sustainability, and to identify common research questions and gaps.

3. Four conceptual approaches to transformations

In this section, we briefly describe the historical background and key propositions of four prominent conceptual approaches to transformations in the global sustainability literature: socio-technical transitions, social-ecological trans-

formations, sustainability pathways, and transformative adaptation. While the four perspectives often overlap, they each contribute important insights and a distinctive view on transformations towards sustainability.

3.1. Transitions approaches

Socio-technical transitions and transitions management approaches ('transitions approaches') have been formative in influencing and underpinning much research concerned with long-term societal change towards sustainability, as readers of this journal would be strongly aware. Collectively, the disciplinary roots of transitions approaches are broad, weaving together strands of scholarship from technology studies, complex systems, institutional analysis, and evolutionary and institutional economics (e.g. Kemp et al., 2007; van den Bergh et al., 2011). Prominent concepts include a multi-level perspective (i.e. niche, regime, landscape levels) where transition is understood to involve change at multiple levels, and co-evolutionary change involving technological, social, institutional, and economic systems (Kemp et al., 2007; Geels, 2002; Geels and Schot, 2007).

There are different emphases within contemporary transitions scholarship focusing on either a 'multi-level perspective' or 'transition management' (van den Bergh et al., 2011). The multi-level perspective views transitions as occurring through niche-level innovations that have the potential to disrupt established socio-technical regimes, embedded within a broader socio-technical landscape (Geels, 2002). Under this view, a variety of transitions pathways can arise, not all of which constitute 'complete' transition as the pathways may become stalled or locked-in along the way (Geels and Schot, 2007). Transitions management focuses on the complex adaptive systems nature of transitions, and draws on systems thinking concepts (e.g. self-organisation, attractors, feedback) to underpin a purposeful approach to shaping transition processes through cultivating experiments, focusing on front runners, and collaborative visioning (Foxon et al., 2009; Loorbach, 2009). Transitions pathways emerge from four interconnected spheres of activity: strategic (creating a transition arena, particularly focusing on 'frontrunners' and vision), tactical (developing a concrete transition agenda such as possible transition paths, and barriers to be overcome), operational (transitions experiments are encouraged and attempts made to scale-up promising options), and reflexive (monitoring and evaluation of actors, actions, and progress towards the transition agenda) (Loorbach, 2009).

3.2. Social-ecological transformations

A social-ecological systems perspective is another body of scholarship that has strongly influenced emerging notions of transformations towards sustainability. Its disciplinary roots are historically associated with ecology, but over time this has merged with an eclectic diversity of social sciences disciplinary perspectives, although not without critique (e.g. Cote and Nightingale, 2012). Social-ecological systems literature is based on complex adaptive systems theory, and highlights 'transformability', along with resilience and adaptability, as a key property of interest in social-ecological systems (Gunderson and Holling, 2002; Berkes et al., 2003; Walker et al., 2004; Folke et al., 2010). Transformability is defined as: "the capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable" (Walker et al., 2004), which results in "different controls over system properties, new ways of making a living and often changes in scales of crucial feedbacks" (Chapin et al., 2009). It is linked to resilience, because "transformational change at smaller scales enables resilience at larger scales" (Folke et al., 2010) and, conversely, undesirable transformations imply a loss of resilience.

It is proposed that transformations "can be purposefully navigated or unintended" (Chapin et al., 2009), and particular attention has been given to actively navigated transformation processes (e.g. Olsson et al., 2004, 2006; Gelcich et al., 2010; Pelling and Manuel-Navarrete, 2011). Transformation processes have been conceptualised as involving three key steps: being prepared or actively preparing a system for change; navigating a transition in management and governance regimes when a suitable window of opportunity opens; and then working to consolidate and build the resilience of the new regime (Folke et al., 2005; Olsson et al., 2006; Chapin et al., 2009). Some scholars have particular highlighted the role of social innovation (e.g., Biggs et al., 2010; Westley and Antadze, 2010; Westley et al., 2011, 2013) and 'strategic agency' (Westley et al., 2013) within transformation processes. Although overall, trajectories of transformative change are viewed as emerging from interplay between top-down institutional conditions and bottom-up (catalytic and disruptive) innovation, leveraged through the agency of institutional entrepreneurs and networks across multiple levels of organisation (Westley et al., 2011).

3.3. Sustainability pathways

'Sustainability pathways' is an approach that is promoted for dealing with complex and dynamic sustainability problems from both research (Leach et al., 2007a) and governance (Leach et al., 2007b) perspectives. It primarily constitutes an orientation for understanding and analysing transformations in a way that is sensitive to the fundamentally political and intersubjective nature of sustainability problems. It has diverse disciplinary roots, drawing on anthropology, development studies, economics, political science, and complex systems, though is perhaps most strongly oriented as a critique of technocratic and depoliticised development approaches. It merits being viewed as a distinct perspective because it makes a range of conceptual claims about the nature of sustainability transformations. For example, it emphasises that sustainability problems involve dynamics, complexity, incertitude, and contested interests (Leach et al., 2010). Therefore, efforts to shape pathways towards sustainability involve dealing with contested values, multiple narratives of change, and the politics of

knowledge, and require questioning dominant narratives, empowering marginalised actors (Stirling, 2014; Scoones et al., 2015), and "putting institutions and politics centre stage" (Leach et al., 2007a).

More recently, the sustainability pathways approach has been broadened by incorporating insights from social-ecological resilience thinking on planetary boundaries (Leach et al., 2012, 2013). The planetary boundaries framework identifies key global biophysical thresholds that cannot be crossed without fundamentally compromising the resilience of planetary life support systems (Rockström et al., 2009). It has been argued that social conditions (e.g., equity, justice) are equally important and should form another set of boundaries to be met (Raworth, 2012). New hybrid narratives have been created that frame transformations towards sustainability as being about navigating pathways of human development between the 'foundation' of social boundaries and the 'ceiling' of planetary boundaries (Leach et al., 2012, 2013).

3.4. Transformative adaptation

'Transformative adaptation' is an emerging perspective arising particularly in response to vulnerability and equity concerns linked to climate change (e.g. Pelling, 2011; O'Brien, 2012). This approach has disciplinary roots in human geography, political ecology, and development studies. It pivots on growing attention to the problem of adapting to global change, arguing that it is insufficient for adaptation to focus only on accommodating change, and must also focus on contesting change and creating new alternatives and possibilities (Pelling, 2011). This literature focuses on the interface between local problems of vulnerability, and the broader global conditions and dynamics that produce these problems.

In the context of deliberate social transformations under climate change, transformative adaptation seeks to instigate fundamental changes at a structural level of complex socio-technical-ecological systems. The key political argument for a transformative approach to adaptation holds that adjusting incrementally to anthropogenic changes in the Earth system will remain ineffective unless the systemic aspects of vulnerability and unsustainability are sufficiently addressed (Ribot, 2011; O'Brien, 2012). Transformative adaptation thus aims to alter fundamental systemic structures and paradigms that produce vulnerability in the social sphere (Schulz and Siriwardane, 2015). To initiate social action for change, transformative adaptation accentuates human agency and 'intrinsic' forms of motivation, which may be cognitive, emotional or value-based (O'Brien and Wolf, 2010).

4. Reflections on the conceptual approaches through the ESG framework

This section reflects on the four conceptual approaches to transformation described in Section 3, through the lens of the ESG framework described in Section 2. It first disentangles the differing foci of each approach (i.e. how problem domains are constructed), and then considers each approach agains the three axes of the adapted ESG framework presented in Fig. 1: the vertical dimension (the "5 A's"), the horizontal dimension (cross-cutting themes), and the temporal dimension (trajectories of change over time). This helps to identify complementary insights among the various approaches, and to appreciate existing insights on the governance and politics of transformations.

4.1. What is being transformed?

Firstly, the four conceptual approaches take differing perspectives on the problem domain at hand (i.e., what is being 'transformed'). Transitions approaches often take a sectoral perspective (e.g. energy, waste, water, food systems), and focus on transformation in human-technological interactions for achieving sustainable patterns of production and consumption. There is also emerging attention to the 'geography of transitions' (spatial location, scale) (Coenen et al., 2012; Hansen and Coenen, 2014). Social-ecological transformation approaches take a place-based perspective of linked human and ecological systems, and focus on transformation in human-ecosystem interactions for resilient natural resource use and management. Sustainability pathways approaches take a contextually-grounded sustainable development perspective, and focus on transformation in human development for sustainable and just pathways of change. Transformative adaptation approaches take a systemic and structural perspective on human vulnerability and focus on power assymetries within transformative processes in order to create opportunities and new possibilities for vulnerable groups and societies' futures.

4.2. The five A's: architecture, agency, adaptiveness, allocation and access, and accountability

In terms of *architecture*, all approaches emphasise the multi-level nature of the structural contexts within which transformations play out (e.g. geographically, institutionally, temporally), and highlight that transformation towards sustainability involves changes playing out across multiple levels. Although, how they conceptualise "levels" varies. Transitions approaches (under a multi-level perspective) view levels as levels of time scale and of structuration, rather than hierarchical levels (Geels and Schot, 2007; Schot and Geels, 2008). Social-ecological transformations approaches place central importance on multi-scalar dynamics, and the interplay of innovation at local scales with changes in institutional conditions at broader levels (Westley et al., 2011). Sustainability pathways approaches focus on institutional structures in terms of their effect in enabling or constraining the ability of poorer and marginalized people to participate in political decision-making about their future (Leach et al., 2007b). Transformative adaptation approaches focus more conceptually on the idea of transforming social and political structures and relations in society (O'Brien and Selboe, 2015).

All approaches strongly emphasise the role of *agency* in processes of transformation. Transitions approaches emphasise the importance of entrepreneurs and leaders (e.g. 'front runners') in innovation processes (Loorbach, 2009), and the role of a transition team in steering collective efforts (Grin et al., 2010). Social-ecological transformations approaches emphasise social and institutional entrepreneurship in fostering social innovation (Westley et al., 2011, 2013), and leadership for actively navigating transformation processes (Olsson et al., 2006). Sustainability pathways approaches highlight the need to recognise and enable poorer and marginalised people to exert their agency in political decision-making (Leach et al., 2007b). Transformative adaptation approaches argue for "deliberate transformations" that are "not about social engineering or 'designing' the future, but rather about recognizing that some fundamental shifts are necessary to enable desirable futures to emerge" (O'Brien, 2012).

All approaches place central conceptual significance on *adaptiveness*, including learning and reflexivity (whether implied or explicit), within unfolding transformation contexts. Transitions approaches (especially transitions management) emphasise the complex systems nature of transitions, and the importance of learning and reflexivity in transitions governance (Foxon et al., 2009; Loorbach, 2009; Grin et al., 2010). Social-ecological transformations are built on theory that is centrally focused on change and adaptiveness in complex and dynamic systems (Walker et al., 2004; Folke et al., 2005; Armitage and Plummer, 2010). Sustainability pathways approaches place importance on adaptive and reflexive governance for dealing with uncertainty, contested knowledge, and power differences (Leach et al., 2007b; Scoones et al., 2015). Transformative adaptation approaches fundamentally emerged in response to the challenge of adaptiveness, but as a critique of conventional depoliticized meanings of adapting to climate change, prompting a pivot towards transformation (Pelling, 2011; O'Brien, 2012).

Allocation and access, which relates to considerations of power-distribution, equity, and justice, is a theme that is less consistently addressed. Transitions approaches and social-ecological systems approaches have been critiqued by some scholars for a lack of attention to issues of power and politics (e.g. Smith and Stirling, 2010; Fabinyi et al., 2014), although there is significant growing attention to these topics (see Section 4.3). On the whole however, there appears to be little attention so far to questions relating to allocation and access (e.g. equity, justice). On the other hand, sustainability pathways approaches place central focus on these kinds of concerns through critically reflecting on how transformations towards sustainability perform in terms of poverty reduction and social justice outcomes (Leach et al., 2007a, 2013). Similarly, transformative adaptation approaches are strongly motivated by concerns about allocation and access of vulnerable or marginalized groups, and the need to contest existing power structures producing inequitable outcomes (O'Brien and Selboe, 2015; Schulz and Siriwardane, 2015).

Lastly, *accountability* is an area where all the conceptual approaches surveyed appear to be weak. Accountability entails both *answerability* and *enforceability* meaning that actors answer for their actions and the means to enforce commitments when these are not reached (Newell, 2008). Issues such as who *ought* to have the responsibility for transformations towards sustainability, and what are the mechanisms for holding someone accountable if it fails, are important. There is thus a relational element to accountability between accountability holders and accountability takers, which becomes challenging in multi-level perspectives where democratically elected government is not perceived as the ultimate actors. For example, transitions approaches have been critiqued for implying that "transition managers appear as a vanguard sitting apart from governance actors ... but nonetheless seeking to intervene and transform" (Smith and Stirling, 2010). More generally, it is crucial to consider the relationship between accountability and democratic decision-making within purposeful efforts to foster transformations (Hendriks and Grin, 2007; Smith and Stirling, 2010). Sustainability pathways approaches are strongest in this regard in emphasizing democratic concerns (Stirling, 2014). On the other hand, questions are also raised about accountabilities for change over the long timeframes over which transformations are likely to unfold.

4.3. Power, knowledge, norms, scale

These four cross-cutting themes of the ESG framework are strongly interconnected and difficult to separate on a theme-by-theme basis. Hence the four conceptual approaches are discussed more comparatively in this section, particularly where similarities are observed between the transitions approaches and social-ecological transformations approaches on the one hand, and the sustainability pathways and transformative adaptation approaches on the other.

Transitions approaches and social-ecological systems approaches have been critiqued for a tendency to under-appreciate dilemmas associated with power differences and contested norms and values among actors (Smith and Stirling, 2010; Fabinyi et al., 2014). For example, fundamental questions such as who makes decisions, what is considered a desirable future, and (even if we assume consensus) how do we get there, are not often directly addressed. Nevertheless, the topic of power has been receiving increasing attention in the transitions literature in recent years. For example, Avelino (2009) and Avelino and Wittmayer (2015) relate power and empowerment to core notions of transitions studies, such as the multi level perspective, by theorising categories of power in the specific context of transitions studies, and exploring tensions between aspirations for empowerment contrasted against the challenge of overcoming constraints on empowerment (such as short-term timeframes, and familiarity with extrinsic rather than intrinsic incentives for action). Hoffman (2013) relates power to the multi level perspective through drawing on Grin (2010) and others who identify different types of power at different transition levels, exploring how ideas about agency, creativity, and social fields help to understand interplay between power and structural change. Wittmayer et al. (2014) investigate action research as a way of empowering citizens

who feel powerless, and Wittmayer and Schäpke (2014) explore how researchers engaged in action research within transition contexts can deal with power both internal and external to group processes.

More broadly, Meadowcroft (2011) calls for attention to the political dimensions of societal transitions, "because politics plays a potentially powerful role" in ways such as "defining the landscape, propping up or destabilizing regimes, [and] protecting or exposing niches". From a broad sustainability perspective, Stirling (2014) argues that viable transformations are more likely to arise from contexts of plural knowledges and values, rather than a singular vision. In the social-ecological systems literature, Cote and Nightingale (2012) state that the application of ecological principles within the social realm has reduced opportunities to ask important normative questions concerning the role of power and culture. In reflecting comparatively on both of transitions and social-ecological approaches, Olsson et al. (2014) suggest that key areas requiring attention are: power relations and interests that reinforce existing system configurations, political power across scales, agency of actors initiating transformations, and participation and deliberation within transformation processes.

The relative emphasis on knowledge varies between transitions approaches and social-ecological transformations approaches. The social-ecological systems literature has strongly emphasized the importance of multiple kinds of knowledge, particularly the importance of bringing together local knowledge with scientific knowledge (Berkes et al., 2003; Chapin et al., 2009). Transitions approaches have been less explicit in regards to the roles of different kinds of knowledge, although the importance of non-technical alongside scientific knowledge is implied by the emphasis on niches practices and innovations.

Sustainability pathways and transformative adaptation approaches particularly emphasise power, knowledge, and norms, and contestations related to these issues. For example, sustainability pathways approaches focus on knowledge politics, contested norms and values, and differing assumptions about how change happens (Leach et al., 2007a; Scoones et al., 2015). They also highlight contested and plural framings regarding transformation, for example, Scoones et al. (2015) identify multiple narratives reflecting technocratic, marketised, state-led, and citizen-led perspectives. They argue that no single normative version of the future will be complete or universally desirable, and we therefore need to cultivate a plurality of possible pathways with multiple sets of norms and values (Stirling, 2014). Transformative adaptation approaches take as a starting point that power relations condition the options available to marginal and vulnerable groups to shape their own desirable futures, thus requiring keen attention to issues of social difference, power, and knowledge. They particularly highlight the role of norms in setting the cognitive bounds of understanding 'what is possible' in terms of transformation, and highlight the importance of contesting change to create alternative possibilities and new social and political relations and distributions of power (Pelling, 2011; O'Brien, 2012; O'Brien and Selboe, 2015).

All approaches recognize issues of scale, but transitions approaches and social-ecological transformations approaches particularly emphasise the multi-scalar nature of transformative change as a central concept. Transitions approaches have a multi-level conception of societal organization (niche/micro, regime/meso, landscape/macro) as a core tenet (Rotmans et al., 2001; Geels, 2002). Social-ecological transformations approaches view cross-scale dynamics as a fundamental attribute of social-ecological systems, and emphasise the interrelationship between resilience and transformation at different scales (Walker et al., 2004; Folke et al., 2005). Sustainability pathways approaches also give strong regard to scale through a political lens in emphasizing that actors at different scales perceive and experience change differently, and the enabling or constraining effect of societal structures at different scales on the ability of poorer and marginalized people to participate in political decision-making (Leach et al., 2007b). Transformative adaptation approaches are likely to be open to accounting for issues of scale in transforming social and political relations, although this theme is not necessarily emphasised so far.

4.4. Trajectories of change over time

All the approaches are interested in understanding deliberate or desirable transformations in society, although how they conceptualise trajectories of change over time (or do not), especially looking forward into the future, varies significantly.

Transitions approaches and social-ecological transformations approaches have been perhaps the 'boldest' in hypothesising trajectories of change. Socio-technical transitions, under a multi-level perspective, has proposed a typology of transition pathways (Geels and Schot, 2007). Strategic niche management "suggests that sustainable innovation journeys can be facilitated by creating technological niches . . . as building blocks for broader societal changes towards sustainable development", but is now situated within a broader multi-level perspective that emphasizes interplay between niches and broader level dynamics (Schot and Geels, 2008). Transitions management focuses on using niche experimentation and visioning within 'transition arenas' (involving both niche and regime actors) to trigger emergent changes in the broader regime, based on a complex adaptive systems perspective (Loorbach, 2009). Together, these multiple views indicate that resulting patterns of change are shaped by transition context (whether transitions are purposefully steered or unintended, and whether resources to innovate are within or external to the system in question), as well as specific efforts towards transitions management (de Haan and Rotmans, 2011).

From a social-ecological transformations perspective, it has been proposed that actively navigated transformations involve several phases: triggers, preparation for change, navigating a transition, and institutionalizing the new trajectory (Olsson et al., 2006; Moore et al., 2014). Another view from a broader scale is that transformations emerge from interplay between top-down institutional conditions and bottom-up (catalytic, disruptive) innovation (Westley et al., 2011). Hence transitions approaches and social-ecological transformations approaches take a largely conceptual orientation towards the question of how trajectories of change unfold over time.

Sustainability pathways and transformative adaptation approaches are less focused on conceptualizing mechanisms and trajectories of change per se, and more focused on applying a critical perspective to ideas of transformations. Sustainability pathways approach emphasise the need to 'cultivate plural pathways' (Stirling, 2014) because no single actor has a monopoly on visions of the future that are appropriate for everyone, sustainable, just, and complete (Scoones et al., 2015). Hence trajectories of change are viewed as emerging from political and discursive struggles that play out in complex, dynamic, and contested situations in ways that are highly contextual (Stirling, 2014). However, at the same time, sustainability pathways approaches have begun conceptualizing pathways of change as being about navigating trajectories of development between a 'ceiling' of acceptable ecological limits and a 'foundation' of acceptable social limits (Leach et al., 2012, 2013). Transformative adaptation approaches focus on contesting change, and transforming social and political relations and paradigms to open up new possibilities for the future (Schulz and Siriwardane, 2015). A pluralist approach to social change and experimentation is taken, as trajectories of change are largely left open. Hence sustainability pathways and transformation adaptation approaches take a plural and emancipatory orientation towards the question of how trajectories of change unfold over time.

5. Research challenges and opportunities

This section discusses research challenges and opportunities for understanding and analysing transformations, building on the previous discussion of conceptual approaches in Sections 3 and 4. These issues are placed within the context of the broader notion of transformations towards sustainability. Key issues discussed are: dealing with the deeply political nature of transformations, the challenges of thinking about transformation ex-ante, and tensions between steering transformations and their open-ended and emergent nature.

5.1. The deeply political nature of transformations

Transformations towards sustainability are deeply political (e.g. Leach et al., 2007b; Meadowcroft, 2011; WBGU, 2011; Scoones et al., 2015). The fundamental importance of governance and politics in regard to societal transformations should be clear because transformations are likely to have redistributional impacts, resulting in (actual or perceived) winners and losers (Meadowcroft, 2011; van den Bergh et al., 2011), normative sustainability goals invoke political stances and demands (Schulz and Siriwardane, 2015), and actors who promote transformations do so from particular political perspectives, carrying with them a set of worldviews and values that influence their vision of what constitutes a desirable future (Hulme, 2009; Stirling, 2011, 2014). Concerns relating to whose knowledge counts, what changes are necessary and desirable, and even what constitutes the end goal of transformation are all intensely political processes.

The four conceptual approaches provide a rich range of insights on the governance and politics of transformations. There are also major untapped opportunities for cross-fertilising insights among the approaches. For example, the orientation towards conceptualising transformative change processes offered by the transitions approaches and social-ecological transformations approaches, could be enriched by learning from the political and emancipatory orientation of the sustainability pathways and transformative adaptation approaches, and vice versa. However, a weakness revealed by the analysis using the ESG framework is that issues of access and allocation need to be more explicitly addressed (e.g. equity, fairness, justice). A further critical gap is that accountability does not seem to be given sufficient attention in the approaches analysed.

More generally, deeply political challenges that confront transformations towards sustainability include: time pressure on incremental policy change and the inadequacy of short-termism in policy-making; dealing with powerful opposing interests and forces linked to existing path-dependencies; institutional fragmentation and poor coordination; and deficits in representation (e.g., voices not heard, including future generations) (WBGU, 2011). In this context, the German Advisory Council for Global Change (WBGU, 2011) emphasise the need for a 'new social contract' for sustainability and a 'proactive state' that "actively sets priorities for the transformation, at the same time increasing the number of ways in which its citizens can participate" (WBGU, 2011). However, this also raises questions about power, norms, and accountability. For example, how new norms may arise and become embedded among societal actors, and whether there are tensions between a singular overarching transformation agenda as opposed to a more pluralist perspective of transformation 'pathways' in different cultural contexts (Stirling, 2014). Questions also arise regarding sources of agency (e.g., whether from state or non-state actors) and its role in multi-scale transformations (Folke et al., 2005; Olsson et al., 2006; Westley et al., 2011).

5.2. The challenges of thinking about transformations ex-ante

Thinking about transformations towards sustainability raises the major challenge of understanding and analysing change in a largely ex-ante (forward looking) sense. It is commonly suggested that historical transformations can help to understand future transformations towards sustainability (e.g., WBGU, 2011; Future Earth, 2014a,b). However, this may be insufficient given the unprecedented challenges of transformations towards sustainability (Scoones et al., 2015). Transformations towards sustainability are likely to be very difficult to understand looking forward because there may be "no obvious turning or tipping points . . . for clearly indicating the before and after of a transformation" (WBGU, 2011). Similar points are also made in relation to uncertainties regarding thresholds governing transformations within resilience literature, and it is difficult to know the distance to a threshold until it has happened (Rockström et al., 2009). Furthermore, fostering transformations may require changes in the criteria used to judge the appropriateness and performance of systems in society

that are the object of transformation (Kemp and van Lente, 2011). As van den Bergh et al. (2011) state, "in order to support long-term structural shifts, policies may have to interact with many transformative changes as they unfold rather than being defined and fixed at some initial date". Such issues raise important questions about the short-term and long-term dynamics of transformations. For example, what do the early stages of transformations look like (e.g., timescale of years), and what types of dynamics are involved over the longer-term (e.g., timescale of decades)?

Transitions approaches in particular have been one of the main pioneers of ex-ante concepts and methods for understanding large-scale systemic change towards sustainability. This has included extensive and ongoing work to theorise, study, and experiment with change processes in society. It also includes the development of many concepts and heuristics that are influential in thinking about ex-ante processes of change, such as the multi-level perspective and transition pathways (Geels, 2002; Geels and Schot 2007), and key contributions to broader topics such as complex adaptive systems (Loorbach, 2009; de Haan and Rotmans, 2011), scenarios (Hofman and Elzen, 2010), and reflexive governance (Grin et al., 2004; Voß et al., 2006). For example, Schot and Geels (2008) emphasise that understanding future 'innovation journeys' needs to recognise multi-level relationships between niche innovation (the role of which is to "allow nurturing and experimentation with the co-evolution of technology, user practices, and regulatory structures" (Schot and Geels, 2008, p.538)) and broader external processes at 'regime' and 'landscape' levels (e.g. the authors point towards the importance of political economic processes such as global commodity prices and effects of trade liberalization (Schot and Geels, 2008, p.544)). Hofman and Elzen (2010) developed a method of socio-technical scenarios which particularly highlights social dimensions of change processes, such as the inherent need for re-organization of actors and rules related to technological changes to facilitate transformational change. In other words, the "co-evolution of technology and its societal embedding" (Hofman and Elzen, 2010, p.656), focusing not only on outcomes but also on transitions paths (Hofman and Elzen, 2010, p.668). de Haan and Rotmans (2011) emphasise the complex adaptive systems nature of transition processes, and argue that understanding transition paths needs to focus on understanding complex chains of converging factors that play out dynamically over time.

Interest in ex-ante analysis and exploration of scenarios of transformation pathways is also increasing elsewhere (e.g., Smith et al., 2005; Bernstein and Cashore, 2012; Fischer-Kowalski et al., 2012; Sachs et al., 2014), including through the use of foresight approaches. An example is the "Roads from Rio +20" study conducted by the Dutch Environmental Assessment Agency (PBL, 2012) that sought to quantify the feasibility of multiple transformative pathways toward achieving the Sustainable Development Goals. Building on this initiative, the "World in 2050" initiative, led by the Sustainable Development Solutions Network, the Earth Institute, the International Institute for Applied Systems Analysis and the Stockholm Resilience Centre is seeking to develop quantified pathways toward a common vision based on the SDGs with leading global researchers and support from global development organizations. A bottom-up approach is taken by the Future Earth "Bright Spots—Seeds of a Good Anthropocene" project which aims to identify a wide range of practices that could be combined to contribute to large-scale transformative change. Such foresight initiatives have to deal questions of legitimacy and representativeness, credibility and salience to societal actors across different scales in order to be useful (Cash et al., 2003).

These concepts and experiences can provide many ideas for ESG scholars in framing and conceptualizing transformations in an ex-ante sense. However, we also argue that it is crucial to give strong regard to questions of politics and governance in thinking about sustainability transformations ex-ante. The diversity of actors, values, sense-making frames, scales and priorities involved suggests that inclusive, pluralistic and dynamic, iterative and dialogue-based approaches may be worth aspiring to; yet approaches such as foresight run the risk of being too scattered and lacking the power of strong organizing ideas and metaphors (Newell, 2012). They are also likely to be deeply challenged by issues of politics (e.g. ambiguity, contested interests), power (e.g. vested interests, obscure locations of power), and exogenous forces that constrain opportunities for change (e.g. broader political economic systems, dominant discourses such as neoliberalism). There may be trade-offs between the strengths and drawbacks of more centralized versus more pluralistic approaches to foresight related to the governance of transformations as they are taken forward, in terms of their ability to understand as well as help facilitate transformative change. ESG scholars are particularly well placed to bring to bear knowledge on governance and politics to contribute to addressing these topics and thus contribute to enriching understanding sustainability transformations in a forward-looking sense.

5.3. Tensions between steering change and its open-ended and emergent nature

Tensions are evident in the ways scholars talk about the potential for shaping transformations, versus the open-ended, emergent, and to a large degree unpredictable nature of transformations. On the one hand, governance of and for transformations (such as via the UN Sustainable Development Goals) may be important for driving deep societal change. Earth system governance in the Anthropocene is understood to require a rethinking of existing global institutions to better equip them for contemporary challenges and for driving deep societal change (Biermann, 2014). At the same time, it is also important that a focus on global-level approaches does not lead to a 'cockpit' view where it is assumed that "top-down steering by governments and intergovernmental organizations alone can address global problems" (Hajer et al., 2015). Both top-down steering and bottom-up self-organisation are likely to be needed, because transformations will emerge from complex and co-evolutionary interactions across multiple sectors of human society and scales over time, which often may not be possible to predict. It seems vital to consider how both top-down steering (e.g. the role of a 'strong state') and bottom-up self-organisation, contribute to transformations (following Smith et al., 2005; Westley et al., 2011).

It is also important to critically reflect on the relationship between incremental change and longer-term transformation. Is it possible to pursue incremental change with a transformative agenda through situating incremental efforts (such as policy change) within a broader transformations narrative (Section 2.2)? Can incremental reforms with a general commitment to sustainability actually lead to systemic transformations (Pelling, 2011)? Scoones et al. (2015, p.21) argue that "rather than there being one big green transformation, it is more likely that there will be multiple transformations that will intersect, overlap and conflict in unpredictable ways". This highlights the need to consider change in multiple interconnected areas (e.g., social, institutional, political, ecological, technological, cultural) in contextually relevant ways that appreciate the potential for co-evolutionary and non-linear outcomes.

This would require significant capacity for long-term thinking (Voß et al., 2009) and reflexivity in governance (Hendriks and Grin, 2007; Grin et al., 2010; Voß and Bornemann, 2011) to identify early signals of change (or lack of change) and to adapt collective efforts over time. For example, Grin et al. (2004) explore the challenge of creating institutional arrangements to allow 'reflexive policy design, which involves "reciprocal, argumentative exchange" (Grin et al., 2004, p.128) among actors involved and affected by a problem, with a focus on reaching legitimate and effective "congruencey" around a course of action (c.f. consensus). Significantly however, they find that "creating an appropriate institutional arrangement is a necessary but not sufficient condition" and of critical importance is "the art of dealing with those circumstances that cannot be adequately pre-empted by such rules" (Grin et al., 2004, p.140). Another possibility is to try to create positive feedback mechanisms that allow policy changes to 'stick' over the long-term (Jordan and Matt, 2014). Additionally, based on the gap identified in Section 4.2 regarding accountability, it would be critical to consider how purposeful efforts to foster transformations give regard to accountability (or perhaps create new accountabilities?) within institutional and political systems. New accountability mechanisms may be needed to ensure that actors who 'should' be responsible, actually are, both in the short term and longer-term, although how to achieve this is an open question.

6. Conclusions

The emerging notion of 'transformations towards sustainability' offers a promising new narrative for focusing research and policy attention on bringing about deep change in human society for environmental sustainability and human wellbeing. While the importance of governance and politics is recognised within various conceptual approaches to transformations, particularly the literature cited in this paper, overall it is underdeveloped and needs greater attention. In order for the notion of transformations to move beyond metaphor (Feola, 2014) and be meaningful for shaping action, it is vital to engage with the governance and politics of transformations. Fortunately, rich bodies of literature exist that conceptualise transformations in a range of ways. There is also major opportunity to strengthen these approaches by cross-fertilising insights among them, and drawing on other salient bodies of literature that have until now largely remained untapped, such as on allocation and access (e.g. equity, fairness, justice), and accountability.

A plurality of conceptual approaches is useful for giving differing and complementary insights on understanding and analysing transformations, which is beneficial for exposing blind spots of different approaches (Feola, 2014). Approaches need to be bold in proposing ways of understanding transformations, but also critical and reflexive, and particularly attentive to the challenges of real-world situations. It is not necessary or desirable to aspire to a single conceptual approach to transformations, and continued experimentation from multiple angles will be crucial to ongoing theory development. In this light, the ESG framework is useful as a meta-framework for highlighting discursive-normative, governance and political aspects of transformations. It is a high-level framework for thinking about governance, and does not give specific guidance on processes of transformation, but is flexible enough to accommodate different conceptual approaches that might be applied by different scholars. It therefore does not in any way usurp specific traditions of thought on transitions and transformations, but is useful as a heuristic for guiding a research inquiry into different dimensions/topics of governance that may be important in any particular situation. It can help reveal aspects of governance and politics that are likely to be important to consider, and support structured reflection and cross-case analysis (even when differing conceptual approaches to transformations are applied) which could inform theory-building over time. This will be especially useful as the emerging field of transformations continues to flourish and develop in diverse directions into the future.

An important area for future research regarding the ESG framework itself (with the added temporal dimension in Fig. 1) is to relate to existing work on temporal aspects of sustainability transformations. For example, strong opportunities exist in relation to the multi-level perspective (e.g. Schot and Geels, 2008), and in regards to reflexive governance for long-term problems (e.g. Voß et al., 2009; Lissandrello and Grin, 2011). For now, the temporal dimension applied in Fig. 1 has been used in a more heuristic fashion in order to explore the applicability of the framework for governance and politics questions relating to sustainability transformations. However, it is acknowledged that this is an aspect requiring further work.

Overall, a variety of questions are opened up which governance scholars (such as those working with the ESG framework), as well as those within particular research communities on sustainability transformations, should be concerned with. For example, questions regarding the processes of transformation include:

- What are the short-term and long-term dynamics of transformations, and how can we observe when (or when not) transformations are occurring?
- How can transformative change and its feasibility be understood and analysed in an ex-ante sense?

- What are the sources of agency and roles for both state and non-state actors in enabling and supporting transformations?
- What drives transformations towards sustainability over long timeframes, and how do these drivers arise?

Questions regarding institutions and governance systems include:

- What types of institutions and governance arrangements are needed to enable and shape transformations towards sustainability across multiple scales?
- What kinds of innovation in institutions and governance arrangements are needed in different problem domains, and how might this innovation arise and diffuse?
- How might 'battles of institutional change' (Chhotray and Stoker, 2009) play out, particularly when change is disruptive and met with strong resistance?
- How can policy and decision-making that is anticipatory and long-term be encouraged over short-termism?

Questions regarding cultural-cognitive dynamics include:

- How might new norms, ethics and values needed to underpin transformations towards sustainability arise?
- How could a 'new social contract' for sustainability (WBGU, 2011) be created?
- What are the benefits and drawbacks between a single transformations agenda versus more pluralistic approaches, and how are different perspectives heard and negotiated in the context of contested knowledge?

Finally, questions regarding embeddedness within broader political systems include:

- How can accountability mechanisms be developed to ensure that actors who 'should' be responsible, actually are, both in the short term and longer-term?
- By which mechanisms can power inequalities be productively addressed to allow actors who are poorly represented to meaningfully participate in shaping transformation processes?
- How can powerful opposing interests and forces linked to existing path-dependencies be addressed?
- More broadly, "how do global and regional political economies influence transformations to sustainability in different domains?" (Future Earth, 2014b).

These are pressing questions for future research which require insights from multiple scholarly communities, with a particular focus on governance and politics. We believe that there are incredibly fruitful overlaps and complementarities waiting to be found through cross-fertilising ideas and insights from various scholarly communities, and have sought to contribute to bringing together diverse perspectives to strengthen the foundation for doing so.

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