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Critical social science perspectives on transformations to sustainability☆

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This article introduces a special issue on the contribution of social science to addressing transformations to sustainability. Articles underline the importance of embracing theoretically rooted, empirically informed, and collaboratively generated knowledge to address sustainability challenges and transformative change. Emphasis is placed on the role of the social sciences in elaborating on the politicisation and pluralisation of transformation processes and outcomes, helping situate, frame, reflect and generate societal action, while acknowledging the complexity of societal transformation in different contexts.

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Introduction

As the international community confronts the urgency of global environmental challenges, calls have grown for fundamental transformative change to how we live on the planet and approach the systems that sustain our lives, recognising that this needs to occur at a scale, degree and urgency that renders business-as-usual untenable for sustainable societies [1–6]. Moreover, fuelled by how global inequalities shape the unequal impacts of climate change and the Covid-19 pandemic [7••], there is increasing attention to the need for transformation to incorporate principles of equity and justice [8•,9••,10•]. This underlines the value of developing new visions and narratives of plausible futures to guide attitudes, choices, policies, and actions [11].

We approach this Special Issue from the premise that the social sciences (and humanities) can contribute critical perspectives for understanding how transformative societal change towards sustainability can be addressed. We view this as going beyond identification of toolkit-style solutions to environmental crisis to provide context, framings, approaches, and reflection on societal transformation [12]. As the climate and biodiversity crises and the Covid-19 pandemic all demonstrate, scientific facts have to be connected politically to how sustainability is articulated socially, culturally, economically, and environmentally in different contexts [13]. This requires problematizing how global environmental challenges are framed and perceived, identifying opportunities for transformation, and understanding what agency and capacities different groups of people have to respond to change.

This Special Issue brings together articles from eleven three-year projects funded in 2018 under the NORFACE/Belmont Forum research programme 'Transformations to Sustainability' (T2S).[1] Table 1 presents a list of article titles, and associated project names and acronyms, summarising the approach to each project.[2] In addition, our annotated bibliography includes studies from a precursor programme.[3] The 'Transformations to Sustainability' programme has the motivation to support 'sustainability research . . . [that is] . . . based on good understanding of how societal transformation comes

☆ Given their role as Guest Editors, Eleanor Fisher, Eduardo Brondizio and Emily Boyd had no involvement in the peer-review of this article and has no access to information regarding its peer-review. Responsibility for the editorial process for this article was delegated Opha Pauline Dube.

[1] NORFACE brings together national research funding agencies in Europe. The Belmont Forum is a partnership of funding organizations, national science councils, and regional consortia committed to transdisciplinary science for understanding, mitigating and adapting to global environmental change.

[2] Information on each project and links to project webpages can be found here: https://t2sresearch.org/projects/.

[3] Between 2014–2019 three transformative knowledge networks were funded: ACKOWL_EJ, the Academic-Activist Co-Produced Knowledge for Environmental Justice' project, PATHWAYS, the Transformative Pathways to Sustainability project, and T-LEARNING, The Transgressive Learning Project. See https://transformationstosustainability.org/.

Table 1

Summary of approaches to transformations to sustainability: T2S Programme (Belmont Forum/NORFACE)

(i) Research approaches and methods	(ii) Approach to T2S	(iii) Challenges and opportunities	(iv) Attention to scale
Project: Transforming Unsustainable Pathways in Agricultural Frontiers (TRUEPATH) *Article: 'Fostering bottom up actor coalitions for transforming complex rural territorial pathways', Bastiaensen et al.* *Agricultural frontiers – Nicaragua.*			
Participatory development, development sociology, economics, agrarian systems.	Territorial pathways framework. Emergent, open-ended, involving contested socio-political processes.	Dominant territorial pathway challenges transformation; territorial alternatives identified.	Recognises multi-scale processes; focuses on local action situated within regional context.
Project: Localizing Land Registration in Conflict Affected Areas (SusTenSusPeace) *Article: Promoting land tenure security for sustainable peace: lessons on the politics of transformation, van Leeuwen et al.* *Land registration in conflict-affected settings – Burundi and Democratic Republic of Congo.*			
Critical development studies, political ecology and legal/ political anthropology.	Political, contested claim making processes stimulating unintended development outcomes.	Elite capture of transformation politics. Localisation stimulates opportunities for social justice.	Focuses on local action within national contexts.
Project: Amazonian Governance to Enable Transformations to Sustainability (AGENTS) *Article: Making place-based sustainability initiatives visible in the Brazilian Amazon, Brondizio et al.* *Initiatives for sustainable forest management in the Amazon – Brazil, Peru, and Bolivia.*			
Participatory development, geospatial analysis, institutions for collective action.	Place-based initiatives as forces for change within transformative pathways, with (dis)continuities.	Governance works against amplification/replication. Potential for transformation.	Recognises historical legacies and cross-scale interactions; focuses on local, national, regional levels.
Project: Towards Convivial Conservation (CON-VIVA) *Article: Transformation beyond conservation: how critical social science can contribute to a radical agenda in biodiversity conservation, Massarella et al.* *Conservation, human – wildlife relations – Brazil, Finland, Tanzania, and USA.*			
Combines political ecology and justice theory.	Radical alternatives and knowledge pluralisation for equity and justice. Politicises environmental issues.	Separating conservation from political economy restricts T2S. Challenges dominant perspectives.	Multi-scaled; local action is situated within global framing.
Project: Transformation to Groundwater Sustainability (T2SGS) *Article: Transformations to groundwater sustainability: from individuals and pumps to communities and aquifers, Zwarteveen et al.* *Groundwater sustainability in relation to agriculture - Algeria, Chile, India, Morocco, Peru, Syria, Tanzania, and USA.*			
Anti-colonial critique, feminism. Ethnography, hydrogeology, engineering, action research.	Anchors T2S in collective action and practices of care, emphasizing scope of grassroots initiatives.	Inequality in science-dominated solutions. Pluralisation widens possibilities for transformation.	Multi-scale, with emphasis on local action.
Project: Migration, Transformation and Sustainability (MISTY) *Article: The migration-sustainability paradox: transformations in mobile worlds, Franco Gavonel et al.* *Human migration dynamics, sustainability - Bangladesh, Belgium, Ghana, Mozambique, Netherlands, and USA.*			
Human geography, macroeconomics, demography, migration studies.	Migration transition dynamics; capital asset based framework on sustainable development.	Inequalities challenged through wellbeing and equality improvements.	Multi-scale; local cases are situated in national contexts, with attention to macro-level (global/regional).
Project: Pathways to Sustainability in Marginal Environments (TAPESTRY) *Article: Transformation as praxis: responding to climate change uncertainties in marginal environments in South Asia, Mehta et al.* *Climate change uncertainties in vulnerable coastal areas of Mumbai, the Sundarbans and Kutch – India and Bangladesh.*			
Critical development/science technology studies, political ecology, history, GIS, ethnography.	Transformation as praxis; transformative alliances work to reconfigure development.	Challenges of marginalisation; opportunities through individual agency and collective action.	Multi-scale, with emphasis on bottom-up action within national and regional contexts.
Project: Intellectual Property in Sustainability Transitions (IPACST) *Article: Sustainability transitions in manufacturing: the role of intellectual property, Eppinger et al.* *Intellectual property models, manufacturing - Sweden, Germany, India, and UK.*			
Interdisciplinarity informed by engineering, intellectual property rights law, and sustainability science.	Intellectual Property Rights systems, tools unlock sustainable innovation in transition.	Lack of partnership, weak diffusion create barriers. Collaboration and joint innovation facilitate change.	Multi-scale; firm and cross-industry; industrialized and developing countries.
Project: Governance of Sociotechnical Transformations (GoST) *Article: The governance of sociotechnical transformations to sustainability. Beck et al.* *Sociotechnical transformations in energy systems, agriculture, and urban digital infrastructures - Germany, India, Kenya, UK, and US.*			
Science and technology studies, sociology, environmental politics and governance.	Sociotechnical imaginaries (STI) framework; non-linear pathways for transformation alternatives.	Imaginaries of sustainable futures enable or limit scope and spaces of political action for transformation.	Multi-scale; focus on selected sectors within globally interconnected national contexts.

Table 1 (*Continued*)

(i) Research approaches and methods	(ii) Approach to T2S	(iii) Challenges and opportunities	(iv) Attention to scale
Project: Sustainable Flood Risk Governance for Urban Resilience (WATERPROOFING DATA) *Article: The role of data in transformations to sustainability: a critical research agenda, Porto de Albuquerque et al.* *Role of data in flood risk management - Brazil, Germany, and UK.*			
Geography, GIS/urban analytics, media and development studies, data science, critical pedagogy.	Transformation pathways incorporate data innovations, within socio-material processes.	Barriers from power asymmetries (etc.). Data-enabled pathways catalyse and inform change.	Multi-scale; frames attention to different actors and types of data at macro, meso, and micro scales.
Sustainability Transformations in Artisanal and Small-scale Gold Mining: Multi-Actor and Trans-Regional Perspectives (GOLD MATTERS) *Article: Transforming matters: sustaining gold lifeways in artisanal and small-scale mining, Fisher et al.* *Artisanal and small-scale gold mining – Brazil, Burkina Faso, French Guiana, Ghana, Guinea, Suriname, and Uganda.*			
Anthropology, development studies, GIS, mining engineering, and visual arts.	Social - material encounters stimulate transformation in association with technology.	Political and structural barriers to change. Locally situated practice generates transformative action.	Multi-scale, but emphasis on local action within national and regional contexts.

Source: Authors, information drawn from articles in special issue v.49 and from https://t2sresearch.org/.

about and how – if at all – it can be initiated, fostered, accelerated and steered towards ends that are at the same time ecologically sound, economically viable and socially just'.[4] All eleven articles describe projects that are transdisciplinary, led by a social scientist, and developed in collaboration with partners within the Americas, Africa, Europe, and/or Asia.

Against this background, this Special Issue sets the stage for a range of social science perspectives on transformation, contributing to an examination of what transformation looks like in different contexts. Contributors were asked to address: 'What combination of theoretical orientation, analytical perspective, and research practices have guided your project's approach to transformation to sustainability?' In keeping with the aims and scope of this journal, articles provide a concise review of a subject field or issue, in some cases including illustrative examples to contextualize the literature or situate the project within a regional historical context.

Next, we first turn to provide a brief overview of different schools of thought on sustainability transitions/transformations in order to situate the conceptual orientation of the articles within a broad field. Second, we reflect on how articles address transformations to sustainability. Finally, we conclude with observations on the emerging contribution of critical social science, with the potential to contribute plural social science perspectives to transdisciplinary research on transformations to sustainability.

Overview of schools of thought on transition/transformation

There is a burgeoning literature on transformation from different schools of thought within the social sciences and allied disciplines [14••,15,16••,17•,18–20]. While there is agreement that transformation involves fundamental change that is non-linear and non-teleological, what is considered transformational – processes, characteristics, outcomes – and how transformation arises, or indeed can be recognized, is debated [15]. This is important because different ways of understanding transformation influence the identification of new insights, and what policies and actions can be advocated [21••].

Across the literature, a distinction is apparent between 'sustainability transitions' and 'sustainability transformations' (or 'transformations to sustainability'), with discussion over whether they are competing or complementary concepts [22•]. We view this distinction as part of a broad epistemic terrain shaping contemporary thinking and do not intend to debate the utility of one expression over another. Instead, we will proceed by providing a brief overview of schools of thought associated with these concepts, turning first to sustainability transitions scholarship and then to sustainability transformations scholarship.

Predicated on recognizing the interdependence of people and nature, scholarship on social-ecological systems informs the first school of thought for framing transitions. Here we can identify two strands: on resilience, and on institutional analysis and development. Thinking on resilience has roots within ecological science from at least the 1970s [23]. Over a fifty-year period, resilience thinking has developed significantly, incorporating an interlinked focus on society and ecology as intertwined and co-evolving, building an understanding of the fast changing dynamics of tipping points and planetary boundaries [24–26], and encompassing the value of complexity based approaches [27]. The influence of the political economist Elinor Ostrom helped broaden social-ecological systems analysis in the 1990s [28–30]. Ostrom [28] proposed Institutional Analysis and Development (IAD) as a 'multi-level nested framework for analysing outcomes achieved in social-ecological systems' (p. 420). In her view, applications for the framework include helping to identify factors that may affect the likelihood of, for

[4] See: https://t2sresearch.org/about/.

instance, particular policies enhancing sustainability in one collective action situation around a natural resource and not others.

Building on this rich theoretical heritage, studies include consideration of how resilience at different scales encompasses both adaptation within current development trajectories and the crossing of thresholds into new development trajectories when old systems become untenable [31,32]. Research also examines the unanticipated and negative consequences of resilience, with 'lock in' generating barriers to sustainability transformation [33]. Parallel social science perspectives likewise provide critique of resilience as an obstacle to development and to transformation [34,35].

Scrutiny of how social and ecological 'feedbacks' can reinforce one another to 'lock' a system into an undesirable state places attention on the value of 'disruption' for producing greater environmental sustainability and human wellbeing, highlighting the importance of women's empowerment, of co-management, and of indigenous knowledge [36•,37]. This is seen in the application of 'Transformation-Labs (T-Labs)', a methodology for generating innovative approaches to transforming social-ecological systems [21••,38••,39••]. Shocks linked to disruption also provide an entry point for investigation of whether and under which conditions socio-political change stimulates transformation in natural resource governance, with capacity for success dependent on 'cognitive, structural and agency related capacities throughout all phases of the transformation' [40••] (p. 11).

In examining the unanticipated consequences of resilience for transformation, Olsson *et al.* [33] counter assertions that resilience theory cannot contribute to addressing sustainability transformations, including associated power relations, arguing it is a misperception that resilience theory is biased towards persistence, rather than transformation. They emphasise the need for theoretical integration and collaboration, notably through linkages between social-ecological systems resilience and socio-technical transitions thinking.

This prompts us to turn to a parallel school of thought on sustainability transitions that emerged in the Netherlands in the 1990s, namely that associated with the Sustainability Transitions Research Network [17•,20]. Instead of resilience theory's emphasis on inter-twinned social-ecological systems, a core concern for this group of researchers is the co-evolution of society and technology, with technology used as an 'entry point' to wider systems [16••]. With roots in science, technology and innovation studies, drawing too from evolutionary and neo-institutional economics, transitions scholarship considers co-evolving social, institutional, technological and economic changes within complex systems. Two frameworks are 'Transition Management' (TM) and the 'Multi-Level Perspective' (MLP) [16••,41]. In advocating for a MLP approach to sustainability transitions, Geels [16••] argues it provides an integrative approach that encompasses transitions in the socio-technical systems (transport, energy, agro-food, etc.) that provide a basis for societal functions, and which therefore require fundamental change.

Geels [16••] and Köhler *et al.* [17•] counter criticisms levelled at socio-technical transitions scholarship that weak attention is paid to power, politics, culture, and conflict, and that emphasis on what Geels [16••] refers to as 'distribution systems', disregards social sustainability (poverty, labour conditions, etc.) and the structural roots of inequality, with capitalism treated as a 'landscape factor' for socio-technical transitions [42]. A body of recent research, particularly on the energy transition, also challenges such criticisms [43,44,45••].

Echoing Olsson *et al.*'s [33] earlier call for conceptual pluralism, urban sustainability scholars propose a social-ecological-technical-systems (SETS) approach that bridges thinking on social-ecological systems and on socio-technical transitions respectively [9••,46,47••]. SETS incorporates the significance of technological mediation of human-environment relationships, translated across fields of research for a pluralistic understanding of how different domains interact [57]. For example, using the concept of a 'good Anthropocene,' McPhearson *et al.* [9••] argue for five principles to act as preconditions for development that is just, equitable, resilient and sustainable. These five principles are rethinking growth, efficiency, state, commons, and justice for systems-led transformation, with interconnections considered fundamental to building innovations that can drive global-scale change. (C.f. the Earth Systems Governance Framework (ESGF) [48]).

We turn to thinking on sustainability transformations and note that distinct schools of thought are harder to delineate, although the influence of qualitative social science traditions within human geography, political ecology, political science, development studies, and social anthropology are apparent. To be pragmatic, we will highlight three lines of thinking: on sustainability pathways, on transformative adaptation, and on social movements; we illustrate the latter with reference to initiatives in the Global South.

Research on the politics of sustainability that has emerged from the STEPS Centre hosted at the Institute of Development Studies (IDS) and Science Policy Research Unit (SPRU) at the University of Sussex and their global networks, has led to the development of a perspective on transformations captured within a pathways approach to sustainability [49–51]. This builds on a

legacy of work on participation, power and sustainability, bringing together development studies and science technology studies (STS). Thinking on sustainability pathways places emphasis on challenging the power structures that perpetuate inequality, with sustainability the subject of plural knowledge framings and multi-actor perspectives that shape choices and pathways for action. This includes transdisciplinary research on the co-construction of transformative pathways to sustainability, methodologically incorporating T-Labs to develop innovative responses to social-ecological problems [21••,52–54].[5] Thinking on sustainability from development scholars has been combined with research on planetary boundaries by resilience scholars [55]. Recent work has placed emphasis on theoretical and methodological pluralism to be equipped for transformative change [21••,56••], including bringing together understandings of structural processes with those of unruly, context-specific change to envisage radically different futures within post-pandemic transformations [56••].

A second body of transformations scholarship, namely on transformative adaptation, principally in relation to climate change, also pays attention to the underlying social and political structures that produce marginalization and inequality, shifting emphasis away from adaption within the status quo to transformational change that challenges the structural roots of vulnerability [57,58,59•,60,61,62••]. For example, Pelling [58] proposes a framework for empirically analysing choices related to resilience (stability), transition (incremental change), and transformation (new rights claims and changes in political regimes). Leach *et al.* likewise proposes that adaptive challenges require choices linked to new ways of viewing problems and solutions. This leads them to identify three 'spheres of transformation' – the personal, the political, and the practical – which incorporate the need to recognize beliefs, values and worldviews, and to acknowledge this is political, involving validation of social norms and legitimation of forms of governance, in order to encapsulate what is desirable and achievable within practical strategies.

Thinking on sustainability pathways brings issues of power and equity to the fore; there is also emphasis on lives and livelihoods in the Global South. Nevertheless, one might counter – drawing from transitions perspectives presented above – that this orientation is at the expense of the well-grounded understanding of ecology and natural systems at different scales, as found in resilience scholarship, or attention to the systems that govern the socio-technical dimensions of modern life, as found in transitions scholarship. This leads to a criticism that while contextually based studies on sustainability pathways can be invaluable for understanding local complexity, weaknesses emerge with regard to framing issues of scale, uncertainty and global environmental tipping points.

A final area contributing to thinking on sustainability transformations, relates to perspectives on social activism in the Global South that give attention to different epistemologies on sustainability [37] and to post-humanist thinking on ways of being in the world [63]. These perspectives inform environmental justice movements and radical critiques of development, including challenges to dominant notions of sustainability and transformation [45••,64•,65]. Concepts such as *Buen Vivir* (South America) and *Ubuntu* (Southern Africa) provide alternatives to dominant world views about human wellbeing, that is, foregrounding a wider set (than income, education, and longevity) of material, non-material, and contextual conditions underlying not only livelihood circumstances and opportunities, but different ways of experimenting and knowing the world, and thus what should be transformed, why and for whom [63,64•,66]. These orientations demonstrate how transformative alternatives are not only there to be imagined for the future, but exist already within peoples' lived experience and can offer valuable counterpoints to dominant perspectives on transformative change.

This overview has highlighted how many different perspectives have emerged from different bodies of scholarship to inform thinking on sustainability transition/transformation within the social sciences. One challenge is moving from a high level of abstraction to ground understanding of transformations to sustainability within empirical research and practical action, in order to build learning on the contribution of social science for addressing real world and rapidly evolving sustainability challenges. With this in view, we turn to focus on the eleven articles in this Special Issue.

Transformations to sustainability: approaches, opportunities and challenges at different scales

Articles to this special issue focus on 'transformations to sustainability' by addressing different sustainability challenges, as indicated in Table 1. Conceptual pluralism is apparent in how transformation is addressed, nevertheless, with exceptions [75••,76••], articles lean towards transformations scholarship and away from transitions scholarship (*Overview of schools of thought on transition/transformation*). Bearing this in mind, we focus on two main areas. Firstly, approaches taken to research on transformations to sustainability, including the social science informing the research (Table 1, i-ii); and,

[5] The 'Transformative Pathways to Sustainability' project was set up as a transformative knowledge network by the International Social Science Council with funding from SIDA, acting as a precursor to the eleven projects discussed in this editorial. See https://transformationstosustainability.org/.

secondly, identification of opportunities and challenges for addressing transformations to sustainability, including attention to scale (Table 1, iii–iv).

Approaching transformation

Surveying the articles (Table 1), it is clear how wide-ranging is the social science, with orientations including: political ecology; structuration theory; environmental and social justice; science and technology studies; collective action theory; an actor-oriented approach; participation; action research; institutional bricolage; and feminist, anti-colonial and subaltern critiques.

Bastiaensen *et al.* [67••], van Leeuwen *et al.* [68••], Brondizio *et al.* [69••], Massarella *et al.* [70••], Zwarteveen *et al.* [71••], Mehta *et al.* [72••], and Fisher *et al.* [73••] address sustainability challenges in the Global South. They have a development orientation and encompass how colonialism, capitalism, and development or conservation shape sustainability challenges. Issues of social justice are prominent. Franco Gavonel *et al.* [74••], Eppinger *et al.* [75••], Beck *et al.* [76••], and Porto de Albuquerque *et al.* [77••] lean away from a development orientation, framing analysis within a global or sectoral perspective, or according to specific expertise (intellectual property regimes, data innovations).

Informed by understanding of agrarian systems and development, Bastiaensen *et al.* [67••] consider how within agrarian frontiers of Nicaragua transformative pathways can emerge from power-laden interactions, framed by dominant ideas, social structures and 'rules-in-use'. Van Leeuwen *et al.* [68••] use critical development studies and anthropology to consider how land registration (Burundi, the Democratic Republic of Congo) depoliticises inherently political choices, with transformation generating unexpected outcomes.

Drawing on approaches to collective action and participation, Brondizio *et al.* [69••] address how place-based initiatives involving individual and collective action have roles in promoting regional sustainability in the Amazon. Combining political ecology and justice theory, drawing too from post-humanist thinking (*Overview of schools of thought on transition/transformation*), Massarella *et al.* [70••] focus on biodiversity conservation (Brazil, Finland, Tanzania, USA) to consider how the social sciences can politicise and pluralise conservation debates while facilitating transformative alternatives.

Zwarteveen *et al.* [71••] focus on groundwater and agricultural intensification (Africa, Middle East, India, USA) to anchor transformations to sustainability within collective action linked to forms of care, away from government efforts to control individual behaviour. Mehta *et al.* [72••], debate how transformation can be conceptualized 'from below' in marginal environments of India and Bangladesh marked by climate uncertainties, proposing the notion of transformation as praxis within bottom-up change. Finally, Fisher *et al.* [73••] address precarity, heterogeneity and the politics of artisanal and small-scale gold mining (Africa, South America) to challenge dominant legalistic approaches that ignore the social-material relationships and role of technology in stimulating transformative change.

Franco Gavonel *et al.* [74••] situate global human migration in relation to migration transition dynamics, building on theories of migration as social transformation and as development in research seated within human geography but informed by macroeconomics, demography, development, and migration studies. In contrast, Eppinger *et al.* [75••] focus on intellectual property rights (IPR) in manufacturing. Their interdisciplinary thinking on sustainability innovation within socio-technical transitions reflects the influence of IPR legal studies, engineering, and sustainability science. Beck *et al.* [76••], with a focus on sociotechnical transformations in agriculture, energy systems and urban infrastructure, are informed by scholarship in science and technology studies, using a 'Socio-Technical Imaginaries (STI) framework' to position science and technology in relation to political power and to governance. Finally, Porto de Albuquerque *et al.* [77••] broaden perspectives on the role of data for enabling transformations with an application to flood risk management, adopting an interdisciplinary approach that draws on geography, media studies, GIS, social data science, critical pedagogy and development studies.

Opportunities and challenges in regional contexts at different scales

The eleven articles (Table 1, iii–iv) grapple with, on the one hand, complex non-deliberative transformations and, on the other hand, how to generate action to stimulate sustainability transformations. In the process, issues of equity and justice are foregrounded regarding for whom desirable sustainability outcomes should be realised. Given this 'conceptual grappling', we see innovation in how the social sciences can help researchers define their locus of concern. In several instances, this echoes thinking on sustainability pathways (*Overview of schools of thought on transition/transformation).*

To illustrate, Mehta *et al.* [72••] propose the notion of '*patches of transformation*' 'sites and exemplars amidst largely unsustainable processes where hybrid alliances and their innovation initiatives, reimagine sustainable development and inspire transformative societal changes that can be scaled up and out'. In comparison, Bastiaensen *et al.* [67••] focus on '*territorial pathways*' to 'side with evolving co-created sustainability perspectives built from multiple entry points by innovative actor-coalitions, often involving previously excluded or invisible

groups'. While Fisher *et al.* [73••] take the notion of '*gold lifeways*' to reflect on the 'unruly edges' of gold extraction, giving expression to its situated, heterogeneous character. These examples of how articles seek to develop plausible accounts of situated action within large-scale transformations lean towards middle range theory, in the sense of seeking a 'middle ground between a universalist explanation and the need for empirical contextualization . . . based on thick, data-rich analysis' [78,79]. Here, arguably, this contrasts with research framed according to meta-level unifying transition/transformation models, such as SETS [56••], ESGF [67••], and an MLP [16••] (*Overview of schools of thought on transition/transformation*).

A 'bottom up' or 'situated' locus of research on transformation (*patches*, *pathways*, *lifeways*, etc.) contrasts with the orientation of other articles. Beck *et al.* [76••] and Franco Gavonel *et al.* [74••] are illustrative. The STI framework of Beck *et al.* [76••] positions science and technology in relation to political power and to governance – with the relationship between knowledge and power played out over what counts as a desirable future and for whom, plus the political choices this entails. This helps 'capture the tensions between alternative visions and contingencies in policy choices, as well as discern the forms of power at work in articulating futures that 'ought' to be attained . . . [raising] . . . the question whether or not, and to whom, the particular societal futures imaginable through techno scientific changes seem worth attaining' (p.144). For Franco Gavonel *et al.* [74••], their framing calls for conceptualizing transformation processes within a migration – sustainability nexus. They suggest that migration facilitates transformations to sustainability if it simultaneously improves the three dimensions of sustainability: (a) migration increases aggregate wellbeing while lowering environmental burdens; (b) it reduces inequality in multiple spatial, economic, and health dimensions; and, (c) it represents or promotes diversity, political freedom and reduced insecurity.

Most articles (Table 1) give attention to regional development within trajectories of planned intervention and the (unintended) consequences. This holds learning for stimulating deliberative 'transformations to sustainability' and for the challenge of working across scales, including when outcomes cannot be controlled or predicted. Brondizio *et al.* [69••] illustrate this well be examining the emergence of place-based initiatives in the Brazilian Amazon. The article focuses on actions by local actors who have ownership (and take the risk) in implementing ideas intended to transform their social and environmental realities, even if the initiatives are externally initiated and supported. They emphasise the role of historical processes and development interventions and ideologies affecting place-based initiatives today, calling attention to the importance of cross-scale interactions, alongside the complexity involved in understanding whether the achievement of a goal at one level is resilient and can contribute to more emergent and desirable outcomes at higher levels.

As indicated in Table 1 (ii), approaches to transformation suggest articles recognise a need to encompass diverse actors and interests, alongside consideration of which or whose visions of transformation or a desirable future are privileged, plus whether this is just and equitable. In this respect, the majority of articles stress how identification of opportunities for transformations to sustainability, and associated challenges, involves political choices. For social scientists, this necessitates scrutiny of power and politics, knowledge and agency. It also highlights the need to understand the reproduction of inequality. Such understandings shape the selection of social science theory, a point well elaborated by Scoones *et al.* [21••] in their overview of bodies of social science and political theory that inform 'structural', 'systemic' and 'enabling' approaches to transformation.

Emphasis on power and politics brings to the fore epistemological issues, in terms of what forms of knowledge inform understanding of transformation and sustainability, and whose perspectives gain credibility. Many articles focus on groups of people who are marginalised from dominant society and whose knowledge is disregarded by development planners. This leads Zwaarteveen *et al.* [71••] to emphasize the value of plural knowledges within the politics of care 'allowing many knowers, knowledges and visions of groundwater to co-exist, learning from and living with, rather than overcoming, difference.' Alternatively, for Porto de Albuquerque *et al.* [77••], this means taking seriously the value of citizen science and attention to local and indigenous knowledge, while being mindful of the need to avoid instrumentalising knowledge processes.

For some articles, attention to knowledge also links to reflection on researcher positionality and the role of research in action on transformation. For example, Mehta *et al.* [72••] focus on the praxis of transformation to generate 'informed action which seeks to facilitate socially just processes through an explicitly normative positioning of praxis as value-orientated and bottom-up change' (p.112). Likewise, and in contrast, Fisher *et al.* [73••] approach transdisciplinarity through 'co-labouring' [80], with emphasis on mutual learning rather than researchers' direct involvement in transformative action. Likewise, Bastiaensen *et al.* [67••] draw attention to how researchers' own epistemologies, interests and values interact with those of other actors to shape the identification and evolution of transformative alternatives. Researchers and development practitioners may hold certain perspectives on the importance of social justice or on the need for systemic change to achieve

transformation to sustainability, they thereby have to be aware that the process of searching for alternatives is inevitably conditioned by how their own (also diverse) epistemologies and interests interact with those of other actors [43,77••].

Inevitably, challenges and opportunities for transformation arise in the 'messy business' of how political choices are made and transformative societal action unfolds. This underlines the value of social science for addressing transformations to sustainability.

Conclusion

It is early days to conclude what contribution articles – and the research projects on which they are based – will make to thinking on transformations to sustainability, although a promising start is captured. Building on earlier studies [21••,53,54,65,81], articles underline how different social science orientations and forms of transdisciplinary collaboration can inform understandings of transformations to sustainability by giving attention to societal dynamics and locating these dynamics in historical and comparative perspectives.

Increasingly, and positively, the widening of approaches and voices on transformation/transition, within and beyond the social sciences, introduces different worldviews and narratives into the debate [64•,82]. This facilitates understanding of how approaches (both methodological and empirical insights) can be generated by social sciences more precisely, as well as progressively helping to tease out cultural, social, economic and political obstacles to change [12,21••,83].

This all underlines the importance of embracing theoretically rooted, empirically informed, and collaboratively generated knowledge to address sustainability challenges within different contexts [21••,56••]. The value of transdisciplinarity, involving academic and non-academic actors in co-design and co-production, comes to the fore to address these complex challenges [84,85]. By necessity, attention to sustainability involves coupling issues of nature and society, while politicizing and pluralizing transformation processes and outcomes to help to ensure transparency and to safeguard against appropriation by singular perspectives on what constitutes a sustainable future and how to achieve it [14••]. Transformations to sustainability are necessarily plural and will continue to unfold in different ways.

Conflict of interest statement

Nothing declared.

Data availability

Data will be made available on request.

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