Review

Five priorities to advance transformative transdisciplinary research

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In response to the climate and biodiversity crisis, the number of transdisciplinary research projects in which researchers partner with sustainability initiatives to foster transformative change is increasing globally. To enable and catalyze substantial transformative change, transformative transdisciplinary research (TTDR) is urgently needed to provide knowledge and guidance for actions. We review prominent discussions on TTDR and draw on our experiences from research projects in the Global South and North. Drawing on this, we identify key gaps and stimulate debate on how sustainability researchers can enable and catalyze transformative change by advancing five priority areas: clarify what TTDR is, conduct meaningful people-centric research, unpack how to act at deep leverage points, improve engagement with diverse knowledge systems, and explore potentials and risks of global digitalization for transformative change.

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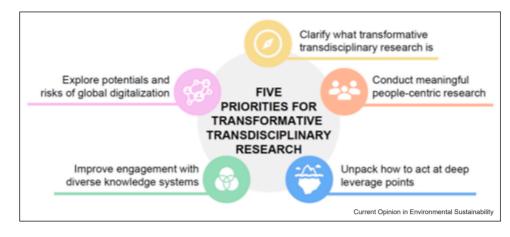Corresponding author: Augenstein, Karoline
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Introduction

The urgency and complexity of sustainability problems, such as climate change and biodiversity loss, call for transformative change to enable people to live within Earth's planetary boundaries in a just, equitable, and sustainable way [1]. Transformative changes, also called transformations, are large-scale changes in structural, functional, relational, and cognitive aspects of diverse social–technical–ecological systems that can lead to different and new patterns of interactions and outcomes [2]. The call for transformative change has recently been highlighted in the policy sphere by diverse organizations, ranging from Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) [3] to the global Fridays for Future movement led by younger generations. In the last two decades, there is a growing understanding of what transformative change is and how researchers can play an active role in contributing to much needed changes for sustainability [4–7].

Transformative transdisciplinary research (TTDR) has developed into an established research practice that cuts across various traditions and communities in sustainability science, transitions, and transformation research. Core characteristics of TTDR are (1) that it contributes to solving complex real-world sustainability problems with researchers from different disciplines collaborating with diverse practitioners, communities, and policy-makers (*transdisciplinary*) [8–10]; and (2) that it adopts an enabling approach to transformations by focusing on creating the context and capacities that empower individuals and communities to act for transformative change on their own behalf (*transformative*) [1]. In our understanding, we thus include research approaches that are collaborative beyond disciplinary and science–society boundaries and aim to proactively catalyze radical change. TTDR seeks to be transformative by developing evidence-supported solution options for sustainability problems while enabling close collaboration among a range of societal actors, within and beyond academia (e.g. researchers, practitioners, community members, policy-makers, and so on) [8,9,11]. Coproduction of knowledge is at the core of TTDR and consists of iterative and collaborative processes where actors with different forms of expertise generate context-specific knowledge and pathways for

Figure 1

Five priorities to advance TTDR.

sustainable futures [12]. Through pluralistic and integrated approaches of coproduction [13], action-oriented knowledge can be cocreated for the design, enactment, and implementation of transformative change [14,15]. In this way, TTDR differs from research on sustainability transformations that seeks to study transformations rather than trying to enable them [16] and also from action research, which has inspired TTDR, but does not focus on sustainability transformations as an overarching normative framework [7].

There is a growing number of TTDR projects that specifically collaborate with sustainability initiatives [17–19]. Sustainability initiatives (elsewhere referred to as 'Bright Spots' or 'Seeds of a Good Anthropocene') are social, technological, economic, or social–ecological ways of doing, thinking, or organizing "that exist, at least in prototype form, and that represent a diversity of worldviews, values, and regions, but are not currently dominant or prominent in the world" [20]. Examples of such initiatives are environmental or social nongovernmental organizations (NGOs; e.g. working on conservation of nature or cultural built heritage), grassroots initiatives (e.g. permaculture or food sharing initiatives), and projects initiated by government or business actors that provide sustainable products or services (e.g. fairtrade coffee, organic vegetables) [20–22]. Even though they tackle different sustainability problems and have different visions, their aspirations lie within a broad frame of safe and just development trajectories. While these initiatives can occur outside or within existing institutions (e.g. NGOs, government organizations), they are often seeking to develop new and innovative practices, relationships, policies, and outcomes outside of formal institutional frameworks and structures. Thus, they are seeking to do 'business unusual' in the name of transforming systems toward sustainability.

Sustainability initiatives are especially relevant in the early stages of transformations (i.e. preparation phase) [23] because they provide alternative ways of doing, thinking, and organizing, often as a direct response to the dominant unsustainable patterns, which they seek to challenge, alter, or replace [24,25]. In the preparation phase of transformations, actors and their initiatives make sense of unsustainable trajectories, envision new innovations and visions for the future, and gather momentum around promising ideas and solutions that can foster more desired futures [21,25,26]. Often initiatives try to amplify or scale their impact to foster transformative change, which is a complex and challenging task [27,28]. An example of a transdisciplinary research project with initiatives to enable transformative change is the work of Sellberg et al. [22], who collaborated with diverse actors to better understand transformations of food systems in Stockholm, Sweden.

However, to make substantial progress for transformative change within this decade, sustainability research is now more than ever needed to coproduce knowledge with society about transformative change and provide guidance on how to enable and catalyze action. We reflect on five priority areas currently discussed in the literature, which are displayed in Figure 1. In addition, we illustrate our arguments with insights from seven transdisciplinary research projects with sustainability initiatives in diverse systems of the Global South and North (Appendix A, Box 1). Our findings from current literature as well as research practice are aimed at researchers involved in TTDR projects and particularly young researchers facing common challenges. We also discuss structural conditions in the science system, its organizational and funding structures, where they contribute to challenges experienced in TTDR practice. We aspire to stimulate debate on how researchers and societal actors can collaboratively help sustainability

research to evolve and to actively steer transformative change.

In the following sections, each of the five priorities will be introduced, and the challenges related to them will be described briefly. Based on current literature and insights from seven TTDR projects, approaches will be discussed on how to address the priorities in the context of research projects, and we will reflect on implications for institutional and funding structures in the science system.

Clarify what transformative transdisciplinary research is

Sustainability researchers have made important contributions to understanding transformative change and have developed frameworks, methods, and practical guidance for how to conduct TTDR. Prominent frameworks include transformational transdisciplinary sustainability research [8,9], transition management [29], and transformative space making [30] that use innovative formats and methods, such as real-world laboratories [31] or T-Labs (transformation laboratories) [32]. They often use methods that coproduce action-oriented knowledge that potentially contribute to transformative change [12–14,33]. More recently, the Theory of Change [34] and arts-based methods from design research are gaining increased interest due to their potential to understand societal impact and collaborate with diverse practitioners [35]. These advancements are essential but often complex and theoretically overwhelming for practical application.

Recent literature and projects describe the manifold challenges of conducting TTDR (Appendix A, Box 1). For example, collaborations with researchers from different disciplines and diverse practitioners involve diverse expectations regarding outcomes that can be very concrete and solution oriented (e.g. developing a restoration plan) but also very intangible and process oriented (e.g. network and capacity building) [33,36–38]. Such research requires diverse expertise and skills to keep academic and societal actors engaged [39,40], integrate the different approaches to transdisciplinary research [13,41], weave together different stories and pathways of transformative change [42,43], and navigate inclusivity, ethics, emergence, and flexibility [44,45]. Managing emergence and flexibility in TTDR with sustainability initiatives remains a key challenge. It requires developing methods that ensure scientific rigor while allowing adaptability and seizing new windows of opportunity [46]. This includes activities and tools to keep societal actors engaged even while only intangible process-oriented outcomes are generated [47–50]. Navigating these challenges requires researchers to advance frameworks, methods, practical guidance, and at a structural level to advocate for an academic system that acknowledges and rewards transformative research. In the following priority areas, we will provide concrete examples of methods and approaches. This section focuses on the more general issue of how to help clarify purposes and core elements of TTDR in the research community, within research groups and in the context of supporting structures in the science system.

From the perspective of researchers, a key priority is to further advance TTDR by providing theoretically well-founded, methodological and experience-based guidance on the practicalities of doing TTDR. Meaningful relations are key to managing emergence, both for dealing with unexpected and undesirable change, as well as being able to capitalize on opportunities [50,51]. A key priority for adapting structural conditions in the science system can be identified here as well because existing academic training and supervision are insufficient to prepare researchers — especially on an early-career level — for the challenging tasks of transformative research [51,52]. We need capacity building that prepares researchers for the relational, personal, and process-oriented challenges of TTDR [51,53]. This requires changes in the academic system, such as funders and academic institutions that support and finance TTDR, and supervisors who understand, guide, and encourage TTDR, in which scientific excellence is shown also by its stimulation of transformative change and not only citation scores [54].

Conduct meaningful people-centric research

We argue that a people-centric approach, that is, an approach that integrates the personal development of involved researchers and societal actors, group dynamics in transdisciplinary teams, principles of diversity and inclusivity in the actual research process, can support TTDR to unfold its full potential to contribute to transformative change. A people-centric approach means to put people and their relationships (e.g. researchers, societal actors, community partners, and so on) at the heart of all transdisciplinary research processes [55,56]. Building on insights from the field of leadership and business management, a people-centric approach assumes that people deeply influence the processes and outcomes of operational processes [57,58]. For TTDR projects, this means promoting a culture where everyone involved understands that they are equally responsible to act for transformative change. This includes focusing on how people feel and change internally and to incorporate those insights into project decisions [59]. It also means considering diversity and inclusivity to make people feel represented, valued, and empowered so that they can thrive and feel encouraged to pursue purpose-driven actions [60,61]. Importantly, a people-centric approach acknowledges and explores the diverse values

held by the actors involved and addresses ethical engagement in an explicit and on-going manner [45].

People-centricity responds to many challenges that transdisciplinary researchers face when working together with initiatives, especially challenges that relate to the quality of relations between researchers and societal actors (Appendix A, Box 1). A people-centric approach emphasizes the need to build meaningful and respectful relations between societal actors and researchers. The importance of relations to build trust in transdisciplinary collaborations has been intensively discussed [60–62]. Building relations between seemingly competing actors with different narratives of change has a particularly high potential for transformative actions [43,63]. However, the scientific literature lacks practical guidance on how meaningful relations can be built between researchers from different disciplines, societal actors with different expertise and opinions, and among researchers and societal actors.

We identify the following key priority for researchers: focusing on people suggests rethinking the idea of solution-oriented sustainability science by including a process-relational perspective. According to Garcia et al. [64], a process-relational perspective focuses on nonequilibrium dynamics and relations between processes of continuously changing systems, which questions the idea of fundamental entities and stability. Thus solutions, relations, processes, and people in transdisciplinary research projects need to be understood as continuously changing. For example, the strengthening of networks and relations among societal actors is a relevant outcome of TTDR but often less valued due to its intangibility [65,66]. A process-relational perspective can help to understand that people, networks, and relations continuously change and that this dynamic needs to be better researched to understand transformative change.

People-centricity requires managing expectations to produce outcomes and benefits equally distributed among researchers and societal actors [45]. Tangible and direct benefits for societal actors often remain limited, vague, and of secondary priority in TTDR practice [67]. A people-centric approach entails primarily focusing on the direct and concrete benefits for societal actors while working secondarily on intangible, nonlinear, unpredictable, and long-term outcomes that are often discussed as relevant in the literature (e.g. capacity and network building, social coherence). This is to motivate societal actors to continue with their actions and to acknowledge that they often understand the systems in which they act best. In an urban real-world laboratory project in Wuppertal, Germany, an experiment for spatial development was designed in such a way that emerging topics and issues relevant for the local context could continually be integrated [68]. A people-centric approach was followed in this project (Appendix A, Box 1) through a flexible and long-term involvement of the partners fostered by research funding oriented toward transdisciplinary principles and institutional infrastructures built over the course of several projects [69,70].

This takes us to a key priority for adapting structural conditions as well: putting people at the center of TTDR projects requires spending more time, in a sustained manner, on fewer research projects [71,72] instead of many as demanded by the current academic system. This striving in academia to conduct many projects (i.e. projectification) in different places — something experienced quite intensely by early-career researchers — constitutes a barrier for TTDR [73]. Focusing on fewer longer projects supports long-term collaborations and enables meaningful relations, which are essential for successful TTDR projects. Sellberg et al. [22] have been working with food initiatives in Stockholm, Sweden, for more than 5 years. This long-term engagement in one place is valuable since transformative change requires time and an in-depth understanding of the context [74]. Established relations make it easier to develop new collaborative projects (one collaboration leading to another) while networks, teams, and impacts are built gradually over time. In Southern Transylvania, Romania, Leuphana University has been working with NGOs for more than 7 years on sustainable landscape development, which has led to meaningful relations that in turn provided new opportunities for research and actions for transformative change [75]. The long-term transdisciplinary work has also led to meaningful relations between previously unconnected and competing NGOs [37] and has enabled researchers to work carefully with community partners and other societal actors to explore shared and different values and conduct ethical research [46,68,72].

Unpack how to act at deep leverage points

Scientific discussions about interventions on deep leverage points for transformative change have intensified recently, but without sufficient advice for action. The idea of deep leverage points stems from Donella Meadows' pioneering research on system dynamics and describes places in systems where interventions are rather difficult to nudge (i.e. in the design or intent of a system) but have a great potential to bring about transformative change [76,77]. Researchers have explored deep leverage points in diverse areas [78], such as in food and energy systems [79], wildlife conservation [80], environmental management with indigenous peoples and local communities [81], design research [82], gender equality, and human well-being [83], and social networks [38,51]. Also, the IPBES is increasingly focusing on leverage points that can bring about

transformative change for biodiversity conservation [84]. However, it remains unclear what deep leverage points exactly are, how to identify them, what they have in common, and what actions for interventions might be.

A key challenge is how to unpack the concept of deep leverage points in terms of operationalizing and integrating it in methods and approaches of TTDR. We use the term 'unpack' to mean careful opening up and analysis of the kinds of actions needed for transformation. Deep leverage points, focusing on the transformation of paradigms, mindsets, and deeply rooted belief systems [85], have been recently associated with the inner worlds of individuals or personal dimensions of sustainability [86]. Inner worlds have long remained outside the scope of typical knowledge production with recent publications changing this trend [52,87,88]. Drawing on an iceberg metaphor, values, beliefs, emotions, identities, and the relationship with self are all part of the lowermost and hence hidden and inaccessible level underpinning system function [86,87]. Personal characteristics, such as compassion, empathy, and generosity, indicate individual expressions for sustainability and transformative change [87]. However, how to engage with these complex cognitive, emotive aspects remains unclear, and the need to pay attention to the 'self' in addition to the usual focus on science and society in TTDR is only slowly being acknowledged in the literature [52,89]. The well-established disciplinary ways provided by, for example, environmental psychology or behavioral sciences seem ineffective when aiming to operate in an action-oriented transdisciplinary way, signaling the importance of rethinking the science–society relationship. Moreover, changes of mindsets and shifts of values are discussed as deep leverage points promising to foster sustainability and transformative change, but their operationalization remains elusive and ethically challenging [90,91].

From the perspective of researchers, a key priority and what is now needed are efforts to unpack, that is, open up and analyze, theoretically and methodologically how to act at deep leverage points in TTDR, going beyond established disciplinary approaches mentioned above. To date, only a few research projects have collaborated with people on deep leverage points. One example is the T-Lab project in the wetlands of Xochimilco, Mexico City, where the transdisciplinary processes focused on working through iterative cycles of reframing (around the perceptions of the system dynamics and the sense of agency of the participants) to explore the suitability of certain methods that could foster change in narratives and the emergence of collective agency (Appendix A, Box 1) [51,92,93]. The design of such reframing spaces entailed exposing participants to diverse participatory tools and activities that could enable alternative ways of experiencing and reflecting [48,49]. As part of the results of these

processes, new and more empathetic narratives were identified. Another example is from the Tsitsa Project in South Africa, where researchers worked with community partners and natural resource management practitioners on landscape restoration. In the process, it became clear how personal transformations of those involved in the work [11], and radically different ways of relating among diverse actors [55] were as important as the transformation of the ecosystem and the governance processes needed to enable more sustainable land management [56].

Improve engagement with diverse knowledge systems

Engaging with the concept of transformative change from different knowledge systems (e.g. indigenous and local knowledge systems) and in diverse languages can provide different perspectives on transformative change and actions [1,55,94,96]. The scientific discourse on transformative change toward sustainability is dominated by Western scientific knowledge systems — especially in English — which limits its understanding and actions. Recently, the role of indigenous and local knowledge for sustainability, transformative change, environmental conservation, and global assessments (e.g. IPBES, IPCC) has gained increased relevance [44,96–98]. However, a review of the English scientific literature on transformative change showed that indigenous and local understandings of transformations are rarely discussed to complement the scientific discourse [94].

The scientific discourse on transformative change could address this challenge by engaging with diverse understandings and actions for transformative change that go beyond Western scientific knowledge systems in English. This entails working with people from different cultures, practices, scientific disciplines, and knowledge systems to explore complementarities and synergies that transgress outdated barriers such as hierarchies and power asymmetries [67,99]. However, despite the often-highlighted call for recognition and bridging of different knowledge systems, this remains a challenging endeavor with unclear practical guidance. For example, in the Tsitsa Project, researchers have found it difficult to integrate knowledge from scientists, engineers, and local people's knowledge on landscape restoration priorities and practices, especially because the scientific and engineering knowledge has been considered superior for so long [99].

Furthermore, it is not always the case where diverse knowledge systems are brought together, but that previously marginalized groups and their ways of understanding and being in the world are not included due to biases in what is regarded as expertise. For example, in South Africa, local isiXhosa knowledge on the ocean (e.g. in the form of the stories of 'Grandmothers of the Sea') has been long disregarded in decision-making,

despite this being an important source of inspiration and insight on the value and meaning of oceans for millions of local people [67,100].

Structural constraints in terms of established Western knowledge systems persist [67,99]; however, as a key priority, this issue can be addressed by researchers involved in TTDR projects. For example: in the Western Cape food systems T-Labs facilitated in South Africa (Appendix A, Box 1), it was a deliberate act to involve groups who had previously not been included in food system discussions, such as activists in informal settlements and people representing the informal sector [101]. While this was not about bringing diverse knowledge systems together *per se*, it was about opening up to including more diverse perspectives in how we think about transformations. This was a steep learning curve for the researchers involved as many of their assumptions were challenged and ethical issues around how to go about undertaking transdisciplinary research with vulnerable groups were explored.

Yet, moving toward a focus on humility and acknowledging diverse values seems one of the first steps for engaging with diverse knowledge systems [46,102,103]. Recognizing and unpacking long-held assumptions, for example, even how we think about time as linear, allows for a more pluriversal approach to TTDR [104].

Explore potentials and risks of global digitalization

The coronavirus disease 2019 pandemic has forced academia to engage more with rapid and global digitalization. This ranges from exploring the possibilities of working, collaborating, collecting data, organizing conferences, and teaching to building relations with societal actors online. To date, only a few have highlighted the potentials and risks of digitalization for sustainability, transformative change, and TTDR. Recent research highlights the systemic risks of artificial intelligence for sustainability [105], the potential of social media data for urban sustainability [106] and governance of agrifood sustainability [107], the role of games for sustainable futures [108], or the use of digital mobile devices to visualize decision-making in transdisciplinary research processes [109]. Currently, digitalization is mostly driven by private companies (e.g. Google, Facebook) without much focus on sustainability and collaboration with sustainability researchers. Thus, the potentials and risks of digitalization for sustainability and transformative change are still poorly understood although they influence many social–technical–ecological systems that sustainability researchers seek to transform.

A challenge and understudied area is, for example, the role of social media use for transformative change. In January 2021, more than 4.2 billion people used social media actively in their daily life [110]. Social media is an important tool for people to connect local sustainability issues to global narratives. For example, social media use was imperative in the 2018 School Strike for Climate led by the Swedish youth climate activist Greta Thunberg. On March 15, 2019, over one million youth in 125 countries joined the strike for climate change. This global climate strike was largely connected through social media under the #FridaysForFuture and activated other societal groups (e.g. parents, scientists). A similar example is the antiausterity movement in Spain (the 15-M Movement), which utilized Facebook to mobilize the movement and disseminate information [111].

This key priority can be addressed by researchers as shown by the following examples: In Romania, Leuphana University has been using social media platforms to share posts from partner NGOs (e.g. updates about their initiatives), to invite people to open events of the transdisciplinary research project, and to stay in constant contact with partners (Appendix A, Box 1). The Facebook page 'Sustainable landscapes in Central Romania' has over 1000 followers and accompanied the transdisciplinary endeavors in Southern Transylvania as of 2014, and it is still being maintained today. The choice for a Facebook page was culturally sought, seeing the popularity of the social media platform in Romania in general and among civil society activists in particular. It was a way to temper the initial competition among the different local members of the civil society and bring them together. Blog entries, online surveys, and event management websites complemented the use of digitalization. The main implication of using these digital tools was conveying a sense of 'togetherness' even when members of the team could not be in the field for face-to-face encounters.

In the Lüneburg 2030+ project, several working groups for real-world experiments used the open-source digital platform Wechange (Appendix A, Box 1). In this platform, people from different organizations could work together, meet, and exchange ideas about sustainability solutions in a digital room. The groups on the Wechange platform are intended for people who have already decided to get deeply involved in the work of Lüneburg 2030+ and actively shape the real-world experiments. In addition, Lüneburg 2030+ works with popular social media platforms, such as Instagram (weekly story update), Twitter, Facebook, and YouTube channels as well as the project homepage. The popular social media platforms provide information and encourage participation.

Sustainability research can derive relevant insights for sustainability, TTDR, and transformative change by exploring the full potential and risks of global digitalization. This includes studying, for example, how

artificial intelligence can be used to increase sustainability, how use of social media influences learning about sustainability and leads to change, and how TTDR can take place online (e.g. digital methods for participation). This is especially interesting for collaborating with younger generations and people living in remote areas (e.g. indigenous peoples and local communities) [112]. However, the social justice challenges related to digital access also need to be carefully considered to not leave people behind and exacerbate the digital divide, especially in poorer and less literate communities of the Global South [112]. Still, understanding how digitalization can be used to steer transformative change and how scientific results can be spread via social media for a broader societal reach, beyond filter bubbles, entails a great potential.

Conclusion

Sustainability research can provide knowledge for and engage actively in transformative change for sustainability. However, for this potential to be realized, we argue that there is a need to focus on five priority actions, namely, clarify what TTDR is, conduct meaningful people-centric research, unpack how to act at deep leverage points, improve engagement with diverse knowledge systems, and explore potentials and risks of global digitalization for transformative change. Our aim is to stimulate debate on priorities for researchers involved in this field. It is also clear that this requires the academic system and funders to support and acknowledge TTDR, which is currently limited. It also requires universities and academia to shift training and goals to allow this kind of research to be undertaken and rewarded. Radical actions within this decade are crucial, and there is no time to wait for scientific results to be applied by society and decision-makers alone. Priorities for TTDR cut across domains and can best be addressed in a collaborative effort by researchers and societal actors. Acknowledging the urgency of the global climate and biodiversity crises, then now is the time to work together in generating action-oriented knowledge through TTDR projects together with society.

Data Availability

No data were used for the research described in the article.

Declaration of Competing Interest

None.

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Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.cosust.2024.101438.

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Papers of particular interest, published within the period of review, have been highlighted as:

- • of special interest
- •• of outstanding interest

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