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SHORT COMMENTARY

Bridging divides in sustainability science

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Abstract Transdisciplinary research between diverse academic and societal actors is a core practice in sustainability science. However, it often seems to fail in delivering new scientific insights *while also* significantly contributing to sustainability transformations. It is also often experienced as a burden instead of adding value, which leads to fatigue and disengagement. To address these challenges, we propose to bridge four divides: (i) positioning and linking disciplinary and transdisciplinary research; (ii) transferring and scaling insights from real-world experimentation; (iii) opening the "extended ivory towers" and reaching a majority of relevant societal actors; (iv) aligning research practice with broader sustainability values such as collaboration, mindfulness, and altruism.

Keywords Sustainability science theory · Solutions · Impact · Stakeholders · Engagement · Transformations

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Introduction

Over the past years, sustainability science has advanced through theoretical and empirical studies (e.g., Wiek et al. 2012, 2015; Wuelser et al. 2012; Miller et al. 2014; Van Kerkhoff 2014; Siew et al. 2016), with special attention being paid to processes, principles, challenges, and coping strategies of transdisciplinary research (e.g., Lang et al. 2012; Brandt et al. 2013; Polk 2014; Clark et al. 2016; Pohl et al. 2017). Principles and quality criteria of transdisciplinary sustainability research are widely shared (Lang et al. 2012). However, sustainability science, and its transdisciplinary stream, seem to not fully live up to the promise to significantly support the transformation towards sustainability (e.g., Van der Leeuw et al. 2012; Miller et al. 2014; Abson et al. 2017). Projects often seem to lead to fatigue and disengagement among researchers and societal stakeholder due to the perceived additional burden of collaboration, unclear added value, and negligible real-world impact (cf., Bracken et al. 2015).

This situation seems to be caused, at least in part, by various divides that consolidated in sustainability science over the past years (Gethmann et al. 2015; Shahadu 2016). These divides exist between independently pursued or even conflicting research practices: (i) disciplinary vs. transdisciplinary; (ii) generalization vs. contextualization; (iii) collaborating with select stakeholders vs. reaching the broader public; and (iv) prescribing the path to sustainability vs. being stuck in unsustainable practices ourselves. These divides can distract from collaborative opportunities and potential synergies, hindering more significant advancements of our field.

We offer here critical and constructive reflections on some prevalent practices (our own included), and suggest that for making sustainability science in general, and transdisciplinary sustainability research in particular, more impactful and deliver on its promise, we need to promote and implement a research practice that bridges these divides.

Divides and bridges

The aforementioned divides have emerged by accident, tradition, or ignorance rather than by conscious choice. Yet, they are likely to obscure potential synergies among different practices. Observing and reflecting on these divides is a useful first step to offer ideas on how to bridge them.

Bridging divide 1—Standing on the shoulders of giants vs. collaborating with the real world

The challenge here is that sustainability science projects, typically, not sufficiently utilize disciplinary *and* transdisciplinary approaches. That is reflected in scientists maintaining the divide between disciplinary vs. transdisciplinary approaches (also: fundamental vs. transformative; problem- vs. solution-oriented research) and argue for, or against, one or the other (e.g., Miller et al. 2014; Schneidewind 2015). Yet, identifying and providing evidence of viable solutions does often not depend on disciplinary *or* transdisciplinary approaches *alone*.

This polarization seems counterproductive (Lang et al. 2012; Gethmann et al. 2015; Hering 2016) as disciplinary and transdisciplinary sustainability research could go hand in hand. Let's take the case of contaminated site remediation. Transdisciplinary approaches can help with: identifying legitimate stakeholders; building trust between researchers and actors outside academia; clarifying the research needs; defining research questions that target both new scientific insights and viable solutions; conducting research that facilitates the collaboration among different experts (from all strands of academia and society); and integrating the generated knowledge to be utilized for real-world remediation efforts (cf. Foley et al. 2017). Disciplinary research, if conducted as problem- and solution-oriented (intervention) research in chemistry, for example, offers evidence on contamination levels and pathways, as well as decontamination projections for different remediation technologies. While chemistry can offer important insights to contamination problems and solutions, transdisciplinary approaches can add powerful settings to align these insights with additional disciplinary insights, and ultimately decision and implementation contexts.

In summary, sustainability science should be less about delineating disciplinary and transdisciplinary research, but rather positioning the respective contributions of these practices and linking them in the execution.

Bridging divide 2—Generalization vs. context matters

The challenge here is that sustainability scientists, typically, conduct *either* context-specific sustainability research *or* research striving for generalization, often based on global/regional models using "big data". Yet, the sustainability transformation needs *both* insights on workable solution options for specific contexts *as well as* generalizable insights to explore scalability and transferability. To date, these two streams of research communities have largely developed independently, often creating a divide between small-scale, real-world sustainability case studies and large-scale, global/regional modelling efforts (Lang et al. 2016).

Advances in sustainability transition experiments (e.g., Luederitz et al. 2016 in press) and complex-adaptive systems modeling (e.g., Janssen and Ostrom 2006) *alone* will not suffice to bridge this divide. Yet, insights from

science and technology studies might help that identify *hybrids* of individual/micro/specific *and* collective/macro/generalized actions, processes and concepts (e.g., Callon and Law 1997). Instead of *either* focusing on the generic *or* on the specific features of a case, they are being perceived as facets or integral components. With this idea in mind, combining context-specific experimentation with general modelling of complex adaptive systems would create several co-benefits by realizing four synergies: (i) global/regional models could help to identify suitable locations and contexts for real-world sustainability experiments (stratified sampling); (ii) models could inform the design of impactful real-world sustainability experiments by anticipating potential impacts (ex-ante/anticipative evaluation); (iii) results from real-world sustainability experiments could be fed into models to explore their generalizability, and more specifically their scalability and transferability; and (iv) results from real-world sustainability experiments could enhance validity and explanatory power of global/regional models. Getting back to the contaminated site remediation example referred to earlier, real-world local experimentation with remediation options on a specific site are often not linked to big data and global/regional models of water or soil contamination and its human and environmental impacts. If we would find a collaborative way, for example, to use big data and models of contamination to explore the scalability and transferability of effective and efficient remediation option (tested in real-world sustainability experiments), this would offer valuable input for evidence-based policy-making and public investments (synergy iii, above).

In summary, instead of separating real-world experimentation and general systems modelling because of their distinct research epistemologies and methodologies, they could be linked to support sustainability transformation by providing evidence on solutions and their scalability and transferability, for instance. Bridging real world-experimentation and systems modelling could be facilitated through innovative long-term transdisciplinary programs similar to the US National Science Foundation's long-term ecological research or other long-term research programs.

Bridging divide 3—Preaching to the converted vs. the rest of the world

The challenge here is that even though transdisciplinary sustainability research aims at extending *beyond* the ivory towers, it often engages the "usual suspects" on fairly uncontested issues. It rarely reaches out more widely and more seriously to address structural (deep seated) challenges underlying sustainability problems (Abson et al. 2017). While this practice complies with some design principles of transdisciplinary sustainability research, it often only results in "extended ivory towers", i.e., working with likeminded and similarly socialized actors outside academia. The majority of actors remain unengaged and continue their paths because of structural and ideological barriers (Brandt et al. 2013). Projects often avoid reaching this deeper level of engagement. For example, sustainability scientists often rather address efficiency questions related to energy consumption than structural injustices that cause unsustainable patterns of energy consumption. Such projects often focus on shallow rather than deep leverage points for sustainability transformations. There is a world out there that has trouble engaging with questions that determine our collective future. Sustainability science still too often refrains from confronting people with the root causes of unsustainability and scientists too often falsely assume literacy, interest, capacity and knowledge sufficient for productive stakeholder engagements on those topics.

What is needed is opening up the "extended ivory towers" and applying innovative ways for reaching a majority of relevant societal actors on issues that matter to them and future generations (it might need some time to reveal what these might be in a given community) (cf. Brent and Swilling 2013). We need to find solutions that are not limited to the few adopters, who are well educated, have a satisfying job, and live in a safe environment. In the contaminated site remediation example from above this could mean: shedding light on the structural injustices the current remediation process might be based on (e.g., a group of experts and lawyers of the affluent "potentially responsible parties", on the one side, vs. the community supported by an underpaid graduate student, on the other side); unconventional ways of engagement (e.g., collective and explorative dance); involvement of the previously unengaged (e.g., school kids and young adults), or making scientific data accessible to laypeople (e.g., increasing the font size and using simple explanations on a remediation map) (Foley et al. 2017).

In summary, instead of continuing the practice of transdisciplinarity in "extended ivory towers", we need to face the pertinent challenges together and find ways to get everyone involved.

Bridging divide 4—Talking one way vs. walking the other way

The challenge here is that sustainability scientists often do not lead by example regarding collaboration, mindfulness, and solution orientation. Embedded in highly competitive environments, incentivizing distinction and exclusion, we experience and maintain work environments that feed

individualism, pressure, and stress. At the same time, many scientists and administrators orient their work towards citations and third-party funding, more so than towards quality education or societal impact. This often coincides with focusing on sustainability problems, i.e., system degradation and passing of planetary boundaries, instead of engaging with solutions (Sarewitz et al. 2012; Miller et al. 2014). In our teaching and supervisory activities, we experience that focusing on positive outcomes is, therefore, often more difficult for junior researchers and professionals who have been socialized within problem-focused paradigms.

A viable resolution seems to aligning research practice with basic sustainability values of collaboration, mindfulness and altruism. There are various ways to bridge this divide: reflection, meditation, appreciative inquiry, change of academic incentives, positioning oneself in society, and so on. Getting back to the contaminated site remediation example from above, engaging the community and students into joint remediation work and events, reflecting on values related to land and people, as well as addressing issues of self-care and caring for each other, beyond everyone's familiar group, would build mindfulness and altruism. What is needed is not only to do research on mindfulness (Wamsler et al. 2017), but also include mindfulness exercises in our everyday sustainability research practice (Brundiers and Wiek 2017). This includes recognizing the unique challenges posed to early career researchers engaging in inter- and transdisciplinary research on pressing sustainability problems (Haider et al. 2017 in press; Ruppert-Winkel et al. 2015). Besides orienting curricula towards sustainability competencies, they should also include mapping out well-paced career paths both inside and outside academia.

In summary, it should be less about leading by distinction and exclusion, but rather about leading by collaboration, mindfulness and altruism, providing deep leadership and guidance to young scholars and societal stakeholders, willing to learn as much from them as we offer them.

Conclusions

The field of sustainability science has made major strides in building out its epistemology, methodology, and pool of empirical studies over recent years. In that, the practice of *transdisciplinary* sustainability research has received a great deal of attention. In parallel, quite unconsciously, it seems that a set of divides has solidified, as described above. This might, at least in part, have been driven by the will to protect scientists' research identity, history, preferences, and habits. Yet, considering the dynamics, shifts, transitions, and changes currently happening in the world—often with detrimental effects to the environment, vulnerable populations, and long-term economic viability, but also with grand opportunities for improvements—it seems that sustainability scientists would be well advised in recognizing these divides and working actively on bridging them.

Bridging these divides will imply shifts in our research practice and even developing new ones. Yet, this is a continuum of adjustments and changes—and everybody can participate in a way that accepts certain boundaries and supports safe explorations. Building the bridges discussed above requires structural changes, e.g., where to seek research funds, what research opportunities to recognize and select, how to conduct research, with whom to collaborate, where to publish the results, and how to incentivize early-career researchers. Yet, incremental reform and seeking out specific types of collaboration might be an appropriate way to enable and complement these deeper shifts. In all cases, a good balance needs to be cast between orientation towards scientific insights *and* real-world positive change, on the one side, *as well as* individual willingness *and* capacity, on the other side. In these times of major detrimental changes and grand opportunities for improvements, there is the need to change ourselves significantly or incrementally—to be better positioned to support the world in finding and walking the paths of sustainability.

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