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Reflexivity-Situatedness Matrix: An intervention-centered analytical framework to enable transformations through transdisciplinary partnerships

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Abstract

The Transformative Change assessment of the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES) calls for an urgent transformative change for a just and biodiversity-rich world (IPBES, 2024). The need for such transformative change is well recognized in funding calls and relevant policies dedicated to addressing social-ecological challenges with, for example, transformations, interventions, and leverage points on the one hand, and transdisciplinary partnerships on the other hand, having become core terminology in recent years. However, a greater understanding is still needed as to how specifically partnership-based working can enable transformations. This knowledge gap is particularly evident in efforts to address biodiversity loss, a critical issue often neglected in transdisciplinary research and decision-making. To bridge this gap, we developed the Reflexivity-Situatedness Matrix (RSM)—an intervention-centered analytical framework that allows simultaneous and critical discussion of desired transformations and means to achieve them. Here we demonstrate how the RSM supports research interventions for biodiversity prioritization across multiple levels of decision-making. In particular, it takes into account equity and equality considerations such as power asymmetries inherent to transdisciplinary partnerships. Delving into the literature on transformations and partnerships and using the RSM, we suggest a refined theoretical understanding of transformations and interventions to facilitate them. We do so by drawing on our

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experience from a transdisciplinary Horizon Europe project, PLANET4B. Our work can serve as a guide for researchers, policymakers, and practitioners aiming to build transdisciplinary partnerships and facing the challenge of identifying and operationalizing transformative interventions.

KEYWORDS

biodiversity, interventions, partnerships, transdisciplinary, transformative change

INTRODUCTION

The accelerating and alarming decline in biodiversity presents a significant threat to both the biosphere and human well-being by disrupting essential ecosystem services while also deepening social inequalities (IPBES 2022), which in turn drive further biodiversity loss (Kubiszewski et al., 2023; Mikkelsen et al., 2007). Despite substantial scientific evidence demonstrating biodiversity's critical role in sustaining ecosystem services and societal well-being, it remains marginalized in political agendas and everyday decision-making (Westveer et al., 2022). The primary direct drivers of biodiversity loss—including intensive agriculture, overexploitation of natural resources, climate change, unsustainable land use, and invasive alien species—are reinforced by indirect drivers rooted in materialistic value systems and inadequate governance. The diverse societal values of biodiversity are frequently overlooked within entrenched power structures that perpetuate business-as-usual resource use and economic growth-driven dynamics (IPBES 2019).

One of the main objectives of research on biodiversity loss is driven by the normative goal of facilitating change aimed at halting or reversing loss of species, habitats, and ecosystems. In this field, there is a growing acknowledgement that transformations are needed to address the ongoing and deepening biodiversity crisis (IPBES 2019, 2022, 2024). The biodiversity literature increasingly calls for transformations to move societies from overwhelmingly instrumental relationships with nature toward ones that are less instrumental and more based on care and reciprocity such as stewardship, trusteeship, and alike (e.g., Chapin et al., 2022; Gilbert et al. 2023). Likewise, explicit references to transformation and transformative governance are, for instance, increasing in key biodiversity policy documents (e.g., the EU Biodiversity Strategy for 2030 and the Kunming-Montreal Global Biodiversity Framework). Transdisciplinary partnerships are promoted as integral to the achievement of such transformation, both by scholars (e.g., Deutsch et al. 2023; Plummer et al. 2022) and funding agencies (e.g., Belmont Forum 2020; Norström et al. 2020). At the same time,

increasing attention is also given to the need for plurality to be mainstreamed within biodiversity discourse (IPBES, 2022). The IPBES Transformative Change Assessment underscores the importance of co-creating knowledge and fostering collaboration in partnerships to facilitate effective knowledge exchange while upholding the principles of plurality and inclusion as one of the key strategies to steer transformation (IPBES, 2024). However, while being critically aware of the normative discourse, thus far there is much less discussion on how specifically such collaborative partnerships could and should be formulated and how best to understand and enable their transformative potential across a range of different scales and settings.

To address this knowledge gap, we present a Reflexivity-Situatedness-Matrix (RSM). Applied specifically in the paper to transdisciplinary partnership working, we explain how the framework can be used for guiding its formulation and realizing its transformative potential. In putting forward the RSM, we are informed by the following research question: how to conceptualize the available knowledge on the role of transdisciplinary partnerships in enabling transformations in a way capable of addressing complex social-ecological challenges such as biodiversity loss (Nielsen et al., 2021); and in doing so, how to ensure that plurality is adequately and equitably attended to in such transdisciplinary partnerships, as well as in main transformative frameworks more broadly.

The empirical foundation for the RSM is our experience of co-coordinating an ongoing Horizon Europe project, PLANET4B (2022–2025) (PLANET4B n.d.). PLANET4B is an acronym that stands for understanding Plural values, intersectionality, Leverage points, Attitudes, Norms, behavior, and social lEarning in Transformation for Biodiversity decision-making. This 16-partner strong consortium project was conceived through a responsive-mode submission to a Horizon Europe funding call for increasing understanding of behavior, gender, lifestyle, religious, and cultural values' aspects in biodiversity relevant decision-making addressing civil society, policymakers, financing, and business leaders (European Commission, 2021). The

ultimate aim of PLANET4B is to understand the underlying causes of biodiversity loss (societal disconnection from nature; inequitable power structures) along with indirect drivers (inapt governance; conflicting vested interests) in different contexts and, accordingly, to forge new knowledge and tools to address these, ensuring higher prioritization of both biodiversity and just transformation on three different decision-making levels (intrapersonal, interpersonal, and institutional). To do this, PLANET4B assesses key theories, evaluates and combines various methods targeting factors related to values and behavior, tests these methods in five place-based and six sector-based case studies, and investigates upscaling of these messages to relevant policy and business arenas to support transformations toward a just and biodiversity-rich world. As a project, PLANET4B serves as a good illustration of the fact that, at an EU project funding level, the need for transdisciplinary partnership-based “consortium” working is common. Most calls require at least three partners from various organizational backgrounds (e.g., public research institutes, SMEs, NGOs) considering geographical distribution and experience managing large grants. Without the establishment of a strong partnership ethos, the chances of achieving the ambitions of contemporary funding calls can be extremely slim.

Taking PLANET4B as our primary point of empirical reference and bringing our experience with conceptual discussions on transformations, the remainder of this paper is structured as follows. First we elaborate on how we understand transformations and the potential ways in which they can be enabled through targeted interventions. We begin by reviewing the leverage points framework of Meadows (1999) and its more recent adaptations. We select this framework in accordance with its relatively high level of prominence within scientific and policy debate on societal transformations as a means of combating the biodiversity crisis, also exemplified by the fact that the call to which PLANET4B responded explicitly required identification of “leverage points” for transformative change. We then discuss the role of transdisciplinary partnerships in enabling transformations. This is followed by key methodological considerations providing background to the iterative approach of the research presented here and the development of the RSM as an analytical framework. We then introduce our key results: the RSM and our lessons about its dual potential as an analytical framework for guiding partnerships (1) in terms of their internal workings—how to develop partnerships; and (2) in relation to their role in enabling societal transformations—via the selection and operationalization of interventions aimed at triggering transformations. Then we discuss the key implications of

this work for theory and practice before concluding. While existing studies report on the experiences retrospectively, or offer external critiques of other projects, critical reflection from within an ongoing transdisciplinary project with active field experimentation is relatively rare (Riedy, 2022). Hence, we extend such knowledge by bringing in first-hand synchronous experience from PLANET4B.

LEVERAGE POINTS TO INTERVENE IN A SYSTEM AND TRANSDISCIPLINARY PARTNERSHIPS ENABLING TRANSFORMATIONS

Revisiting leverage points and transformations

There are several strands of literature that are particularly relevant for addressing the need for operationalizing transformative change as a basis for tackling the biodiversity crisis. Here, we specifically focus on a relatively influential body of scholarship which conceptualizes transformation within complex social-ecological systems as requiring targeted interventions at a series of predefined leverage points (Meadows, 1999). The corresponding leverage points framework by Meadows (1999) has become a milestone in social transformations scholarship and practice dedicated to social-environmental but specifically biodiversity challenges (e.g., Abson et al., 2017; Chapin et al., 2022; O'Brien, 2018 for scholarly uptake or European Commission, 2021; Biodiversa+, 2024–2025 for uptake in policy and practice). The framework recognizes that interventions (or levers) target different system properties—leverage points—with correspondingly different transformative potential. Here, we reexamine the framework's underlying logic, highlight its strengths, and discuss key developments relevant to our work. Additionally, we address its primary limitation—its inability to fully account for what we refer to as the situatedness of interventions in driving transformative change. Meadows identified 12 leverage points with paradigm and mindset changes having the most transformative potential because they necessarily affect change on the system properties below them. Meadows asks the question how can we change the system and suggests that if we align all the different types of interventions, we can see a continuum from more biophysical or technical interventions—developing infrastructure, creating buffers, organizing material flows, creating and dealing with delays in the system—to interventions that target

the social dimensions of the system—incentives, information, institutions, behaviors, worldviews, values, mindsets, and paradigms. The main argument of Meadows is that to be transformative our interventions need to focus more on the upper part of the lever as smaller changes there can have more impact on the entire system (see also Dorninger et al., 2020).

Abson et al. (2017) subsequently extended Meadow's idea of leverage points in a nuanced but important way. Reviewing the current social-environmental interventions, they begin by simplifying the original framework into four categories of intent, design, feedback, and parameters. They argue that many current interventions focus only on the lower half of the lever (feedback and parameters) which have shallow leverage, and that we, as a society, need to focus more on deeper leverage points (intent and design) that have greater potential but are under-researched and under-applied. However, Abson et al. (2017, p. 36) clarify that they “[...] do not suggest that deep leverage points should be studied in isolation, but rather that an explicit focus on deeper leverage points may help uncover some of these systemic relations”. Further, multiple studies highlight that systems are complex and are often multi-scalar and nested (e.g., Davila et al., 2021; Leventon, Abson, & Lang, 2021), while understanding transformations in a system can be likewise approached from various perspectives (e.g., Ajulo et al., 2020; Feola, 2015; Horcea-Milcu, 2022; Moore et al., 2018). Engaging with this complexity and understanding how focal systems are situated and interconnected can help to identify the systems that constrain and shape behavior change and broader systems transformations.

It is particularly useful here to note that transformations can be conceptualized in ways that highlight different directions of change. For example, a strand of literature investigating various forms of environmental crises (e.g., IPBES, 2019; O'Brien, 2018; Visseren-Hamakers & Kok, 2022) characterizes transformations as more “fundamental” forms of change that should involve change at the levels of underlying values and beliefs in a society. The logic here is that change is necessary at these levels to then shape the social relations and consequences for the environment. According to this strand of literature, without changes in what is considered important by individuals, collectives, and society as a whole, solutions that build on current rather unsustainable and exploitative forms of social organization will necessarily fail, by for example producing rebound effects (e.g., Alcott, 2005). At the same time, following a broader literature on societal and particularly institutional change that highlights the role of path dependencies, transformations can be interpreted as a result of a multitude of incremental changes over time, until such a stage that

the form of the social practices at the starting point becomes unrecognizable (e.g., North, 2005; Williamson, 2000). This is also in line with the diffusion theory that highlights how innovations spread (both material and nonmaterial innovations) can be broken down into micro-processes of social change (Rogers, 1962, 2003a, 2003b). The latter body of scholarship thus suggests that there is a continuum between incremental or little change and radical change, all of which could lead to rather substantial forms of change or transformation in the longer term (collapse due to little change, revolutions, or perhaps both and in non-linear ways) (see also Mahoney & Thelen, 2009).

In drawing together and expanding on these existing works, we propose to refine the debate on the leverage points framework for enabling transformations in the context of transdisciplinary partnerships in three ways. First, we argue that multiple system characteristics and any combination of intent, design, feedback, and parameters can be a leverage point for triggering transformations, and thus it might be valuable to conceptualize levers as interventions addressing a combination of system characteristics. Second, given the power of path dependencies, we posit that for addressing complex social-ecological problems, such as what is increasingly observed in addressing biodiversity loss, it is very likely that a choreographed sequence of multiple interventions, as well as interventions at multiple levels (institutional to individual), will be necessary. Thus, it is worthwhile to conceptualize any single intervention that aims at transformation as part of a set of interventions from the outset. Finally, we stress that taking into account the virtually omnipresent plurality of actors in transdisciplinary partnerships, combined with unique relational characteristics of place, context, social dynamics, and temporal moments, as well as underlying policy-institutional conditions, is crucial in making any intervention effective and resulting transformations sustainable. Accordingly, while we agree that leverage points and interventions can be seen through a continuum of their transformative potential, alongside this, we propose considering interventions that specifically fit the context and target appropriate combination(s) of intrapersonal, interpersonal, and institutional leverage points for any given case (see Figure 1).

Transdisciplinary partnerships enabling transformations

When it comes to tackling the direct and indirect drivers of biodiversity loss, the biodiversity domain (where research has historically been led by natural sciences) could benefit from a better understanding of whether and

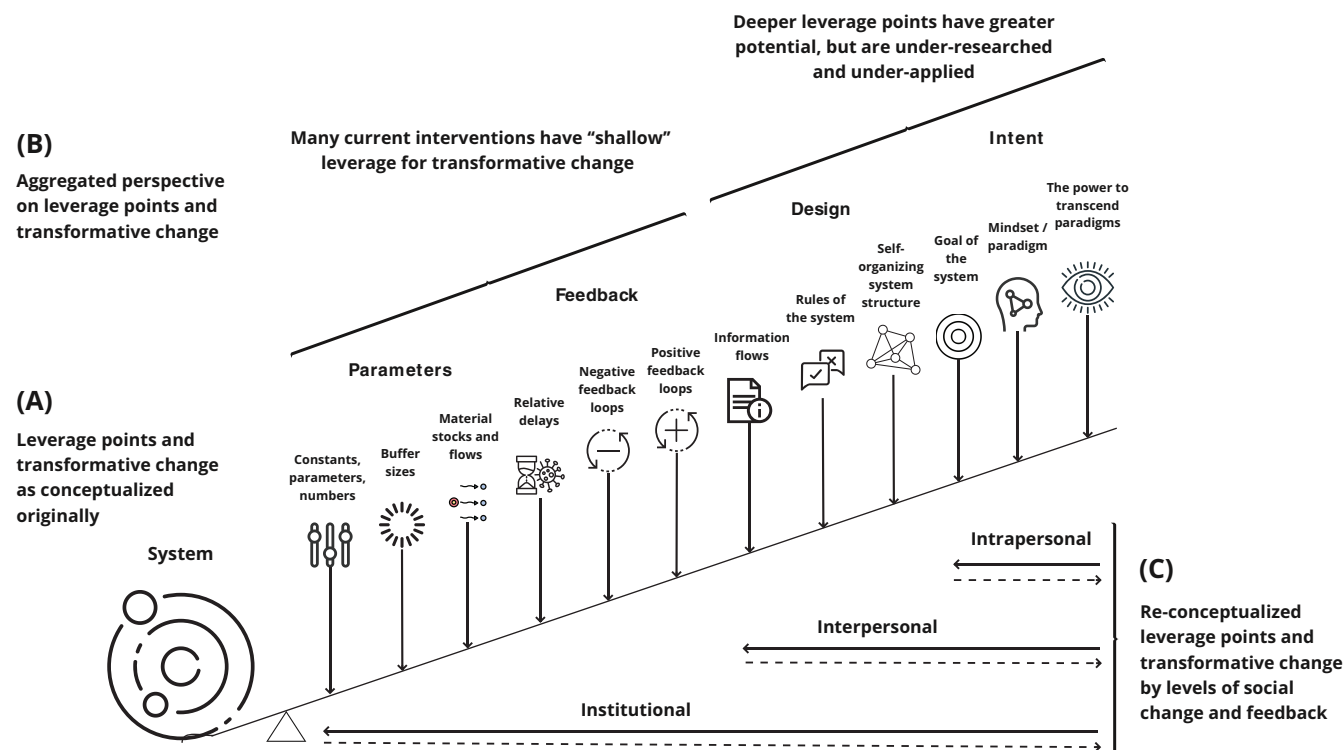


FIGURE 1 Leverage points: (A) as originally suggested by Meadows (1999); (B) based on an extension by Abson et al. (2017); and (C) how we propose to extend.

how desired transformations can best be brought about through a combination of targeted social-ecological research interventions and transdisciplinary partnerships (Leventon, Duşe, & Horcea-Milcu, 2021). The biodiversity domain remains relatively new in its integration with social sciences and the practice of social change for addressing indirect drivers and underlying social causes of biodiversity decline (e.g., compared to scholarship on climate change), and even more so in its engagement with what such an integration entails—transdisciplinary partnerships (Wyborn et al., 2021). In the last decades, transdisciplinary partnerships that envision synergies between academia and practice have gained particular prominence due to the problem-oriented nature of the sustainability sciences, which, when applied to transformations, by default raises questions of finding a balance between understanding transformations and actively facilitating transformations (e.g., Cash et al., 2003). It is argued that due to the complexity of challenges in transformations toward sustainability, the need to reconcile perspectives and preferences of various actor groups to develop real-world solutions, as well as increasing the legitimacy and ownership of such solutions, necessitates the integration of plural knowledge systems and diverse practical experiences (e.g., Lang et al., 2012). This is also particularly relevant for the biodiversity domain, where sustainable change requires not only natural science

insights but also social science perspectives and the knowledge and practices of Indigenous and local communities within their cultural and political contexts. To ensure such an integration, scholars have increasingly advocated for transdisciplinary research approaches that bridge disciplinary boundaries and also foster collaboration that goes beyond academia (e.g., Pohl et al., 2010; van Kerkhoff, 2014).

A number of frameworks exist on knowledge coproduction, participatory, integrated or transdisciplinary research that are valuable for guiding transdisciplinary partnerships toward sustainability transformations. These frameworks are also directly relevant for the biodiversity domain, particularly in its efforts to gain broader attention from scholars, policymakers, and practitioners. Without the goal of providing an exhaustive list here, we can highlight the framework suggested by Cash et al. (2003, p. 8086) that particularly stresses the fundamental challenge of partnerships to “... manage boundaries between knowledge and action in ways that simultaneously enhance the salience, credibility, and legitimacy of the information they produce”. Barreteau et al. (2010) emphasize the diversity of scale of “participatory” within an academic research context and how the location of power is decisive for avoiding that partners disengage for “the wrong reasons”. They build on work by Biggs (1989) and Probst et al. (2003) to

distinguish “contractual,” “consultative,” “collaborative,” and “collegiate” modes of participatory research, “where control over the research process gradually shifts from scientists to local people” (Barreteau et al., 2010, p. 3). For them, researchers should be particularly cautious about “disappointing” actors during participatory processes. Lang et al. (2012) analyze and suggest key components and design principles for how to do transdisciplinary sustainability research and suggest an ideal-typical transdisciplinary research process that could serve as an orientation in the analysis of partnerships. They particularly highlight how an ideal-typical research process can be characterized by the fact that the problem-framing and team building is done collaboratively, with solution-oriented transferable knowledge cocreated, and knowledge (re-)integrated and applied in partnership. Although Lang et al. (2012) do not explicitly analyze plural knowledge systems and diverse practical experiences or resulting equity and equality considerations such as power asymmetries in partnerships, they stress the universal quality of transdisciplinary research, particularly in sustainability science, to be an interface practice, or area of collaboration and friction, between society and science.

In our experience, such qualities of transdisciplinary research are arguably even more relevant for the biodiversity domain due to the more acute definitional uncertainties (still) present here. The term “biodiversity” essentially encompasses plurality in a single word, thus making it virtually impossible to pin it to anything singular. This in turn requires more time and facilitation for creating a shared understanding of biodiversity (e.g., compared to terms “water,” “land” or “forest,” all of which can be complex but more readily imaginable as a singular ecosystem, a social-ecological resource system, or a place; whereas any subcategory or proxy of biodiversity necessarily reduces it to something that is not biodiversity in its full sense by definition). Another important definitional issue is whether biodiversity as a term can and should be interchangeable with terms such as “nature” and “environment,” which are fundamentally not the same for both ontological (what they are) and epistemological (how we know about them) reasons, but can be helpful for developing a shared understanding between specialists and nonspecialists. These definitional challenges already justify and continue to require stronger integration of natural scientists in discussions of biodiversity, as the need to clarify what is meant by biodiversity is ubiquitous. At the same time, the historically low political and financial support for biodiversity (e.g., compared to climate change or sustainability) means setting specifically the biodiversity issue higher on the societal agenda necessitates a better understanding of social and political processes, which in turn requires

stronger integration of social scientists, policymakers, practitioners, and local communities.

Van Kerkhoff (2014), offering another perspective on what she describes as integrative partnerships and being largely in line with the considerations above, stresses the importance of a learning orientation. She explains that with a learning orientation in a transdisciplinary research process, “[g]enerative relationships that create innovation and new approaches need not take place within the confines of a particular order of events laid out in a research plan, and are as likely to emerge through spontaneous or serendipitous contact as through planned interactions” (van Kerkhoff, 2014, p. 150). In essence, recognizing the value of each partner’s unique expertise within a collaborative project likewise implies a mutual acknowledgment of knowledge gaps and inevitable added value from engaging in reciprocal learning.

Van Kerkhoff (2014, p. 145) further brings to attention the importance of reflexivity and situatedness of actors at all times within particular systems. Citing Spangenberg (2011, p. 279), she conceptualizes reflexivity as “the capacity of an individual agent to act against influences of socialization and social structure, based on critical self-assessment”. In our view, this is very much in line with the arguments brought forward within the leverage points framework as discussed above—higher reflexivity, for van Kerkhoff (2014), would mean the capacity to transcend paradigms in the way conceptualized by Meadows (1999), while lower reflexivity would mean to tweak rather technical parameters without reflecting on changing worldviews and the prevailing socialization and social structure shaping these worldviews. This accords with broader literature on reflexivity, particularly in sociology, political sciences, anthropology, philosophy, and qualitative research that highlights the importance of carefully considering social structures, power dynamics, and personal biases in knowledge production, research, and decision-making among others (e.g., Bourdieu, 2004; Clapp & Fuchs, 2009; Finlay, 2002). Likewise, this is in line with the psychological and decision-making literature, which is particularly relevant for better understanding the mental processes around critical self-assessment. Such literature distinguishes between the two ends of the spectrum in the reflexive processes (1) intuitive, unconscious, automatic mental processes, and (2) conscious, intentional, and intense mental processes (also known as System 1 and System 2 thinking) (Stanovich & West, 2000).

In contrast, however, the leverage points framework does not aid the analysis of situatedness within particular systems to the same degree that it lends itself for analysis of reflexivity. In seeking to address this gap the literature on reflexivity discussed above offers a valuable further contribution. If we follow the framework suggested by

Meadows (1999) and assume that to be transformative our interventions need to focus more on the upper part of the lever, that is paradigms, worldviews, and mindsets, and less on the lower part of the lever, that is parameters, infrastructure, and material flows, then we are addressing the reflexivity dimension of the interventions. In other words, interventions in this case would target reflexive or critically self-aware change that require conscious, intentional, and intense mental processes (unlike interventions that focus on the biophysical and technical change). However, this does not address the challenge that such reflexive or critically self-aware change might not be what is universally required for every desired transformation. It is very likely that different transformations will require different mixes of interventions taking into account both social and biophysical situatedness of the context (e.g., Bourdieu, 2000; Ostrom, 2005). Similarly, many system methodologies, within which Meadows (1999) can be located, also address reflexivity and situatedness simultaneously. Notably, works based on Ulrich (1983) and boundary critique in system sciences call for systematically questioning whose knowledge counts, whose values matter, and who has the power to decide depending on the identified system boundaries—hence uniting reflexivity with situatedness. Contu and Willmott (2003, p. 285) (based on the situated learning theory proposed by Lave and Wenger (1991)) argue that there is an important difference between “what goes on in individual heads” and what skills or knowledge one acquires. They underscore the value of building specific relations with specific people and in specific locations, highlighting “demonstrated ability to ‘read’ the local context” or “participate actively in the diffusion, reproduction, and transformation of knowledge-in-practice about agents, activities, and artifacts”. According to both the literature on integrative research that highlights a learning orientation and the scholarship on reflexivity and situated social learning, reflexivity and situatedness thus represent distinct dimensions of learning in partnerships.

In further considering the significance of situatedness to the practicing of transdisciplinary partnerships, also of note is the plurality of knowledge systems and practical experiences stemming from the diversity of actors involved in such partnerships. This has implications for equity and equality considerations in the form of power asymmetries resulting from distinct strengths and weaknesses of situated expertise. In this regard, Arnstein’s (1969) seminal examination of power imbalances in citizen participation within cooperative endeavors can offer valuable insights into all too often overlooked or under-acknowledged facets of transdisciplinary partnerships. Arnstein delineates a continuum of

participation levels intertwined with power dynamics, as illustrated in Figure 2 (see Figure 2A). These levels span from instances of “nonparticipation,” such as manipulation and therapy, to structures fostering power-sharing. Token participation, represented by activities like “consultation,” “informing,” and “placating,” occupies the substantial middle ground between these extremes. Jahn et al. (2021), drawing from their analysis of 59 empirical transdisciplinary research undertakings, reveal a somewhat akin participatory spectrum. Their findings (see Figure 2B) elaborate on the disparities in involvement and influence of actor groups more oriented toward practical applications (referred to here as “practitioner partners”) within transdisciplinary research. In particular, they find transdisciplinary research can vary in terms of the orientation of the research more toward real-world or academic problems, who initiates or leads the project (practitioner partners focused more on practice of change or academic partners more oriented toward generating evidence about change), who defines the research question, and whether collaboration is short term or continual and long term—all variously shaping different degrees of power-sharing between the partners.

The scales introduced by Arnstein (1969) and Jahn et al. (2021) thus represent the situated relationship between research and practice and could extend the applicability of Meadows’ Leverage Points to the analysis of collaborative practice by recognizing the intricate power dynamics inherent in partnership arrangements. Overall, an essential limitation of the Leverage Points framework is that it does not acknowledge power asymmetries of transformative change, where certain actors may either not be represented (e.g., ethnic minority groups), be sidelined from decision-making, or have their needs disregarded through seemingly insignificant actions like minimal knowledge, data sharing or collection, reminiscent of token gestures of partnership. In contrast, addressing the ways power is shared is in line with the normative balance between persuasion and opening space for actors to make their own meaning-making, a challenge viewed as central to the transdisciplinary research on transformations toward sustainability (e.g., Riedy, 2022). Building on these scales, we propose a corresponding reconceptualization of the leverage points framework, as explained and presented in the remainder of this work.

ITERATIVE ANALYTICAL APPROACH

The research presented here has been conceptualized iteratively and recursively (Bryman, 2016) between

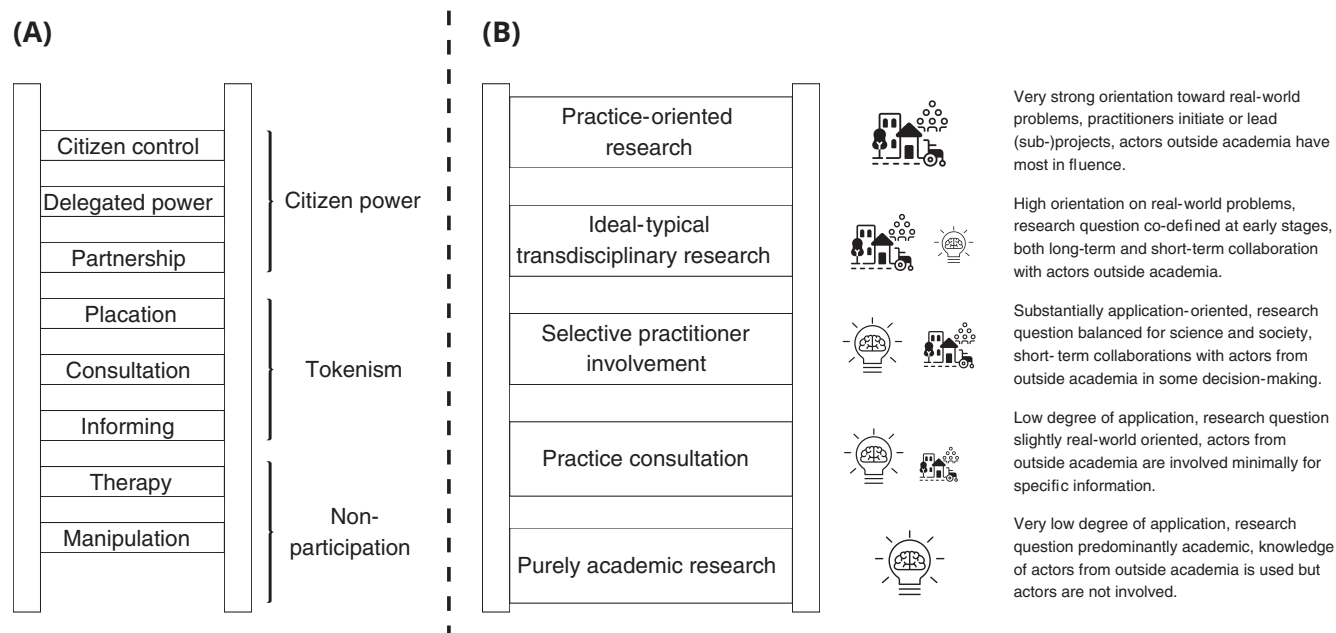
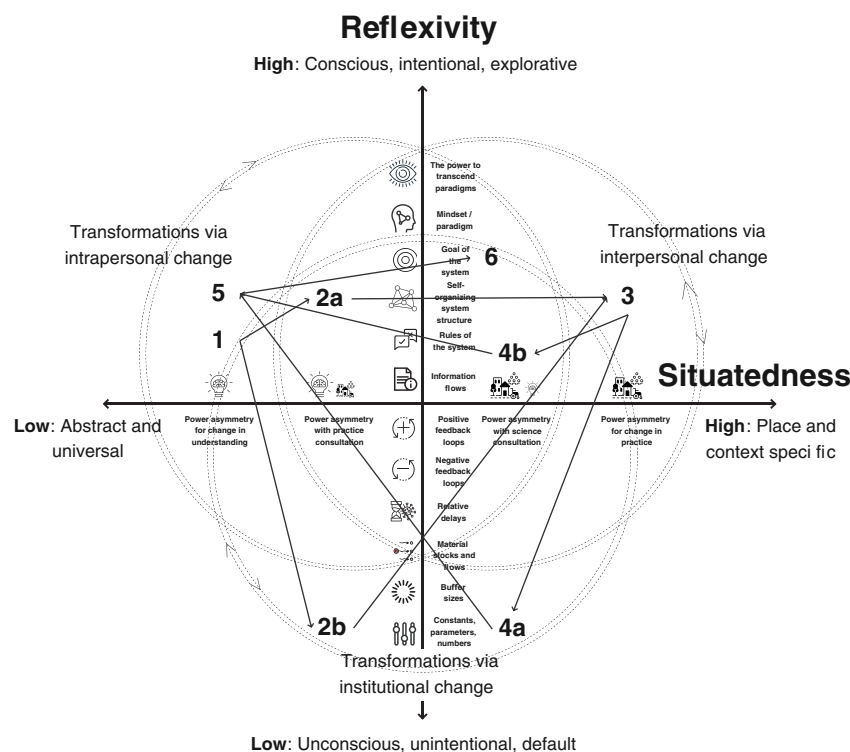


FIGURE 2 Two gradients of participation: (A) “ladder of participation” by Arnstein (1969), and (B) own representation of participation in research based on a cluster analysis of empirical research by Jahn et al. (2021).

(1) the theoretical considerations discussed above and (2) active empirical experimentation and continual theory building as a result of learning. Within PLANET4B, this constituted repeated cycles of a three-tier iteration between: multidisciplinary reviews, where the authors brought forward knowledge and reflections from their disciplinary backgrounds (sociology, political sciences, institutional economics, behavioral sciences, policy studies, anthropology, human geography, sustainability sciences); interdisciplinary dialogues, where the authors engaged in conversations to develop a shared understanding of key concepts; and transdisciplinary exchange and experimentation, where the authors observed and participated in processes of change involving collaborations beyond academia. Each of these cycles led to us revisiting our understandings of theory and practice, with particular focus on partnerships, interventions, and transformations. It is particularly important in this context to highlight PLANET4B’s intentional emphasis on interventions. Through PLANET4B, we have come to realize that experimenting with interventions can effectively bridge theoretical questions about desired change with practical considerations of the capabilities available to—or acquirable by—actors in partnership. Focusing solely on either future possibilities or present realities risks producing either unrealistic visions or insignificant plans that uphold the status quo. Therefore, for partnerships to drive meaningful transformations, we argue that critical discussions of interventions must simultaneously and iteratively address both dimensions.

Within PLANET4B, one of our primary objectives was to understand how certain sets of interventions beyond the classic regulatory, market mechanisms, and information provision interventions (creative and deliberative methods, serious and experiential games, and choice architecture methods) could steer biodiversity prioritization at intrapersonal, interpersonal, and institutional levels. We began by compiling an initial directory of interventions using a targeted approach to the mapping of interventions both inductively and deductively, combining scoping literature, expert input through consultations and workshops, and narrative review. The focus was on targeted review and mapping of the variation of interventions from both theoretical and practical perspectives. The result was the identification and preliminary assessment of a substantial variety of individual interventions with the potential of steering transformative change. The current collection in the directory encompasses 100 interventions consisting of 29 serious/experiential games, 11 choice architecture interventions, including channeling attention, framing, nudging, activating social norms and emotions, and 60 deliberative, creative, and arts-based interventions (Soliev et al., 2023).

As we were in search of interventions, we increasingly questioned the purpose and qualities of interventions, as well as implications thereof for partnerships and transformations. In this process of search, we repeatedly asked questions that retrospectively could be grouped into ones that stress reflexivity and situatedness by which interventions aim to trigger transformations. We present



Reflexivity-Situatedness Matrix: illustrative ideal-typical iterations of identifying transformative interventions in transdisciplinary partnerships

1 - An ideal-typical starting point for a transdisciplinary research by an academic partner as lead, particularly focusing on transformations via intrapersonal (rather abstract) and institutional change (rules of the system).

2 - Consultations with partners focused on practice (e.g., NGO) (2a) and policy (e.g., policy maker/ advisor) (2b), with shifts in focus toward more situated action, particularly responsibilities (self-organizing system structure) and indicators for action.

3 - Practice partners (e.g., NGO, local communities) defining what the context-specific values, needs, as well as the most important interventions that could lead to fulfilling identified needs.

4 - Policy partners (policy makers, gate keepers, multipliers) advise on the feasibility of and/or act on institutionalization by e.g., adjusting indicators (4a) or integrating new information flows (education, public awareness campaigns, political platforms) (4b) or any other intervention.

5 - Academic partners critically review the practices against the knowledge in literature, ethics, communicate the results linking the action back to more abstract theories of change and encourage practice partners and policy to strengthen reflexivity.

6 - Policy partners (policy makers, gate keepers, multipliers) advise on the feasibility of and/or act on institutionalization by adjusting parameters, indicators or integrating new information flows (education, public awareness campaigns, political platforms).

FIGURE 3 Reflexivity-Situatedness Matrix for understanding transformations in transdisciplinary partnerships and ideal-typical iterations of social learning.

and discuss the analytical framework built upon these dimensions, as well as the lessons from our ongoing observations from applying this framework to PLANET4B in the next section.

THE RSM: AN INTERVENTION-CENTERED ANALYTICAL FRAMEWORK FOR TRANSFORMATIONS THROUGH TRANSDISCIPLINARY PARTNERSHIPS

Reflexivity and situatedness as key analytical dimensions

Building on and expanding the above discussion and broader literature on social change, we argue that understanding how partnerships can enable transformations requires an analysis of (1) reflexivity and (2) situatedness of interventions necessary for triggering the desired transformations. We propose a RSM for facilitating such understanding, which constitutes the main result of our conceptual work (see Figure 3).

First, largely in line with the recent literature on leverage points and transformations, we argue that interventions can be analyzed by the degree of reflexivity by

which they aim to trigger transformations. By reflexivity we mean the continuum in the quality of interventions to trigger social change by intensity or depth of reflection processes. The change via reflexivity thus varies between (1) deeper levels of change where change is conscious and intentional with focus on mental processes and higher order thinking, such as rethinking assumptions that are often taken for granted, engaging with the challenges, critical thinking, and problem solving; and (2) change at levels where it can occur without conscious awareness or intention—for example, in response to new default processes, such as a new regulation (or how it is presented) that might expand, restrict, or reorganize available choices. Interventions that aim to trigger transformations through more reflexive, conscious, intentional change as a nominal starting focus tend to trigger change from the bottom up. As individuals, groups or a society develop deeper beliefs about what is valuable, they then begin to shape their behavior and devise their institutional arrangements accordingly. In contrast, interventions with focus on change through lower reflexivity as a nominal starting point tend to trigger change rather from top-down. External stimuli and predefined default choices largely determine the availability of choices, and more importantly, the choices that will likely be made, integrating them into everyday life and on a larger scale. It should be noted however that, in line with our

arguments in the previous section, once the new default choices are in place, we do not exclude them from triggering changes that occur with higher degrees of reflexivity. For example, to achieve transformations one might consider interventions that are expected to trigger “fundamental changes in views or values” as suggested in the definitions of transformation by IPBES (2019, 2022, 2024). Alternatively, one can look at interventions, for example as Thaler (2018, p. 431) argued, as “...improving the environment in which people choose—what we call the ‘choice architecture’—they can make wiser choices without restricting any options”. In the latter case, interventions are typically subtle and they only “nudge” without necessarily making individuals critically reflect on choices. The implications from both—what either of these two types of interventions can kickstart—can be transformative.

Second, Figure 3 also illustrates a continuum of situatedness for interventions aimed at triggering transformations. This continuum ranges from (1) interventions focused on abstract contexts or contexts that emphasize relationships in a society in general, to (2) interventions situated in place-based and issue-specific contexts—for example explicitly emphasizing relationships around biodiversity, nature, or the environment within a specific sector or location. By situatedness in this context we mean the continuum in the quality of interventions to trigger social change by degree of contextualization and embeddedness of these interventions and power asymmetries inherent to transdisciplinary partnerships with plural knowledge systems and diverse practical experiences. The assumption here is that most challenges related to the prioritization of biodiversity in society in some ways stem from deeper and often non-biodiversity-related social issues. This includes, for example, the prevailing values, traditions, customs in a society, how these values shape how we govern ourselves and various issues as a society, and what the resulting power structures are that define societal priorities. All of these factors have defining implications on to what extent biodiversity is prioritized on the societal agenda (see also Cikara et al., 2022 for debate on the need to integrate richer context in social psychological research). As such, interventions with lower overall situatedness, such as those purely focused on understanding causality in simulated and generic lab experiments, or those that involve abstract discussions, deliberations, events that are meant to make us rethink the prevailing and more fundamental discourses in a society (without accurate representation of facts on the ground, but for example with metaphorical parallels to “reality”) can be relevant for all representatives in a society and the outcomes are more intangible. Highly situated interventions, on the other hand, are not

abstract. They are filled with thick descriptions from the actual case and aim to facilitate change with a very specific focus on particular groups of actors as participants in the decision-making processes, in specific locations, and around specific issues (such as biodiversity, nature, and the environment). Here the interventions such as stakeholder workshops, joint scenario-building activities, actions involving co-creation or co-transformation of space, citizen deliberations and alike, take place on the ground within the contexts where transformations are desired, and the outcomes are more tangible.

A further valuable aspect of thinking about the composition and operational focus of interventions using the situatedness spectrum is that it provides indications in terms of the types of resources required (i.e. knowledge and skills, but also a range of other capacities) in order for planned interventions to trigger transformations while allowing a collective critical reflection in the existing partnership about both the desired change and the means to achieve it. Highly situated interventions tend to require more engagement on the ground, at a specific location, to ensure involvement of specific actors and development of details that more accurately represent the reality (e.g., if interventions take place in Halle, Germany, about social transformations related to biodiversity prioritization in or through urban gardens, interventions with high situatedness will likely require nuanced knowledge and integration of specific actors, places, circumstances reflecting the situation on the ground). More abstract interventions with lower situatedness tend to require a different set of resources, often involving conditions that support the generation of knowledge (e.g., creating an academically controlled environment or collecting new data for understanding the effects from application of new approaches).

This categorization of interventions helps us, in turn, to make further sense of different groups of leverage points for intervening in terms of their prevailing focus: intrapersonal, interpersonal, and institutional change. Highly abstract interventions with low situatedness, such as more abstract arts exhibitions of a general concept like biodiversity loss, or academic lab experiments with a range of hypothetical assumptions with the purpose to trigger deeper reflections about more universal issues at hand (such as thinking about individual's own role in society, not about specific people, places) primarily focus on intrapersonal change. The more situated the interventions become (about certain people, certain places, certain issues) the more they center around interpersonal change, where specific relationships between individuals, groups, and communities take the prevalent focus. Interventions that focus on achieving transformations through changes in external stimuli such as choice

architecture, framing, and reframing, whether they are about certain people, places, issues or not, often focus on institutionalizing or normalizing the desired change at a larger scale; that is, making certain actions a default choice formally or informally. Notably, however, we propose this analytical approach as a conceptual tool for understanding transformative interventions and partnership forging, rather than as a rigid or exclusive categorization tool. In practice, all these categories often overlap and intersect. Still, the distinction is useful for understanding and analysis. We argue that when thinking of leverage points to intervene in a system, partnerships and transformations are enhanced through considering various mixes of interventions along these continua. This includes reflections on to what extent interventions are abstract or situated and in which direction they trigger transformations in terms of reflexivity, and how well they take into account the resources and capacities available to or acquirable in the existing partnership.

Applying the RSM as an analytical framework in PLANET4B

Within PLANET4B, our above noted starting point of compiling a long list of (100) potential interventions (Soliev et al., 2023) raised the question to what extent these could be conceptualized in terms of the change they can bring about. The RSM proved informative in guiding us toward answering this question with both the rigor and flexibility needed in a transdisciplinary consortium (van Kerkhoff, 2014). We found the dimensions of the RSM to be useful for consortium-wide collective critical thinking about the significance of transdisciplinary working and mapping of interventions that could help prioritize addressing biodiversity loss in decision-making. Such a conversation was valuable for critiquing desired social change, indirect drivers and barriers of change, as well as intersectionality-related challenges (Figure 4A provides an image of how key intervention sets in PLANET4B can be conceptualized). The RSM also proved to be a valuable tool for understanding the change sought in a project, reflecting on the degree of reflexivity (conscious vs. nonconscious) and situatedness (context-specific vs. abstract) to be targeted by the interventions. In most cases, PLANET4B partners leading individual case studies reported that their aim was to induce not a single but a mix of changes across both dimensions, reflecting the complexity of addressing biodiversity prioritization (Barton et al., 2024).

Using the dimensions of the RSM for individual case studies was, on the one hand, helpful for strategically reflecting on interventions that complement and

reinforce each other across different levels of change. On the other hand, such an analysis helped match the desired change (along the reflexivity axis) with the situated access of case study partners to potential partners beyond project and available resources (along the situatedness axis). It also made the role of individual partners in the consortium more explicit by crystallizing which partner can and should best lead work on which type of interventions and how specific partners envision specific outcomes.

Figure 4B also provides an illustrative example of applying the RSM to the context of the ongoing experiences and experimentations in an individual place-based case study on urban youth and nature led by two of the consortium partners: one a local practitioner partner (Culture Goes Europe e.V. [CGE]); the other, an academic institution (Martin Luther University Halle-Wittenberg [MLU]). In this case study, age and migration are the key intersectionality dimensions explored in relation to biodiversity prioritization. We co-develop and experiment with interventions that could enable young people, particularly with a migration background, to reflect upon and potentially realize their access (or lack of it) to decision-making on biodiversity and nature. Embedded within the discussions at the consortium level, the partners jointly constructed the case study frame and developed interventions to understand attitude and behavior change on the ground involving a core group of volunteer urban youth case study participants. Interventions were selected to reflect the specifics of the case and to address the desired levels of change resulting in a mixture of interventions on different axes of the matrix. The discussions started with the development and testing of the Pathbreak: A Biodiversity-Food-Governance Game¹ together with debriefing sessions before the local practice partner devised interventions with the potential to trigger higher reflexivity. This included, for example, multi-day outdoor immersive activities with reflections about human-nature relations (both in abstract terms and about specific places where the activities are held); activities that are highly abstract, such as outdoor cinema, at a glance featuring fictional life on another planet; and also additional highly situated activities, such as excursions and study tours, to actual places of transformation. These interventions shifted the corresponding power—the know-how—to the practice partner in the sense they were in a position to

¹This is a stylised participatory game based on experimental economics, sociology, and political sciences developed in PLANET4B for facilitation of experiential learning on social dimensions of addressing biodiversity loss. Further information is available at www.pathbreak.eu and www.planet4b.eu.

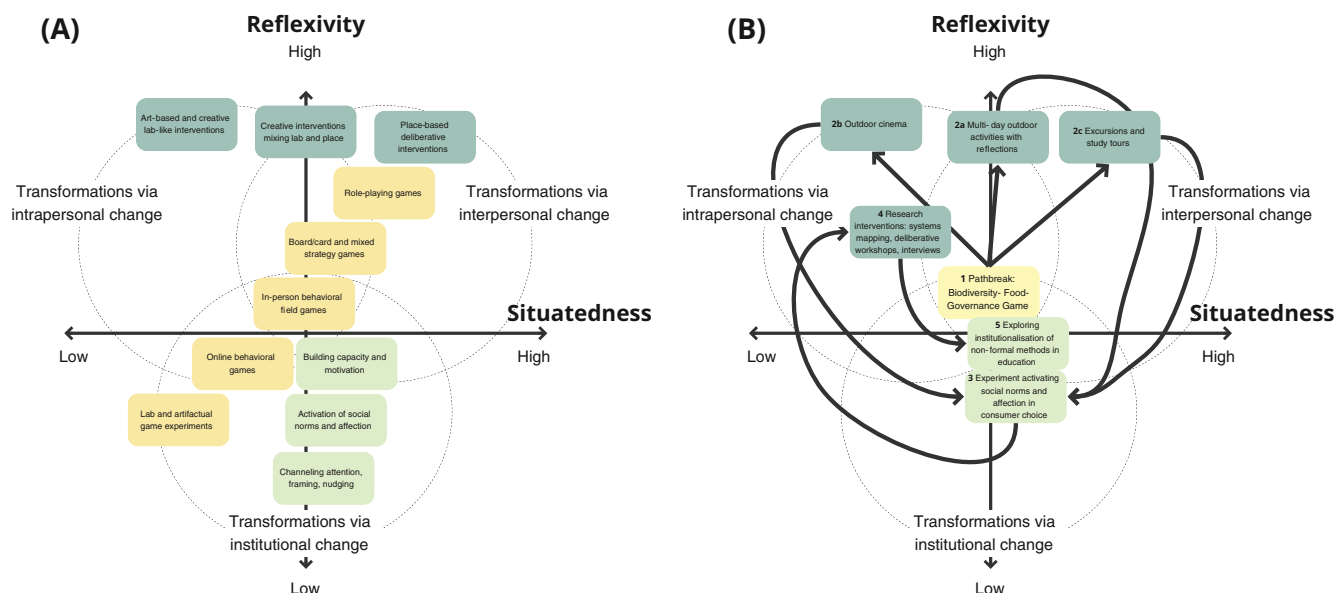


FIGURE 4 Illustrative example of the Reflexivity-Situatedness Matrix in use: (A) for conceptualizing transformative interventions applicable in the project focusing on games (yellow), attention and framing (light green), and arts-based, creative, deliberative methods (dark green) and (B) for reflections on the selection of interventions and developing associated partnerships in a single case study.

suggest what should be the desired change and a set of interventions for achieving it. Such a shift was justified and constructive as the team on the ground had the situated knowledge about the local opportunities and barriers for change and preexisting expertise in facilitating activities matching these circumstances. The academic partner, MLU, then started more focused conversations about other interventions (including, for example, attention, framing, nudging experiments for understanding institutionalization of various choices), which were considered promising, but might be less familiar to the practice partner. The dialogue around these suggestions led to extended discussions on research interventions, including learning across case studies in PLANET4B—how we can understand the impact of interventions best and, once again, what impact or package of impacts we want to achieve.

A further broader insight derived from the experiences and experimentation in this case study, but also across all case studies in PLANET4B, is related to the specific focus of the project on biodiversity. Exploring biodiversity-related challenges from a transdisciplinary perspective raised a plethora of questions. For instance, whether or not using the term biodiversity (exclusively) in policy and practice in fact helps the cause or might create an additional hurdle in communication due to its rather “technical” and multifaceted nature. Hence, the uncertainty already inherent to the biodiversity domain, as discussed earlier, due to the complexity of some causal relations (including also time lags between

action and detectable impact) creates even more room for deliberations on what course of action and on what level should be best prioritized to address the challenges. This uncertainty and complexity make the RSM and the dialogue, which its use prompts between transdisciplinary partners, particularly useful. It evidences the need for achieving a shared clarity at the higher meta-level of analysis, in contrast to less complex and less uncertain domains, where reflecting upon actions and their consequences might be more straightforward.

Overall, the experiences and experimentations in PLANET4B are helping to generate knowledge about the two dimensions of leverage points to intervene in a system for transformations (namely reflexivity and situatedness). At the same time, our experimentation and iterative rounds of social learning have also confirmed the value of critically reflecting about interventions and partnerships using these two dimensions. Table 1 provides a summary of illustrative interventions, transformations, and partnerships particularly from the perspective of the prevailing dimensions of the RSM, types of transformative change, types of partnerships, power-sharing, as well as some examples derived from the authors’ work and observations in PLANET4B more broadly. These findings support extending Meadows’ (1999) leverage points framework by integrating thus far largely overlooked advances from the social sciences that analyze social change, transformations, power relations, and social learning (e.g., Lave &

TABLE 1 Illustrative examples of interventions, transformations, partnerships through the RSM lens.

Prevailing characteristics of interventions	Prevailing type of transformative change	Prevailing type of partnerships in research	Power asymmetries	Examples of interventions and partnerships from PLANET4B
High reflexivity–Low situatedness	Intrapersonal change	Relatively academic-driven research exploring causality with low degree of immediate application	Power predominantly lies with the partners closely working with (abstract and theoretical) concepts being questioned	Consortium level discussions and deliberations, often about more universal issues, such as the wheel of power and privilege.
High reflexivity–High situatedness	Interpersonal change	Relatively balanced academic and practice-oriented research exploring causality and facilitation of change on the ground	Power predominantly lies with the partners focused on change of practice in their daily work and corresponding access to the place-based relations and resources	Packages of interventions in place-based intensive case studies, such as deliberative workshops and deeper debriefing sessions about interventions, immersive outdoor activities, study tours, experiential learning games, etc.
Low reflexivity–High to Low situatedness	Institutional change	Relatively practice- and policy-oriented research exploring facilitation of change in practice and policy	Power largely lies with the partners focused on practice and policy change in their daily work and corresponding access to these processes	Channeling promising results to policy, attention, framing, nudging interventions, etc.

Wenger, 1991; Mahoney & Thelen, 2009; North, 2005; Rogers, 1962, 2003a, 2003b; Williamson, 2000).

DISCUSSION: IMPLICATIONS OF RSM FOR THEORY AND PRACTICE

By enhancing the way Meadows (1999) and others presented leverage points to intervene in a system through our RSM, a number of substantial implications arise for both theory and practice. With regard to the practice component especially, this applies with respect to both how transformative interventions are identified and the significance of partnership working in their selection, adaptation, and application. First, conceptualizing interventions through the prism of the RSM allows for moving away from the potentially misleading notion of change in a single leverage point driving system transformations and that it is a matter of discovery. Instead, we can conceptualize transformations, especially in addressing complex social-ecological challenges such as biodiversity loss through the involvement of partners across academia, policy, and practice, requiring a coordinated package of interventions and continual critical dialogue. Second, there is value in these interventions being carefully sequenced and combined, tailored to the specific context, rather than adhering to a rigid hierarchy where change at “deeper” leverage points is prioritized

by default and universally over change at “shallower”, “non-fundamental” levels. While socially “deep” leverage points are indeed crucial, we argue for keeping all options on the table, recognizing the diverse needs and strengths of the partners and that interventions targeting change via both high and low reflexivity can play a vital role in the broader mix (see also Manlosa et al., 2019).

Third, following from the above, there is added value in viewing sets of interventions as reinforcing (or conflicting with) one another across multiple levels—from individual to institutional. Our intuition is that this can result in more effective and sustainable outcomes than targeting a single level in isolation or when supported by only a certain partner. Fourth, one can expand the possibilities in the selection of interventions when approaching them as a part of a participatory and negotiated process, especially in transdisciplinary partnerships. This approach not only has the potential to enhance partnerships and collaboration among actors in science, policy, and practice, but also to foster continual social learning and critical reflection, rather than merely identifying the “best” solution for achieving the desired change. It follows that effective partnerships within transdisciplinary research often have the chance to embrace an iterative process characterized by dynamic leadership. As partners engage in repeated cycles of collaboration, knowledge exchange, and critical reflection, their understanding of the problem domain and of each

other's expertise and priorities deepens. This iterative learning can foster a sense of shared ownership and facilitate the emergence of fluid leadership structures, where different individuals or groups may assume leadership roles at different stages, depending on the specific expertise required. This dynamism in leadership (as illustrated above, with the PLANET4B urban youth case study) can result in multiple shifts in power-sharing, ensuring that decision-making authority is not fully fixed at any single point across the spectrum of situatedness.

Further from a temporal perspective, transdisciplinary research projects necessitate a nuanced understanding of partnership dynamics from both short-term and long-term perspectives. While forms of collaboration characterized by high levels of control (e.g., tokenism) might seem undesirable, they may play a short-term role in catalyzing initial project phases (e.g., in the case of projects originating from responsive-mode bidding). Such partnerships might be strategically leveraged to gain buy-in, access resources, or navigate bureaucratic hurdles (Armitage et al., 2009). However, focusing on longer term goals of sustainability and coproduction emphasizes a gradual shift toward more empowering partnership models. Ideally, these transitions foster trust and build capacity among stakeholders over time (Lang et al., 2012). Acknowledging this potential evolution may make the occurrence of an initial less empowering phase of partnership slightly more palatable, where it reflects an externally imposed stepping stone within the context of a broader strategic vision for equitable and sustained collaboration (Pohl & Hirsch Hadorn, 2007).

Finally, even though reconceptualizing the leverage points framework as we suggest here expands the options of how partnerships can enable transformations, we have to remember that partnerships and interventions addressing complex social issues are themselves situated within a framework of existing institutional arrangements at all times (Meyer, 2010; North, 2005; Ostrom, 2005). This institutional context can either facilitate or hinder progress, sometimes regardless of how one conceptualizes interventions. However, it is also for this very reason that carefully analyzing and choreographing fit-for-context interventions within similarly carefully developed partnerships is essential (Gupta et al., 2010; Marciniak et al., 2024; Wittmayer et al., 2024). Moreover, it is valuable to keep in mind that this is a two-way relationship. Supportive policies and broader political will of key actors that provide clear mandates, incentives, and resources can serve as powerful catalysts for collaborative efforts (Newig et al., 2010). Conversely, timely and iterative engagement—both within a carefully forged partnership and with relevant actors beyond it—combined with the analysis of desired change and alignment of potential

interventions can help initiate change in institutional arrangements and generate broader political will. The RSM facilitates the dual alignment of interventions, along the continua of reflexivity and situatedness. It aids partnership working aimed at understanding and facilitating agreed-upon social change in ways that take fully into account the situated and nuanced context of practice.

CONCLUSIONS

Addressing the contemporary challenges around nature, biodiversity, and the environment has been increasingly driven by the normative goal of facilitating multilevel societal transformations, enabling shifts from instrumental relationships with nature toward those grounded in care and reciprocity. However, there has been thus far much less discussion on how to critically and systematically analyze interventions in collaborative efforts, as well as how to forge and work in partnerships addressing transformations. To fill this gap, we have critically reviewed Meadows' framework on leverage points for transformations and suggested its extension through the RSM evolved from lessons in our 16-partner strong transdisciplinary consortium on biodiversity prioritization. We argue that comprehending partnerships and interventions available to them through the lenses of reflexivity and situatedness offers crucial insights for both understanding and enabling transformations. The continuum of reflexivity emphasizes the degree to which change is facilitated through conscious and intentional or nonconscious and default mental processes. It allows for the analysis of interventions in terms of to what extent they are directed at internalizing norms or institutionalizing (formally or informally) the desired choices. Critically exploring reflexivity as forms of intrapersonal, interpersonal, and institutional change shows that interventions aiming to trigger higher degrees of reflexivity can lead to transformative change from bottom-up, involving conscious and deliberate social change. Meanwhile, those aiming at change via the lower degrees of reflexivity allow for transformations to be facilitated from top-down, without necessarily involving conscious and deliberate social change. Situatedness, in turn, highlights the degree of abstractness or embeddedness of interventions to match specific social, cultural, and historical contexts, as well as the implications from the plurality of knowledge systems and practical experiences for power structures in transdisciplinary partnerships. Overall, our work extended the Meadows' framework by (1) explicitly moving the focus in the analysis of transformative interventions from any single intervention or leverage point to mixes of interventions, (2) stressing the value of

situatedness, especially in terms of taking into account the degree of contextualization in interventions and corresponding power asymmetries, (3) highlighting the reinforcing and conflicting interactions between interventions targeting different levels of transformative change (intrapersonal, interpersonal, institutional), and (4) bringing forward the temporal and learning dimensions in partnerships. We demonstrated how such an analytical framework has been valuable in partnership forging and working in our ongoing transdisciplinary project PLANET4B dedicated to both understanding and facilitating transformative change. By recognizing the diversity of interventions along the continua of reflexivity and situatedness, researchers, practitioners, and policymakers alike can fundamentally change how they view the co-creation of solutions that resonate with local needs and aspirations, thus enhancing the sustainability and impact of collaborative efforts.

AUTHOR CONTRIBUTIONS

Ilkham Soliev: Conceptualization; formal analysis; funding acquisition; investigation; methodology; resources; supervision; validation; visualization; writing – original draft; writing – review and editing. **Agnes Zolyomi:** Conceptualization; formal analysis; funding acquisition; investigation; methodology; writing – review and editing. **Alex Franklin:** Conceptualization; formal analysis; funding acquisition; investigation; methodology; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

This research represents a theoretical conceptualisation by the authors. Empirical data were not collected for this research.

ETHICS STATEMENT

For the work in the project, ethical approval was obtained from the Ethics Committee of the Martin Luther University Halle-Wittenberg on 10.08.2023.

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