



# Conducting sustainability research in the anthropocene: toward a relational approach

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Received: 26 July 2023 / Accepted: 21 March 2024 / Published online: 24 May 2024  
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## Abstract

Scholars and practitioners are urgently highlighting the need to apply a relational approach to effectively address societal crises. At the same time, little is known about the associated challenges, and there is little advice regarding how to operationalize this approach in sustainability science. Against this background, this article explores how we can break out of our current paradigms and approaches, and instead apply relational thinking, being, and acting in the way we conduct research. To achieve this, we systematically list all major research phases, and assess possible pathways for integrating a relational paradigm for each step. We show that moving toward a relational paradigm requires us to methodically question and redefine existing theories of change, concepts, and approaches, for instance by combining abductive reasoning, first-person inquiries, and decentering the human through critical complexity theory. Challenging mainstream thought, and daring to ask different questions in each step is crucial to ultimately shift scientific norms and systems. Hence, we offer a catalog of questions that may help to systematically integrate relational being, thinking, and acting into the process, as a tool for transforming current paradigms in research, and associated education and practice. Finally, we highlight the importance of further research to develop and refine our outcomes.

**Keywords** Eco-justice · Inner transformation · Inner transition · Existential sustainability · Paradigms · Relationality · Relational ontology · Systems thinking · Transformation research · Existential resilience · Inner-outer transformation

## Introduction

The anthropocene is characterized by significant human impact on the Earth's geology and ecosystems; examples include biodiversity loss, climate change, social inequalities, and conflicts (IPCC 2021). These challenges are part of an underlying metacrisis of accelerating, causally entangled, complex grand challenges (Jørgsen et al. 2023; Rosa

2019). In fact, there is mounting evidence that today's societal crises have one common denominator, or root cause: they are a reflection of an inner, human crisis of disconnection or separation from self, others, and nature, which is grounded in modern societies' social paradigm (Ives et al. 2023; Leichenko and O'Brien 2020; Rowson 2021; Wamsler et al. 2021; Wamsler and Bristow 2022). Hence, the current focus on external, technological approaches is insufficient to support transformation toward sustainable and just futures (ibid).

Consequently, there is also a need for sustainability science to re-consider and expand its ontological, epistemological, and ethical foundations, and associated approaches for researching and engaging with complex, wicked sustainability challenges (Alford and Head 2017; Ives et al. 2023; Lang et al. 2012; Lönngren and van Peock 2020; Mauser et al. 2013; Wiek and Lang 2016; Xiang 2013). Accordingly, an increasing number of scholars and practitioners argue that effectively addressing and researching sustainability

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challenges requires a shift in paradigms<sup>1</sup> to address societal crises differently (Ives et al. 2023; Walsh et al. 2020; Wamsler et al. 2021).

The dominant social paradigm in the modern, industrialized world is what we refer to in the following as the ‘mechanistic paradigm’. Scholars and practitioners highlight that current mechanistic approaches, and associated reductionist strategies and perspectives, are inadequate for tackling sustainability issues (Leichenko and O’Brien 2020; Porter and Reischer 2018). Furthermore, it can be argued that the paradigm’s underlying values (individualism, materialism, capitalism) and the associated norms,<sup>2</sup> mechanisms, and structures enhance separation from self, others and nature, and a kind of alienation, as an integral element of modern life, forms (Wamsler and Bristow 2022; Rosa 2019).

The core pattern that emerges from the mechanistic paradigm, which is especially relevant in the context of today’s sustainability crises and associated research, is that we are increasingly exhausting and exploiting ourselves, others, and nature (Wamsler and Bristow 2022). This is based on the perception that humans are separate from each other, that they are separate and superior to the rest of the natural world, and that nature, like any other system, behaves like a machine, and can be controlled and known by reducing it to its parts (Capra and Luisi 2014; Redclift and Sage 1994; Rees 1999; Walsh et al. 2020). The result is separation between self, others, and the more-than-human world (Ives et al. 2019; Wamsler and Bristow 2022).

The mechanistic paradigm has dominated both policy-making and research. It favors “outer” approaches and solutions (IPCC 2022a, b; Wendt 2015; Todd 2016; Wamsler and Bristow 2022), while largely ignoring the inner dimension of sustainability, which includes people’s individual and collective mindsets, beliefs, values, worldviews, and associated inner qualities/capacities (Capra and Luisi 2014; Redclift and Sage 1994; Rees 1999; Wamsler 2020; Wamsler et al. 2021, 2022a). This has, in turn, narrowed the possibilities for

deeper change that can tackle the underlying root causes of today’s crises, while fostering mechanistic and unsustainable interactions with the living world around us (Leal Filho and Consorte McCrea 2019; Wamsler et al. 2021).

To address this gap, an increasing number of scholars advocate for a shift toward a relational paradigm (e.g., Audouin et al. 2013; Böhme et al. 2022; Hertz et al. 2020; Ives et al. 2023; Mancilla Garcia et al. 2020; Stalhammar and Thorén 2019; Walsh et al. 2020; Wamsler et al. 2021, 2022a; West et al. 2020). A relational paradigm<sup>3</sup> attempts to understand complex phenomena in terms of constitutive processes and relations and recognizes the intricate interconnectedness of humans and the more-than-human world, as well as the associated nonlinear dynamics, uncertainty, and the emergence of change (West et al. 2020; Walsh et al. 2020). It builds on the ontological premise that inner and outer phenomena are entangled and interconnected across individual, collective, and system levels, and recognizes the multiple potential that is latent within each of us to enable transformative change across these scales (Ives et al. 2023). From an epistemological point of view, it requires the inclusion of diverse perspectives, and the expansion of knowledge systems for enhanced “transformation”<sup>4</sup> toward more sustainable futures (Ives et al. 2023; Künkel and Ragnarsdottir 2022).

On these premises, relational research should not be understood as simple introspection, but as a new form of praxis for integrative inner–outer transformation that includes different modes of activating the inner human dimension across individual, collective, and system levels, and the generation of so-called transformative capacities through intentional practices (Ives et al. 2023; Spreitzer 2021). “Such cognitive, emotional and relational capacities support the cultivation of values, beliefs, and worldviews regarding how people relate (or reconnect) to themselves, others, nature, and future generations in ways that can support transformation” (Wamsler et al. 2022a, b, p. 9).

In contrast, current scientific mainstream approaches and methods risk reproducing and strengthening the dominant social paradigm that underlies today’s sustainability crises, instead of questioning and reframing the underlying assumptions (Fischer et al. 2015; Walsh et al. 2020). While these challenges are increasingly addressed in emerging frameworks and perspectives that may form the foundations of transformative approaches toward more sustainable and just

<sup>1</sup> Paradigms shape our ways of knowing, being, and acting in the world (Walsh et al. 2020) and can thus be both a critical barrier and driver for sustainability. They not only influence us personally (i.e., our motivation, values, attitudes, and psychological makeup), but also shape our systems (social, economic, political, technical, ecological) and cultural associations (i.e., narrative frames and cultural norms) (Escobar 2017; Lakoff 2014; Orr 2002; Wahl 2017). Paradigms represent the dominant thought patterns in societies, and thus underlie the theories and methods we use in science (O’Brien 2016; Walsh et al. 2020). This is also true for sustainability, climate science, and any other related field (Kuhn 1996). As a result, they hold significant potential as catalysts for transforming systems (Meadows 1999).

<sup>2</sup> In the context of research, related norms are characterized by rationalism, reductionism, empiricism, dualism, and determinism (Redclift and Sage 1994; Rees 1999; Capra and Luisi 2014; Böhme et al. 2022).

<sup>3</sup> Despite a rich discourse on relationality, there is no single, comprehensive definition of a relational paradigm. It can rather be seen as an umbrella term that encompasses various strands of thoughts (Walsh et al. 2020), as presented in our article.

<sup>4</sup> Transformation literacy is the skill to steward transformative change collectively across the boundaries of institutions, nations, sectors, and cultures (Künkel and Ragnarsdottir 2022).

futures (e.g., Ison 2018; Gearty and Marshall 2020; Hertz et al. 2020; Wamsler et al. 2021), there is little knowledge on how to systemically conduct sustainability science from a relational paradigm perspective (Fischer et al. 2015; Walsh et al. 2020; West et al. 2020).

Sustainability science is both an inter- and transdisciplinary field, and it is concerned with addressing complex challenges that threaten humanity and the planet (Wiek and Lang 2016). It bridges natural and social sciences and the humanities in the search for creative solutions to these challenges (Jerneck et al. 2010; Kajikawa et al. 2014; Miller 2012; van Kerkhoff 2013). Accordingly, sustainability research tends to combine “descriptive-analytical” and “transformational” approaches with different methodologies, based on systems thinking as an epistemological frame (Miller et al. 2013; Wiek and Lang 2016). While the descriptive-analytical stream draws mostly on systems modeling for describing and analyzing the causes and effects of complex sustainability challenges, the transformational stream often focuses on evidence-based solutions, by accommodating systems thinking for generating actionable insights into how to address sustainability challenges more effectively (Abson et al. 2017; Wiek and Lang 2016). Hence, both approaches are built on the premise of addressing un/sustainability by identifying and “solving” wicked problems. In general, however, these premises and their corresponding understanding of systems, and systems change, operate within the dominant social paradigm (Latour 2005; Poli 2013). In other words, they typically do not align with, or support, a relational paradigm, notably its epistemological, ontological, and praxis dimensions (Ives et al. 2023). Despite the above-described call for a relational turn in sustainability science, related endeavors are still in their infancy, and there is a need for further efforts to learn how to nurture more relational and, thus, transformative approaches.

Put together, there is an urgent need for a move toward more relational thinking, being and acting, and thus a related shift in: (1) how we see the world; and (2) how we get to know, (3) engage, and (4) ensure quality and equity considerations across these aspects (Ives et al. 2023; Walsh et al. 2020; Wamsler et al. 2021, 2024). This involves examining how ethical considerations shape our understanding of reality (ontology), influence the ways we acquire, validate, and apply knowledge (epistemology), and translate it into action (praxis).

Against this background, in this article we explore how we can break out of societies’ dominant social paradigm and apply a relational paradigm to the conduct of sustainability research in more transformative ways. More specifically, we identify key implications and possible ways forward for all major steps typically found in any scientific research process.

## Methodological considerations

In the next section, we describe the particularities that result from a relational paradigm for each of the following research steps: (1) identifying the research problem and niche; (2) reviewing the literature; (3) creating research hypotheses; (4) designing the overall approach; (5) data collection and analyses; (6) writing up the results; and (7) disseminating them (Booth et al. 2016; Cohen et al. 2018; Creswell 2018). For each of these steps, we compare: (1) how sustainability research is generally conducted based on the mechanistic paradigm; and (2) how the approach might change if a relational paradigm is applied. Related analyses are based on an exploratory analysis<sup>5</sup> of the literature that calls for a relational shift in sustainability and social sciences. While our comparison relates to mainstream sustainability approaches that are built on a mechanistic paradigm, we recognize the existence of alternatives (cf. Bradbury 2015, 2022; Dawson et al. 2017; Goodchild 2021; Mbah et al. 2022; Romm 2015; Rowell et al. 2017).

We do not attempt to present a comprehensive overview of research methodologies based on a relational paradigm. Instead, we critically reflect on existing approaches and review how a relational paradigm could be operationalized in sustainability research, particularly as there is no single, coherent relational paradigm to build upon (Alvesson and Sandberg 2020; Böhme et al. 2022).

To do so, we do not present tools, methods, or steps with specific prescriptions and instructions for how to move toward a more relational paradigm and overcome related challenges—instead, we offer a proposition that could trigger conditions of emergence (Springgay 2015). This is important, because the idea that specific actions lead to defined outcomes is not aligned with a relational perspective and thus on how transformation can be supported in complex systems (Smartt Gullion 2018). Moreover, relational epistemologies question the idea that tools can be used to represent reality, without acknowledging the entanglement of the researcher who is co-creating the knowledge (Latour 2005). Ultimately, “tools are never ‘mere’ tools ready to be applied: they always modify the goals you had in mind” (Latour 2005, p. 143). Offering a practical tool runs the

<sup>5</sup> Our work draws heavily on a literature review that explores relational ontologies, epistemologies, and ethics by Walsh et al. (2020). We also included recent research papers that specifically address sustainability science and relational perspectives. Examples include Hertz et al. (2020) and Mancilla Garcia et al. (2020), who look at socio-ecological systems research from a process-relational perspective, and West et al. (2020), who look at the relational turn in sustainability science in general. These key sources led us to further papers dealing with the relational research approaches relevant for our review.

risk of offering a simplistic conceptualization that narrows understanding and changes our object of study (Mancilla Garcia et al. 2020).

Instead, in each section, we conclude with some questions that can be used to make the implicit explicit when conducting research within a relational paradigm. Making the implicit explicit is an important strategy for dealing with complexity (Audouin et al. 2013; Cilliers 2005). We thus follow Puig de la Bellacasa (2017), who suggests that the aim should be a commitment to asking how things could be different, as developing processes and practices of asking can challenge the status quo and, thus, help to increasingly integrate the relational paradigm into current approaches.

## Pathways toward a relational paradigm in research

### Step 1: identifying the research problem and niche

The first step in the process is the identification of the research problem and niche.

From a mechanistic paradigm, the problem and niche can be found by identifying and isolating certain parts of a system that relate to a particular sustainability challenge. For example, a focus on carbon emissions in a particular sector (e.g., transportation).

A relational paradigm would require adding a perspective that is based on an understanding of sustainability challenges as evolving, complex adaptive systems marked by interdependencies, connectedness, nonlinearity, uncertainty, and emergence (Ives et al. 2023; Turner and Baker 2019). Instead of focusing on individual parts of systems—such as carbon emissions in transportation—a relational approach thus also requires looking into relationships, and the quality of these relationships, within and between systems, and how this influences or prevents integrative inner–outer transformation processes across individual, collective, and system levels (Wamsler et al. 2021, 2022a, b). In this context, “boundaries” do not define a research problem or theoretical puzzle, but “interfaces” do, which are understood as dynamic interchanges that form the edges of systems, and, are, at the same time, the focus; that is, “the appropriate center of interest in a particular system, process, or mind” (Bateson 1979; Charlton 2008, p. 41).

An important aspect to consider during the first research step is the fact that paradigms form frames and language, and vice versa (Lakoff 2014; Ives et al. 2019). Reframing sustainability challenges is thus crucial for supporting transformation (Lakoff 2014) and must be accounted for when conducting research. While formulating the problem, it is for instance essential to consider which pre-defined concepts the problem is based upon, as moving toward a

relational paradigm asks us to question established norms and understandings.

A relational paradigm also requires special attention to the wording of the research gap and associated niche, including the use of expressions that can foster or challenge dominant beliefs, values, and worldviews. Examples of wording that aims to support more relational understandings are natureculture and intra-action (Barad 2007; Hertz and Mancilla Garcia 2021), socialecological (Böhme 2023), thinking-with (Vu 2018), or the more-than-human world (Haraway 2016). In contrast, Hertz et al. (2020) point out that current sustainability research often employs “the environment” or “nature” and “the social” or “culture” as separate entities or phenomena, which can reinforce a reductionist paradigm. The separation between the social and the ecological also manifests in research in the so-called socio-ecological systems, a conceptualization that has strongly been influencing related research, frameworks, theories, methods, and policy insights.

In summary, identifying the problem through the lens of a relational paradigm involves a shift from focusing only on analyzing certain parts of a system, to the quality of relationships, associated meaning-making, and integrative inner–outer transformation processes. It also involves identifying and developing appropriate frames, language, and concepts that align with these characteristics.

A study on reducing carbon emissions from transportation might, for instance, be framed within a continuum and integrative understanding that links analyses at the level of behavior, at the level of systems and structures, and at the level of individual and collective mindsets. Moreover, employing a relational paradigm might involve framing emission and transportation-related challenges also around concepts of community well-being, social connectivity, and environmental justice.

In conclusion, the following questions can help in moving toward a relational paradigm:

- I. How do my research problem and associated niche consider interdependencies, connectedness, nonlinearity, uncertainty, and emergence? How do they account for (the quality of) relationships and related inner–outer transformation processes across individual, collective, and system levels? For example, if my research focus and associated aims reinforce (the perception of) a separation between humans and non-humans, I might want to reframe the research.
- II. Is the wording of the problem, niche and associated aims aligned with relational perspectives, or does it strengthen current mechanistic paradigms? For example, “if the words in a given language focus on shapes over function, then no wonder the speakers of that language prefer to group things according to

their shape rather than their function” (Bollier and Helfrich 2019, p. 708).

- III. How can I explain relational, unfamiliar, or new concepts so that others (co-researchers, readers), who are new to this way of thinking, can understand? How can I create a bridge between the current and a potential new, more sustainable paradigm? For example, I could consider adding a glossary of newly-formed or uncommon terms.

## Step 2: reviewing the literature

In general, the literature review entails identifying relevant sources and databases, and screening and selecting articles based on predetermined criteria. After extracting relevant information and data from the selected articles, researchers systematize and synthesize the findings to identify gaps, themes, and patterns.

From the perspective of the dominant mechanistic paradigm, scientific, peer-reviewed information is generally considered the key source for ensuring credibility and reliability. Adopting a relational paradigm challenges this notion. It requires questioning the dominance of the existing sense-making frames and discussing their possible limitations, biases, and blind spots, including regarding the ontological premises underlying other epistemological and ethical considerations and emergent phenomena (Storm et al. 2019; Ives et al. 2023; Alvesson and Sandberg 2020).

Epistemologically, the focus shifts from privileging empiricism and positivism to embracing multiple ways of knowing. It acknowledges that different knowledge systems offer unique perspectives and understandings of the world. This may include lived experience, traditional and Indigenous wisdom, artistic expression, and other non-conventional sources that can offer valuable insights into the complexities of environmental issues, associated human–environment relationships, and aesthetics (Osgood et al. 2020). It challenges the idea that only ‘objectifiable’ data is valid and recognizes that experiential, subjective, and transpersonal insights are equally essential in comprehending sustainability and the associated literature (Storm et al. 2019).

Ethically, the relational paradigm prompts critical reflection on whose knowledge is recognized and legitimized. It questions power dynamics within knowledge production, highlighting the need to amplify marginalized voices and perspectives that may have been historically excluded or undervalued within academia or the scientific discourse. It thus requires decolonizing strategies for identifying and reviewing the literature (Vu 2018).

Continuing with the example of carbon emissions from transport that was given in step 1, a relational paradigm would also require reviewing related, non-scientific literature

and other sources and perspectives that shed light on aspects that have so far not been explored by mainstream science. This might involve considering the (limited) methodological bases and foci of the examined literature, and including additional data and voices for a more comprehensive review (e.g., examining all levels of transformation, related views, structures, and practices that might add additional context and perspectives).

Other common assumptions during step 2 are that the literature presents external, fixed knowledge, which the author has developed, and that the reader interprets the literature through a reflective process that is independent of dominant social paradigms. Accordingly, a systematic literature review should always lead to the same results and interpretations when repeated, regardless of the author(s), researcher(s), and reader(s). In contrast, a relational paradigm acknowledges the relational nature of knowledge creation, distribution, and interpretation, which arises from a process of entangled relations and associated paradigms (Barad 2007). The literature review is thus as much influenced by the researcher(s) themselves, as it is influenced by the perspective(s) of the respective author(s).

In the light of these observations, reviewing the literature is as much about understanding current knowledge as it is about understanding and considering how knowledge came to be. A relational paradigm thus posits that knowledge arises because it is co-produced by sociomaterial configurations and associated inner–outer change processes; it is neither fixed and permanent, nor individualized. Knowledge is a product of intra-action, “not something that someone or something has” (Barad 2007, p. 178). As Cilliers (2005, p. 609) argues, “There are facts that exist independently of the observer of those facts, but the facts do not have their meaning written on their faces. Meaning only comes to be in the process of interaction. Knowledge is interpreted data.”

Put simply, any literature review needs to recognize that (the analyzed and produced) knowledge is co-created and influenced by dominant social paradigms and associated inner–outer change processes. By conducting a literature review, we participate in a relational configuration through the entanglements of the involved agents.

The following guiding questions might thus help in moving toward a relational paradigm:

- I. How can I integrate sources beyond scholarly articles to better understand current knowledge? Are there ways to systematically include non-human perspectives? For example, if the identified literature only represents knowledge from certain elements, communities or groups, other sources need to be considered (e.g., illustrated by Vu’s (2018) ethico-auto-ethnographies or Kuntz and Presnall’s (2012) intra-views).

- II. What underlying or tacit ontological, epistemological, and ethical assumptions might be present within the reviewed literature? For example, how might dominant social paradigms and perspectives have influenced the presented theories of change, the exclusion of inner dimensions, or an overlooking of marginalized agents and non-human actors?
- III. How does my perspective, subjectivity, and social-ecological position influence the interpretation and analysis of the literature, and how can I take account of this? For example, I could consider adding related considerations when discussing the limitations of the review.

### Step 3: creating research hypotheses

From a mechanistic, positivist stance, a literature review is generally used to formulate hypotheses about the relationship between the independent and dependent variables. Within our dominant paradigm, these are generally expressed as testable hypotheses, and each hypothesis should be specific, concise, and presented as a statement that establishes a clear cause-and-effect relationship between the variables. They should also be falsifiable, which means that they offer supportive or neglective evidence through empirical qualitative or quantitative testing. Commonly, such hypotheses are formulated using either inductive or deductive reasoning (Smartt Gullion 2018).

An alternative approach, which is aligned with a relational paradigm, is abductive reasoning (Tullio 2016), sometimes also referred to as adductive reasoning. Abduction differs from both deduction and induction. It begins with an observed phenomenon that requires an explanation, then speculates on potential answers. Related reasoning involves a leap of the imagination and proposing hypotheses or interpretations that go beyond current evidence or knowledge. It is essentially a creative process of suggesting answers based on relational patterns, analogies, and insights from diverse sources. The researcher synthesizes information and uses speculative reasoning to suggest potential explanations, in addition to ‘obvious’ hypotheses (Nersessian 2010; Selg and Ventsel 2020; Van der Hoorn 1995). As Hertz et al. (2020, p. 9) point out:

“Abduction reverses the order of reasoning. It focuses on a phenomenon that needs explaining and then ponders potential causes. During this speculative activity, novel conceptualizations and dynamics can be introduced to an explanatory scheme. Methods and approaches in social-ecological systems research with this potential include place-based and context-rich qualitative research methods (like narratives and par-

ticipatory scenario development) and computational methods.”

Bateson (1982) argues that abductive reasoning is particularly pertinent for studying complex systems, such as ecosystems, social systems, and associated mental processes. Engaging in abductive reasoning allows researchers to extend their understanding beyond existing knowledge, potentially revealing deeper insights (ibid).

This can be illustrated by studying community resilience in the face of natural disasters. From a positivist perspective, the focus might be on testing specific hypotheses that predict the relationship between factors like socioeconomic status and disaster preparedness. Each hypothesis would be clearly defined and testable, aiming to establish a cause-and-effect relationship between independent and dependent variables. For instance, a hypothesis could propose that higher socioeconomic status correlates with better disaster preparedness measures. In contrast, adopting a relational paradigm would also involve abductive reasoning, which allows for additional exploration of the phenomenon and associated inner–outer transformation processes, enabling the researchers to identify and explore further hypotheses.

In summary, formulating hypotheses from a relational perspective requires their anchoring in the above-described steps 1–2. In addition, it should not only involve inductive and deductive, but also abductive reasoning. Deductive reasoning starts with a general rule, and inductive reasoning begins with a specific observation. In contrast, abductive reasoning assumes that observations are incomplete. Abductive reasoning embraces the idea that phenomena are unpredictable, contingent, dynamic, and emerge through open-ended intra-actions and relationships.

To explore this alternative path and move toward a relational paradigm, the following guiding questions might assist:

- I. Do my hypotheses reflect the dominant social paradigm and related ontological assumptions? For example, are they based on a ‘fix-it’ and ‘fix-others’ mindset that reinforces current, unsustainable paradigms? Do they only focus on apparent external problems and solutions without due consideration of related inner dimensions of transformation? Or do they presuppose a division between nature and culture? If yes, I might need to reconsider or make explicit related biases and effects.
- II. How do my hypotheses adequately consider the role of relationships (to self, others, nature, and the world at large)? For example, if they examine values without considering the relationships from which these values are co-created and emerge across individual,

collective, and system levels, I might consider redirecting their focus.

- III. How might abductive reasoning enhance my hypotheses? For example, I might speculate on potential explanations through the lens of different disciplines and sources, including Indigenous and local knowledge systems.

#### Step 4: defining the overall research design

During the design process, the research object is further defined, and an overall methodology is chosen to investigate it. Within the mechanistic paradigm, the boundaries of the object are clearly drawn. Complex phenomena are broken down into simpler components. The prevailing thought is that all complexity can be reduced to manageable parts and then understood through discrete analyses, measurements, or computational simulation (Smartt Gullion 2018).

It is clear that reductionist approaches are necessary in all scientific approaches to study some ‘thing’ or some ‘one’. At the same time, reduction has to be handled with particular care to include relational, ever-moving, and changing processes and aspects of systems that are key for understanding and transformation. For example, Bateson (2021) argues that common research approaches alone cannot answer questions regarding what and how autopoietic cycles of adaption within complexity are learning (Bateson 2021). In other words, overly mechanistic reduction might result in overlooking, or not engaging enough with so-called ‘warm data’, which is information about the interrelationships that form complexity, and thus the foundation of living systems and life itself. Warm data capture qualitative dynamics and offer another dimension of understanding to what is learned through “living data” (Bateson 2021, 2022).

The overall research design has to take account of this relational living systems information and associated knowledge creation processes. It requires consideration of constantly emerging inner–outer learning processes of experiences, cultural beliefs, and perspectives. Unreflected simplification might lead to unintended or even harmful outcomes and consequences that support unsustainable paradigms.

At the same time, as the relational paradigm builds on the ontological premise that everything is related to everything else, the challenge is to design research in a way that stays true to its ideas, while not becoming too diffuse or abstract. A view that attempts to encompass all relations risks losing the distinction between the system and its environment. Researchers can then fall into two traps—either a radical openness systems view that leads to relativism, or an approach that relies on measurement and computational simulation (Morin 2008). The former is criticized for being a reaction to reductionism and promoting a kind of holism

that negates the need for ontology. The latter fails to recognize the intangible nature of emergent properties (Preiser 2012). Therefore, both views have limitations: they either neglect the need for a reliable ontology, or oversimplify the intangible nature of ever-moving and emergent properties. A rigorous understanding of complexity denies total holism and total reductionism simultaneously, resulting in what Cilliers (2005, p. 261) describes as “performative tension”.

In practice, this performative tension can be addressed by drawing boundaries, while simultaneously redirecting attention to related interfaces and being aware of, and making explicit, the fact that these boundaries are artificial. This is also referred to as “critical complexity” (Audouin et al. 2013), which transcends and incorporates mechanistic strategies while recognizing the need for reduction and transparency. Critical complexity can bring value-based choices to the forefront, if the reduction itself is a conscious value-based choice, where the researcher chooses which aspects to focus on, while staying aware that the research and the researcher(s) themselves are part of the living system of engaging with knowledge creation (and thus are constantly changing and are changed through responsively relating with the emergent character of this process). It is not either the researcher(s) or the research outcome that independently creates knowledge; instead, the overall design process can be regarded *as* learning and potentially transformation on all levels (Bateson 2021; Preiser 2012; Wamsler et al. 2022a, b). This differs from the mechanistic approach, which often overlooks the consequences of reductionist practices, especially when defining the overall research design.

The critical complexity rationale recognizes that reductionism, under specific conditions, can by itself effectively enhance understanding. For instance, Cilliers (2005) argues that although reduction is unavoidable in our efforts to comprehend socioecological systems, we can shift our focus toward framing the strategies that are employed during the process of reduction. This change promotes a more relational standpoint, fostered through self-reflection.

Overall, finding an appropriate methodology can be a challenge and requires the careful consideration of relationships and engagements regarding both external and internal research stakeholders. Although several relational methodologies exist, such as intra-views (Kuntz and Presnall 2012), diffractive ethnography (Smartt Gullion 2018), ethico-auto-ethnography (Vu 2018), phenomenology, integral and narrative-based methodologies (Snowden and Greenberg 2021; Van der Merwe et al. 2019; Wilber 2021), the relational paradigm does not advocate prescriptive methodologies.

In summary, the challenge is to maintain a relational perspective without becoming overly abstract and risking relativist holism. This requires explicitly: (1) acknowledging the limitations of reductionist strategies; (2) accounting for relationships and associated inner–outer change processes

(individual, collective, system levels) that are relevant for understanding the research object; and (3) considering how the overall design can itself support transformation, both regarding its object and stakeholders.

For example, when investigating the impact of a city's electric vehicle adoption program on reducing carbon emissions, the researcher might consciously adopt a design that avoids falling into the trap of exhausting and exploiting oneself, others, and the planet (e.g., through explicit consideration of wellbeing, equity issues, the research's inherent CO<sub>2</sub> emissions, time management, and meeting formats). At the same time, methodologies can be applied in ways such that they, themselves, can support individual, cultural, and system transformation toward post-carbon behaviors (e.g., Osberg et al. 2024; Wamsler et al. 2022b).

To navigate alternative pathways for designing an overall research methodology, the following guiding questions might be thus helpful:

- I. How can I explicitly integrate a relational perspective when using reductionist methodologies? For instance, would it be beneficial to develop a research process that pursues a reductionist approach, while critically highlighting its limitations?
- II. How can I design the overall research approach in a way that accounts for relationships and associated inner–outer change processes (individual, collective, and system levels) that are relevant for understanding the selected object? For instance, how might I employ a hybrid methodology that integrates qualitative, quantitative, and related innovative approaches to ensure a comprehensive understanding (e.g., contemplative and creative approaches)?
- III. How can the overall design support transformation, for example, a change toward a more relational paradigm (both regarding the research object and stakeholders)? For instance, what relational approaches exist, and how might I combine them in my overall research design?

<sup>6</sup> According to integral theory (Wilber 2021), there are two dimensions of reality: an internally versus externally experienced dimension; and an individually versus collectively experienced dimension. Combining these two dimensions yields four domains of human experience, or ways of generating knowledge about the world. These four dimensions involve: (1) 'it'—knowledge of exterior and individual phenomena; (2) 'they'—knowledge of exterior and collective phenomena and their interactions; (3) 'we'—knowledge of internal and collective phenomena and their interactions' and 4) 'I'—knowledge of internal and individual phenomena and experiences (Esbjörn-Hargens 2010). In sustainability science, the fourth dimension—'I'—

## Step 5: data collection and analysis

Data collection aims to gather relevant information and answer the research questions and/or hypotheses. Diverse methods and techniques are used to systematically collect, record, organize, examine, and interpret related data and draw meaningful conclusions.

Within the mechanistic approach, new scientific knowledge and theory is usually built on the collection and analysis of credible sources of data. In this context, focus tends to be on certain (but not all) dimensions of reality and associated methods for data collection, and, consequently, certain (but not all) ways of generating knowledge about the world (Ives et al. 2019).<sup>6</sup>

The relational paradigm questions this fragmented approach (cf. Steps 1–4). In a context where all parts (e.g., culture, institutions, individual and collective behavior and views) are colored by the dominant social paradigm, the combination of scientific, philosophical,<sup>7</sup> and other methods of enquiry is particularly important to support both an integrated understanding of existing ways of knowing and innovative pathways for new knowledge generation. It requires introspection, contemplative, esthetic, visual, sensory, and embodied forms of sensemaking, and it also demands that we decolonize current methods, for instance, to avoid undermining local knowledge and the experiences of marginalized populations.

From a relational perspective, data that can be used to construct and test ideas can be empirical, but can also take theoretical, conceptual, or other forms (Bhaskar et al. 2016). For instance, viewing first-person enquiry or embodiment as a way of perceiving and understanding the world distinguishes it from the dominant mode of knowledge (Frank et al. 2024), known as propositional knowing. Propositional knowing primarily relies on creating conceptual maps, which, although helpful, can sometimes be deceptive as they oversimplify reality (the map is not the territory). According to systems theorist Nassim Nicholas Taleb, phenomenological knowledge is often more resilient and adaptable than propositional knowledge (Taleb 2013). This does not mean that propositional knowledge should be disregarded entirely; rather, when enriched by phenomenological knowledge, it creates space for the emergence of more imaginative and practical ideas (Pöllänen et al. 2023).

Footnote 6 (continued)

and the in-depth assessment of the relationship between the different dimensions has been largely neglected (Ives et al. 2019, 2023).

<sup>7</sup> For a philosophical theory to be valid, it must be internally consistent within its self-referential axioms and core assumptions. Philosophy makes reasoned arguments based on systems of logic, while science is focused on the systematic collection of evidence (Esbjörn-Hargens 2010).



Purely objective data does not exist, as pointed out by post-structuralists (Kirby 2011). Accordingly, St. Pierre (2013, p. 226) states that “if being is always already entangled, then something called data cannot be separate from me, out there for me to collect.” Denzin (2013, p. 35) therefore suggests thinking about data in terms of “empirical materials”. Data selection and interpretation thus always have material consequences (Barad 2007; Smartt Gullion 2018). Based on this understanding, data are phenomena that “cannot be engineered by human subjects but are differential patterns of mattering produced by neither the material nor the cultural but the material–cultural” (Vu 2018, p. 85) or naturecultural (Haraway 2016). Phenomenological and narrative-based methods explicitly account for this perspective (see related studies by Pöllänen et al. 2023; Wamsler et al. 2022b).

Furthermore, a relational paradigm involves acknowledging the potential relevance of data that are generally dismissed (Smartt Gullion 2018). For example, in statistical modeling, deviation from the mean is often dismissed as noise. To streamline the analysis, ‘noisy’ data undergo various manipulations including outlier removal, logarithmic transformation, or smoothing, ultimately resulting in a linear form (ibid.). While reductionist approaches are necessary (cf. Step 4), noise might conceal significant insights, for instance from non-human or marginalized groups (West 2006).

West (2006, p. 72) asserts that “smoothing or filtering the time series might eliminate the very thing we want to know.” Such processing tends to neglect the unique variability that characterizes individuals and emphasizes commonalities. Additionally, the understanding that large sample sizes are good undermines individual variability. As sample sizes grow, models tend to produce statistically significant results. However, this significance is purely a statistical concept and does not always reflect substantial relationships between variables. Even random correlations can appear statistically significant with large sample sizes (Smartt Gullion 2019). For certain studies, it might thus be beneficial to scrutinize the noise.

Building on the previous arguments, it is crucial to employ methods that can investigate all, also today’s ‘hidden’ dimensions, of reality and their inherent relationships. This requires combining traditional methods with other techniques and data sources, such as introspection, contemplative, esthetic, visual, sensory, and embodied forms of sensemaking.

For example, instead of merely using a statistical analysis of the number of bikes rented daily, and the corresponding decrease in individual car usage and emissions, researchers who are studying the impact of a city’s new bike-sharing program on reducing carbon emissions might also consider data from users about underlying (shifts in) values, beliefs,

emotions, and paradigms, inter-group variations, and obstacles and enablers for inner–outer change, which can take different forms (e.g., collected stories, constellations, or drawings).

When collecting and analyzing data from a relational perspective, the following questions should be considered to move toward a relational paradigm:

- I. How can I critically examine my role as a researcher during the data collection and analysis process? For example, how might my perspectives, assumptions, and values shape my data selection and interpretation?
- II. How can I embrace a broad range of methods, data types, and formats beyond traditional textual or numerical approaches? For example, maybe I can incorporate experiential, visual, or sensory forms of data to capture relevant human and non-human interactions.
- III. What is the noise that I might be overlooking? For example, if I have smoothed or filtered data, it might be relevant to revisit those data points (if possible) for a closer examination.

## Step 6: the writing process

The end product of research is some form of representation of the findings. Commonly, findings are reported in written form in an international journal, a poster, a book, or a monograph. The underlying assumption is that the results—through the use of language—can reflect and influence reality.

This is based on a certain understanding of objectivity and the role of information. From a mechanistic paradigm, research results represent an objective truth that was discovered. Epistemologically, the common understanding is that a knowing subject (the researcher) can objectively study objects (things in the world) to understand them.

As described above, relational epistemology questions the idea of an objective observer (Ngunjiri et al. 2010). This understanding is by no means original in its attempt to expose the limitations of reductionist practices. “Philosophers of science, such as Popper (1963), Feyerabend (1975), and Kuhn (1996), are well known for their arguments against false claims of objectivity and scientific autonomy” (Audouin et al. 2013, p. 17).

The challenge that arises from this understanding is how to represent this subjectivity when reporting results, sometimes referred to as a crisis of representation (Smartt Gullion 2018). The crisis of representation comes from asking whether the final product represents reality. Is it accurate? Trustworthy? Ethical? It results from speaking for others—in sustainability science, this is often marginalized humans

or non-humans—and the adequacy of their representation (*ibid.*).

Within the relational paradigm, the crisis of representation could be addressed by explicitly acknowledging related challenges, choosing alternative or additional forms of representation (art, stories, music), and portraying the self as performative (Verlie 2018). The latter can for instance involve moving away from a first-person scholarly narrator who is self-referential and unavailable to criticism or revision (Pollock 2007).

In contrast to representationalism, performativism focuses on “understanding thinking, observing, and theorizing as practices of engagement with, and as part of, the world in which we have our being” (Barad 2007, p. 133). This understanding of self represents identity and experience as uncertain, fluid, and open to interpretation and revision (Jones and Adams 2010).

Although this last research step makes the performative ‘I’ visible, related considerations are relevant for all steps. In the latter case, it relates to: inquiries about one’s role and entanglements; actively engaging with the subjects of research, for example, through dialog; making deliberate methodological choices; considering potential power dynamics, informed consent, confidentiality, and the well-being of participants and oneself; and being transparent about the role of the performative ‘I’ in shaping outcomes.

Another important aspect to consider during the writing process is the fact that writing itself can (and should) be understood as a relational process that, in turn, can foster or hamper relationality in real life (Barad 2007; Puig de la Bellacasa 2017). For example, the process can be constrained by project schedules, power structures, or other external pressures. This scenario tends to result in a more mechanical, instrumental, and task-oriented approach to crafting or ‘fitting’ content, scope, and form. Conversely, when writing emanates from an integrated self and an embodied, deeper connection to one’s thoughts, emotions, body, and creativity, words can flow more organically. In these instances, the writing process becomes an expressive act, which allows the person to tap into their full potential, rather than fulfilling external demands. Hawkins (2015) points out that writing is not merely a cognitive or linguistic activity, but is deeply entwined with social, emotional, and spatial contexts and relationships. Thus, writing itself is affected by relational influences, and the way of writing can support or hamper engagement in transformational change (*ibid.*).

In summary, the writing process requires addressing relational aspects of representation. It involves explicitly addressing related limitations (such as power dynamics and ethical considerations), portraying the self as performative, and using alternative or additional forms of representation where relevant (art, stories, music).

To integrate relational perspectives into the writing process, the following questions can thus be helpful:

- I. How might my perspectives and assumptions shape the interpretation and representation of my results, and how can I make them explicit in my writing? For instance, do I acknowledge related limitations in the description of research outcomes?
- II. Who do I speak for? Am I contributing to empowerment and justice, or am I disempowering certain individuals, groups, or other agents? For example, how can I give voice to non-human actors and consider their perspectives and interactions? How can I make my writings widely accessible for diverse audiences?
- III. What kind of world or other ways of representation can I use to support integrative understanding and transformation? For example, do my research results contribute to, or challenge, existing paradigms and practices? How can I reach people’s minds and hearts, and foster individual and collective agency, hope, and courage to act?

### Step 7: dissemination of the results

Lastly, the research process involves the dissemination of its results. Especially in sustainability science, the transfer of knowledge is a crucial step for fostering transformation, and results are disseminated through publishing in academic journals (*cf.* step 6).

From a relational perspective, relationships also play a key role in dissemination. As relational approaches require the consideration of the perspectives, needs, and relationships of human and non-human stakeholders, it is important to involve stakeholders in different forms in all research steps. In the context of dissemination, this relates to the sharing and application of research findings. Science communication increasingly uses dissemination formats beyond academic papers, such as podcasts, books, or policy briefs that aim to reach different societal groups. However, to support transformation, more relational communication and implementation strategies might also be needed, for instance, the creation of reflection and generative dialog spaces, community workshops, communities of practice, or other interactive formats (Mar et al. 2023). What makes these formats particularly relevant is their co-creative approach, placing researchers within a learning ecosystem, field, or network, as learning subjects themselves. Moreover, dissemination could place greater emphasis on the relationships and contexts in which the results were generated. This could involve storytelling, case study illustrations, or imaginary narratives as part of the dissemination strategy that highlight the interconnectedness of the findings within specific social, cultural, or environmental contexts.

Another key aspect of the relational paradigm that is relevant for dissemination is epistemic justice (Fricker 2007; Puig de la Bellacasa 2017; Whyte 2020). Epistemic justice calls for the recognition and amplification of marginalized or underrepresented voices in knowledge production and learning. In the context of dissemination, this translates into actively seeking out, addressing, and including diverse perspectives and knowledge holders in the communication and sharing of research findings. It involves sharing results beyond the scientific community, both with humans and other agents, where possible. It also includes the use of diverse communication channels and formats that cater to different audiences, languages, and accessibility needs. Such an approach embraces tangible actions and accessibility, to have a more inclusive impact that integrates different ways of learning and understanding.

In summary, dissemination requires actively seeking out and addressing relationships and diverse perspectives, and making research outcomes widely accessible in ways that integrate cognitive, social, emotional, ethical, and embodied learning.

For example, when disseminating outcomes, the researcher might also want to represent and ‘let speak’ other voices—such as birds or trees—through videos, photographs, or exhibitions, as an addition to the dissemination of written material.

To integrate relational perspectives into the dissemination process, the following questions can be helpful:

- I. In what forms can I best share these research results to account for, and address diverse stakeholders, needs, and perspectives? For example, are videos, exhibitions, networks, or communities of practice relevant channels for dissemination and implementation?
- II. Am I conveying information accurately, respectfully, and in ways that honor diverse contributions and contexts, particularly those of marginalized groups? For example, have I critically examined and reframed narratives that perpetuate injustices or exclude certain perspectives?
- III. How do I engage with relevant stakeholders during the dissemination process to support integrative understanding and transformation? For example, how can I move from traditional communication formats to more relational approaches that challenge current paradigms?

Our assessment of the different research steps has shown that some characteristics of a relational paradigm apply to several, or all, steps. For example, it is important to consider that sustainability science, by nature, is intertwined with human values, societal norms, and

ethics throughout the process. It is inherently subjective and normative, which makes the idea of “total” objectivity obsolete (Ngunjiri et al. 2010). Consequently, inner dimensions, including people’s individual and collective mindsets, beliefs, values, worldviews, and associated inner qualities/capacities are key for defining, pursuing, and achieving sustainability goals across all levels (individual, collective, system). Embracing a relational approach in sustainability science therefore necessitates an explicit consideration of related inner–outer transformation processes, which, in turn, requires conscious inter- and intrarelated through introspection and reflexivity. This shift broadens the scope of sustainability science and poses epistemological, ontological, ethical, and praxis-related questions regarding (1) how we see the world, (2) how we get to know, (3) how we engage, and (4) how we ensure equity considerations across all aspects (Ives et al. 2023; Wamsler et al. 2024). The relational paradigm thus decenters the human in the production of knowledge. We have explained related aspects in detail in the previous sections, and in those research steps in which their influence is greatest.

## **New pathways for sustainability science: toward a relational approach in research**

Given the challenges of the anthropocene, scholars are increasingly calling for a relational turn to address the root causes of today’s polycrisis. At the same time, little is known about the associated challenges, and there is little advice regarding how to operationalize the approach in sustainability science.

Against this background, this paper explored how we can break out of modern, unsustainable paradigms and approaches, and instead apply more relational thinking, being, and acting in the way we conduct research. To achieve this, we systematically list all major research phases and assess possible pathways for integrating a relational paradigm (see Table 1 for an overview and supplemental material).

We show that moving toward a relational paradigm requires us to methodically question and redefine existing theories of change, concepts, and approaches. However, transitioning from a mechanistic to a relational paradigm in the domain of sustainability science and beyond does not involve a straightforward substitution.

Instead of viewing paradigm shifts as abrupt replacements, our analyses highlight the evolutionary and emergent nature of such changes. Contrary to Kuhn’s (1996) concept of successive paradigms, our approach recognizes the value of integrating and acknowledging the partial validity of multiple, preceding, and mutually informing

**Table 1** Overview of possible questions to help moving toward a relational paradigm in research

Research process step	Possible questions that can be used to make the implicit explicit when conducting research and developing processes and practices of asking to increasingly integrate the relational paradigm into one's work
Step 1: identifying the research problem and niche	<p>I. How do my research problem and associated niche consider interdependencies, connectedness, nonlinearity, uncertainty, and emergence? How do they account for (the quality of) relationships and related inner–outer transformation processes across individual, collective, and system levels?</p> <p>II. Is the wording of the problem, niche, and associated aims aligned with relational perspectives, or does it strengthen current mechanistic paradigms?</p> <p>III. How can I explain relational, unfamiliar, or new concepts so that others (co-researchers, readers), who are new to this way of thinking, can understand? How can I create a bridge between the current and a potential new, more sustainable paradigm?</p>
Step 2: reviewing the literature	<p>I. How can I integrate sources beyond scholarly articles to better understand current knowledge? Are there ways to systematically include non-human perspectives?</p> <p>II. What underlying or tacit ontological, epistemological, and ethical assumptions might be present within the reviewed literature?</p> <p>III. How does my perspective, subjectivity, and social–ecological position influence the interpretation and analysis of the literature, and how can I take account of this?</p>
Step 3: creating research hypotheses	<p>I. Do my hypotheses reflect the dominant social paradigm and related ontological assumptions?</p> <p>II. How do my hypotheses adequately consider the role of relationships (to self, others, nature, and the world at large)?</p> <p>III. How might abductive reasoning enhance my hypotheses?</p>
Step 4: defining the overall research design	<p>I. How can I explicitly integrate a relational perspective when using reductionist methodologies?</p> <p>II. How can I design the overall research approach in a way that accounts for relationships and associated inner–outer change processes (individual, collective, and system levels) that are relevant for understanding the selected object?</p> <p>III. How can the overall design support transformation, for example, a change toward a more relational paradigm (both regarding the research object and stakeholders)?</p>
Step 5: data collection and analyses	<p>I. How can I critically examine my role as a researcher during the data collection and analysis process?</p> <p>II. How can I embrace a broad range of methods, data types, and formats beyond traditional textual or numerical approaches?</p> <p>III. What is the noise that I might be overlooking?</p>
Step 6: the writing process	<p>I. In what forms can I best share these research results to account for and address diverse stakeholders, needs, and perspectives?</p> <p>II. Am I conveying information accurately, respectfully, and in ways that honor diverse contributions and contexts, particularly those of marginalized groups?</p> <p>III. How do I engage with relevant stakeholders during the dissemination process to support integrative understanding and transformation?</p>
Step 7: dissemination of the results	<p>I. How do my research problem and associated niche consider interdependencies, connectedness, nonlinearity, uncertainty, and emergence? How do they account for (the quality of) relationships and related inner–outer transformation processes across individual, collective, and system levels?</p> <p>II. Is the wording of the problem, niche, and associated aims aligned with relational perspectives, or does it strengthen current mechanistic paradigms?</p> <p>III. How can I explain relational, unfamiliar, or new concepts so that others (co-researchers, readers), who are new to this way of thinking, can understand? How can I create a bridge between the current and a potential new, more sustainable paradigm?</p>

paradigms. It is about taking small steps and creating bridges between the current and a potential new paradigm, by exploring how best to be in relationship, with ourselves, our fellow humans, and the other-than-human in a regenerative way.

Yet, as Raymond et al. (2021) point out, methodological challenges and pragmatic decisions to move toward more

relational thinking must be addressed, such as the need for setting certain systems boundaries or interfaces. As suggested by the concept of critical complexity, it is possible to transcend the limitations of our dominant mechanistic approaches, while acknowledging the necessity for reduction in research. It embraces the nuanced understanding that some reductionist practices are indispensable, while

advocating for a broader framework that encompasses the complexity of entangled socio-ecological systems. Moreover, as Walsh et al. (2020) point out, applying a differentiated relational ontology acknowledges both the separate as well as the relational reality. For instance, dealing with challenges such as identifying leverage points in research—which stems from a bifurcation—means that we acknowledge paradoxes. We might apply the leverage points model to identify where to intervene in the system, while at the same time acknowledging that the model is limited and not fully aligned with relational thinking (Raymond et al. 2021). The need to embrace paradoxes is, in fact, part of moving toward a relational approach (e.g., Kulundu-Bolus 2023): it requires a humble and thus relational attitude and understanding of the research process and the results in themselves.

A key challenge for moving toward a relational paradigm is the current landscape within which sustainability science operates, as it is in itself an expression of the dominant modern paradigm. The field operates within a larger context that is characterized by constant acceleration, a high-speed society, exponential technological development, and continuous social change, all of which affect our own relationships and those involved in any research object (Rosa 2019). Tensions thus arise from the clash between the inherent qualities of a relational approach—which emphasizes interdependencies, connectedness, nonlinearity, uncertainty, and emergence—and systemic pressures that prioritize rapid outputs, quantifiable outcomes, and often individualistic gains. We therefore acknowledge that a paradigm shift needs to go hand in hand with an overall reevaluation of how systems, institutions, policies, and practices are structured and incentivized within sustainability science.

To integrate a relational paradigm into the researcher's work, we suggest developing processes and practices of reflexive praxis, such as interrupting existing conversations, listening deeply to overlooked, marginalized, or suppressed perspectives, and daring to ask difficult and new questions that support mutual learning toward the emergence of a more relational being, understanding, and acting upon the world (Spreitzer 2021). Moving toward a more relational paradigm is thus not just about adopting a different framework, but is about cultivating individual and collective capabilities and capacities that allow us to challenge conventional norms, structures, and institutions, and encourage exploration and creation from diverse viewpoints toward potential alternatives (Wamsler et al. 2024).

Challenging mainstream thought and daring to ask different questions in each research step are crucial to shifting current scientific norms and systems. Hence, we offer a catalog of questions that allows us to systematically integrate relational being, thinking, and acting into the research process (see Table 1, as well as suppl. material for an overview

of the questions and examples). Each question encapsulates underlying assumptions and implications for the research process and can thus serve as a catalyst for embracing a more relational perspective.

Many of the characteristics of a relational paradigm have an impact across multiple research steps. These aspects include the need to decenter the human perspective, account for the role of relationships, support integrative inner–outer transformation processes across individual, collective, and system levels, and encourage deep reflection on one's positionality. While these characteristics influence the entire research process, their significance becomes more pronounced in certain steps, which we therefore explored in more detail in the previous sections.

Although we offer some concrete ideas regarding how to move toward a relational paradigm, further research is required to test our theoretical and conceptual considerations and generate further measures and pathways. As the relational paradigm focuses on the (quality of) relationships within systems, and associated inner–outer transformation processes, one key aspect to consider is whether, and how, changes in relationships can be best addressed. Research on the human–nature connection, such as the Connectedness to Nature Scale (Mayer and McPherson Frantz 2004), already exists. However, this only addresses a small part of the story, and related work is generally not linked to sustainability outcomes across individual, collective, and system levels. Other ways to study changes in relationships and their link to sustainability outcomes have been tested, for instance, in the context of leadership training for the European Commission, the UNDP Conscious Food Systems Alliance, and the Inner Development Goals (IDG) initiative (Janss et al. 2023; Jordan 2021; Ramstetter et al. 2023; Rupprecht and Wamsler 2023; Wamsler et al. 2024). Based on the inner–outer transformation model, the change in the relationship to self, others, nature, and the world at large is here applied as a proxy for inner–outer transformation and associated sustainability outcomes (Wamsler et al. 2021). Research is needed to further assess related aspects, for instance to account for intergenerational trauma and power dynamics, and identify whether the latter might be transactional or a means-in-itself, as transactional relationships often lead to overexploitation and injustice (Rosa 2019).

To conclude, we must dare to question our questions, and dare to ask new questions—relational, existential questions about our identity, our role, and our responsibility in the world in more reflexive and thus transformative ways. It is about developing sustainability and regeneration as a capacity, and as a foundation for pursuing research not as only a form of 'about-ing' and 'enact-ing', but also as a 'within-ing' and thus 'be-ing'. The suggested guiding questions may appear to be small, individual acts. However, these small choices can have profound impacts, as they can help to

initiate deeper changes, to let go of mental habits, decolonize our minds, and, ultimately, challenge the cultural, institutional, and political landscape that maintains the story of separation of humans and nature, and the story of human dominance and superiority over the “living” that underlies both our current research approaches and today’s sustainability crises.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s11625-024-01510-9>.

**Acknowledgements** This article is a co-creation, encompassing the more-than-human-world, along with our cultural heritage and predecessors who have formed our knowledge and understanding, and the cultural and technological tools such as networks and laptops and people involved in their development.

The research was supported by the Existential Resilience project funded by Lund University and two projects funded by the Swedish Research Council Formas: (1) Mind4Change (grant number 2019-00390; full title: Agents of Change: Mind, Cognitive Bias and Decision-Making in a Context of Social and Climate Change), and (2) TransVision (grant number 2019-01969; full title: Transition Visions: Coupling Society, Well-being and Energy Systems for Transitioning to a Fossil-free Society).

**Funding** Open access funding provided by Lund University.

## Declarations

**Conflict of interest** The authors declare no competing interests.

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