Environmental Science and Policy 153 (2024) 103683

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

Can we talk? Disrupting science circles with narrative-led dialogs

Sina Leipold [a,b,*], Anran Luo [a], Machteld Simoens [c], Hanna Helander [d], Anna Petit-Boix [e]

[a] Helmholtz Centre for Environmental Research - UFZ, Department of Environmental Politics, Permoserstr. 15, Leipzig 04318, Germany
[b] University of Jena, Chair of Environmental Politics, Bachstr. 18k, Jena 07743, Germany
[c] University of Basel, Social Transitions Research Group, Rheinsprung 24, Basel 4051, Switzerland
[d] University of Kassel, Center for Environmental Systems Research, Wilhelmshöher Allee 47, Kassel 34109, Germany
[e] Sostenipra Research Group (SGR 00734), Institute of Environmental Science and Technology (ICTA), Unidad de excelencia "María de Maeztu" (CEX2019-0940-M), Universitat Autònoma de Barcelona (UAB), Bellaterra, Barcelona 08193, Spain

ARTICLE INFO

Keywords:
Narratives
Disruption
Interdisciplinarity
Group values
Sustainability transformation
Reflexivity

ABSTRACT

Sustainability scientists are increasingly expressing concerns about the lack of creativity and reflexivity, vital elements for driving sustainability transformations, in their profession. We argue that these concerns stem from established scientific practices of knowledge accumulation and interdisciplinary research, often neglecting the influence of group values and disciplinary paradigms. In response, we propose the narrative-led dialog as a tool for sustainability scientists to recognize, analyze and engage with such values and paradigms within interdisciplinary scientific practice. Building upon existing methods, the use of narratives offers scientists an additional way to identify and address the complexities of conflicts, overlaps, and uncertainties inherent in the values and paradigms that guide scientific research and collaboration. This process of revelation can assist sustainability scientists in disrupting traditional academic boundaries, fostering an environment that better nurtures sustainability transformation. Through the narrative-led dialog, scientists can achieve several crucial objectives; they can (1) deepen their scientific practice, (2) identify, discuss and negotiate the underlying values shaping their research, and (3) create an environment conducive to breakthrough ideas, both within their specific fields and across broader sustainability science communities.

1. Introduction

When we are young, our circle of friends means the whole world to us. As soon as we meet new people through school, travel or hobbies, we realize how small and incomplete that world was. Sometimes this realization can trigger a change of direction in our lives. Sustainability science thrives on such disruptive insights that can initiate and shape a change of direction towards sustainability. However, Park et al. (2023) argue that such reorientations have become alarmingly rare. Similarly, sustainability scholars increasingly perceive their profession as insufficiently contributing to informing and shaping societal change. Scholars have attributed such shortcomings to a lack of reflection on overarching problematizations as well as disciplinary and theoretical paradigms (Giampietro, 2023; similarly Grabs et al., 2021; Cashore, 2022). Additionally, they point out the proliferation of partly overlapping or contradictory concepts and bodies of knowledge (Geissdoerfer, 2017; Apetrei et al., 2021), as well as an inflation of highly specialised, fragmented empirical studies (Pauliuk, 2020; Kirchherr, 2023), which are often not anchored in established concepts and theories (Newig and Rose, 2020; Kuhlicke et al., 2023).

We argue that these concerns about scientific progress and contribution arise in part from established practices of doing science. Sustainability scientists use two core practices to enable scientific progress with new, potentially disruptive ideas. One is knowledge accumulation, using literature reviews, expert panels, surveys or other tools to collect, synthesize and analyze existing knowledge. It allows an overview of what has already been achieved, thereby facilitating learning, problem solving and reasoning (e.g. Jensen & Rodgers, 2001). However, under current conditions of rapidly expanding knowledge and information, there is an increasing danger that accumulation will focus only on "narrow slices of existing knowledge" and that the overall picture will be overlooked (Park et al., 2023, p. 142; Drupp et al., 2020). A second common practice in sustainability science is to engage with different disciplines. These interdisciplinary interactions promote the expansion of scientists' 'comfort zones' and the integration of different ideas and bodies of knowledge. While this practice has proven to be crucial in

* Corresponding author at: Helmholtz Centre for Environmental Research - UFZ, Department of Environmental Politics, Permoserstr. 15, Leipzig 04318, Germany.
E-mail address: sina.leipold@ufz.de (S. Leipold).

https://doi.org/10.1016/j.envsci.2024.103683
Received 20 July 2023; Received in revised form 18 January 2024; Accepted 21 January 2024
Available online 26 January 2024

fostering ground-breaking sustainability science, it risks disorientation by mixing diverse concepts, problematizations and paradigms, some of which challenge each other or may "crowd out" more marginal views (Pearce and Ejderyan, 2020; Lawrence et al., 2022; Leipold et al., 2023).

We argue that bypassing the role of values and paradigms limits the potential of knowledge accumulation and interdisciplinary research to enable new ideas and scientific progress. Scholars have long argued that the scientific endeavor is as much based on rational arguments as on group-specific paradigms and values (Kuhn, 1962; Stephan, 2015; Lahsen and Turnhout, 2021). A widely accepted paradigm in sustainability science, for instance, is the balancing of environmental conservation with human material interests. This paradigm rests on anthropocentric (human-centered) values, e.g. resource efficiency, economic prosperity. While these values shape the work of entire research communities (see, for instance, Cashore, 2022), sustainability scholars repeatedly criticize the lack of consideration of normative assumptions in their field (e.g., van der Hel, 2018; Norström et al., 2020; Caniglia et al., 2021). They see this as particularly problematic for a scientific field that aims to shape social change, inherently fusing science with policy, knowledge with values, and experts with the public. Certainly, addressing values and paradigms will not solve all problems in sustainability science, e.g. those related to scientific (mis)incentive systems. Nevertheless, the engagement and reflection of scientists on their values and paradigms is a crucial step to foster fruitful interdisciplinary exchange and potentially disruptive ideas that could initiate and shape societal changes of direction towards sustainability (Miller et al., 2014; Horcea-Milcu et al., 2019; Hazard et al., 2020).

Drawing inspiration from existing practices, we introduce an approach – the narrative-led dialog – that further enables sustainability scientists to recognize, analyze and engage with the role of values in an academic and interdisciplinary setting. By studying the narratives of communities in sustainability science, the dialog reorganizes knowledge along underlying values, which we understand as an entanglement of cognitive, relational, and political values (Chan et al., 2018; Longino, 1996). Its originality lies in its ability to (1) deepen existing scientific practices to address the role of values, (2) discover, discuss and negotiate the values and value conflicts underlying their research, and (3) generate an environment for new ideas within and beyond research communities and disciplines. While we cannot control or predict new perspectives on paradigms and values in science, the narrative-led dialog can help to create an environment that makes them more likely.

2. Using narratives to recognize, analyze and engage values and paradigms in science

The narrative-led dialog uses narrative as a human communication device that uniquely highlights values and paradigms underlying social processes like scientific integration and collaboration (Hajer, 1995; Kaplan, 1993, Feldman et al., 2004). The human brain can process information in a more complex way when it is presented as a story (Hardy, 1968; Graesser and Ottati, 1995).

In this paper, we use the term 'narrative' to describe stories that give meaning to social or physical phenomena. They make sense of these phenomena by condensing and structuring complex information, offering interpretations of who or what is considered significant (Hajer, 1995; similarly Dahlstrom, 2014). These stories typically involve a setting in which sentient and emotional characters engage in a sequence of events that form a coherent plot. This plot often culminates in a conclusion - or moral - that provides guidance for future action or behavior (Fischer and Forester, 1993, Roe, 1994). In science, such stories reveal the foundations of disciplines and theories. These ontological and epistemological foundations describe varied interpretations of what is real in the world and the concepts and categories deemed essential for studying physical and social phenomena (Smith, 1999; Oxford Dictionary, 2022). Through narrative analysis, new perspectives emerge that show how ontological and epistemological views converge or diverge, for example in relation to societal change.

Through their morals, narratives serve as value carriers (Stone, 1989; Hajer, 1995). They help get everyone on the same page and establish acceptable behavior. At the same time, dominant narratives legitimize existing scientific conventions and power relations, supporting them or making them seem natural. By giving specific attention to the narratives of research communities, the narrative-led dialog offers a hands-on tool for researchers to become more aware of their own as well as others' underlying values and paradigms that influence collective scholarship. The set of narratives encourages exploration and reflection beyond our 'circle of friends' and helps scientists realize the full potential of knowledge accumulation and interdisciplinary research.

In particular, the narrative-led dialog offers three steps to use narratives for bringing values to light and creating the environment for open and engaging communication (see Fig. 1 as well as Section 3 for a detailed description). The goal is to create an environment for different communities to recognize and reflect on their underlying values and paradigms. Similar to the quantitative story-telling approach, the narrative-led dialog identifies the narratives that are used to inform policy, but its aim is not to "check the quality of an elected story-telling and related policy narratives" (Renner and Giampietro, 2020, p. 2). Our proposal provides a space where different communities can engage with the overlaps and differences between their narratives, illuminating new ways of seeing the world and fostering potentially disruptive ideas. The creation of the narrative-led dialog is based on our experiences, learnings, and challenges as an interdisciplinary team focusing on narratives and the circular economy (CE) (Leipold et al., 2023; Luo et al., 2023; Petit-Boix and Leipold, 2018; Helander et al., 2019; Simoens et al., 2022). CE is a topic emblematic of many debates in sustainability science, where scientists often hold diverse and sometimes conflicting views, based on disciplinary ontologies as well as diverse values towards sustainability problems and potential solutions. In Box 1, we illustrate the narrative-led dialog with experiences collected during an interdisciplinary project in this field.

2.1. The narrative-led dialog

In order to use the benefits of narratives and to enable a more value-aware sustainability science, a new approach is needed. Ideally, this approach will help interdisciplinary research communities recognize their own narratives, analyze underlying values and paradigms, as well as realize their implications when addressing sustainability issues. Team science has shown that teams that agree on common research principles and are able to reach consensus face fewer collaboration challenges (e.g. Stokols et al., 2008). However, interdisciplinary teams in sustainability science may encounter conflicts due to different goals and expertise (Hall et al., 2018).

In this context, there is an emerging literature on paradigms and values in sustainability science (Raymond et al., 2019). Most articles suggest to "consider the ways values are studied or operationalized in transformational sustainability science" (Horcea-Milcu et al., 2019) and propose frameworks for organizing how values are/can be considered in sustainability science (e.g. van der Hel, 2018, Horcea-Milcu, 2022). What is missing from these works is a hands-on tool to create a systematized scientific practice that helps realize these goals. Hazard et al. (2020) propose one of the few practical tools for reflecting on values in the research process by providing a heuristic for researchers to self-reflect on research positions in sustainability transitions. Similarly, Crouzat et al. (2018) emphasize scientists' self-awareness at the science-policy interface, providing a decision tree to help highlight the intertwining of personal values and scientific neutrality. Both approaches agree on the importance of reflexivity in scientific disciplines that influence policy. While we argue for team-based introspection and value negotiation in interdisciplinary contexts, Hazard et al. and Crouzat et al. emphasize an individual's ethical-political stance. Finally, Winowiecki et al. (2011) propose collective exercises like mind mapping,

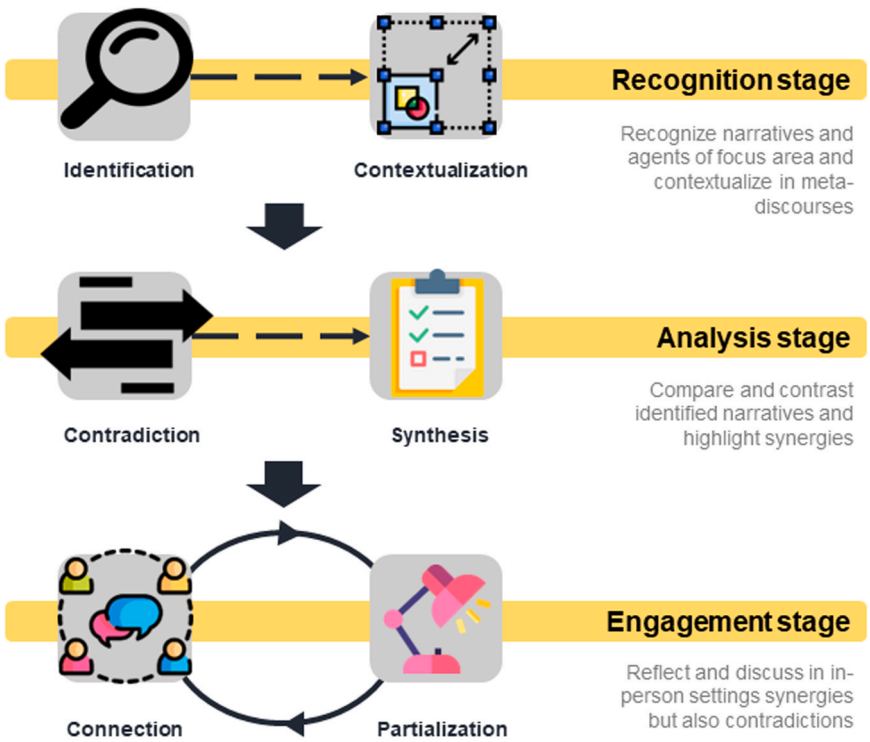

Fig. 1. A narrative-led dialog for sustainability science. Image credit: Icons created by Freepik available through Flaticon.

cross-impact analysis, and backcasting to create common research objectives and questions in interdisciplinary teams.

In contrast, our tool uses narrative (de)construction to reveal and highlight concepts and categories that researchers consider relevant to societal transformation. This means that the narrative-led dialog focuses not only on identifying common goals and questions, but also on deep-rooted contradictions, and on unpacking and understanding the underlying values and paradigms that might inform and shape these research goals. In doing so, the narrative-led dialogue builds on existing work on provoking radical or disruptive reframing in social learning and futures studies. For example, Stompff, Smulders, and Henze (2016) highlight the impact of cognitive disruption and reframing in social influence and design. Similarly, Sol et al. (2013) focus on trust and reframing in social learning, which aligns with our emphasis on interdisciplinary collaboration. Heinonen and Ruotsalainen (2013) introduce Futures Clinique, a method for promoting foresight and radical futures. The narrative-led approach shares common themes with these works, such as the importance of reframing and collaborative processes. However, it differs in its specific application to sustainability science and its focus on deepening current scientific practices through engagement with underlying values and paradigms, and fostering interdisciplinary understanding and innovation. As Horcea-Milcu (2022) argues, "increasing evidence highlights that it is less about revisions in value systems, but about the imperative to reflect on and engage with diverse and plural values" (p. 8, similarly Wiek et al., 2011). We argue that narratives are an appropriate means to this end. The narrative-led dialog provides a practical guide to enable a reflection of diverse and plural values because it is tailored to group-level (rather than individual) reflection and engagement.

What values need to be reflected on? Research communities need to ask themselves what conclusions - or morals - their collective plots ultimately reach, and what messages they convey about how to behave in the future. To do this, we need to reflect on the normative assumptions that underline scientific practices (e.g. the selection of research topics). These assumptions are always based on the attribution of values to the phenomena to be transformed (e.g. valuing waste), to the actors who should drive the transformation (e.g. corporations), and to the best ways of doing so (e.g. environmental stewardship) (Carolan, 2006; Rosenlund et al., 2017, Horcea-Milcu, 2019).

How can we reflect on these values? Inspired by the existing efforts in the literature outlined above as well as building on our collective experiences of interdisciplinary sustainability and narrative research, we suggest six specific strategies: 1) identification, 2) contextualization, 3) contradiction, 4) synthesis, 5) connection, and 6) partialization (Fig. 1). These strategies are suggested as a facilitation roadmap for value-aware dialog between scholars, going through three stages of recognition, analysis and engagement The dialog is intended to be an iterative process. The facilitators of this process can choose to focus on all or just a few of the strategies, depending on the goal and setting of their application in practice, as well as time and resources available. Leipold et al. (2023) provide one first example of its application possibilities.Overall, the narrative-led dialog encompasses diverse goals of interdisciplinary projects such as development of sustainability concepts at the theoretical and practical levels, interdisciplinary engagement as well as the identification of future research directions. It suggests an alternative approach for disclosing and addressing the variety of scholarly insights. As such, we propose that interdisciplinary research project teams investigating sustainability concepts (e.g. circular economy, ecosystem services, climate mitigation, resilience) as ideal facilitators of the narrative-led dialog, as they have the motivation, time, and resources. We also recommend sustainability scholars working in consortia, partnerships or any interdisciplinary environments to try out the narrative-led dialog. Facilitating this process may not only lead to an increased understanding and acceptance between the scholars involved, but the results and outcome of the process can also be published jointly. This would make the narratives and debates transparent for the broader sustainability community (and other communities). It would also serve to reflect on and further develop the narrative-led dialog and help establish regular narrative-led dialogs at conferences and workshops within the community.

2.2. Recognition stage

2.2.1. Identification

The first strategy is the identification of both the narratives on the topic (e.g. CE) or field (e.g. industrial ecology) at hand as well as the agents who reproduce them within science. This strategy is a crucial prerequisite for the other stages of the narrative-led dialog. The identification of the narratives and agents can be done through a traditional literature review focused on underlying narratives or through a survey of key scholars about their assumptions or values related to their work. Based on this data, the narratives underpinning the findings and research needs can be illuminated, using established methods of narrative research (e.g. Hajer, 1995, 2006; Leipold and Winkel, 2017). This strategy, thus, uses narratives to organize large amounts of research along the assumptions the findings are based on. The respective morals these narratives present will then disclose the underlying normative and political assumptions that we all carry.

2.2.2. Contextualization

The following strategy enables contextualizing the identified narratives within more general meta-discourses of sustainability science (see for example Dryzek, 2021; Bäckstrand & Lövbrand, 2006). Especially when focusing on a rather specific topic or small subfield, or aiming for accumulation across various topics or subfields, contextualization is key. By relating these narratives to larger sustainability debates (e.g. on economic transformation in the case of CE), the normative underpinnings and assumptions become clearer. The contextualization can be integrated with the identification strategy and build on the existing literature in the field.

2.3. Analysis stage

2.3.1. Contradiction

Building on the findings of the recognition stage, the following strategy focuses on comparing and contrasting the narratives. This generates more transparency about how the ontological differences in disciplinary and theoretical paradigms also form an explanation for different perspectives on the topic or field (e.g. in different understandings of the relationship between CE and policy). At this stage, narratives help to manage disciplinary divides and use them productively by enabling a common language among diverse groups. Narratives overcome disciplinary language more easily than epistemology, theory and assumptions. While these concepts provide a necessary depth and exactness for scientific advancement, they demand an understanding of distinct disciplines. Expressing research ontologies in the form of narratives provides an easy-to-understand baseline that is graspable for scientists working across disciplines. Narratives are particularly helpful to see whether and how different disciplinary viewpoints correlate, overlap, or contradict each other – opening new questions and revealing blind spots.

2.3.2. Synthesis

The recognition stage also provides the basis for highlighting points of overlap between the narratives and to present an integrated overview or synthesis. This synthesis can be done either in conjunction with "contradiction" or as an individual exercise. Once major overlaps and complementarities between the narratives have been delineated, it is advisable to also discuss these with the identified scholars of the topic or field to verify their plausibility and make sure that no overlaps have been missed or misrepresented. Again, this verification and feedback can be achieved via a workshop or written feedback.

At this stage, narratives increase research transparency. Research transparency includes terms, definitions, methods or data. Underlying ontologies and disciplinary traditions (e.g. how to formulate meaningful research questions) are equally important. We must know and recognize our own biases and blind spots. With the help of narratives, we can access underlying ontologies and discuss latent ontological choices within and across disciplines. Narratives enable explaining which viewpoints underpinned a certain research question, a specific comparison or the choice of system boundaries. Doing so facilitates quality assurance and evaluation (Eisenhardt, 1989). More importantly, it reduces the risk of "adverse ontological selection, whereby certain approaches and insights are systematically ignored and certain problem conceptions are prioritized over others" (Grabs et al., 2021). Delineating areas of agreement and disagreement on the underlying goals that we want our research to contribute to opens up a new level of scholarly transparency and enhances science's transformative potential.

2.4. Engagement stage

2.4.1. Connection

In this last stage, we move from analyzing the narratives to realizing the potential of the narrative-led dialog. With the strategy of engagement, it is crucial to reflect and discuss the narratives in an in-person setting. We argue that this form of engagement can contribute substantially to the scholarly advancement of topics and fields. One outcome of this strategy could be the development of a research agenda covering gaps and contradictions but also overlaps between narratives. Another outcome could be the joint formulation of key take-aways for decision-makers and practitioners about a topic or research field. An important outcome could be building a joint language across disciplines and narratives as well as substantial trust-building within the community.

2.4.2. Partialization

With the strategy of partialization, we suggest taking the misalignments of narratives and related findings during the contradiction strategy a step further. The specific disagreements can be identified and placed next to each other. Without aiming to integrate, this strategy can better illuminate why some findings do not fit together and, thus, show gaps and blind spots. This can be done as an individual step or as part of the "connection" strategy. Eventually, partialization can help to formulate new research questions or a research agenda covering areas in between the misaligned parts. This strategy follows the argument that "refining partial paradigms, and specifying the classes of actions for which they are relevant, may be a more fruitful path to limited theory and propositions than the route of instant generalization" (Allison, 1971, p. 275; in Grabs et al., 2021). This recognition of different classes of action and the available knowledge about them may be particularly relevant when it comes to decision-making that may cut across diverse classes of action.

2.4.3. The pilot case: interdisciplinary narrative-led dialog in circular economy research

The narrative-led dialog emerged from our experiences, learnings, and challenges as an interdisciplinary team of three social scientists and two industrial ecologists collaborating on the circular economy (CE) within the five-year research project "Circulus". In the project, we undertook a first effort to accumulate knowledge on CE across disciplines. This exercise was conducted in a Delphi-style format (see Leipold et al., 2023 for a full publication) that inspired the structure of the narrative-led dialog. Building on this experience, we provide a first example of how the different stages of the narrative-led dialog can be applied and the findings it can offer. For more practical details on timing, facilitator requirements, etc., see the methods section of (Leipold et al., 2023).

THE ISSUE: CE makes a good illustrative example for the narrative-led dialog strategies as it is a major normative and political paradigm for sustainability transformations (Korhonen, 2018, Blomsma and Brennan, 2017; Genovese and Pansera, 2021). CE provides a toolbox for sustainability innovations (Lazarevic and Valve, 2017) while being increasingly concerned with actions, practical solutions and societal

change (Geissdoerfer, 2017; Kirchherr et al., 2017). The interdisciplinary nature of the CE concept provides a unique opportunity to connect technological, economic, social, and behavioral disciplines of science. However, **the assumptions and values of CE scholars may lead to different kinds of study designs and policy recommendations.**

THE RECOGNITION: We surveyed the scholarly community working on CE across disciplines to gather their lessons learned and their perspectives on future research needs for policy-relevant research. To do so, we systematically selected key CE scholars based on publication records. These scholars were invited to participate in an online survey and discussion rounds. We asked for three policy-relevant lessons learned throughout their careers as well as three pressing research questions. 54 scholars participated in the overall process. Based on this data, we **identified** the narratives underpinning the findings, illuminating an **optimist, reformist, and skeptical narrative** (also **contextualized** within larger sustainability debates) on the potential of CE for sustainability transformations.

THE ANALYSIS: Subsequently, we compared the optimist, reformist and skeptical narratives, which generated more transparency about how ontological differences informed **contradictions** in perspectives on the CE. The optimist narrative perceives CE as a crucial foundation of a sustainability transformation and the research building on this perspective often presents concrete actions. This narrative is mainly built around values of trust in technology, resource efficiency, and business opportunities. The reformist narrative takes a more cautious perspective, arguing that CE holds potential but sustainability transformations can only be met if current societal structures are overcome and addressed, attaching greater value to, for example, social dimensions of the CE concept. Lastly, the skeptical narrative questions the usefulness of CE for sustainability in general. It argues that the concept lacks a critical reflection on the distributional and environmental consequences of economic growth as well as the feasibility of decoupling economic and environmental impact, and reinforces business-as-usual practices. As such, the skeptical narrative is driven by values of democracy, community and justice. The study also applied a second analytical strategy, using the points of overlap between the 3 master narratives to **synthesize** an integrated overview and outline a concrete research agenda, making the disciplinary findings more accessible for policy and practice.

THE ENGAGEMENT: The process and findings of the study were brought together in an academic publication (Leipold et al., 2023), thus engaging the wider research community in a **dialog** on the contradictions in the three narratives. Due to the mobility limitations during the COVID-19 pandemic, the participants engaged in online discussions and written feedback rounds to voice their opinions on the narratives, how they contradict one another and how they are best synthesized to be comprehensive and transparent. A deep **partialization** process could not be conducted due to time and resource restrictions but the CE scholars did **engage** with their own and others' positioning within the three narratives, which facilitated a communication process among disciplines and worldviews. By focusing on conflicting and disintegrating findings, a deeper reflection would illuminate that the narratives contain **partial** knowledge and reveal specific disagreements and blind spots.

2.5. Contributions of the narrative-led dialog to sustainability transformations

To support paradigm shifts and disruptive ideas for sustainability transformations, the engagement and reflection among scholars on the values underpinning their research is critical. With the narrative-led dialog, we present three steps and six specific strategies to recognize, analyze and engage with the role of values in scientific projects and communities. Concretely, we see three core contributions of the narrative-led dialog: (1) deepening current scientific practices by addressing the risk of bypassing scholars' values and paradigms; (2) offering tools to discover, discuss and negotiate values underlying different scholar's research; and (3) breaking down barriers, encouraging creativity and generating an environment that enables disruptive ideas.

2.6. Deepen current practices to address values underlying sustainability research

Current practices used in sustainability science to enable disruptive ideas, such as knowledge accumulation and interdisciplinary research, hold the risk of providing an overly narrow or shallow perspective and bypassing the role of values in these processes of integration and collaboration. With the narrative-led dialog, the values and paradigms underlying the research that is being accumulated or underlying the various research communities and disciplines engaging in an interdisciplinary process are brought to light. In this way, the narrative-led dialog does not aim to replace existing scientific practices in sustainability science. Rather, the tool aims to deepen current practices by navigating their risks and overcoming their limitations. Moreover, with the narrative-led dialog, a common language and mutual understanding can be created without the need for a deep understanding of other disciplines' ontological and epistemological basis. Instead of addressing the underlying scientific theories, narratives disclose and highlight relevant aspects for societal transformation, showing overlaps as well as differences between scholars and scientific communities. This helps scholars navigate and learn from diverse values in order to facilitate interdisciplinary understanding and collaboration as well as knowledge accumulation across a plurality of theories and approaches.

2.7. Discover, discuss and negotiate values of sustainability science

The recognition, analysis and engagement with scholarly narratives create the opportunity to discover, discuss and negotiate values and paradigms underlying current research. In other words, the recognition of narratives sheds light on value-based assumptions underlying research, which increases transparency across disciplines. The analysis stage helps scholars position themselves in a broader knowledge landscape, increase awareness of their assumptions and foster self-reflection. This has both an intrinsic value for scientific advancement and also paves the way for an engagement with other scholars' narratives. The realization step enables this engagement. It enables scholars to negotiate the values and value conflicts underlying their research. Facilitating engagement with value conflicts and negotiating shared values can break down barriers and encourage creativity. High levels of participation and knowledge sharing are critical precursors of creative work environments (Schepers & Van Den Berg, 2007). The narrative-led dialog enables broad scientific participation to unpack shared values, paradigms and deeply held assumptions. By sharing this knowledge and reflecting on its implications openly and inclusively, the narrative-led dialog facilitates creative and new ideas as well as shared decisions about future research needs.

One of the most important benefits of a narrative-led dialog is that it enables the reorganization of knowledge along underlying normative and political assumptions. Structuring knowledge along narratives highlights aspects relevant for societal transformation. If scholars discover that they share a certain narrative with others, they can use this shared narrative to communicate their assumptions, paradigms and values more clearly and understandably. This not only allows scholars from opposing edges of a research field to engage in trust-building despite disagreements. More importantly, it allows them to take ownership of shared narratives. Researchers can refer to these shared narratives in future research, easing the task to position their research in a topic or field and to summarize what has (not) been done before. Referring to (a) shared narrative(s) may also help scholars to find a common voice towards society. It highlights the societal implications of

research and encourages reflective advocacy towards a more sustainable future.

2.8. Generate an environment for disruptive ideas and new directions

The contributions discussed above show how the narrative-led dialog helps to 1) break down barriers between research communities and 2) reorganize existing knowledge along paradigms and values as a foundation for novel and creative ideas (Lewis et al., 2018). These two characteristics make the narrative-led dialog a promising tool to generate a fruitful environment for disruptive ideas in sustainability science and to support sustainability transformations by fostering open discussions on values.

We envisage that the tool will be most effective within interdisciplinary project teams, research communities or organizations. In these settings, a variety of academic perspectives converge, making the identification of shared or conflicting narratives particularly powerful. In these settings, individuals are also likely to have greater leverage to influence the collective direction in terms of research questions, frameworks and methodologies.

For optimal results, project or organizational leaders might consider including the dialog as part of a dedicated work package or organizational change process. Specific commitments may include hiring a narrative analyst experienced in facilitation techniques for a series of workshops and/or training to familiarize team members with the dialog approach, with appropriate time and financial resources allocated. For the preparation and delivery of workshops or training, various methods can be used, such as Delphi study (Linstone and Turoff, 1975), and scenario-building (Durance and Godet, 2010). The development of a methodological guide is underway, but its completion will depend on more extensive implementation and testing of the tool.

3. Challenges and limitations

No useful tool can be built without significant investment. Applying the dialog regularly will require time, a critical number of participants to span a topic or field, substantial preparation for identifying all relevant knowledge strands, skilled facilitators, and resources for physically bringing people together. Therefore, the tool will be significantly shaped - and limited - by its settings and agents. Gaining experience with applying the narrative-led dialog will help create best-practice examples and develop the practical implementation of the tool. Furthermore, the dialog's outcome also depends on how successful the strategies support breaking out of groupthink and disrupt hierarchical thinking to enable an environment for disruptive ideas. Well-established facilitation methods (e.g. anonymizing participants, small group work) and facilitators with skills that strengthen participation and effectively respond to power imbalances can have a significant influence on the process (Lind and Kaner, 2007). As in any participatory process, creating inclusive spaces requires that all participants feel comfortable. To achieve this, the facilitator must be sensitive to existing inequities, reflect their own social biases and be well selected both in terms of skills and social attributes (e.g. age and gender) that impact group dynamics (Zaremba et al., 2021).

It is worth noting that the tool was developed in a Western context by an all-female team. Although we had a diverse group of participants during the Delphi study (see Leipold et al., 2023) that inspired the development of the narrative-led dialog, including individuals from non-Western cultures, these participants were primarily based at Western universities. Facilitation techniques need to be adapted for successful use of the tool in different contexts and institutional settings (for examples and principles see, e.g. Zaremba et al., 2021).

If successful, the dialog holds the potential to foster a greater democratization of critical community-specific and disciplinary intelligence across academic status, discipline, and academic age. Certainly, the lack of disruptive ideas in sustainability science is not only a result of claims of value-neutrality and non-engagement with paradigmatic pluralities. We also face an academic system that is built on professional incentives that reward quantity of results and publications rather than deepening scientific practices (Van Dalen & Henkens, 2012). The dialog's three steps - recognition, analysis and engagement - could help facilitate discussions on how to overcome such structural barriers. At the same time, we recognize that the tool is not designed to address all the structural issues facing academia. Therefore, the narrative-led dialog can only be one of many efforts to move sustainability science towards paradigm shifts and disruptive ideas for sustainability transformations.

In its current form, the narrative-led dialog is proposed for interdisciplinary academic settings. While we believe there is potential to broaden its scope towards transdisciplinary contexts involving policy, industry and civil society actors, this requires integrating principles and activities of knowledge co-production (e.g. Norström et al., 2020; Chambers et al., 2021).

3.1. Expanding our world to transform sustainability science

In life, as in science, our exploration and understanding can sometimes be hampered by existing paradigms and a narrow focus on particular problems. Echoing the sentiments of interdisciplinary collaboration underscored in the literature, the narrative-led dialog is an invitation to interdisciplinary project teams, research communities or organizations to take the time to recognize, analyze and engage with their own perspectives, possibly inviting (former) opponents. The ultimate goal is to foster an environment that will keep us open to a change of direction. The narrative-led dialog is original in that it uses narrative to create shared understanding between interdisciplinary researchers without requiring a detailed understanding of the theoretical underpinnings of each discipline. Current practices of knowledge accumulation and inter-disciplinary research often invite scientists to reflect on their research by presenting their findings and contextualizing their significance in their respective disciplines with its established methods of data collection and analysis (Hazard et al., 2020; van der Hel, 2018). Informed by previous research in sustainability science, we believe that narratives can help make these practices more adaptable to the varied needs of interdisciplinary contexts, less focused on narrow problems and disciplinary perspectives, and more transparent. In the long run, narratives have great potential to generate trust and open environments that support creativity, break out of groupthink and enable more disruptive sustainability science. If sustainability science is to engage with society to inform and shape societal change, it needs to become more self-reflective about overarching questions, values and paradigms.

CRediT authorship contribution statement

Leipold Sina: Conceptualization, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing. **Luo Anran:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Visualization. **Simoens Machteld:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Helander Hanna:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Petit-Boix Anna:** Conceptualization, Methodology, Visualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

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

Acknowledgements

We thank Mariana de Brito for her thoughtful comments on an earlier draft of this paper and the two anonymous reviewers for their valuable feedback. We express our gratitude for the financial support of this research by the German Federal Ministry of Education and Research, research group 'Circulus – Opportunities and challenges of transition to a sustainable circular bio-economy' [031B0018], the European Research Council Horizon 2020 programme (MAT_STOCKS, grant agreement No 741950), and the Horizon Europe programme (CircEUlar, grant agreement No 101056810). A. Petit-Boix acknowledges the support of the María Zambrano grant (MZ 2021-19) under the European Union's "NextGenerationEU" program, funded through the Spanish Ministry of Universities; the Catalan agency AGAUR through its research group support program (2021 SGR 00734), and the Spanish Ministry of Economy, Industry and Competitiveness for funding the "María de Maeztu" program for Units of Excellence in R&D (CEX 2019-0940-M).

References

Allison, G.T., 1971. Essence of Decision: Explaining the Cuban Missile Crisis. Harper Collins,, New York.
Apetrei, C.I., Caniglia, G., von Wehrden, H., Lang, D.J., 2021. Just another buzzword? A systematic literature review of knowledge-related concepts in sustainability science. Glob. Environ. Change 68, 102222.
Bäckstrand, K., Lövbrand, E., 2006. Planting trees to mitigate climate change: contested discourses of ecological modernization, green governmentality and civic environmentalism. Glob. Environ. Polit. 6 (1), 50–75.
Blomsma, F., Brennan, G., 2017. The emergence of circular economy: a new framing around prolonging resource productivity. J. Ind. Ecol. 21 (3), 603–614.
Caniglia, G., Luederitz, C., von Wirth, T., Fazey, I., Martin-López, B., Hondrila, K., Lang, D.J., 2021. A pluralistic and integrated approach to action-oriented knowledge for sustainability. Nat. Sustain. 4 (2), 93–100.
Carolan, M.S., 2006. Scientific knowledge and environmental policy: why science needs values. Environ. Sci. 3 (4), 229–237.
Cashore, B., Bernstein, S., 2022. Bringing the Environment Back in: Overcoming the Tragedy of the Diffusion of the Commons Metaphor. Perspectives on Politics, pp. 1–24.
Chambers, J.M., Wyborn, C., Ryan, M.E., Reid, R.S., Riechers, M., Serban, A., Pickering, T., 2021. Six modes of co-production for sustainability. Nat. Sustain. 4 (11), 983–996.
Chan, Kai M.A., Gould, Rachelle K., Pascual, Unai, 2018. Editorial overview: relational values: what are they, and what's the fuss about? Curr. Opin. Environ. Sustain. 35, A1–A7.
Crouzat, E., Arpin, I., Brunet, L., Colloff, M.J., Turkelboom, F., Lavorel, S., 2018. Researchers must be aware of their roles at the interface of ecosystem services science and policy. Ambio 47, 97–105.
Dahlstrom, M.F., 2014. Using narratives and storytelling to communicate science with nonexpert audiences. Proc. Natl. Acad. Sci. 111 (Suppl. 4), 13614–13620.
Drupp, M.A., Baumgärtner, S., Meyer, M., Quaas, M.F., von Wehrden, H., 2020. Between Ostrom and Nordhaus: the research landscape of sustainability economics. Ecol. Econ. 172, 106620.
Dryzek, J.S., 2021. The Politics of the Earth. Oxford university press,.
Durance, P., Godet, M., 2010. Scenario building: uses and abuses. Technol. Forecast. Soc. Change 77 (9), 1488–1492.
Eisenhardt, K.M., 1989. Building theories from case study research. Academy of management review 14 (4), 532–550.
Feldman, M.S., Sköldberg, K., Brown, R.N., Horner, D., 2004. Making sense of stories: a rhetorical approach to narrative analysis. J. Public Adm. Res. Theory 14 (2), 147–170.
Fischer, F., Forester, J., 1993. The argumentative turn in policy analysis and planning. Duke University Press,, Durham, NC.
Geissdoerfer, M., Savaget, P., Bocken, N.M., Hultink, E.J., 2017. The circular economy–a new sustainability paradigm? J. Clean. Prod. 143, 757–768.
Genovese, A., Pansera, M., 2021. The circular economy at a crossroads: technocratic eco-modernism or convivial technology for social revolution? Capital. Nat. Social. 32 (2), 95–113.
Giampietro, M., 2023. Reflections on the popularity of the circular bioeconomy concept: the ontological crisis of sustainability science. Sustain. Sci. 1–6.
Grabs, J., Auld, G., Cashore, B., 2021. Private regulation, public policy, and the perils of adverse ontological selection. Regulat. Govern. 15 (4), 1183–1208.
Graesser, A.C., Ottati, V., 1995. Why stories? Some evidence, questions, and challenges. Knowl. Mem.: Real. Story 8, 121–132.
Hajer, M.A., 1995. The Politics of Environmental Discourse: Ecological Modernization and the Policy Process. Clarendon Press,, Oxford.
Hajer, M.A. (2006). Doing discourse analysis: coalitions, practices, meaning. Netherlands geographical studies (ISSN 0169–4839), (344).
Hall, K.L., Vogel, A.L., Huang, G.C., Serrano, K.J., Rice, E.L., Tsakraklides, S.P., Fiore, S. M., 2018. The science of team science: a review of the empirical evidence and research gaps on collaboration in science. Am. Psychol. 73 (4), 532–548.
Hardy, B., 1968. Towards a poetics of fiction: 3) An approach through narrative. In: In Novel: A forum on fiction, Vol. 2. Duke University Press,, pp. 5–14.
Hazard, L., Cerf, M., Lamine, C., Magda, D., Steyaert, P., 2020. A tool for reflecting on research stances to support sustainability transitions. Nat. Sustain. 3 (2), 89–95.
Heinonen, S., Ruotsalainen, J., 2013. Futures clinique—method for promoting futures learning and provoking radical futures. Eur. J. Futures Res. 1, 1–11.
Helander, H., Petit-Boix, A., Leipold, S., Bringezu, S., 2019. How to monitor environmental pressures of a circular economy: an assessment of indicators. J. Ind. Ecol. 23 (5), 1278–1291.
Horcea-Milcu, A.I., 2022. Values as leverage points for sustainability transformation: two pathways for transformation research. Curr. Opin. Environ. Sustain. 57, 101205.
Horcea-Milcu, A.I., Abson, D.J., Apetrei, C.I., Duse, I.A., Freeth, R., Riechers, M., Lang, D. J., 2019. Values in transformational sustainability science: four perspectives for change. Sustain. Sci. 14, 1425–1437.
Jensen, J.L., Rodgers, R., 2001. Cumulating the intellectual gold of case study research. Public Adm. Rev. 61 (2), 235–246.
Kaplan, T.J., 1993. Reading Policy Narratives: Beginnings, Middles, and Ends. In: Fischer, F., Forester, J. (Eds.), The Argumentative Turn in Policy Analysis and Planning. London: UCL Press, Taylor and Francis.
Kirchherr, J., 2023. Bullshit in the sustainability and transitions literature: a provocation. Circ. Econ. Sustain. 3 (1), 167–172.
Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. Resour. Conserv. Recycl. 127, 221–232.
Korhonen, J., Nuur, C., Feldmann, A., Birkie, S.E., 2018. Circular economy as an essentially contested concept. J. Clean. Prod. 175, 544–552.
Kuhlicke, C., de Brito, M.M., Bartkowski, B., Botzen, W., Doğulu, C., Han, S., Rufat, S., 2023. Spinning in circles? A systematic review on the role of theory in social vulnerability, resilience and adaptation research. Glob. Environ. Change 80, 102672.
Kuhn, T.S., 1962. The Structure of Scientific Revolutions, vol. 111. University of Chicago Press,, Chicago.
Lahsen, M., Turnhout, E., 2021. How norms, needs, and power in science obstruct transformations towards sustainability. Environ. Res. Lett. 16 (2), 025008.
Lawrence, M.G., Williams, S., Nanz, P., Renn, O., 2022. Characteristics, potentials, and challenges of transdisciplinary research. One Earth 5 (1), 44–61.
Lazarevic, D., Valve, H., 2017. Narrating expectations for the circular economy: towards a common and contested European transition. Energy Res. Soc. Sci. 31, 60–69.
Leipold, S., Winkel, G., 2017. Discursive agency:(Re-) conceptualizing actors and practices in the analysis of discursive policymaking. Policy Stud. J. 45 (3), 510–534.
Leipold, S., Petit-Boix, A., Luo, A., Helander, H., Simoens, M., Ashton, W.S., Xue, B., 2023. Lessons, narratives, and research directions for a sustainable circular economy. J. Ind. Ecol. 27 (1), 6–18.
Lewis, P.A., Knoblich, G., Poe, G., 2018. How memory replay in sleep boosts creative problem-solving. Trends Cogn. Sci. 22 (6), 491–503.
Lind, L., Kaner, S., 2007. Facilitator's Guide to Participatory Decision-making, second edition.,. Jossey Bass Inc.,.
Linstone, H.A., Turoff, M., 1975. The Delphi method: Techniques and Applications. Addison-Wesley,, Reading, MA.
Longino, H.E., 1996. Cognitive and Non-Cognitive Values in Science: Rethinking the Dichotomy. In: Feminism, Science, and the Philosophy of Science. Springer,, Dordrecht, pp. 39–58.
Luo, A., Rodríguez, F., Leipold, S., 2023. Explanations of the political gridlock behind international circular economy: Waste Ban narratives in the China-EU cooperation. Ambio 52 (1), 126–139.
Miller, T.R., Wiek, A., Sarewitz, D., Robinson, J., Olsson, L., Kriebel, D., Loorbach, D., 2014. The future of sustainability science: a solutions-oriented research agenda. Sustain. Sci. 9, 239–246.
Newig, J., Rose, M., 2020. Cumulating evidence in environmental governance, policy and planning research: towards a research reform agenda. J. Environ. Policy Plan. 22 (5), 667–681.
Norström, A.V., Cvitanovic, C., Löf, M.F., West, S., Wyborn, C., Balvanera, P., Österblom, H., 2020. Principles for knowledge co-production in sustainability research. Nat. Sustain. 3 (3), 182–190.
Oxford Dictionary (2022) Ontology. https:// www. lexico. com/ definition/ ontol ogy. Accessed 12 Aug 2022.
Park, M., Leahey, E., Funk, R.J., 2023. Papers and patents are becoming less disruptive over time. Nature 613 (7942), 138–144.
Pauliuk, S., 2020. Making sustainability science a cumulative effort. Nat. Sustain. 3 (1), 2–4.
Pearce, B.J., Ejderyan, O., 2020. Joint problem framing as reflexive practice: honing a transdisciplinary skill. Sustain. Sci. 15 (3), 683–698.
Petit-Boix, A., Leipold, S., 2018. Circular economy in cities: reviewing how environmental research aligns with local practices. J. Clean. Prod. 195, 1270–1281.
Raymond, C.M., Kenter, J.O., van Riper, C.J., Rawluk, A., Kendal, D., 2019. Editorial overview: theoretical traditions in social values for sustainability. Sustainability. Science 14, 1173–1185.
Renner, A., Giampietro, M., 2020. Socio-technical discourses of European electricity decarbonization: Contesting narrative credibility and legitimacy with quantitative story-telling. Energy Res. Soc. Sci. 59, 101279.
Roe, E., 1994. Narrative Policy Analysis: Theory and Practice. Duke University Press,.
Rosenlund, J., Notini, P., Bravo, G., 2017. Exploring attitudes to societal relevance: the effects of reflection on research practices among Swedish environmental scientists. J. Responsible Innov. 4 (3), 337–353.
Schepers, P., Van Den Berg, P.T., 2007. Social factors of work-environment creativity. J. Bus. Psychol. 21, 407–428.

Simoens, M.C., Fuenfschilling, L., Leipold, S., 2022. Discursive dynamics and lock-ins in socio-technical systems: an overview and a way forward. Sustain. Sci. 17 (5), 1841–1853.

Smith, B. (1999). An introduction to ontology. In: Peuquet D, Smith B, Brogaard B (eds) The ontology of fields, report of a specialist meeting held under the auspices of the Varenius Project. NCGIA, Bar Harbour, Maine, USA.

Sol, J., Beers, P.J., Wals, A.E., 2013. Social learning in regional innovation networks: trust, commitment and reframing as emergent properties of interaction. J. Clean. Prod. 49, 35–43.

Stephan, P., 2015. How Economics Shapes Science. Harvard University Press,.

Stokols, D., Misra, S., Moser, R.P., Hall, K.L., Taylor, B.K., 2008. The ecology of team science: understanding contextual influences on transdisciplinary collaboration. Am. J. Prev. Med. 35 (2), S96–S115.

Stompff, G., Smulders, F., Henze, L., 2016. Surprises are the benefits: reframing in multidisciplinary design teams. Des. Stud. 47, 187–214.

Stone, D.A., 1989. Causal stories and the formation of policy agendas. Political Sci. Q. 104 (2), 281–300.

Van Dalen, H.P., Henkens, K., 2012. Intended and unintended consequences of a publish-or-perish culture: a worldwide survey. J. Am. Soc. Inf. Sci. Technol. 63 (7), 1282–1293.

van der Hel, S., 2018. Science for change: a survey on the normative and political dimensions of global sustainability research. Glob. Environ. Change 52, 248–258.

Wiek, A., Withycombe, L., Redman, C., Mills, S.B., 2011. Moving forward on competence in sustainability research and problem solving. Environment 53 (2), 3–13.

Winowiecki, L., Smukler, S., Shirley, K., Remans, R., Peltier, G., Lothes, E., Alkema, L., 2011. Tools for enhancing interdisciplinary communication. Sustain.: Sci. Pract. Policy 7 (1), 74–80.

Zaremba, H., Elias, M., Devi, J.T., & Priyadarshini, P. (2021). Inclusive participatory approaches: A facilitator's guide.