Earth System Governance 28 (2026) 100333

Contents lists available at ScienceDirect

Earth System Governance

journal homepage: www.sciencedirect.com/journal/earth-system-governance

The politics of transdisciplinary research: coping with power in puzzling for sustainability governance

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1. Introduction

To address grand societal challenges, such as climate change and biodiversity loss, many global and national governmental organizations call for transformative change towards. These policy visions of societal transformation aim for more sustainable and just societies (OECD, 2020; UNDP, 2023). This requires careful governance, as they involve changing power-dynamics, vested interests, path dependencies and discursive lock-ins (Turnhout et al., 2020; Stirling, 2008). The emerging field of sustainability governance explores, designs and implements more democratic collective decision-making for a more sustainable public good (van Dokkum et al., 2023). Sustainability governance adheres to policy visions of large-scale transformations that aim to address the challenges posed by planetary boundaries and a just social foundation (Biermann et al., 2012; Chambers et al., 2021; Gupta et al., 2023; Pickering et al., 2022). These forms of governance take place at the global level (for example in the Paris Climate Agreement), but also at national and regional levels in transition strategies toward a circular economy or, for example, renewable energies. At all those administrative levels, characteristics of sustainability governance are that: (1) it is mission-driven and aims to address the challenges posed by climate change, (2) it aims for forms governing within and, at the same time, towards a safe operating space (Rockström et al., 2009; Steffen et al., 2015), and (3) sustainability governance aims to be transformative by changing current dominant anthropocentric ways of thinking and acting in science, society, and policy, see for example the Nijmegen agenda as developed by and for the Earth Systems governance community (ESG, 2024). Sustainability governance is always forward-looking, aiming at systems transformations by changing prevalent discourses and practices. Through processes of formal and informal democratic decision-making, sustainability governance aims to create more inclusive and fair approaches to long-term sustainable pathways and solutions (Leach, 2023; Pickering et al., 2022).

To support these new forms of sustainability governance, researchers have argued that transdisciplinary research (TDR) is necessary (Kalinauskaite et al., 2021; Klenk and Meehan, 2017). This type of knowledge production is a process that integrates existing and new disciplinary expertise, information, and goals across policy domains, and includes local and experiential knowledge. In addition, in useable and transformative TDR production, the role of diverse values, also within and about knowledge systems, needs to be acknowledged (Bulten et al., 2021; House et al., 2024; Turnhout et al., 2020). Hence, TDR is a process of knowledge co-creation that (1) integrates different (disciplinary) knowledges, (2) crosses policy domains with societal challenges, (3) includes experiential and local knowledge of all sorts of actors, (4) acknowledges the multiple values held by stakeholders in the knowledge production process (Hakkarainen et al., 2020; Leventon et al., 2021) and (5) aims to co-design pathways for change or solutions (Klenk and Meehan, 2017; Lang et al., 2012; Wolf et al., 2023). The literature on transdisciplinary research (TDR) pays attention to the design of TDR processes e.g. joint problem framing (Pearce and Ejderyan, 2020). It recommends ways in which science and society can co-produce knowledge that is more holistic or systemic, and better accounts for the wickedness of the societal challenges (Kalinauskaite et al., 2021). As such, TDR is a process of *puzzling* together, where puzzling is the exploration of different problem-definitions, and solutions, considering different knowledge systems both within the academic world as well as in society (Culpepper, 2002; Hoppe, 2011; Visser and Hemerijck, 1997). This puzzling together should contribute with better integrated knowledge and values to the ambitions of sustainability governance in being more inclusive, fair, and eco-friendly decision making.

Researchers developing processes of TDR, often emphasize the need for explicit facilitation of a participatory process to integrate knowledge and overcome barriers to knowledge integration (Tress et al., 2007;

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https://doi.org/10.1016/j.esg.2026.100333
Received 29 July 2024; Received in revised form 11 April 2026; Accepted 22 April 2026
Available online 6 May 2026

Benard and De Cock-Buning; Cundill et al., 2019). In the organization of knowledge co-creation process, there needs to be attention for the systemic features (legal agreements, formal power differences, institutional differences); attention for relational features (trust, leadership) and a careful design of the integration process (Cundill et al., 2019). The latter includes spaces for reflection on perspectives, values, and power imbalances that hinder co-production of knowledge and need to be mitigated to come to a shared language, inclusivity and knowledge integration (de Geus et al., 2023; House et al., 2024; Klein, 1996; Pohl et al., 2020; Repko and Szostak, 2016; Tress et al., 2007). Most often, the literature on TDR focuses on designing and creating inclusive spaces which are safe environments in which a person or groups of people can explore, reflect, and learn together to divert path dependencies, integrate knowledge, and break routines, as well as shift power relations.

More recently a call has been made in literature to move from powering *over* - to powering *with* (e.g. Avelino, 2021; Turnhout et al., 2020). In the knowledge co-creation process, unsafe spaces may occur when power is not shared between parties, and some actors use their agency to increase their status or power within a given setting. Powering over refers to the exercise of power and authority by an actor for attaining certain solutions to a social problem (Avelino and Wittmayer, 2016). This power-over can occur strategically but also tacitly. As such, processes of knowledge co-production are inherently political (Turnhout et al., 2020). Within processes of puzzling together, powering over will occur. The literature on TDR recognizes the powering that takes place in these processes, for example when the valuing of different types of knowledge and interests takes place (Bendik-Keymer, 2023). However, there is little examination into what practical forms 'powering over' can take within the processes of puzzling in TDR. This powering over leads to critical moments at which the TDR process may change into multi-disciplinary research or consultancy, for example. Critical moments are points in time and space where the relationship between stakeholders change and when an unexpected turn of events occurs (Verloo, 2018; Yuana et al., 2020).

This paper empirically investigates the question: *What critical moments do knowledge co-creators encounter within processes of transdisciplinary research for sustainability governance, and what are ways to cope with these moments?*

To answer this question, we explored the issues that researchers run into when facilitating and participating in TDR and how they cope with them. A collaborative autoethnography approach (Hernandez, 2017; Lapadat, 2017) is used, where the authors of the paper (i.e., social science researchers) engaged with each other and other academics at Wageningen University and Research, to share their lived experiences and interpret them collectively. This engagement took place in four workshops, where the academic papers (see Appendix B), research projects and results of a semi-structured survey (N = 10) disseminated among other colleagues were also discussed. This material was analyzed to identify critical moments at which 'powering over' starts to take place and recognize patterns in the handling of these moments. A limitation of this autoethnography is the bias of the researchers' understanding of the critical moments in a TDR project. A second limitation is that only researchers from Wageningen University and Research (WUR) were involved in exploration of what entails TDR. To mitigate some of this, the results have been discussed in a workshop (June 2023) organized at a conference from Transdisciplinary Research, Education and Dialogue (TRED) initiative at WUR and the Centre for Unusual Collaborations (a collaboration between four Dutch technical universities), and in a meeting of the Transdisciplinary Lab with seven other experienced TDR researchers at TU Delft (28th of May 2024).

The aim of the paper is twofold (1) to enhance the discussion on the politics of TDR by gaining better insights on the role of powering over in TDR, and (2) to offer knowledge co-creators in TDR processes practical action-repertoires to better cope with the inevitable 'powering over'. In the discussion, we offer entry points for reflection and moving to powering *with* all sorts of participants at critical moments of powering-over.

2. Transdisciplinary research

The term transdisciplinarity was introduced over fifty years ago and has resulted in different definitions, applications, and approaches for implementing TDR (Lawrence et al., 2022). TDR is often confused with multidisciplinary research and interdisciplinary research (Benard &De Cock-Buning, 2014; Lawrence et al., 2022). Multidisciplinary research is the cooperation of researchers from different disciplines seeking to address the same problem using their disciplinary concepts, methods and knowledge (Thomas et al., 2018). It "draws on knowledge from different disciplines but stays within their boundaries" (Choi and Pak, 2006, p. 351). Interdisciplinary research transcends disciplinary boundaries and harmonizes links between disciplines into a coordinated coherent whole (Choi and Pak, 2006). In interdisciplinary research, disciplinary knowledge (concepts, methods and results) from different disciplines is integrated and often developed into a common language and combined data set (Thomas et al., 2018). Like interdisciplinarity, transdisciplinarity involves crossing boundaries (Klein, 1996). A key difference is that transdisciplinary processes also engage with knowledge and perspectives outside academia in the research process. Transdisciplinary research can be distinguished from multi- and interdisciplinary research as it integrates academic, experiential and practical knowledge which is made relevant for practice (Klein, 1996; Regeer and Bunders, 2003; Repko and Szostak, 2016; Thomas et al., 2018). TDR is not a replacement for multidisciplinary or interdisciplinary research but is better suited for certain types of problems and follows different processes and outcomes that require building bridges between society and science (Funtowicz and Ravetz, 1993, 2003).

Among the diverse definitions of TDR (e.g. Herrero et al., 2019; Mattor et al., 2014), researchers agree on three general characteristics that are related to what we call 'puzzling together' (see also Renn, 2021):

1. *Trans*-means beyond, over or across. This indicates that TDR transcends disciplinary boundaries and uses knowledge and methods from various disciplines. This characteristic is similar to interdisciplinary research. Researchers emphasize that TDR is most of all a process in which disciplines are assembled and information is recombined (Choi and Pak, 2006, p. 357). Intensities of knowledge integration (in problem definition, conceptualization, methods, and results) differ in transdisciplinary processes and are a way to classify degrees of transdisciplinarity (Huutoniemi et al., 2010; Klein, 1996; Repko and Szostak, 2016).
2. *Trans*-also refers to crossing boundaries between science (and scientists) and society (Hoes et al., 2008). Unlike interdisciplinary research, TDR extends beyond the scientific world to include societal knowledge, values and perspectives in the process (Thomas et al., 2018). In TDR, the emergence of new ideas, methods, knowledge and solutions stems from integrating academic and societal knowledge, values and perspectives to address societal problems (Repko and Szostak, 2016).
3. Processes of TDR often aim to actively apply knowledge to the betterment of humankind (Mahan, 1970, pp. 194-195). TDR focuses on complex and societally relevant problems, contribute to their solution through change, and is therefore inherently future-oriented (Regeer and Bunders, 2003, 2007).

3. Research methods

In transdisciplinary knowledge co-creation processes, critical moments may occur. To identify these critical moments emerging in processes of TDR, we engaged in a collaborative autoethnography approach (Hernandez, 2017; Lapadat, 2017), and a mini survey at WUR among researchers from the Wageningen Centre of Sustainability Governance (WCSG). Overall, we followed an abductive approach, iterating back and forth between theory-building and empirical exploration (van Hulst

and Visser, 2024).

The WCSG is composed of an interdisciplinary group of researchers contributing to knowledge on sustainability governance in the domain of food, nature, and environment. Researchers are encouraged to collaborate with critical actors inside and outside academia to address transnational challenges and uncertainties through transformative sustainable practices. This group is well-suited to reflect on the critical moments they encountered in TDR. Appendix A provides an overview of the researchers and the projects involved. This selection of mostly social science researchers and projects all on the sustainability governance domain, may limit the results. Therefore, we validated the findings in two workshops with a broader audience (see Fig. 1 for a graphical representation of the research process). In the first three workshops, eight to ten researchers from WCSG from different disciplines and positions participated. Everyone gave oral consent for the use of the results from the workshops for this paper writing.

The input for the first workshop was a set of scientific papers on TDR chosen by the participants (see list in Appendix B). We discussed the meaning of TDR and through a mind mapping exercise came to the elements of a shared definition as presented above. Additionally, we

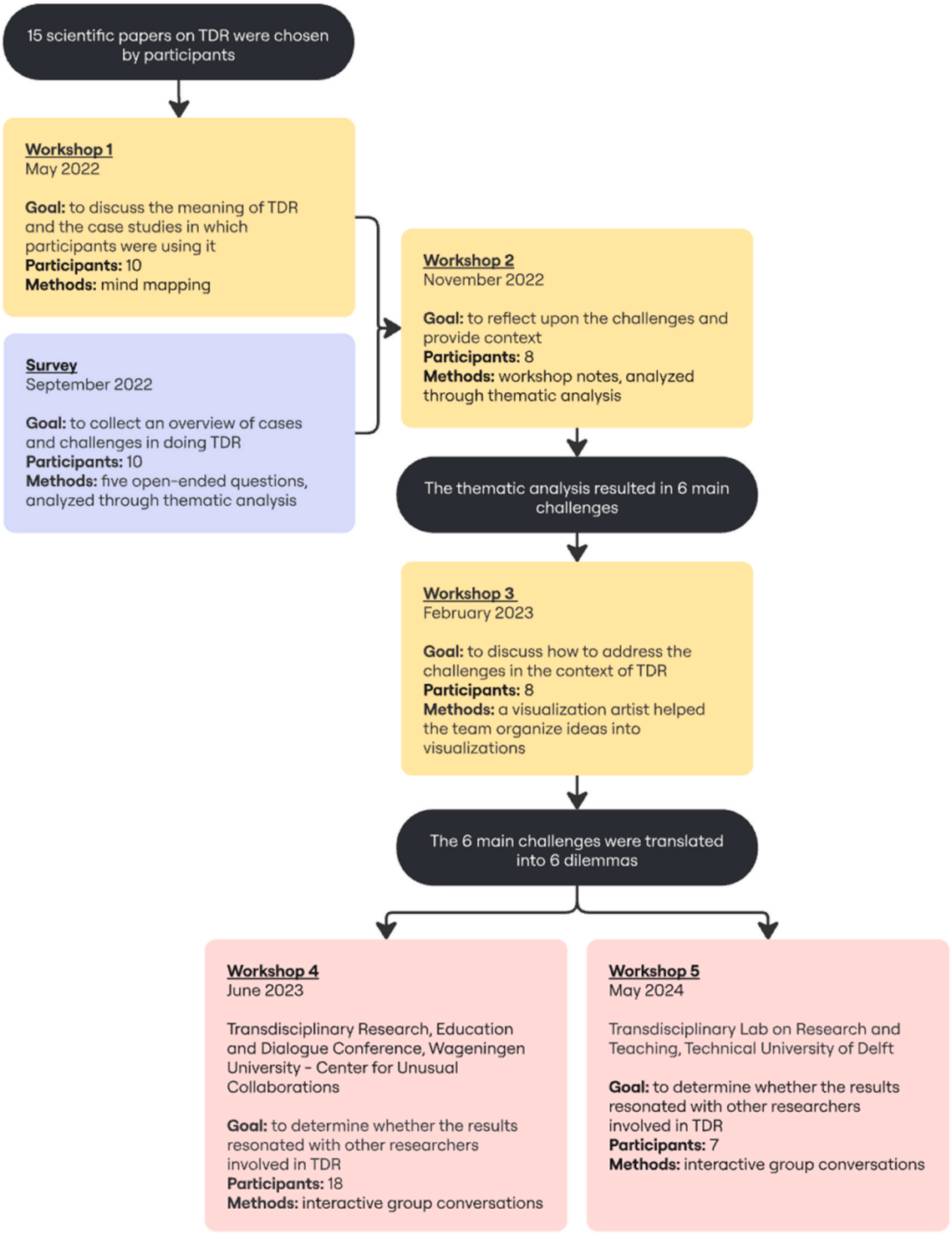

Fig. 1. Overview of research process.

collected information about the projects in which researchers were convening, facilitating, or participating in TDR processes, and shared some of the critical moments we encountered. After the first workshop, a survey was distributed by email among all researchers from the WCSG. The survey included five open-ended questions to collect data about the critical moments that researchers face while doing TDR. In total, 10 responses were collected. Survey respondents were invited to a second sense-making workshop (Weick, 1995), in which the critical moments were reflected upon and were provided with more context. The results of the survey and the notes taken during the second workshop were analyzed through thematic analysis (Braun and Clarke, 2006). This involved organizing the data using inductive labels (i.e., codes) to identify patterns related to participants' lived experiences and perspectives (i.e., themes). In total, 15 different codes emerged, which were then grouped into six themes describing the critical moments that academics encountered in TDR projects (Table 1).

The results of the thematic analysis were discussed in a sense-making session (Weick, 1995) during the third workshop. Researchers discussed the six critical moments that came out of the thematic analysis. A visualization artist helped the team in organizing the critical moments into a visual representation. The artist asked the researchers to reflect on the internal tensions within these challenges and externalized the insights into visualizations in a shared space. Through these interactions, the researchers recognized that the six critical moments did not represent specific problems that could be easily solved or removed. Instead, the visualizations made clear that the experiences of the researchers reflected dilemmas, characterized by competing situations that researchers continuously navigate. Therefore, we reformulated the critical moments into dilemmas. These dilemmas were further made sense of, in a world café method (Löhr et al., 2020). With a broader group of 15 participants in the Transdisciplinary Research, Education and Dialogue Conference at WUR in June 2023, the fourth workshop. Next to social scientists, researchers with other disciplinary backgrounds joined this conference. In addition, the dilemmas were made sense of with seven scholars from the Transdisciplinary Lab on Research and Teaching from the Technical University of Delft working with TDR on different policy domains. The results of these two additional workshops were discussed in an online meeting of the authors, to cross-check the limitations and biases of the coded materials and where necessary added as notes to the data set.

Table 1
From codes and themes to dilemmas.

Codes	Themes/challenges	Dilemmas
· Being relevant · Research vs practical solutions	· Stakeholders see universities as a resource for solutions, but researchers must remain critical and independent.	1: Practical solutions powers over critical thinking
· People are busy · Different timeframe · Post action	· Stakeholders are busy and they don't have time, while research often requires more time. · Stakeholders seek short term solutions, while research project are often focused on addressing broader, long-term societal and environmental challenges.	2: Short-term problem solving versus long-term societal challenge
· Strict planning · Uncertainty	· Traditional ways of doing research don't facilitate TDR, as researchers follow strict guidelines while stakeholders navigate real-world uncertainties.	3: Planning and project management versus flexibility in process management
· Different vocabulary · Different frames · Different approaches · Different knowledge · Keep an open mind	· Difficulty in getting actors on the same page due to different disciplines, knowledge, vocabulary, frames and methods.	4: Professionals versus citizens: diversity and knowledge integration 5: Measuring versus meanings
· Find reviewers · Publishing · Financing	· Traditional ways of doing research don't facilitate TDR, with difficulties in findings reviewers, publishing and adapting to different ways of creating knowledge.	6: Dissemination versus on-going knowledge co-creation

4. Results: dilemmas identified in transdisciplinary practices

We distinguished six dilemmas that can be encountered in TDR, and at which 'powering over' starts taking place despite all the attempts to create a 'puzzling' environment. These dilemmas are: (1) Practical solutions powers over critical thinking, (2) Short-term problem-solving powers over long-term societal challenge (3) Planning and project management powers over flexibility in process management (4) Professionals powering over (i.e., are preferred over), citizens, (5) Measuring powers over meanings, and (6) Dissemination of knowledge powers over on-going knowledge co-creation.

For each of these dilemmas, the thematic analysis also showed social scientists had ways of coping with them in different stages of TDR processes. See Table 2 below for an overview. We will present these dilemmas and ways of coping in more detail below.

4.1. *Practical solutions powers over critical thinking*

Whereas TDR for sustainability governance is often started to puzzle together and develop sustainable systemic solutions, in practice there

Table 2
From 'powering over' to 'powering with'.

Dilemma	Powering over	Powering *with* participants
1. Critical/pragmatic contributions of researchers	… the critical contributions needed for change by pragmatic solutions that are more appreciated	Reflect as a group to answer: What are the diverse (plural forms of) academic contributions that re-order and provide multiple solutions in desired sustainable directions?
2. Short term/long term answers	… the long-term problems by the short available project time	What time is available dedicated to what is *needed?* How does the research consider m*ultiple* timeframes? What is considered urgent and by whom? How to reconcile the tensions between immediate needs and space required for longer-term understanding and solutions?
3. Planning/ flexibility	… the needed flexibility in process management by clear outputs required in project management	What project management aspects are necessary? Where is flexibility in the process to enable and ensure co-creation?
4. Professionals/ general public	… the local and experiential expertise by professionals, including academics	What plural expertise and sources of power are needed to value and different sources of expertise?
5. Measuring/ Meaning	… the qualitative knowledge by quantified empirical observations	What multiple methods provide meaning and matter to diverse parties?
6. Knowledge dissemination/ knowledge co-creation	… knowledge co-creation by the desire to disseminate knowledge (of academics) after it is being produced.	Which knowledge valorization is co-created? What are alternative ways of disseminating knowledge and making impact for transformative sustainability governance?

are often more pragmatic reasons for engaging in TDR. Researchers participating in our workshops reported what we call *powering over critical thinking by pragmatic solutions*. Rather than being transformative, TDR can be welcomed as a pragmatic and engaging way to ensure that the available academic knowledge from various disciplines and backgrounds is transferred to those working in society and made applicable. Participants frequently felt that, social scientists' (and other stakeholders') contributions are considered valuable when they (1) create support for the project's goals and (2) know what the end-user needs are and how to include these in, for example, technology development, or (3) when social scientists can translate and better communicate the technical information and technological benefits from engineers to a social context. For example, in one of our workshops, it was mentioned that "other researchers keep on referring to what I contribute as science communication". Another example is that in one of the TDR projects, the grant agreement pointed out that the task of an involved social scientist was to identify and overcome societal acceptance barriers of novel biorefinery technologies. At these moments, TDR participants perhaps unintentionally limit TDR to being an instrument – a practical way – to gain support for new technologies or for disseminating knowledge, rather than to move to a more mission driven and inclusive type of research needed for sustainability governance.

In addition, the process of bringing in new types of knowledge, experiences, and values, to be more inclusive and adhere to complexities of grand challenges, may be criticized for overcomplicating knowledge production or even mobilizing critical voices. As such, TDR can be rejected by some for unnecessarily delaying or complicating trying out practical solutions, e.g., emerging technologies. For example, critical social scientists might aim to make existing assumptions and biases in a TDR project explicit: is an energy system only consisting of producers and consumers? But: what is the role of prosumers? Critical and unexpected insights contest existing assumptions and thereby scrutinize power imbalances. In some cases, scientific colleagues consider this knowledge counter-productive and unpractical. For example, one researcher in our workshops reported that researchers developing the CrisprCas gene-editing technology considered a more critical social science approach as fueling protest against gene editing. Hence, many researchers and others participating in TDR do not necessarily think of these transdisciplinary processes as a form of knowledge co-creation. Rather, they aim to solve practical problems based on 'sound' (often empirical) academic knowledge. This is the 'powering over' of critical approaches by pragmatic needs.

4.1.1. Coping with practical solutions versus critical thinking

To cope with the dilemma of pragmatic solutions versus critical scrutinization necessary for transformative change, our recommendation for TDR participants is to identify a shifting in balance to pragmatic solutions and bring back attention to questions on who is and should be involved in puzzling. To (re)pluralize and appreciate the diverse set of knowledge that researchers and others contribute, to invite a more diverse group of people to the table, and to recognize their distinct contributions as relevant, can lead to deeper reflection on what needs to be changed and why. This requires practical work of *telling* - literally talking about - and (repeatedly) *showing* - meaning giving evidence - why inclusion of more plural forms of knowledge and values are relevant in TDR. Telling is, for example, convincing research commissioners and other participants that technological or top-down solutions will run into societal resistance, that these solutions will miss out on opportunities to contribute to more innovative, radically sustainable, or fair contributions to society. Showing, for example, can enable other tools or help develop prototypes (of a technology or a policy) that can be tested and improved in steps (see also work on how to reconcile accountability and learning (Regeer et al., 2016). These actions help to re-embed critical thinking for TDR to result in more transformative and change institutions, structures, including those of knowledge production - rather than TDR being instrumental in sustainable transformations.

4.2. Short-term problem solving versus long-term societal challenge

Distinct time availabilities determine with whom and how a project is implemented. Ideally, time for a TDR project that supports a sustainability governance challenge is accessible to all collaborators throughout the project. However, time is not experienced the same by all individuals in TDR. During the workshops, we identified several incongruencies in the experience of time: should TDR projects focus on delivering short term solutions or aim to address a long-term societal challenge?

First, our results show that researchers and professionals particularly have distinct expectations of the time frame in which output is delivered. Participants in the workshops mentioned that professionals often needed answers or results within weeks, whereas the academic process can take years. In addition, professionals act and move fast, but researchers want to generate robust knowledge. On this note, researchers found it challenging to balance being relevant for the initiatives, governmental actors, and maintaining academic rigor. From the workshops, we learned that timescale discrepancies between researchers and professionals were particularly challenging during data collection stages. Researchers tend to require more time to understand and analyze the problem than what some professionals prefer.

Second, perspectives of the timeframe in which a problem occurs can be distinct: is the problem an urgent isolated challenge or is it part of a larger societal challenge that requires a wider lens and more long-term solutions? During our workshops, participants acknowledged that researchers are sometimes more future- and long-term oriented because their research is usually part of a bigger research agenda and not limited to the specifics of a particular problem. However, they may be limited by the research project scheduling. For professionals, the problem often stems from a current and potentially urgent need, which is framed as relevant to their organization instead of the wider society. At the same time, professionals often work for a longer period on the same issue, have longer lasting networks and commitments. Third, TDR processes and collaborations take time to develop trust and create opportunities to integrate knowledge before outcomes can be realized. Both researchers and professionals may not be able to engage for the whole duration of a project due to, for example, changing commitments and personal and occupational circumstances. This requires established plans, task division, ideas, and outcomes to be revisited to renegotiate time in the distinct timeframes.

These incongruencies create the dilemma of what timeframe is leading in the TDR: the longer-term societal challenges or shorter-term solutions? The relative importance of differences in timeframe sets the tone of how parties puzzle together. One time frame can power over the other. The different time-experiences introduce implicit powering over both the importance and the boundaries of TDR: how important is it to the organizations participating (and how much time are they willing to allow their employees to participate); how important are the problem and solution beyond the local manifestation of grand societal challenges; what is considered sufficient to fulfil requirements posed by the project and funders'; and should the results be valuable and meaningful beyond the boundaries of the specific project?

4.2.1. Coping with divergent timeframes

Inclusive TDR recognizes plurality in timeframes, to determine what can be done within the current time frame by whom and with what consequences within, as well as beyond, a project. Balancing short-term and long-term timeframes can be supported by reflexive discussions on distinct timescales and can be followed by practical actions. Reflexive questions can bring clarity on what would make the problem more tangible or at what kinds of transformative change the different parties look at in different timeframes. For example, do participants consider it a problem bounded within the project, or are they focusing on problems that transcend the boundaries of the specific TDR project? Moreover, ongoing monitoring to make more explicit whose timeframe is being

prioritized provides opportunities to consider how to rearrange the project set-up or envisioned outcomes to incorporate the different contributors more inclusively. Discussing expectations in terms of commitment, availability, process, problem-framing, and potential outcomes gives space to determine in what ways distinct needs can be balanced and where the collaboration will focus. In practical terms, it is key to collaboratively consider how and when people participate in a TDR project: Is it part of the main aim or an add-on? How to create and manage expectations of participants? How much time are they given to focus on this collaboration? In what ways are they compensated for their time? How can people stay involved and able to contribute to decision-making when time availability does not align? These reflections on whose timeframes are being prioritized enables knowledge co-creators to recognize limits to inclusivity and opportunities for plurality. Noting the distinction in availability as well as the temporal framing of problems and solutions can help redesign TDR processes that identify situations that lead to powering *over* instead of *with*.

4.3. Planning and project management versus flexibility in process management

A third dilemma in TDR can emerge due to a dominant idea of planning and project management that pushes out flexibility and more adaptive forms of process management. Since TDR is an iterative and cyclic process, adjustments are needed. Knowledge co-creation leads to new insights, sharpens research questions, or necessitates new outputs that must be integrated into the rest of the process. Setting up a detailed planning beforehand can be challenging and flexibility to changes and process management to adapt are required. However, researchers depend on research funding and must meet funding bodies' application requirements, which include detailed planning and clear outline of research steps (Lawrence, 2015). In some projects, funding agencies ask for specific outputs, leaving less room for flexible research processes and incorporating new insights that change a project's focus. For example, one participant explained how including a more flexible way of planning, in this case for co-creation of appropriate methods and financing those, was impossible in the required template for the research proposal. Another example is the difficulty of ascertaining the different outputs and outcomes a *priori*.

A second difficulty is that researchers are trained early on to clearly outline all the research steps. In the Netherlands, graduate schools often require PhD candidates to submit elaborate research proposals containing detailed time planning. This often clashes with TDR, where research steps, according to a workshop participant, “can often change and need to be adapted all the time”. One participant explained the challenge of applying TDR in PhD projects as “PhDs are in a less flexible position to initiate transdisciplinary cooperation, because we have a very demarcated and strict project planning, and at the time of finishing my proposal, we were still finding out what our project was actually about”. It is very easy in the early stages of a TDR project to let the requirements of project management power over the more cyclic and flexible process management approach needed for TDR.

4.3.1. Coping with different types of project planning

This necessity for project management can dominate a more flexible and adaptive process management. This means that in practice, co-creators need to balance adaptivity with a clear collaboration structure and planning. This balancing requires including all relevant actors in the project design stage to set expectations about the project's structure and planning, and to indicate when flexibility is needed and possible. This also means to include professionals and citizens when composing the research agenda and ensuring that scientific and societal actors are equally and well represented (Kareem et al., 2022). Further, as different individuals participate in TDR, more reflexive and flexible process planning is crucial determining who contributes to what and when. This includes agreeing on what project elements might be open-ended and not necessarily result in specific, timebound deliverables (see e.g. Schmidt et al., 2020; Vermeulen and Keitsch, 2020). For example, in one of the projects discussed during the workshop, an initial plan was drafted and followed up with regular evaluation meetings within that project. Those evaluation meetings were considered moments during which to discuss how the last weeks proceeded, how research directions progressed, and how the planning could be adapted accordingly. The initial plan combined with the evaluation meetings helped to get different societal actors on board and provided flexibility to adapt to *ad hoc* needs and new research directions. Some funding schemes emphasize such collaboration instead of concrete deliverables *ex ante*, e.g. seed funds or network establishments (Cundill et al., 2015).

4.4. Professionals versus citizens: diversity and knowledge integration

In TDR, a diverse group of societal actors, including professionals from all sorts of organizations, industry, NGOs, governmental organizations, but also active citizen groups, can be involved to better integrate diverse sets of knowledge and experiences. TDR strives to encompass a diverse range of viewpoints and experiences, to be more inclusive and less elitist (Platteau, 2004; van der Gaast et al., 2022). In addition, indigenous groups and individual citizens have valuable local and experiential expertise and may have obstructive power to object to solutions proposed by researchers and professionals. Many processes of TDR make use of methodologies that facilitate obtaining more inclusive perspectives such as partnerships with community organizations, citizen juries (Ross et al., 2021) and living labs (Asenbaum and Hanusch, 2021; Hansen and Fuglsang, 2020).However, it can be hard to include citizens and keep them involved in TDR for several reasons. Firstly, it is often not clear ‘what is in it for them’. There is usually no direct benefit, and citizens are asked to contribute voluntarily. Second, citizens are not organized, and as individuals or small groups, they very often have few formal power sources and little financial or legal standing. Third, it can be difficult to consult with every single individual for practical reasons: how to reach those who may have relevant experiences and knowledge? Fourth, citizens can also feel that they have no standing in these processes and that these are not meant for them.

In TDR, the convenors and facilitators of knowledge co-creation make efforts and apply facilitation tools, as well as offer compensation for time invested. Still, there are often moments of unintentional exclusion of citizens, or moments at which new citizens become involved. Also, there can be moments at which the lived experiences and experiential knowledge of citizens become undervalued compared to professional knowledge. The more general and systemic perspectives of professionals tend to ‘power over’ lived experiences and local knowledge (Lawrence, 2015). This is particularly relevant in the context of the Global South. For instance, development projects, primarily relying on Western scientific knowledge and normative perspectives, can be counterproductive when they fail to adequately consider or incorporate local and indigenous knowledge (e.g. IPBES, 2022).

4.4.1. Coping with different roles and types of knowledge

When powering over from experts and professionals in TDR happens, despite all the efforts to be more inclusive, this needs to be recognized. Researchers, professionals, and citizens need to reflect together on the questions of what are the plural sources of power, and what are different types of expertise needed to connect the systems and living world? Through these reflective conversations the researchers and other participants can “accommodate pluralism, contestation and distinct perspectives and knowledge systems” (Díaz-Reviriego et al., 2019, p. 457; Sylvester and Brooks, 2020).

4.5. Measuring versus meanings

In the process of TDR, another reported form of ‘powering over’ that occurs is that quantitative empirical research is valued differently than

qualitative and interpretive forms of research. Researchers working within positivist and empirical traditions can look down upon other types of knowledge, including that of other positivist disciplines that may contradict their findings (Lélé and Norgaard, 2005). Disciplinary focus and favoring of specific methods has been recognized as a long-standing hurdle to TDR (Giri, 2002). This poses a dual challenge for TDR to produce 'reliable knowledge' for science and 'socially robust knowledge' (Nowotny, 2003). This dual accountability can make TDR challenging, but also exciting.

In the workshops, we found that discrepancies between scientists indeed often emerge because of preferences for specific types of research methods and their ontological and epistemological differences. One participant explained how the qualitative research methods that she chose to apply were "not considered equal to quantitative methods". She struggled to "find the space to get appreciation for the contribution" that she brought to the project. In TDR practice, the challenge is to get researchers, professionals, and citizens to break out of their comfort zones and embrace discomfort when considering multiple meanings and measures.

4.5.1. *Coping with different ontologies and resulting methodological choices*

To cope with this, qualitative researchers can speak up and be clear about their contribution, but quantitative researchers need to be willing to reconsider their assumptions and preferences too. The researchers working in TDR practices coped with this dilemma in several ways. One way was by including diverse methods. For example, when asked how the researcher with qualitative methods tried to overcome the challenge, she explained that she "tried to come closer to the project partners' way of understanding things" by using a mixed-method approach. Another way is to recognize this powering over, and for one of the co-creators to start a reflective conversation about it, and together decide what is needed for a TDR process. For example, in a transdisciplinary Landscape Restoration education project, the project coordinator recurrently emphasized the aim of transdisciplinarity. Then, the different disciplinary approaches were introduced and explained by participants in two interactive and reflective workshops. This was supported by using a glossary of terms. The knowledge co-creators explicitly valued different concepts, methods, and analytical approaches. This illustrates an approach that embraced friction and discomfort with new and different methodological approaches.

4.6. *Dissemination versus on-going knowledge co-creation*

A sixth challenge identified by workshop participants is to balance on the one hand the expectations that TDR will lead to knowledge co-creation and on the other, the more traditional knowledge dissemination and valorization that is often required in funding schemes. Knowledge co-creation is ideally a process in which TDR participants exchange different types of knowledge and aim to integrate those. As mentioned earlier, TDR is a cyclic process in which knowledge is integrated, applied, and improved. Like research by design, prototyping can be part of knowledge creation. All actors involved in the co-creation process bring some sort of knowledge to the table and can learn from each other. However, a dilemma during TDR – starting in the proposal writing stage emerges between this a more linear idea about knowledge production that will start *powering over* the knowledge co-creation process. The upfront formulation of academic output (scientific innovations) and knowledge valorization and dissemination is requested by funding agencies, by universities, and from professionals and citizens in society, but knowledge co-creation also comes with collaborative agenda setting, development of concepts, methods, and outputs which makes it impossible to know what the specific output will be. One example of this powering over by classical dissemination requirements came from a PhD candidate participating in our workshops. She was struggling with the TDR process and the thesis requirements to produce scientific papers. Other examples brought up in the workshops were that professional partners would rather work on output relevant for societal partners, such as a one-page policy brief, an infographic, a social media post, an education video, a podcast, or a press release, rather than an academic paper. Moreover, from our analysis of the mini-survey and workshops, we learned that particularly consortia with industrial partners have to deal with business and patenting secrets, which require embargos on findings which may delay publications. Hence, knowledge co-creation implies that knowledge is also immediately available and shared by those involved in the co-creation process, but this is difficult to satisfy all partners in practice.

4.6.1. *Coping with divergent useable knowledge needs*

When *powering over* the co-creation process occurs and more traditional ideas about knowledge production and valorization start to take over; powering with participants in TDR is needed to re-iterate that different types of knowledge are being produced, it is necessary to use diverse ways to disseminate knowledge. In our workshops, one participant explained how she presented the results of her TDR research project to stakeholders by going there in person and using a big scale printing format with visualizations of the outcomes. This step was meant to directly translate the results in a way that was useful and understandable for the stakeholders, "It helped to start a conversation between practitioners and professionals". In another example, one participant explained how they coped with this challenge by co-creating and translating knowledge in boundary objects, which were sketches but also simulation models for policy analysis (Metze, 2009) and talking with people, especially with practitioners and professionals. When more traditional ways of knowledge-use and valorization start to power over the iterative process of knowledge co-creation, knowledge co-creators need to return to the question why and what knowledge is co-created and what are multiple ways of dissemination or 'impact-making' (van der Gaast et al., 2023).

5. Discussion

Through processes of TDR knowledge is cocreated to support sustainability governance. Whereas TDR focusses on knowledge cocreation for sustainability challenges, sustainability governance are the processes in which multi-actor groups explore, design and implement more democratic collective decision-making for a more sustainable public good. Typically, the role of power is assigned to the realm of decision making and governance (Meadowcroft, 2009). However, the results of our auto-ethnography indicate that TDR is also concerned with shifting power-balances, expressed in taken for granted assumptions, values, and (incumbent) interests. While it has been recognized in the literature that power and empowerment are important to consider in TDR and that a power-sensitive approach can make power discussable and manageable in TDR processes (Cundill et al., 2019; Rigolot, 2020; Strumińska-Kutra and Scholl, 2022); our results show that there are specific critical moments of 'powering over' that raise dilemmas for participants. These dilemmas require decision-making by all actors to either reproduce existing power-relations, or that change these toward being more inclusive and diverse. We found that these moments occur across all stages of a research project, and across all learning stages (team building, problem definition, shared research project design, and interventions implementation) (Benard &De Cock-Buning, 2014). Powering over cannot be designed out of a TDR project, but participants can cope with this through reflective conversations. The six dilemmas make visible in detail that processes of (tacit) exclusion or discursive lock in (Stirling, 2008) also take place within knowledge cocreation processes, and not only in more formal political and policy making realms.

In addition, we found that coping with these dilemmas is not only a matter of acknowledging different perspectives and including those. Stakeholders can be explicitly empowered or empower themselves. This requires acknowledging and including different sources of power that may give participants different forms of agency (Avelino, 2021; De Geus

et al., 2023). Sources of power identified in the literature include legislative (formal position), material (financial or other resources), cognitive (expertise), social (networks, mobilization power), leverage (access to formal decision making, using procedures), discursive (dominant narratives and discourse) and symbolic power (moral legitimacy, normative claims) (Nasiritousi et al., 2016; Lawrence, 2015; De Roo et al., 2024; Moon, 2025). For example, citizens who feel that they do not have standing, may be given or demand standing (the 'power to' …) based on less formal but still important power resources, such as morality. The questions that we formulate in Table 2 help to continuously balance power at challenging critical moments to try minimizing such unintended outcomes. At this point we need to point out that this table should be further investigated and adapted. In our auto-ethnography we were biased from a social sciences perspective on TDR which will also limit the dilemmas we found.

A broader implication of this foregrounding of the power struggles within TDR processes is that we need to rethink the relationship between TDR and sustainability governance. Sustainability governance, as is TDR, is mission-driven and aims to address the challenges posed by climate change, (2) it aims for forms governing within and, at the same time, towards a safe operating space and (3) it aims to be transformative by changing current dominant anthropocentric ways of thinking and acting in science, society, and policy. As we saw, there are similarities with the TDR projects. Rather than being merely projects of knowledge integration, in transdisciplinary research power relations are shifted, new (societal) problem definitions are being created, and new solutions developed (and tested). Therefore, we propose considering TDR as a form of Experimental Sustainability Governance. Experimental governance (e.g. Potjer and Hajer, 2019) is rooted in experiential learning (Kolb, 1984) and is the iterative process of knowledge co-creation and innovation of decision making for the public good. In addition to the different types of knowledge being integrated, in experimental governance, decisions about the best ways forward are also tested out, reflected upon and transformed. We saw this also happening at the critical moments in the processes of TDR. Further research is needed to better understand the implications of considering TDR a process of experimental sustainability governance and foregrounding the transformation of power relations between science, policy and society.

6. Conclusion

In this paper, we empirically captured the powering over that may occur in transdisciplinary research. Based on workshops and a short survey with researchers working in TDR, we formulated six dilemmas inherent in multi-stakeholder, transdisciplinary research processes: (1) Practical solutions versus critical thinking, (2) Short-term problem solving versus long-term societal challenge (3) Planning and project management versus flexibility in process management, (4) Professionals versus citizens: diversity and knowledge integration, (5) Measuring versus meanings and (6) Dissemination versus on-going knowledge co-creation. While we recognize that these dilemmas can be experienced by researchers and stakeholders, social researchers play a crucial role in balancing these quandaries. Recognizing the six dilemmas and the offered coping strategies in this paper will support researchers in making powering over explicit in transdisciplinary research and make it an inclusive but also diversifying form of experimental sustainability governance.

CRediT authorship contribution statement

Tamara A.P. Metze: Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Núria Coma-Cros:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Verina J. Ingram:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization. **Nina de Roo:** Writing – review & editing, Data curation. **Ayla F. Schwarz:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization. **Jan R. Starke:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization. **Jillian R. Student:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization. **Joline J. Wierda:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization. **Sigrid C.O. Wertheim-Heck:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization.

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.

Appendix A

Table 1
Overview of participants and TDR projects at WUR participating in the auto-ethnography

Job position	Main discipline	Role in this project	Gender	TDR project
Professor	Public Administration and Policy	Workshop participant	M	The project addressed the societal impacts of water scarcity by enhancing regional resilience through innovative technologies, involving academics, government, NGOs and industry stakeholders.
Associate Professor	Public Administration and Policy	Author, workshop participant	F	Connected Circularity: Changing together: The project consisted of an interdisciplinary teams of academic researchers from WUR and closely collaborated with industrial and societal initiatives, government actors in the context of the circular bio-based economy.
Associate Professor	Forest and Nature Policy	Author, workshop participant	F	Biodiversity Wild Card: Landscape Restoration Education and project on Transformative change for biodiversity and equity. Engaging diverse stakeholders and explore plural perspectives within the EU and partner countries of Cameroon, Colombia, and Kenya, including policymakers and local communities
Associate Professor	Environmental Policy	Author, workshop participant	F	Researchers collaborate across universities and disciplines in close partnership with societal actors to drive the transition to a sustainable food system

(*continued on next page*)

Table 1 (*continued*)

Job position	Main discipline	Role in this project	Gender	TDR project
Postdoctoral researcher	Consumption and Healthy Lifestyles	Author, workshop participant	F	The project promotes physical activity among youth through gamified apps, integrating research with neighborhood sport coaches, politicians and game designers in living labs.
Postdoctoral researcher	Environment and Climate Research	Author, workshop participant	F	Project on coastal tourism and climate change, project to assess the effects of sea level rise (SLR) in Barbados and Curacao, two coastal tourism destinations in the Caribbean
Postdoctoral researcher	Public Administration and Policy/ Knowledge, Technology and Innovation	Author, workshop participant	F	Four TDR programs at Wageningen University: (1) a CRISPRcon dialogue (3-days event) that was organised to explore different perspectives on CRISPR/cas, a gene-editing technology (CC); (2) The Nature-Inclusive Agriculture (NIA) dialogues (2 events) that aimed for consensus building and agenda setting. In addition, we studied (3) Table Debates (from now on called Table) which is an ongoing collaboration between Wageningen University and Research, Oxford University and Sveriges lantbruksuniversitet (Swedish University of Agricultural Sciences) and (4) the Wageningen Dialogues programme (WD).
PhD candidate	Public Administration and Policy	Author, workshop participant	M	The project investigates new ways to create valuable products from grass silage and seaweed, involving engineers, economists, social scientists, industry and government stakeholders.
PhD candidate	Religion and Nature	Workshop participant	F	The project integrates religious studies and forestry science to examine nature-based spirituality in forest management through knowledge cocreation sessions.
PhD candidate	Consumption and Healthy Lifestyles	Workshop participant	F	Researchers collaborate with municipalities, supermarkets, train companies and restaurants to improve local food environments and health.
PhD candidate	Consumption and Healthy Lifestyles	Author, workshop participant	F	Researchers co-create knowledge and solutions with five healthcare institutions to enhance hospitals' food environment. The project gather more than 50 hospitals, where researchers and hospital workers discuss sustaining and improving healthy food environments.
Junior researcher	Sustainability governance	Author, workshop participant	F	The project aimed to foster policy learning across European cities by bringing together policymakers, social initiatives and academics.
Science communicator officer	Sustainability governance	Workshop participant, visualization creator	F	Visualizations for multiple TDR projects from the Wageningen Centre for Sustainability Governance.

Appendix B

Overview of initial list of articles discussed in workshop:

Bammer, 2015 Toolkits for transdisciplinarity. *GAIA-Ecological Perspectives for Science and Society*
Chambers et al., 2021 Six modes of co-production for sustainability *Nature Sustainability*
Funtowicz and Ravetz, 1993 Science for the post-normal age *Futures*
Funtowicz, S., & Ravetz, J. 2003. Post-Normal Science. *International Society for Ecological Economics*, 1–10.
Grange, 2017 (Trans)disciplinary research (re)considered *South African Journal of Higher Education*
Hadorn et al., 2008 The Emergence of Transdisciplinarity as a Form of Research *Book: Handbook of transdisciplinary research*
Herrero, Dedeurwaerdere & Osinski, 2018 Design features for social learning in transformative transdisciplinary research *Sustainability science*
Kalinauskaite et al., 2021 Facing Societal Challenges in Living Labs: Towards a Conceptual Framework to Facilitate Transdisciplinary Collaborations Sustainability
Klein, J. T. (1996). *Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities*. University Press of Virginia
Lang et al., 2012 Transdisciplinary research in sustainability science: practice, principles and challenges *Sustainability science*
Leischow et al., 2008 Systems Thinking to Improve the Public's Health *American journal of preventive medicine*
Mattor et al., 2014 Transdisciplinary research on environmental governance: a view from the inside. *Environmental science and policy*
Pohl et al., 2017 Ten Reflective Steps for Rendering Research Societally Relevant *GAIA – Ecological Perspective for Science and Society*
Schneider and Buser, 2018 Promising degrees of stakeholder interaction in research for sustainable development *Sustainability science*
Queste and Wassenaar, 2019 A practical dialogue protocol for sustainability science to contribute to regional resources management: its implementation in Réunion *Natural Resources Forum*
Scholz and Steiner, 2015 The real type and ideal type of transdisciplinary processes: part I-theoretical foundations *Sustainability* science
Turnhout, E., Metze, T., Wyborn, C., Klenk, N., & Louder, E. 2020 The politics of co-production Participation, power, and transformation. Current Opinion in Environmental Sustainability, 42, 15–21. https://doi.org/10.1016/j.cosust.2019.11.009

Data availability

The data that has been used is confidential.

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