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Social-ecological resilience thinking as a bridging concept in transdisciplinary research on climate-change adaptation

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Abstract This paper explores the advantages of applying the concept of social-ecological resilience (SER) and the related thinking in transdisciplinary research. The theoretical reflections are exemplified by transdisciplinary research experiences using the concept of SER as a bridging concept in the field of climate-change adaptation instead of developing a new and very context-specific conceptual bridge. The findings are based on ontological reflections concerning the complex and hybrid phenomenon of climate change and the need for transdisciplinary research as well as on reflections on the performed interdisciplinary research and the exploratory transdisciplinary research approach with practitioners from the German administration. The experiences so far have shown that it was more focused on the general ideas of social-ecological resilience thinking instead of using the concept of SER as an analytical tool. We conclude that the use of a common conceptual framework in general and of social-ecological resilience thinking in particular offers tangible advantages in transdisciplinary research dealing with climate change and adaptation to the impacts of climate change. In our case, social-ecological resilience thinking helped—after translation into practical terms—to open the field for further consideration from the very beginning as well as to open the space for common creative work; to define the problem; and to choose the relevant variables to look at.

Keywords Social-ecological resilience thinking · Transdisciplinary research · Bridging concept · Climate-change adaptation

1 Introduction

Climate change has become an umbrella term for a range of physical, social and social-ecological phenomena and images. Not least in the course of transformation from a purely scientific concept to a highly relevant socio-political problem, climate change seems to have gained a remarkable degree of complexity. Accordingly, this complexity is not only

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based on multifaceted interactions of biophysical variables (e.g. as embodied in scientific climate-change models), but it is even more pronouncedly derived from the fundamentally hybrid nature of climate change, representing an amalgam of biophysical and cultural factors. In addition, global environmental problems such as climate change tend to be rather remote from our direct experience or, in other words, they are epistemologically distant (Carolan 2004). It is this complex and hybrid nature of climate change as well as its epistemological distance that provide a strong argument for integrative approaches and research perspectives. Hybridity-driven complexity and epistemological distance are mutually reinforcing and entail a corresponding increase in epistemological and methodological pluralism. In other words, the more complex and epistemologically distant an environmental phenomenon is, the more different perspectives and the more methods and disciplines are needed to analyse and make sense of it (Esbjörn-Hargens 2010).

Yet, how can this integration of disciplines, methods and perspectives be organised in order to facilitate, for instance, a process of adaptation for such a complex phenomenon as climate change? How can it be ensured that multiple viewpoints, forms of knowledge and epistemologies are incorporated into the same problem-solving process without overburdening the whole process in a way that makes it unfeasible in practical terms? In this article, we argue that transdisciplinary research or, more precisely, a specific approach to transdisciplinary research based on a common conceptual framework can contribute to this integration of knowledge and epistemologies which is, in our opinion, a precondition for an integrative, holistic approach to climate-change adaptation. Furthermore, we try to demonstrate that a resilience perspective, as a way of thinking about social-ecological systems, may serve as a common conceptual framework in transdisciplinary research processes aimed at facilitating adaptation to climate change. Accordingly, in the first section of this article, we briefly discuss our perspective on transdisciplinary research and focus primarily on the benefits of utilising a common conceptual framework or, in our words, a bridging concept. Next, we present the social-ecological resilience (SER) framework and discuss its potential advantages as a bridging concept within our transdisciplinary research approach to climate-change adaptation. The fourth section describes our previous experiences with the resilience framework within the scope of our transdisciplinary process. We conclude that the use of a common conceptual framework in general and of SER thinking as a bridging concept, in particular, offers tangible advantages in transdisciplinary frameworks dealing with climate change and adaptation to the impacts of climate change.

2 Transdisciplinary research: the bridging concept dilemma

A rather new field that deals with integrative approaches is transdisciplinary research. In line with Pohl and Hirsch Hadorn (2007: 30), we see transdisciplinary research as aiming to grasp complex phenomena, striving to take into account the diversity of the lifeworld and different disciplinary perceptions of problems and trying to integrate abstract and case-specific knowledge in order to solve problems in the practical world. In doing so, transdisciplinary approaches try to identify the gaps in relevant existing disciplinary knowledge and, even more importantly, they try to make most out of the combination of different types of knowledge, such as scientific, lay or informal. In order to avoid potential borders of knowledge, transdisciplinarity transcends disciplinary boundaries, integrates different disciplinary worldviews, goes beyond scientifically generated knowledge and integrates non-scientific societal knowledge (Gibbons et al. 1994; Hirsch Hadorn et al. 2008; Mittelstraß 2004; Thompson-Klein et al. 2001). With reference to the practical problem

definitions and the integration of knowledge other than that which is scientific or academic, a transdisciplinary research approach should be designed in a twofold way: first, choose the method by which the practical knowledge will be generated within the common process; second, offer possibilities of how this generated knowledge will be integrated into the research process itself.

This raises the question of how the related research processes can be drawn up, as transdisciplinary-oriented research is not only a dispersed but also a relatively young field still lacking its own paradigms and criteria for scientific reliability in terms of specific transdisciplinary integration methods, forms of stakeholder participation and connections between results of facts and findings as well as of norms and values (Zierhofer and Burger 2007). Nevertheless, a closer look into the field of transdisciplinary research reveals that the integration of different epistemologies, knowledge forms and data in a commonly shared theoretical or conceptual structure is considered to lead to strong transdisciplinary results and forms a central part of transdisciplinary methodology (Bergmann et al. 2010; Lieven and Maasen 2007; Becker and Jahn 2006; Pohl and Hirsch Hadorn 2006).

In addition, recourse to already available concepts and research heuristics may lead the way in avoiding the overburdening of resource-restricted transdisciplinary research due to the given additional need to develop common conceptual ground. Lynch et al. (2008) suggest the use of what they call frameworks for the interaction of scientists with stakeholders and also highlight the consequent dilemma that choosing a specific framework will determine further work by guiding it in a certain direction and rendering some procedures for developing adaptation strategies to handle the impacts of climate change more suitable than others. Also, Becker and Jahn (2006) doubt the usefulness of resorting to uniform theories. Although such concerns cannot be easily dismissed, we argue in the following sections that the use of a specific, common conceptual framework as a bridging concept may facilitate the transdisciplinary research on climate-change adaptation strategies.

To do this, we also draw on our experience with a specific transdisciplinary process dealing with adaptation to climate change in a model urban region in Northeast Germany. The aim of this process is to generate common and integrated adaptation strategies to climate change impacts with reference to future land-use within the model city and the peri-urban region. Within the scope of the transdisciplinary process, we established a core group consisting of researchers as well as practitioners from local and regional planning and environmental administration. In addition, we have regular encounters with heads of relevant administration departments and key politicians. The tool of strategic scenario planning is used to identify relevant drivers of land-use and their interplay with climate change and its impacts as well as their manifold linkages and feedbacks. As a next step, plausible and consistent storyboards of alternative future developments of the model urban region are jointly developed together with a wider range of stakeholders from the entire urban region.

Within the scope of this transdisciplinary endeavour, a bridging concept serves as a conceptual framework and analytical link for all researchers involved in the process and, more importantly, also for the common research–practice process. It constitutes the common conceptual point of reference and claims to connect and integrate the approaches, questions and perspectives of the participating disciplines and sectors—it is an instrument of coordination, aiming at connecting different fields and horizons of thought. In our understanding, the transdisciplinary process of managing and maintaining a bridging concept should be directed towards specific normative goals—in our case, adaptation to climate change. In this specific context, the conceptual framework of social-ecological resilience (SER) thinking appears to be suitable to serve as a bridging concept within the scope of our transdisciplinary research.

Yet, as already mentioned, the crucial question is not only whether or not to resort to a common conceptual framework (bridging concept) at all, but also, and even more delicate, whether to introduce it from the very beginning (with all potential restrictions, this may place on the whole process) or to leave everything open and to determine and develop jointly a unifying bridging concept in the course of the transdisciplinary process. Only after having taken these important methodological steps, a decision can be made in favour of a specific conceptual framework that can serve as a bridging concept. Our decision to set up the transdisciplinary research process with the help of an already existing concept was not only made to avoid the already mentioned overburdening of the transdisciplinary research process that is limited in terms of resources, but also to be connected to a broad ongoing discussion on environmental change and to overcome the constricted new development of an again new but strongly context-dependent integration concept. The aforementioned dilemma of using a predetermined conceptual framework in the transdisciplinary process cannot be completely eliminated, at least not in theoretical or conceptual terms. However, as we will argue in Sect. 4, this dilemma can be partially resolved by entering the process with a malleable and open concept, which resilience thinking largely is. In this way, the bridging concept can be further developed in a recursive process together with practitioners. Yet, it needs further specification in order to serve as a bridging concept in the sense described earlier. Against the background of this specific understanding of boundary work, the following pages reflect on potential contributions of SER thinking as a bridging concept in transdisciplinary research on adaptation to climate change.

3 Social-ecological resilience thinking as a bridging concept for transdisciplinary research in the field of climate-change adaptation

Initially, the concept of resilience was comprehensively introduced in ecology to refer to ecosystems and—with their linear functioning and existing specific state of equilibrium in mind—it was conceptualised as the speed at which the system returns to this single stable state after disturbance. Holling (1973) relinquished the idea of linearity and equilibrium, and instead introduced the concept of multiple potential stable states with surprise and inherent unpredictability being dominant in ecosystems. The resilience concept did not remain solely within ecology, but has been explored and reworked by different disciplines. Within social sciences, psychology and economics, resilience is also seen in the context of the ability of individuals, groups and businesses to resist disturbances (e.g. Briguglio et al. 2006; Rutter 1987). Increasingly, concepts of SER that emphasise the interrelationships between ecosystems and society have been the subject of discussion and describe the ability of interdependent social-ecological systems (SESs) to withstand disturbances (Adger 2000; Berkes et al. 2003; Folke et al. 2002; Walker et al. 2006). Within this context, SER can be understood as the ability of SESs to persist through maintaining essential functions and structures and to evolve mainly by incorporating change while they are confronted with unpredictable and sudden events, disturbances or even shocks that strongly shape their future development (Walker et al. 2004; Holling 2003; Berkes et al. 2003; Folke et al. 2002).

In the following, we distinguish between SER as an analytical tool and social-ecological resilience thinking. As an analytical tool, the SER concept is used to describe and measure the resilience of a system with very specific features such as the adaptive cycle. As social-ecological resilience thinking, we consider the more general thinking behind the SER concept, that emphasises complexity (and thus non-linearity), transformational change,

uncertainty, surprise and potential nescience. The conceptual framework of SER and of the thinking behind it is considered as a helpful initial conceptual bridge for transdisciplinary research on adaptation to the future impacts of climate change for different reasons.

(a) The concept already deals with global environmental change.
(b) Furthermore, applying the SER facilitates meeting one of the characteristics of transdisciplinary research—the focus on problems of the practical world. This is also supported by looking at the case studies performed thus far using the SER concept (e.g. Walker et al. 2006; Gunderson et al. 2006; Adger et al. 2005). Here, particular attention has been paid to issues such as natural resources management and ecosystem services. Moreover, a research branch looking at resilience in complex contexts, e.g. urban contexts, is evolving (e.g. CSIRO et al. 2007; Alessa et al. 2009). Applying resilience thinking allows dominant assumptions of linear future development and partial worldviews within the practical management approaches to SESs so far to be put into question.
(c) In addition, a participatory research approach is mainly followed, implying a necessary inclusion of practitioners and interest groups and their specific knowledge of resilience research or resilience assessments. This seems to be increasingly the case in a range of research approaches, case studies and scenario-based approaches (Resilience Alliance 2007; Gadgil et al. 2003; Folke et al. 2002; Walker et al. 2002, 2004). Looking at the characteristic transdisciplinary research process commonly performed by practitioners and researchers by applying a resilience concept that does not provide for explicit norms or values, it becomes necessary to debate and define them openly within the research process. As Adger (2008) stresses, resilience as such does not distinguish between desired or undesired states of SESs, but preserves both. So the SER concept bears an open and flexible framework that, while being applied, requires a discussion of each transdisciplinary research process for every single social-ecological system being considered to define the norms and values at stake and, as a consequence, define the essential structures and functions of the SES that should be preserved. Also, it has to be carefully observed which actor groups, generations, systems, scales or institutions might take advantage of new trade-offs produced by applying the resilience concept (see e.g. O'Brien et al. 2009; Wheeler et al. 2009; Jasanoff 2008; Shah et al. 2008; Swanstrom 2008).
(d) SER offers a strategy to deal with potential nescience, uncertainty and surprise, which are particularly attributed to the hybrid phenomenon of climate change and related impacts and which are not to be isolated from other forms of stress or perturbation experienced in SESs, such as political, social and cultural changes (O'Brien et al. 2009). Moreover, there are also knowledge gaps and open questions concerning the further arrangement of institutional approaches, financing and implementing adaptation to the impacts of climate change, as it is also a multi-scale global problem that is characterised by infinitely diverse actors, multiple stressors and multiple time scales (Blanco and Alberti 2009; Adger 2006).
(e) Perceiving and conceptualising SESs are helpful as interaction dependencies and feedbacks between the social and the ecological spheres make them inseparable systems and entities in their own right; stress, shocks and surprises influence both the ecosystem and the social system at the same time, and disturbances influence the specific social-ecological interplays and feedbacks within the specific system (Folke 2006). Furthermore, the systems perspective can be considered to be of good value

especially to understand complex, coupled ecological and social systems and to perform analyses across multiple scales.

(f) The advantage of this approach is its conceptualisation of coupled social and ecological systems interacting in complex feedback as one system. It is this understanding that allows the integration of natural and social scientists and the bridging of their conceptual approaches. The conceptualisation of interdependent SESs and SER has a flexible, integrative epistemological approach for interdisciplinary research with links to the social and natural sciences. The transgression and integration of different disciplinary paradigms are the main intention giving birth to the SER concept. But here, it has to be emphasised that using the SER concept as an analytical tool—with characteristics such as panarchy—appears to be easier for ecological and natural scientists to grasp than for social scientists. Here, it appears that applying resilience thinking and using social-ecological systems as a common reference point in analysis is helpful in being able to perform the integration task.

Besides obvious strengths of resilience thinking as an analytical framework—such as the focus on transformational change, uncertainty and complexity—its practical use as a conceptual bridge within transdisciplinary research aimed at identifying the potential impacts of climate change and developing appropriate adaptation strategies that could address the issue of climate change in specific complex coupled SESs (Walker et al. 2006), also means meeting further challenges as it does not offer an easy-to-grasp framework or even an established ready-made theory. First experiences will be shown in the following section.

4 Social-ecological resilience and transdisciplinarity: how to resolve the dilemma of using a predetermined conceptual framework?

The crucial question raised in the beginning was: how can a "real" transdisciplinary approach be reconciled with a predetermined conceptual framework and scientific problem-framing? We referred to this dilemma very briefly in Sect. 2, mentioning the possibility of using an open, malleable bridging concept in transdisciplinary research in order to at least mitigate the negative consequences of prior conceptualisation. It is rather obvious that the utilisation of a predetermined bridging concept more or less sets the general course of the transdisciplinary process. This is unavoidable, yet partly remediable further in the course of the transdisciplinary process. First, bridging concepts are not all the same. In line with the argumentation of Brand and Jax (2007), we use SER in a broader meaning and more as a way of thinking or a perspective on social-ecological systems. In this way, resilience is intended to facilitate boundary work and remains open enough for further conceptual development. In other words, by entering the research process with a bridging concept that is as open and malleable as possible, the potential negative ramifications of the conceptual predetermination for the transdisciplinary process remain within reasonable limits. In doing so, resilience also serves as a guiding principle for the development of adaptation strategies by its focus on uncertainty and surprise and general openness to different disciplines and sectors.

Already at the very beginning of our transdisciplinary process, a core group was established, consisting of researchers and representatives of key departments from the administration of the model urban region in northeastern Germany. Our discussions, proposed measures and working methods were informed by resilience thinking right from

the start but were also a kind of reaction to the expectations by the participating practitioners, who were waiting for initial conceptual input. Initially, the focus on uncertainty, surprises and complexity, which is inherent to resilience thinking and important in the context of climate change, has proved to be fairly challenging for some of the practitioners at the beginning of the common process. As a consequence, the resilience thinking needed some kind of translation and further clarification and was—after the development of a common language within the core group—discussed in the first sessions as a new approach to thinking going beyond the usual day-to-day practice.

Yet, all in all, this way of thinking has not only been generally well absorbed by most practitioners, but it has also opened up surprising spaces for thought. Obviously, the resilience perspective challenges traditional thinking in political–administrative structures, which have mostly focused on developing tangible adaptation strategies for the specific (and seemingly threatening), anticipated impacts of climate change so far. At the same time, some policy makers and planners have been looking for instruments and concepts that can help them deal with uncertainty regarding future climate change and its local impacts without neglecting previous experiences and hitherto successful coping strategies, while others were doubtful whether they were entitled to act due to the uncertainty aspects. This is exactly where resilience thinking has proved its worth. Within our transdisciplinary process, it paved the way for using margins and ranges as well as alternative futures in order to deal with uncertainty and surprises. In this way, it has been possible to combine scientific epistemologies (e.g. modelling) with practical experiences and historical margins while incorporating the possibility of unknown, surprising events (e.g. using the possibility of wild cards in preparation of the scenario-planning process).

This conceptual translation of resilience thinking—using margins, ranges, alternative future scenarios, etc.—has been institutionalised in two forms of transdisciplinary cooperation. The aforementioned core group has served as the most important platform for encounters between different forms of knowledge, epistemologies and horizons of thought. This is also the main forum in which the specification of the resilience concept through the identification of important experiences and relevant variables in the given social-ecological context and situation has taken place and has been the focal point of transdisciplinary work.

Another useful feature of resilience thinking in our transdisciplinary process has been the inherent focus on specific system contexts. The social-ecological systems do not appear as black boxes that are exposed to external climate-change effects, but virtually call for a consideration of properties, influencing factors and interactions in a given system. In this way, the impacts of climate change do not appear as a single key variable, but compete with other variables, such as fiscal situation, political constellations, ecosystem services. This way of thinking is much closer to the everyday experience of practitioners who strive to integrate climate change into existing frameworks and connect it with available knowledge. However, the resilience framework has also been criticised for being heavily rooted in systems thinking, and accordingly for being rather oblivious to the issue of agency (Bohle et al. 2009). Although this critique still largely holds, the advantages of the systems approach inherent to the resilience framework have been more pronounced within our transdisciplinary research process. In addition to the aforementioned context-specific consideration of systems, the key advantage seems to be in the fact that it gives very strong credence to an integrative and holistic approach to research practice and assists thinking about the dynamic complexity of social-ecological problems (Fazey 2010). This is not trivial. For many practitioners, thinking in complex, dynamic systems is not a matter of course and, within transdisciplinary processes, system thinking has shown the potential to spur an active interest in acquiring knowledge about system properties and

interconnections, indirectly stimulating cross-sector cooperation. In this way, the resilience thinking may indeed contribute to knowledge generation in transdisciplinary research contexts and thus far has been implemented in gathering available experiences and data with reference to key variables of the system in a common iterative transdisciplinary process (in preparation of the scenario process).

To mention just one example of the integration of practical knowledge into the research process: the scientific modelling of potential impacts of climate change in the model urban region is heavily dependent on the input by the participating practitioners. In particular, the practical knowledge about relevant socio-economic variables and their interactions or the assessment of plausible future trends regarding those variables serve as indispensible input for the modelling exercise and the entire research process.

Furthermore, the use of the resilience perspective as a bridging concept in transdisciplinary research inevitably raises the issue of normativity. As briefly discussed in Sect. 3, resilience has been used in a wide range of ways: as a metaphor, a perspective, an approach, a way of thinking, a system property and a technical concept (Maru 2010). Some of these concepts appear to be primarily descriptive. Some are described as hybrid (e.g. social-ecological resilience) and some as largely normative (Brand and Jax 2007). In line with Adger (2008), we assume that the concept of resilience as such does not distinguish between desirable or undesirable states of social-ecological systems, yet its application as a bridging concept within a specific transdisciplinary research process involves taking a close and critical look at the norms and values that underlie the decision(s) as to which essential structures and functions of the SES should be preserved. A development of practically relevant adaptation strategies is difficult to imagine without such normative decisions on the relative importance of individual variables, their interdependencies and potential future trajectories. A scenario-planning process has been established to facilitate this process. At large, the consideration of values and normative standpoints has proved to have strong effects on actors' participation and inclusion. Consequently, through broader participation and inclusion, this downstream normative dimension of the resilience concept indirectly facilitates the generation of practical knowledge and its integration into the transdisciplinary research process.

5 Concluding remarks

Climate change seems to possess a remarkable degree of ontological complexity, epistemological distance and hybridity. This requires the integration of different perspectives, knowledge forms and approaches to gather a comprehensive picture of the impacts of climate change in order to be able to develop and analyse potential adaptation strategies. This makes a strong case for the need for transdisciplinary research. Within this paper, the advantages of applying an already given conceptual approach—in our case, the concept of social-ecological resilience—as a bridging concept in transdisciplinary research were explored. The SER concept seems already from a theoretical perspective to be adequate to perform this bridging task for transdisciplinary research on climate-change adaptation as it deals with global environmental change; offers a strategy to deal with uncertainty and surprises that are particularly attributed to the hybrid phenomenon of climate change; conceptualises social-ecological systems as inseparable systems and entities in their own right; puts a strong focus on practical problems; follows an already participatory research approach; and, finally, has a flexible, integrative epistemological approach for interdisciplinary research with links to the social and natural sciences.

The experiences within the transdisciplinary process so far have shown that it was more focused on SER thinking instead of using the concept of SER as an analytical tool. Moreover, it can be stated that it is worth starting with a given concept due to limited resources and the fact that in the transdisciplinary process at hand, the practitioners were expecting conceptual input from the researchers. So the SER thinking helped—after translation into practical terms—to open fields for further consideration from the very beginning, open the space for common creative work, generally define the problem and choose the relevant variables to look at. In this respect, the SER thinking was of good use as a framework for orientation, especially with reference to the epistemologically distant problem of climate change and its potential future impacts. However, there was translation work as well as mutual and common learning necessary from the participating practitioners and the researchers within the established core group. Also, the final bridging concept has to be further developed in a recurrent process, mutual responsibility and more specific detail, even though this renders the concept more tightly bound to the specific context of participating disciplines and their ontological and epistemological approaches, the specific worldviews and experiences of the practitioners and especially the given social-ecological context and situation.

Therefore, the idea of a bridging concept implies in our context an understanding of a bridging concept in transition throughout the transdisciplinary process and continuous conceptual development on a transdisciplinary base with mutual responsibility for building this bridge. Moreover, the application of the given concept of SER means constant and intense inter- and transdisciplinary discussions and reflection. And still, the following problem persists: there has to be a detailed bridging concept developed in the specific transdisciplinary research process that remains bound to the specific context of participating disciplines and their ontological and epistemological approaches as well as to the specific worldviews of the practitioners and the specific SES under consideration (Bergmann et al. 2010). However, the openness and malleability of the social-ecological resilience thinking has significantly reduced the risk of a strong predetermination and pre-structuring of the research process. By fostering the communication across the disciplinary and sector borders, the resilience thinking has proved rather valuable as a bridging concept. Therefore, as opposed to Brand and Jax (2007), we think that a rather broad concept of resilience may serve as an enabling factor in scientific progress, if science is understood more in transdisciplinary terms. Bridging frameworks as a distinct approach to transdisciplinary research do not only facilitate interdisciplinary and cross-sector communication, but might also enable more complex, multilevel, multidirectional, transgressive forms of knowledge generation. This is also an important contribution to scientific progress.

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