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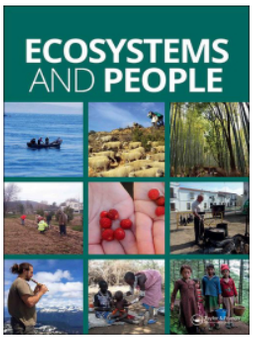

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REVIEW

Anticipating and transforming futures: a literature review on transdisciplinary coastal research in the Global South

Lilly Baumann[a*], Maraja Riechers [a,b*], Louis Celliers [a,c] and Sebastian C. A. Ferse [d,e]

[a]Faculty of Sustainability, Social-ecological Systems Institute, Leuphana University Lüneburg, Lüneburg, Germany; [b]Thünen Institute of Baltic Sea Fisheries, Fisheries and Society, Rostock, Germany; [c]Climate Service Center Germany (GERICS), Helmholtz-Zentrum Hereon, Hamburg, Germany; [d]Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany; [e]Faculty of Biology and Chemistry, University of Bremen, Bremen, Germany

ABSTRACT

Anticipation of futures using transdisciplinary approaches is critical to provide the basis for appropriate action to cope with current and future risks and to foster sustainability transformations. Coasts in the Global South in particular are subjected to severe environmental and societal challenges exacerbated by climate change. Yet, traditional research methods and epistemologies may not reflect the need for envisioning radically different sustainable futures. To gain an overview of and identify gaps in the current practices of transformational transdisciplinary research in coastal regions of the Global South, we conducted a systematic literature review of empirical English-language research articles ($n = 256$). Our results showed that most of the articles reviewed focused on past and current state analysis. Those articles using anticipation methods rarely analysed or established a link between anticipation and sustainability transformation. Yet, transdisciplinary and anticipation research have synergistic effects to foster sustainability transformation. A combination of these approaches may integrate pluralistic voices and values of stakeholders and foster potential alternative visions to counter unsustainable narratives. Thereby, the visions for possible futures may become more inclusive and reflective of realities in the Global South. Anticipation of the future using transdisciplinary approaches can provide a basis for adaptive management of future environmental and societal challenges. It may provide the knowledge-base which can be used to identify, reduce or prevent governance actions that result in undesirable states of the future. The inclusion of anticipation and foresight in transdisciplinary research creates the potential for achieving or progressing towards innovative and sustainable visions of the future.

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Introduction

Sustainability challenges threaten the integrity of coastal ecosystems worldwide. Anthropogenic climate change leads to higher temperatures, rising sea levels, ocean acidification, and an increase in extreme weather events (IPCC 2019, 2022). Coasts and oceans face pollution from nutrients, plastics, and other contaminants (Jambeck et al. 2015; Riechers et al. 2021), and changing land-use in parts of coastal areas leads to the destruction of ecosystems and biodiversity loss. These trends can cause irreversible impacts on coastal social-ecological systems (Halpern et al. 2015; IPBES 2019).

Changes in coastal ecosystems affect countries, communities, and people living in the Global South most detrimentally (Bennett et al. 2016; Lau et al. 2019). Due to a legacy of colonialism and continued neo-colonial approaches, regions and people in the Global South are adversely affected by capitalist globalisation (Dados and Connell 2012). Many countries in the Global South are characterised by unstable political, economic, and social systems (Sen Roy 2018), and face 'issues associated with limited statehood, such as public insecurity, corruption, and limited infrastructure' (Ayala-Orozco et al. 2018, p. 22). Climate change will exacerbate existing problems, and populations of these regions may be particularly affected by global environmental changes. The Global South both needs, and at the same is a source of, innovative adaptations and interventions for sustainable futures (Vervoort and Gupta 2018; Aykut et al. 2019).

Peoples' and societies' visions of desirable, sustainable futures are embedded in their social organisation and inherently normatively based (Bennett et al. 2016; Jiren et al. 2021; Shumi et al. 2023). The social organisation of societies, and mainstream visions for the future, can therewith influence policy preferences, scientific practices and technological innovation

CONTACT Lilly Baumann lillybaumann@gmx.de; Maraja Riechers Riechers@leuphana.de
*These authors are equally contributed to this work.
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(MacKenzie 1998; Fujimura 2003; Lübker et al. 2021). To develop innovative adaptations that support visions for sustainability, scientific endeavours must result in, or produce, methodologies and methods that allow society to break with development trajectories that are not sustainable. Anticipation research can help to foster sustainability transformation by strengthening alternative visions of the future that are not limited by the current system and trajectory (Pesch 2018). Such research processes and methods can create imaginative spaces and offer people and societies alternative ways to live (Loorbach et al. 2017; Pansera and Owen 2018; Chambers et al. 2022), in turn fostering transformation by highlighting radical, innovate and sustainable goals and agendas (Pereira et al. 2018; Pereira, Davies, et al. 2020; Mattijssen et al. 2020).

Traditional academic knowledge alone may not be sufficient to create opportunities to enable alternative visions of a sustainable future (Fazey et al. 2020; Chambers et al. 2021). In the last decade, transdisciplinary research has been proposed as a mode of knowledge production with which to address sustainability challenges (Brandt et al. 2013; West et al. 2019). While there are various definitions of transdisciplinary research, there is also general agreement that it includes a collaboration of stakeholders and experts from across non-academic and academic fields of knowledge (Schmidt et al. 2020). In this article, we use the term 'transdisciplinary research' to include approaches such as 'mode 2' (research based on non-linear, transdisciplinarity knowledge co-production by heterogeneous groups, e.g. Nowotny et al. 2003; Swan et al. 2010), participatory research, and public participation (Lang et al. 2012; Fazey et al. 2018). In the Global South in particular, transdisciplinary processes may be in place without reference to the terminology (such as Talanoa practices in Fiji, Kitolelei et al. 2022). For simplicity, in this article we use the term transdisciplinarity when we speak of research (processes) that include collaborations of stakeholders from different academic and non-academic fields of knowledge.

The use of anticipation in transdisciplinary research may require a much greater willingness of all actors to engage in the face of uncertainties (e.g. climate projections interpreted together with the inherent uncertainties of public sector management, politics and economies (Ritzema 2013; see also Jiren et al. 2021).; As many understandings of anticipation exist in the academic literature, we opted for a broad definition of anticipation as an action that takes into account or forestalls a later action as well as the general act of looking forward into the (near) future (Adams et al. 2009). We distinguish between anticipation perspectives, approaches, and research. An *anticipation perspective* is a willingness and ability to recognise the need for prior action to forestall a later action. This implies an action now, which may not inherently and immediately have value or benefit. An *anticipation approach* is a broad and common understanding that anticipation, and an anticipation perspective, can be actioned using different methods and tools, i.e. anticipation methods. Anticipation approaches and methods can help deal with the complexity and uncertainty of current changes and hence have become more prominent in the last few years (Boyd et al. 2015). Finally, *anticipation research* comprises the academic or research actions that a) develop new anticipation methods, and/or b) apply such methods and tools to understand trends in anticipation as an approach.

In this article, we analyse the extent to which transdisciplinary approaches applied to cases in the Global South consider 'anticipation of the future' of coastal systems. Coastal social-ecological systems have unique features that distinguish them from terrestrial or mountain systems, for example. Coastal systems are less clearly delineated, interface with both marine and terrestrial realms, are inherently dynamic, are more likely to experience impacts from climate change and human population pressure, and often have overlapping and conflicting legal and political boundaries (Adger et al. 2005; Dajka et al. 2020; de Alencar et al. 2020). Thus, methods and approaches developed for other systems cannot necessarily be transferred to coastal systems.

To gain a synoptic view of scientific knowledge on transdisciplinary anticipation research conducted in coastal ecosystems in the Global South, we conducted a systematic literature review analysing 256 peer-reviewed articles. We used Wiek and Lang's (2016) 'transform framework' and Muiderman et al. (2020) 'approaches to anticipatory governance' as an underlying conceptual framework for this systematic literature review resulting in a classification of anticipation approaches and methods. Based on our results, we propose strengthening a combination of transdisciplinary and anticipation approaches in research to emphasise (likely already existing) alternative visions of sustainability and give voice to pluralistic values, epistemologies and ontologies (Ayala-Orozco et al. 2018; Saxena et al. 2018; Vincent 2022).

Methods

Theoretical background

Transform framework

The 'transform framework' developed by Wiek and Lang (2016) consists of four steps and acts as a methodological guideline for transformative sustainability research. It can be used to develop answers to sustainability challenges as well as to transform the

current system in the direction of sustainability (Wiek and Lang 2016). The first step in the framework is the past and current state analysis (I), followed by scenario construction and assessment (IIa), visioning research (IIb), and lastly intervention research (III). It comprises two dynamic perspectives which are considered as anticipation approaches: Foresight, which consists of analysis of the past and current state, looking for likely future states with the help of scenarios; and backcasting pathways to desirable future states developed on the basis of visions, which are traced back to the current state (for backcasting see also Dreborg 1996). In the last step, intervention research is conducted with the design and testing of desirable visions whilst preventing unwanted future scenarios. The framework is designed for transformational sustainability research using transdisciplinary research methods, and as such it differs from descriptive-analytical research, which analyses and describes sustainability problems.

Anticipatory framework

Muiderman et al. (2020) developed a framework representing four ideal-typical 'approaches to anticipatory governance'. This framework can help classify anticipatory approaches according to their 'conceptualisation of the future', 'implications for the present' and 'ultimate aims to be realised' (see Figure 3). In the first approach, the research aims to evaluate *probable* and improbable futures with a focus on strategic planning in the present to reduce future risks. The futures are seen as complex and uncertain, but research in this approach 'argue[s] that future risks can be prevented and future opportunities can be shaped' (Muiderman et al. 2020, p. 7). In the second approach, multiple *plausible* futures are envisioned, aiming to the improvement of preparedness and strengthening capacities to navigate a variety of (uncertain) futures. Whereas similarities to the first approach exist, here, an emphasis is put on 'the need to enhance preparedness to reflexively steer sociotechnical developments in mitigating potential future harms' (Muiderman et al. 2020, p. 8). The third approach focuses on diverse, *pluralistic* futures and to mobilise societal actors to co-create such desired futures. In this approach, futures are inherently socially constructed and understandings of plausibility are hence subjective as different people might perceive different futures to be more or less believable. A focus in this approach is a collective imagining and co-creating of radical, transformative futures. The fourth approach conceptualises *performative* futures 'interrogating the performative power and politics of engaging with and imagining the future' (Muiderman et al. 2020, p. 9) to highlight how these performative effects have political implications in present-day decisions and general governance trajectories. All four approaches are, however, not static and distinct, but assist in broadly classifying anticipation approaches used in the existing scientific literature.

Data collection

The systematic review includes scientific articles in the English language, focusing on anticipation of the future in transdisciplinary coastal research in the Global South. For this purpose, the Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) system was used to structure the research process (Moher et al. 2009; Page et al. 2021). The PRISMA system consists of three steps, namely identification, screening, and inclusion, shown in Figure 1.

The Scopus database (www.scopus.com) was searched using a search string to identify relevant peer-reviewed empirical (meaning those that collected original data) articles. The search string consisted of different sections with the broad topics transdisciplinarity, transformation and transition, and coastal ecosystems. The search string can be found in the supplementary material. A broad definition of transdisciplinarity was chosen to account for different conceptualisations: all articles which either dealt with 'synthesis of knowledge', 'collaboration' or 'making change happen' (Bammer 2017) were included in the selected articles. A timeframe of 20 years from 2000 to 2020 was set as during this period, transdisciplinary research has become increasingly important (Brandt et al. 2013).

Our approach has a number of limitations. Only English language articles were included, due to the authors' language limitations. Analysing non-English peer-reviewed or grey literature is likely to yield more data. Research shows that the same approach and search string may yield different results in different languages (Hanspach et al. 2020; Burke et al. 2023), hence further research on anticipation approaches in the Global South is needed. Further, we focused on peer-reviewed articles from the Scopus database. An analysis of other databases (Web of Science, Google Scholar) and inclusion of grey literature would likely show different results. In addition, while the search string was designed by a group of interdisciplinary researchers in the context of the German Committee Future Earth (DKN) working group 'Anticipating and Transforming Coastal Futures', all but one of the authors are from the Global North, and all are Western-educated. The two conceptual frameworks used to analyse the literature have also largely been developed by Western-based and -educated scholars and may not fully allow for an incorporation of non-academic knowledges (see e.g. critique in Milgin et al. 2020; Vincent 2022). Transdisciplinary research, sustainability and sustainability transformations are inherently normative concepts (Scholz 2017; van der Hel 2018). Alternative concepts of sustainability and a 'good life' in balance with nature exist beyond those developed and used by academics in the Global North (e.g. Breidlid 2013; Acosta

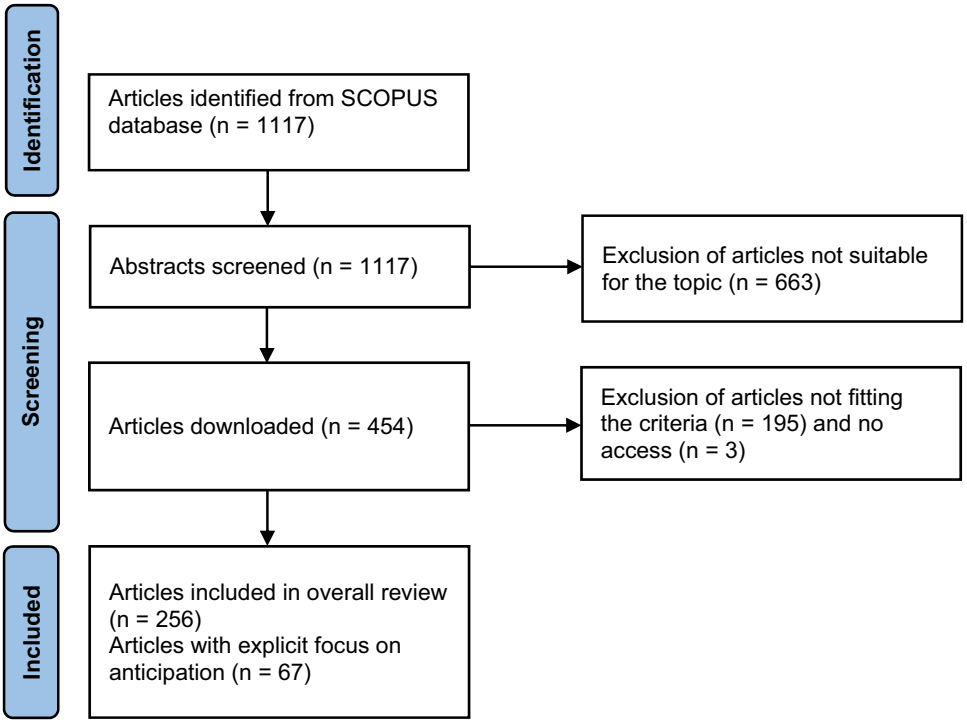

Figure 1. Flow diagram for a systematic literature review selection process following PRISMA (Moher et al. 2009; Page et al. 2021).

and Abarca 2018). A more comprehensive review including additional types of knowledge generation, for example, projects and associated knowledge produced in the context of coastal planning or environmental/social licensing procedures, would certainly yield interesting additional insights but was outside the scope of this study.

In total, 1117 articles fitting the search string criteria were found on Scopus. The titles and abstracts of these articles were screened, and articles that did not meet the following inclusion criteria were excluded: (i) articles concerned with coastal systems in regions of the Global South, (ii) research design complied with the characteristics of transdisciplinary research, i.e. research that involved academic and non-academic actors and that aimed for 'synthesis of knowledge', 'collaboration' or 'making change happen', (iii) empirical data was collected and/or case studies conducted, (iv) articles had to be available in English (exclusion of $n = 663$). The resulting 454 articles were read in their totality. Of these, 195 were excluded on the basis of the aforementioned inclusion criteria; three were excluded due to being inaccessible.

Data analysis

To collect, classify and analyse data resulting from the reviewed articles, codes were deductively developed based on two conceptual frameworks described above, as well as inductively from information emerging from the articles (for inductive and deductive coding, see Mayring 2008). Information about the name and a description of the codes, the type of data analysis, the number of analysed articles and the source for the code and data analysis can be found in Table 1. The total number for each variable may vary, as some codes could be applied to all articles ($n = 256$), while others were only relevant to articles using anticipation methods ($n = 67$), or articles not using anticipation methods ($n = 189$). The full list of included article references can be found in the supplementary material.

Articles with ($n = 67$) and without ($n = 189$) sufficient information on anticipation approaches or methods were analysed differently. For the set of articles not using any anticipation approaches or methods, we collected their general perspective on the future. For those that gave specific information on anticipation research, we coded anticipation approaches and methods based on the anticipation framework (Muiderman et al. 2020). If the article mentioned the aim informing the selection of a specific method, that aim was noted to look for reasons why anticipation research is important. The number of assignments to the respective variables of the anticipation methods is shown in the framework (see Figure 5 below). Each article could relate to more than one step, variable, or method.

Results

Our analysis of transformational transdisciplinary research conducted in coastal ecosystems in the Global South comprised 256 articles. Figure 2 shows the continental distribution of articles per country in

Table 1. Coding scheme based on deductive coding categories linked to Loch and Riechers (2021), Muiderman et al. (2020) and Wiek and Lang (2016).

Code name	Description	Analysis type	No. of articles
Biogeographical data	Ecosystem type, continent, country	Quantitative content analysis	256
Step of the transform framework	Transform framework steps: (I) past and current state analysis, (IIa) scenario construction and assessment, (IIb) visioning research, (III) intervention research	Qualitative content analysis leading to the classification of an article into the transform framework steps and subsequent quantitative content analysis using frequency counts. Integration of results into the original framework	256
Future perspective of articles not using anticipation methods	Search for the words 'future*', 'anticip*', 'vision*' and 'scenario*'	Inductive coding process on information on how articles deal with the future. Subsequent development of categories according to the qualitative content analysis.	189
Methods of anticipation	Methods used in articles doing anticipation research and method description	Qualitative content analysis based on inductive coding.	67
Aim for using an anticipation method	Mentioned aim of using a certain method	Qualitative content analysis based on inductive coding.	67
Anticipation approach	Classification of article into approaches for anticipatory governance	Qualitative content analysis leading to the classification of an article to a variable and subsequent quantitative content analysis using frequency counts. Integration of results into the original framework	67
Sustainability problems	Sustainability problems stated in the articles	Qualitative content analysis based on inductive coding.	67

the Global South to identify gaps in the geographic regions researched by the reviewed articles.

Most articles described studies on the Asian continent ($n = 93$; 36% of all 256 articles), followed by South America ($n = 56$; 22%), Africa ($n = 48$; 19%), Oceania ($n = 37$; 15%) and North and Central America ($n = 26$; 10%). Most studies took place in Indonesia ($n = 20$; 8%), followed by the Philippines ($n = 18$; 7%), Bangladesh, Vietnam and Brazil (all $n = 16$; 6%) (Figure 2).

Transform framework

Figure 3 shows the frequency of articles that have performed one or more steps of the transform framework. The size of the circles is relative to the number of articles.

Figure 3 shows that, of the 256 articles included in this literature review, 90.6% ($n = 232$) used a past and current state analysis (Step I of the transform framework). Step IIa 'Scenario Construction and Assessment' was done in 24.2% of the articles. The least used was Step IIb 'Visioning Research' with 5.5%. 'Intervention Research' (Step III) was done in 18.8% of the articles (Figure 3). The majority (68.8%) concentrated only on one of the steps of the transform framework – mainly a past and current state analysis (Step I, $n = 157$, 61.3% of all articles). Two steps were combined in 25.2% of the articles, 3.5% combined three steps, and 2.3% used all four steps. The most frequent combinations were between Step I and IIa ($n = 37$; 14.5%) and Step I and III ($n = 20$; 7.8%).

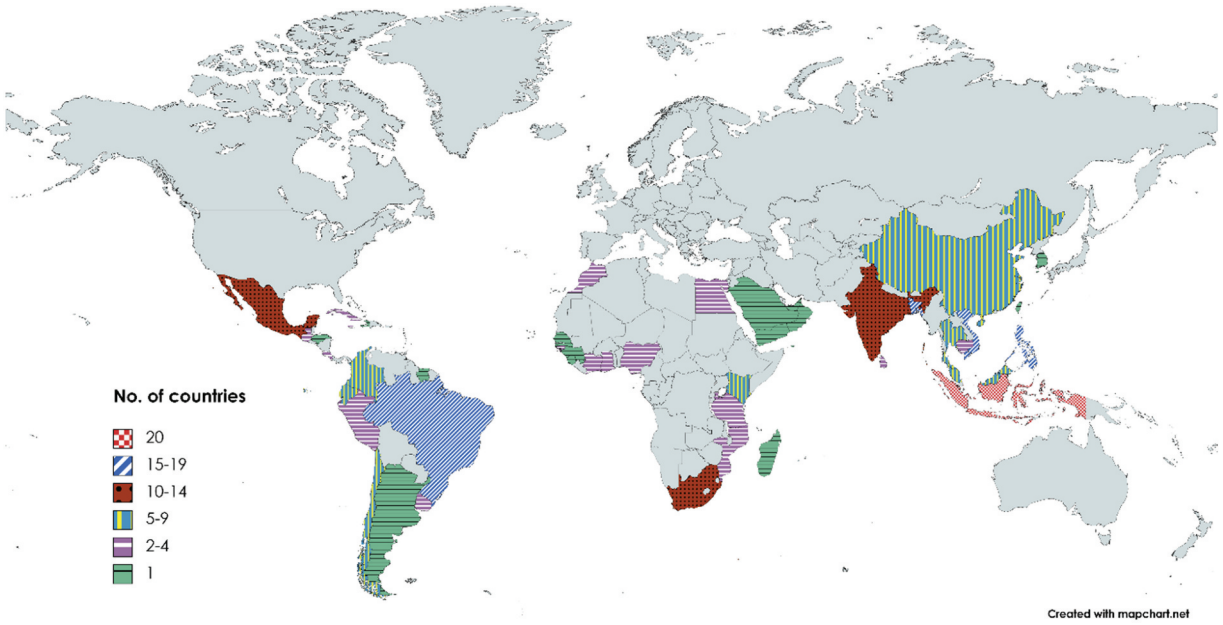

Figure 2. Distribution of articles by country in which the research was conducted.

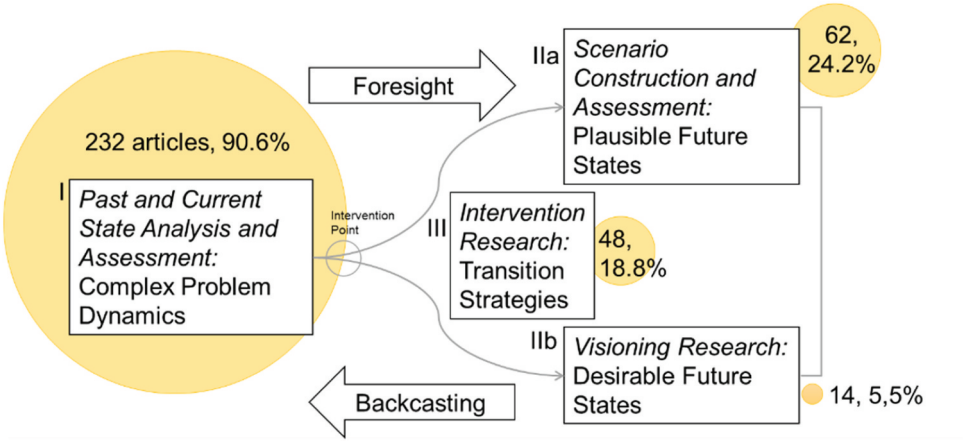

Figure 3. Transform framework with integrated numbers of articles found in each step, represented by the size of the circles. One article could perform more than one step of the framework. Adapted from (Wiek and Lang 2016).

Anticipation of the future

The number of articles using anticipation approaches and methods within transdisciplinary research approaches has slowly risen in the last two decades (from occasionally one before 2010, to 8 in 2015 and 9 in 2020). Yet, this is likely due to the general increase of scientific articles as the percentage of the articles using anticipation methods in relation to those working with 'the future' in more vague terms has been decreasing (Figure 4). Of the 256 articles reviewed, 67 (26.2%) specified anticipation approaches and methods. Some of the other 189 articles (73.8%) use more general perspectives of the future (see Table 2).

In the following we focus on the sub-set of articles (n = 67/26.2% of the original 256 articles) that specified anticipation approaches and methods. The anticipation approaches developed by Muiderman et al. (2020) and how often they could be found in the reviewed articles that used anticipation methods are shown in Figure 5. The size of the circles is relative to the number of articles addressing the combination of the two variables.

The two most frequently targeted anticipation goals and implications were strengthening capacities as implications for the present (n = 54 of 67 articles; 80.6%) and a 'plausible' conceptualisation of the future (n = 50; 74.6%). The most commonly applied approach (n = 36; 53.7%) combined conceptualisations of a plausible future and strengthening capacities as implications for the present. The second most frequently used approach was the combination of probable and improbable futures with strengthening capacities as implications for the present (n = 30; 44.8%), the third most frequent 'exploring plausible futures in order to mobilise diverse societal actors' (n = 23; 34.3%), followed by 'engendering pluralistic futures combined with strengthening capacities' (n = 22; 32.8%). The least used conceptualisation of the future was a performative one (n = 12; 17.9%) and 'interrogating as implication for the present' (n = 6; 9%). Hence, of the predefined approaches by Muiderman et al. (2020),

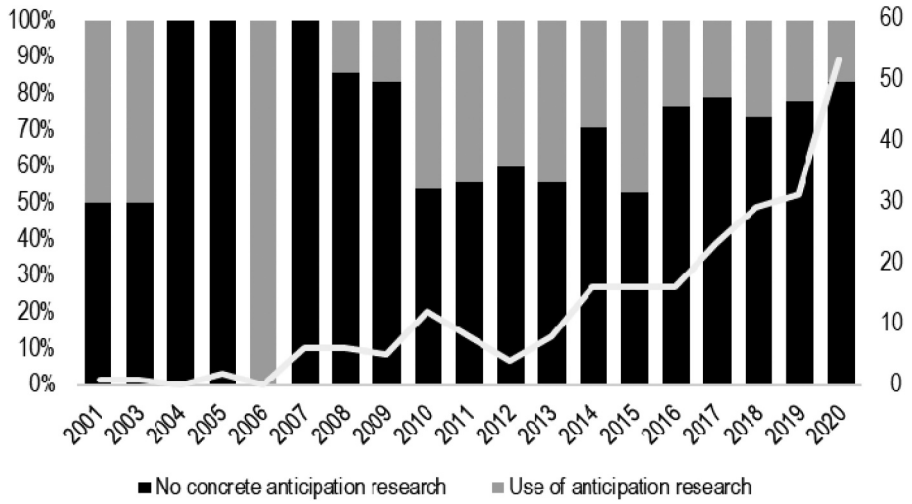

Figure 4. Distribution of reviewed articles describing transdisciplinary and transformative research that work with (grey) and without (black) anticipation approaches specifically and from 2001 to 2020 in percent (legend on the left); number of articles in this literature by time (legend on the right).

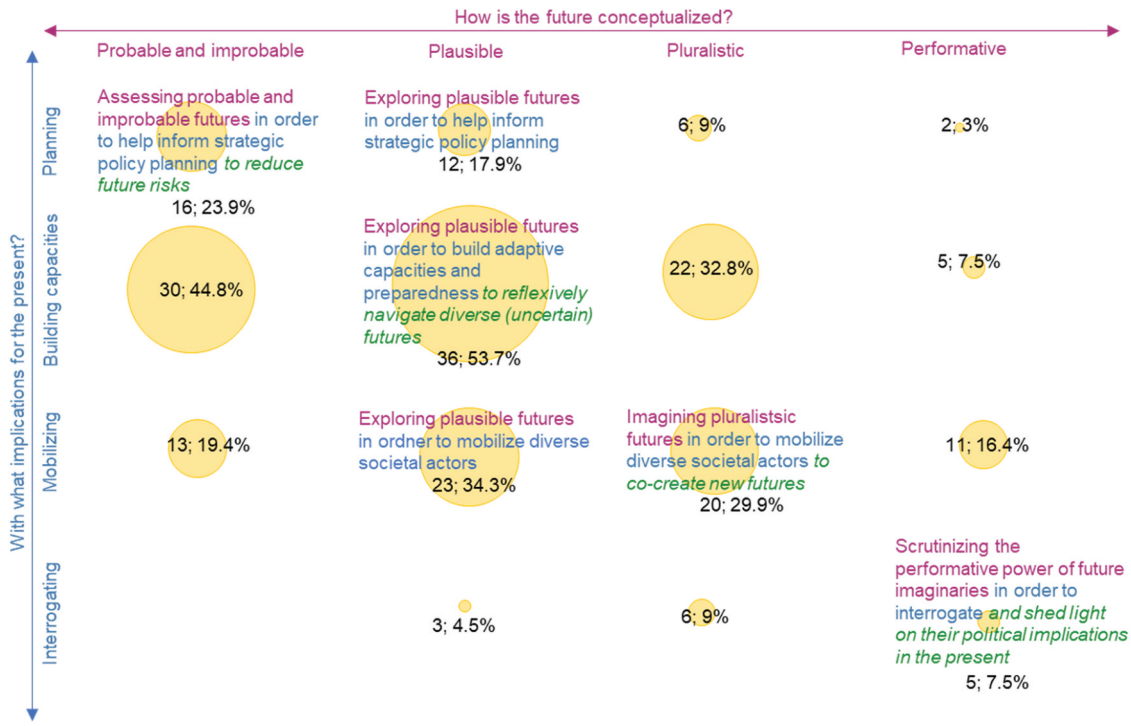

Figure 5. Approaches to anticipatory governance with integrated numbers of articles found in each approach, represented by the size of the circles. One article could apply more than one step of the framework. Adapted from (Muiderman et al. 2020).

Table 2. Future perspectives of articles not specifying anticipation methods.

Perspectives	Examples from the literature
Article is a starting point for creation of scenarios or visions	Basis to define a common vision
Generally desirable 'visions' for the future	Vision of a desirable, sustainable future
Generally desirable 'futures'	Imaginaries of the future
	Towards a desired, sustainable future
Articles mentioning the uncertainty of the future	Increasingly difficult to foresee future
	High uncertainty makes management/action difficult
	Hopelessness due to uncertainty
Anticipation knowledge of indigenous and local communities	Early warning systems and coping strategies for minimising future threat
	Resilience attributes to ameliorate impacts and to create adaptive capacities

'scrutinizing the performative power of future imaginaries in order to interrogate and shed light on their political implications in the present' ($n = 5$; 7.5%) was conducted least often.

Regarding the ultimate aims of the anticipation research based on the classification of Muiderman et al. (2020), 43% ($n = 58$) aimed to reflexively navigate diverse uncertain futures, 27% ($n = 36$) to imagine and co-create new futures, 22% ($n = 67$) to mitigate or reduce future risk, and 8% ($n = 11$) to shed light on the political implications in the present of speculative future imaginaries.

The sustainability problems these articles were focusing on (Figure 6) were mainly related with climate change ($n = 28$; 41.8%), biodiversity loss and ecological degradation ($n = 25$; 37.3%), and/or resource management and conflicts ($n = 17$; 25.4%).

In the reviewed articles various methods and combinations thereof were used to engage with the future. The most common methods emerging were scenario development and assessment, often with an inclusion of modelling and quantifying stakeholder preferences (Table 3).

Discussion

While there are many studies on coastal systems in the Global South, there is still great potential to do and/or publish more transdisciplinary anticipation research that addresses sustainability challenges. Whereas many studies have likely not been included through our focus on peer-reviewed, English-language articles, other studies may not have used terms in their publication to be included in this review. We acknowledge that due to power imbalances within transdisciplinary research teams, inequalities in access to funding and research infrastructure (Chilisa 2017; Vincent 2022), and due to the added difficulty when implementing transdisciplinary research or suggested solutions because of issues related to public insecurity or corruption (Ayala-Orozco et al. 2018; Senbeta 2021), researchers from the Global South may not find their results in our article. Our findings should be understood within those limits.

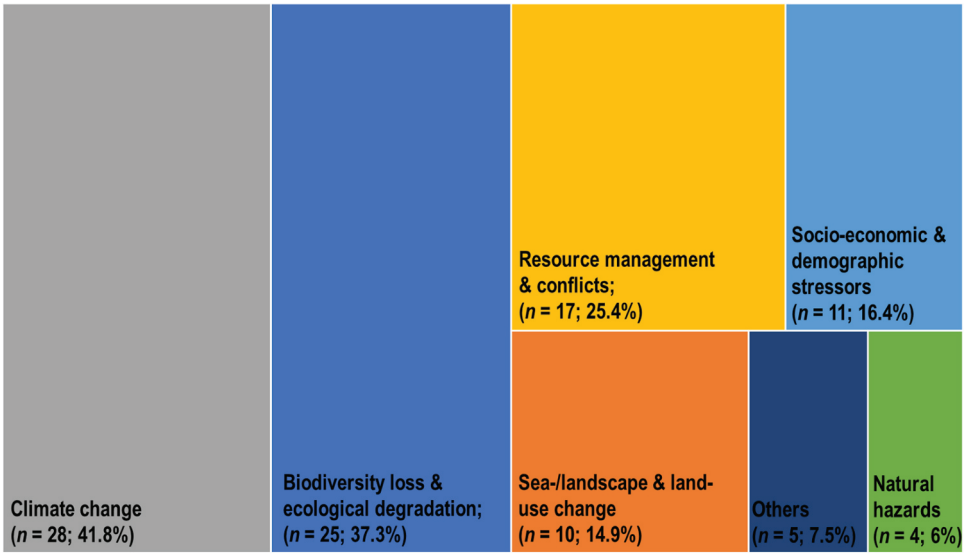

Figure 6. Aggregated sustainability problems stated in the articles ($n = 67$) using anticipation approaches. Categories are not mutually exclusive as individual articles could address multiple problems.

Table 3. Examples of different anticipation research methods used in studies from the Global South.

Anticipation method	Category	Examples of anticipation research methods and processes
Scenario development	Information basis	Workshops, consultations, public meetings
		Local and regional expert knowledge
		Qualitative research (e.g. interviews, Delphi, social network analysis)
		Based on previous projects and the current situation
		Fuzzy cognitive mapping
		Based on IPCC scenarios, literature, and workshops
	No. of scenarios	2,3,4
	Timespan	15–20 years
	Type	Possible future scenarios
		Descriptive narratives with description of winners and losers
		Policy scenarios
		Preferable future scenarios
		Problem focussed scenarios (e.g. sea level rise scenarios)
Scenario assessment	Process	Evaluation/weighting criteria by stakeholders
		Assessment based on comparison of scenarios
		Based on economic valuation
		Ranking/selecting desired scenarios by stakeholders
		Assessment of scenarios (through, e.g. Strategic Environmental Assessment)
		Assessment of social acceptability by stakeholders
Modelling	Type	Participatory modelling
		Economic modelling
		Simulations
	Goal	To simulate and evaluate scenarios
		Create quantitative projections to avoid costs
		Model externalities when resources get depleted
Evaluation of scenarios	Evaluation methods	Economic valuations
		Story lines/narratives
		Quantitative surveys, risk mapping
		Qualitative (focus groups, workshops, interviews, role playing games)
	Type of scenarios	Policy scenarios
		Adaptation options in different likely scenarios
		Hypothetical scenarios
Visioning	Type	Biodiversity vision
		Shared vision
	Outcome	Conservation plans, protected area management
		Initiating actions

Distributions of, and insights from, studies conducted in the Global South

When analysing the geographical distribution, our results showed that the transdisciplinary research assessed was distributed unevenly across and within continents. While for example small island states were sparsely represented, this distribution may not reflect their vulnerability to climate and environmental change, but rather academic infrastructures. Further, when looking at the African continent ($n = 51$; 19.4% of all 256 articles), more than half of the research took place in South Africa alone ($n = 24$; 9.4%), underlining an uneven distribution of transformative transdisciplinary research in the assessed literature.

To foster alternative, even radical, visions for sustainable futures, the integration of local experts and change agents is necessary. Such a process of visioning needs an approach and co-productive agility (Chambers et al. 2022) in which 'knowledge is open, emergence is held, inclusive logic is respected, and tolerance in contradictions can be explored' (Vogel and O'Brien 2022, p. 654). Vogel and O'Brien (2022, p. 655) further state that these processes and places are 'more than opportunities for dialogues where "stakeholders" are gathered for inputs; they are carefully crafted spaces where people can discuss, debate, and co-create complex futures'. A great deal of knowledge about environmental change exists among the local populations that may not be reflected in academic research. Transdisciplinary anticipation research could enable integrating academic researchers in local knowledge systems to re-frame sustainability challenges and co-produce solutions (Kareem et al. 2022; Vogel and O'Brien 2022; Hartel et al. 2023). Transdisciplinary anticipation approaches and methods are well-suited to support the design of adaptation options that often require, e.g. negotiated trade-offs, acceptance of loss and alternative livelihoods, as alternative, possibly radically new visions (e.g. based on feminist, decolonial, degrowth perspectives) could be strengthened through anticipatory research and to decolonialise futures (Otero et al. 2020; Staffa et al. 2021; Bourgeois et al. 2022; Kareem et al. 2022; Vincent 2022). Transdisciplinary approaches are particularly suited to enabling local voices and the development of alternative narratives to counter the prevailing hegemony of countries and actors in the Global North (Milgin et al. 2020). Moreover, the responsibility for global environmental changes predominantly lies with countries in the Global North, and research should facilitate working towards mitigation and providing financial compensation and assistance to those most affected by these global changes to ensure sustainable futures.

Klein (2014) proposes that transdisciplinarity brings together imperatives of transcendence, problem-solving, and transgression. In this way, it has always been about imagining futures. In the climate science community, the future is about objective truth (of an observed pattern and future trend in the climate); for a community of elders, it is about the quality of a finite life, invoking beliefs, and values. Transdisciplinarity can be useful to transcend differences in the way that different communities understand and engage with the future (e.g. Pereira, Frantzeskaki, et al. 2020; Ziervogel et al. 2021). Narratives and agendas in the context of climate change, including in academia, are still predominantly shaped by actors from the Global North, due e.g. to uneven distribution of power and resources. To fully allow for emancipatory and decolonial approaches to be strengthened in research across the globe, specific and anticipatory transdisciplinary approaches may need to be considered (e.g. Lotz-Sisitka et al. 2016; Chilisa 2017). In addition, transdisciplinary research may aim to empower actors (non-academic and academic) to devise and re-frame sustainability problems and possible solutions together and strengthen south-to-south connections (Biggs et al. 2022).

Transformational sustainability research

Descriptive research of the past and the current state was the most common research type in our sample, showing that more transformational sustainability research is needed. Our results revealed that 90.6% of the reviewed articles ($n = 232$) did a past and current state analysis relating to the first step of the transform framework. While some articles combined this step with other steps of the transform framework, over half of all articles ($n = 157$, 61.3%) only conducted a past and current state analysis. This is not unexpected since most academic research, especially in the natural sciences, operates in the field of descriptive research and is concerned with investigating past and current trends (Fazey et al. 2010), and these are still frequently used to make inferences about the future (e.g. in the fields of environmental history, palaeoecology, or climatology). Yet, the rapid anthropogenic environmental changes characterising the Anthropocene and the increasingly realised complexity of coupled social-ecological systems, both of which are particularly manifest in coastal systems (Partelow et al. 2020), imply that these systems constitute 'moving targets' whose future states usually do not have historical analogues and depend to some extent on goals negotiated and set by society (Ingeman et al. 2019).

Depending on the definition, transdisciplinary research can aim for transformational research and thus goes beyond descriptive research (Fazey et al. 2010; Lang et al. 2012). In the definition of Lang et al. (2012), transdisciplinarity has the goal to be solution- or transition-oriented (see e.g. studies that used multiple steps of the transform framework: Schmitt et al. 2013; Butler et al. 2016). Articles that only present the first step of the transform framework can be classified as descriptive research, falling short regarding the solution and transition-oriented potential of transdisciplinarity. For example, understanding institutions, how they relate to anticipatory governance and if they hinder or foster sustainability transformation is a crucial step for transdisciplinary research (Manlosa et al. 2023). Anticipation research could, for instance, focus on eliciting which institutions are addressing sustainability challenges as well as

analysing how to change institutions that are reproducing unsustainability, going beyond analysing the past and current state. Transformational sustainability research could enable a co-production of sustainable futures, based on different paradigms, cultures and perspectives (Chambers et al. 2022). A combination of these different perspectives may generally increase the value of anticipation – possibly creating a more hopeful or culturally sensitive outcome (Westoby and McNamara 2019; Fischer and Riechers 2021).

Co-constructing futures

Considering the aspect of anticipation in the transform framework, which compromises scenario construction and assessment (IIa) and visioning research (IIb), only 26% ($n = 67$ of 256 articles) of all reviewed articles used anticipation methods. Whereas Boyd et al. (2015) show that anticipation research in the context of sustainability challenges is increasing, our data cannot confirm this trend within transdisciplinary research in the Global South (Figure 4). Identifying and applying appropriate methods, also in the context of transdisciplinary research, therefore remains one of the major challenges (Muiderman et al. 2020). Anticipation methods in the context of transdisciplinary research are still developing. The complexity of undertaking transdisciplinary research is recognised (and generally, Simon et al. 2018; in the Global South; Celliers et al. 2021). In addition, in the literature, a focus on anticipation invokes concepts such as uncertainty and risk (McNeeley and Lazrus 2014; Seidl 2014), preparedness, pre-emption and precaution (Anderson 2010). This is over and above the different cultural, religious, philosophical, and economic conceptions of the future and how to live now in anticipation of the future, hence, posing additional challenges to anticipation research.

Most articles were sorted in the category of exploring probable (first anticipation approach) and plausible (second approach) futures (Figure 5). Methods used in these approaches are typically modelling and scenario planning (Muiderman et al. 2020). Scenarios are a prevalent and well-established tool in futures research and have been used increasingly in social-ecological studies and in a participatory manner (e.g. Oteros-Rozas et al. 2015; Blythe et al. 2021; Jiren et al. 2021). Scenarios provide systematic ways for exploring and evaluating the future in unpredictable and complicated environments (Biggs et al. 2012). Displaying plausible future states can prepare for future challenges and advise society regarding uncertainty. Thus, scenario construction and assessment are important in the context of adaptation and transformation (Wiek and Iwaniec 2014). Furthermore, scenario planning can be used to create guidance for planning, which is mentioned as an aim for anticipation research (Zscheischler and Rogga 2015). Scenarios can be developed in transdisciplinary settings, as many different normative perspectives can be included to represent a broad and realistic result (Iwaniec et al. 2020), increasing the complexity and resource intensity of the research (Fazey et al. 2018; Staffa et al. 2021).

That being said, the focus hereby mostly lies on transferring knowledge from academic researchers to local stakeholders (Muiderman et al. 2020). Concerning the level of involvement and participation (Arnstein 1969; Krütli et al. 2010), this one-sided information flow can fall into the category of 'information', which displays the lowest level of stakeholder involvement and does not give a lot of room for knowledge co-creation. In this context, information is transferred unidirectionally from academia to the public (Brandt et al. 2013). While the knowledge co-production part may not result in peer-reviewed articles, it can be said that if the entire project has a low level of involvement, this can diminish the positive effects of transdisciplinary research (Krütli et al. 2010). In collaborative processes, non-academic stakeholders and researchers can co-design the procedure and the result, in turn establishing a two-way communication process leading to the generation and integration of diverse knowledges (Krütli et al. 2010). The more interaction there is between actors, the greater the resulting societal output and impact, which makes higher levels of involvement desirable (Jahn et al. 2022). The maximum degree of involvement is empowerment, where stakeholders are afforded a certain degree of autonomy and direct involvement in collaborative decision-making processes (Arnstein 1969; Krütli et al. 2010).

The power of visions & visioning exercises

The focus on pluralistic futures (third anticipation approach) has not been very prevalent but holds high potential for anticipatory transdisciplinary research for transformations ($n = 20$ of 67; 30%). The use of scenarios and visions enables the imagination of pluralistic futures including possible steps for achieving such futures. In this approach, high importance is placed on stakeholder participation with the intention to create transformative futures. The third approach draws a close link between anticipation and sustainability transformations. It integrates perspectives from future studies and sustainability sciences. Probability and plausibility are considered limiting because of their relationship to the present, whilst a plurality of social presents and pasts can be included through collective imagination (see e.g. Gerhardinger et al. 2022). Performative futures (fourth approach) were observed very rarely ($n = 5$ of 67; 7.5%). This approach focuses on scrutinising

the performative power of future imaginaries to interrogate and shed light on their political implications in the present. Yet, including a focus in transdisciplinary research on who can intervene in a given system to foster system-wide transformation (Abson et al. 2017; Fischer and Riechers 2019) is crucial. Hence, our review underlines the need for transdisciplinary approaches and joint development, experimentation (and visioning) for transformation research. However, it is likely that with the rise of focusing on places to intervene in a system. i.e. leverage points for sustainability transformation (Meadows 1999) through e.g. its uptake in IPBES (Chan et al. 2020), research on envisioning desired futures and ways to get there will increase.

Developing desirable future visions can motivate and inspire people to act together towards a shared vision, as shown by Miclat et al. (2006). The main difference between scenario planning and visioning lies in their different perspectives. In contrast to scenarios, whose starting point is located in the past, the generation of visions starts in the future (Sheppard et al. 2011; Tschakert et al. 2016; Gaziulusoy and Ryan 2017). This affords visions the advantage of not being limited by possibilities of the past (Muiderman et al. 2020). Whilst scenarios can be sufficient in relation to a short-term time horizon, visions need a long-term time horizon (Boyd et al. 2015) and are the basis of long-term transformation strategies such as transformation roadmaps and policy/research missions (Miedzinski et al. 2019). The aim to motivate and instigate action and imagine alternative futures was apparent when searching for aims to use anticipation methods (Farley et al. 2010; Nthane et al. 2020). Visioning research is based on cognitive engagement with a possible future state. This process gains from diverse epistemologies, ontologies, preferences, and perceived needs to jointly conceptualise and define a vision for a sustainable future (Wiek and Iwaniec 2014). Visioning processes are an excellent opportunity to co-create and decolonialise futures, strengthen capacities (of academic and non-academic stakeholders), and empower local communities (Fazey et al. 2010; Wiek and Iwaniec 2014; Bourgeois et al. 2022). Current discussions on real-world laboratories highlight their potential to allow a long-term transdisciplinary process (see e.g. Wanner et al. 2018; Franke et al. 2023).

Yet, some challenges facing coastal communities in the Global South now are urgent and need rapid action (IPCC 2022). In this case, research on sustainability interventions might be prioritised (Meadows 1999; e.g.; Riechers et al. 2022). Our results, however, showed that intervention research and following potential interventions into the system are predominantly based on analysing the past and current state without conducting anticipation research. Interventions designed without anticipation research have a higher likelihood of leading to unintended outcomes and may instead strengthen the unsustainable Status Quo of a system (Stein et al. 2020). To prevent that, knowledge about the past and current state as well as of plausible, plural and desirable futures is needed. Based on this knowledge, intervention research can then develop strategies and pathways to the desired future (Wiek and Lang 2016). A similar case is made in the sustainability impact assessment literature, where ex-ante analysis of potential impacts that draws on scenarios and outlooks is used to identify unintended outcomes and shape adequate pathways and actions (Helming et al. 2011). Furthermore, anticipation based on premises and concepts stemming from the Global North could, even if unintentionally, further entrench existing hegemonic paradigms and structures, hindering emancipatory and decolonial futuring. The development of anticipatory approaches by actors from the Global South, based on Indigenous and traditional communities' concepts, may thus be needed to transform existing structures. Further research with a broader assessment of the non-English and grey literature might be able to assess the extent to which such locally led approaches exist already.

To enhance the accessibility of knowledge about the future, having various options for interventions and adaptation is important to prevent unanticipated shocks (Tschakert and Dietrich 2010). Reactive adaptations appear after a hazard occurs to react in a particular situation. In contrast, anticipatory adaptation includes anticipation and long-term thinking before a certain event happens, which may support social-ecological systems in reducing or avoiding immediate future risks. Both types of adaptation can also take place in parallel when adapting to current situations while at the same time anticipating the future to prevent unpreparedness (Ung et al. 2015). To overcome barriers in adaptation is especially difficult in communities and countries where not enough resources are available to adapt quickly (IPCC 2022). Anticipatory research should therefore be carried out as early as possible to find suitable adaptations that support sustainable development now and in the future.

A scarcity of transdisciplinary anticipation research?

We focused our review on research specifically addressing coastal systems which face particular challenges in the context of global change. Coastal systems are less well-studied and data are more scarce compared to most terrestrial systems. Likewise,

coastal systems are particularly complex and characterised by overlapping boundaries, particular human migration issues, and interconnectedness to both terrestrial and marine systems (Schlüter et al. 2019). These characteristics pose additional challenges to anticipation and futuring and may mean that research in this context is scarcer compared to other systems. In addition, comparably more resources for research may still be directed to establishing basic understanding and filling existing data gaps in coastal compared to other systems. Marine social sciences are a nascent, rapidly evolving field and lag behind marine natural sciences and social science in terrestrial systems in terms of resources and output.

A further explanation for the lack of peer-reviewed publications on coastal anticipatory transdisciplinary research may be a lack of appropriate funding (Jahn et al. 2022). Since transdisciplinary research is based on cooperation with stakeholders, the more people are included in a research process, the more resources, such as time, money, and materials are needed (van Kerkhoff and Lebel 2015; Chambers et al. 2021). Increased resources on the part of researchers and stakeholders are often implicitly expected but not acknowledged in research funding (regarding costs and time of the projects) (Tschakert and Dietrich 2010). On the one hand, the strengths of transdisciplinary research lie in the greater societal outcome and impact that traditional research can achieve. On the other hand, transdisciplinary research can lead to a decrease in the academic outcome, which can limit the motivation and capabilities of researchers to foster transdisciplinary processes (Staffa et al. 2021; Jahn et al. 2022; Shackleton et al. 2023) – and impact the visibility in literature analyses based on peer-reviewed, English language articles. Transdisciplinary research has the potential to start system transformations, and the resources spent can be seen as a proactive investment in the future.

Conclusion

In this systematic review, we set out to analyse to what extent transdisciplinary approaches in coastal transformation research conducted in regions of the Global South consider an 'anticipation of the future'. We contribute to the wider discourse on anticipatory research by using a structured approach to characterise what is currently being done and identifying which areas require further emphasis. Our results suggest a bias towards past and current state analyses, rather than research on plausible futures, transition strategies or visioning research. When anticipation research was used, the focus clearly lay on plausible and (im)probable futures, instead of pluralistic or performative ones as well as on an aim to strengthen capacities in the present, instead of mobilising or interrogating diverse social actors and the political implications within the present. It is possible that this bias resulted partially from the limitations of our selection criteria for literature to include. A broader analysis including non-English and grey literature would thus be desirable to further explore the observed patterns. To combat the increasing impacts of environmental and climate change on coastal social-ecological systems, especially in the Global South, we need anticipatory solutions/interventions to foster sustainability transformations. Transformative transdisciplinary research makes it possible to include pluralistic knowledge systems and to co-create alternative, sustainable futures. In 2021 the IPBES launched its new call for a 'Transformative Change Assessment' with the aim to understand and identify factors in social-ecological systems that may be leveraged to bring about transformative change, including a chapter on visions and visioning for a sustainable world – highlighting the importance of transdisciplinary anticipatory research, especially in and from the Global South, to bring forth new imaginaries to counter existing un-sustainable ones.

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ORCID

Maraja Riechers http://orcid.org/0000-0003-3916-8102
Louis Celliers http://orcid.org/0000-0001-5096-1713
Sebastian C. A. Ferse http://orcid.org/0000-0003-0930-5356

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