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## Perspectives on transformational change in climate risk management and adaptation

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## TOPICAL REVIEW

Perspectives on transformational change in climate risk  
management and adaptation

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E-mail: [deubelli@iiasa.ac.at](mailto:deubelli@iiasa.ac.at)**Keywords:** transformation, transformational change, climate change, adaptation, climate risk, disaster risk, resilience, systematic review

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**Abstract**

In the context of strong evidence on mounting climate-related risks and impacts across the globe, the need for ‘transformational change’ in climate risk management and adaptation responses has been brought forward as an important element to achieve the Paris ambitions. In the past decade, the concept has experienced increasing popularity in policy debates and academic discussions but has seen heterogeneous applications and little practical insight. The paper aims to identify relevant perspectives on transformative approaches and transformational change in the context of climate risk management and adaptation to propose an actionable definition for practical application. Using a systematic search and review approach, we review different perspectives across policy and scientific publications, focusing on work published in the past decade and identify common features of what transformational change in the context of climate risk management and adaptation may involve. We show that different perspectives on transformational change in the context of climate risk management and adaptation persist, but certain areas of convergence are discernible. This includes understanding transformational change as part of a spectrum that begins with incremental change; involves climate risk management and adaptation measures focusing on deep-rooted, system-level change and tends to aim at enabling more just and sustainable futures; often oriented towards the long-term, in anticipation of future climate-related developments. In addition, we identify an ‘operationalisation gap’ in terms of translating transformational change ambitions into concrete transformative measures that can be replicated in practice.

**1. Introduction**

Accelerating climate change and first evidence of adaptation limits, along with rising compound risk, call a sole reliance on conventional approaches for addressing climate-related risks into question (Dow *et al* 2013, Colloff *et al* 2017, IPCC 2018b, 2019) and create new challenges across all sectors (Nalau and Handmer 2015). While climate risk management and adaptation approaches have become widely accepted as indispensable for managing current observed and future expected negative impacts of climate change (Tesfaye and Seifu 2016, Magesa and Pauline 2019), projected vulnerabilities and risks are increasingly becoming so profound that standard approaches may no longer suffice (Kates *et al* 2012, Park *et al* 2012, Klein *et al* 2017). Calls for transformative approaches to climate risk management and adaptation, including for relevant epistemic approaches (David Tàbara

*et al* 2019) that facilitate ‘radical and fundamental change’ (Feola 2015) for the better (Mustelin and Handmer 2013) are increasingly voiced as the number of disasters associated with climate change increases (Klein *et al* 2014, Nalau and Handmer 2015, Mechler and Schinko 2016, Panda 2018, Thomalla *et al* 2018, Roberts and Pelling 2019).

Particularly in environmental and development policy and science arenas, the need for a shift towards ‘transformative approaches’ to climate risk management and adaptation to prevent disasters and enable sustainable development pathways is receiving increasing attention (Feola 2015, Godfrey-Wood and Naess 2016), albeit less so still than the parallel mitigation and socio-technical transitions literature. Spearheaded by the Intergovernmental Panel on Climate Change (IPCC), which in several reports referred to the need for transformational adaptation—among others in the Special Report on Managing the Risks

of Extreme Events and Disasters to Advance Climate Change Adaptation in 2012 (IPCC 2012), in the Fifth Assessment Report in 2014 (IPCC 2014) and most recently, in 2018 in the Special Report on Global Warming of 1.5 °C (IPCC 2018b) and the Special Report on the Ocean and Cryosphere in a Changing Climate (IPCC 2019), academic and policy debates have picked up on the concept over the past decade, often presenting transformational change in climate risk management and adaptation as an inherently positive shift (O'Brien 2012, Abeling *et al* 2018) that harbours 'the solution to environmental change' (O'Brien 2013, p 670), a 'promise of "hail" and success towards climate change resilience' (Tröger 2016, p 353).

This increasing attention offers opportunities for advancing towards a cogent and actionable conceptualisation of 'transformative' approaches to climate risk management and adaptation and the change processes entailed therein, but has also resulted in an array of interpretations across the body of research (O'Brien 2013, Feola 2015, Nalau and Handmer 2015, Godfrey-Wood and Naess 2016, Few *et al* 2017). A heterogeneous conceptualisation of the term, however, may hamper its potential to unlock deep change towards comprehensive climate risk management and adaptation that addresses the root causes of risks and enables sustainable futures (Mechler *et al* 2014, Few *et al* 2017). In addition, objectives and characteristics of such approaches in the climate risk management and adaptation literature rarely feature clear quantitative goals unlike in the parallel mitigation and socio-technical transitions literature (e.g. net zero targets for mitigation), further motivating our research interest in this area.

In this paper, we chart the use of transformative approaches and similar concepts in the context of climate change adaptation and risk management across the literature, focusing on work published in the decade since the publication of the Fourth IPCC Assessment Report in 2007, which called for a step-change in adaptation efforts (IPCC 2007). In line with Vermeulen *et al* (2018), this article uses 'transformative' when describing the change process (e.g. transformative climate risk management and adaptation) and 'transformational' when referring to the outcome of the change process itself (e.g. transformational change) for reasons of clarity, but traces both across the literature.

Our focus on climate risk management and adaptation implies that our main research interest lies with deliberate transformational change processes (Mechler *et al* 2014, Feola 2015, Colloff *et al* 2017, Few *et al* 2017, Fazey *et al* 2017) for building development-centred resilience and sustainable futures (Keating *et al* 2017), although we acknowledge that transformative progress towards resilient and sustainable futures may in some instances be achieved by chance (O'Brien 2013). Using a systematic literature review

approach based on a search and review, we trace the development of the concept and identify specific features with a view to bridge existing approaches towards an actionable conceptualisation of transformational change in the context of climate change adaptation and risk management that relates the different conceptions. We argue that such bridging work offers novel insights and encourages a shift in climate risk management and adaptation more commensurate to the scale of action needed in a world headed for 1.5 °C and more global warming (see IPCC 2018b).

## 2. Methodological approach

We performed a systematic search and review of scientific scholarship (Grant and Booth 2009, Ford *et al* 2011) on transformational change and similar concepts in the context of climate change adaptation and risk management. A systematic search and review differs from a literature review in that it involves a more rigorous and transparent review, where documents are selected according to systematic and explicit criteria that are fully reported (Ford *et al* 2011). As its aim, it seeks to map out existing literature with view to identifying commonalities and gaps that may need to be addressed in further research (Grant and Booth 2009).

We reviewed literature published in the decade since the publication of the Fourth IPCC Assessment Report (i.e. 2008–2019), expanded with a hand search of publications from select agenda-setting international organisations published in the same timeframe<sup>1</sup>. The searches were performed between 16 August and 20 September 2019 and calibrated on 16 October 2019<sup>2</sup>.

We opted to use the Thomson Reuters (formerly ISI) Web of Science Core Collection (SCI<sup>™</sup> Expanded, SSCI<sup>®</sup>, ESCI, BKCI-S<sup>®</sup>, BKCI-SSH<sup>®</sup>) and Elsevier's Scopus bibliographic databases to compile a bibliography of relevant literature for their wealth of articles from the environmental and social sciences (Landauer *et al* 2015, Jurgilevich *et al* 2017). To capture relevant literature from these databases, we narrowed our search to the following disciplines: Environmental Sciences, Environmental Studies, Development Studies, Urban Studies, Economics, International Relations, Political Science, Public Administration, Social Sciences (other topics/interdisciplinary), Sociology and multidisciplinary Sciences (Web of Science), as well as Environmental Science, Social Sciences, Earth and Planetary Sciences

<sup>1</sup> N.b. Unlike scientific literature, which is collected in centralised databases on which automated searches can be performed, grey literature cannot be retrieved in the same replicable manner. The grey literature featured in this review thus only reflects a proxy snapshot.

<sup>2</sup> Articles published after this date are not reflected in this review, the dataset for 2019 thus is necessarily incomplete.

and Economics, Econometrics and Finance and Multidisciplinary (Scopus)<sup>3</sup>. For analytical consistency and given the difficulties in including non-English speaking publications, only articles published in English were considered. We do, however, not argue that the two databases capture all published literature on transformational change and similar concepts in the context of climate change adaptation and risk management and acknowledge the limitations inherent to a keyword-based search in that certain articles or contributions—especially those only accessible through other databases—may not be captured, despite relevant.

We used a snowballing approach to develop the below search strings<sup>4</sup> (table 1) that we then used to identify relevant literature from the two bibliographic databases. Boolean and proximity operators were used to identify articles that employed the conceptual search term transform\* (or synonyms from the search core) within 30 words of the subject marker<sup>5</sup>, thereby already excluding articles that use the conceptual search terms in another context. The asterisk (\*) was placed as a wildcard to include different iterations of the search terms as used in the literature. Each search was carried out using one of the below search strings in title, abstract and keywords. For each string, we recorded the number of publications on the respective bibliographic database and retrieved the available bibliometric information, which we fed into an Excel 2019 template (Microsoft, Redmond, WA, USA) and into the Mendeley reference manager (Elsevier, London, UK).

For identifying relevant publications from international organisations published between 2008 and 2019, we performed a hand-search of the web-repositories of the following organisations, which we identified for their agenda-setting role<sup>6</sup>: IPCC United Nations Environment Programme (UNEP), United Nations Framework Convention on Climate Change (UNFCCC), United Nations Office for Disaster Risk Reduction (UNDRR), the Organisation for Economic Co-operation and Development (OECD), the Global Commission on Adaptation and the World Bank. Where needed due to the high number of publications listed in a repository ( $\geq 15$ ) and possible, the above search-strings were applied, otherwise simplified search strings were used to support the manual repository search (see table 2). For each web repository, we then recorded the number of publications

and retrieved the available bibliometric information, which we then also fed into the Excel 2019 template (Microsoft, Redmond, WA, USA) and into the Mendeley reference manager (Elsevier, London, UK).

Search results were subsequently narrowed down through a check for duplicates and a manual screening of article titles and abstracts, excluding publications that (a) were not actually targeting climate change adaptation or climate risk management as a topic and/or (b) employed the search-terms in an unrelated context (e.g. transform high seas management to build climate resilience in marine seafood supply). Where we were uncertain about the eligibility of an article based on its title and abstract, the decision for inclusion was made on a full-text screening.

All remaining articles were then hand-screened for relevance using expert judgement, with articles that (a) explicitly employ transformation and in the context of climate change adaptation and risk management (see above search strings) and (b) propose an explicit and/or implicit definition and/or specific attributes of 'transformative adaptation' or similar concepts and/or (c) outline transformational change in the context of climate change adaptation and risk management included for in-depth full-text review. See figure 1 for the search process, as well as the criteria for inclusion (a) explicit use of 'transformative adaptation' or similar concepts as per the above search strings AND (b) definition/attributes of 'transformative adaptation' or similar concepts as per the above search strings AND/OR (c) exemplary measures/processes of outlined), based on a hermeneutic approach.

To structure the review, we inductively coded the literature with descriptors, including if it proposes (a) a definition and/or (b) specific features as part of the definition; (c) distinguishes transformational and incremental change in the context of climate change adaptation and risk management; and (d) outlines exemplary measures and processes. The underlying dataset also includes the following bibliographic information: Year and location (country, municipality, city where applicable) of the literature; short description (abstract) and source of publication.

In the following, the dataset was expanded with the results from a qualitative analysis of the selected literature, during which we extracted descriptive themes until saturation (Saunders *et al* 2018). During this step, we read and manually coded the publications that provide the basis for the review several times to identify emergent themes and commonalities. We then categorised the themes into conceptual groups to subsequently derive specific attributes of transformational change in the context of climate change adaptation and risk management. As part of this step, we also discerned several conceptual strands within the reviewed literature.

<sup>3</sup> Discipline tags differ across databases platforms; the disciplines listed here were selected both for their topical relevance and their cross-repository synonymity

<sup>4</sup> Discussions with experts from the Zurich Flood Resilience Alliance supported the identification of the search strings.

<sup>5</sup> The number of words was chosen based on the mean sentence length of academic articles published in English, which ranges between 25 and 30 words per sentence (Moore 2011).

<sup>6</sup> Discussions with experts from the Zurich Flood Resilience Alliance supported the identification of these organisations.

**Table 1.** Systematic literature review: search strings and results—Web of Science and Scopus.

	Time period	Search strings—Web of Science	Results	Search strings—Scopus	Results
1	2008–2019	TOPIC: (((transform* OR radical OR fundamental) NEAR/30 'climate change adaptation'))	63	TITLE-ABS-KEY ((transform* OR radical OR fundamental) W/30 'climate change adaptation')	107
2	2008–2019	TOPIC: (((transform* OR radical OR fundamental) NEAR/30 'adapt* to climate change'))	48	TITLE-ABS-KEY ((transform* OR radical OR fundamental) W/30 'adapt* to climate change')	75
3	2008–2019	TOPIC: (((transform* OR radical OR fundamental) NEAR/30 'adapt* to environment* change'))	3	TITLE-ABS-KEY ((transform* OR radical OR fundamental) W/30 'adapt* to environment* change')	9
4	2008–2019	TOPIC: (((transform* OR radical OR fundamental) NEAR/30 'respon* to environment* change'))	8	TITLE-ABS-KEY ((transform* OR radical OR fundamental) W/30 'respon* to environment* change')	22
5	2008–2019	TOPIC: (((transform* OR radical OR fundamental) NEAR/30 'respon* to climate change'))	39	TITLE-ABS-KEY ((transform* OR radical OR fundamental) W/30 'respon* to climate change')	75
6	2008–2019	TOPIC: (((transform* OR radical OR fundamental) NEAR/30 'climate risk management'))	2	TITLE-ABS-KEY ((transform* OR radical OR fundamental) W/30 'climate risk management')	4
7	2008–2019	TOPIC: (((transform* OR radical OR fundamental) NEAR/30 'disaster risk management'))	8	TITLE-ABS-KEY ((transform* OR radical OR fundamental) W/30 'disaster risk management')	14
8	2008–2019	TOPIC: (((transform* OR radical OR fundamental) NEAR/30 'disaster resilience'))	6	TITLE-ABS-KEY ((transform* OR radical OR fundamental) W/30 'disaster resilience')	9
9	2008–2019	TOPIC: (((transform* OR radical OR fundamental) NEAR/30 'climate resilience'))	10	TITLE-ABS-KEY ((transform* OR radical OR fundamental) W/30 'climate resilience')	15
10	2008–2019	TOPIC: (((transform* OR radical OR fundamental) NEAR/30 'disaster risk reduction'))	18	TITLE-ABS-KEY ((transform* OR radical OR fundamental) W/30 'disaster risk reduction')	46
		Total Web of Science	205 (191 without in-database duplicates)	Total Scopus	376 (348 without in-database duplicates)

### 3. Systematic search results—bibliometric analysis

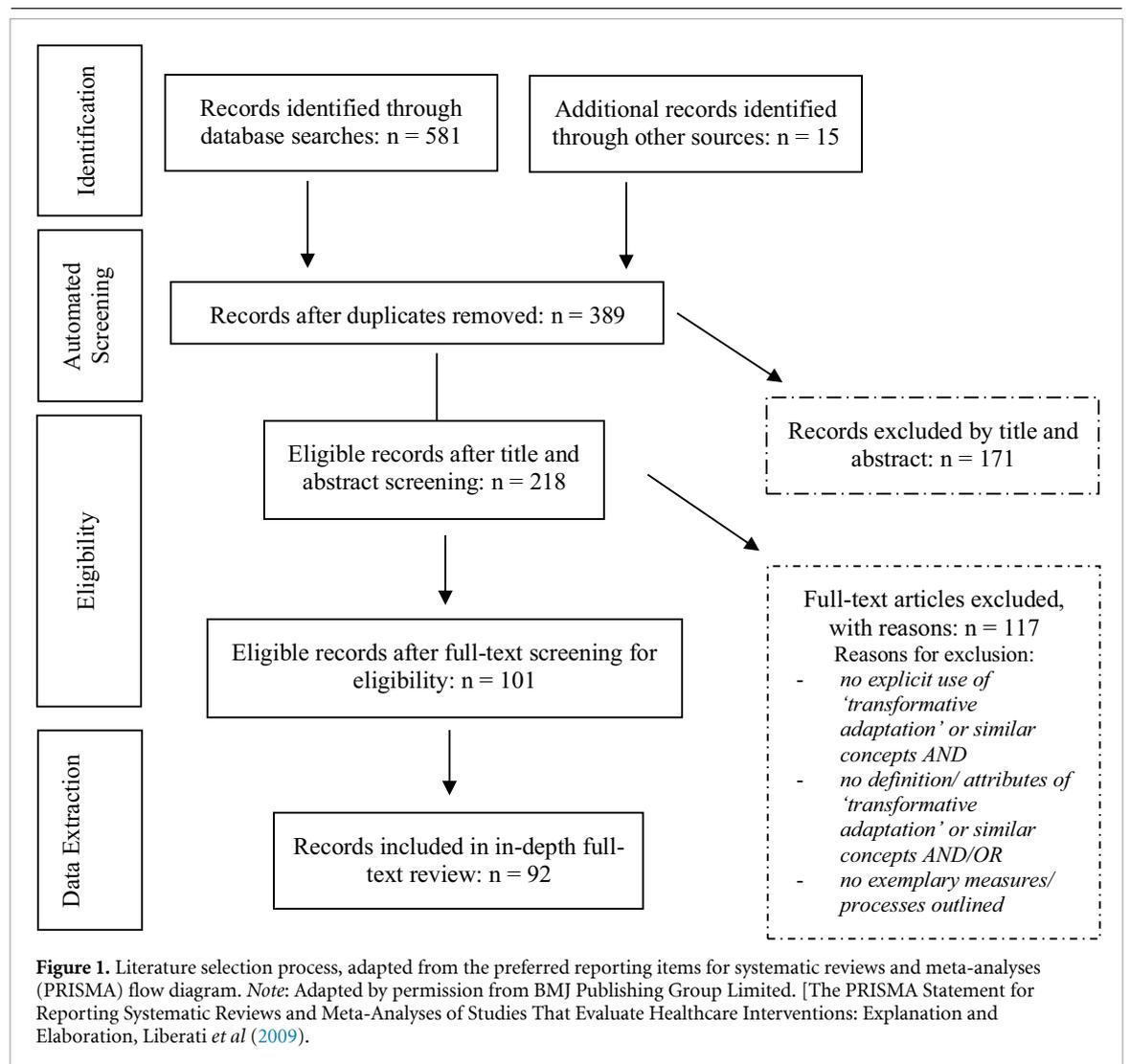
The application of the nine search strings to the Web of Science Core Collection and to the Scopus bibliographic databases resulted in a total of 581 publications for the time period (2008–2019) (figure 2), which feature the search strings in either their title, their abstract or their keywords. An additional 15 articles were retrieved through a hand-search of the web-repositories of selected international organisations (table 2). After duplicates were removed, a total of 389 articles remained (figure 3), further narrowed down to 218 after a manual screening of article titles and abstracts and to 101 following a full-text screening

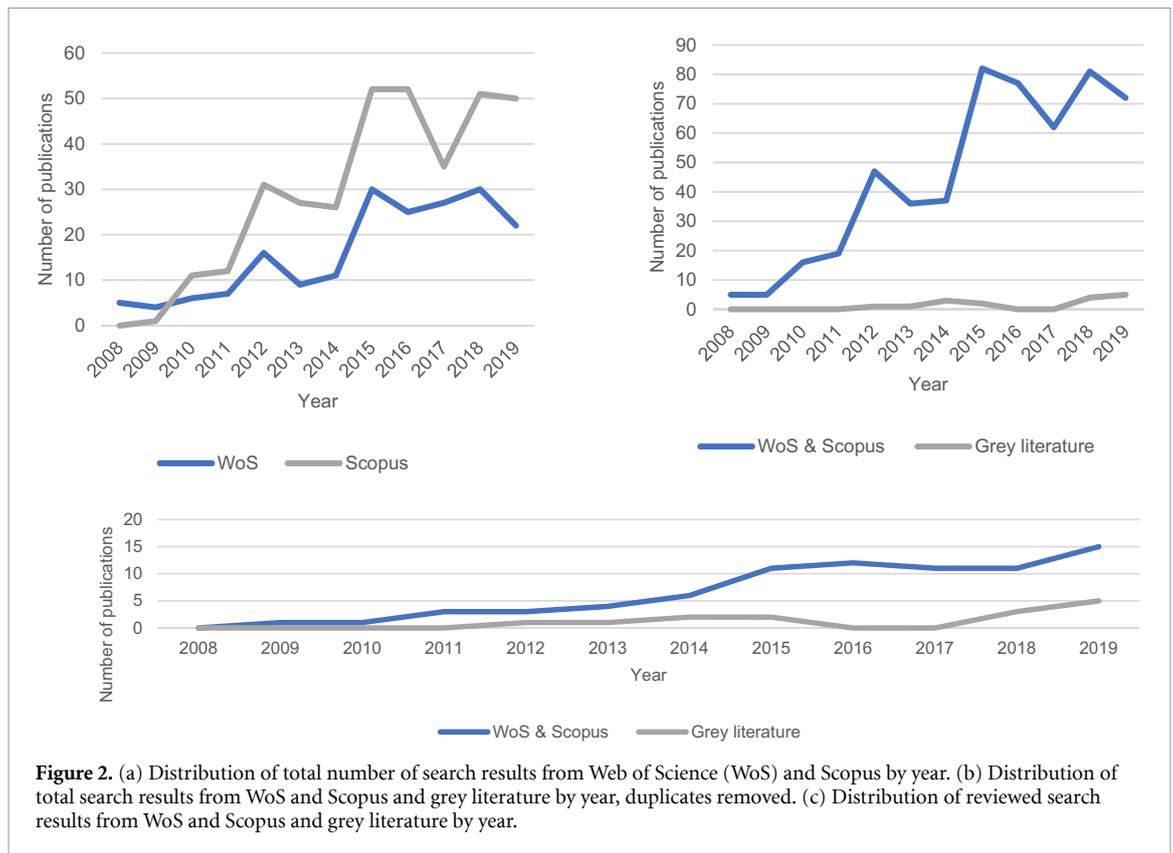
for eligibility. The 92 articles that passed the full-text screening were then reviewed and coded in line with the approach presented above.

Figures 2(a)–(c) illustrate the distribution of reviewed records by year of publication. Overall, the number of records has increased consistently over the time period reviewed in this article, with a majority published in the year 2014 or later. The publication of the 2012 IPCC Special Report 'Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation', which highlighted that effective climate risk management and adaptation will increasingly require 'transformation or fundamental change' (IPCC 2012, p 1) and the first international research conference specifically on transformation in

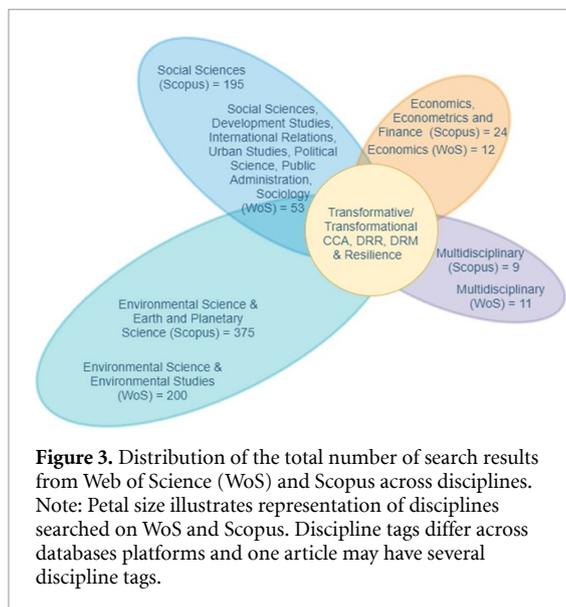
**Table 2.** Grey literature search and results—web repositories of selected international organisations.

Organisation/repository	Time period	Search strategy	Relevant results
IPCC: Reports Repository <sup>7</sup>	2008–2019	Hand-search of all listed reports	5
UNEP: Knowledge Repository <sup>8</sup>	2008–2019	Hand-search of all accessible publications retrieved with the search string ‘climate change adaptation’	0
UNFCCC—Documents and Decisions Repository <sup>9</sup>	2008–2019	Hand-search of all accessible publications retrieved with the search strings ‘transform* adaptation’, ‘transform* risk management’ and ‘transformation’	1
UNDRR: Global Assessment Reports <sup>10</sup>	2008–2019	Hand-search of all listed reports	2
OECD: Publications on climate change <sup>11</sup>	2008–2019	Hand-search of all listed publications	3
World Bank: Research and Publications <sup>12</sup>	2008–2019	Hand-search of all accessible reports and working papers retrieved with the search string ‘transform* adaptation’, ‘transform* risk management’ and ‘transformation’	4





**Figure 2.** (a) Distribution of total number of search results from Web of Science (WoS) and Scopus by year. (b) Distribution of total search results from WoS and Scopus and grey literature by year, duplicates removed. (c) Distribution of reviewed search results from WoS and Scopus and grey literature by year.



**Figure 3.** Distribution of the total number of search results from Web of Science (WoS) and Scopus across disciplines. Note: Petal size illustrates representation of disciplines searched on WoS and Scopus. Discipline tags differ across databases platforms and one article may have several discipline tags.

with a total of 170 hits across the two databases, followed by ((transform\* OR radical OR fundamental) W/30 ‘adapt\* to climate change’ with 123 hits and ((transform\* OR radical OR fundamental) W/30 ‘respon\* to environment\* change’) with 114 hits. Search strings that linked the adjectives transform\* or radical or fundamental with climate or disaster risk management, disaster risk reduction or resilience were much less represented (see table 1). The lower representation of articles from the disaster risk management/reduction and resilience fields compared with climate change adaptation literature coincides with the attention given to transformative approaches within the respective field’s agenda-setting publications at the international level: while the IPCC since 2012 has paid increasing attention to the need and potential to link transformation with climate change adaptation, the 2015 and 2019 UNDRR Global Assessment Reports on Disaster Risk Reduction do not feature similar articulations.

a changing climate hosted by the University of Oslo and co-sponsored by the IPCC in 2013 parallel the mounting interest in the topic (University of Oslo 2013).

Figure 3 shows that most of the assessments were from the field of environmental science, followed by the social sciences as another recurring field. Records from economics and multidisciplinary assessments were substantially less represented. Within our honed list of disciplines the by far most popular search terms were ((transform\* OR radical OR fundamental) W/30 ‘climate change adaptation’)

### 3.1. Systematic search results—qualitative analysis

In this systematic review, we aimed at reviewing the diverse perspectives on transformative approaches and transformational change in the context of climate change adaptation and risk management across scientific and selected grey literature with view to discerning key attributes that help to better relate its different conceptions in a way that lends itself to consideration for in climate risk management projects, plans and policies.

**Table 3.** Descriptive and analytical themes and relative importance in terms of number of papers.

Descriptive themes		Analytical themes
33	Anticipatory/long-term view	
19	Innovative	
29	Novel	
20	Planned/directed/deliberate/strategic	
16	Co-generation/co-production	
19	Empowerment of marginalised, vulnerable groups	
14	Reconfiguration of social networks and patterns of interaction	
42	Inclusive, participatory processes	Intervention design
12	New institutional arrangements and regulatory frameworks	
49	Shifts in power relations/governance structures	
40	Learning and reflexive capacity oriented	
5	Experimental	Learning Process
10	Positive, normative futures	
30	Equitable, just futures	Change objective
18	Sustainable futures	
50	Large-scale, fundamental, deep-rooted	
38	Paradigm shifts (changes in behaviour, values, priorities, and norms)	
52	System-wide	Change focus
47	Addresses underlying vulnerabilities and root causes of risk	

For this, we extracted descriptive and analytical themes until saturation across the reviewed literature (Saunders *et al* 2018)—distinct features of transformative adaptation and similar concepts, which differ in relative importance, i.e. ratio of publications referring to a theme. In table 3, the descriptive and analytical themes established across the reviewed literature are depicted. Some of the themes stand out as comparatively more important than others, based on the number of references across the reviewed literature. In a next step, we moved to extracting conceptual strands ('perspectives') across the reviewed literature, as depicted in table 4. Many of the themes we identified are shared across the conceptual strands, with deep-rooted, fundamental change towards change of the system rather than change within the system stressed particularly often (see e.g. Park *et al* 2012, Armitage *et al* 2017, IPCC 2019).

At its core, 'transformation' and 'transformative' approaches to climate risk management and adaptation are understood to be about change but not congruent with change. Across the reviewed literature, authors share the view that in one way or another, transformation entails qualitative shifts towards a more resilient state (see e.g. Folke *et al* 2010, Pelling 2011, IPCC 2014, Pokrant 2016) and a more desirable future (see e.g. O'Brien 2012, Jakku *et al* 2016, Abeling *et al* 2018). Often, the change resulting from transformative approaches is perceived as inherently positive across much of the literature, and named key for achieving sustainable futures, along with prosperity and equity goals (see e.g. Folke *et al* 2010, Pelling 2011, Faldi and Macchi 2017, Bosomworth 2018). Some publications, however, are less prescriptive and do not go so far as to argue that positive outcomes are necessary for change to identify as transformational. Instead, this second strand acknowledges that potentially non-desirable directions or maladaptation may qualify as transformational change, too (see e.g. Marshall *et al* 2012, O'Brien 2012, Tröger 2016, Blythe *et al* 2018) and caution of the inherent uncertainties of change efforts (see e.g. Manuel-Navarrete and Pelling 2015).

Papers widely agree that transformative approaches in the context of adaptation and climate risk management can take place at systems of 'any level, from the individual through to the collective, industry or region' (Park *et al* 2012, p 199), as well as across multiple dimensions and contexts (see e.g. O'Brien 2012, Feola 2015). Examples of loci and settings where transformational change may occur may entail a whole society or functionally more delimited systems (see e.g. Feola 2015), and include governance regimes and power structures, group and network dynamics, ecological, agricultural, economic and social systems, livelihood schemes, as well as development paradigms, values and worldviews (O'Brien 2012). As a common denominator, these loci and settings share characterisations as complex, multi-tiered and dynamic, requiring change processes at scale (see e.g. Kates *et al* 2012, Feola 2015), although some papers, such as Nalau and Handmer (2015, p 355) caution 'for a careful consideration of what exactly needs to be changed and how'.

In most papers, transformational change tends to be describe the depth of change (see e.g. Pelling *et al* 2015): large-scale, profound and deep-rooted (see e.g. Kates *et al* 2012, O'Brien 2012, IPCC 2014, Feola 2015, Nalau and Handmer 2015) changes that 'fundamentally alter the entire system' (Fedele *et al* 2019, p 116) in question and result in 'changes that affect the socio, cultural, political and structural conditions' (Fazey and Carmen *et al* 2018, p 37). Charged with reviewing and assessing the relevant literature, the IPCC (2018a, p 542) confirms this understanding with its definition of transformative adaptation as 'adaptation that changes the fundamental attributes

**Table 4.** Perspectives on transformational change in the context of adaptation and climate risk management (examples).

Framing	Examples
Qualitative change	'Transformative adaptation: adaptation that involves transforming toward more <i>sustainable and just futures</i> by addressing the structures of development and overarching political–economy regimes that maintain our currently unsustainable and inequitable trajectories.' (Bosomworth 2018)
System change	'Adaptation that changes the fundamental attributes of a <i>social-ecological system</i> in anticipation of <i>climate change</i> and ... characterised by <i>system-wide change or changes</i> across more than one system, by a focus on the future and long-term change, or by a direct questioning of the effectiveness of existing systems, social injustices and power imbalances.' (IPCC 2019, p 678)
Profound, large-scale change	'At least three classes of adaptations that we describe as transformational: those that are adopted <i>at a much larger scale or intensity</i> , those that are truly <i>new</i> to a particular region or resource system, and those that transform places and shift locations' (Kates <i>et al</i> 2012, p 7156)
Spectrum of change	'"Transformative adaptation" as the more radical end of a spectrum of change that begins with incremental adaptation (...) and extends through systems adaptation (...), mapped against an increasing degree of climate change.' (Rickards and Howden 2012, p 242) 'Transformation, by definition, <i>transcends incremental adaptation</i> and requires new and novel interactions between the social and ecological subsystems.' (Joyce <i>et al</i> 2013, p 522)
Focus on root causes	'Transformative adaptation emphasizes a need to shift our foci from proximate causes of vulnerabilities, risks, inequalities and unsustainability to their <i>structural, sociopolitical root drivers</i> ' (Bosomworth 2018)
Governance change	'Adaptation as transformation is composed of adaptive acts that consciously target reform in or replacement of the dominant political-cultural regime as primary or secondary goals' (Pelling 2011, p 69)
Development pathways	'Fundamental change ... to shift existing systems (and their component structures, institutions and actor positions) onto alternative <i>development pathways</i> , even before the limits of existing adaptation choices are met' (Pelling <i>et al</i> 2015, p 114)
Paradigm change	'Transformation: A change in the fundamental attributes of a system, often based on <i>altered paradigms, goals or values</i> .' (Bartlett and Satterthwaite 2016, p 18)
Resilience as transformation	' <i>Resilience</i> —when understood as concept to deal with changes in a transformative way towards a new (future) status of the system—includes as core building stone its resourcefulness, including the capacity to learn and to progress' (Abeling <i>et al</i> 2018, p 464) '... adaptive and transformative capacity as elements of <i>resilience</i> . The distinction between adaptation and transformation depends on the degree of change, with transformation becoming clearer when the system is fundamentally changed or dismantled to create a new system' (Manyena <i>et al</i> 2019, p 6)
Novel and innovative adaptation	'Three levels of adaptation: (1) incremental—moderate changes are made to existing actions and behaviours; (2) systemic—changes are made at the system or structural level; (3) transformational—large scale, <i>novel</i> responses create a <i>fundamentally new</i> system or process' (Dowd <i>et al</i> 2014, p 558)

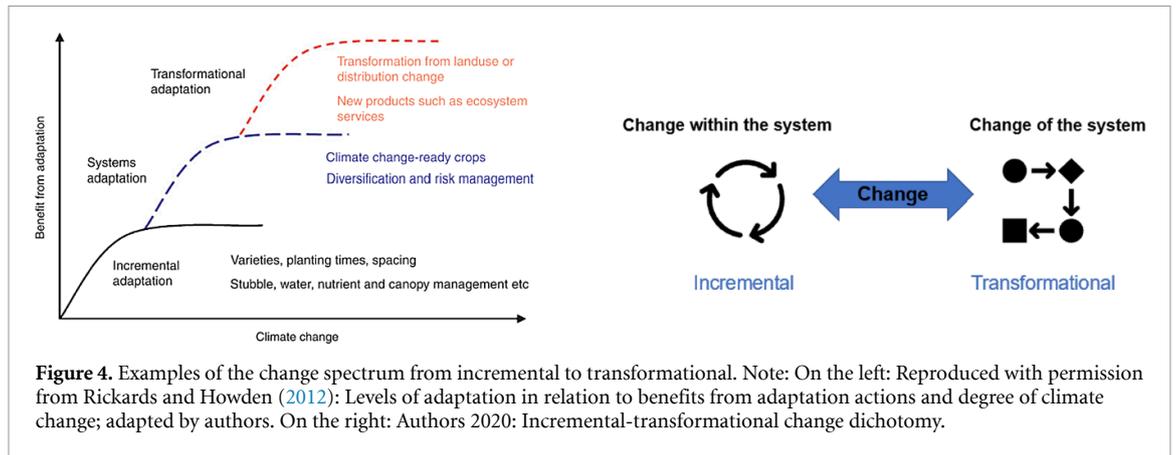
of a socioecological system in anticipation of climate change and its impact'.

Often, transformational change is listed at the higher end of a change aspect (see figure 4) that entails various phases along a continuum from incremental to transformational (see e.g. Rickards and Howden 2012, Jakku *et al* 2016, Termeer *et al* 2017), where the two 'opposing' ends of the spectrum can be differentiated by the ratio between continuity and change. For transformative approaches, the ratio between ratio between continuity and change would be low: 'more of the system is changed than continued as is' (Rickards and Howden 2012, p 242), while incremental approaches as the opposing end of the change spectrum would focus on maintaining a system's essence, thus at the system level less is changed than is kept as it was and only small changes to existing practices are performed (see e.g. IPCC 2012, 2018a, Park *et al* 2012, Rickards and Howden 2012, Lauer and Eguavoen 2016, Young and Essex 2019).

Incremental change in such a dichotomy (see figure 4) thus would take place within the existing structures and objectives of a system as 'homeostatic

change' that enables a system to 'keep its identity while adjusting to changes within its environment' (Manuel-Navarrete and Pelling 2015, p 560), whereas transformational change entails profound changes of the system, challenging its status quo (see e.g. Park *et al* 2012, Armitage *et al* 2017). Yet, given the often vastly different loci of change, the level of change that may qualify as 'transformational' nevertheless remains relative and contextual (see e.g. Rickards and Howden 2012, Termeer *et al* 2017). Some go so far as to caution that there is a need to go beyond the incremental-transformational change dichotomy (see e.g. Termeer *et al* 2017), as 'in some cases, incremental adaptation can accrue to result in transformative adaptation' (IPCC 2018a, p 542).

Building on the notion of system change as a key characteristic of transformative adaptation and risk management, many authors underpin that transformative approaches would go beyond addressing the proximate causes risk by addressing the underlying, social, cultural and economic root causes of risk (see e.g. Pelling 2011, O'Brien 2012, Tschakert *et al*



2013, Bahadur and Tanner 2014, Pelling *et al* 2015, Bosomworth 2018), taking the work into the social development sphere. Several authors qualify those adaptive measures as transformational that shift systems onto alternative development pathways towards socially just, equitable and sustainable development; even before existing adaptation options have been fully exhausted (see e.g. Bahadur and Tanner 2014, Pelling *et al* 2015).

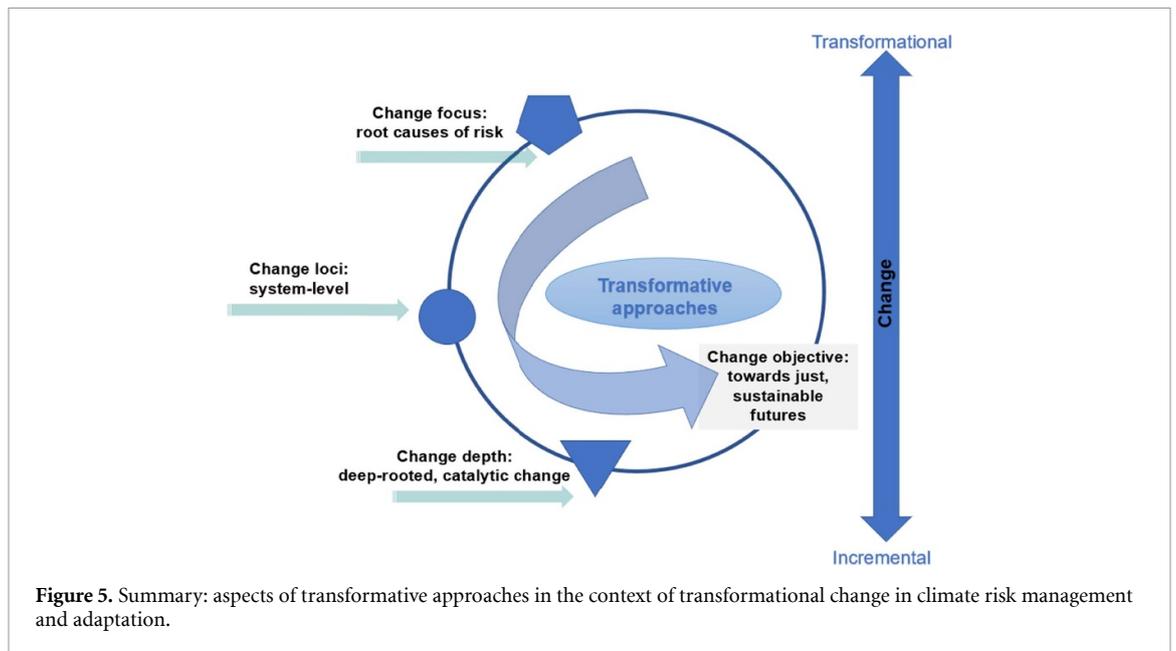
Many papers refer to agency and power relations and explicitly note challenging and overstepping authorities and hierarchies towards a change in governance regimes, institutional arrangements, community dynamics and power structures, as appurtenant to transformative adaptation and risk management (see e.g. Bahadur and Tanner 2014, IPCC 2014, 2018b, Feola 2015, Manuel-Navarrete and Pelling 2015, Campos *et al* 2016, Fazey *et al* 2018, Magesa and Pauline 2019). This framing of transformational change as somewhat ‘rebellious’ is also ascertainable in several papers that note transformative approaches as challenging existing norms, values and world-views, resulting in a fundamental paradigm change process away from the status quo (see e.g. Pelling 2011, O’Brien 2012, O’Neill and Handmer 2012, Bartlett and Satterthwaite 2016, Magesa and Pauline 2019). However, some papers differentiate between transformative climate risk management and adaptation as a functionally or spatially more narrow change process and ‘societal transformation’ as one that encompasses radical societal redesign (see e.g. O’Brien and Barnett 2013, Feola 2015).

On the other hand, several publications approach the role of agency through a focus on capacity and social learning as drivers of transformational change (see e.g. Marshall *et al* 2012, Aall *et al* 2015, Manyena *et al* 2019, Morchain *et al* 2019, Mummery and Mummery 2019). Several stress long-term ‘triple-loop’ learning processes that involve ‘people, institutions and policies, and discourses’ (Aall *et al* 2015, p 405) with view to enabling fundamental change in the status quo (see e.g. O’Neill and Handmer 2012,

Govind *et al* 2018, Manyena *et al* 2019, UNDRR 2019) as a key feature of transformative approaches. Matyas and Pelling (2015, p 12) add that in addition to behaviour changes linked to learning, learning ‘can be about excising unwanted dimensions, processes or attributes’.

Several papers also include novelty and innovation as a differentiator between incremental and transformative approaches (see e.g. Kates *et al* 2012, Park *et al* 2012, O’Brien *et al* 2013, Dowd *et al* 2014, Abeling *et al* 2018). Innovations and novel approaches can range from practical innovations such as innovative or new technological and management approaches to addressing risk and resilience challenges (see e.g. Gillard *et al* 2016), to political innovation, for example in the form of novel governance arrangements that enable participatory and inclusive visioning and decision-making (see e.g. Wamsler 2017, Ajibade and Egge 2019). For some, innovations may also involve changes in behaviour, values and worldviews (see e.g. Gillard *et al* 2016), while others highlight that innovations as an aspect of transformative approaches need to ‘produce significantly new patterns of viability’ (Fazey *et al* 2018, p 37) or ‘new and novel interactions between the social and ecological subsystems’ (Joyce *et al* 2013, p 522).

Much of the reviewed literature suggests that transformational change can result from both exogenous and endogenous processes (see e.g. Feola 2015). Many papers focus more on deliberate and actively initiated (see e.g. O’Brien 2012, O’Neill and Handmer 2012, Eriksen 2013, Fedele *et al* 2019) or forced (see e.g. Folke *et al* 2010) transformational change processes in adaptation and risk management efforts, with many underscoring a more anticipatory and long-term oriented vision as characteristic, noting that transformational change does not happen overnight and may occur in nonlinear ways (see e.g. Campos *et al* 2016, Dowd *et al* 2014, Noblet and Brisson 2017, Termeer *et al* 2017, Thomalla *et al* 2018, World Bank 2019a). Others recognise that transformational change may also come about by chance as an unintended outcome of a process or event (see e.g.



Manuel-Navarrete and Pelling 2015) or in reaction to shock events, including a breach of adaptation limits (see e.g. Kates *et al* 2012, Marshall *et al* 2014, Mechler and Schinko 2016, Thomalla *et al* 2018).

In terms of drivers of change, Fazey *et al* (2018, p 37) remind that ‘there are no magic bullets for working towards transformations, which are usually highly contested and counter cultural’ and curtailed by barriers linked to deep uncertainties, locked-in practices (e.g. land use and resource management) and societal features and opposition (see e.g. Kates *et al* 2012, IPCC 2014, Tröger 2016, Mummery and Mummery 2019). Other hurdles may involve costs, trade-offs, as well as ‘hesitation within ... agencies to expose structural inequalities, ethical limitations ... , and often entrenched dependencies’ (Tschakert *et al* 2016, p 184).

Several enablers of successful transformational change are listed across the literature, sometimes also referring to the organisational adaptation literature. Given the trade-offs involved in transformational change in the context of climate risk management and adaptation, societal readiness to initiate and accept change is often listed as an important success factor for transformational change processes along with the presence of incentives (see e.g. IPCC 2012, O’Brien 2012, Pelling *et al* 2015, Morchain *et al* 2019, Mummery and Mummery 2019). Other factors referred to across the literature include ‘applying practices that unleash human potential’ (Fazey *et al* 2018, p 37) and creativity, learning capacities, regular monitoring and evaluation of progress towards change, but also strategic approaches that include short-term goals and low-regret anticipatory interventions and assess trade-offs and thresholds, visionary leadership and individual change champions, broad stakeholder engagement

and collaboration in change coalitions, as well as sufficient access to resources and effective communication (see e.g. Moser and Ekstrom 2010, Kates *et al* 2012, O’Brien 2012, Jakku *et al* 2016, Wamsler 2017, World Bank 2019b).

When it comes to practical examples of transformative approaches to climate risk management and adaptation, however, the literature becomes much scarcer, with only few listing specific examples. Across the literature, relocation—both actual and planned—is most commonly cited as an example of a transformative approach to managing climate-related risks (see e.g. Kates *et al* 2012, IPCC 2014, Thomalla *et al* 2018, World Bank 2019a). Some papers also refer to specific processes, such as Oxfam’s Vulnerability and Risk Assessment methodology (Morchain *et al* 2019) or the mainstreaming of climate risk management and adaptation (Wamsler 2017), as examples of transformative approaches, connoting its potential to foster more inclusive, development-centred approaches to climate risk management and adaptation. Others suggest that transformational approaches entail ‘a complete change in direction ... [as for example] drought-resilient crops may be of no use if the site is not fit for’ (World Bank 2019a, p 18), changes in livelihood strategies following continued crop loss due to changing rain patterns or a shift to addressing the underlying drivers of risk, which in the case of flood risk could entail a shift from sea walls to a change in city planning and flood water management (IPCC 2018b). Several others caution that while linear measures may suggest major change (e.g. changes in regulatory frameworks), on their own they may not be able to unleash transformational change (Nalau and Handmer 2015), alluding to the complexities surrounding an identification of measures as transformative.

## 4. Discussion and conclusions

In this paper, we have systematically reviewed literature on transformational change and transformative approaches in the context of climate risk management and adaptation across academic and selected grey literature, focusing on work published in the decade since the publication of the Fourth IPCC Assessment Report (i.e. 2008–2019), expanded with a hand search of publications from select agenda-setting international organisations published in the same timeframe. Our review was driven by the ambition to arrive at an actionable conceptualisation of transformational change in the context of climate risk management and adaptation that accounts for a rapidly changing climate and compound risk.

We note that in the decade since the publication of the Fourth IPCC Assessment Report, there has been a rapid increase in the number of publications, contributing to a better understanding of the concept. While different perspectives on transformational change in the context of climate risk management and adaptation persist, that are not necessarily reducible to one another, certain areas of convergence are discernible amongst perspectives on transformational change in the context of climate risk management and adaptation. Figure 5 illustrates these areas of convergence, which we identify as common features of transformational change in the context of climate risk management and adaptation. It illustrates the transformational change spectrum that begins with incremental change and has transformational change at its upper end, the pathway to which involves transformative measures and action that focuses on deep-rooted, system-level change that addresses the root causes of risk with view to enabling more just and sustainable futures.

In terms of the focus of change, we discern from the literature that transformative approaches in the context of climate risk management and adaptation focus on addressing the underlying, social, cultural and economic root causes of risk (see e.g. Pelling 2011, O'Brien 2012, Tschakert *et al* 2013, Pelling *et al* 2015, Bosomworth 2018), including challenging existing power and governance structures, norms, values and world-views (see e.g. Pelling 2011, O'Brien 2012, O'Neill and Handmer 2012, Bartlett and Satterthwaite 2016, Magesa and Pauline 2019).

In line with the broad approach taken in many of the papers, where often some or a combination of several properties and criteria rather than a requirement for all to be met if featured (see e.g. Kates *et al* 2012, Garschagen *et al* 2018), we conclude that transformational change most commonly takes place at the system level as the loci of change (see e.g. Kates *et al* 2012, O'Brien 2012, Park *et al* 2012, Feola 2015, IPCC 2019)—from functionally more delimited systems such as a single community or industry

to whole societies. Reflecting the focus on deliberate and actively initiated (see e.g. O'Brien 2012, O'Neill and Handmer 2012, Eriksen 2013, Fedele *et al* 2019) that may result from exogenous drivers, such as in reaction to shock events, including a breach of adaptation limits (e.g. Kates *et al* 2012, Marshall *et al* 2014, Mechler and Schinko 2016, Thomalla *et al* 2018), or endogenously, e.g. in anticipation of future climate-related developments and long-term oriented (see e.g. Dowd *et al* 2014, Campos *et al* 2016, Noblet and Brisson 2017, Termeer *et al* 2017, Thomalla *et al* 2018), enabling more sustainable, equitable futures is often listed as the objective for change (see e.g. Folke *et al* 2010, Pelling 2011, Bahadur and Tanner 2014, Faldi and Macchi 2017, Bosomworth 2018).

We also conclude from the reviewed literature that for change to qualify as 'transformational' in the context of climate risk management and adaptation, it entails large-scale, profound and deep-rooted (see e.g. Kates *et al* 2012, O'Brien 2012, IPCC 2014, Feola 2015, Nalau and Handmer 2015) changes of the system, challenging its status quo (see e.g. Park *et al* 2012, Armitage *et al* 2017). To bring about such transformational change, transformative approaches to climate risk management and adaptation may draw on innovative and learning capacities, broad stakeholder engagement, regular monitoring and evaluation, and strategic leadership, amongst others (see e.g. Moser and Ekstrom 2010, Kates *et al* 2012, O'Brien 2012, Jakku *et al* 2016).

In terms of practical applications, our reading of the reviewed literature on transformational change and transformative approaches in the context of climate risk management and adaptation finds a clear 'operationalisation gap' in terms of translating transformational change ambitions into concrete transformative measures that can be directly replicated in practice, as cautioned previously by Feola (2015), Godfrey-Wood and Naess (2016) and Tschakert *et al* (2016), among others, and also illustrated by the comparatively small number of grey literature on the topic. While we do not necessarily view that as a handicap per se, further investigation in this regard would be useful to prevent a tokenistic use of the concept and instead enable policymakers and practitioners to deliver the radical change needed to achieve sustainable futures and build resilience in the face of intensifying climate change (Feola 2015, Few *et al* 2017, Fazey *et al* 2017).

### Data availability statement

The data that support the findings of this study are available upon reasonable request from the authors.

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