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DOI
10.1080/14693062.2024.2437422

Publication date
2024

Document Version
Final published version

Published in
Climate Policy

CLIMATE POLICY
https://doi.org/10.1080/14693062.2024.2437422

Taylor & Francis
Taylor & Francis Group

REVIEW ARTICLE

Giving up land? Explaining planned retreat in times of climate change

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ABSTRACT

Transformational adaptation to climate change becomes increasingly urgent. Experiencing a severe hazard event is insufficient to enable a transformational response. Yet, there is no solid theoretical or empirical evidence on what policy and other social explanations enable transformational adaptation to climate-induced hazards. Our article addresses this gap by critically examining empirical evidence on theory-grounded explanations for transformational responses to the most costly and devastating climate-induced hazard: flooding. After systematically collecting empirical research, we compare transformational responses to floods, focuzing specifically on managed retreat and planned relocation. Our analysis combines qualitative data analysis and network analysis and covers 54 articles describing over 105 cases in more than 31 countries worldwide. By differentiating levels of change, we find that transformational adaptation is reported in the literature as occurring via various types of policy change: from incremental steps to a paradigm shift. Most studies pay attention to shocks like floods that trigger transformational adaptations (45 out of 54 articles). Notably, specific combinations of social explanations are reported to enable transformations as a series of steps (i.e. economic/financial and socio-behavioral factors facilitate first-order policy changes), complemented by changes in the legal system (for second-order policy changes). Empirical evidence confirms that the paradigmatic third-order policy change additionally necessitates policy entrepreneurs and advocacy coalitions. Our analysis calls for interdisciplinary efforts to link case-study insights with theoretically embedded explanations from policy and legal studies, and the economic and socio-behavioral domain to systematically reveal generic combinations of explanations that enable transformational adaptation.

Key policy insights

- Transformational climate change adaptation (TCCA) could be realized via incremental steps, from a change of policy instruments, and via a paradigm shift that transforms place-based human ecosystems.
- For incremental change, behavioral and economic explanations are especially important but are either underexplored or not specified in empirical literature.
- Besides shocks, the most reported policy-change explanations for TCCA are policy entrepreneurship, advocacy coalitions and framing.
- As climate-related hazards intensify, policymakers might anticipate these windows of opportunity for policy changes to mobilize transformations.
- Besides policy change scholarship, other social science theories are needed to account for financial/economic and behavioral drivers explaining TCCA.

ARTICLE HISTORY
Received 8 June 2023
Accepted 28 November 2024

KEYWORDS
Transformation; climate change adaptation; policy change; relocation; managed retreat; policy process theories

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/14693062.2024.2437422.

1. Introduction

Worldwide, societies face risks from climate-induced water hazards. IPCC (2022) anticipates increasing frequency and severity of floods and accelerating sea level rise, affecting many – rich and poor – places. In 2022 alone, Typhoon Nanmadol forced nine million residents in southern Japan to evacuate (BBC, 2022a), Typhoon Noru affected half of the Philippines' 110 million population (BBC, 2022b), and Hurricane Ian caused 119 deaths in Florida from floods, winds, and strong storm conditions (NBC, 2022). The alarming acceleration in speed, scale, and impacts of climate change increasingly demands transformational climate change adaptation (TCCA). TCCA assumes new radical changes in societal responses that massively scale up existing practices, introduce novel measures, or shift geographical locations of activities (Kates et al., 2012). Typically, TCCA disrupts the status quo, and hence is difficult to implement in practice because of low social acceptance, high upfront costs, vested interests, and institutional and infrastructural lock-ins.

Data reveals that severe hazard events alone do not prompt transformational policy responses (Nohrstedt et al., 2021). Analysing past transformational responses to hazards may reveal enabling conditions that could be leveraged to proactively stimulate positive TCCA, without waiting for the next disaster to disrupt the status quo. Understanding facilitators/inhibitors of past TCCA is increasingly vital as accelerating sea level rise necessitates proactive relocation worldwide (Haasnoot et al., 2021). Evidence on explanations – including factors (drivers and constraints) and mechanisms (cause–effect relationships between factors) – would facilitate the design of climate-resilient adaptation policies. Since TCCA concerns transformational policy change, using explanations derived from existing policy change theories is valuable to synthesize knowledge across literatures.

Empirical evidence on the policy-change explanations behind TCCA is fragmented, lacking systematic studies on the combination of policy mechanisms involved. Existing policy literature on transformational adaptation largely focuses on specific policy-change explanations: social learning (Chung Tiam Fook, 2017), problem framing (Dupuis & Knoepfel, 2013), or policy entrepreneurship (Mintrom & Luetjens, 2017). Fragmented literature focuses on specific policy arenas (e.g. agriculture, Vermeulen et al., 2018) and/or specific regions (e.g. coasts, Kuhl et al., 2021). Conceptual TCCA analysis highlights the role of policy factors in enabling transformational responses, including leadership, focusing events, and policy windows that facilitate changes following external shocks (Kates et al., 2012).

This article systematises empirical evidence on theory-grounded policy-change explanations behind past transformational responses to hazards. Given diverse definitions of transformations (Few et al., 2017; Kates et al., 2012), we focus on a vivid example of TCCA: planned relocation and managed retreat. Not all shifts in locations constitute transformations, as not all relocations fundamentally alter practices, structures, and norms (Siders et al., 2021). Acknowledging differences between policy output and impact, we consider relocations/retreats as resulting from previous policy changes (output) aimed at supporting communities' resilience (impact). Thereby, TCCA, like relocations/retreats, may occur through incremental steps within existing policy goals using conventional or new policy instruments (first- or second-order policy changes, Hall, 1993), or through major, non-linear shifts challenging existing paradigms (third-order policy change).

Our goal is to identify what policy (and other social) explanations, have been reported in empirical literature as crucial in enabling managed retreat/planned relocation. Using explanations hypothesized by established policy-change theories (Weible & Sabatier, 2018), we perform a meta-analysis of the empirical literature on managed retreat/planned relocation globally. Toward this goal, we answer the following research questions: (1) Does TCCA always require a paradigmatic policy shift? (2) What policy-change explanations of TCCA dominate in reported global empirical evidence on managed retreat/planned relocation? (3) Given the empirical literature on managed retreat/planned relocation, which TCCA explanations – policy and other social – jointly co-occur?

We first provide a brief review of TCCA literature and key explanations from established policy process theories. The Methods section reports data collection and analysis procedures. Results present the core outcomes of our analysis, and Discussion and Conclusion elaborates on their significance and implications for future research and policy practice.

2. Theories explaining transformational climate change adaptation

2.1. Transformational adaptation and its association with types of policy change

A growing body of literature connects societal transformations with climate change adaptation (Fazey et al., 2018; Feola, 2015; Few et al., 2017; Kates et al., 2012; O'Brien, 2016; Pelling, 2010). TCCA is commonly contrasted with incremental adaptation, which is insufficient to curb adverse climate-induced impacts to acceptable risk levels. TCCA concerns radical societal responses to hazards (Kates et al., 2012) like: (i) adopting conventional measures at massive scales, for example upgrading traditional dykes to gigantic sea-walls; (ii) introducing novel measures or institutional arrangements to a region, like establishing flood insurance or buyouts where they were previously absent; (iii) shifting geographical locations of activities, like managed retreat or planned relocation. Among the three TCCA forms, the first option, scaling-up, is debated, especially regarding exact interpretations of what constitutes a large transformation (Few et al., 2017). The second type could also be questioned with respect to speed, scope, and scale of innovations. Here, we focus on the third form: managed retreat/planned relocation including giving space for water. These interchangeable terms indicate purposeful land-use restrictions in hazard-prone areas in favor of safer locations (Hino et al., 2017) and allocation of selected areas for controlled flooding. Mach and Siders (2021, p. 1294) suggest that managed retreat 'will be a component of many climate-driven transformations that involve fundamental shifts in societies'. It is, therefore, important to study the key explanations of these climate-driven transformations that challenge the status quo.

To understand TCCA outcomes, adaptation research must consider policy processes leading to such fundamental changes (Moss et al., 2021), differentiating among types of change. The three dimensions of change – depth, scope, speed – define whether adaptation is transformational (Termeer et al., 2024). Regarding depth, TCCA can manifest as first-, second-, and third-order policy change (Hall, 1993; Van der Heijden et al., 2021). First-order change refers to a process of adjusting a policy without challenging the existing policy paradigm, hence incremental steps that cumulatively drive transformations. Second-order change involves moderate policy adjustments by developing new instruments without challenging the existing paradigm. Here TCCA occurs within existing mindsets by reframing problems and practices. Third-order change involves radical changes in policy discourses, leading to a paradigm shift through critical reflections on existing assumptions, norms, and interests.

2.2. Policy process theories and policy-change explanations

Public administration and policy literature has long researched how policy change occurs, distinguishing between first-, second-, and third-order changes. Yet, empirical studies discussing transformational responses to past hazards are interdisciplinary. Hence, it often misses policy-change lenses. To systematically elicit evidence on policy-change explanations behind TCCA, we rely on three key policy process theories (Figure 1): the advocacy coalition framework (ACF), the multiple streams framework (MSF), and punctuated equilibrium theory (PET). Major policy changes occur rarely (Jones & Baumgartner, 2005), therefore these theories explain the dynamics between periods of stability and change.

ACF focuses on action arenas or polycentric system where actors interact and build coalitions around policy-making in process (Jenkins-Smith et al., 2018; Workman & Weible, 2022). According to ACF, the status quo persists because of the long-term establishment of a dominant policy and a stable coalition of actors. Stability is maintained because coalitions' strong core beliefs are unlikely to change and because of a coalition's long-term domination (Weible & Sabatier, 2018). Policy changes occur from the reconfiguration of actor coalitions and the learning process about policy solutions and problems when new information is acquired.

MSF portrays the policy process as consisting of three parallel streams: problems, policies, and politics (Kingdon, 2011). Major policy change occurs when a window of opportunity opens in response to a shift in the problem stream (e.g. a sudden crisis situation after a focusing event like a flood) or in the political stream (e.g. a new government). An open window of opportunity is, however, insufficient. For a major policy change to occur, if a problem attracts attention and reaches the policy agenda, viable solutions must be

Policy process theories	**Explanations for policy stability**	**Explanations for policy change**
Advocacy Coalition Framework (ACF)	 Dominance of a stable policymaking coalition, that generates policies based on belief. • Constitutional structure • Fundamental socio-cultural values and social structure • Attributes of the problem and distribution of natural resources	 Shocks lead to instability and restructuring of coalitions. • External shocks • Policy-oriented learning • Internal shocks, new governing coalitions • Negotiated agreements • Competing advocacy coalitions • Friction and mobilization
Multiple Streams Framework (MSF)	 Independent streams form preconditions to policy change, where a single stream cannot form policy change per se. • Macrosystem designed to promote status quo • Bounded rationality • Policy monopolies	 A window of opportunity for policy change can open and be exploited. • Change in national mood • Interest group campaigns • New governing coalitions • Focusing events • Feedback and indicators • Policy entrepreneur that couples the three streams
Punctuated Equilibrium Framework (PET)	 Policymakers' tendency to focus disproportionately on specific policy problems resulting from: • Macrosystem designed to promote status quo • Bounded rationality • Policy monopolies	 Policy processes are periods of incremental change that are interrupted by unpredictable and rapid episodic change resulting from: • Reframing policy problems • Institutional/cultural friction • Focusing events

Figure 1. Main explanations for policy stability and change according to three policy process theories.

proposed by policy experts and accepted by a majority of (political) participants (Herweg et al., 2018). Policy entrepreneurs are the key actors who couple the favored solutions to particular understandings of the problems and push for policymakers' attention.

PET stipulates that long periods of stability and policy continuity occur with minor changes and continuation of policy monopolies, because of stable institutions, existing power relations, and resistance to new problem frames or possible solutions (Jones & Baumgartner, 2005). Occasionally, such periods of relative stability are interrupted by sudden punctuations of political attention on certain issues stimulating a major policy change (Baumgartner et al., 2018). Policy change occurs in response to problem (re)framing, focusing events or venue-shopping where conflict is expanded across multiple venues and leads to interactions between groups that previously worked in parallel. Such episodic policy change is often driven by a combination of unexpected disturbances and crises with positive feedback loops of increased attention and new policy arenas.

3. Methods

Our data come from a systematic literature review and qualitative meta-analysis of empirical studies on managed retreat/planned relocation worldwide. To systematically identify, filter, and analyse the empirical literature on TCCA, we adopt the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) procedure (Gjaltema et al., 2020; Shamseer et al., 2015). Appendix A visualizes our data collection and analysis steps discussed in detail below.

3.1. Dataset

We performed a systematic literature search in the Scopus database to review academic literature for explanations of TCCA. We focus on planned relocation/retreat as a vivid TCCA case, rather than compiling a general database of planned relocations (as in Bower & Weerasinghe, 2021). We selected Scopus, which covers reviewed articles published in environmental change journals and assists in narrowing the selection with the type of journal and key discipline. To collect the first pool of articles about managed retreat/relocation as a TCCA policy, we used the following search queries in the fields of Abstract, Title, and Keywords: (a) 'climate change' AND (b) 'adaptation' AND (c) 'retreat OR relocation' AND (d) 'governance' OR 'polic*' OR 'public management' OR 'public administration' OR 'mechanism' OR 'policy process'. Including climate change in our query excludes cases of relocations related to volcanic eruption or earthquakes present in other collections studying retreat, like Bower & Weerasinghe, 2021. Furthermore, while a lot of literature discusses TCCA in a conceptual manner, we defined the search terms more precisely to increase the likelihood of finding relevant empirical literature reporting societal and, specifically, policy explanations of realized TCCA processes. Interestingly enough, none of the sampled articles used the PET, ACF or MSF policy process theory as an analytical or conceptual framework. Instead, the reviewed articles mostly relied on interdisciplinary literature to explain some key concepts such as climate change adaptation, managed retreat and resettlement. In addition, early scholarly literature on relocation/managed retreat policies in response to climate-induced hazards did not use terms like TCCA, as is the case, for example, for the Room for the River program in the Netherlands. To account for the evolving terminology over the years, we used a second search query focusing on: 'Room for the River': (a) 'climat* chang*' AND 'room for the river' OR (b) 'implementing room for the river'. Room for the River is included in the search query because this water management program involved a well-documented transformational change from heightening dykes for fighting water to creating water retention areas for living with water (Pot et al., 2023). Articles included in our sample are peer-reviewed journal articles, written in English, from the environmental or social science disciplines. These searches, performed in November 2021, yielded an initial collection of 92 records (Appendix A, box 1).

3.2. Literature screening and eligibility

After omitting duplicates, we examined titles, abstracts, and keywords, and excluded articles that did not cover empirical cases of relocation/managed retreat. To screen full texts, inclusion and exclusion criteria were applied.

Included articles discussed climate change, informed 'what has happened' and/or what 'explained the process' in empirical literature on managed retreat/relocation, and elaborated either on governance or policy processes. We excluded articles that did not discuss climate-induced hazards or only described 'what should be done' instead of providing an in-depth understanding of what was actually done. Fifty-four articles (Appendix A, box 2) were included in the analysis, covering over 105 cases across all continents in more than 31 different countries, including Fiji, Vietnam, Louisiana USA, Alaska USA, Dominican Republic, Mexico, Mozambique, Sweden, the Netherlands, France, China, and New Zealand (see Appendix B).

3.3. Coding unit and procedure

Our coding units are articles, because (same) cases are reported and analyzed differently and with varying levels of detail across articles. Moreover, 21 of our 54 articles cover multiple cases (up to 16). We consistently coded on the article-level even if cases in one article may differ with regard to level of change and relevant mechanisms. We found that articles themselves do not differentiate between first-, second-, and third-order policy change (Hall, 1993) on a case-level, because this conceptualization was not necessarily a point of attention to respective authors. We applied Hall's conceptualization of change since articles differ in how they write about pathways to change, some reporting that transformative change has been achieved via small steps, while others focus on paradigmatic changes. As we capture how often mechanisms and outcomes occur across articles, results reflect the state of current knowledge about TCCA. Our data shows mechanisms reported in the literature that have been present when retreat/relocation occurs and how the literature writes about TCCA as a series of small or medium steps versus large changes.

Using ACF, MSF, and PET (Figure 1), we developed a codebook with 11 policy-change explanations used in the academic literature to explain TCCA (Appendix C). These codes were applied deductively to all 54 articles, using Nvivo v.11. Furthermore, we inductively added codes denoting explanation for managed retreat/planned relocation in the included articles, not covered by policy process theories. We use the term explanations for all factors and mechanisms that, according to the articles included, appear to be present when managed retreat/planned relocation occurs.

The inductively added codes for explanations beyond the policy process theories, included five additional types of explanations (Appendix C): legal (e.g. legal decisions and regulation), economic/financial (e.g. markets, economic growth, public investment), environmental (e.g. ecology, natural resources, climate system), socio-behavioral (e.g. individual and social behavior, subjective experiences, motivation, justice), and technological/engineering explanations (e.g. technological innovation). We applied two rounds of coding: first, coding policy-change explanations, types of policy change, and other types of explanations; second, comparing codes across articles and cases. To assess intercoder reliability (Lavrakas, 2008), at the start of the coding all four authors coded several articles individually to evaluate the percentage of agreement among them about explanations and the type of policy change, resulting in 83% intercoder reliability. With this two-step validation of the coding procedure the codebook was refined (Appendix C). We made sure that each code is distinct, even if they could be related. For example, a behavioral explanation, like individual hazard risk perception, may relate to a policy explanation, like national mood: when millions of individuals change their risk perceptions, it could change the national mood towards more support of TCCA. Using this thorough coding procedure, we relied on the insights reported throughout the entire text – abstract, introduction, main body, results and discussions – of each article.

3.4. Data analysis

Our analysis proceeds in four steps. First, we identify the type of policy change (first-, second-, third-order) reported in the articles. Second, we focus on the 11 policy-change explanations grounded in ACF, MSF, and PET and five additional explanations behind TCCA identified via inductive coding (Appendix C). The policy-change explanations derived from ACF, MSF and PET are more likely to explain second and third-order change because these theories were developed to explain major policy shifts. Third, we apply network analysis to elicit combinations of explanations for relocation/retreat. Network analysis is a method of data analysis for

relational data based on graph theory (Newman, 2018). As we expect no simple explanations for relocation/retreat, network analysis allows us to decode dependencies between explanations for TCCA and illustrate where diverse literatures cross-fertilize each other to explain TCCA. Absent dependencies point to siloed literatures. For this analytical step, we transform an n (articles) x m (explanations) matrix into an m x m adjacency matrix of co-occurring explanations in UCINET (version 6). To populate the matrix, the number of articles that explain TCCA are counted. Values range from 0–19, where 0 indicates that a pair of explanations is never reported jointly; values 1–19 indicate that in 1–19 articles this pair of explanations triggers managed retreat and planned relocation. We graphically depict the co-occurring explanations across the coded articles via network plots. In our network plots, nodes represent the coded explanations, and the strength of ties illustrates how often any pair of explanations co-occurs. We set node size proportional to how frequently explanations are used in combination across articles, which –in network terminology– is called degree centrality, i.e. number of adjacent, undirected ties. We colour-coded nodes based on the policy process theory featuring the respective policy-change explanation. An unconnected isolate means that either an explanation was not reported in the sampled articles to explain TCCA or that the explanation was not found in combination with another in any of the sampled articles. The latter does not occur in our dataset. Finally, network graphs are created using Python 3 (Van Rossum & Drake, 2009). Fourth, we create a heatmap to relate the type of policy change (first-, second-, third-order change) with the coded explanations of TCCA based on frequency statistics, using the Python packages NetworkX, CMasher, and Colorcet (Hagberg et al., 2008; van der Velden, 2020). Darker colours illustrate a higher frequency than lighter colours. Values range between 0 and 18 (the most popular explanation).

4. Results

We present our results on the types of policy change reported in the empirical literature (section 4.1), frequency of occurrence of various policy and social explanations driving TCCA individually (section 4.2) and in combination (section 4.3), and relationships between explanations and types of policy change (section 4.4).

4.1. Types of policy change behind transformational adaptation

The collected empirical evidence suggests that policy change driving TCCA takes different forms, without necessarily challenging existing paradigms. Empirical articles report managed retreat/planned relocation being achieved via all three forms of policy change, each constituting just a bit more or less than ⅓ of the share of the reviewed articles: 33%, 26% and 41% for the first-, second- and third-order policy change respectively.[1]

In *first-order change*, TCCA typically occurs via incremental steps with small adjustments to existing policies. A case study of Lake Macquarie, Australia, shows the development of some policies that include planned retreat, primarily as a long-term strategy but still leave quite some questions unsolved. For example, a coastal management manual is developed to prepare for sea level rise and offers some cost-sharing principles for planned retreat. However, clear methods for complementing this step with the alignment of economic policy, like sharing costs and benefits or funding models for planned retreat, remain undeveloped (Appendix B, #13). In New Zealand, Hayward (Appendix B, #20) despite an innovative managed retreat, the policy process occurs as 'complex decisions about climate adaptation to local governments [impose] difficult wider political choices about which values and assets' to protect. Similarly, in Australia the adaptation to sea level rise is left to local policies and decisions that lead to inconsistency and first attempts to come up with local adaptation plans (Appendix B, #13).

In *second-order policy change* where TCCA involves moderate change and new policy instruments, policy change often requires a change of governance, finance, and policies. For example, in South East Queensland, Australia, where an innovative planned retreat policy was proposed but then cancelled, it is argued that changes to coastal governance are needed, such as enabling flexible changes of rules and incentives in response to changing circumstances, as well as an institutionalization of catastrophes as opportunities for change (Appendix B, #1). Another study of pacific islands refers to the introduction of seasonal migrant

worker program (Appendix B, #7) and a study of California shows how public versus private responsibilities matter (private properties restrain managed retreat efforts to a large extent) and proposes regulations for prohibiting new developments in high-risk areas (Appendix B, #10).

In *third-order policy change*, TCCA occurs with a more radical paradigm shift that transforms place-based human ecosystems, including, for example, relocation program that incorporate 'migration with dignity' (Appendix B, #2), social inclusion in relocation (Appendix B, #3), a flexible plan for relocation that involves livelihood prospects and governance processes (Appendix B, #4), and socioeconomic reorganization (Appendix B, #5). Aktürk and Lerski (Appendix B, #3) show that a successful relocation includes transformative societal processes with 'cultural, ethnic, and social concerns in planning and implementation, such as designing houses to accommodate extended families'.

4.2. Policy-change explanations behind TCCA

Our analysis of policy-change and other types of explanations behind relocation/retreat reveals the explanations used by literature (Figure 2). The most frequently reported explanation is External shock/Focusing event. 45 of 54 analyzed articles used shocks to explain TCCA in at least one of their cases. Mentioned

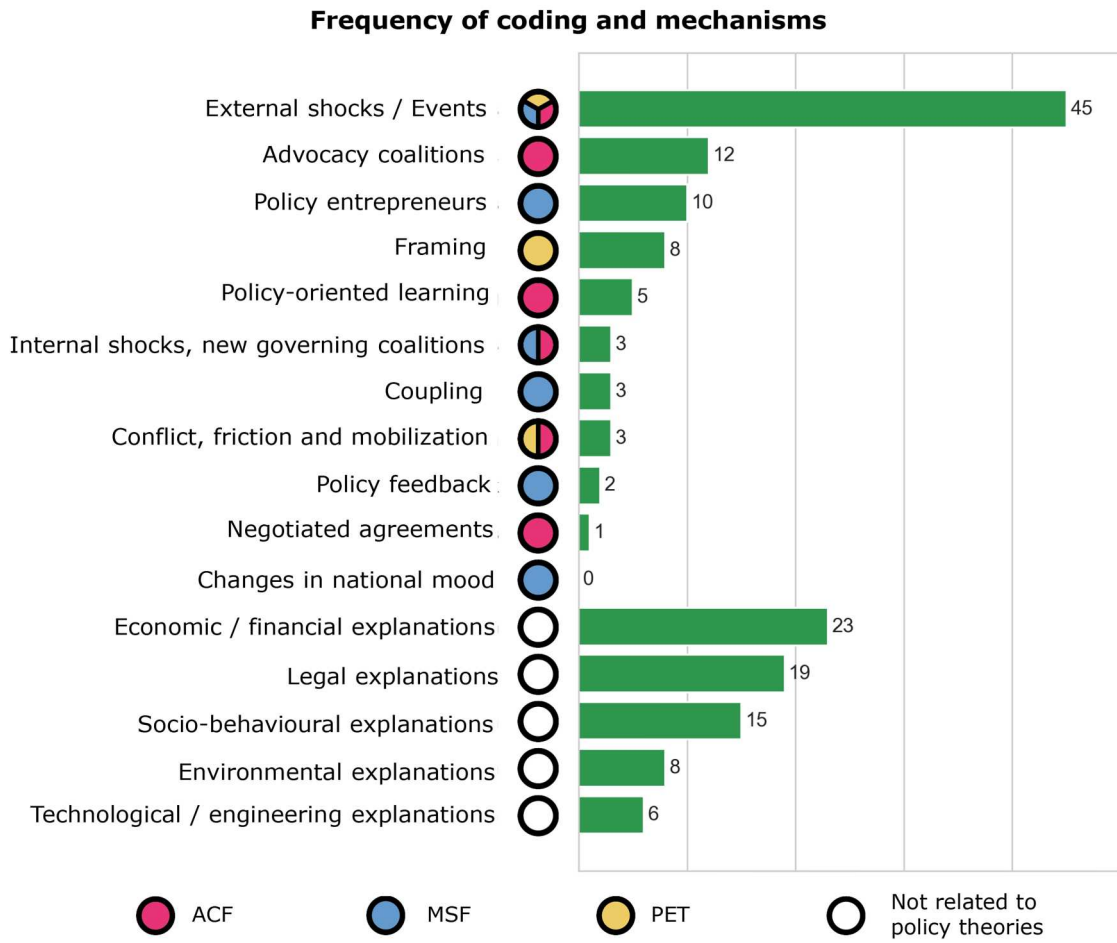


Figure 2. Overview of explanations for managed retreat and planned relocation.

Note: The numbers indicate the number of articles in which the explanations were coded. In the 54 articles, 279 codes were applied, of which 146 were explanatory factors. In one article, one explanation may have been coded multiple times; however, only a single code count was attributed to each article to generate the figure.

shocks are often weather-related extremes including storm surges and coastal erosion (Appendix B, #1) and large-scale flooding (Appendix B, #5), sometimes related to climate change (Appendix B, #8). External shocks include slow-onset hazards such as rising seas and rapid climate-related events (inundation, extensive flooding, storm surges) affecting low-lying nations (Appendix B, #7) and/or climate-induced drastic changes to coastal villages' physical landscape (Appendix B, #8). For example, in Fiji, external climate-induced shocks forced low-lying coastal communities to relocate permanently: 'Fiji is […] where low-lying coastal communities are beginning to relocate or plan for climate-related relocation' (Appendix B, #7), and, in 2014, Vunidogoloa village 'became the first Fijian village to be permanently relocated because of the impacts of climate change' (Appendix B, #8). In the USA, 'climate-induced environmental changes are causing some Alaska Native communities to choose to relocate' (Appendix B, #11).

Although a shock seems to be almost a necessary condition for TCCA to occur, it is insufficient, as illustrated by the variety of policy explanations mentioned in the articles. For example, advocacy coalitions, the presence of policy entrepreneurs, mediators, or policy brokers, and framing appear to be important explanations driving policy changes towards TCCA among the reviewed empirical literature.

4.3. Combinations of policy-change explanations behind transformational adaptation

As a policy change does not result from a single external shock but involves a complex interaction between different processes, we proceed by revealing the combinations of policy-change explanations used in the literature for past TCCA. Network plots show whether and how often articles reported a combination of explanations behind TCCA (Figure 3). The key policy-change explanations that co-occur most often are external shocks & advocacy coalitions (nine times, Figure 3a), external shocks & framing (six times), and external shocks & policy entrepreneurs (six times).

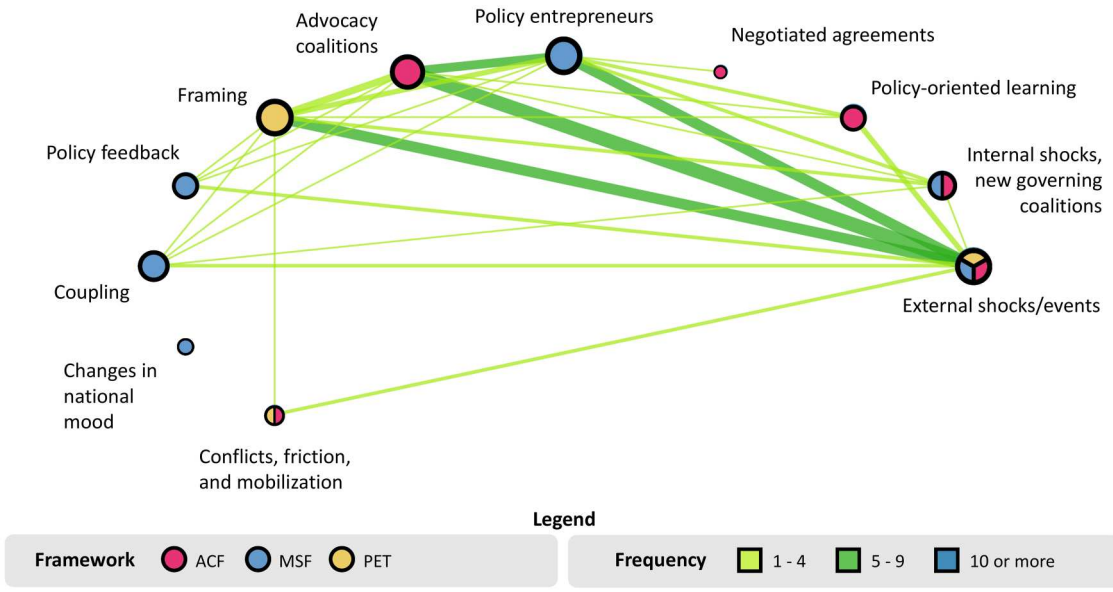
The literature uses *external shocks & advocacy coalitions* when highlighting that a shock event creates impetus for actors with shared beliefs to create coalitions and advocate together for creating political will towards TCCA (Appendix B, #7). Such articles also emphasize the role of advisory groups in planning (Appendix B, #10) and interdisciplinary governmental decision making to integrate indigenous knowledge (Appendix B, #11).

Articles that explain TCCA via *external shocks & framing* emphasize that shocks have led to a reframing of managed retreat. Managed retreat has, for example, been framed as an issue of real estate rather than as a complex social problem of climate change (Appendix B, #10). In the Dutch Room for the River program, reframing shifted attention towards allowing space for water instead of heavy infrastructure and engineering solutions (Appendix B, #9).

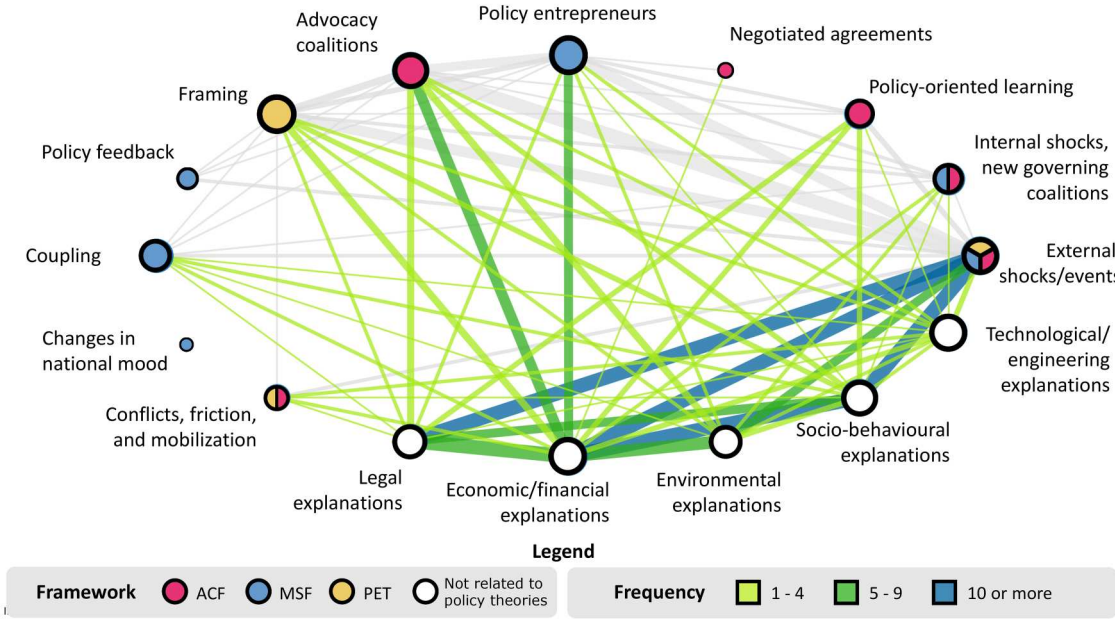
The literature explaining TCCA via *external shocks & policy entrepreneurs* emphasizes strong local leadership in facilitating relocation, prioritizing actions, allocating resources, and promoting cooperation (Appendix B, #2, #7, #42). For example, policy entrepreneurship in the Newtok, Alaska, case involves strong local leadership, facilitating effective communication of 'its vision to community residents (to avoid misinformation) and to external agencies' (Appendix B, #42).

Other policy-change explanations used in combination include advocacy coalitions & policy entrepreneurs/brokers/mediators (five times), framing & advocacy coalitions (four times), and framing & policy entrepreneurs/brokers/mediators (three times) (Figure 3a). Missing ties between policy process factors illustrate gaps in the literature: little or no attention is given, for example, to the combination of policy feedback and policy-oriented learning, or, policy feedback and framing respectively (Figure 3a).

Key explanations for TCCA build on factors covered in ACF, MSF, and PET (colour-coded in red, blue, and yellow, respectively, Figure 3a). Other explanations considered important for TCCA in the reviewed empirical literature include: legal, economic/financial, environmental, socio-behavioral, and technological/engineering explanations (Figure 3b). These explanations are inconsistent with the explanations theorized about in the ACF, MSF or PET frameworks, but are typically described in generic terms in the analyzed articles. Therefore, they received separate, yet rather generic codes. The resulting expanded network analysis (Figure 3b) reveals new combinations of explanations of TCCA. Again, shocks receive much attention in the empirical literature, particularly in combination with legal (19 times), economic/financial (17 times) and socio-behavioral



a. Combinations of policy-change explanations



b. Combinations of policy-change and other explanations

Figure 3. Network analysis of explanations of transformational adaptation to climate-related hazards in the empirical literature on managed retreat/planned relocation. a. Combinations of policy-change explanations derived from the three policy change theories (ACF: advocacy coalition framework, MSF: multiple streams framework, PET: punctuated equilibrium theory) b. Combinations of policy-change and other explanations reported in empirical literature.

Note: The nodes represent the explanations. The ties indicate how often any pair of explanations is reported jointly across articles in our dataset. The node size is proportional to degree centrality, i.e. a node's number of adjacent ties illustrating the popularity of each explanation.

explanations (12 times). Our network analysis confirms the crucial role of certain pairs of TCCA explanations (Figure 3b), especially economic/financial & socio-behavioral (12 times), legal & economic/financial (10 times), economic/financial & environmental (eight times), and legal & socio-/behavioral (six times). These

pairs have thick ties in Figure 3b because our coding was generic for these variables. With more nuanced codes for the economic/financial, socio-behavioral, legal and environmental categories, each tie would turn out comparably less thick. Nevertheless, results illustrate the prominence of these pairs of broader explanations in the literature. Finally, economic/financial explanations & advocacy coalitions are often used in the literature to jointly explain TCCA (six times). Results indicate that a major interdisciplinary effort is required to fully map various policy, behavioral, and environmental explanations driving TCCA.

4.4. Types of transformational responses explained by combinations of factors

Empirical literature on past flood adaptations concerning geographical shifts in locations of activities reveals that such societal transformations have been achieved via incremental policy change without challenging existing paradigms (first-order) or via radical paradigmatic policy shifts (third-order). Shocks trigger all types of policy change, and we show patterns in the types of societal mechanisms – policy and beyond – that drive first-, second-, and third-order policy changes (Figure 4).

First-order, incremental, change is explained mainly by combinations of socio-behavioral and economic drivers (first-order column, Figure 4), revealing the channels via which such TCCA occurred: behavioral change leading to the social acceptance of risks and policies as well as economic redistribution of costs and benefits of past planned relocations/managed retreats. However, the considered policy frameworks (ACF, MSF, PET) have not been designed for explaining first-order TCCA policy change; alternative theoretical lenses on how incremental policy changes eventually lead to societal transformations are therefore required.

The empirical evidence confirms that *second-order change* occurs when new policy instruments are introduced: economic, legal, behavioral instruments and new technological solutions (second-order column, Figure 4). Furthermore, advocacy coalitions, policy entrepreneurs, and framing are key policy-change explanations (according to ACF and MSF) complementing shocks in second-order change transformations.

Likewise, advocacy coalitions, policy entrepreneurs/brokers, and framing are reported as key policy-change enablers of third-order TCCA (third-order column, Figure 4). Local policy entrepreneurs advance policy process outcomes with a 'facilitating and catalytic role' (Appendix B, #43), sometimes shifting the dominant frames and influencing the emergence of advocacy coalitions. Such policy brokers advocate a policy and invest resources to advance TCCA (e.g. international organizations that exhibit commitment, leadership, and action that enables relocations, Appendix B, #4) or create and communicate visions of relocation (e.g. community leaders like Tribes and Indigenous Peoples, Appendix B, #30, #42). Drastic changes in economic and legal regulations are prominent explanations behind paradigmatic third-order TCCA, whereas behavioral and technological change appear less critical.

5. Discussion and conclusion

This article systematises empirical evidence on planned relocations/managed retreat worldwide to reveal (combinations of) policy-change and other social explanations that are reported to lead to TCCA.

The term TCCA suggests that fundamental policy changes are necessary, articles however vary in how they describe the pathways to such change. Articles write about transformational change happening in incremental steps (first-order policy change), from a change of policy instruments (second-order policy change), and via a paradigm shift (third-order policy change). This is good news, since 59% of articles about TCCA did not mention paradigmatic shifts in policy, which are known to be harder to realize (Weible & Sabatier, 2018). This also aligns with some of the previous work that hypothesized that even major changes in the policy course might occur in incremental steps (Termeer & Dewulf, 2019; Termeer et al., 2024).

The empirical literature on retreat and relocation pays considerable attention to external shocks as emphasized in policy change theories (ACF, MSF, PET) (Ahmed et al., 2015; Shi & Moser, 2021). 45 of 54 analyzed articles used shocks to explain TCCA in at least one of their cases. While 21 of these 45 papers cover multiple cases, results highlight a general consensus in the literature: shocks matter as a generic driver of action. A threat and flood experience is also critical in economics and psychology theories explaining decisions under risks (van Valkengoed & Steg, 2019). However, waiting for disaster should not be the only message to retain from

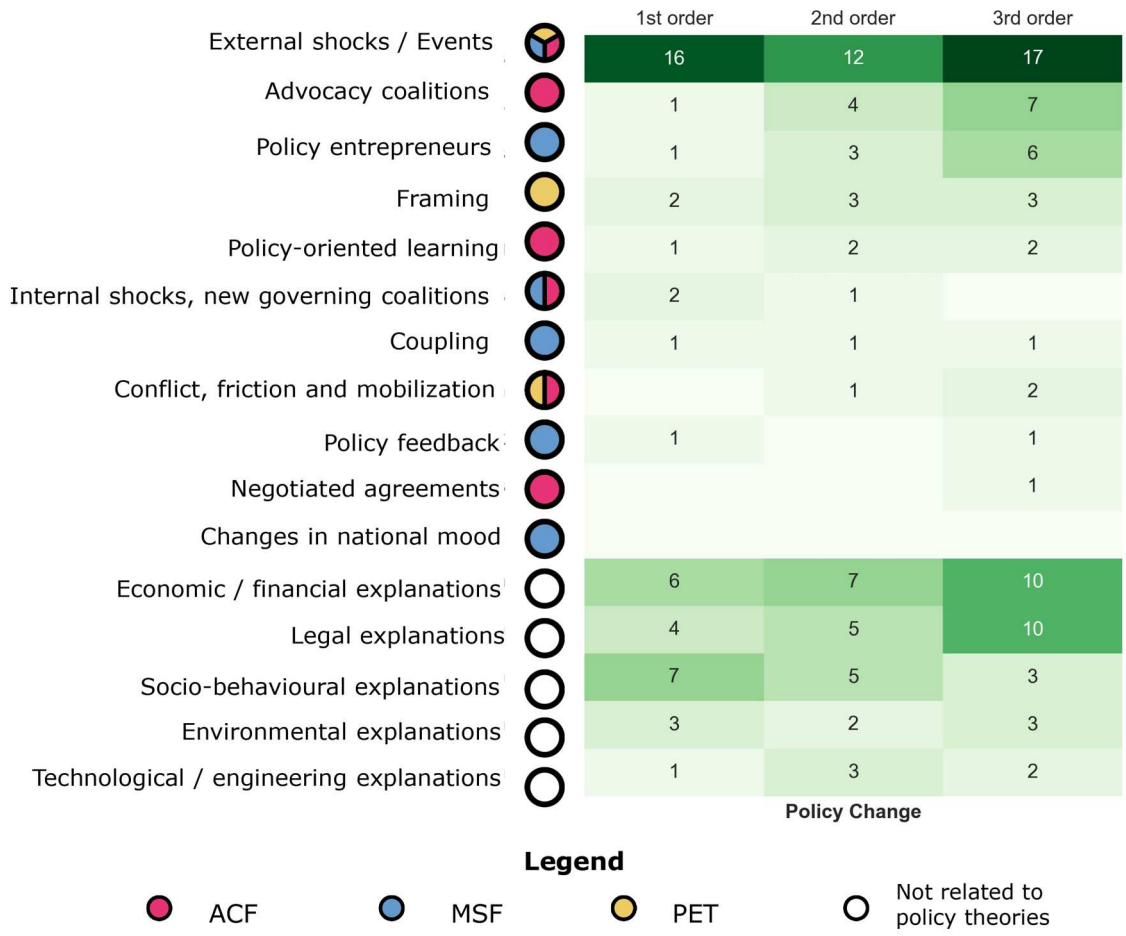


Figure 4. Overview of explanations behind first, second or third-order policy change resulting in managed retreat/planned relocation.

Note: Figure shows a heatmap. The intensity of the green colour indicates how frequently an explanation is mentioned in the empirical literature. The coloured circles indicate the particular policy change theory conceptualizing a particular explanation.

the literature. Constructive mechanisms should be given more attention in research to motivate forward-looking policy action for TCCA. Nohrstedt et al. (2021) showed that shocks alone are insufficient to drive a major policy change. Our analysis goes further and adds novel insights into which policy and social mechanisms appear critical in driving first-, second- and third-order policy changes in empirical cases of TCCA. Specifically, first-order policy change is described most frequently with economic/financial and socio-behavioral explanations. Second-order policy change is discussed in connection with these two factors and legal explanations. Third-order policy change is associated mostly with policy entrepreneurs and advocacy coalitions combined with legal and economic/financial explanations.

Our analysis reveals that the *most reported policy-change explanations for TCCA in empirical literature are policy entrepreneurship and advocacy coalitions*, followed by framing, which corresponds with key policy change theories ACF, MSF, and PET (Weible & Sabatier, 2018). Specifically, external shocks can be utilized when support is created for necessary changes before events occur and that specific actors are capable of coupling novel solutions or strategies to a (re)framing of the particular shock and bringing that into a political venue together with like-minded others. This is in line with the policy change literature (John, 2003; Pierce et al., 2020), and has also been reported for other transformations outside the climate adaptation literature (Birkland, 2006; Ilieva et al., 2023; Ingold & Varone, 2012; Rose & Baumgartner, 2013).

Besides the policy-change explanations hypothesized by ACF, MSF, and PET, the literature often refers to broader societal drivers of TCCA. We conclude two things. First, the literature discussing managed retreat/planned relocation makes limited use of the key policy process theories and theoretical policy-change explanations. Second, the three considered theories do not account for the financial/economic and socio-behavioral drivers that are important for explaining managed retreat/planned relocation. Notably, behavioral and economic explanations are especially important in achieving, first-order, TCCA. The empirical evidence here centres on people's adaptation actions, when transformations are a result of individuals who independently or collectively decide to relocate for self-serving or pro-social reasons (Wilson et al., 2020). Hence, the behavioral aspects may no longer be overlooked by scientists as part of a managed retreat, a concern voiced in the past (Agyeman et al., 2009). As with policy-change explanations, exact mechanisms of behavior change or economic/financial factors that trigger TCCA are rarely mentioned in the empirical literature on planned relocation/managed retreat. It is, however, vital to leverage the rich knowledge regarding behavioral change explanations grounded in psychological theories, such as Protection Motivation Theory, which explains individual climate change adaptation (Noll et al., 2022), or Protective Action Decision Model (Lindell & Perry, 2012) focusing on risk communication. Further research is also needed on the exact economic mechanisms – beyond generic labels like 'economic stakes' or 'financial stimuli', specifying e.g. economic feedback for local housing markets (De Koning & Filatova, 2020), cascading financial risks (Mandel et al., 2021), insurability of climate risks (Taylor & Weinkle, 2020), role of banks (Gourdel et al., 2024), economic actors' boundedly-rational expectations (Hommes, 2013), or impacts of risk judgments on economic choices (Noll et al., 2023).

5.1. Novel contributions

Besides offering the first systematic overview of policy-change and broader explanations driving TCCA in the form of managed retreat/planned relocation, our article expands the traditional research method of a systematic literature review in a novel way. Firstly, we complement the systematic literature review with an in-depth and structured analysis of theory-grounded policy change drivers behind retreat/relocation, using a clear coding scheme.

Secondly, we employ network analysis to show the combinations of explanations empirically reported to matter in each type of policy change. Such meta-analysis offers a promising method to systematically collect, analyse, and visualize patterns in fragmented literatures in line with theory-grounded explanations of policy change. It highlights literature gaps or even silos with promising, yet underexploited combinations of explanations for TCCA such as policy feedback and policy-oriented learning. Our findings motivate future interdisciplinary research that bridges policy sciences and environmental sciences to link case-study insights on TCCA with policy processes as well as economic and behavioral explanations. Such research requires a large-scale international and interdisciplinary effort.

5.2. Limitations and future research

The first limitation concerns the selection of articles: Based on our focused search terms, our dataset confines to flood-related managed retreat/planned relocation as an example of a clear shift from a status quo towards a TCCA. Given this scoped set of search terms, including the case of Room for the River as one of the well-studied examples of successful planned relocation, it is not surprising that 41% of our articles present TCCA as large, paradigmatic, third-order policy change. Future research could encompass a greater diversity in TCCA policy outcomes, beyond retreat/relocation and embrace other climate-induced hazards. Climate-induced hazards like heatwaves and droughts, rely more on private action, where TCCA is realized through a massive uptake of new practices or relocation, rather than public policy change, hence warranting the shift of focus on socio- behavioral and economic explanations. Widening the scope for both the outcome and hazards could enable an inclusion of cases analyzed by the same set of theories.

The second limitation is generic to any meta-analysis: its quality depends on how well the cases are described in the original articles. In our dataset, cases are described by authors from various disciplines,

researching them through the lenses of different theories, if any. This influences the explanations reported: our findings depend on the factors of interest to the authors of the original articles. As they address different research questions, we acknowledge that information about possible policy change-explanations potentially relevant to our meta-analysis might have been omitted. Furthermore, some articles cover multiple cases (up to 16), whereas others provide one in-depth case analysis. The level of detail per case therefore differs. Because the case is so differently reported and analyzed per article, we focus our analysis on the explanations that are present at the article-level. Future research could further zoom in on the combinations of TCCA explanations per case, for example by developing an elaborate description of each case-study and applying the policy process theories more explicitly to trace possible policy feedback loops that received little attention in the peer-reviewed literature on managed retreat/relocation so far. A way to do so would be to systematically collect and analyse scientific articles, grey literature, and newspapers about each case and events within the region within a particular timeframe. By experience, the challenge then is to find appropriate codes when articles report differently about the same case. Nevertheless, a database of cases will enable future comparative studies on TCCA, similar to databases such as SCAPE for cases on environmental decision making (Newig et al., 2019), the collaborative governance case databank (Douglas et al., 2020) or Climate-ADAPT[2] and GAMI[3] for climate adaptation should TCCA be differentiated there.

Finally, future work could address the third limitation: selected TCCA explanations. We explicitly focused on explanations grounded in three policy frameworks (ACF, MSF, PET). This proved valuable for TCCA involving second- and third-order policy change, because these theories tend to focus on explaining major policy shifts in attention and resources and these frameworks are often overlooked by TCCA scholars. Our results also suggest other frameworks that could shed new light on the explanations driving TCCA via incremental steps, like incrementalism (Lindblom, 2018), sensemaking (Weick, 1995), and the small wins framework (Termeer & Dewulf, 2019). Furthermore, theoretical frameworks from psychology and economics outlined above offer a solid set of mechanisms explaining behavioral change and financial and economic dynamics potentially triggering TCCA.

5.3. Concluding recommendations for practice

External shocks can prompt policy action, which can be transformational for locations and people. Yet, it is not only undesirable to wait for a disaster to enable TCCA, but also insufficient, as several policy-change and broader societal explanations need to align to achieve a successful TCCA. Our results suggest that if policy-makers build coalitions with like-minded others, they can gain support for novel paradigm-shifting policies and couple solutions/problems/politics when a policy window opens. On the one hand, coalition-building seems more and more difficult in today's Western democracies. On the other hand, windows of opportunity for action open more often with increasing severity and probability of climate-induced hazards. More frequent and intense disasters stretch the limits of incremental adaptation, demanding radical alternatives. With increasing sense of urgency political actors are under pressure to respond with novel solutions instead of repeating practices that worked well in the past but might not hold in the 'new normal'.

Notes

1. The level of change is coded on an article-level even if articles include multiple cases, whereby cases may vary with regards to the level of change. Our results capture how articles write about TCCA as first-, second-, or third-order policy change.
2. https://climate-adapt.eea.europa.eu/en
3. https://globaladaptation.github.io/index.html

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This research was supported by the funding of the 4TU.HTSF DeSIRE program of the four universities of technology in the Netherlands. Tatiana Filatova is also thankful to the funding from the NWO VIDI grant number 191015. We thank Sherman Lee for his help with the illustrations.

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References

Agyeman, J., Devine-Wright, P., & Prange, J. (2009). Close to the edge, down by the river? Joining up managed retreat and place attachment in a climate changed world. *Environment and Planning A: Economy and Space*, *41*(3), 509–513. https://doi.org/10.1068/a41301

Ahmed, F., Gersonius, B., Veerbeek, W., Alam Khan, M. S., & Wester, P. (2015). The role of extreme events in reaching adaptation tipping points: A case study of flood risk management in Dhaka, Bangladesh. *Journal of Water and Climate Change*, *6*(4), 729–742. https://doi.org/10.2166/wcc.2014.102

Baumgartner, F. R., Jones, B. D., & Mortensen, P. B. (2018). Punctuated equilibrium theory: Explaining stability and change in public policymaking. In C. M. Weible & P. A. Sabatier (Eds.), *Theories of the policy process* (4th ed., pp. 55–102). Routledge.

BBC. (2022a). *Japan storm: Nine million people told to evacuate as super typhoon Nanmadol hits*. 19 September. https://www.bbc.com/news/world-asia-62952942

BBC. (2022b). *Typhoon Noru: Five rescuers dead as typhoon hits Philippines*. 26 September. https://www.bbc.com/news/world-asia-63023891

Birkland, T. A. (2006). *Lessons of disaster: Policy change after catastrophic events*. Georgetown University Press.

Bower, E., & Weerasinghe, S. (2021). Leaving Place, Restoring Home: Enhancing the Evidence Base on Planned Relocation Cases in the Context of Hazards, Disasters, and Climate Change. Platform on Disaster Displacement (PDD) and Andrew & Renata Kaldor Centre for International Refugee Law.

Chung Tiam Fook, T. (2017). Transformational processes for community-focused adaptation and social change: A synthesis. *Climate and Development*, *9*(1), 5–21. https://doi.org/10.1080/17565529.2015.1086294

De Koning, K., & Filatova, T. (2020). Repetitive floods intensify outmigration and climate gentrification in coastal cities. *Environmental Research Letters*, *15*(3), 034008. https://doi.org/10.1088/1748-9326/ab6668

Douglas, S., Ansell, C., Parker, C. F., Sørensen, E., 'T Hart, P., & Torfing, J. (2020). Understanding collaboration: Introducing the collaborative governance case databank. *Policy and Society*, *39*(4), 495–509. https://doi.org/10.1080/14494035.2020.1794425

Dupuis, J., & Knoepfel, P. (2013). The adaptation policy paradox: The implementation deficit of policies framed as climate change adaptation. *Ecology and Society*, *18*(4), 31. https://www.jstor.org/stable/26269408

Fazey, I., Moug, P., Allen, S., Beckmann, K., Blackwood, D., Bonaventura, M., Burnett, K., Danson, M., Falconer, R., Gagnon, A. S., Harkness, R., Hodgson, A., Holm, L., Irvine, K. N., Low, R., Lyon, C., Moss, A., Moran, C., Naylor, L., … Wolstenholme, R. (2018). Transformation in a changing climate: A research agenda. *Climate and Development*, *10*(3), 197–217. https://doi.org/10.1080/17565529.2017.1301864

Feola, G. (2015). Societal transformation in response to global environmental change: A review of emerging concepts. *Ambio*, *44*(5), 376–390. https://doi.org/10.1007/s13280-014-0582-z

Few, R., Morchain, D., Spear, D., Mensah, A., & Bendapudi, R. (2017). Rethinking higher education and its relationship with social inequalities: Past knowledge, present state and future potential. *Palgrave Communications*, *3*(1), 1–9. https://doi.org/10.1057/s41599-017-0001-8

Gjaltema, J., Biesbroek, R., & Termeer, K. (2020). From government to governance … to meta-governance: A systematic literature review. *Public Management Review*, *22*(12), 1760–1780. https://doi.org/10.1080/14719037.2019.1648697

Gourdel, R., Monasterolo, I., Dunz, N., Mazzocchetti, A., & Parisi, L. (2024). The double materiality of climate physical and transition risks in the euro area. *Journal of Financial Stability*, *71*, 101233. https://doi.org/10.1016/j.jfs.2024.101233

Haasnoot, M., Lawrence, J., & Magnan, A. K. (2021). Pathways to coastal retreat. *Science*, *372*(6548), 1287–1290. https://doi.org/10.1126/science.abi6594

Hagberg, A., Swart, P. J., & Schult, D. A. (2008). *Exploring network structure, dynamics, and function using NetworkX*. (No. LA-UR-08-05495; LA-UR-08-5495). Los Alamos National Laboratory (LANL), Los Alamos, NM (United States). https://www.osti.gov/biblio/9606.

Hall, P. A. (1993). Policy paradigms, social learning, and the state: The case of economic policymaking in Britain. *Comparative Politics*, *25*(3), 275–296. https://doi.org/10.2307/422246

Herweg, N., Zahariadis, N., & Zohlnhöfer, R. (2018). The multiple streams framework: Foundations, refinements, and empirical applications. In C. M. Weible & P. A. Sabatier (Eds.), *Theories of the policy process* (4th ed., pp. 17–53). Routledge.
Hino, M., Field, C. B., & Mach, K. J. (2017). Managed retreat as a response to natural hazard risk. *Nature Climate Change*, *7*(5), 364–370. https://doi.org/10.1038/nclimate3252
Hommes, C. (2013). *Behavioural rationality and heterogeneous expectations in complex economic systems*. Cambridge University Press.
Ilieva, R. T., Fraser, K. T., & Cohen, N. (2023). From multiple streams to a torrent: A case study of food policymaking and innovations in New York during the COVID-19 emergency. *Cities*, *136*, 104222. https://doi.org/10.1016/j.cities.2023.104222
Ingold, K., & Varone, F. (2012). Treating policy brokers seriously: Evidence from the climate policy. *Journal of Public Administration Research and Theory*, *22*(2), 319–346. https://doi.org/10.1093/jopart/mur035
IPCC (Intergovernmental Panel on Climate Change). (2022). *Climate change 2022: Impacts, adaptation and vulnerability – Summary for policymakers*. WMO and UNEP.
Jenkins-Smith, H. C., Nohrstedt, D., Weible, C. M., & Ingold, K. (2018). The advocacy coalition framework: An overview of the research program. In C. M. Weible & P. A. Sabatier (Eds.), *Theories of the policy process* (4th ed., pp. 135–172). Routledge.
John, P. (2003). Is there life after policy streams, advocacy coalitions, and punctuations: Using evolutionary theory to explain policy change? *Policy Studies Journal*, *31*(4), 481–498. https://doi.org/10.1111/1541-0072.00039
Jones, B. D., & Baumgartner, F. R. (2005). A model of choice for public policy. *Journal of Public Administration Research and Theory*, *15*(3), 325–351. https://doi.org/10.1093/jopart/mui018
Kates, R. W., Travis, W. R., & Wilbanks, T. J. (2012). Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences*, *109*(19), 7156–7161. https://doi.org/10.1073/pnas.1115521109
Kingdon, J. W. (2011). *Agendas, alternatives and public policy*. Longman.
Kuhl, L., Rahman, M. F., McCraine, S., Krause, D., Hossain, M. F., Bahadur, A. V., & Huq, S. (2021). Transformational adaptation in the context of coastal cities. *Annual Review of Environment and Resources*, *46*(1), 449–479. https://doi.org/10.1146/annurev-environ-012420-045211
Lavrakas, P. J. (2008). Intercoder reliability. In P. J. Lavrakas (Ed.), *Encyclopedia of survey research methods* (pp. 344–345). London: Sage Publications Ltd.
Lindblom, C. (2018). The science of "muddling through". In J. Stein (Ed.), *Classic readings in urban planning* (pp. 31–40). Routledge.
Lindell, M. K., & Perry, R. W. (2012). The protective action decision model: Theoretical modifications and additional evidence. *Risk Analysis: An International Journal*, *32*(4), 616–632. https://doi.org/10.1111/risk.2012.32.issue-4
Mach, K. J., & Siders, A. R. (2021). Reframing strategic, managed retreat for transformative climate adaptation. *Science*, *372*(6548), 1294–1299. https://doi.org/10.1126/science.abh1894
Mandel, A., Tiggeloven, T., Lincke, D., Koks, E., Ward, P., & Hinkel, J. (2021). Risks on global financial stability induced by climate change: The case of flood risks. *Climatic Change*, *166*(1–2), 4. https://doi.org/10.1007/s10584-021-03092-2
Mintrom, M., & Luetjens, J. (2017). Policy entrepreneurs and problem framing: The case of climate change. *Environment and Planning C: Politics and Space*, *35*(8), 1362–1377. https://doi.org/10.1177/2399654417708440
Moss, E. D., Evans, D. M., & Atkins, J. P. (2021). Investigating the impacts of climate change on ecosystem services in UK agro-ecosystems: An application of the DPSIR framework. *Land Use Policy*, *105*, 105394. https://doi.org/10.1016/j.landusepol.2021.105394
NBC. (2022). *Ian was one of the most lethal hurricanes in decades. Many of the deaths were preventable*. 22 November. https://www.nbcnews.com/news/us-news/hurricane-ian-florida-death-toll-rcna54069
Newig, J., Jager, N. W., Kochskämper, E., & Challies, E. (2019). Learning in participatory environmental governance–its antecedents and effects. Findings from a case survey meta-analysis. *Journal of Environmental Policy & Planning*, *21*(3), 213–227. https://doi.org/10.1080/1523908X.2019.1623663
Newman, M. (2018). *Networks* (2nd ed.). Oxford: Oxford University Press.
Nohrstedt, D., Mazzoleni, M., Parker, C. F., & Di Baldassarre, G. (2021). Exposure to natural hazard events unassociated with policy change for improved disaster risk reduction. *Nature Communications*, *12*(1), 193. https://doi.org/10.1038/s41467-020-20435-2
Noll, B., Filatova, T., & Need, A. (2022). One and done? Exploring linkages between households' intended adaptations to climate-induced floods. *Risk Analysis*, *42*(12), 2781–2799. https://doi.org/10.1111/risa.13897
Noll, B., Filatova, T., Need, A., & de Vries, P. (2023). Uncertainty in individual risk judgments associates with vulnerability and curtailed climate adaptation. *Journal of Environmental Management*, *325*, 116462. https://doi.org/10.1016/j.jenvman.2022.116462
O'Brien, K. L. (2016). Climate change and social transformations: Is it time for a quantum leap? *WIRES Climate Change*, *7*(5), 618–626. https://doi.org/10.1002/wcc.413
Pelling, M. (2010). *Adaptation to climate change: From resilience to transformation*. Routledge.
Pierce, J. J., Peterson, H. L., & Hicks, K. C. (2020). Policy change: An advocacy coalition framework perspective. *Policy Studies Journal*, *48*(1), 64–86. https://doi.org/10.1111/psj.12223
Pot, W., Scherpenisse, J., & 't Hart, P. (2023). Robust governance for the long term and the heat of the moment: Temporal strategies for coping with dual crises. *Public Administration*, *101*(1), 221–235. https://doi.org/10.1111/padm.12872
Rose, M., & Baumgartner, F. R. (2013). Framing the poor: Media coverage and U.S. Poverty policy, 1960–2008. *Policy Studies Journal*, *41*(1), 22–53. https://doi.org/10.1111/psj.12001
Shamseer, L., Moher, D., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Petticrew, M., Shekelle, P., & Stewart, L. A. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: Elaboration and explanation. *BMJ*, *349*(jan02 1), g7647. doi:https://doi.org/10.1136bmj.g7647

Shi, L., & Moser, S. (2021). Transformative climate adaptation in the United States: Trends and prospects. *Science*, *372*(6549), eabc8054. https://doi.org/10.1126/science.abc8054

Siders, A. R., Ajibade, I., & Casagrande, D. (2021). Transformative potential of managed retreat as climate adaptation. *Current Opinion in Environmental Sustainability*, *50*, 272–280. https://doi.org/10.1016/j.cosust.2021.06.007

Taylor, Z. J., & Weinkle, J. L. (2020). The riskscapes of re/insurance. *Cambridge Journal of Regions, Economy and Society*, *13*(2), 405–422. https://doi.org/10.1093/cjres/rsaa015

Termeer, C. J., & Dewulf, A. (2019). A small wins framework to overcome the evaluation paradox of governing wicked problems. *Policy and Society*, *38*(2), 298–314. https://doi.org/10.1080/14494035.2018.1497933

Termeer, K., Dewulf, A., & Biesbroek, R. (2024). Three archetypical governance pathways for transformative change toward sustainability. *Current Opinion in Environmental Sustainability*, *71*, 101479. https://doi.org/10.1016/j.cosust.2024.101479

Van der Heijden, J., Kuhlmann, J., Lindquist, E., & Wellstead, A. (2021). Have policy process scholars embraced causal mechanisms? A review of five popular frameworks. *Public Policy and Administration*, *36*(2), 163–186. https://doi.org/10.1177/0952076718814894

van der Velden, E. (2020). CMasher: Scientific colormaps for making accessible, informative and 'cmashing' plots. *Journal of Open Source Software*, *5*(46), 2004. https://doi.org/10.21105/joss.02004

Van Rossum, G., & Drake, F. L. (2009). *Python 3 reference manual*. *CreateSpace*.

van Valkengoed, A. M., & Steg, L. (2019). Meta-analyses of factors motivating climate change adaptation behaviour. *Nature Climate Change*, *9*(2), 158–163. https://doi.org/10.1038/s41558-018-0371-y

Vermeulen, S. J., Dinesh, D., Howden, S. M., Cramer, L., & Thornton, P. K. (2018). Transformation in practice: A review of empirical cases of transformational adaptation in agriculture under climate change. *Frontiers in Sustainable Food Systems*, *2*, 65. https://doi.org/10.3389/fsufs.2018.00065

Weible, C. M., & Sabatier, P. A. (Eds.). (2018). *Theories of the policy process* (4th ed.). Routledge.

Weick, K. E. (1995). *Sensemaking in organizations* (Vol. 3). Sage.

Wilson, R. S., Herziger, A., Hamilton, M., & Brooks, J. S. (2020). From incremental to transformative adaptation in individual responses to climate-exacerbated hazards. *Nature Climate Change*, *10*(3), 200–208. https://doi.org/10.1038/s41558-020-0691-6

Workman, S., & Weible, C. M. (2022). The design of policy process research. In C. M. Weible & S. Workman (Eds.), *Methods of the policy process* (pp. 1–23). Routledge. https://doi.org/10.4324/978100369083-1