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The enablers of adaptation: A systematic review

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Knowledge of the practice of climate change adaptation is slowly shifting from a focus on barriers and limits to an understanding of its enablers. Here we take stock of the knowledge on the enablers of adaptation through a systematic review of the literature. Our review of empirical articles explaining how adaptation is enabled finds that there is a tendency in the literature to focus on local-scale case studies. Across all studies, some factors seem to be more important than others, including resources (particularly money), awareness of climate risks and responses, leadership, bridging and bonding social capital, and the support of higher-level institutions. Our analysis also highlights significant gaps in knowledge about enablers, including those that affect change in regional/provincial and national governments, in the private sector, and in non-local not-for-profit and non-governmental organisations.

Over the past two decades, considerable effort has been devoted to identifying the barriers to climate change adaptation, with the intention of overcoming the impediments to institutional changes that reduce vulnerability[1–3]. Less prominent, but of growing importance, is research that explores the factors that create and promote opportunities for adaptation action[4]. The published research on these "enablers" of climate change adaptation has grown in recent years[5,6]. In this paper, we present the results of a systematic review of the literature on the enablers of climate change adaptation in human systems. We focus on empirical studies that identify factors that enabled the implementation of adaptation to reduce the vulnerability of people and social systems. This review seeks to understand how adaptation practitioners might positively influence the adaptation cycle, to understand the scope of current empirical literature and to identify gaps in existing knowledge on enabling adaptation.

Methods

Search Criteria

We conducted a systematic search of the Scopus database for peer reviewed literature on enablers of climate change adaptation. The purpose of this review was to analyse the existing knowledge of factors shown to enable climate change adaptation, identifying key trends and gaps that have emerged in recent years. A process of trial and error was used to identify the most appropriate search terms, which are shown in Table 1.

The key search terms used for this review are applicable to a variety of other contexts where searching title, abstract, and key words returned over 27,000 results, hence these terms were searched in title-only to help limit results to the most relevant. This reflects the sparse and diverse literature on adaptation and the challenges of using systematic approaches in adaptation research[7] and demonstrates a limitation of our search. Nonetheless, a systematic approach was helpful in ensuring our review was transparent and replicable.

Screening

The search was conducted in February 2023 and was limited to literature from 2013 to 2023 (inclusive). Most literature on adaptation has been produced within the past fifteen years, such that limiting this search to the past ten years only eliminated 10% of the search results. Earlier literature does introduce the idea of the enablers of climate change adaptation and its theoretical underpinnings, however limiting our search by year helped to ensure the results we reviewed draw on more recent empirical understandings of adaptation and illustrate the current state of knowledge.

Using the filters provided within Scopus, we screened the results by removing keywords related to 'autonomous' adaptations within biophysical systems and non-human species, such as 'genetics' 'phylogeny' 'acclimation' or 'nonhuman', which are beyond the scope of this study's focus. With these filters applied, and removing corrections and commentaries, the search produced 320 papers for further review (see Fig. 1 for the selection process as per the Preferred Reporting Items for Systematic Reviews and Meta Analysis (PRISMA) guidelines[8]).

The titles, keywords, and abstracts for the remaining 320 papers were then screened for eligibility against our criteria for empirical papers that identified enablers, drivers or determinants of adaptation in human systems.

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Table. 1 | Description and justification of each of the selected Boolean search terms

Boolean terms	Justification
Enablers, drivers or determinants of adaptation TITLE (enabl* OR driv* OR determin* AND adapt*)	This research is focused on understanding factors that enable climate change adaptation to occur, hence this formed the basis of our search terms. We consider enablers to be factors that create or promote opportunities for adaptation to be implemented. Drivers and determinants were identified as key synonyms. Other key terms were tested, however many rarely returned results relevant to this research. For example, the term opportunities typically focuses on the potential for adaptation to occur.
Climate TITLE-ABS-KEY (climat*)	Climate ensured the results were relevant to climate change adaptation. Keeping the term broad as climate helped to capture both climate change trends and thresholds as well as the various manifestations of climate change which can all be relevant to climate change adaptation. Title, abstract, and key words were searched.

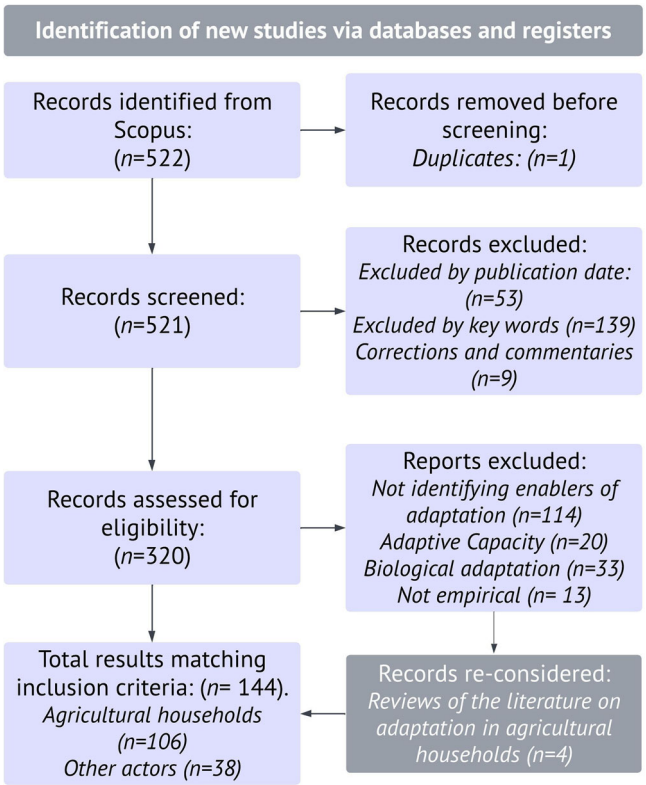

Fig. 1 | Systematic Review Approach. An outline of the systematic review approach that resulted in a total of 144 papers matching inclusion criteria, reported using the PRISMA guidelines[8].

Rejected articles

At total of 202 search results were removed at screening and a further 176 papers were removed after initial review. This included: 114 papers that upon closer reading were not in any way about enablers of adaptation; 33 papers about adaptation in biological systems (see below); 20 papers that were about adaptive capacity and not adaptation practices per se; and 18 papers that were not empirical. We excluded papers that theorise about enablers or investigate adaptive capacity, given the recognition that there is often a significant gap between what is thought to cause adaptation and actual adaptation practice[9].

Included articles

Over 100 of the papers matching our inclusion criteria investigated drivers or determinants of adaptation in agricultural households (or by agricultural landholders). To avoid skewing results through the experience of this particular sector and set of actors, we chose to review these papers separately and draw on several existing reviews which had previously analysed the findings and methods of these papers (drawn from the existing search results, see Fig. 1). The remaining 38 papers that were included describe the enablers of adaptation among various actors working at different scales and sectors, allowing for a clearer analysis of patterns in the research.

Coding and data extraction

The results were coded according to key criteria including research focus, case study location, scale of analysis, and methodology. Qualitative data on the key enablers, determinants or drivers identified in each paper was extracted, analysed, and grouped into common or reoccurring themes.

The literature predominantly consisted of empirical case studies investigating how to enable adaptation at a specific scale, and most often focussing on a specific type of actor (as opposed to networks of actors). Our analysis is therefore coded according to the actors whom the findings primarily apply to. This differentiation is important because it is not always straightforward: for example, Lawrence et al. explore local government adaptation to climate risk by taking into consideration the role of federal and regional governments[10].

In some cases, articles employed mixed-method approaches to understand enablers of adaptation, which included literature reviews or reviews of adaptation policy in conjunction with empirical data. In these circumstances, the research team only extracted data based on empirical findings. This is similar to the approach of Berrang-Ford et al. who tested whether theorised determinants of adaptive capacity are associated with adaptation policy outcomes[11].

Findings

Drivers of adaptation in agricultural households

Over 70% of the papers matching our inclusion criteria ($n = 105$) were investigating the drivers or determinants of adaptation decision-making or outcomes in agricultural households (or by agricultural landholders). Of these papers, 54% are case studies from the Sub-Saharan Africa region, and over 35% are case studies from across Asia (Fig. 2). This body of literature has been growing in recent years, with 4 papers published in 2013 and 23 papers published in 2022 (Fig. 3). These articles shared similar research approaches and had similar findings, as has been shown in four reviews of this literature[12–15].

The review of the research on enablers of adaptation among agricultural households by Ajala and Chagwiza classifies the determinants of agricultural household adaptation into socio-economic and demographic factors (i.e. age, gender, literacy levels, household size, wealth), institutional factors (i.e. access to extension services, access to credit facilities, government policies), technological factors (i.e. information on climate, new farming technologies), socio-cultural factors (i.e. shared values) and cognitive factors (i.e. relationship with risk)[13]. Similarly, the review from García de Jalón and colleagues grouped drivers of adaptation into human capital, financial resources, infrastructure and technology, social interaction and governance, food security, dependence on agriculture, and attitudes towards the environment and climate change[14]. These enabling factors were echoed in the papers across Africa[12,15] and in other regions[16].

The importance of knowledge and access to information was particularly emphasised in these studies, as was stakeholder engagement and participatory approaches for successful knowledge integration[12,15]. The importance of financial resources was also recognised across the studies: for example, Seidl et al.'s study of irrigators in Australia found financial capital to be the most statistically significant driver of adaptation actions[16].

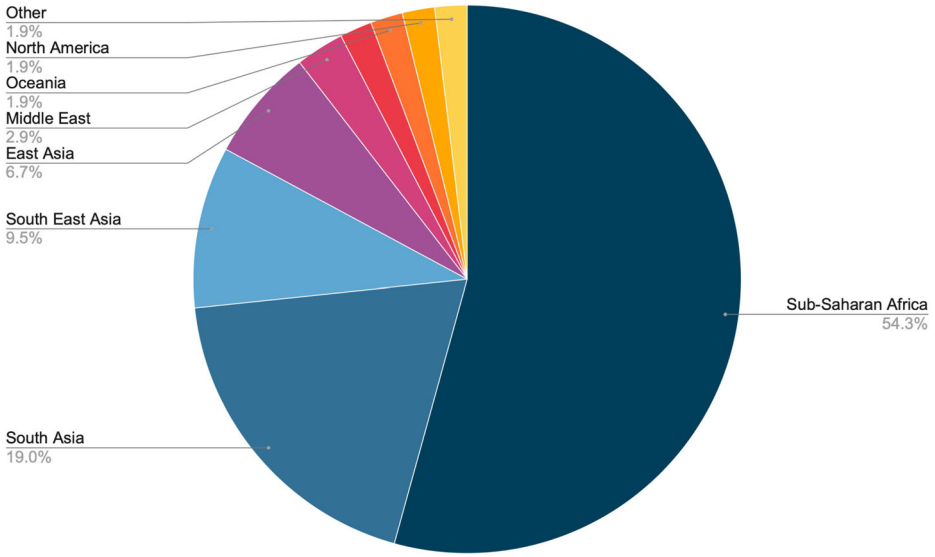

Fig. 2 | Distribution of results on drivers of adaptation in agricultural households, % per region. The geographic regions in which case studies were conducted, for the 105 articles looking at drivers or determinants of agricultural households' adaptation decision-making, showing a concentration in Sub-Saharan Africa.

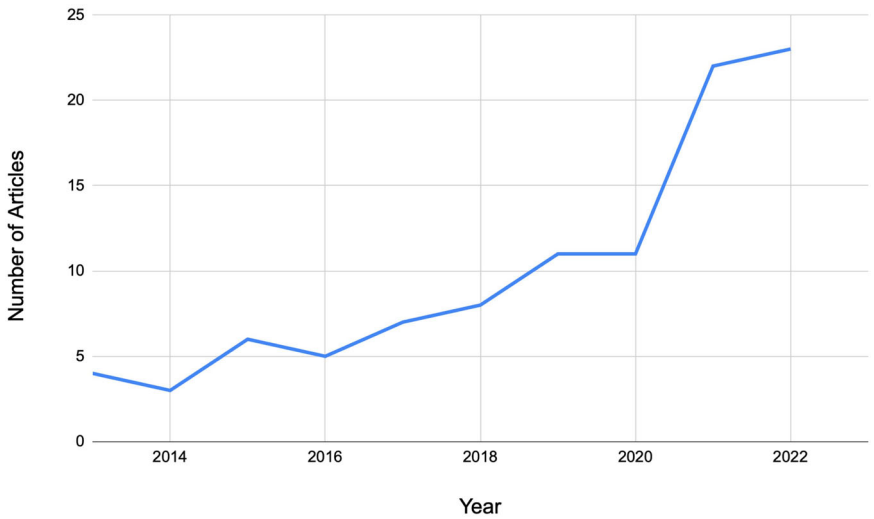

Fig. 3 | Number of results on drivers of adaptation in agricultural households, per year. The number of papers per year, for the 105 articles looking at drivers or determinants of agricultural households' adaptation decision-making, showing a gradual increase.

Trends in the empirical research from other actors

From here forward, our findings refer only to the 38 papers not focused on agriculture.

There were no clear trends in the date of publication of the 38 remaining articles: the most published in any given year was seven (in 2018), and the least was 2016 (1 paper). A large share (41.6%) of the studies were from journals Scopus categorised as primarily being in the field of environmental studies, such as *Current Opinion in Environmental Sustainability* or *Environmental Science and Policy*, closely followed by those identified as being in the social sciences, such as *Climate and Development* (32.5%). The empirical case studies reviewed were predominantly reporting on cases in Europe, sub-Saharan Africa, Oceania, and North America.

We grouped the enabling factors identified according to common or reoccurring themes, which are discussed in detail below. Figure 4 summarises the enabling factors identified in the literature according to the number of papers in which they were discussed and the main actors in each paper. It shows that there were a disproportionate number of studies focussing on local actors, be they local governments ($n = 15$) or local communities ($n = 8$). Studies of enablers applied to local communities and local governments both tended to emphasise the importance of leadership and social capital but made little mention of incentives or values.

In contrast, the literature provides little evidence about what enables adaptation at the level of individuals, in the private sector, in regional or provincial levels of government, and among national governments. Though there was mention of factors such as institutional support, risk perception, and trigger events, there was limited empirical evidence to justify that these were important enabling factors for these actors. Moreover, despite some insightful findings, there was no compelling evidence about the importance of some enabling factors, such as values and place attachment[17], laws, and regulations[18], or mainstreaming[19].

Below we summarise the ten most mentioned enabling factors in the 38 articles reviewed (Fig. 4). These should not be read as definitive given the number of empirical papers is small and the absence of many studies beyond the local scale (Fig. 4), as is discussed further below.

Proactive Leaders

The idea of leadership was widely examined in this literature. In most cases, leadership referred to individuals who champion adaptation and who work to overcome barriers or create enabling conditions[4,20–22]. This enabler was particularly prominent in cases of adaptation in local communities and local governments (Fig. 4).

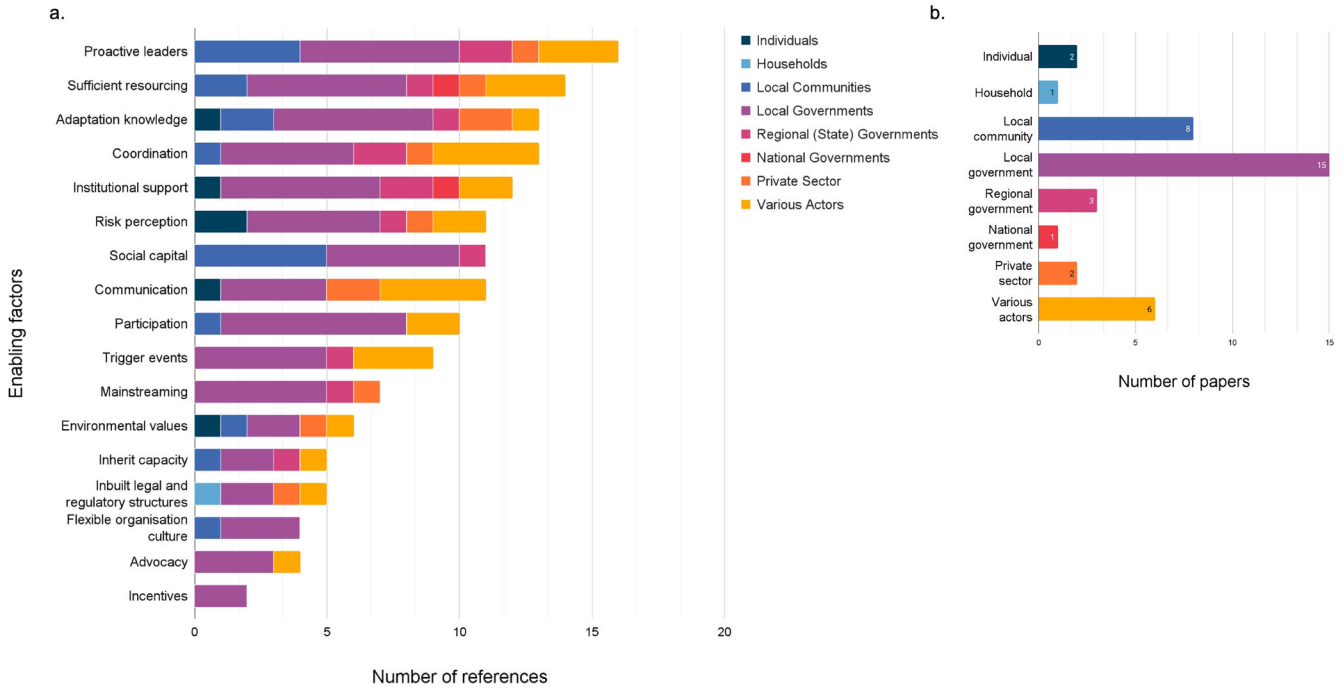

Fig. 4 | Enabling factors identified in the empirical research from non-agricultural actors, according to scale. a The number of references to different enabling factors and the actors those factors are primarily applied to (most papers refer to more than one enabler). **b** The total number of papers for each actor, ordered by scale.

It is clear from the literature that government and private sector personnel who are committed, dedicated, and motivated to pursue adaptation in a professional capacity can play a significant role in enabling change[23–26]. Typically, these individuals understand the importance of climate change, are often involved in climate change research, and notice climate change impacts in their environment[25,27]. Such leaders often initiate change by putting in place adaptation policies, strategies and guiding documents, and ensuring these become normalised through their organisations[4,28–30].

Local communities have also been shown to lead adaptation themselves through 'bottom-up' approaches[31], which can achieve outcomes that are better suited to their local context[21,32]. Such efforts are even more effective when supported by leaders at higher levels[33].

Sufficient resourcing

Much of the literature demonstrates the need for financial, human, and natural resources, as well as technology, to enable adaptation[4,10,20,23,28,34,35]. These factors were seen to be particularly important for local governments.

The importance of resources is self-evident, though the discussion tends to focus on the financial resources[23,33], which perhaps reflects the emphasis placed on adaptation funding in the climate change regime, as well as the chronic problem of insufficient funding for local governments in most countries. The literature shows that because finance is so important, those who control its supply have disproportionate power in the adaptation process, often to the detriment of the priorities of lower-level stakeholders[32,34,36]. There is not only a tendency of donors to ignore local priorities (e.g. as presented by Westoby et al[32].), but also for international donors to ignore national priorities[34].

Resources are also shown to matter for the private sector, where actors are of course motivated to pursue climate change adaptation when it delivers economic benefits such as a reduction in costs, increased competitive advantage, or increasing property values[37], though the literature regarding the private sector is small. The literature also fails to explore the influence of resources on the adaptation behaviour of individuals.

Some studies recognise that sufficient resourcing does not guarantee action on adaptation, let alone effective action. The study by Birchall and colleagues of regional governments reveals that although sufficient resources were guaranteed toward adaptation, conflicting priorities caused momentum to be lost before implementation was complete[28]. This suggests resources are best considered to be important among a larger set of conditions that contribute to an enabling environment for adaptation.

Adaptation knowledge

The literature often demonstrates that knowledge of climate risk and of possible adaptation responses is necessary to enable adaptation across almost all actors[21,33,37–39]. Considerable focus is placed on how knowledge is transferred into the adaptation process, including by engineers, consultants, extension services, and academics[4,10,27]. Training courses and other programs that develop the capacity of individuals working on climate change are considered important, as trained people are better equipped to find and handle the information necessary to make informed adaptation decisions[21,36].

Coordination

Often mentioned in the literature about adaptation in governments, horizontal and vertical coordination between and within levels of government has been shown to enable consistent and efficient adaptation action[10,22,28,29,40]. The means of such coordination varies, as to be effective it should take into consideration factors including the physical environment, social structure, and local economy, and should be developed to fit the particular context[41,42]. In government, defining clear roles and responsibilities for different actors can allow lower levels of government to be more proactive, help share the risks of action and inaction, and promote knowledge sharing[10,22,29,30,36]. Conversely, the literature suggests that a lack of communication across levels of government can lead to poor planning decisions or maladaptation[22].

Institutional support

The literature suggests that adaptation is enabled when the goals, policies and priorities of actors align to support those (leaders) who seek to implement adaptation. This was said to be most important at all levels of government (Fig. 4).

Shared goals, policies, and priorities give adaptation practitioners the independence necessary to progress adaptation, and the confidence that they are aligning with mandated priorities[25,26,28]. A well-integrated mandate for adaptation action within a governing body allows for a gradual increase in investment and capacity development[23,34,36]. It can also help to streamline the incorporation of adaptation across an organisation and incentivise policy actors to implement adaptation more actively and explicitly[26,36]. This is all, however, dependent on the support of elected officials, which in turn hinges on a mandate (or at least not popular opposition) for climate change adaptation. Political stability is also important as it creates a stable operating environment that gives governments the ability to make decisions and see them through[4,20,23,24].

In Bowen et al.'s study of adaptation in the health sector in Cambodia, interviewees identified the formation of a National Climate Change Committee as the key change that enabled adaptation activities[34]. In this case, the Prime Minister was named Honorary Chair of the committee, which created significant buy-in from diverse actors and meant that higher levels of government had political incentives to commit to adaptation activities[34].

Risk perception

The literature consistently shows that people, institutions, and organisations who perceive their climate risk to be high are most likely to take action to reduce their vulnerability[20,23,39,41,43–45]. Information that increases awareness of climate risks and a sense of urgency to responses can therefore help enable adaptation action[44]. There is also some evidence that those who know and understand the causes and consequences of climate change are more concerned about its potential effects, and so more likely to seek to implement change[38]. Understanding risk can lead to understanding that climate change can result in costly impacts, which can lead to financial arguments in favour of adaptation[4,41], even in the absence of other external motivators[23]. Knowledge of effective adaptation measures can also overcome information barriers, and increase expectation of success, and in these ways helps enable adaptation actions[39,44]. Similar to financial resources, the influence of other external factors on these processes is important to consider, as is discussed below in *trigger events*.

Social capital (Networks)

The literature emphasizes the role of both bonding and bridging networks in enabling adaptation[4,21,32,46]. These social connections were most often discussed in relation to adaptation by local communities and local governments (Fig. 4).

Bonding social capital is shown to be important in building community resilience to climate shocks[46–48]. For example, community groups can be important in connecting vulnerable households to the resources and support they need to achieve sustainable adaptation[46]. Bonding social capital also helps foster collective action by increasing participation, cooperation, and problem solving[32,48]. Bridging social capital was shown to be important in systems of government, where networked individuals and organisations enable cooperation, knowledge sharing, and skill transfers that help promote adaptation[25,35,36,49]. Partnerships and networks can also help overcome human, financial, and knowledge resource barriers[25].

Effective communication

Closely related to the issue of consultation or community participation (below), the literature also highlights the need for clear and accessible communication of climate risk and adaptation information in enabling adaptation decisions[10,20,33,38,45,47]. Communicating information helps to build a mandate for change, alleviate opposition to change, and allows stakeholders to participate and contribute purposefully to adaptation plans[33,41,42,50].

Participation

Stakeholder participation as an enabler of adaptation is strongly tied to activities conducted by local governments (see Fig. 4), which likely reflects their role as key liaison to communities on new initiatives. The literature demonstrates that active engagement of stakeholders in decision-making processes (beyond more basic consultation processes) for adaptation policy and project development can promote the inclusion of different knowledges, perspectives, and experiences[10,26,32,42,50]. The evidence demonstrates that local people usually have the best understanding of the adaptation context, are best placed to anticipate and account for unintended effects of adaptation, and devise better responses[20,32,50]. Engagement can therefore improve the quality of decision-making processes, helping to assure the legitimacy and acceptance of adaptation amongst local communities[50], or clarify the expectations and objectives of the private sector[37]. Participation in a collaborative and open adaptation process can also build capacity[34,35].

Trigger events

Finally, the literature demonstrates that there are triggering events or windows of opportunity in which the environment is more favourable for the implementation of adaptation[20,25,27,30]. The influence of trigger events was particularly emphasised in reports of local-scale action[20,25]. Understanding their influence on private sector and national governments appears to be a significant gap in the literature (Fig. 4).

Certain events can trigger a change in the perception of climate risk and the need to adapt, and these most often include focussing events such as extreme weather and disasters but can also include other drivers such as Conferences of Parties to the UNFCCC, increases in funding, or energy crises[23,25,34,43,45]. The influence of trigger events is linked to risk perception and the tendency of people to distance themselves from climate risks over time[45]. The literature suggests that trigger events increase the salience and valence of climate risks, and so give leaders a stronger mandate to implement adaptation, innovation, and new communication strategies[4,45]. Whether these outcomes can be sustained during recurrent or increasingly severe climate events, political instability or other influential circumstances is, however, important to consider, though the literature reviewed here is not conclusive on this. While trigger events are therefore recognised as important for enabling adaptation, they are not sufficient by themselves[23], and change is greatly enabled when pre-determined ideas and plans are able to be drawn on at short notice. For example, in their study of adaptation in local government in South Africa, Spires, and Shackleton explore how it was important for the momentum created by certain events to be used to drive the institutionalisation of adaptation and/or long-term interventions rather than allowing reactive responses[25].

Other enabling factors

Adjacent to the idea of 'risk perception', several papers mention that experience with responding to climate variability can positively influence a community or person's sense of self-efficacy and in turn its propensity to adapt[21,34,44,45]. For example, in their study of fishing communities in Northeastern USA, Maltby et al. note that the community's historical experiences with adjusting to variability in fish stocks significantly influenced their ability to adapt to new challenges[21]. This suggests that experiential learning plays a role in enabling climate change adaptation and links to additional evidence that was not captured by this review, discussed below.

A number of other important enabling factors were identified in our review of the literature including mainstreaming: the practice of integrating adaptation policies and planning throughout government or business[42,51], laws and regulations: which have the power to both enable and constrain adaptation[37,42] and environmental values: which can influence a person to be more amenable to supporting adaptation actions[38,39]. The evidence found in this review for these remaining enabling factors was sparse and not sufficient to draw any conclusions.

Discussion

Interrogating the scope of the literature

It is possible that a proliferation of evidence about the enablers of adaptation comes from research at the local scale because this is where most action happens, which would be consistent with the common understanding that adaptation is a local issue that influences local populations and geographies

and requires planning at the local level[4,22,50,52]. Nevertheless, this bias in evidence seems to miss more than it includes given it is also widely understood (and is confirmed by the studies reviewed here) that adaptation is enabled and more effective when it is a collective activity that works across scales and sectors. The relative lack of studies from higher scales and other sectors therefore suggests a need for much more research with non-local government actors, and with civil society and private actors at all scales. Indeed, there are surprisingly few studies focused on not-for-profit or non-government organisations beyond those rooted in local communities[32]. Similarly, it is important to consider the drivers or enablers of individual adaptation actions and the role they may play in generating demand for adaptation policies and projects from the government. It is very likely that more detail on factors enabling adaptation for these actors, as well as national governments, could be found in grey literature case studies which were not reviewed in this paper.

Limitations to our approach may also have influenced this evidence about the enablers of adaptation, and the distribution shown in Fig. 4. In using Scopus we no doubt excluded articles from journals not listed in Scopus, which may explain the lack of literature from law, medical, or health journals. Thus it is likely that laws and regulations as enablers have been explained more than is been represented in our study. It is also possible that our use of keywords omitted some insights on enablers from environmental conservation and biological fields of study.

Given the overlap of research on adaptation with other disciplines, future work should seek to capture a wider body of literature from databases such as PubMed, and from those that better capture grey literature (such as Google Scholar). This is especially important for some fields such as law and health sciences which tend to have their own bespoke databases, and capture outputs produced by non-profit organisations, national governments, and the private sector. Alternate methodologies such as scoping review could also be used to identify relevant papers that use different language or keywords to discuss factors important to enabling adaptation, such as the paper by Porter et al. discussing the importance of high-level political support[53] or work on the importance of experiential learning by Baird et al. among others[54,55]. Finally, the link between adaptive capacity and actual adaptation implementation has not been well represented here and could be a focus of future investigations.

Considering barriers and enablers

As their counterpart, several papers take the approach of identifying enabling factors and barriers concurrently[20,25,30], and enabling factors are sometimes posed as the opposite of the well-researched barriers to adaptation. While there is undoubtedly a strong correlation between enabling factors and barriers to adaptation, our review suggests that enabling factors are not independent of one another and may not directly remove barriers. Instead, the existing literature suggests that to promote adaptation a combination of enabling conditions must be facilitated to create an enabling environment. This was demonstrated, for example, by Birchall and colleagues highlighting the need for other enablers alongside financial resources[28].

While our approach of grouping the literature helps to demonstrate that there are likely many combinations of associations between enabling factors and actors that mutually enable change, it was not able to fully capture these connections or highlight which factors are most influential, given the still small number of empirical studies from which to learn. These processes were explained well in two papers in particular[10,22]. Further work to translate this knowledge of enabling factors into a tangible and accessible resource of benefit to different actors would require frameworks or models that show how these sequencing of factors can affect change, as has been done extensively regarding barriers[5,6] or when developing decision making frameworks[56].

Conclusion

Understanding of how adaptation is enabled is constrained by the relatively small number of empirical studies that explain actual instances of adaptation. Our review finds that some factors seem to be more important than others, including resources (and especially money), knowledge of climate risks and responses, leadership, social capital, and the support of institutions in which adaptation actors are nested. Together, the literature suggests that to promote adaptation a combination of different enabling factors is necessary to create an enabling environment amenable to change. These findings have explanatory power when applied to adaptation at local and household levels, which is the focus of much of the research. There is a need, however, for further research that can explain the factors and processes that enable adaptation in institutions that are not 'local', in regional/provincial and national governments, in the private sector, and non-local not-for profit and non-governmental organisations.

Data availability

The authors confirm that all data generated or analysed during this study are included in this published article.

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Authors contributions

Tia Brullo: conceptualisation, methodology, data collection, analysis, writing, review and editing, final approval of completed version, project administration. Jon Barnett: conceptualisation, methodology, writing, review and editing, final approval of completed version, supervision, project administration, funding acquisition. Elissa Waters: conceptualisation, review, editing, final approval of completed version. Sarah Boulter: conceptualisation, review and editing, project management, funding acquisition, final approval of completed version.

Competing interests

The authors declare no competing interests.

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