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**Article title:** Adaptive Capacity: Exploring the Research Frontier

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**Abstract**

In the past 15 years there has been rapid growth in research on adaptive capacity. This paper critically reviews this literature, describing changes in the field over time, and highlighting the new frontiers in research. It explains how research on adaptive capacity began and remains heavily influenced by a one-size-fits-all assets based theory that assumes that adaptation action is commensurate with the possession of capitals. It explains how this theory has been unable to explain how adaptation is actually practiced across diverse contexts and scaled. The paper then highlights new research, particularly that which extends analysis to include psycho-social and institutional dimensions applied at smaller scales of analysis. This shift recognizes and helps overcome the limits of traditional approaches to adaptive capacity, but the field still lacks approaches that can explain the relationship between adaptive capacity and adaptation outcomes.

Drawing on findings from disaster risk reduction and behavioral science literatures, this paper outlines a framework comprised of six factors that better explain how capacity is translated and mobilized into action, namely: risk attitudes, personal experience, trust in and expectations of authorities, place attachment, competing concerns, and household composition and dynamics.

**Introduction**

It is inevitable that people and places will need to adapt to the impacts of climate change. Even if atmospheric greenhouse gas concentrations are stabilized as promised in commitments made under the Paris Accord, there is already a commitment to some degree of climate change, with warming likely to be at least 2.6°C above pre-industrial levels. There is much we do not know about how people and places will adapt to climate change, and how effective these responses will be. Research on adaptation is based on too few empirical studies to be able to build robust theories able to explain the drivers and constraints adaptation. Given the paucity of...
empirical studies of adaptation, the adaptation literature has tended to rely on assessing capacity to adapt as a proxy for actual adaptation.

Adaptive capacity is defined by the IPCC as ‘the ability of a system to adjust to climate change’.4 It relates to the factors that assist social systems to manage and adjust to changing environmental and socio-economic conditions. As well as being used as a substitute for understanding actually existing adaptation processes, assessments of adaptive capacity are also integral to understanding social vulnerability: for vulnerability is a latent condition that is a function of exposure to risk, sensitivity to risk, and the capacity to adapt to avoid, reduce, or capitalise on risk.5,6,7

For these reasons there is a growing body of research on adaptive capacity. By way of evidence, a search in Scopus for articles with ‘adaptive capacity’ in the title, and ‘climate’ in the title, abstract or key words reveals 282 articles, beginning with Yohe and Tol’s influential article in 20028, reaching 10 articles for the first time in 2009, and growing to 59 articles in the first 11 months of 2016. A review of this research is timely, not least because there has been a movement in the field in recent years that is pushing the frontiers of knowledge in new ways, yet which many researchers have failed to appreciate so that they continue to use dated explanations and methods. Our aim here is to provide such a review, charting the evolution of the field, describing the increasingly sophisticated theories that have been applied, and providing a framework to guide further research that seeks to advance knowledge about adaptive capacity at smaller scales of analysis.

First generation theory and method

As initially proposed, the concept of adaptive capacity has its roots in Sen’s capabilities theory and the sustainable livelihoods assessments that were subsequently developed in the 1980s and 1990s.9,10,11 When applied to climate change, this theory explains capacity to adapt as a function of entitlements to material assets and social opportunities, where more entitlements is read as more capacity to adapt to climate change, and fewer entitlements is read as greater vulnerability.12,13 For example, the IPCC’s Third Assessment Report states that ‘those with the least resources have the least capacity to adapt and are the most vulnerable.’4

There is no single method to assess adaptive capacity following this theory, and studies apply different factors and indicators to capture the outcomes of entitlement processes, making it difficult to compare adaptive capacity across studies.14 Nonetheless, the five capitals used to assess sustainable livelihoods tend to most often be used as the basis for assessing adaptive capacity, namely access to:

- **Natural capital** to provide the natural resources necessary to sustain a livelihood to adapt (such as land, water, vegetation for farming practices);9,15
- **Physical capital** to provide the necessary infrastructural support (such as roads and irrigation) and technological solutions to impacts;16,17
- **Financial capital** to pay for adaptation;8,18
- **Social capital** to provide the social bonds and networks to assist adaptation;19,20,21
- **Human capital** to provide the physical and mental resources to adapt (education and health)22,23

These five capitals form the basis of what is sometimes called ‘generic’ adaptive capacity - the factors required to adapt to a (generic) range of threats.24 Additional factors to explain generic adaptive capacity sometimes include **institutions, governance, and access to knowledge** as these address the information and process whereby entitlements are activated and adaptation is practiced.10,25,26,27,28

One of the challenges with the first generation of adaptive capacity studies is their application across diverse scales and risks, as Katherine Vincent was quick to note.12 Capabilities based theory and associated methods apply most meaningfully to households, and have diminishing explanatory power when applied to progressively larger institutions: thus it may have some relevance when...
applied to small villages, and very little relevance when applied to countries. It may also explain little about the behavior of different individuals within households whose actions shape the particular adaptations of any given household institution. Further, adaptation is perhaps not well understood as a generic task but rather as specific actions in response to specific risks. Therefore, assessments of generic capacity applied across large areas or to diversely scaled institutions may explain very little.

Nevertheless, assessments of generic adaptive capacity across broad spatial scales using aggregate indicators are common. This is a tradition of research that began when international climate change negotiations were concentrating on defining global measures to understand the extent of the climate threat and on galvanizing political action to reduce climate vulnerability. This created a demand for adaptive capacity assessments at national and global spatial scales, which have since continued apace.

Many assessments of adaptive capacity at large scales use aggregated and secondary forms of data such as Gross National Income (to demonstrate wealth), regional literacy rates (to demonstrate education), government health expenditure (to demonstrate institutional stability), and infant mortality rates (to demonstrate human capital). The indicators used to inform these assessments are typically weighted equally to establish an index of adaptive capacity. Adaptive capacity can then be mapped at large spatial scales (regional, national and international) and used to classify social systems using a simple set of categories (such as high, medium or low capacity). This approach is comparable to that of the Human Development Index, and indeed many other indexes, which all suffer from the same sorts of criticisms concerning subjective criteria for weighting, redundancy among variables, and the unsuitability of such measures for making and measuring policy. Whilst highly salient in policy, the reliance on large scale aggregated data means that these assessments are not sensitive to the differential, context-specific nature of adaptation, and as such they obscure more than they show the differences in places and communities. Perhaps the most important limitation of these first generation assessments of adaptive capacity is the theoretical assumption that capacity translates into action. This is an assumption that remains to be properly tested. There are indeed many studies of responses to current or past stresses as a proxy to understand adaptation which suggest that adaptation practices arise from far more nuanced and relational processes in which stocks of assets are not the only or the most important explanatory variable. Some of these studies assess the effectiveness of initiatives to alleviate vulnerability and most conclude with recommendations for adaptation that correspond with sustainable development goals.

Importantly, a few studies show that higher capacity households are not adapting as well as households with lower capacity. For example, in a study in Northern Burkina Faso, Nielsen and Reenberg found that households from the traditionally disadvantaged ethnic group Rimaiibe were adapting better than the Fulbe, an ethnic group with traditionally higher social standing and wealth. The Rimaiibe engaged in multiple livelihood strategies which enabled adaptation whereas the cultural values of the Fulbe, such as valuing living in isolation in the bush rather than the village, constrained their adaptation. Likewise, a study of artisanal fisheries in South India demonstrates that the most vulnerable households were not those that were poorest, but rather wealthier households that were dependent on fishing as their single livelihood strategy. Research in developed countries also demonstrates that adaptation is not occurring in places where the theory of adaptive capacity suggests adaptation it should. For example, an extensive review of over 300 examples of adaptation in the United Kingdom found that over half of the adaptations were research activities which demonstrated an investment into the intention to adapt rather than adaptations per se. Ford and colleagues came to similar conclusions in their review, arguing that adaptation in developed countries is heavily constrained due to a lack of political will to...
address climate change and an apparent ‘mismatch between national statements and local action’. In Australia Waller and Barnett argue that adaptation is the subject of rhetoric more than action, and that investments in research dominate, because these enable hard decisions to be deferred. Restrictive institutional mechanisms and low political will have been identified as significant barriers to adaptation in the USA, leading Moser to argue that the USA is ‘ill-equipped’ for climate change adaptation despite ‘assumptions that developed nations like the U.S. face relatively low vulnerability and possess high adaptive capacity’.

So, if people with seemingly low adaptive capacity are adapting, and people with high adaptive capacity are not adapting, then the relationship between adaptive capacity and adaptation is far from direct, and theories and evidence that can better explain the association are required. Two empirical studies explicitly assess adaptation alongside adaptive capacity such that they can examine the extent to which capacity explains adaptation. Grothmann and Patt propose a Model of Private Proactive Adaptation to Climate Change (MPPACC) which draws on Protection Motivation Theory to assess a range of socio-cognitive factors (such as perceptions of climate risk and adaptation options, cognitive biases). What is significant about this study is that the authors found that the MPPACC approach was fairly effective in explaining adaptation, and that it was more effective than basic socio-economic measures comparable to traditional adaptive capacity assessments. This assessment departs significantly from traditional approaches to assessing adaptive capacity, re-orienting the assessment from a top-down structural approach to an understanding of adaptation that is contingent on social values and individual perceptions.

Similarly, Truelove and colleagues systematically examine the extent to which a formal approach to assessing adaptive capacity is effective in explaining the adaptation intentions of rice paddy farmers in Sri Lanka. In this study the researchers apply a Risk, Coping and Social Appraisal (RCSA) model of adaptation decision-making (which includes drought risk perceptions, efficacy beliefs, village identification and perceived social norms) alongside an assessment of assets and demographic factors (consistent with traditional adaptive capacity models). Like Grothmann and Patt, they found that their psycho-social model was more explanatory of people’s intentions to adapt than the assets and demography model. Indeed, they found that efficacy beliefs were the strongest predictor of adaptation intentions.

The second generation: from assets to mobilisation

It seems then that asset based theories and methods are insufficient to explain or anticipate adaptation. There is a gap between capacity and action that requires greater understanding, and new research has been advancing this by focussing on the factors that mobilise capacity such that change is enacted. This shift to focus on mobilising capabilities is captured in the definition of adaptive capacity by Nelson et al, as the ‘preconditions necessary to enable adaptation, including… the ability to mobilise these elements’. They contend that adaptive capacity must be activated or translated into action through social or biophysical triggers. Pelling and High likewise acknowledge the difference between latent capacity and mobilising capacity.

Much of the focus of this research is on psycho-social factors. Gifford and colleagues provide a comprehensive review of various theoretical frameworks, such as protection motivation theory, the theory of planned behaviour, the theory of reasoned action, the norm activation model, and value-belief-norm theory. They contend that no model seems sufficient to account for the complexity of behaviour, but they all demonstrate the importance of psycho-social factors as elements of adaptive capacity.
A number of studies focus on the psycho-social attributes necessary for adaptation. For example, Jain and colleagues examine perceptions of weather variability and risk taking behavior alongside assets-based components of capacity. Marshall and colleagues assess Australian farmers’ perceptions of risk and uncertainty, skills for planning, ability to cope with change, and their interest in change. Grothmann and Patt examine risk perception and also perceived adaptive capacity, arguing that individuals’ self-efficacy and assessment of the costs and efficacy of adaptation options needs to be considered in assessments of adaptive capacity. Other studies examine the role of trust in government. In each of these studies the interpretation of adaptive capacity is not so much about assets or resources but rather attributes that enable social systems or actors to adapt. These studies are important contributions, but they are constrained by a lack of evidence of adaptation, and this lack of evidence on the dependent variable limits their ability to test explanations of the capacity-adaptation relationship. Nevertheless, they point to a new frontier in research on adaptive capacity, that focuses on psycho-social factors, often applied in cases of adaptation to specific rather than generic risks.

One way of overcoming the limitations of existing research, and to advance this new second frontier in adaptive capacity research, is to draw on studies from other disciplines. The wealth of empirical studies in the disaster risk reduction and behavioral science provide insight into why social systems might not prepare and respond well to extreme events despite seemingly high adaptive capacity. There have been moves to integrate this learning but it remains on the periphery of adaptation scholarship. Assuming disaster management can be taken as an analogue for climate change adaptation, this research can help advance understanding of the capacity-adaptation relationship. Working from this assumption, our comprehensive review of studies on household action in response to extreme events points to several important mobilising factors that help explain why households do not apply their capacity to adapt, or why households with little capacity still manage to adapt effectively. We focus on households as this is at this scale in which climate risks are often most acutely experienced, and they are a critical locus of decision-making around adaptation. The mobilising factors now discussed are by no means a definitive list, but it is hoped that they will help to advance theorizing and further research about the capacity-adaptation relationship.

Risk attitudes

Risk attitudes consist of the ways in which individuals perceive the probability and severity of climate risk (risk appraisal), the way in which they perceive their capacity to perform those options (self-efficacy), the perceived costs and benefits associated with adapting (adaptation appraisal), and cognitive biases such as wishful thinking, denial, fatalism (avoidant maladaptation). Perceptions of risk and self-efficacy play an important role in shaping individuals’ engagement with adaptation and disaster risk reduction. Distorted beliefs in people’s own ability to manage climate stress and impacts can be a barrier to adaptation. In a study of the elderly and their responses to heat wave risk in the UK, Wolf and colleagues found that elderly respondents acknowledged that elderly people were vulnerable to heat waves but they did not personally identify themselves as old or vulnerable. Respondents’ distorted perception of their self-efficacy was associated with low uptake of self-protection measures, leading to exacerbated vulnerability during heat wave events.

The gambler’s fallacy is a good example of a cognitive bias that affects individuals’ assessment of the probability of a climate risk or natural hazard, in which an individual reasons that if an event has occurred recently then it is unlikely to reoccur in the immediate future. The normalization bias demonstrates how cognition can influence an individual’s assessment of their ability to cope with climate impacts. An individual who has coped with minor cyclone impacts, for example, may infer that they are able to deal with future cyclones to the extent that they may disregard disaster warnings. Optimism bias describes a cognitive process in which people underestimate the likelihood of negative events affecting them personally, to the extent that they do not take adequate protective measures. Wishful thinking, denial, and fatalism can also be very powerful.
constraints to individual action in response to climate risks. In the wildfire literature attitudes such as ‘it won’t happen to me’ (denial and wishful thinking) or ‘it will go up in flames anyway so why bother’ (fatalism) have been identified and provide some indication as to how households might be failing to adapt to known climate risks. Drawing on these studies, it is easy to imagine an individual with high capacity that does not adapt to known climate risks because they simply don’t believe they are exposed to the risk. Likewise, we can imagine someone with a high level of concern about climate risk who prioritizes adaptation investments despite their low capacity.

Personal experience

Personal experience of climate risks and hazards is a significant factor shaping individual risk perception, although the nature of that influence is contested. Some studies demonstrate that previous experience of a hazard increases people’s preparations, and one study finds no correlation between experience and preparedness. Mortreux and Barnett find an association between length of time spent in a climate risk area and risk perception, with older Tuvaluans drawing on past experience to inform their perceptions of climatic change. Gow’s study of wildfire preparedness suggests that it is the physical closeness and intensity of hazard experience that influences preparedness, with more intense experiences resulting in higher preparedness levels. Likewise, a case study of household adaptation to flood risk in Guiana and Suriname found that lower income households were more engaged in adaptation compared to wealthier households as they had incurred damage to their housing and health from past flood events. Elsewhere however, the intensity of previous experience has been shown to reduce preparedness, where people become fatalistic and feel that no action could prepare them for what they regard as a random and uncontrollable risk. This was found to be a significant reason for inaction for wildfires in Michigan and in Western Canada, despite the seemingly high adaptive capacity of these communities. The time that has passed since the hazard experience is also important, with preparedness levels increasing immediately after the event but returning to lower levels after a few years. This is concerning given that hazard risks often reduce immediately after a risk and increase again several years later (flood and cyclone events usually have a lengthy return period, and wildfire events worsen where vegetation has had time to grow back).

In summary, it is difficult to conclude from the literature what influence previous experience has on adaptation, however, it is clear that in some cases it can impede adaptation. Personal experiences of hazards or climate risks are more likely to become a barrier to adaptation where the experience was not very intense such as near-miss experiences, where the experience was a number of years in the past, and where the experience was so intense that people felt they had little or no control over the situation. People’s capacity may remain fairly static over time, however their commitment to adaptation might change substantially depending on their changing experiences and interpretations of climate risks.

Trust and expectations in authorities

A number of institutional constraints to adaptation have been identified. A lack of trust in authorities has been associated with low levels of household adherence to advice from authorities regarding basic preparations for known hazards. Conversely, high levels of expectations of institutions and a belief in the capacity and responsibility of authorities to protect properties have been found to result in lower levels of household adaptation. O’Neill and Handmer’s analysis of fatalities from the Black Saturday wildfires in Victoria, Australia, shows that a number of individuals were waiting for a direct warning from fire authorities before deciding to evacuate, suggesting complacency and a deferral of responsibility to trusted authorities. It should be noted that this complacency occurred in relatively wealthy communities where adaptive capacity is seemingly high based on standard measures.
The lessons from the empirical studies in the wildfire literature can be extended to the way in which households are likely to adapt to known climate risks. The literature indicates that the relationship between communities and authorities is fraught. It is difficult to achieve a culture of trust in authorities that avoids community complacency about wildfire risk. With the exception of one study of over-zealous homeowners, complacency in adapting to wildfire risk seems to be the dominant response, either because communities place too much trust (and expectations) in authorities, or because communities do not trust authorities enough to comply with advice.

**Place attachment**

In environmental psychology and geography, place attachment describes the emotional ties individuals have to specific places. Time spent living in that place, identification with the broader community, and dependence on natural resources found in that place are several factors seen to influence emotional ties to place. The economic and social factors that ‘root’ someone to a particular place are particularly important.

The adaptation literature has tended to frame place attachment as ‘inherently positive’ with little suggestion that ‘one can be excessively attached to a place’. The literature has examined how climate change poses risks to communities that are emotionally tied to specific places, such as the psychological risks that relocation poses for communities living on coral atolls. The literature also examines the importance of ‘bringing climate change home’ so that climate risk is made relevant to people in the places they value rather than being perceived with moral and psychological distance. Elsewhere the adaptation literature suggests that place attachment may play an important role in motivating people to act on climate change. For example, in a study on responses to cyclones and flooding in Queensland, Australia, Marshall and colleagues find that those fishermen and tourism operators with strong attachment to place were more likely to plan for extreme events. This was linked with their occupational dependence on natural resources.

In contrast, the disaster risk reduction literature demonstrates that attachment can act as a barrier to household preparation for known hazards. Again, using the example of wildfire, people’s desire for a private home tucked away in forest, often on scenic ridge lines, heightens the risk of wildfire, yet for many homeowners this risk is justified because they value living in these places and are attached to the lifestyles they offer. Emotional attachment to trees and other landscape features may prevent people from removing trees close to their house, even if they pose significant risk in a wildfire. There may be conflict between wildfire risk reduction aims and other needs, such as planting or keeping trees close to houses to provide shade and windbreaks.

This literature also speaks to the importance of financial investment and housing status in shaping how households prepare for wildfires. A number of studies find that homeowners are far more likely to take actions to protect their homes from wildfire than rental-occupiers. These findings could be taken to support the theory that high adaptive capacity leads to higher adaptation, however, financially invested homeowners may also put themselves at risk in order to save their property. Home-owners may regard their home as a ‘physical expression of self, of achievement, of one’s way of life’ and a study by Harries suggests that the desire to feel secure within this construct of ‘home’ may be so strong that people overlook actual risks to their physical security.

**Competing concerns**

The presence of competing concerns can be a major barrier to adaptation. In the psychology literature, Linville and Fischer describe that people have a limited capacity to worry such that increases in worry about one issue in life will lead to a decrease in worry about other issues. Ziervogel’s study of South Africa is a good example of this in which the community faced multiple stressors: water shortages, unemployment, sanitation and flood impacts along with HIV/AIDS, and...
other diseases.\textsuperscript{121} It is understandable that in the midst of significant stressors, adapting to climate change is not a priority, particularly given climate change is regarded as something that will happen in the future, and so is discounted heavily.\textsuperscript{92} In wealthier industrialized contexts, household concerns may seem slight in comparison, nonetheless worry is relative to people’s lived experience, and stressors such as mortgage repayments may be sufficient to decrease worry about known hazards and climate risks. Eriksen and Gill found, for example, that women are less likely to be involved in wildfire preparedness as they often have multiple responsibilities (looking after children, domestic work, paid work), and so have less time and energy to commit to household wildfire preparation.\textsuperscript{116} The literature suggests then that the presence of competing concerns significantly constrains adaptation, even where households may have relatively high adaptive capacity.

**Household composition and dynamics**

Household composition and dynamics have not been considered as a possible barrier in the adaptation literature, however, there are studies in the DRR literature that suggest that the dynamics within a household - how decisions are made, and adaptation actions performed or carried out – can to some extent explain household adaptation. The presence of children within a household is associated with higher levels of hazard preparedness.\textsuperscript{122} Gender has been found to be a good predictor of people’s attitudes towards natural disasters.\textsuperscript{123,124,125} Wildfire preparations are largely regarded as “men’s business” in which women are less likely to be involved and less empowered to take defensive action during fire events.\textsuperscript{124} Differences in opinion within households about how to respond to wildfire, including decisions about when to evacuate, are often gendered and may lead to serious disagreements both in preparation stages and as fire approaches. It is reasonable to conclude from the literature that household composition and dynamics can, in some cases, act as a barrier to adaptation. Differences of opinion within and between households about how to manage known climate risks may constrain adaptation by delaying or preventing important decisions. Having children in a household may increase the attention households pay to adaptation, although it is also possible that it would reduce action due to competing concerns.

The five factors reviewed here help to explain why high capacity social systems may resist adaptation, and why low capacity systems may adapt well despite having a low resource base. This attention to mobilizing capacity provides a strong starting point for developing a deeper understanding of adaptation that can extend first generation assessments of adaptive capacity. Where asset-based capacity components are seen to assist social systems in adapting, the factors identified here interfere with the capacity-adaptation relationship. We can imagine individuals within a household, for example, who perceive there to be little climate risk, who hold high levels of trust in authorities to manage whatever risk there is, and who have little time to engage in simple activities to adapt to known climate risks. This household may have very high levels of adaptive capacity based on standard measures, yet not be adapting.

**Conclusion**

Adaptation is a complex social phenomenon in which climate risk is negotiated and acted upon in diverse social and environmental contexts. This complexity confounds theories of adaptation, with many researchers instead focusing on adaptive capacity, and assessing it using aggregated data across large scales. Whilst there is little evidence to compare adaptive capacity with actual adaptation outcomes, that which does exists does not support the assumption that systems with high adaptive capacity will adapt well, and that systems with low adaptive capacity are more vulnerable.

A second wave of research on adaptive capacity is highlighting the way psycho-social factors influence the ways in which assets are (and are not) mobilized to affect adaptation actions. This paper has drawn from wider literatures to help consolidate understanding of these mobilizing factors.
factors at the household scale, showing that risk attitudes, personal experience, trust and  
expectations of authorities, place attachment, and competing concerns all influence adaptation  
actions in important ways. Further empirical research is necessary to understand the relationship  
between adaptive capacity and adaptation, the conditions under which systems are most likely to  
apply their capacity to adapt, and the extent to which mobilising factors, such as those highlighted in  
this paper, are helpful in understanding adaptation.

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