

Article title: Why is socially-just climate change adaptation in sub-Saharan Africa so challenging? A review of barriers identified from empirical cases

First author: Full name and affiliation; plus email address if corresponding author

[Sheona Shackleton*, Department of Environmental Science, Rhodes University, s.shackleton@ru.ac.za]

Second author: Full name and affiliation; plus email address if corresponding author

[Gina Ziervogel, Department of Environmental and Geographical Science, University of Cape Town]

Third author: Full name and affiliation; plus email address if corresponding author

[Susannah Sallu, Sustainability Research Institute, School of Earth and Environment, University of Leeds]

Forth author: Full name and affiliation; plus email address if corresponding author

[Thomas Gill, Office of International Programs, College of Agricultural Sciences, 106 Ag Admin Bldg, The Pennsylvania State University, University Park, PA. 16802]

Fifth author: Full name and affiliation; plus email address if corresponding author

[Petra Tschakert, Department of Geography and the Earth and Environmental Systems Institute, 322 Walker Building, The Pennsylvania State University, University Park, PA 16802]

Abstract

To enhance understanding of the process of climate change adaptation and to facilitate the planning and implementation of sustainable adaptation strategies deeper consideration of the factors that impede adaptation is required. Barriers to climate change adaptation are, consequently, being increasingly reported. But, despite this progress, knowledge of barriers that hamper adaptation in developing countries remains limited, especially in relation to underlying causes of vulnerability and low adaptive capacity. To further improve understanding of barriers to adaptation and identify gaps in the state-of-the-art knowledge, we undertook a synthesis of empirical literature from sub-Saharan Africa focusing on vulnerable, natural resource dependent communities and livelihoods. Our review illustrates that: 1) local level studies that reveal barriers to adaptation are diverse, although there is a propensity for studies on small-holder farmers; 2) many of the studies identify several barriers to adaptation, but appreciation of their interactions and compounded impacts remains scarce; and 3) most of the barriers uncovered relate broadly to biophysical, knowledge and financial constraints on agricultural production and rural development. More hidden and under-acknowledged political, social and psychological barriers are rarely mentioned, unless captured in studies that specifically set out to investigate these. We finish our review by highlighting gaps in understanding and by suggesting future research directions, focussing on issues of social justice. We argue that research on barriers needs to start asking why these barriers emerge, how they work together to shape adaptation processes, who they affect most, and what is needed to overcome them.

Introduction

Researchers, policy makers and practitioners are increasingly acknowledging that neither autonomous nor planned adaptation to climate change is necessarily materialising in the ways expected or at the pace desired.^{1,2,3} Practical examples show that adaptation, if it is to effect socially equitable and environmentally sustainable change on the ground, requires so much more than simply providing the right technology, information, and sufficient funding; the dominant approach to

date.^{1,4,5,6} For instance, there is much evidence that poor people often face serious structural, cultural and social hurdles in their own efforts to respond to changes and stress, while planned attempts to support adaptation and strengthen adaptive capacity often fall short for assorted reasons that can range from the organisational to the psychological and institutional.^{3,7,8,9,10} Consequently, most climate change scholars now accede that adaptation is a complex and continuous process, influenced by a variety of factors and conditions at multiple scales, some of which may act individually or together to hinder this process.^{6,11} It is this perspective that is recognized in a recent body of theoretical literature on barriers (referred to as constraints in Chapter 16³ of the IPCC's AR5) and limits to climate change adaptation, with several authors developing organising typologies and frameworks that endeavor to make greater sense of these multiple and, often, hidden obstacles.^{6,8,10,11,13,14,15,16,17,18,19,20,21,22} In these new framings social, governance and cross-scale factors are highlighted.

However, despite this increased attention to the conceptual dimensions of adaptation and the factors that impede it, there have been few efforts to synthesize findings from empirical studies and projects, especially in the global south.¹⁰ In this review, we respond to this need and present a synthesis and analysis of literature on barriers to climate change adaptation in sub-Saharan Africa (SSA); a setting that allows for in-depth exploration of the complexity of adaptation challenges within a highly dynamic and challenging climatic and socio-economic context. SSA is typified by persistent poverty and socio-economic inequality, low levels of development, high dependence on climate sensitive livelihood sectors, limited economic capacity and countless governance and institutional challenges²³, resulting in low adaptive capacity and a significant adaptation deficit.²⁴ New risks from climate change include warming and drying, more intense and prolonged droughts, and more floods.^{23,24} These changes will have major impacts on agriculture, fisheries and food security across the region, and feedback into the development system, undermining progress in dealing with poverty and low levels of human development.²³

Consequently, we believe that an analysis of barriers to adaptation in the region can be constructive in providing a more nuanced understanding of the types of barriers that have been found, why and under what conditions they materialize, who is primarily affected, and how entrenched they are. Such a consolidated perspective is necessary if barriers are to be strategically dealt with and effort made to overcome them, especially in situations where emerging or reinforced inequalities create new vulnerabilities.¹²

In the next section, we provide some further background on barriers, highlighting the various complexities involved in unravelling what hampers adaptation. We then outline the framework for our analysis of the literature, as well as propose a system for organising our findings based on groupings of barriers. We employ this categorisation to discuss the various barriers identified in the cases we review, illuminating the scope of existing work on barriers to climate change adaptation in SSA, as well as what the findings mean for adaptation. We conclude by highlighting gaps in our current understanding, and suggest future research directions and emerging research questions.

BACKGROUND, FRAMING AND APPROACH

Setting the scene: background, concepts and complexities in understanding adaptation and barriers

In this paper we draw on literature that relates specifically to human adaptation to climate change and that includes responses that reduce vulnerability to current as well as future climate variability and change. Human adaptation is defined as “the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities” (p. 3).²²

Barriers and limits are the climate and non-climatic factors and conditions that may hamper or prevent this adjustment.¹⁰

Moser and Ekstrom¹¹ recognize that the process of adaptation involves multiple linked steps at several scales, including identifying and learning about risks, evaluating response mechanisms, creating enabling conditions, mobilising resources, implementing adaptation options, and revising choices with new learning. They argue that barriers can emerge at each of these steps and that there is a need for improved knowledge of these barriers. For instance, the best technical solutions may be ignored or rejected if cognitive, behavioral and cultural barriers exist regarding perceptions of risk, the need to adapt and the willingness to accept change. In other cases, the ability of certain individuals or actors to employ particular forms of adaptation may be impeded by regulative controls, societal norms and various forms of institutional inequities. While such barriers may delay, divert or block adaptation and make it more difficult to plan and implement sustainable adaptive action²⁵, they are seen 'in principle' to be surmountable (p. 22027).^{11, 16}

However, if overcoming barriers is costly, beyond the capacity of actors, or biophysically impossible (e.g. such as temperature thresholds for crops or sea level rise), these barriers could present as limits or absolute obstacles. Similarly, complex combinations of social, biophysical, economic and political barriers acting together across scales may also pose a limit to adaptation.^{7,21,26} Dow et al.^{16,26} in their conceptualization of adaptation and limits within an actor-centred, risk-based framework propose that the purpose of adaptation is to reduce risks to valued social objectives (health, safety, security, a livelihood), and thus define a limit as "the point at which an actor's objectives cannot be secured from intolerable risks through adaptive actions" (p. 387). Limits thus are seen to represent thresholds or intolerable risks beyond which existing activities and system states cannot be maintained or modified¹¹ with the result that incremental adaptive actions, or the protection of what is valued, is not possible, especially for the most vulnerable^{3,16,27}. In these situations "carefully planned and managed transformational adaptations on the basis of redefinition of objectives by actors" are needed (p. 384).¹⁶ Transformative adaptation or a process of transformation (a shift to a new state) may include access to particular forms of state support, migration, social protection or major structural reform to provide alternative livelihood pathways and options.^{16,27,28}

While recognising that barriers to adaptation are almost always context-specific and dependent on normative judgments⁶, attempts have been made to develop categorisations that distinguish several types of barriers¹⁹, with some of these barriers being relatively obvious (e.g. financial, technical), while others are more hidden and often forgotten (e.g. social cultural, political-economic). Adger et al.⁸ highlight how social cultural barriers, typically endogenous to society, are easily missed as they are socially constructed and highly subjective, contingent on individual and community knowledge, personal and societal values⁴, perceptions of risk and loss, and power structures.¹⁶ The focus on technical adaptation strategies frequently fails to take into consideration such important social contexts.²⁸ Furthermore, if sustainable adaptation (which according to Eriksen and colleagues is adaptation that contributes to socially and environmentally sustainable development pathways)⁵ is to be achieved, then more attention needs to be paid to institutional, political, discursive, structural and contingent barriers that may prevent equitable and socially just adaptation and exacerbate vulnerability for some people. For example, strong vested interests can form a barrier to more sustainable forms of adaptation through the exclusion of some individuals and social groups.^{5,30}

The barriers categorisations that have been developed so far, thus, help to provide a systematic way to explore the factors and conditions that may hamper society, governments, communities and individuals adapting to perceived and future climate variability and change.^{15,19} But, as Beisbroek et al. (p. 1123)¹⁰ highlight, while such classifications "provide a useful structuring heuristic to guide scientific enquiry" most empirical studies of adaptation, including the majority reviewed for this

synthesis, recognize several barriers that cut across all these categories making it difficult to classify them. In reality the boundaries between categories are much more subtle than many of the typologies imply. Also, what is or isn't a barrier can become blurry. For example, are the starting conditions that undermine adaptive capacity (often referred to as an adaptation deficit or low generic adaptive capacity³¹) a barrier? Communities themselves often don't distinguish between the stressors that impact their livelihoods and the factors that prevent them responding to shocks and risk³². Biesbroek et al. (p. 1119) argue that the list of possible barriers is "seemingly endless".¹⁰

Further complicating this story is the heterogeneous ways in which barriers operate in different contexts and the cumulative effects of barriers across scales.^{33,34} Some factors may or may not hamper adaptation depending the type of adaptation, the actors involved and their value systems, and the regions and contexts covered. For example, the circumstances in which different types of barriers to adaptation emerge or are even thought of as barriers can vary according to whether adaptation is planned or autonomous, anticipatory or reactive, long-term or short-term, private or public and by the type of strategies employed – i.e. whether related to mobility, exchange, rationing, pooling, diversification, intensification, innovation or revitalisation.^{29,35} In terms of anticipatory adaptation, much of the literature shows that some experience of change, often extreme events, or clear evidence of a threat is a critical trigger for adaptation action and that without such experiences strong cognitive and psychological barriers to making adjustments are likely to exist.^{36,37,38} How climate change 'sits' in relation to other, possibly more immediate and context specific stressors on people's lives is also an important factor influencing the decision to take action or not in response to climate stimuli; often other problems may take priority particularly in poor regions like SSA.^{37,39,40} Further, some factors and conditions may constitute barriers for some actors and not others, with poor and marginalized people in less developed countries likely to face more barriers to adaptation. The issue of equality is an important one and influences who experiences what barriers. Interacting contextual factors such as culture, governance systems, health of ecosystems and their services, social networks and political context are also critical to consider as they will influence how barriers emerge in local places. Indeed, some of these contextual factors and conditions are often reported as barriers themselves. Islam *et al.* (p, 208)⁴¹ recognize this when they argue that the barriers that hinder adaptation are a function of "the people involved, the nature of the specific systems involved and/or the larger context in which the people and systems operate", while Biesbroek et al. (p. 1119)¹⁰ view barriers as "factors and conditions that emerge from the actor, the governance system or the system of concern". Barriers therefore need to be seen as part of a complex of factors that interact to influence adaptation.

Our framing and approach to the review

We use a meta-theoretical approach in our review. We recognise the links between low levels of development and the notion, albeit somewhat problematic, of an adaptation deficit in Africa^{24,42}. We think about barriers primarily in terms of how they hamper the building of both generic adaptive capacity (associated with fundamental human development goals) and specific adaptive capacity (associated with climate risk management).^{31,43} Our overarching framework is one of social justice that draws attention to the structural and relational drivers of inequalities, marginalization, and differential vulnerabilities that shape adaptive capacities and barriers for specific individuals and groups of people, as reflected in the work of Lemos et al.⁴³, Pelling⁴⁴, Ribot⁴⁵ and Tschakert et al.⁴⁶ Ribot⁴⁵ argues for the need to consider the underlying social-political causes of barriers to adaptation for the poor, specifically those which limit access to representation, education, healthcare and social security. Similarly, several authors^{5,47,48,49} highlight how issues of social and intergenerational equity are key if 'sustainable adaptation' is to simultaneously address both climate change and poverty and development concerns. However, Brown⁴⁸ cautions that the vagueness of this term may result in it being used to justify existing policies and approaches, when what is actually required is

“fundamental institutional reconfiguration in support of long-term equity and resilience” (p. 29). This perspective is very different to advocating for the mainstreaming of adaptation into current development approaches. Our framework also reflects the conceptualizations of multidimensional vulnerabilities and inequalities, as well as poverty traps, as described in Chapter 13 ‘Livelihoods and Poverty’⁵⁰ in the IPCC’s AR5, and the categories described in Chapter 16 ‘Adaptation Opportunities, Constraints, and Limits’³ in the same report. In our analysis, we focus on barriers or constraints, rather than limits *per se*, since these are more common and more frequently covered in the literature, although we acknowledge where there may be limits to adaptation.

In terms of locating papers and cases, we undertook some initial database searches to obtain literature on barriers and constraints to climate change adaptation, but few empirical cases were retrieved from this search as many of them do not use barriers and constraints terminology. Instead we employed a snowballing technique, where one case or paper led us to the next until we felt we had exhausted the literature. As a result, the studies represent both the peer-reviewed and grey literature. Altogether we reviewed 64 case studies that cover various aspects of perceptions and responses to climate variability and change. These are summarized in Table 1. Many of them have a focus on agriculture and small-holder farmers, with much fewer urban studies. In terms of geographic spread, the majority of cases represent work from Southern and Eastern Africa (39 and 17 respectively), with only 14 from West and Central Africa. While our focus was on place-based community level studies and on the livelihoods of poor and marginalized people whose experiences of barriers are likely to be particularly acute¹⁷, we did consider cross-scale barriers that affect local dynamics. We also prioritised holistic studies rather than specific sectors (e.g. water, fisheries, etc. for which there is more extensive literature) or private commerce. Furthermore, we aimed to highlight cases that examine less commonly mentioned social barriers (often embedded in complex livelihood contexts). Many of the studies and projects reviewed reported multiple barriers, although relatively few were designed to explicitly research barriers to adaptation. Instead, the identification of individual or simultaneous barriers (commonly termed constraints in the reviewed literature) emerged in the course of answering other research questions. In contrast, studies specifically using a barriers lens tended to focus on one type of barrier.

[INSERT TABLE 1 ABOUT HERE]

Given the background to barriers and our framing outlined above, we organise our synthesis and analysis around four main sections related to four categories of barriers based on the emerging literature^{7,8,15,19,20,21}, our own understandings and experiences in SSA, and the findings from the review. We argue that it is neither straight forward nor particularly essential to categorize barriers due to real life overlaps, and so we keep the categories broad and include a final section that captures some of the constraints on adaptation that are complex, cumulative, interlinked and not easily pigeon-holed. Our categories include: 1) physical (e.g. ecological, climatic), 2) financial and technological, 3) social, cultural and informational (e.g. normative, cognitive, institutional, cultural, epistemological, economic, discursive, political, governance) and 4) contingent, cumulative and cross-scale (factors and conditions that cannot be separated out, e.g. the interaction of multiple stressors experienced in particular contexts, historical processes and path dependency, role of wider influencing systems and cross-scale interactions). These four categories are further explained in Table 2. Within the last category we emphasize the importance of considering cross-scale barriers that shape adaptation at the local level. Adaptation decision-making occurs in a multi-scale context with decisions at international, national, provincial and municipal level influencing options and actions at community level.³³ Cross-scale barriers are strongly intertwined with policy, institutional, political and discursive barriers, often in relation to a lack of collaboration across tiers of government, sectors (government, NGO, business) and disciplines (physical and social science).^{9,34}

With regards to reporting the findings, we first consider studies that predominantly relate to small-holder farming which describe multiple barriers to adaptation, and include several of the barrier categories outlined in Table 2. Following that, we zoom into the last two categories of barriers in Table 2, namely social, cultural and informational and contingent and cross-scale, as less explicitly discussed dimensions of barriers, yet, highly relevant for community-based sustainable adaptation.

[INSERT TABLE 2 AROUND HERE]

EVIDENCE OF BARRIERS TO ADAPTATION IN AFRICA: WHAT DO WE KNOW?

Multiple barriers to responding to climate variability and change amongst small-holder farmers

Given the centrality of rainfed agriculture in African livelihoods, numerous studies on how small-holder farmers have responded to climate variability and change, including the factors that inhibit action, have been undertaken across SSA (Table 2). Many of these explore barriers or constraints from the perspective of the resources needed for adaptation, the factors influencing adaptive capacity, the reasons for not employing particular adaptive strategies or not responding to climate change signals, and the reasons why some groups or individuals adapt and not others (Table 1).^{51,52,53,54,55} Much of this work reveals that generally only a portion of farmers are able to respond to perceived changes in climate, while others are restricted by a suite of local and higher level barriers. Many of these barriers reflect those more easily detected, i.e. financial, biophysical, technological, informational and governance, with the lack of adequate assets such financial resources for farming inputs and the adoption of new technologies (e.g. irrigation), and insufficient information regarding options for alternative or modified farming practices being the most frequently cited across all the cases (Figure 1). Few of the studies ask why these barriers emerge, and most pay little attention to the underlying political-economic and structural factors that create the constraints mentioned and that make farmers vulnerable in the first place.

A study on climate change adaptation amongst small-holder farmers in Ethiopia and South Africa, found that 37% and 62% respectively of farmers interviewed had not taken any adaptive action to perceived changes in temperature and rainfall.⁵⁴ In South Africa, this lack of action is attributed to a mix of financial, physical, social and information factors including the lack of access to credit/money (cited as the most serious constraint by 36% of respondents), insufficient access to water for irrigation (8%), inadequate and/or inaccessible information about climate change and adaptation strategies (5%), poor market access (3%) and insecure property rights (1%).⁵⁴ Similarly, a study of livestock farmers in the Eastern Cape, South Africa, found an even higher percentage (71% of 500) of farmers interviewed had not employed any climate change adaptation strategies, with a similar set of factors highlighted as blocking adaptation, including: lack of farming inputs (46%), limited financial resources (23%), lack of information related to options for adaptation and new farming practices (17%), insufficient property (9%) and poor access to climate information (3%).⁵⁶ These findings are echoed for other parts of South Africa.^{57,58} The findings for Ethiopia were similar with the main barriers cited as shortage of land (27%), lack of information regarding farming options (23%), no credit (21%), shortage of labor (8%) and no irrigation (3%).⁵³ Of note is that some barriers are specific to the employment of particular adaptation options (e.g. shortage of land is more of a constraint to soil and water conservation than changing crop variety), while others, such as lack of access to credit, inhibit almost any adaptation response within the farming sector.⁵³

A comparable study in Kenya revealed that only some 19% of farmers had not adjusted their farming practices.⁵⁴ However, the actual adaptation strategies employed by farmers tended to be fairly low cost (e.g. planting different varieties, and soil and water conservation) while other strategies they listed as desirable such as irrigation, water harvesting or changes in crop type were often constrained by a lack of resources⁵⁴. Specific barriers mentioned included financial (no cash or

credit), biophysical (poor access to water), institutional and physical (insecure access to land, few inputs), and informational (limited information on agroforestry/reafforestation, different crop varieties or types) (similarly reported for Burkina Faso⁵⁹). Other constraints alluded to included shortages of labor and governance-related barriers such as poor quality of seed and inputs attributed to a lack of quality controls by the Kenyan government and corrupt business practices by traders. Factors such as low soil quality, land fragmentation, poor roads and agricultural pests and diseases were also mentioned as additional barriers⁵². Furthermore, participatory activities undertaken as part of the studies revealed the need for improving human and organisational capacity, suggesting social barriers to collective action. Other social and political barriers highlighted included the growing rate of theft, crime, insecurity, violence and conflict.⁴¹ These same socio-political factors were identified as 'vulnerabilities' by communities in the Eastern Cape of South Africa and were said to negatively affect adaptation choices.^{60,61}

A similar range of factors were identified as 'stressors' and constraints by farmers in a study in Zimbabwe and Zambia, with the lack of draught power (caused by livestock diseases and drought) and weakened government capacity in terms of the provision of basic services being emphasized as particularly critical.⁶² Other factors mentioned, that cross scales, included hyper-inflation, disintegrating infrastructure, and corruption related to who receives inputs. Such findings are fairly ubiquitous, with a study from the Sekyedumase district in Ghana demonstrating that less than half of farmers had tried to respond to experienced changes in climate with the main barriers to adaptation being informational (limited information on adaptive strategies and farming practices and the weather), financial (poverty and poor access to funds or credit), as well as biophysical and institutional factors such as low soil fertility and tenure insecurity.⁶³ The first two factors were also found to be significant barriers in Ethiopia and South Africa^{64,65}, while research by Ifejika Speranza^{51,66} on drought responses amongst agro-pastoralists in Makueni district Kenya, found insecure property rights, poverty, low self-organisation, inadequate climate data, limited responses to market dynamics, livestock diseases, decreased mobility, inadequate skills and poor infrastructure all posed barriers to sustainable and resilient adaptation. Regarding social barriers, she found that agro-pastoralists' cultural attachment to livestock deterred livestock disinvestment during drought periods, resulting in disadvantageous sales that impacted on farmers' ability to rebuild their herds afterwards. Looking across scales, a study from Mozambique shows how the interaction between barriers at different scales acted as a hindrance to farmers responding to climatic disturbance.⁶⁷ In particular, the study highlights disaster risk reduction policies that fail to consider the role of local migrant income and entrepreneurs, in addition to poor infrastructure and uneven access to micro-finance. In a narrower study from Malawi, Nordhagen and Pascual⁶⁸ assess small-holder farmer access to informal and formal seed systems in the context of climate change adaptation. Specifically they consider how climate shocks affected household reliance on different seed sectors. Barriers to adaptation here too manifested, and cut across each of the main categories: social (access and linkage to seed exchange networks), informational (access to information and local knowledge of locally adapted varieties), biophysical and technical (availability of germplasm resources, quality of germplasm resources), financial (assets to acquire new germplasm), and infrastructural (poor transportation links to seed markets).

[INSERT FIGURE 1 ABOUT HERE]

In the African context, aridity and drought have been particularly well studied. Roncoli et al.⁵² found that farmers in more constrained arid environments in Kenya were less likely to implement adaptive strategies against climate change impacts relative to those in temperate regions, and that amongst the latter a greater range of adaptive responses were recorded (27 versus 10). This suggests that the biophysical characteristics of arid areas (i.e. unpredictability of climate and natural resource scarcity), interacting with other stressors including, in many cases, geographic isolation, could result

in more risk prone livelihoods and fewer options to diversify through adaptive measures, certainly for more vulnerable groups. Such situations could, thus, present limits for these groups, especially if current climate change trends continue, as is illustrated in work by Sallu et al.⁶⁹ in Botswana. They found the most vulnerable members of a selection of two rural communities had not succeeded in fully recovering from a severe drought experienced years previously – this group lacked adaptive options after having exhausted most of their livelihood assets, and survived by working for others and becoming heavily dependent on social welfare. Such groups may face real limits in the future and may need targeted support, for instance through adaptive social protection programs.⁷⁰

Many of the barriers highlighted in this section are not exclusively barriers to adaptation, but also barriers to improved or productive small-holder farming livelihoods and, more broadly, to rural development in general (Figure 1). Most of the barriers encountered are not new and have been explored outside of the climate change literature and most are related to non-climate factors. Many manifest themselves across scales from, for example, governance issues at the national level (e.g. hyper-inflation in Zimbabwe) to local corruption in the extension services or input suppliers. The vast majority of barriers appear to be beyond poor farmers' control and a consequence of poverty, low levels of development typical of the SSA context, inappropriate policies and inadequate governance systems (i.e. what has been called an adaptation deficit). Almost all the barriers identified can be linked back to these overarching structural factors.

Specific studies focussed on social, cultural and informational barriers

Relatively few of the local-level studies and projects described above offer in-depth attention to the role of social (cognitive, normative behavioral, cultural) barriers in adaptation uptake, although several mention limited access to suitable information. However, this issue is rarely discussed in terms of how such information might be perceived and used. Moreover, the majority of the studies focus on agriculture, downplaying the multiple activities that contribute to rural livelihoods in SSA. However, we do recognize that, in some instances, social barriers may not have surfaced in the studies and projects reviewed, mainly because barriers tend to operate in a hierarchical manner with some only emerging once others, such as financial or technical barriers, are overcome. Nonetheless, some specific studies, discussed below, on particular social, cognitive and informational barriers demonstrate the importance of paying attention to these at the early stages of planned adaptation.

Cognitive and psychological barriers

Several authors argue that understanding psychological factors such as mind sets and risk perceptions is crucial for supporting adaptation, and failure to do so could compromise success.^{19, 71, 72, 73} The work by Grothman and Patt⁷², which includes a case study from Zimbabwe on how farmers use forecast information to decide whether to plant maize or sorghum, emphasizes the significance of risk perception, motivation and perceived abilities as underlying determinants of action. Artur and Hilhorst⁷⁴, in a study from Mozambique, outline how local explanations of extreme events and changes in the weather related to religion (God's will), the ancestors and witchcraft can all hinder the uptake of planned adaptation projects. Seeing climate variation and change as a natural phenomenon and beyond human control is also common and is likely to act as a cognitive barrier to adaptation.^{19, 75} Generally, farmers try to make sense of what is happening in their environment based on the socio-cultural frames in which they operate^{75, 76}, and may be sceptical of the idea of predicting future climate. Semantics and language can also be problematic as shown by Simelton et al.⁷⁷ in a study undertaken in southern Africa (Botswana and Malawi). These authors argue that perceptions of rainfall are likely to be confounded unless farmers, scientists and practitioners work towards common notions of changes in actual rainfall, the impacts of rainfall and in the farming system's sensitivity to rainfall. Differences in understanding can also be exacerbated by difficulties

in translation of some of the concepts across languages and could act as a barrier to the uptake of weather forecasting and planned adaptation strategies.⁶⁷

Institutional and cultural barriers at the local level

Institutional barriers, other than the tenure issues mentioned earlier, have similarly not received much attention.^{15,29} In a recent briefing paper, Ludi et al.² list three ways in which institutional barriers were found to prevent sustainable adaptation based on evidence from an ACCRA project (Africa Climate Change Resilience Alliance: 2010 -2011) in Uganda, Ethiopia and Mozambique. These included: 1) elite capture of some institutions and corruption; 2) poor survival of institutions without social roots – e.g. a savings group that did not conform to existing norms; and 3) the lack of attention to the institutional requirements of new technological interventions. For example, the authors mention how improvement of water infrastructure for irrigation as an adaptive strategy does not necessarily guarantee better access to water for all members of the community. Institutional and social-cultural barriers play a role in blocking access for some groups; for instance women continue to experience water insecurities as they lack money to pay bribes and the social standing to make claims to the water.² Institutions and norms that restrict equitable access to resources can create and sustain social exclusion and serve as a barrier to enhancing sustainable adaptation at the local level by maintaining structural inequities related to gender and ethnicity.²⁹

The issue of elite capture is clearly illustrated in work by Sallu et al.⁶⁹ in Khawa, Botswana. The authors show how unequal access to ecological diversity and natural resources across the landscape prevented adaptation amongst the poorest households. Their entitlements to water, and wild animal and plant resources were suppressed by the rural elites who had preferential access to water and non-degraded pastoral lands through exertion of political and financial power within the District Council, Village Authority and the Development Trust (the principal decision-making institutions).

There is also evidence that innovation and subsequent adaptive responses may be suppressed if the dominant culture disapproves of departure from the ‘normal way of doing things’.^{2,29} In particular, women’s ideas may not be supported because their opinion may not be valued or given much weight or their preferences may be ranked lower than men’s.^{79,80,81} Poor recognition of gender and other social differences could prevent certain people, often the most vulnerable, from adapting as was the case in the Central Africa Republic in relation to a REDD+ program.⁸² Women often face barriers such as lack of access to land, forest and other natural resources, credit and decision-making.¹⁵ Other gender related barriers mentioned by Ludi et al.² for Uganda, Ethiopia and Mozambique include a lack of ability to take financial risk, lack of confidence and limited access to information and new ideas, all of which suppress innovation.

Regarding cultural barriers, Nielsen and Reenberg⁸³ provide an interesting study of two ethnic groups in northern Burkina Faso (the *Rimaiibe* and *Fulbe*) that illustrates how social and cultural factors, including value systems and identities, either facilitate or block the adoption of adaptive strategies that contribute to livelihood diversification, which is seen as an essential strategy amid increasingly unreliable outcomes from rain-fed agriculture. In particular, they showed how a strict *Fulbe* identity, notions of freedom and personal integrity, a preference for living in the bush and unwillingness to live and interact with their ‘inferiors’ (the *Rimaiibe*), and a traditional emphasis on pastoralism narrowed household livelihood options for this particular ethnic group, although younger men were beginning to question this counterproductive and inflexible stance. Interestingly, the particular cultural and value barriers highlighted in this study were not found in other parts of Burkina Faso amongst the same ethnic group, underlining how complex, context-specific and dynamic such barriers can be.

Informational and knowledge barriers

Informational barriers tend to be more commonly elicited to explain the lack of response to changing climate signals than social barriers; often, these informational barriers surface as not knowing what to expect or what to do, especially when people feel that their traditional knowledge may no longer suffice. Such informational and knowledge barriers are strongly linked with cognitive barriers as alluded to earlier. Climate uncertainty, high levels of variability, a lack of information on the frequency and intensity of extreme events and poor predictive capacity at a local scale are often cited as barriers to adaptation from the individual to national level (Box).^{15,20,84,85} At the local level, it can be difficult for farmers to detect trends amidst short term fluctuations, since variability has always been part of their experience of the weather and the climate and they may underestimate the severity of changing conditions.^{51,85} Consequently, these difficulties can result in cognitive barriers to adaptation. However, evidence illustrates most rural farmers perceive changes in weather patterns and acknowledge the associated risks, although the causes of the changes are not always known or are attributed to God's or Allah's doing, supernatural forces or punishment for societal misdemeanor.^{52,53,56,57,58} Mismatches between farmers' perceptions and interpretations of variability and changes in the climate and those of scientists also often occur and some argue that this may form a barrier to adaptation through creating misunderstanding and mistrust.^{77,85}

The SSA situation, thus, appears to differ from some other contexts where there is evidence of much more overt scepticism and divided views.^{20,86,87} However, lack of access to appropriate real-time and future climate information that can help in decision-making for different users is a universal barrier (Box 1).^{19,78} In Durban, South Africa, lack of information on the combined effects of sea storms and sea level rise has hampered decision-making at the municipal level.⁸⁸ The frequent citing of poor access to information on climate and possible adaptive strategies has already been mentioned as a reason provided by small-holder farmers for their lack of response. Several studies have shown that farmers with access to weather information and who engage in community-based monitoring are more likely to be aware of changes and to make adjustments accordingly^{62,89}, although there are also many factors that discourage the use of this external information, including some of the cultural and cognitive barriers mentioned above.⁹⁰ Other factors relate to the degree to which information matches or is tailored to farmers' needs, the extent to which resources are available to make adjustments, and the ways in which forecasts are translated and delivered, including the type of media and workshops processes employed.^{91,92,93}

Governance and approaches to planned adaptation

Regarding planned adaptation at community level, several of the studies reviewed show that the approaches used for supporting adaptation can, in themselves, act as a barrier to adaptation. For example, Erikson and Lind (p. 832)¹ propose that external development support often "disregards the logic of peoples' own adaptation strategies" and ignores their own understandings of their vulnerabilities, which can result in climate change policies and strategies that inhibit local and regional adaptation options. Nyanga et al.⁵⁵ argue that the extension services in Zambia focus too closely on technical skills and fail to address critical social factors (culture, beliefs, values) that influence the adoption of new technologies. The authors interpret such a technical emphasis as a major barrier to farmers making the links between climate change and conservation agriculture as a prerequisite for adaptive thinking and decision making. Ludi et al.² also point out that the top-down mode of planned adaptation support commonly provided by NGOs and governments can act as a barrier to long-term adaptation as little attention is given to building local agency and innovation through the provision of information and opportunities for learning. Approaches that underrate sufficient engagement of local people and other stakeholders face a strong likelihood of failure², with 'climate change citizenship' being seen as a way to promote engagement⁹⁴. Furthermore, a perception of the urgency for adaptation can result in quick fixes that neglect more "inclusive processes of dialogue and negotiation" (p. 8)⁹⁵ and, thus, more responsible and ethical decision-

making as well as the opportunity for learning and experimentation. Planned adaptation that does not pay attention to how adaptation options impact what people most value is also likely to meet obstacles.⁴

Barriers acting together: contingent, cumulative and cross-scale barriers

Situating climate change adaptation within the development and political context and in relation to other stressors

In many parts of Africa, especially the drylands, traditional, autonomous adaptation strategies have been constrained by rapid and accumulative social-ecological change. Drivers such as population growth, conflicts and competition between groups, land privatisation, land degradation, widespread poverty, HIV/AIDS, poorly conceived social and environmental policies, and erosion of traditional knowledge inhibit the possibility of responding to climate variability and risk in ways that people did in the past.^{1, 19,51,69,96,97,98,99} For example, like in other contexts and countries¹⁰⁰, Laube et al.¹⁰¹ highlight the theme of multiple stressors, discussing how the “double exposure” to the simultaneous and often unpredictable impacts of environmental change (influenced strongly by climate change) and economic globalization was the most significant barrier to farmers’ livelihood adaptation in Northern Ghana. New stresses with negative feedbacks on sustainable adaptation are also often created through short-term diversification strategies, such as charcoal production, unmanaged natural resource harvesting and sale, and artisanal mining, that increase long-term risks through instigating further and potentially more dramatic ecological change and the loss of ecosystem services to fall back on.^{97,102,103} Local ethnic and political conflict (e.g. in Kenya and Ethiopia^{1,102}) and declining security including theft and violence (e.g. in South Africa^{57,58,60,61}) also generate additional stress and are increasingly being reported as barriers to adaptation. The evidence suggests that as a result of multiple stressors coinciding, the number of autonomous response options has decreased compared to the past and traditional coping strategies are no longer sufficient. For example, increasingly local people are reporting obstacles to mobility, collective practices, efficient use of indigenous knowledge and diversification activities that hinder their ability to adapt and may pose limits on their adaptation.^{51,61,102} Such situations, especially in SSA arid and semi-arid pastoral and agro-pastoral systems, can lead to poverty traps. In arid regions recurring droughts, deterioration of rangelands, restricted mobility due to land tenure policies, enclosure of the commons and local conflicts that limit access to drought grazing areas, adverse terms of trade, political and ethnic conflicts, and the conversion of arable and grazing land to commercial agriculture and biofuels have effectively trapped farmers in a situation that prevents sustainable adaptation responses.^{51,102,104} Political and structural change or reform and redistribution of resources and support will be essential to overcome these barriers and to promote new practices and adaptive strategies.¹ Furthermore, Bryan et al.⁵⁴ have pointed out that most autonomous adaptation usually involves minor adjustments to current practices (e.g. changes in planting decisions) and that there are simply too many barriers for local people to implement substantial or transformational changes (e.g. agroforestry and irrigation). Such adaptation strategies require government and private sector/NGO support, which, in turn, may require deep-seated political and economic reform and a more pro-poor agenda. In the absence of this, many poor groups in SSA may face real limits to adaptation.

Thinking about history and the political economy

Historical processes and temporality of change cannot be ignored when considering adaptation. There are numerous examples from SSA where historical political, structural and environmental processes and events have resulted in some of the poorest people on the continent being trapped in chronic poverty.^{69,105} The barriers that create these inequalities and traps are often long-term and complex and controlled by feedbacks, making them extremely difficult for people to escape. In South Africa, while apartheid ended two decades ago, inequality and poverty has continued to persist and

some argue has even worsened.^{106,107,108,109,110} The lingering effects of the entrenched segregation policies of apartheid including poor education, poor service delivery, lack of land tenure rights and access to land, the undermining of agriculture and self-sufficiency, and the creation of a labor pool can still be seen and continue to impact on people's livelihood options today.^{58,60,67} This context will continue to form a major barrier to building the generic capacity^{31,43} needed for adaptation in the previous Bantustans and urban townships into the future,^{99,110} unless the current government fundamentally changes the way it views these areas. This type of situation is not unique to South Africa. Deep rooted inequalities and systematic marginalization of certain groups of people have historically characterised many countries in SSA⁴³ and, without transformational shifts in political discourses and governance structures, these will continue to block poor people's ability to adapt to new, specific climate risks.

However, not all of these situations necessarily present limits indefinitely – there are some positive stories. The successful greening of the Maradi and Zinder regions of Niger in the Sahel, after decades of degradation, is a case in point.¹¹¹ Multiple barriers were overcome when macro-level institutional changes in governance, which resulted in a move away from the historical top-down, centralized and authoritarian system of governance, interacted in a cascading manner with other processes and factors, in particular increased rainfall, to provide an opportunity for farmers to adapt their farming practices.¹¹¹ This example again highlights how linked, multiple factors at different scales may combine to undermine local people's ability to deal with change and that these barriers have to be tackled simultaneously, with a fundamental change in political-economic system often being the necessary trigger. We need more studies of this nature.

Cross-scale political, discursive and governance barriers

As already suggested, contingent barriers at a higher level can also affect local adaptation (Box 1). Some policy-orientated studies have shown that adaptation options in Southern Africa have been blocked by political and institutional inefficiencies.^{57,112,113,114} Other authors suggest that climate change and adaptation are often not perceived as a priority and of insignificant political value to warrant attention among policy makers and during election cycles.^{94,114,115} Madzwamuse¹¹⁶ suggests that the slow response to climate change adaptation in South Africa is the result of a continuously dominant mitigation discourse because of the country's heavy reliance on fossil fuels. The neglect of the poor and their needs and aspirations, in particular, is attributed to the lack of political champions to speak for and represent their interests. She argues that, to move forward with climate change adaptation implementation a greater understanding of the barriers to adaptation both by African governments and the donor community is required. Berrang-Ford et al.³⁷ suggest that poor monitoring of adaptation progress and positive outcomes may act as a barrier to governments investing in adaptation interventions, while Ziervogel and Parnell^{38,117} highlight the lack of national support for local adaptation in South Africa. Lack of local participation in policy formulation, the neglect of social and cultural context and the inadvertent undermining of local coping and adaptive strategies have also been identified by several commentators as barriers to appropriate national policies and frameworks that would support local level adaptation in SSA.^{102,118,119}

Policy and government laws and regulations themselves can also act as barriers to adaptation at a local level (see Box 1). Bunce et al.⁹⁸ found that government policies controlling water flows in upstream dams, the designation of conservation areas and the expansion of urban development and tourism all worked as barriers to adaptation amongst poor coastal communities in Tanzania and Mozambique. Political short-termism makes it hard to plan for longer-term changes in climate³². Linked to this, Conway and Schipper¹⁸ suggest that discourses and policies that take a disaster-focused, short-term view of climate variability and that focus on transient food insecurity and relief can act as a barrier to a longer-term perspective that emphasizes sustainable adaptation, livelihood

security and resilience. They also argue that the perception of climate change as an environmental issue rather than a broad development issue, as observed for instance in Ethiopia's government, results in it being side-lined and so constitutes a barrier to action; this is echoed for Botswana¹¹⁴ and South Africa^{38,94,117}. Indeed, the isolation of adaptation policy from broader development discourses, policies and initiatives serves to obscure the inter-relations between generic and specific adaptive capacity and block local level adaptation in Southern Africa¹²⁰. Further, narratives of environmental change that are distant to local people's experiences can manifest as discursive barriers to adaptation support, as described by Slegers⁸⁵ in relation to agricultural production in central Tanzania. Factors such as bureaucratic inertia can also block sustainable adaptation progress¹¹⁸. Brockhaus and Djoudi¹¹⁸ argue for Mali that "adaptation in the socio-political subsystem is lagging behind autonomous reactive adaptation and hindering the switch from the latter to planned adaptation through reflective and strategic decision making processes" (p. 1).

[INSERT BOX 1 AROUND HERE]

The political context can also undermine autonomous adaptation; for instance, Smucker and Wisner¹²¹ found that political and economic changes (e.g. land ownership privatisation, decentralisation, and different market conditions) in Kenya meant that farmers could no longer use traditional strategies for coping with climatic shocks and stressors, with the poorest increasingly having to resort to coping strategies that undermined their long-term livelihood security, such as more intensive grazing of livestock and shorter crop rotations. Stringer et al.¹²⁰ also underscore how national policies are often at odds with autonomous local adaptation strategies, and how poorly developed mutually supportive links between these can act as a barrier to adaptation, especially where cultural, traditional and context-specific factors are ignored⁷¹. A clear example of this is in Eriksen and Marin's¹⁰² work in Afar, Ethiopia. These authors found a disconnect between local pastoralists' values and ways of life and national level aims to modernize farming and expand cultivation at the expense of grazing lands. Other types of political barriers identified specifically for Southern Africa include a shortfall in government funding for local development of research and planning; political opposition to adaptation; insufficient interdepartmental coordination and collaboration; the challenge of competing priorities (mineral-energy complex); lack of adaptation mandates; and legal constraints¹¹³. This is echoed by Kalame et al. for Burkina Faso¹¹⁵.

WHAT DO THESE FINDINGS MEAN FOR ADAPTATION IN SUB-SAHARAN AFRICA? SUMMARY, GAPS IN UNDERSTANDING, AND FUTURE RESEARCH DIRECTIONS

Why do certain barriers emerge? Addressing underlying causes

In this review we have highlighted the complex web of interacting barriers that manifest from national to local level to impede sustainable, local level adaptation in Africa. Many of these barriers are entrenched and will be far from easy to overcome; some, especially where they are cumulative, may act as limits to adaptation for particular social groups such as poor natural-resource dependent households, women and other marginalized peoples. As is expected, given the SSA context, the majority of barriers we identified can be traced to poverty; marginalisation; inequity and inequality; rapid and complex social-ecological change; weak institutional capacity and governance; low levels of development; and low prioritisation of climate change in relation to many other societal challenges in the African context (also see Biesbroek et al.¹⁰). This is partially illustrated through the repeated use of the words "lack of" (finances, assets, capacity, information, technology, political will, consultation, markets, etc.) in the literature relating to barriers, as well as the particular contexts that people find themselves in, which limit and undermine their generic and specific adaptive capacity. To tackle such complex barriers requires action simultaneously at several scales, and at the highest level may mean major structural, political and discursive change.^{13,27,28} But, in many cases blindness, or even resistance, towards the need for reform to support a more equitable society is

one of the prime barriers to socially just adaptation, especially where it is likely to threaten existing power relations and resource distribution.⁴³

Further research is therefore required to understand *why* certain barriers emerge for some sectors of society⁴⁵ and the opportunities for transformation to remove these barriers. This includes consideration of the possibilities for closer integration of climate change adaptation, disaster risk management, sustainable development and poverty alleviation⁶ to build generic adaptive capacity, while simultaneously supporting adaptation to specific climate threats. Lemos et al.⁴⁵ propose the idea of ‘adaptive development’ (which may help overcome some of the limitations of sustainable adaptation discussed earlier) to specifically tackle the combined aspects of poverty and inequality and new climate related threats, and thus address both generic and specific adaptive capacity. They argue, through this, “it becomes possible to identify the essential difference between development in the face of climate change and development as growth, human development and/or sustainable development” (p. 448) and to consider the intersections between the two. “Adaptive development strategies would work to reduce the riskiness of development choices, even as they attend to the criteria of equity and sustainability” (p. 449).

Hidden and under-researched barriers

In the more in-depth cases, it was revealed that steps to overcome some of the more obvious, external barriers, e.g. financial or technical, can result in the emergence of more hidden, internal social barriers that may have uneven outcomes for different individuals and communities. We have shown that these are clearly less well researched and reported and thus necessitate more explicit attention. Consequently, while a more sophisticated and dynamic understanding of all the types of barriers to adaptation is required; there is some urgency for particular attention to political and structural barriers at higher spatial and institutional levels as well as to social (cognitive, institutional, and cultural/normative including values) barriers at the local level. Particularly, there is limited material from the region on the role of worldviews, norms, values and sense of place and identity in influencing adaptation⁴, with the exception of cursory discussions of traditional and religious belief systems as cognitive barriers. Yet, it is these very areas in which barriers that result in socially differentiated ability to adapt at the local level often manifest. If we are to understand intersectional inequalities and adaptation, then we need to understand these barriers. Further, the role of conflicts, corruption, vested interests and power relations in blocking adaptation, especially for the most marginalized, are similarly poorly studied^{1,102}. We argue that only through greater insights into these social justice issues will it be possible to plan for more sustainable and equitable adaptation.

Interactions and linkages among barriers

Barriers to autonomous adaptation, to date, have received more attention than barriers to planned adaptation in the SSA literature, with limited endeavor being made to organize barriers around how they hinder critical governance processes or specific types of adaptation actions (e.g. diversification, pooling, migration or intensification²⁹). Most importantly, while several papers list numerous barriers to adaptation, the complex interactions between these different types of barriers and their compounded impacts on adaptation, or particular adaptation options, are rarely discussed (an exception being a very recent paper by Antwi-Agyei et al.¹²² (see Box 2). However, there is more mention of contingent and cross-scale barriers for semi-arid regions than elsewhere on the continent, and examples of these interactions have already been discussed in the previous section. Singling out particular barriers or focusing on barriers within sectors may provide insight into specific interventions, but we maintain can divert attention from deep-rooted structural inequalities and misguided development for which national governments and the larger international community ought to take responsibility or even contribute to maladaptation (e.g. providing irrigation without deeper consideration of ecological and social context and consequences).

Careful consideration of multiple barriers can thus be constructive in understanding how climate change adaptation at different levels can be best supported and promoted, and how poverty traps and downward spirals of vulnerability can be avoided. Consequently, we argue further research is needed on how barriers interact, particularly across scales, and how perhaps addressing barriers at a higher level may remove obstacles at a lower level or alternatively amplify them⁷. An important question is what types of barriers, if removed, could result in cascading positive changes towards more sustainable adaptation at the local level. We assert that it is only through a comprehensive systemic understanding of interacting and dynamic barriers to particular types of adaptation that policies, plans, strategies and actions can be developed and implemented that will remove the most restrictive obstacles, avoid maladaptation and traps and lead to livelihood and ecosystem resilience and enduring and fair adaptation strategies.

[INSERT BOX 2 ABOUT HERE]

Who faces barriers? Barriers and social differentiation

Continuously, throughout this review, we have emphasized the need to understand the heterogeneity of impacts from barriers on different sectors of society (gender, age, class, and ethnicity). However, there is little in the empirical literature to shed light on this. Most mentions of gender and other social categories were made in reference to socio-cultural and institutional barriers at the local level. Particular norms and rules can constrain the options available to some people. For example, women are often unable to migrate, access credit or participate in decision making, while very poor households may be restricted in their access to assets such as land. An explicit focus on intersecting dimensions of inequalities would help shed light on the complex drivers that prevent certain groups of disadvantaged people from successfully adapting to climatic change, while others may be more fortunate or even benefit. To further expand on this, we believe it is necessary not just to explore what makes certain people vulnerable but also the question: how do the more privileged members of society adapt, what allows them to do this and how does their successful adaptation impinge on adaptation choices of the more marginalized? These questions are particularly relevant in countries with high levels of inequality (comparable to Latin America) such as most of southern Africa, Nigeria and parts of central Africa.¹³²

Thinking about trade-offs between barriers

Another gap in the state-of-the-art knowledge on barriers to adaptation is our limited understanding of the role of trade-offs in adaptation decision making, and how choices of options is influenced by knowledge or lack thereof (e.g. severity of change, types of risks, uncertainty and lack of information), cognitive factors (preferences, aversion to certain options, priorities), institutional factors (who has a voice) and financial factors (costs). Trade-offs, especially in planned adaptation, are likely to reflect different policy interests (e.g. cost efficiency versus equitability and best-bet and win-win options), different time frames (immediate responses versus long-term sustainability), different sectors, distinct livelihood activities (e.g. smallholder farmers versus urban wage labor), and social groups (e.g. the elderly versus gender inequality). We argue that such explicit or masked trade-offs inevitably favor some groups over others and may lead to the misdirection of adaptation support, barriers to some people and further marginalisation of the most vulnerable. Ludi et al.², for instance, argue that there is evidence of this in East Africa. They discuss how short-term strategies, such as the provision of irrigation in semi-arid areas, are introduced with little effort to consider longer-term climate and socio-economic changes, possibly leading to maladaptation in the future and the favoring of more elite groups. A failure to consider future uncertainties, to think about scale, and to ask wider questions and find sufficient information regarding impacts on different sectors of society can in itself constitute a barrier to adaptation for the most vulnerable. Future research is required to understand how barriers (e.g. financial) influence trade-offs/choices between different

adaptation approaches and options and the consequences of these for different social groups. Simultaneously, it is important to develop a better understanding how different choices may result in the imposition of barriers on certain groups.

[SIDEBAR]

Box 1: Excerpt highlighting the complex interactions between several categories of informational, governance and cross-scale barriers at a policy and planning level

This excerpt from Repetto¹⁷ brings to together succinctly the compounding, cumulative informational, institutional, governance, political and cognitive barriers at higher scales that impede planned adaptation at the local level. It also illustrates that to overcome barriers and identify opportunities we really need to understand these interconnections and tackle multiple barriers simultaneously.

“Public and private sector organisations face significant obstacles to adaptation: uncertainty regarding future climate change at regional and local scales; uncertainty regarding the future frequency of extreme events; and uncertainty regarding the ecological, economic and other impacts of climate change. Organisations lack relevant data for planning and forecasting, and such data are typically outdated and unrepresentative of future conditions (informational and knowledge barriers). Organisations also face institutional and human barriers to adaptation: the need to overcome or revise codes, rules and regulations that impede change; the lack of clear direction and mandates to take action; political or ideological resistance to the need for responsiveness to climate change; the preoccupation with near term challenges and priorities and the lingering perceptions that climate change is a concern only for some time in the future; and the inertia created by a business-as-usual assumption that future conditions will be more or less like those of the past (social, cognitive and political barriers). Without national leadership and concerted efforts to remove these barriers and obstacles, adaptation to climate change is likely to continue to lag. It will be largely reactive rather than anticipatory and preventative, responding to damaging impacts once they have occurred” (p. 20).

[SIDEBAR]

Box 2: Examples of interactions amongst barriers

Antwi-Agyei and colleagues¹²² in a recent paper highlight some of the interactions they observed between barriers that hamper adaptation amongst households in northeast Ghana, while also referring to a systematic literature review of barriers in SSA. Here we list 3 examples.

- 1) The lack of appropriate information on climate variability and changes and impacts is related to infrastructural and financial barriers that prevent the use of adequate and state-of-art equipment within meteorological departments.
- 2) Institutional barriers, specifically weak governance structures, are related to technological and informational barriers (mentioned above) as well a lack of human resources and capacity to properly tackle adaptation. There is a close link between institutional barriers and a lack of communication of climate information to farmers in ways that are appropriate and timely (also see section on informational barriers) due to poor coordination among organisations and departments involved in climate change adaptation.

- 3) Financial barriers at household level are related to infrastructural barriers, specifically the lack of ready markets. Difficulties selling certain crops due to preferences for more culturally appealing staples restricted the planting of drought tolerant crops (such as cassava), illustrating the links between a lack of markets and socio-cultural barriers.

The interconnectedness between barriers is also illustrated in Figure 1.

Conclusion

In this review we have drawn attention to a multitude of barriers that occur simultaneously or reinforce each other, thereby inhibiting local communities' responses to climate disturbances and change in SSA. We have provided insights into the complexity of the interactions between the multi-scalar factors and conditions that block adaptation, as well as the underlying structural and political causes of many of these barriers. By focusing on social, political and cross-scale barriers at the community level, we have highlighted the critical role of a strong social justice framing of barriers and limits to adaptation, expanding on already well-established technological and financial factors. This particular lens demonstrates the relevance of considering cultural, justice, institutional, discursive and cognitive barriers, especially prior to designing and implementing planned adaptation. Omitting these social and political dimensions, risks undermining even the most well-intentioned adaptation efforts and may bypass those who would most benefit from equitable adaptation interventions. While recognition and awareness of barriers is essential, we contend that opportunities for and enablers of adaptation need more attention, and that finding conceptual and practical ways to overcome barriers and support enablers at multiple scales should be the next focus of adaptation research. We also believe that a renewed emphasis on intersecting inequalities as key drivers of adaptation barriers, and, indeed, the need for adaptation in the first place, will ensure closer attention to the most vulnerable, an urgent necessity for adaptation in the SSA context.

Notes

Acknowledgements

We are grateful for a Worldwide Universities Network (WUN) grant for supporting the project on Limits to Adaptation managed by Penn State University, and intellectual contributions from all other team members. The National Research Foundation (NRF) of South Africa provided financial support for Sheona Shackleton's sabbatical when this review was written. We also thank two anonymous reviewers for useful and critical comments that greatly improved the manuscript, as well as Jesse Ribot and Maria Carmen Lemos (the sub-editor) for useful discussions and ideas. All views are those of the authors.

References

1. Eriksen S, Lind J. Adaptation as a political process: Adjusting to drought and conflict in Kenya's drylands. *Environmental Management* 2009, 43:817-835.
2. Ludi E, Jones L, Levine S. Changing focus? How to take adaptive capacity seriously. Evidence from Africa shows that development interventions could do more. ODI Briefing Paper 71, January 2012. ODI, London. www.odi.org.uk.

3. Klein RJT, Midgley GF, Preston BL, Alam M, Berkhout FGH, Dow K, Shaw MR. Adaptation opportunities, constraints, and limits. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. [Field CB, Barros VR, Dokken DJ, Mach KL, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL. eds.]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA; 2014, 899-943.
4. O'Brien K. Do values subjectively define the limits to climate change adaptation? In Adger NW, Lorensoni I, O'Brien K, eds. *Adapting to climate change: Thresholds, values and governance*. Cambridge University Press, Cambridge; 2009, 164-180.
5. Eriksen S, Aldunce P, Bahinipati C, Martins R, Molefe J, Nhemachena CR, O'Brien K, Olorunfemi F, Park J, Sygna L, Ulsrud K. When not every response to climate change is a good one: Identifying principles for sustainable adaptation. *Climate and Development* 2011, 3:7-20.
6. Mimura NRS. Pulwarty RS, Duc DM, Elshinnawy I, Redsteer MH, Huang H-Q, Nkem JN, Sanchez Rodriguez RA. Adaptation planning and implementation. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. [Field CB, Barros VR, Dokken DJ, Mach KL, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL. eds.]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA; 2014, 899-943.
7. Adger WN, Agrawala S, Mirza MMQ, Conde C, O'Brien K, Pulhin J, Pulwarty R, Smit B, Takahashi. Assessment of adaptation practices, options, constraints and capacity. *Climate Change 2007: Impacts, adaptation and vulnerability*. In Parry ML, Canziani OF, Palutikof JP, van der Linden P, Hanson, CE, eds. *Contributions of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK; 2007, 717-743.
8. Adger WN, Dessai S, Goulden M, Hulme M, Lorensoni I, Nelson DR, Naess LO, Wolf J, Wreford A. Are there social limits to adaptation to climate change? *Climatic Change* 2009, 93:335-354.
9. Ziervogel G, Erickson P. Adapting to climate change to sustain food security. *WIREs Climate Change* 2010, 1:525-540.
10. Biesbroek GR, Klostermann JEM, Termeer CJAM, Kabat P. On the nature of barriers to climate change. *Regional Environmental Change* 2013, 13:1119-1129.
11. Moser SC, Ekstrom JA. A framework to diagnose barriers to climate change adaptation. *PNAS* 2010, 107:22026-31.
12. Olsson L, Opondo M, Tschakert P. Chapter 13. Livelihoods and poverty. In Field, CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea S, White L, eds. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, NY, IPCC WG II, AR5. Final draft report, 2014. <http://ipcc-wg2.gov/AR5/report/final-drafts/>.

13. Agrawal A, McSweeney C, Perrin N. Local institutions and climate change adaptation. The social dimensions of climate change. Social development notes, no. 113. Social Development, Department, World Bank, Washington DC; 2008.
14. Ekstrom JA, Moser SC, Torn M. Barriers to adaptation: a diagnostic framework. Report to the California Energy Commission, Sacramento, CA; 2011.
15. Jones L. Overcoming social barriers to adaptation. Overseas Development Institute, Background Note, July 2010. <http://www.odi.org.uk>.
16. Dow K, Berkhout F, Preston BL. Limits to adaptation to climate change: a risk approach. *Current Opinion in Environmental Sustainability* 2013, 5:384-391.
17. Duff L. Introduction. In Masters L, Duff L. *Overcoming barriers to climate change adaptation implementation in Southern Africa*. Africa Institute of South Africa, Pretoria; 2011 xix-xxiii.
18. Conway D, Schipper ELF. Adaptation to climate change in Africa: Challenges and opportunities identified from Ethiopia. *Global Environmental Change* 2011, 21:227-237.
19. Jones L. Social barriers to adaptation. Exploring the implications and identifying options for adaptation policy across the SADC region. In Masters L, Duff L, eds. *Overcoming barriers to climate change adaptation implementation in Southern Africa*. Africa Institute of South Africa, Pretoria; 2011, 41-58.
20. Repetto R. 2008. The climate crisis and the adaptation myth. Working paper number 13, Yale School of Forestry and Environmental Studies; 2008.
21. Orlove BS. The past, the present and some possible futures of adaptation. In Adger NW, Lorensoni I, O'Brien K, eds. *Adapting to climate change: Thresholds, values and governance*. Cambridge University Press, Cambridge; 2009, 131-163.
22. IPCC. Summary for policymakers. In Field CB, Barros V, Stocker TF, Qin D, Dokken DJ, Ebi KL, Mastrandrea DL, Mach KJ, Plattner G-K, Allen SK, Tignor N, Midgley PM, eds. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, and New York, NY, USA; 2012, 1-19.
23. CDKN. *The IPCC's Fifth Assessment Report. What's in it for Africa?* Executive summary. ODI, London; 2014, 1-31.
24. Niang I, Ruppel OC, Abdrabo MA, Essel A, Lennard C, Padgham G, Urquhart P. Africa. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. [Field CB, Barros VR, Dokken DJ, Mach KL, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL. eds.]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA; 2014, 899-943.
25. Jones L, Boyd E. Exploring social barriers to adaptation: Insights from Western Nepal. *Global Environmental Change* 2011, 21:1262-12.

26. Neilsen J, Reenberg A. Temporality and the problem with singling out climate as a current driver of change in a small West African village. *Journal of Arid Environments* 2010, 74: 464-474.
27. Dow K, Berkhout F, Preston BL, Klein RTJ, Midgley G, Shaw MR. *Nature Climate Change* 2013, 3: 305-307.
28. Kates RW, Travis WR, Wilbanks TJ. Transformational adaptation when incremental adaptations to climate change are insufficient. *PNAS* 2012, 109(19):7156-7161.
29. Agrawal A. The role of local institutions in adaptation to climate change. World Bank, Washington DC; 2008.
30. Thomas DSG, Twyman C. Equity and justice in climate change adaptation amongst natural-resource-dependent societies. *Global Environmental Change* 2005, 15:115-124.
31. Eakin HC, Lemos MC, Nelson DR. Differentiating capacities as a means to sustainable adaptation. *Global Environmental Change* 2014, 27:1-8.
32. Shackleton SE, Cobban L, Cundill G. A gendered perspective of vulnerability to multiple stressors, including climate change, in the rural Eastern Cape, South Africa. *Agenda empowering women for gender equity* 2014, forthcoming. DOI:10.1080/10130950.2014.932560
33. Mukheibir P, Kuruppu N, Gero A, Herriman J. Cross-scale barriers to climate change adaptation in local government, Australia. National Climate Change Adaptation Research Facility, Gold Coast; 2013.
34. Juhola S, Westerhoff L. Challenges of adaptation to climate change across multiple scales: a case study of network governance in two European countries. *Environmental Science and Policy* 2011, 14:239-247.
35. Thornton TF, Manasfi N. Adaptation – genuine and spurious: Demystifying adaptation processes in relation to climate change. *Environment and Society: Advances in Research* 2010, 1:132-155.
36. Glantz MH. *Societal responses to climate change: Forecasting by analogy*. Westview Press, Boulder, CO, USA; 1998, 428 pp.
37. Berrang-Ford L, Ford JD, Paterson J. Are we adapting to climate change? *Global Environmental Change* 2011, 21:25-33.
38. Ziervogel G, Parnell S. South African coastal cities. Governance responses to climate change adaptation. In Cartwright A, Parnell S, Oelofse G, Ward S, eds. *Climate change at the city scale: Impacts, mitigation and adaptation in Cape Town*. Earthscan by Routledge, Oxon, New York; 2012 223-243.
39. Ziervogel G, Shale M, Du M. Climate change adaptation in a developing country context: The case of urban water supply in Cape Town. *Climate and Development* 2010, 2:94-110.
40. Tschakert P, Views from the vulnerable: Understanding climatic and other stressors in the Sahel. *Global Environmental Change* 2007, 17:381-396.
41. Islam M, Sallu S, Hubaceck K, Paavola J. Limits and barriers to adaptation to climate variability and change in Bangladeshi coastal fishing communities. *Marine Policy* 2014, 43:208-216.

42. Frankhauser S, McDermott TKJ. Understanding the adaptation deficit: Why are poor countries more vulnerable to climate change than rich countries? *Global Environmental Change* 2014, 27: 9-18.
43. Lemos MC, Agrawal A, Eakin H, Nelson DR, Engle NL, John O. Building adaptive capacity to climate change. In Asrar GR, Hurrell JW, eds. *Climate science for serving society: research, modelling and prediction priorities*. Springer, Dordrecht; 2013, 437-457.
44. Pelling M. *Adaptation to climate change. From resilience to transformation*. Routledge, Abington; 2009.
45. Ribot J. Cause and response: vulnerability and climate in the Anthropocene. *The Journal of Peasant Studies* 2014, 41:667-705.
46. Tschakert P, van Oort B, St. Clair AL, laMadrid A. Inequality and transformation analyses: a complementary lens for addressing vulnerability to climate change. *Climate and Development* 2013, 5:430-350.
47. Eriksen SH, O'Brien K. Vulnerability, poverty and the need for sustainable adaptation measures. *Climate Policy* 2007, 7:337-352.
48. Brown K. Sustainable adaptation: An oxymoron? *Climate and Development* 2011, 3:21-31.
49. Eriksen S, Brown K. Sustainable adaptation to climate change. *Climate and Development* 2011, 3:3-6.
50. Olsson L, Opondo M, Tschakert P, Agrawal A, Eriksen SH, Ma S, Perch LN, Zakieldean SA. Livelihoods and poverty. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. [Field CB, Barros VR, Dokken DJ, Mach KL, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL. eds.]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA; 2014 899-943.
51. Ifejika Speranza C. Drought coping and adaptation strategies: Understanding adaptations to climate change in agro-pastoral livestock production in Makueni district, Kenya. *European Journal of Development Research* 2010, 22:623-642.
52. Roncoli C, Okoba B, Gathaara V, Ngugui J, Nyanga T. Adaptation to climate change for smallholder agriculture in Kenya: community-based perspectives from five districts. IFPRI Note, IFPRI, Washington DC; 2010.
53. Bryan E, Deressa T, Gbetibouo G, Ringer C. Adaptation to climate change in Ethiopia and South Africa: options and constraints. *Environmental Science and Policy* 2009, 12:413-426.
54. Bryan E, Ringler C, Okoba B, Roncoli C, Silvestri S, Herrero M. Adapting agriculture to climate change in Kenya: Household and community strategies and determinants. Unpublished report from the World Bank Project "Adaptation of smallholder agriculture to climate change in Kenya", Washington DC; 2011.

55. Nyanga P, Johnsen FH, Aune JB, Kalinda TH. Smallholder farmers' perceptions of climate change and conservation agriculture: Evidence from Zambia. *Journal of Sustainable Development* 2011, 4:73-85.
56. Mandeleni B, Anim FDK. Perceptions of cattle and sheep farmers on climate change and adaptation in the Eastern Cape Province of South Africa. *Journal of Human Ecology* 2011, 34:107-112.
57. Wilk J, Andersson L, Warburton M. Adaptation to climate change and other stressors among commercial and small-scale South African farmers. *Regional Environmental Change* 2012, 13:273-286.
58. Gandure S, Walker S, Botha JJ. Farmers' perceptions of adaptation to climate change and water stress in a South African rural community. *Environmental Development* 2013, 5:39-53.
59. Barbier B, Yacouba H, Karambiri H, Zorome M, Some B. Human vulnerability to climate variability in the Sahel: farmers' adaptation strategies in northern Burkina Faso. *Environmental Management* 2009, 43:790-803.
60. Stadler LT. Assessing household assets to understand vulnerability to HIV/Aids and climate change in the Eastern Cape, South Africa. MSc thesis, Rhodes University, Grahamstown; 2012.
61. Clarke C. Responses to the linked stressors of climate change and HIV/AIDS amongst vulnerable rural households in the Eastern Cape, South Africa. MSc Thesis, Rhodes University Grahamstown; 2012.
62. Mubaya CP, Njuki J, Mutsvangwa EP, Mugabe FT, Nanja D. Climate variability and change or multiple stressors? Farmers' perceptions regarding threats to livelihoods in Zimbabwe and Zambia. *Journal of Environmental Management* 2012, 102:9-17.
63. Fosu-Mensah BY, Vlek PLG, MacCarthy DS. Farmers' perception and adaptation to climate change: a case study of Sekyedumase district in Ghana. *Environment, Development and Sustainability* 2012, 14:495-505.
64. Deressa TT, Hassan RM, Ringler C, Alemu T, Yesuf M. Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change* 2009, 19:248-255.
65. Nhemachena C, Hassan RM. How can African agriculture adapt to climate change? Insights from Ethiopia and South Africa. Micro-level analysis of farmers' adaptation to climate change in Southern Africa. IFPRI Research Brief 15-7, IFPRI, Washington DC; 2008.
66. Ifejika Speranza C. Resilient adaptation to climate change in African agriculture. German Development Institute, Bonn; 2010
67. Osbahr H, Twyman C, Adger WN, Thomas DSG. Effective livelihood adaptation to climate change disturbance: Scale dimensions of practice in Mozambique. *Geoforum* 2008, 39:1961-1964.
68. Nordhagen S, Pascual U. The impact of climate shocks on seed purchase decisions in Malawi: Implications for climate change adaptation. *World Development* 2012, 43:238-251.

69. Sallu SM, Twyman C, Stringer L. Resilient or vulnerable livelihoods? Assessing livelihood dynamics and trajectories in rural Botswana. *Ecology & Society* 2010, 15:3.
<http://www.ecologyandsociety.org/vol15/iss4/art3/>
70. Davies M, Oswald K, Mitchell T. Climate change adaptation, disaster risk reduction and social protection. Promoting pro-poor growth: Social protection. OECD, 2009.
71. Patt A, Schroter D. Perceptions of climate risk in Mozambique: Implications for the success of adaptation strategies. *Global Environmental Change* 2008, 18:458-467.
72. Grothmann T, Patt A. Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change* 2005, 15:199-213.
73. Below T, Artner A, Siebert R, Sieber S. Micro-level practices to adapt to climate change for African small-scale farmers. A review of selected literature. IFPRI Discussion Paper 00953, IFPRI, Washington DC; 2010.
74. Artur L, Hilhosrt D. Everyday realities of climate change adaptation in Mozambique. *Global Environmental Change* 2012, 22:526-536.
75. Mubaya CP, Njuki J, Mutsvangwa EP, Mugabe FT, Nanja D. Climate variability and change or multiple stressors? Farmers' perceptions regarding threats to livelihoods in Zimbabwe and Zambia. *Journal of Environmental Management* 2012, 102:9-17.
76. Brace C, Geoghegan H. Human geographies of climate change: Landscape, temporality, and lay knowledges. *Progress in Human Geography* 2011, 35:284-302.
77. Simelton E, Quinn CH, Batisani N, Dougill AJ, Dyer JC, Fraser EDG, Mkwambisi N, Sallu SM, Stringer LC. Is rainfall really changing? Farmers' perceptions, meteorological data, and policy implications. *Climate and Development* 2013, 5:1234-138.
78. Conway D. Adapting climate research for development in Africa. *WIREs Climate Change*, 2011, 2:428-450.
79. Goh AHX. A literature review of the gender-differentiated impacts of climate change on women's and men's assets and well-being in developing countries. CAPRI Working Paper No. 106, CAPRI, IFPRI, Washington DC; 2012.
80. Codjoe SNA, Atidoh LK, Burkett V. Gender and occupational perspectives on adaptation to climate extremes in the Afram Plain of Ghana. *Climatic Change* 2012, 110:432-454.
81. Djoudi H, Brockhaus M. Is adaptation to climate change gender neutral? Lessons from communities dependent on livestock and forests in northern Mali. *International Forestry Review* 2011, 13:1-13.
82. Peach Brown HC. Gender, climate change and REDD+ in the Congo Basin Forests of Central Africa. *International Forestry Review* 2011, 13:136-176.
83. Nielsen JO, Reenberg A. Cultural barriers to climate change adaptation: A case study from northern Burkino Faso. *Global Environmental Change* 2010, 20:142-152.

84. Ziervogel G, Zermoglio F. Climate-change scenarios and the development of adaptation strategies in Africa: challenges and opportunities. *Climate Research* 2009, 40:133-146.
85. Slegers MFW. If only it would rain; Farmers' perceptions of rainfall and drought in semi-arid central Tanzania. *Journal of Arid Environments* 2008, 72:2106-2123.
86. Buys L, Miller E, van Megen K. Conceptualising climate change in rural Australia: community perceptions, attitudes and (in)actions. *Regional Environmental Change* 2011, 12(1):237-248.
87. Gifford R. The dragons of inaction. Psychological barriers that limit climate change mitigation and adaptation. *American Psychologist* 2011, 66:290-302.
88. Mather A, Stretch DD. A perspective on sea level rise and coastal from Southern and Eastern Africa: A case study near Durban, South Africa. *Water* 2012, 4:237-259.
89. Koelle B, Oettle N. Adapting with enthusiasm: Climate change adaptation in the context of participatory action research, Indigo paper, 2010. <http://www.indigo-dc.org/research.html>
90. Ziervogel G. Targeting seasonal climate forecasts for integration into household level decisions: the case of smallholder farmers in Lesotho. *The Geographic Journal* 2004, 170:6-21.
91. Archer, E. R. M. Identifying underserved end-user groups in the provision of climate information. *Bulletin of the American Meteorological Society* 2003, 84: 1525-1534.
92. Kalanda-Joshua M, Ngongondo C, Chipeta L, Mpembeka F. Integrating indigenous knowledge with conventional science: Enhancing localized climate and weather forecasts in Nessa, Mulanje, Malawi. *Physics and Chemistry of the Earth* 2011, 36:996-1003.
93. Roncoli C, Orlove BS, Kabugo MR, Milton MW. Cultural styles of participation in farmers' discussions of seasonal climate forecasts in Uganda. *Agriculture and Human Values* 2011, 28:123-138.
94. Leck H, Sutherland C, Scott D, Oelofse G. Social and cultural barriers to adaptation implementation. The case of South Africa. In Masters L, Duff, L. *Overcoming barriers to climate change adaptation implementation in Southern Africa*. Africa Institute of South Africa, Pretoria; 2011, 61-82.
95. Tanner T, Allouche J. Towards a new political economy of climate change and development. *IDS Bulletin* 2011, 42:1-24.
96. African Drought Risk and Development Network (ADDN). Proceedings and presentations of the latest third Annual African Drought Adaptation Forums (ADAF), Addis Ababa, Ethiopia; 2008.
97. Paavola J. Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. *Environmental Science and Policy* 2008, 11:642-654.
98. Bunce M, Rosendo S, Brown K. Perceptions of climate change, multiple stressors and livelihoods on marginal African coasts. *Environment, Development and Sustainability* 2010, 12:407-440.
99. Quinn CH, Ziervogel G, Taylor A, Takama T, Thomalla F. Coping with multiple stresses in rural South Africa. *Ecology and Society* 2011, 16: 2. <http://dx.doi.org/10.5751/ES-04216-160302>.

100. O'Brien K, Leichenko RM. Double exposure: assessing the impacts of climate change within the context of economic globalization. *Global Environmental Change* 2000, 10:221-232.
101. Laube W, Schraven B, Awo, M. Smallholder adaptation to climate change: dynamics and limits in Northern Ghana. *Climatic change* 2012, 111:753-774.
102. Eriksen S, Marin A. Pastoral pathways: climate change adaptation lessons from Ethiopia. Norwegian University of Life Sciences, Aas; 2011.
103. Shackleton SE, Shackleton CM. Linking livelihood vulnerability and ecosystem vulnerability in southern Africa: Consequences for ecosystem management and sustainable development. *International Journal of Sustainable Development and World Ecology* 2012, 19:275-286.
104. Sissoko K, van Keulen H, Verhagen J, Tekken V, Battaglini A. Agriculture, livelihoods and climate change in the West African Sahel. *Regional Environmental Change* 2011, 11: S119-S125.
105. Tschakert P, Schaffer J. Ingredients for social-ecological resilience, poverty traps and adaptive social protection in semi-arid Africa. In Sakai S, Umetso C, eds. *Social-ecological systems in transition*. Springer, Tokyo; 2012.
106. Bank L, Minkley G. Going nowhere slowly? Land, livelihoods and rural development in the Eastern Cape. *Social Dynamics* 2005, 31:1-38.
107. Bhorat H, Kanbur R. Poverty and well-being in post-apartheid South Africa: An overview of data, outcomes and policy. Working Paper 05/101, Development Policy Research Unit, University of Cape Town, Cape Town; 2005.
108. Adato M, Carter MR, May J. Exploring poverty traps and social exclusion in South Africa using qualitative and quantitative data. *Journal of Development Studies* 2006, 42:226-247.
109. Özler B. Not separate, not equal: Poverty and inequality in post-apartheid South Africa. *Economic Development and Cultural Change* 2007, 5:487-529.
110. Shackleton S, Luckert M, Cundill G, Cobban L, Clarke C, Shackleton R, Ndlovu P. Transformation and barriers in the context of multiple stressors: Understandings from two rural sites in the Eastern Cape, South Africa. Proceedings of Transformation in a Changing climate 19-21 June 2013, Oslo, Norway. University of Oslo, Trykktet. ISBN: 978-82-570-2000-2.
111. Sendzimir J, Reij CP, Magnuszewski P. Rebuilding resilience in the Sahel: Regreening in the Maradi and Zinder regions of Niger. *Ecology and Society* 2011, 16:1. <http://dx.doi.org/10.5751/ES-04216-1603021>.
112. Magadza CHD. Climate change impacts and human settlements in Africa: Prospects for adaptation. *Environmental Monitoring and Assessment* 2000, 61:193-205.
113. Chevallier R. Political barriers to climate change adaptation implementation in SADC. In Masters L, Duff L. *Overcoming barriers to climate change adaptation implementation in Southern Africa*. Africa Institute of South Africa, Pretoria; 2011, 1- 19.
114. Toteng EN. Political and state system barriers to the implementation of climate change adaptation in Botswana. In Masters L, Duff L. *Overcoming barriers to climate change adaptation implementation in Southern Africa*. Africa Institute of South Africa, Pretoria; 2011, 22-28.

115. Kalame FB, Kudejira D, Nkem J. Assessing the process and options for implementing National Adaptation Programmes of Action (NAPA): a case study from Burkina Faso. *Mitigation and Adaptation Strategies for Global Change* 2011, 16:535-553.
116. Madzwamuse M. Drowning voices: The climate discourse in South Africa. Policy Brief 05/2010, Henrich, Böll Stiftung, Cape Town; 2010.
117. Ziervogel G, Parnell, S. Tackling barriers to climate change adaptation in South African coastal cities. Chapter 3. In Glavovic BC, Smith GP eds. *Adapting to Climate Change, Environmental Hazards*. Springer Science and Business Media, Dordrecht, 2014.
118. Brockhaus M, Djoudi H. Adaptation at the interface of forest and ecosystem goods and services and livestock production systems in Northern Mali. CIFOR Info Brief No. 19. CIFOR, Bogor; 2008.
119. Dkamela GP. The context of REDD+ in Cameroon: Drivers, agents and institutions. Occasional paper 57, CIFOR, Bogor; 2010.
120. Stringer L, Dyer JC, Reed MS, Dougill A.J, Twyman C, Mkwambisi D. Adaptations to climate change, drought and desertification: local insights to enhance policy in southern Africa. *Environmental Science and Policy* 2009, 12:748-765.
121. Smucker T, Wisner B. Changing household responses to drought in Tharaka, Kenya: vulnerability, persistence and challenge. *Disasters* 2008, 32:190-215.
122. Antwi-Agyei P, Dougill Aj, Stringer LC. Barriers to climate change adaptation: evidence from northeastern Ghana in the context of a systematic literature review. *Climate and Development* 2014, DOI: 10.1080/17565529.2014.951013.
123. Chenene M, Cuamba B, Mavume A, Queface A, Tsamba A. Technological barriers to climate change adaptation: The case of Mozambique. In Masters L, Duff L. *Overcoming barriers to climate change adaptation implementation in Southern Africa*. Africa Institute of South Africa, Pretoria; 2011, 201-225.
124. Gbetibouo GA. Understanding farmers' perceptions and adaptation to climate change and variability. The case of the Limpopo Basin, South Africa. IFPRI Discussion Paper 00849. IFPRI, Washington DC; 2009.
125. Kandjiinga L, Smith J, Zeidler J. Economic and trade barriers to climate change adaptation: Namibia country study. In Masters L, Duff L. *Overcoming barriers to climate change adaptation implementation in Southern Africa*. Africa Institute of South Africa, Pretoria; 2011, 111-135.
126. Kiratu S. Economic barriers to climate change adaptation implementation in SADC. In Masters L, Duff L. *Overcoming barriers to climate change adaptation implementation in Southern Africa*. Africa Institute of South Africa, Pretoria; 2011, 89-107.
127. Kithiia J. Climate change risk responses in East African cities: need, barriers and opportunities. *Current Opinion in Environmental Sustainability* 2011, 3:176-180.
128. Motsa B. Financial barriers to the implementation of climate change adaptation measures. In Masters L, Duff L. *Overcoming barriers to climate change adaptation implementation in Southern Africa*. Africa Institute of South Africa, Pretoria; 2011, 141-161.

129. Sallu SM, Twyman C, Thomas DSG. The multidimensional nature of biodiversity and social dynamics and implications for contemporary rural livelihoods in remote Kalahari settlements, Botswana. *Journal of African Ecology* 2009, 47:110–118.
130. West CT, Roncoli C, Quattera F. Local perceptions and regional climate trends on the Central Plateau of Burkina Faso. *Land Degradation and Development* 2007, 18:1-16.
131. Ulrich A, Ifejika Speranza C, Roden P, Kiteme B, Wiesmann U, Nüsser M. Small-scale farming in semi-arid areas: Livelihood dynamics between 1997 and 2010 in Laikipia, Kenya. *Journal of Rural Studies* 2012, 28:241-251.
132. Okojie C, Shimeles A. A synthesis of recent research on the levels, trends, effects and determinants of inequality in its different dimensions in Africa. The Inter-Regional Inequality Facility, Overseas Development Institute, London, 2006.

Figure captions

[Figure 1: Conceptual map of barriers identified from cases related to small-holder farmer adaptation in Africa (the larger the bubble the more often the barrier was mentioned; double headed arrows suggest the connections and links between different categories and types of barriers).]

Tables

Table 1: Summary of case studies reviewed that record barriers and limits to climate change adaptation in Africa (arranged alphabetically)

Source	Focus	Where	Barriers mentioned
Archer 2003 ⁹¹	Small-holder farmers, planned adaptation (weather forecasts)	South Africa	Gender
Artur and Hilhorst 2012 ⁷⁴	National and rural communities, planned adaptation	Mozambique	Cultural, political, institutional, discursive
Barbier et al. 2009 ⁵⁹	Small-holder farmers, autonomous adaptation	Burkina Faso	Biophysical (land scarcity)
Below et al. 2010 ⁷³	Small-scale farmers, autonomous adaptation	Africa (review)	Social, preferences and assets, cultural, cognitive (risk perceptions)
Brockhaus and Djoudi 2011 ⁸¹	Rural communities and national policies	Mali	Political
Bryan et al. 2009 ⁵³	Small-holder farmers, autonomous adaptation	South Africa, Ethiopia	Financial, biophysical (water, land), informational

Source	Focus	Where	Barriers mentioned
Bryan et al. 2011 ⁵⁴	Small-scale farmers, autonomous adaptation	Kenya	Financial (cash and credit), organisational, informational
Bunce et al. 2010 ⁹⁸	Coastal communities, autonomous adaptation	Tanzania and Mozambique	Higher scale barriers – tourism, development, conservation, multiple stressors
Chenene et al. 2011 ¹²³	National	Mozambique	Technological
Chevallier 2011 ¹¹³	National	SADC	Political
Codjoe et al. 2012 ⁸⁰	Rural communities	Ghana	Gender
Conway and Schipper ¹⁸	National, social protection	Ethiopia	Political
Deressa et al. 2009 ⁶⁴	Small-holder farmers, autonomous adaptation	Ethiopia	Financial, informational
Djoudi and Brockhaus 2011 ⁸¹	Local forest and livestock dependent communities	Mali	Gender, lack of power, assets, information
Dkamela 2010 ¹¹⁹	Local communities and forest users	Cameroon	Institutional, political
Fosu-Mensah et al. 2012 ⁶³	Small-holder farmers, autonomous adaptation	Ghana	Financial (poverty), informational, biophysical, institutional
Eriksen and Lind 2009 ¹	Small-holder farmers	Kenya	Contingent, structural
Eriksen and Marin 2010 ¹⁰²	Pastoralists and small-holder farmers	Ethiopia	Contingent, political and cross-scale
Gandure et al. 2013 ⁵⁸	Small-holder farmers	South Africa	Financial, informational, historical and political
Gbetibouo 2009 ¹²⁴	Small-holder farmers, autonomous adaptation	South Africa	Financial
Grothmann and Patt 2005 ⁷²	Small-holder farmers, planned adaptation	Zimbabwe	Psychological and cognitive (perceptions), perceptions of adaptive capacity
Ifejika Speranza	Small-holder farmers	Kenya	Biophysical, financial, cultural, political,

Source	Focus	Where	Barriers mentioned
2010a ⁵¹	and pastoralists		informational
Ifejika Speranza 2010b ⁶⁶	Small-holder farmers and pastoralists	Kenya	Infrastructural, institutional, informational
Jones 2011 ¹⁹	Rural communities	SADC	Social, institutional, structural, normative, cultural, gender
Kalanda-Joshua et al. 2011 ⁹²	Small-holder farmers and weather forecasting	Malawi	Cultural, cognitive, informational
Kalame et al. 2011 ¹¹⁵	National and local rural communities	Burkina Faso	Political, participation
Kandjinga 2011 ¹²⁵	National	Namibia	Economic and trade
Kiratu 2011 ¹²⁶	Regional, national	SADC	Economic
Kithiia 2011 ¹¹⁶	Urban communities	East African cities	Financial, institutional, capacity, knowledge and skills communication, lack of proactive initiatives
Laube et al. 2012 ¹⁰¹	Small-holder farmers, autonomous	Ghana	Unfair/unpredictable patterns of global trading, multiple stressors
Leck et al. 2011 ⁹⁴	Municipal	South Africa	Social and cultural
Ludi et al. 2012 ²	Small-holder farmers, autonomous adaptation	Ethiopia, Mozambique and Uganda	Institutional, cultural, informational, cognitive
Mandeleni and Anim 2011 ⁵⁶	Small-holder farmers, autonomous adaptation	South Africa	Financial, assets
Mather and Stretch 2012 ⁸⁸	Planned adaptation for sea level rise in Durban	South Africa	Informational
Motsa 2011 ¹²⁸	Regional	SADC	Financial
Mubaya et al. 2012 ⁶²	Small-holder farmers, autonomous adaptation	Zimbabwe and Zambia	Multiple stressors combine to become a barrier to adaptation to climate change, cognitive (perceptions)
Mukheibir 2007 ³⁰	Planned adaptation for water scarcity	South Africa	Institutional (capacity), financial
Nhemachena and	Small-holder farmers,	Ethiopia, South	Financial (credit), informational (on

Source	Focus	Where	Barriers mentioned
Hassan 2008 ⁶⁵	autonomous adaptation	Africa	climate), access to inputs
Nielsen and Reenberg ⁸³	Rural communities, autonomous adaptation	Burkina Faso	Cultural (identity and ethnicity)
Nielsen and Reenberg ²⁴	Rural communities, livelihoods	Burkina Faso	Multiple stressors
Nordhagen and Pascual 2012 ⁶⁸	Small-holder farmers, seed systems	Malawi	Social, informational, biophysical, financial, infrastructural
Nyanga et al. 2011 ⁵⁵	Small-holder farmers, planned adaptation	Zambia	Cognitive, informational, institutional and approaches to planned adaptation
Osbaehr et al. 2008 ⁶⁷	Small-holders, rural communities	Mozambique	Cross-scale, political
Paavola 2008 ⁹⁷	Small-holder farmers, autonomous adaptation	Tanzania	Biophysical (resource degradation), multiple stressors
Patt and Schroter 2008 ⁷¹	Rural communities, planned adaptation	Mozambique	Cognitive, risk perceptions
Peach Brown 2011 ⁸²	Forest communities	Central Africa, Congo Basin	Gender, cultural, political
Quinn et al. 2011 ⁹⁹	Rural communities	South Africa	Multiple stressors, institutional, capacity
Roncoli et al. 2010 ⁵²	Small-holder farmers	Kenya, 5 districts	Biophysical, infrastructural, political, social
Roncoli et al 2011 ⁹³	Small-holder farmers	Uganda	Informational, cultural, approaches to planned adaptation
Sallu et al. 2009 ¹²⁹	Rural communities, autonomous adaptation	Botswana	Biophysical, financial (poverty and assets), dependence on social security benefits
Sallu et al. 2010 ⁶⁹	Rural communities, autonomous adaptation	Botswana	Biophysical, financial (poverty and assets), institutional (elite capture of natural resources)
Sendzimir et al. 2011 ¹¹¹	Multiple scales	Niger	Multiple stressors, institutional, biophysical
Simelton et al. 2013 ⁷⁷	Small-holder farmers	Botswana, Malawi	Social and cultural (perceptions, language and semantics), institutional, informational
Slegers 2008 ⁸⁵	Small-holder farmers,	Tanzania	Perceptions, cultural

Source	Focus	Where	Barriers mentioned
	autonomous adaptation		
Sissoko et al. ¹⁰⁴	Small-holder farmers	West African Sahel	Multiple stressors, contingent
Stringer et al. 2009 ¹²⁰	Rural communities, autonomous and planned adaptation	Swaziland, Botswana, Malawi	Policy, political
Thomas and Twyman ³⁰	Rural communities	Namibia, Botswana	Justice and equity, discursive
Toteng 2011 ¹¹⁴	National	Botswana	Political and state
Tschakert 2007 ⁴⁰	Rural communities, livelihoods	Senegal	Multiple stressors, contingent
West et al. 2007 ¹³⁰	Small-holder farmers	Burkina Faso	Discursive
Ulrich et al. 2012 ¹³¹	Small-holder farmers	Kenya	Biophysical, financial, safety nets
Ziervogel 2004 ⁹⁰	Small-holder farmers, planned adaptation (weather forecasts)	Lesotho	Informational, cognitive
Ziervogel et al. 2010 ³⁹	Urban water management	South Africa	Political, institutional, discursive, organisational, governance
Ziervogel and Parnell 2012 ³⁸	Urban poor	South Africa	Governance, political

Table 2: Categories of barriers and limits to adaptation used to organise the findings from the review of the empirical literature. Note many of the barriers overlap (i.e. it was not easy to classify some of the barriers identified in the literature into one category or another) and in any adaptation situation numerous barriers are likely to apply simultaneously. Sources: Adger et al. (2007); Adger et al. (2009); Jones (2011); Repetto (2008); Orlove (2009); Gifford (2011)

Type/category of barrier or limit	Explanation - What kind of barrier?	Illustrative examples
PHYSICAL (e.g. ecological, climate)		

Type/category of barrier or limit	Explanation - What kind of barrier?	Illustrative examples
Physical and biophysical or natural (links to contingent)	Relates to agro-ecological conditions, climate uncertainty, physiology of biological organisms - may involve critical thresholds and impose limits	Sea level rise; salt water intrusion; temperature thresholds for crops, livestock, marine resources, coral; water availability; irreversible loss of productivity in rain-fed agriculture
FINANCIAL AND TECHNICAL		
Financial/economic/market (cross-scale, links to technical)	Relates to costs of technology/infrastructure, cost of insurance, costs to implement strategies, availability of capital, lack of credit, bias in what is funded	Persistent poverty; unequal access to climate-risk insurance schemes; loss of income if practices changed; donor and funding focus; need for cost efficiency and trade-offs
Technical and infrastructural (links to financial)	Relates to technological development and costs of innovations	Unequal accessibility to technical innovations; lack of suitable technology – e.g. protective structures, crop breeds, seeds; costs of new practices; lack of space and flexibility for new or modified infrastructure; roads and access to markets; lack of hard engineering structures; lack of equipment and tools
SOCIAL, CULTURAL AND INFORMATIONAL		
Social and cultural (links to institutional)	Relates to cultural norms, values, beliefs worldviews, different risk tolerances, culturally influenced preferences, social conflicts, and land-use practices	Differential values, worldviews; sense of place and identity; unequal power and participation in decision-making; some change may threaten people's values – based on this they accept or reject particular actions
Cognitive behavioral (links to cultural and informational)	Relates to how psychological and thought processes influence adaptation, e.g. attitudes, behavior, risk perceptions, priorities, preferences, risk aversion, anchoring to the status quo, underestimation of cumulative probabilities at individual and collective level	Climate scepticism, denial, and omission bias; pre-occupation with near-time challenges; change seen as problem for others but not for own group; belief that uncertainty is too great to take adaptation action; unwilling to accept the risks associated with adaptation action; change not seen as a risk; wait for the impact before reacting; belief in fate or 'gods will', superstition; belief that bad things only happen to others; belief that technology/

Type/category of barrier or limit	Explanation - What kind of barrier?	Illustrative examples
		outside support will overcome problems
Institutional and governance (links to discursive, political, social and cultural) (cross-scale)	Relates to the how the organisation and structure of interactions and institutions influence how social actors are prevented or enabled to adapt	Institutional inequities and social discrimination restrict access to key resources and assets needed to adapt; lack of institutional flexibility; poor policy and poor coordination and cooperation between sectors/actors; poor disaster preparedness and poorly organized responses to hazards; lack of secure tenure; weak institutional structure; institutional instability; inconsistent and unstable policies; poor managerial skills; top-down, culturally insensitive, one fits all approaches to planned adaptation; lack of attention to contextual settings
Information and knowledge (links to cognitive)	Relates to knowledge and information which is needed to make decisions, understand what to expect and to choose and evaluate options and technologies	Lack of access to quality information and transfer of knowledge; inadequate packaging of climate information for different user groups; lack of and uncertain information on cost and benefits of large scale and long-term investments such as coastal protection measures; structured ignorance; lack of information on possible response strategies; lack of skills and trained personnel
CONTINGENT, CUMULATIVE AND CROSS-SCALE		
Local context and cumulative interaction of multiple stressors and barriers (can be influenced by cross-scale policy and institutional barriers)	The interaction of multiple stressors/ impacts (especially at different scales) is seen as a barrier in itself, adaptation deficit	Poor health/ HIV, drought, environmental degradation, restrictive land/resource use policies
Historical and contingent	Past contexts have resulted in people being trapped in a situation that is very difficult	Apartheid in South Africa

Type/category of barrier or limit	Explanation - What kind of barrier?	Illustrative examples
	to escape	
Cross-scale discursive and political (links to institutional and financial)	Relates to the broader context in terms of science framings, dominant discourses, gender biases, funding priorities, political will, mitigation focus, failure to address underlying inequalities, ideological resistance	Political and social marginalisation and discrimination; lack of mainstreaming of climate change as a national issue in development – not yet treated seriously; corruption;

Further Reading/Resources

[Leary N, Conde C, Kulkarni J, Nyong A, Pulin, J. Climate change and vulnerability. Earthscan Climate, London; 2008.

Moser SC, Boykoff MT. Successful adaptation to climate change. Linking science and policy in a rapidly changing world. Routledge, Oxon, New York; 2013.]

Related articles from WIRES Climate Change

Conway, D. Adapting climate change research for development in Africa. WIRES Climate Change, 2011, 2:428-450.

Mortimore, M. Adapting to drought in the Sahel: lessons for climate change. WIRES Climate Change 2010, 1:134-143.

Naess LO. The role of local knowledge in adaptation to climate change 2013, 4:99-106.

Ziervogel G, Ericksen PJ. Adapting to climate change to sustain food security. WIRES Climate Change, 2010, 1:525-540.