

**CLIMATE CHANGE COMMUNICATION FOR ADAPTATION: MAPPING COMMUNICATION
PATHWAYS IN SEMI-ARID REGIONS TO IDENTIFY RESEARCH PRIORITIES**

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ABSTRACT

Communicating climate change effectively is an essential step towards creating an enabling environment for widespread societal adaptation. Yet less attention has been placed upon exploring what is known about effectively communicating climate change for adaptation in semi-arid regions, despite their uniqueness. The purpose of this paper is to review the literature on the climate adaptation communications challenge in the drylands of Africa and Asia. The paper maps out the current state of knowledge on how climate change information is communicated, accessed and used for adaptation within the drylands of Africa and Asia. It reveals insights into the unique contextual challenges faced by climate communications efforts in drylands, such as power and equity dimensions of knowledge generation and access. A move towards more dialogic forms of communication and knowledge generation is noted as one potential solution with clear tensions associated with issues of scale and the effectiveness of communication outcomes.

Keywords: climate communication; usable information; adaptation; dryland; Africa; Asia

INTRODUCTION

Effective and appropriate communication of climate change is increasingly stressed as a critical factor affecting climate change adaptation responses by different stakeholder groups (Filho, 2009, Moser, 2014; Moser and Ekstrom, 2010). Successful communication can help to bridge the science-action gap on climate change, allowing individuals and communities to understand the problem, raise awareness, encourage dialogue and influence behavioural change (Moser and Dilling, 2012; Nerlich et al. 2010). In developing countries this issue presents itself as a unique challenge, whereby communicators are confronted not only by the complex convergence of scientific, practitioner and traditional knowledge systems (Naess, 2013; Kihupi et al. 2003) but also sensitivities surrounding power and agency dynamics among the rural poor. Some climate communications processes can serve to unintentionally legitimise or prioritise certain forms of knowledge and in doing so reinforce structural power relationships (Harvey et al. 2012). The accessibility of climate information for marginalised groups through certain climate communications channels, learning processes or modes of knowledge transmission could also vary significantly according to the approach taken. This challenge is particularly pertinent for semi-arid developing world regions, which have been identified as zones of historic marginalisation, with acute human vulnerability to climate change (Wilby et al. 2009; Tucker et al. 2015). This raises questions about how effective current communications efforts in the global south, and specifically its semi-arid regions, are at influencing changes in perception and social change around the challenge of climate change adaptation.

Over the last decade, integration of climate information and concerns into policy and planning in developing countries has become an international priority (Wilby et al. 2009; Pringle and Conway, 2012). While the use of climate risk information and risk assessment tools for development planning through so-called “climate mainstreaming” has grown significantly, the integration of climate information into adaptation planning is lagging significantly behind work on impact assessment (Wilby et al. 2009). The proliferation of sectoral impact assessments in adaptation research to date also reflects the dominance and appeal of physical science approaches for planners, over more nuanced social science research (Tschakert, 2007). However, wider recognition that these perspectives often result in the top-down generation of technical climate information with limited local level utility has prompted a more recent shift towards more people-centred climate risk and decision making (cf. Pringle and Conway; Tshakert, 2007; Paavola and Adger, 2006).

With the emergence of such approaches has come a growing awareness of the importance of analysis on subjective factors in community adaptation, such as how communities themselves cognitively perceive the process of adaptation (Kuruppu and Liverman, 2011; Pringle and Conway, 2012). At the same time, critical assessment of the effectiveness and limitations of existing communication approaches to drive and/or support social and behavioural change in the developing world and the implications of these knowledge gaps for climate communications research has been the subject of less attention. There is a need to know more about how to communicate climate change effectively to facilitate behavioural change and social learning processes in developing country contexts. What do current attempts and available research results teach us?

The purpose of this paper is thus to review the current state of knowledge on how climate change information is currently communicated, accessed and used for adaptation within semi-arid developing world regions, with a focus on the drylands of Africa and Asia¹. The paper draws on a review of existing academic and grey literature on climate change communication

¹ We broaden the focus of our analysis from semi-arid regions to dryland regions generally (including arid, semi-arid and sub-humid areas where mean annual evapotranspiration (PE) ranges from 0.05 to 0.65 after Hulme 1996) since these all share similar characteristics (low and variable rainfall, extreme air temperatures, seasonally high potential evaporation, livelihoods reliant on mobile pastoralism and to a lesser extent rainfed/irrigated farming). By broadening our review to

and its role within adaptation, focused particularly on the vulnerable rural poor conducted during a preliminary phase of research under the five-year Adaptation at Scale in Semi-Arid Regions (ASSAR) project².

The paper seeks to answer the following questions:

1. What is known about how climate change and adaptation is currently perceived by people in the drylands of Africa and Asia?
2. What – if anything – is unique about the climate-communications challenge in these drylands?
3. What is known about the current diversity of channels used for climate change and adaptation communications in drylands and how does this activity compare with key principles emerging from broader climate communications scholarship?
4. What is known about the effectiveness of communication for climate change adaptation in drylands?
5. What are the critical research gaps for improved climate change and adaptation communications in drylands?

The paper is structured as follows. Section 2 starts by positioning this review within the boarder emerging field of climate communications scholarship and establishes the key principles from prior global reviews of available research for effectively tackling the climate adaptation communication challenge. This sets the scene for the paper by both outlining key principles concerning communication for adaptation and current knowledge gaps in the field. Section 3 describes the methodology used within the associated literature review. Section 4 briefly reviews knowledge related to climate perceptions at the local level in the drylands of Africa and Asia, and Section 5 provides an overview of the main climate-communication approaches used in these regions. These approaches, their associated knowledge gaps and barriers to communication are discussed in detail in Section 6. Section 7 concludes by reflecting on how these barriers and knowledge gaps reflect those identified in the wider climate communications literature and the implications of these gaps for adaptation in drylands in particular.

RESEARCH PRIORITIES FOR CLIMATE COMMUNICATIONS

To begin, we ask what wider reviews of the rapidly growing body of scholarly work on climate change communication suggest are important principles for ensuring effective communication and critical priorities for research. This step is important since several authors stress the late arrival of social science enquiry to this issue and that progress on many early climate communication efforts by physical scientists and environmentalists would have been enhanced by learning documented in the wider communication and behavioural research fields (Moser, 2010; Nerlich, et al. 2010). There has been a mismatch between climate knowledge production and use, and the knowledge demands and requirements of different stakeholder groups (Dilling and Lemos, 2011). This has prompted a series of systematic reviews of the climate communications literature (cf. Moser, 2010; 2014; Nerlich et al. 2010; Moser, 2016) and we attempt here to briefly summarise the most salient observations on communication effectiveness for adaptation, and knowledge gaps identified for the climate communications research agenda. Later in this paper we revisit these observations and reflect on whether

drylands we aimed to capture a wider knowledge base from the literature and as a result enhance the analysis and the relevance of the resulting recommendations. .

² <http://www.assaradapt.org/>

or not these differ from fields of communications activity and knowledge gaps emerging from our review of the drylands climate communications literature.

From global reviews of climate communications scholarship, several key principles are stressed as important. These include the importance of identifying clear goals from the outset to help guide choices regarding relevant approaches to communication, the importance of understanding the audience and conveying climate information through credible messengers, and the importance of engaging people emotionally or ensuring appropriate framing of the message (Moser, 2010; Nerlich et al. 2010). Nerlich et al. (2010) stress there is no direct correlation between communication and behaviour change, and that a mix of measures, alongside communication, are needed to embed approaches more directly to practical behaviour in social life. Moser (2014) argues that communicating adaptation is a unique challenge, given that it involves progressive and continual change with long lag times and uncertainties. As a response to this unique problem public engagement on adaptation through small-scale interactions such as workshops is stressed as an effective means to increase knowledge, foster deeper dialogue and transcend political, social or cultural differences (ibid, p.350).

Reviews of the communications literature reveal that approaches that involve face-to-face communication are often more persuasive and effective at influencing personal behaviour than mass-media communication (Moser and Dilling, 2007; Moser, 2010). However, while these dialogic forms of communication counter the shortcomings of a prior tendency for top-down, one-way technocratic information dissemination approaches, there may be an apparent trade-off to be made between the urgency and scale of the response required (and associated mass-mobilisation communications tools), and the need for more effective, interactive approaches that facilitate social learning. For example, Moser (2010) stresses that dialogic forms of communication such as two-way interactive approaches contrast with the potential need for widespread mobilization of action on climate change, and calls for empirical exploration of the role of dialogue for engagement and societal response on the issue.

Effective communication for adaptation is also a particularly unique challenge, since little is known about the acceptability of adaptation in various contexts or how to communicate the need for adaptation responses (Moser, 2014; 2010). Significant usability gaps also remain between the supply of climate information and demand for this information for policy design or the creation of solutions, with improving the two-way flow of information between both sides advocated as a way forward (Kalafatis et al. 2015). Bidwell et al. (2013), for example, argue that the sharing of information between scientists and decision makers is rarely linear, and suggest that a potentially effective way to disseminate knowledge to enable effective adaptation responses to climate risks across broad communities of users is through specialised knowledge networks. Tschakert and Dietrich (2010) go further by stressing the need to create communication networks that can facilitate anticipatory learning given the absence of communication tools and knowledge networks for encouraging regular exchange of information on adaptation within complex vulnerability contexts such as African drylands.

In summary, numerous knowledge gaps and research priorities are stressed including: better understanding of the importance of different messengers for different audiences; the promise and limits and most appropriate use of new media or innovative forms of cultural expression (i.e. theatre and music) for different types of public engagement; the effective and ethical use of visualisation to convey climate change information; and greater understanding on how the public perceive the issue of adaptation (Moser, 2016; Moser 2010). However, despite growing interest in the wider topic of climate communications for adaptation, much less is known about effective communications for decision making and societal adaptation in developing countries.

Before we begin detailing the results of our analysis of the literature on communication for climate change adaptation in drylands, we should make explicit what we considered “effectiveness” in our evaluation of outcomes expressed. Given our review sought to investigate the full diversity of activity from the evidence base on communication for climate change adaptation in drylands (i.e. from one-way information provisioning to awareness raising, public engagement and learning networks), we took a similarly broad approach to evaluating evidence for effectiveness in the communication outcomes reported in the literature. Effective communication outcomes evaluated ranged from cognitive awareness raising, behavioural responses (i.e. changes in climate-related behaviour or political action) to active social learning through knowledge networks.

In the next section, we briefly describe the methodology used for the literature review which informs this article. We then describe what we learnt from the reviewed literature regarding how climate change is currently perceived and understood by various actors in drylands, before summarizing the main communications approaches used to facilitate social learning and action for climate change adaptation.

METHODOLOGY

The review is based on a synthesis of available literature on communicating climate change impacts and adaptation in Africa and Asia, with a particular focus on establishing the state of scientific knowledge on communications approaches currently used within drylands. The research methodology draws upon an academic and grey literature review conducted as a preliminary phase of research under the Adaptation at Scale in Semi-Arid Regions (ASSAR) project. While not aimed at providing a full systematic or comprehensive review of existing literature on the subject, the approach involved defining clear search terms and a range of search strategies, followed by a review of the most relevant literature. The bibliographic databases searched included Web of Science, Scopus and Google Scholar. The search was limited to literature from the year 2000 onwards and a range of potentially relevant keyword search terms and their combinations were used such as: ‘climate change communication AND drylands AND (Africa OR Asia)’; climate change AND communication AND (semi-arid OR arid OR sub-humid) AND (Africa OR Asia); climate change AND innovative communication AND (Africa OR Asia)’; ‘climate change AND adaptation AND information technology communication AND (Africa OR Asia)’. The results were screened for those specifically related to these search terms. The search was supplemented by a collection of relevant peer-reviewed articles and book chapters, along with a range of grey literature reports from relevant projects or climate change planning departments gathered through wider searches of the same databases.

A total of 92 relevant documents were collected and analysed through the review process, including 35 peer reviewed journal papers and 57 grey literature documents. For the full comprehensive bibliography see INTASAVE (2015). Geographically, more research papers investigating African country-specific case studies emerged (37), than those drawing upon contexts within Asian countries (9). The articles identified in the academic literature were diverse covering a wide range of climate communication approaches and research topics, from use of radio, information technology and mobile phone based approaches, and issues concerning the integration of scientific and indigenous knowledge. Whilst most articles focused on specific case studies from Africa or Asia, there were some articles on broader themes of climate communication, which do not take a regional focus. The number of articles relating to each review question established in section one is outlined in Table 1. This illustrates the active area of scholarship specifically focussed on local perceptions and understandings of climate change in drylands, whereas the evidence base supporting questions two to five was embedded more within non-specific articles retrieved from the search.

Table 1 Number of search articles covering review research questions

Review question	Total number of articles containing some content related to review question	Total number of articles closely related to review question	Comments
1. Perceptions and understanding of climate change in drylands	27	17	Investigations of community perceptions and understandings of climate change is an active area of scholarship with most works emerging from Africa (cf. Churi et al. 2012; Kalungu et al. 2013; Roa et al. 2011 ; Speranza et al. 2010; Silvestri et al. 2011; Simelton et al. 2011; Patt and Schröter, D., 2008. Ogalleh et al. 2012; Anandaraja et al. 2008)
2. Unique challenge of climate change communication in drylands	32	2	Few specific papers, yet some treatment of this issue within dryland/Africa texts (cf. Tschakert & Dietrich 2010; Seely et al. 2008)
3. Diversity of communication channels	46	3	Few specific papers, yet some studies reviewing in detail the diversity of approaches used for adaptation planning (cf. Jost 2013; Wilby et al. 2009)
4. Effective communication in drylands	46	2	Few specific papers, yet some treatment of this issue within dryland/Africa texts (cf. Dinku et al. 2014; Hansen et al. 2011)
5. Research gaps for communication and adaptation in drylands	35	0	No specific works seeking to investigate communication for adaptation research gaps in drylands, yet numerous gaps stressed across the searched literature

CLIMATE PERCEPTIONS AND UNDERSTANDING IN DRYLANDS

Understanding local-level perceptions around climate change risks and adaptation responses is an important starting point for those seeking to effectively situate the challenge of communicating climate change adaptation (Moser, 2014). Researchers are increasingly stressing the importance of understanding subjective factors such as how communities cognitively perceive the process of adaptation as critical to explaining adaptive behaviour (Pringle and Conway, 2012). Tschakert (2007) stresses that beyond basic resource availability, adaptive capacity depends largely on the extent to which the problem is understood, knowledge is accessible to vulnerable groups and policy makers, and adaptive responses are recognized and available. This section briefly examines the most salient observations emerging from the literature on perceptions and understandings of climate change risks and adaptation responses in the drylands of Africa and Asia. The intention here is to review critical findings emerging from the drylands of Africa and Asia on how climate change is perceived relevant to the process of communication, rather than provide a comprehensive review of this area of study.

There is a growing body of literature emerging from the drylands of Africa and Asia on local perceptions of climate change, although it should be noted that research activity appears biased towards sub-Saharan Africa (Osbaahr et al. 2011; Gbetibouou 2009; Mbilinyi et al 2013; Rao et al. 2011; Macharia et al 2012; Moyo et al. 2012; Simelton et al 2011; Speranza et al. 2010a; Kalungu et al. 2013; Nyanga et al. 2011; Patt & Schroter 2008; Tschakert, 2007; Jodha et al. 2012). For example, a study of local perceptions of climate variability and adaptation responses in northern Kenya drylands demonstrates how rural people do observe and perceive climate change and stresses the importance of this analysis for understanding entry points for climate policy interventions (Ogalleh et al. 2012). However, wider reviews from Kenya reveal that awareness of climate change at the community level remains low, with farmers finding differentiating climate impacts from those caused by local environmental degradation a challenge (Mutimba et al. 2010). In semi-arid India farmers show close awareness of the role of climate in farming enterprise performance and risk, illustrating the importance

of improving climate information dissemination programmes (Jodha et al. 2012). These observations support those of broader global reviews of public perception studies from a wide range of geographies, which all suggest significant percentages of individuals are observing climate changes and believe they will grow into more of a significant challenge (Moser et al. 2014). However, at the national scale public perception surveys rate African countries are still least aware, compared to those from the developed world (Pelham, 2009).

Additional work is required to move beyond farmer perceptions, to include and contrast the social constructs of non-professionals with those of other more expert actors involved in the wider drylands adaptation-development spectrum (Few et al. *submitted*). Relatively less attention is given to understanding how important actors from policy, practitioner or media groups perceive climate variability and change, and where important knowledge gaps and information needs exist. That said, a handful of studies have attempted to provide such analysis in a variety of contexts. In Senegal, conceptual mapping with farmers, extension agents and local government revealed considerable gaps and misconceptions in climate knowledge, particularly related to meteorological causal factors behind variability, leading to the conclusion that adaptive capacity could be significantly improved through better understanding of the problem and available adaptation strategies (Tschakert, 2007). Patt and Schroter (2008) similarly found significant disparities in how farmers and policy makers perceive climate risks in Mozambique leading to differences in the desire to take action. They conclude that simply providing information about climate change and risks, may not easily facilitate a change in perception and willingness to take action.

The climate change perceptions research agenda should also not neglect analysis of climate change knowledge and perceptions of other actors important to communications pathways, such as those involved in various forms of news media. Indeed, studies show the important role the media can play in mainstreaming climate change concerns into other policy arenas, framing public discourse and perceptions, and serving as an information source on scientific matters, and even confounding public understanding of climate change (Moser, 2014; Boykoff, 2007). Relatively few studies have attempted to investigate this issue in sub-Saharan Africa or Asia. In Zambia, surveys of print media journalists found that editors and journalists had little interest in covering climate change adaptation due to low levels of knowledge on the issue and the low literacy levels of the intended recipients (Harbinson et al. 2006). Where media communicators have been exposed to basic science training and information from professional scientists through training workshops in eastern and southern Africa the results have been a dramatic shift in the effectiveness of communication delivery (Moser and Luganda, 2006).

CLIMATE-COMMUNICATION IN DRYLANDS

This section briefly sets out the range of communication channels documented within the climate-communications literature currently used to reach vulnerable communities in the semi-arid regions of Africa and Asia. The full range of information on climate change and adaptation communicated through these channels is then summarised from the reviewed literature. Finally, the section concludes by discussing the relative accessibility of these approaches with particular reference to access by the poor in the drylands.

Based on the literature review, seven dominant communication channels currently used in the dissemination of climate information in the drylands of Africa and Asia were identified (cf. Gambhir and Kumar, 2013; Kalungu et al. 2013; Mamun et al., 2013). Each of these communications channels are summarised in Table 2, along with a short summary of the typical types of climate information communicated through these approaches. For a more complete description of these see INTASAVE (2015).

Table 2 Climate-communication channels in the drylands of Africa and Asia

Channel	Description
Radio	Radio widely used to convey climate information such as seasonal forecast data, often combined with market information or agricultural productivity advisories. Radio formats range from weather/seasonal forecasts, to the use of radio dramas or factual farm based programmes.
Television	Often used to support improved practical application of agricultural practice alongside climate relevant content. Show-and-tell type approaches such as television reality shows and farmer-field schools used in parts of Africa and Asia.
On-farm demonstrations	On-farm approaches such as farmer-field schools are used by practitioners to communicate-climate information alongside technical agricultural extension advice. Access to information through these programmes is dependent on the presence and geographical reach of donor funded programmes.
Community gatherings/ forums	Community gatherings, religious forums or workshops that involve community-based-organisations are occasionally used to specifically communicate climate related information. Increasingly development actors are using innovative localized communications approaches such as storytelling, visual imagery, experiential scenarios and community theatre to convey climate information or facilitate social learning for adaptation.
Mobile phone	Widely used throughout Africa and Asia to disseminate climate information, often alongside sector related information such as market prices or agricultural advisory services.
Online approaches	Several online knowledge platforms and networks are used by NGO practitioners, researchers and policy makers in Africa and Asia to access climate information and best-practices for climate change adaptation. These knowledge platforms form part of a “community of practice” as a method to disseminate learning and facilitate uptake of best practice.
Printed media	While printed media distribution networks are often more accessible to people outside of the drylands, climate information is regularly provided through this communication channel. Information disseminated tends to focus on short-term climate risks, rather than communications for adaptation.

Information communicated through these channels ranges from the dissemination of data on short-term climate risks and variability to information related to longer-term adaptation responses (Table 3). Examples range from information on seasonal climate forecasts (e.g. the onset and timings of rains), to disaster early warnings (which in drylands particularly relate to droughts and floods, see e.g. Luseno et al. 2003; Mokotjo and Kalusopa, 2010), and extension advisories on adaptation practices (Tambo and Abdoulaye, 2012.). The broad range of research activity within the communication for climate change and development literature from Africa and Asia perhaps reinforces the observation that over the last decade approaches have moved beyond information provisioning to awareness raising and public engagement (Harvey et al. 2012; Moser, 2010; Nerlich et al. 2010). The extent to which this trend has been influenced by scholarly work stressing the need for a wider treatment of the climate-communications discourse across the social and natural sciences, requires deeper systematic analysis within the literature.

Table 3 Range of climate risk and adaptation information communicated

Climate information	Dissemination channels	Citations
Climate seasonal forecasts <i>(includes observation/monitoring data, forecast and outlook data)</i>	Typically disseminated through regional meteorological centres, media (radio, TV, monthly bulletins), extension services, meetings (workshops, village meetings), mobile phones (SMS subscribed services), internet (online knowledge platforms),	Luseno et al., 2003; Anandaraja et al., 2008; Tall et al., 2014a; Tall et al., 2014b; Tall et al., 2014c; Cabana, 2012; Kanno et al., 2013
Disaster early warnings <i>(climate risk data; risk profiles for natural disasters such as flooding, emerging drought, land-slides, typhoons etc.)</i>	Typically disseminated through national meteorological centres, mobile phones (SMS alerts), media (radio, TV, newspapers, social media)	Cohan & Munro, 2011; Wickramasinghe, 2011; Tall et al., 2014a; ALIN, 2013; Giri & Malakar, 2011; Luseno et al., 2003; Ogalleh et al., 2012
Adaptation responses <i>(includes advisories on adaptation practices and response strategies, climate resilient agricultural production methods, short term coping strategies)</i>	Typically disseminated through media (radio, TV, printed media, social media e.g. magazines), meetings (workshops, community meetings, school events), plays & drama, extension services, mobile phones (calls and SMS), internet (online knowledge platforms)	Tambo & Abdoulaye, 2012; Kristjanson et al., 2014; Saravana, 2011; Churi et al., 2012; Bisht & Ahuwalia, 2014; Kangalawe & Lyimo, 2013; Mokotjo & Kalusopa, 2010;

Few studies have conducted comparative analysis to evaluate the relative effectiveness of different communications channels to disseminate climate information to vulnerable or gender differentiated groups, or key decision makers. This is increasingly emphasized as a priority for social research, particularly in drylands (Dinku et al., 2014; Few et al. *submitted*). Those case studies that do discuss the potential of differing climate communications channels to reach target audiences across sub-Saharan Africa or Asia reveal radio and mobile phone approaches have a far higher geographical reach and target greater numbers of people compared to other forms of mass media communication technologies such as television or online approaches (Harvey, 2011; Bisht and Ahluwalia, 2014). That said, limited access to reliable power and widespread poverty reduce the effectiveness of some mass media information communications technologies to reach the poor, particularly online learning or television. For example, an ICT based climate-development communications programme in NE India, which involved establishing village learning centres, faced significant challenges with power cuts necessitating the use of various back-up offline options and printed media (Saravanan, 2011). Similarly, in household surveys of farmers within 12 agro-pastoral transition sites in eastern Africa, Rufino et al. (2013) found large variations in households able to access mobile phones from levels of 0-100%, and an average accessibility level of approximately 54%.

Issues associated with limited infrastructure are compounded by low literacy levels, high levels of poverty and mobility, particularly within pastoralist groups. Luseno et al. (2003) surveyed pastoralists in dryland areas of Kenya and Ethiopia to investigate accessibility of external forecast information and found that one-fifth of the pastoralist population accessed modern forecasts, roughly equal to those owning radios. They found that other external forecast sources (television, newspapers, other printed material, government or non-government extension agents) reach less than 3% of the population in the pastoralist communities surveyed (*ibid*, p.1485). Exactly how equitable access to this external climate information is remains unclear, however.

Through investigating the value of climate forecasts in the drylands of eastern Africa, Luseno et al. (2003) stress that greater effort needs to be given to researching what infrastructural and institutional advances are necessary to facilitate access and use of climate information by pastoralists. Based on work with rural farming communities in semi-arid Tanzania, Churi et al. (2012) also emphasize that greater research effort is needed on the accessibility of external knowledge, particularly through information communication technologies. However, the policy environment in some drylands of Africa and Asia may be directly supportive of improved knowledge access. In their review of national policies focused on the drylands of Kenya and Tanzania, Speranza et al. (2010b) found 17 separate policies that directly encourage improved access to knowledge and information within rural areas. Yet they stress the various challenges constraining the provision of reliable climate information requiring sustained financial and technical support (ibid: 120).

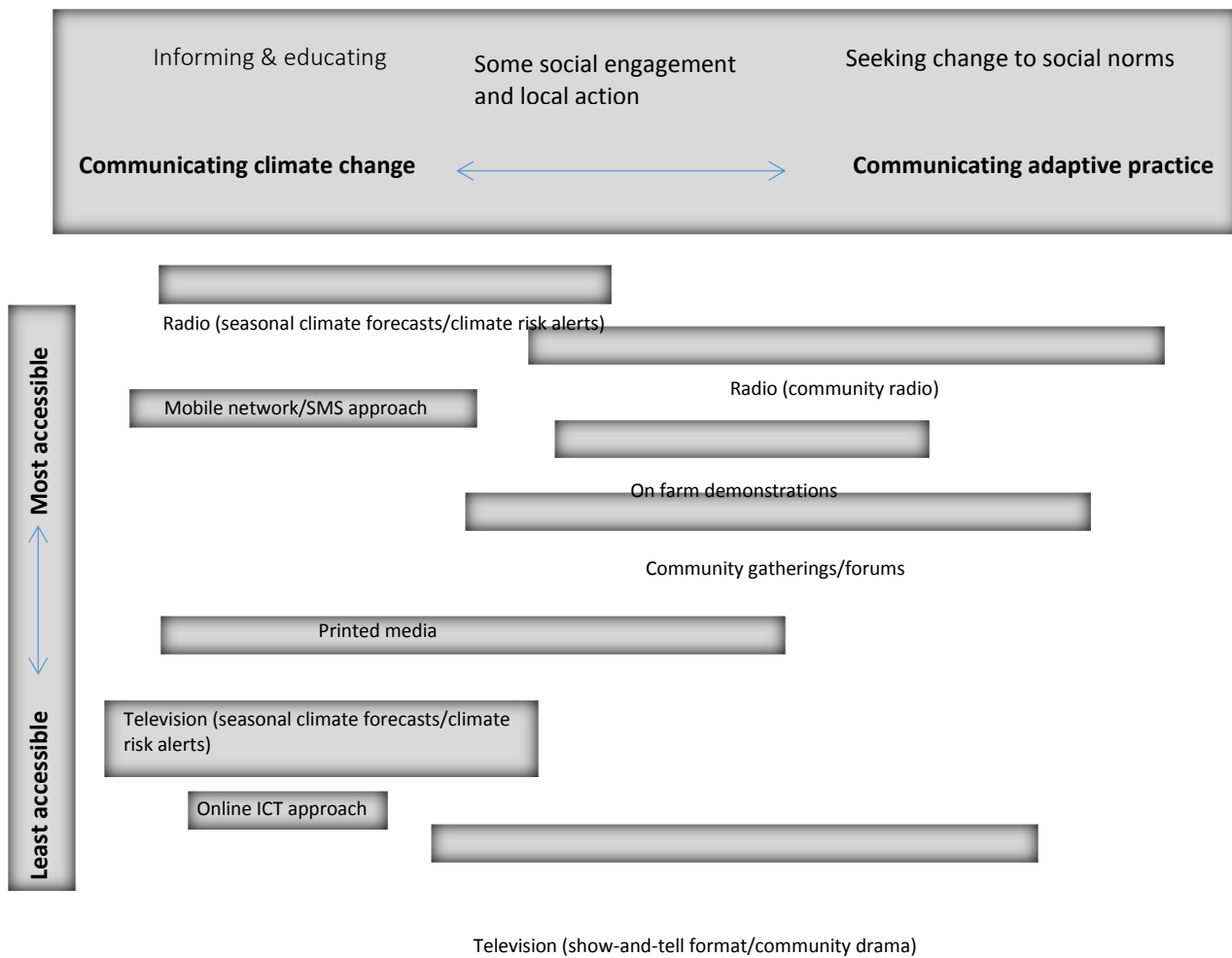
ANALYSING APPROACHES AND BARRIERS TO COMMUNICATION

Understanding and evaluating both scientific and cultural discourses is vital for those interested in effectively communicating for social or behavioural change on climate change (Nerlich et al. 2010). Yet despite increasing evidence that farmers in vulnerable drylands observe and perceive longer term climate changes (Section 4), climate change per se remains one ‘cumulative, diffuse, slow-acting and insidious’ stressor among many, leaving local decision makers uncertain on how to act (Tshakert, 2007: pg. 383). Perceptions and understandings of realities at the farm level in sub-Saharan Africa related to the adoption of new behaviours or technologies are shaped by various social processes, practices and defined by various knowledge systems (Meijer et al. 2015). Within such dynamic contexts where scientific and traditional knowledge systems converge to varying extents, and knowledge and action emerge from ideas, practices, discourses and local perceptions of risk: what do we know from the communication literature about how to effectively communicate climate change to enable social learning and adaptation action among the poor?

Several authors have attempted to categorise climate change communication approaches based on their specific aims, since defining clear goals for the outcomes desired are essential to guide choices towards appropriate delivery mechanisms (Moser, 2010). Harvey et al. (2012), present three broad groups of communication approach by adapting the goal-focused categories distinguished by Moser (2010) for climate change communication in the global south (and recognising that this categorisation does not necessarily imply incremental usage or the ability of communication alone to achieve the desired goals). These include approaches that aim to inform and educate individuals about climate change; approaches that achieve some type and level of social engagement or action; and approaches that seek to bring about changes in social norms and cultural values. This continuum of approaches range from a straightforward “information dissemination” model, to more process orientated approaches designed to facilitate social learning (ibid, p20). To try and understand issues related to communication effectiveness, this section reviews fields of knowledge documented in the literature related to the main climate communication channels identified in Section 5. Through this section we organise fields of climate communications activity into three groups (technology centred; people centred; and mixed approaches) and consider where certain communication approaches lie along the continuum of climate change communications aims posited by Harvey et al. (2012).

Figure 1 draws on some of the specific climate communications activities described in Section 5 and suggests where each might be considered to lie on a climate change communication continuum. We add an accessibility dimension to this representation based on the preliminary observations made in Section 5 from the reviewed literature.

Figure 1 – Locating communications approaches on a climate change communications continuum



The continuum presented demonstrates the utility of certain communications approaches towards addressing particular goals related to climate change communication. While the representation of approaches in Figure 1 is designed to be more indicative than precise, and by no means implies these applications in reality are (or indeed should be) used in their discrete form, it clearly shows a number of approaches in their current form have limited scope in achieving multiple communications goals. The continuum as presented here for the drylands of Africa and Asia also shows considerable overlapping scope for most approaches, yet a bias toward approaches currently focused on the informing and educating end of the continuum. Both radio and television approaches lend themselves to multiple goals, with the former more accessible and agnostic to communications goal or objective.

The following section now provides a short overview of key state-of-the-art knowledge on known applications of each of these fields of climate communications activity in the drylands of Africa and Asia and a summary of what is known about efficacy and impact towards the intended goal. While not intended as an exhaustive review, this section presents the most apparent examples from the literature. As previously discussed we organise these fields of activity into three groups; technology centred, people centred and mixed approaches.

Technology centred

Short message service (SMS) based systems are widely used throughout Africa and Asia to disseminate information related to agricultural productivity, marketing and early warning information (Hansen et al. 2011; Churi et al., 2012; Luseno et al., 2003; Mittal, 2012; Saravanan, 2011; Tall et al., 2014b). Ownership and use of mobile phones is reported to be wider among the rural poor of Asia than Africa, although the market in Africa is rapidly increasing (Jost, 2013). Using SMS systems to disseminate climate information is also common, often where seasonal climate forecast information is disseminated alongside agricultural extension services or marketing information (ALIN, 2013; CARE International, nd; Churi et al., 2012). However, Hansen et al. (2011) report pilot scale successes of combined climate-agriculture mobile phone based information systems across sub-Saharan Africa have been difficult to sustain or scale up, although they omit to suggest the primary cause for this. Some authors stress how SMS based information systems are most effective when used to disseminate timely and urgent messages that enhance rapid responses to climate-related risks (Wickramasinghe, 2011).

Print media is also used both in the form of mass-communication through newspapers and other printed materials. These are typically used to disseminate short-term information related to climate risks, rather than longer-term adaptation responses. For example, the Kenyan Meteorological Department (KMD) provides a three-month seasonal outlook for printed media dissemination, alongside radio and television outlets (Speranza et al., 2010a; ALIN, 2013). Regular access to newspaper information may be a challenge in drylands, however. As noted previously, surveys among pastoralist communities in the drylands of Kenya and Ethiopia reveal external forecast information from newspapers and other printed material reached less than 3% of the population surveyed (Luseno, 2013, p.1485).

Radio is the most common technology centred climate-communication channel used to reach rural communities in the drylands of Africa and Asia (BBC World Service Trust, 2010a; Churi et al., 2012; Kalungu et al., 2013; Hansen et al. 2011). Its broadcast signal can easily reach a wider range of audience with detailed information; and in some vulnerable dryland communities radio ownership is reported to be widespread (ALIN, 2013; Mittal, 2012). That said, while radio may have potential to reach large populations of rural poor, some observe that many local stations in Africa have small ranges (Jost, 2013; Tall et al. 2014). The ways that radio has been used vary from more traditional top-down climate information dissemination approaches used to disseminate scientific knowledge (seasonal climate forecasts) (BBC World Service Trust, 2010a; Luseno et al., 2003; Mpandeli & Maponya, 2013) to independent radio broadcasters or community radio where innovative bottom-up co-production techniques (indigenous knowledge & scientific knowledge) are frequently used. Radio programmes often convey climate information alongside relevant agricultural advisory information related to markets or improved production techniques. In India for example, the Shubh Kal radio shows are used to disseminate seasonal outlook and information on no/low regret adaptation options (Bisht & Ahluwalia, 2014).

Some potential climate and weather information users such as NGO practitioners, researchers and policy makers in Africa and Asia are now embracing the use of online knowledge platforms and networks or “communities of practice” as a way to disseminate adaptation actions and share lessons from ongoing climate change projects (Harvey & Mitchell, 2011; Jackson et al., 2014). Knowledge platforms such as SEA Change, an Asian community of practice on climate intervention³, AfricaAdapt⁴, an African knowledge sharing platform on climate change adaptation information, and weADAPT⁵, an online platform supporting adaptation practices in developing countries bring together practitioners, decision makers and

³ <http://www.seachangecop.org>

⁴ <http://www.africa-adapt.net>

⁵ <https://www.weadapt.org/>

even community-based organisations to share their adaptation practices through written stories, videos and geo-referenced case studies (Harvey & Mitchell, 2011).

People centred

People centred approaches to climate communication facilitate face-to-face interaction, personal interactive feedback sessions (such as through intermediaries, or formal stakeholder engagement at community meetings and workshops) and are most preferred and valued among local communities in SARs in Africa and Asia (Bisht & Ahluwalia, 2014; CARE International, nd; Hansen et al., 2007; Luseno et al., 2003; Njuki, 2013). This is because they promote direct engagement of community members with experts, scientists and practitioners and thus support social learning and faster understanding and uptake of climate change adaptation practices. For example in East Africa, the NGO CARE International conducts participatory workshops with community members and meteorology officers to assist the dissemination of seasonal outlooks and support the community in participatory planning (CARE International, nd; Nderitu and Ayamga, 2013). In the drylands of Kenya, Njuki (2013) report that while access to climate forecast information enabled timely decisions and on-farm actions, farmers rated face-to-face information exchange and access as their preferred method, over radio or mobile phone based communication channels. However, other studies from Kenya's drylands find that current face-to-face dissemination of climate information for adaptation by local opinion leaders can be inadequate and confusing, but concludes that with enhanced training and support this communication approach could be highly effective at influencing social learning and change (Muchunku et al. 2014).

Mixed approaches

These approaches tend to involve a combination of technology-centred delivery mechanisms, blended with people-centred knowledge co-production techniques to generate climate-communications material which is more usable at the local level. For example, several studies stress the importance of face-to-face interaction in climate-communication where farmers are able to clearly describe their problems and become involved in the process of information exchange and knowledge generation (Bisht & Ahluwalia, 2014; Saravanan, 2011). For radio programming this is particularly important for developing effective content that can appeal to local contexts. For example, in India, radio programmes are enhanced with 'listener groups' and on-farm groups that demonstrate adaptation practices to farmers (Bisht & Ahluwalia, 2014). Based on research with radio broadcasters in Ghana, Harvey (2011) argues that the effectiveness of community radio can be significantly enhanced if programmes include active listening content such as question and answer segments, and broadcasters themselves are actively engaged in the process of inquiry, interpretation and transmission of information and messages through these segments.

Show-and-tell type approaches such as television reality shows and farmer-field schools have proven effective in both African and Asian contexts (Kristjanson et al., 2014; Saravanan, 2011). Television programmes can be used to attract and maintain audience attention, to support learning, and to show practical ways of applying adaptation practices (Bisht & Ahluwalia, 2014; Kristjanson et al., 2014; Saravanan, 2011). For example in East Africa the TV show 'Shamba-shape-up' is well-known by the public for its dissemination of climate-smart agriculture information to farmers across Kenya and providing expert advice on different farming related challenges (Kristjanson et al., 2014). The extent to which television as a media can be effective to reach the remote, resource poor, drylands communities remains to be seen, however. Tall et al. (2011) observe that mobile phone based information systems are now being developed to enable two-way

communications between farmers and experts, citing several examples from Uganda and Kenya (p.24). There are also a number of examples of community knowledge centres which combine access to e-learning platforms, alongside other information services such as libraries, community radio and phone information services (Tall et al. 2011). So far this approach is more widely applied in India, than sub-Saharan Africa as poor levels of internet connectivity limit its application, however (Hansen et al. 2011).

DISCUSSION

In many ways the climate communications challenge in developing countries and drylands in particular is unique. Not only are these resource-poor regions beset by knowledge accessibility constraints, there are also historic prejudices surrounding traditional knowledge systems which have been further marginalised by a tendency for one-way dissemination and prioritisation of northern produced knowledge (Harvey et al. 2012). In recent years, there has been a growing interest in how communication tools and approaches might best enable local analysis of climate realities by vulnerable communities thus enabling these groups to fully engage in the process of adaptation and knowledge generation around appropriate solutions (Pringle and Conway, 2012). These are similar to observations from the wider climate-communications literature *per se*, which stress the importance of engaging people in two-way communication, alongside setting clearly defined communication goals and developing greater understanding regarding target audiences (Nerlich et al. 2010; Moser, 2014).

The importance of selection bias and overcoming power relations within public engagement processes on adaptation and climate change is also stressed in both the developing country literature (Harvey et al. 2012) and wider global reviews (Moser, 2014). Many of the studies reviewed emphasize the enhanced effectiveness of communications that are people centred and engage in local dialogue or the co-generation of knowledge to enhance legitimacy, usability and relevance in order to achieve specific goals for climate change adaptation. Again these sentiments are echoed in the wider climate change communications literature (Moser, 2010; 2014). However, language is also a significant barrier to effective communication stressed in the literature from Africa and Asia. When climate knowledge is communicated to local communities in official national languages, rather than local languages it is difficult for communities to understand or relate to information (Roncoli et al. 2008; Simelton et al. 2011; Muchunku et al. 2014). There are stark differences also in the relative importance of different communications channels, with newspaper and television found most important in European and US contexts, whereas radio and informal communication channels are far more essential in resource poor African contexts, for example (Moser and Luganda, 2006).

Our review shows an evolution of approaches from a prior focus on one-way communications aimed at informing and educating, towards more people-centred methods that aim to enable social engagement, learning and action on climate change. While this movement may or may not be a conscious reaction towards the limitations of one-way approaches to produce locally-relevant information, our review shows that putting the vulnerable first in climate communications also presents a unique set of challenges for communicators. First, people-centred approaches are resource intensive and there may be a mismatch between the need for adaptation at scale and more localised, relevant, responses to the climate communications challenge in developing countries. People-centred approaches also place greater emphasis on the role of trusted messengers or local opinion leaders, and issues regarding the competence and positionality of these actors become important. The recent emergence of mixed or hybrid approaches - combining the benefits of communications channels

with scope to reach broader audiences, yet allowing a creative broadening of how the message is framed or knowledge of adaptation responses generated - appear to offer promise and should be explored in greater detail.

CONCLUSIONS

In spite of the proliferation of climate communication approaches for the vulnerable and the poor in developing countries, comparative analysis of the relative importance and effectiveness of different communications channels in developed versus developing countries remains scarce (Moser and Luganda, 2006). Our review established five questions to guide the analysis of literature identified with relevance to climate change communication for adaptation in the drylands of Africa and Asia. The literature reviewed indicate the range of current activity within the climate communications sphere relevant to Africa and Asia, and within the drylands of these regions in particular. Our review illustrated the unique challenges faced by the poor in drylands in accessing relevant and reliable information on climate change, and we stressed the need for greater understanding regarding the relative effectiveness of different communication channels to reach their target audiences. This is a research priority frequently highlighted in the literature (Moser, 2010).

Our review also shows that climate changes are currently perceived at the local level and awareness of the challenge is emerging. However, there is a need to improve knowledge on how climate change and adaptation is perceived by various actors to aid the design of communications strategies. Similarly, greater clarity is needed on the role and limits of local knowledge in effectively responding to the adaptation challenge. We go beyond this to stress that greater understanding related to how climate change is perceived by other important communication messengers from policy, practitioner and media groups would likely expose important knowledge gaps on wider needs for climate information and social learning on the issue.

In reviewing the wealth of research and investigation reported in the academic and grey literature of differing communications modes and channels used in the drylands of Africa and Asia, we find a temporal shift towards the use of more two-way dialogic forms of communication and knowledge generation. This affirms wider observations of a counter movement in reaction to the former overtly technocratic and top-down dissemination of climate knowledge with limited local-level usability in developing countries, towards increasingly collaboration between the fields of climate science and development (Pringle and Conway, 2012). However, we contend that there may be apparent trade-offs that need further urgent investigation. Issues such as the likely conflicts between the need for communications approaches that match the urgency and scale of the adaptation response required (involving scalable mass mobilisation communications tools), and the need for more effective, interactive, dialogic forms of communication and knowledge generation to improve the local relevance and usability of climate information warrant further analysis.

In conclusion, while few studies have documented critical knowledge gaps for the climate-communications agenda in drylands, we can draw some observations of critical knowledge gaps from our review of the academic and grey literature. Despite the growing body of research reported in the literature on the climate-communications for adaptation in Africa and Asia, we observe that there remain several key deficiencies within the knowledge base that warrant greater research effort. Most apparent research gaps exist surrounding the following:

- clarity on the role and limits of local knowledge;
- greater understanding on how knowledge accessibility is socially differentiated, particularly gendered aspects of this issue;

- increased understanding on the role knowledge networks and communities of practice play in the production and dissemination of knowledge and whether their work in drylands make knowledge more usable for decision making applications;
- improved knowledge of local perceptions on risk and adaptation;
- how to effectively link communication goals to delivery mechanisms and knowledge generation processes.

Deeper analysis of these issues will significantly strengthen the science of adaptation communication for the drylands of Africa and Asia.

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REFERENCE

ALIN, 2013. Climate communication for adaptation. Joto Afr. Arid Lands Inf. Netw.

Anandaraja, N., Rathakrishnan, T., Ramasubramanian, M., Saravanan, P., Suganthi, N., 2008. Indigenous weather and forecast practices of Coimbatore district farmers of Tamil Nadu. *Indian J. Tradit. Knowl.* 7, 630–633.

BBC World Service Trust, 2010. Executive Summary, Research Report. Africa Talks Climate (Research Report), Africa Talks Climate.

Bidwell, D., Dietz, T., Scavia, D., 2013. Fostering knowledge networks for climate adaptation. *Nat. Clim. Change* 3, 610–611.

Bisht, H., Ahluwalia, N., 2014. Community Radios and Climate Change Communication: Mapping Grassroots Experiences of the “Shubh Kal” Project in Bundelkhand, Central India.

Boykoff, M.T., 2007, From convergence to contention: United States mass media representations of anthropogenic climate change science. *Transactions of the Institute of British Geographers*, 32, 477-489.

Cabana, P., 2012. Using Radio to Improve Local Responses to Climate Variability: The Case of Alpaca Farmers in the Peruvian Andes (Case Study: Category: ICTs and Agricultural Adaptation to Climate Change Climate Change, Innovation & ICTs Project). Centre for Development Informatics (CDI), University of Manchester, UK, University of Manchester, UK.

CARE International, nd. Adapting to climate change: Participatory Scenario Planning and the experience of the Adaptation Learning Programmes (ALP) in Kenya (Case 3: Participatory Scenario Planning). CARE International.

Churi, A.J., Mlozi, M.R., Tumbo, S.D., Casmir, R., 2012. Understanding Farmers Information Communication Strategies for Managing Climate Risks in Rural Semi-Arid Areas, Tanzania. *Int. J. Inf.* 2.

Chohan, F., Hester, V., Munro, R., 2011. *Pakreport: Crowdsourcing for multipurpose and multicategory climate related disaster reporting* (Case Study: Category: ICTs and Agricultural Adaptation to Climate Change Climate Change, Innovation & ICTs Project) (p. 9). University of Manchester, UK: Centre for Development Informatics (CDI), University of Manchester, UK. Retrieved from http://www.niccd.org/sites/default/files/NICCD_Disasters_Case_Study_Pakreport.pdf

- Dilling, L., Lemos, M.C., 2011. Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy. *Glob. Environ. Change* 21, 680–689.
- Dinku, T., Block, P., Sharoff, J., Hailemariam, K., Osgood, D., del Corral, J., Cousin, R., Thomson, M.C., 2014. Bridging critical gaps in climate services and applications in africa. *Earth Perspect.* 1, 15. d
- Few, R., Satyal, P., Assen, M., Camfield, L., Leavy, J. and McGahey, D., *Submitted*, The development-adaptation spectrum in dryland East Africa: mapping risks, responses and critical questions for social research, *Climate and Development*.
- Filho, W. Leal, 2009. Communicating climate change: challenges ahead and action needed. *Int. J. Clim. Change Strateg. Manag.* 1, 6–18.
- Gambhir, V., Kumar, P., 2013. India: How the people of India live with climate change and what communication can do (Project Report), Climate Asia Project. BBC Media Action, London, UK.
- Gbetibouo, G.A., 2009. Understanding farmers' perceptions and adaptations to climate change and variability: The case of the Limpopo Basin, South Africa. *Intl Food Policy Res Inst.*
- Giri, S., Malakar, Y., 2011. Using mobile phones to reduce the adversities of climate change in rural Nepal (Case Study: Category: ICTs and Agricultural Adaptation to Climate Change Climate Change, Innovation & ICTs Project). Centre for Development Informatics (CDI), University of Manchester, UK, University of Manchester, UK.
- Hansen, J.W., Mason, S.J., Sun, L., Tall, A., 2011. Review of seasonal climate forecasting for agriculture in sub-saharan Africa. *Exp. Agric.* 47, 205–240.
- Harbinson, R., Mugara, R., Chawla, A., 2006, *Whatever the weather: media attitudes to reporting on climate change*. London: Panos Institute.
- Harvey, B., 2011. Climate Airwaves: Community Radio, Action Research and Advocacy for Climate Justice in Ghana. *Int. J. Commun.* 5, 24.
- Harvey, B., Ensor, J., Carlile, L., Garside, B., Patterson, Z., Naess, L.O., 2012. Climate change communication and social learning – Review and strategy development for CCAFS (CCAFS Working Paper No. 22.). CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark.
- Harvey, B., Mitchell, T., 2011. ICT Enabled knowledge sharing in North-South partnerships: Lessons from the Africa Adapt network (Case Study: Category: ICTs and Agricultural Adaptation to Climate Change Climate Change, Innovation & ICTs Project). Centre for Development Informatics (CDI), University of Manchester, UK, University of Manchester, UK.
- Hulme, M., 1996. Recent Climatic Change in the World's Drylands. *Geophys. Res. Lett.* 23, 61–64.
- INTASAVE, 2015. Use and communication of climate information to support uptake of adaptation action in the semi-arid regions of Africa and Asia, ASSAR Working Paper, ASSAR Project Management Unit, University of Cape Town, South Africa. 58p. [Accessed online] <http://www.assaradapt.org/>
- Jackson, C., Cranston, P., LeBorgne, E., 2014. Climate change social learning sandbox. CCSL Learn. Brief No7 4.
- Jodha, N.S., Singh, N.P., Bantilan, M.C.S., 2012. Enhancing Farmers' Adaptation to Climate Change in Arid and Semi-Arid Agriculture of India: Evidences from Indigenous practices: Developing International Public Goods from Development-oriented Projects. Working Paper Series no. 32. [WWW Document]. URL <http://oar.icrisat.org/6071/> (accessed 3.2.15).
- Jost C., 2013. Delivery models for climate information in East and West Africa. CCAFS Working Paper no. 41. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark.

- Kalafatis, S.E., Lemos, M.C., Lo, Y.-J., Frank, K.A., 2015. Increasing information usability for climate adaptation: The role of knowledge networks and communities of practice. *Glob. Environ. Change* 32, 30–39.
- Kalungu, J.W., Filho, W.L., Harris, D., 2013. Smallholder Farmers' Perception of the Impacts of Climate Change and Variability on Rain-fed Agricultural Practices in Semi-arid and Sub-humid Regions of Kenya. *J. Environ. Earth Sci.* 3, 129–140.
- Kangalawe, R.Y.M., Lyimo, J.G., 2013. Climate Change, Adaptive Strategies and Rural Livelihoods in Semiarid Tanzania. *Nat. Resour.* 04, 266–278.
- Kanno, H., Sakurai, T., Shinjo, H., Miyazaki, H., Ishimoto, Y., Saeki, T., Umetsu, C., Sokotela, S., Chiboola, M., 2013. Indigenous Climate Information and Modern Meteorological Records in Sinazongwe District, Southern Province, Zambia. *Jpn. Agric. Res. Q. JARQ* 47, 191–201.
- Kihupi N, Kingamkono R, Dihenga H, Kingamkono M., 2003. Integrating indigenous knowledge and climate forecasts in Tanzania. In: O'Brien K, Vogel C, eds. *Coping with Climate Variability: The Use of Seasonal Climate Forecasts in Southern Africa*. Hampshire: Ashgate Publishing.
- Kristjanson, P., Jost, C., Vervoort, J., Ferdous, N., Schubert, C., 2014. Moving from Knowledge to Action: Blogging research and outcome highlights.
- Kuruppu, N., Liverman, D., 2011. Mental preparation for climate adaptation: The role of cognition and culture in enhancing adaptive capacity of water management in Kiribati. *Glob. Environ. Change* 21, 2, 657–699.
- Luseno, W.K., McPeak, J.G., Barrett, C.B., Little, P.D., Gebru, G., 2003. Assessing the Value of Climate Forecast Information for Pastoralists: Evidence from Southern Ethiopia and Northern Kenya. *World Dev.* 31, 1477–1494.
- Macharia, P.N., Thurania, E.G., Ng'angá, L.W., Lugadiru, J., Wakori, S., 2012. Perceptions and adaptation to climate change and variability by immigrant farmers in semi-arid regions of Kenya. *Afr. Crop Sci. J.* 20, 287–296.
- Mamun, M.A.A., Stoll, N., Whitehead, S., 2013. Bangladesh: How the people of Bangladesh live with climate change and what communication can do (Project Report), Climate Asia Project. BBC Media Action, London, UK.
- Mbilinyi, A., Ole Saibul, G., and Kazi, V., 2013. Impact of climate change to small scale farmers: voices of farmers in village communities in Tanzania. Economic and Social Research Foundation (ESRF) discussion paper No. 47
- Meijer, S.S., Catacutan, D., Ajayi, O.C., Sileshi, G.W., Nieuwenhuis, M., 2015. The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in sub-Saharan Africa. *Int. J. Agric. Sustain.* 13, 40–54.
- Mittal, S., 2012. Modern ICT for agricultural development and risk management in smallholder agriculture in India. CIMMYT.
- Mokotjo, W., Kalusopa, T., 2010. Evaluation of the Agricultural Information Service (AIS) in Lesotho. *Int. J. Inf. Manag.* 30, 350–356.
- Moser, S.C., Dilling, L. 2012. Communicating Climate Change: Closing the Science- Action Gap. Oxford Handbooks Online, in: Dryzek, Norgaard, Schlosberg (Eds.), *Communicating Climate Change: Closing the Science- Action Gap*. Oxford University Press.
- Moser, S. C., Dilling, L., 2010. Communicating Climate Change: Opportunities and Challenges for Closing the Science-Action Gap. In: *The Oxford Handbook of Climate Change and Society*, Richard Norgaard, David Schlosberg, John Dryzek eds., in press
- Moser, S. C., Dilling, L., (eds.) 2007. [Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change](#). Cambridge, UK: Cambridge University Press.
- Moser, S.C., 2014. Communicating adaptation to climate change: the art and science of public engagement when climate change comes home: Communicating adaptation to climate change. *Wiley Interdiscip. Rev. Clim. Change* 5, 337–358.

- Moser, S.C., 2010. Communicating climate change: history, challenges, process and future directions. *Wiley Interdiscip. Rev. Clim. Change* 1, 31–53.
- Moser, S.C., 2016. Reflections on climate change communication research and practice in the second decade of 21st century: What more is there to say? *Wiley Interdiscip. Rev. Clim. Change* 7, 2, 161-313
- Moser, S.C., Ekstrom, J.A., 2010. A framework to diagnose barriers to climate change adaptation. *Proc. Natl. Acad. Sci.* 107, 22026–22031.
- Moser, S., Luganda, P., 2006. Talk for a change: Communication in support of societal response to climate change 1, 17–20.
- Moyo, M., Mvumi, B.M., Kunzekweguta, M., Mazvimavi, K., Craufurd, P., Dorward, P., 2012. Farmer perceptions on climate change and variability in semi-arid Zimbabwe in relation to climatology evidence. *Afr. Crop Sci. J.* 20, 317–335.
- Mpandeli, S., Maponya, P., 2013. The Use of Climate Forecasts Information by Farmers in Limpopo Province, South Africa. *J. Agric. Sci.* 5.
- Muchunku, I.G., Mberia, H.K., Ndati, N., 2014. Evaluating Opinion Leadership Strategies Used to Communicate Adaptive Climate Change Information to Residents of Arid and Semi Arid Areas in Kenya. *Int. J. Sci. Res. Publ.* 4, 6.
- Mutimba, S., Mayieko S., and Olum, P., 2010. Climate Change Vulnerability and Adaptation Preparedness in Kenya, Camco Advisory Services (K) Ltd, Book prepared for c 2010 Heinrich Boll Stiftung, East and Horn of Africa. Regional Office for East and Horn, 1-30.
- Naess, L.O., 2013. The role of local knowledge in adaptation to climate change. *Wiley Interdiscip. Rev. Clim. Change* 4, 99–106.
- Nderitu, J.M., Ayanga, T., 2013. Making seasonal forecasts usable in Ghana and Kenya In climate communication for adaptation. *Joto Afr. Arid Lands Inf. Netw.* Nairobi Kenya.
- Nerlich, B., Koteyko, N., Brown, B., 2010. Theory and language of climate change communication. *Wiley Interdiscip. Rev. Clim. Change* 1, 97–110.
- Nyanga, P.H., Johnsen, F.H., Aune, J.B., Kalinda, T.H., 2011. Smallholder Farmers' Perceptions of Climate Change and Conservation Agriculture: Evidence from Zambia. *J. Sustain. Dev.* 4.
- Ogalleh, S., Vogl, C., Eitzinger, J., Hauser, M., 2012. Local Perceptions and Responses to Climate Change and Variability: The Case of Laikipia District, Kenya. *Sustainability* 4, 3302–3325.
- Osbahr, H., Dorward, P., Stern, R., Cooper, S., 2011. Supporting agricultural innovation in Uganda to climate risk: linking climate change and variability with farmer perceptions. *Experimental Agriculture* 47 (2):293-316.
- Paavola, J., Adger, W.N., 2006. Fair adaptation to climate change. *Ecol. Econ.* 56, 594–609.
- Patt, A.G., Schröter, D., 2008. Perceptions of climate risk in Mozambique: Implications for the success of adaptation strategies. *Glob. Environ. Change, Globalisation and Environmental Governance: Is Another World Possible?* 18, 458–467.
- Pelham, B., 2009. Awareness, Opinions about Global Warming Vary Worldwide. Online publication of Gallup word. 1-2, <http://www.gallup.com/poll/117772/awareness-opinions-global-warming-vary-worldwide.aspx>
- Pringle, P., Conway, D., 2012. Voices from the frontline: the role of community-generated information in delivering climate adaptation and development objectives at project level. *Clim. Dev.* 4, 104–113.
- Rao, K.P.C., Ndegwa, W.G., Kizito, K., Oyoo, A., 2011. Climate variability and change: Farmer perceptions and understanding of intra-seasonal variability in rainfall and associated risk in semi-arid Kenya. *Exp. Agric.* 47, 267–291.

- Roncoli, C., Jost, C., Kirshen, P., Sanon, M., Ingram, K.T., Woodin, M., Somé, L., Ouattara, F., Sanfo, B.J., Sia, C., Yaka, P., Hoogenboom, G., 2008. From accessing to assessing forecasts: an end-to-end study of participatory climate forecast dissemination in Burkina Faso (West Africa). *Clim. Change* 92, 433–460.
- Rufino, M.C., P.K. Thornton, P.K., Ng'ang'a, S.K., Mutie, I., Jones, P.G., van Wijk, M.T., and Herrero, M., 2013. Transitions in agro-pastoralist systems of East Africa: impacts on food security and poverty *Agric. Ecosyst. Environ.*, 179, pp. 215–230
- Saravanan, R., 2011. e-Arik: Using ICTs to Facilitate “Climate-Smart Agriculture” among Tribal Farmers of North-East India. *Clim. Change Innov. ICTs Proj. Case Stud. Cent. Dev. Inform. Univ. Manch. UK* [Httpwww Niccd Org.](http://www.niccd.org)
- Seely, M.E., Dirkx, C., Hager, P., Klintonberg, C., von Oertzen, D., 2008, Advances in desertification and CC research: are they accessible for application to enhance AC? *Global and Planetary Change*, 64, 3-4, 236-243.
- Silvestri, S. Bryan, E., Ringler, M., Herrero, M., Okoba, B. 2011. How Kenyan Farmers Perceive and Adapt to Climate Change and what are the Barriers to Adaptation: a Perspective from Agro-Pastoralist Areas, Workshop presented on 19-21 July 2011 Mexico City, Mexico
- Simelton, E., Quinn, C., Antwi-Agyei, P., Batisani, N., Dougill, A., Dyer, J., others., 2011. African farmers’ perceptions of erratic rainfall, *Sustainability Research Institute Paper*, 27
- Speranza, C.I, Kiteme, B., Ambenje, P., Wiesmann, U., Makali, S., 2010 a. Indigenous knowledge related to climate variability and change: insights from droughts in semi-arid areas of former Makueni District, Kenya. *Clim. Change* 100, 295–315.
- Speranza, C.I, Ayiimba, E., Ludi, E., Mbeyale, G.E., Mwamfupe, D., Ong’Anyi, P., 2010 b. Strengthening policies and institutions to support adaptation to climate variability and change in the drylands of East Africa. *Global Change and Sustainable Development: A Synthesis of Regional Experiences from Research Partnerships, Perspectives of the Swiss National Centre of Competence in Research (NCCR) North-South* 5.
- Tall, A., Davis, A., Guntuku, D., 2014a. Reaching the last mile: best practices in leveraging the power of ICTs to communicate climate services to farmers at scale (Working paper No. 70). CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark.
- Tall, A., Hansen, J., Jay, A., Campbell, B., Kinyangi, J., Aggarwal, P.K., Zougmore, R., 2014b. Scaling up climate services for farmers: Mission Possible. Learning from good practice in Africa and South Asia (CCAFS Report No. 13). CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark.
- Tall, A., Kristjanson, P., Chaudhury, M., McKune, S., Zougmore, R., 2014c. Who gets the information? Gender, power and equity considerations in the design of climate services for farmers (Working paper No. 89). CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark.
- Tambo, J.A., Abdoulaye, T., 2012. Climate change and agricultural technology adoption: the case of drought tolerant maize in rural Nigeria. *Mitig. Adapt. Strateg. Glob. Change* 17, 277–292.
- Tschakert, P., 2007. Views from the vulnerable: Understanding climatic and other stressors in the Sahel. *Glob. Environ. Change* 17, 381–396.
- Tschakert, P. and Dietrich, K., 2010, Anticipatory learning for climate change adaptation and resilience. *Ecology and Society*, 15, 2, 11

Tucker, J., Daoud, M., Oates, N., Few, R., Conway, D., Mtisi, S., Matheson, S. 2015. Social vulnerability in three high-poverty climate change hot spots: What does the climate change literature tell us?' *Regional Environmental Change* 15: 783-800.

Wickramasinghe, K., 2011. Role of ICTs in early warning of climate related disasters: A Sri Lankan Case Study (Case Study: Category: ICTs and Agricultural Adaptation to Climate Change Climate Change, Innovation & ICTs Project). Centre for Development Informatics (CDI), University of Manchester, UK, University of Manchester, UK.

Wilby, R.L., Troni, J., Biot, Y., Tedd, L., Hewitson, B.C., Smith, D.M., Sutton, R.T., 2009. A review of climate risk information for adaptation and development planning. *Int. J. Climatol.* 29, 1193–1215.

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