Shubh Kal

We change with climate change

Addressing the information and knowledge needs of farmers to enable climate change adaptation

A study of Bundelkhand region in Central India

Project name

From Information To Knowledge And Action

Development Alternatives

Addressing the information and knowledge needs of farmers to enable climate change adaptation- A study of Bundelkhand region in Central India

Authors:

Aditi Jha, Harshita Bisht, Development Alternatives, New Delhi

Reviewers:

Thomas Tanner, Research Fellow, Institute of Development Studies (IDS), UK

Heather McGray, Vulnerability and Adaptation Initiative, World Resource Institute, USA

Mustafa Ali Khan, Policy Specialist at Indian Himalayas Climate Adaptation Programme, CCD/SDC, New Delhi

Zeenat Niazi, Vice President, Development Alternatives, New Delhi

Abstract

The challenge of adapting to the impacts of climate change is growing and researchers are identifying the importance of climate change information and knowledge systems in climate sensitive sectors. This paper analyses key challenges in the outreach of locally appropriate information to support decision making for adaptation to climate change impacts in small-scale agriculture. Primary survey from the Bundelkhand region of central India suggests that farmers make planting decisions based on sources of information from within their local communities and traditional indicators of seasonal change not necessarily informed by scientific research. There is a pressing need to strengthen institutions that work as knowledge intermediaries by translating scientific information into usable knowledge that links to existing practice and knowledge in a local context. There is also a need to use media that is accessible to small scale farmers for dissemination of locally relevant information.

1. Introduction

Climate change poses a direct and growing threat to the livelihoods of millions of people in India. Poor rural households, whose livelihoods depend predominantly on agriculture and natural resources, will bear a disproportionate burden of adverse impacts of climate change (Satapathy et al. 2011, Mendelsohn et al. 2007, Kates 2000) and thus should be the focus of adaptation interventions. The impacts of climate change vary by agro-climatic zones, socio-economic factors and other facets of vulnerability; response capacities of communities also vary. Therefore, adaptation to climate change is different across locations, making it a local process (Blaikie et al, 1994 Agrawal et al. 2008).

In order to enable practical adaptation at the grassroots level, it is vital that systems for information and knowledge sharing between scientists, policymakers and community institutions at the local level exist and function well (Mishra 2012). However, currently there is a lacunae with respect to climate information at a local level as can be seen from this as well as other research studies. Some of the reasons for this are the uncertainty of availability of climate information at a local scale (Dessai 2007), financial and infrastructural constraints (IPCC 2007), lack of tailoring the information to meet needs of local stakeholders (Gauthier 2005, Srinivasan 2012), non-integration of local institutions, cultural practices and experience into actionable adaptation decisions (Ensor and Berger 2009) and a failure to use media that is easily accessible to rural communities (Carpenter et al. 2012).

As the challenge of adapting to the impacts of climate change grows, researchers are identifying the importance of climate change information and knowledge systems in climate sensitive sectors. This paper analyses the key challenges for providing locally appropriate climate information to inform adaptation decision making in small-scale agriculture. It is based on a desk review and field research undertaken through interviews, stakeholder consultations and a survey in the state of Madhya Pradesh with a focus on the Bundelkhand region. The parched geography of Bundelkhand is one of the most underdeveloped regions of the country being low on human development indices. The chronic drought prone region of Central India comprises seven districts of Uttar Pradesh and six districts of Madhya Pradesh states of the country. The semi-arid geography is highly perturbed with variable climatic conditions intensified by erratic precipitation trends, high evapo-transpiration losses, high run off rates, poor water retention capacity of the soil and large area of barren and uncultivable land. Climatic changes have increased frequency of extreme weather events during past 15 years and raised the vulnerability and risk. The region witnessed continuous meteorological, hydrological and agricultural drought for six years in the period 2003-2009 (Inter-Minsterial Central Team, 2008). The continuous drought years in Bundelkhand have severely affected the agriculture productivity and subsequently weakened the livelihood systems.

2. Information and Knowledge for Climate Change Adaptation

There are various types of information required to enable decision making for climate change adaptation by communities and several challenges exist in ensuring that relevant information is made available to user groups. Climate information for adaptation includes reliable and scientific meteorological and hydrological information as well as agro-ecological and socio-economic information (Srinivasan 2011, Khan 2012). Due to the cross-cutting nature of the issue various spheres of agro-ecological and socio-economic development are affected. Thus, climate change adaptation requires a cross-cutting policy approach and a backbone of strong and relevant information for communicating climate change amongst different stakeholders, sectors and levels of development; both horizontal and vertical information sharing and communication are needed.

Climate knowledge is the appropriate use of climate information for reducing economic and environmental risks and strengthening resilience against climate variabilities (Glantz 2005). The transition from information to knowledge requires the integration of locally relevant experiences and practices into climatic information and scientific evidence (Hoo Yoo and Baviera 2010). Thus, knowledge relevant to climate change adaptation comes from scientific research as well as experience, customs and traditions (FAO 2007, Lebel 2011). Relevant knowledge can only be generated when information is contexualised in local perspective and is delivered in forms acceptable to the information users. Currently, the delivery of knowledge on climate change information to the rural population is still a huge challenge. Scientific knowledge on climate change impacts, vulnerability, and adaptation options needs to be translated into a language that both decision-makers and communities as information users understand. It also needs to be converted to timescales appropriate for planning and developing actions to address risk resilience of vulnerable communities.

The climate system is a complex, interactive and dynamic system (IPCC 2007) and one of the main challenges in sharing climate information is the uncertainty inherent in using this information to make decisions. This uncertainty usually comes from random and systematic errors in measurement, probability distributions from expert elicitations and ignorance or blind spots in climate information (Morgan et al 2009). This uncertainty of information often fails to communicate information on expected changes in the weather patterns over short, medium and long time periods and their potential impacts to communities dependent on climate sensitive sectors for their livelihoods. Furthermore, climate information is also currently largely supply driven and shaped by the interests of climate scientists and researchers. Often it is, based on the limited data available rather than on the needs of end users of climate information such as policymakers, project developers and farmers (Carpenter et al Dinshaw et al 2012). The information is scientifically sophisticated and does not get translated into language easily understood by planners, decision makers and policy implementers. Such information usually includes the data generated from climate models, atmospheric physics, oceanography studies, disaster warnings etc. This complexity of information thus creates a communication gap between researchers of climate change,

implementers of climate change adaptation and communities vulnerable to climate change impacts. In addition, the information, delivery tools and mechanisms for climate change communication is also a huge challenge. An important concern, especially in developing countries is the type of media used to disseminate meteorological and other information relevant for adaptation. The internet, television and newspapers are predominant forms of media used which are not easily accessed by rural communities. (ibid). Moreover, the information generated by these sources is not communicated in localised languages and terminologies easily understood by the communities.
Previous studies and researches already highlight the need of new and innovative means for communicating climate change so that it is easily understood by a wide range of stakeholders (officials, social workers, village level planners and communities). There is a need for the process of climate change adaptation – right from information generation to final actionable decision - to be more cross-disciplinary, participatory and user oriented (Meinke et al 2006, Dinshaw 2012). A need for policies, projects and importantly institutions that create and facilitate systemic linkages between climate information producers and users has been envisaged to move towards a more community centered approach to climate change adaptation (Srinivasan et al 2011). Additionally, it has been pointed out individuals, businesses and governments make decisions under uncertainty all the time and thus rather than not share climate information or mask uncertainty – the important thing is to communicate the information along with the kind of uncertainty (ibid). Information needs to be disseminated using media that is regularly accessed by local communities (Harvey 2011). This includes community radio and mobile phones which are often more accessible at the local level then newspapers and television (ibid).

2.1. Institutional systems for information dissemination on climate and agriculture at the local level

Institutions play an important role in facilitating or impeding individual and collective responses and shape the outcomes of these responses; this paper throws light on the institutions that can influence adaptive capacity and adaptation practices among agricultural communities in India, focusing on those with direct links to the grassroots level.

2.1.1. Dissemination of agriculture related information

Agriculture sector acts as the backbone of Indian economy. A large number of people are dependent on agriculture for their livelihood. About 70% of India's population is dependent on agriculture. The sector is still predominantly rain - fed and highly vulnerable to climate change (Aggarwal 2009); The country has various systems in place for disseminating agricultural and meteorological information.

i) Agro-Meteorological Field Units (AMFUs): The Indian Meteorological Department (IMD), set up under the Ministry of Earth Sciences provides weather services in the country. Under its aegis, it has established a specialised division of Agricultural Meteorology to give relevant information to the farming community and provides advisory services through its 130 Agro-

Meterological field units (AMFUs). An initiative to meet farmer's information needs in real time has been initiated in association with relevant agricultural research institutions such as the Indian Council of Agricultural Research (ICAR), Ministry of Agriculture (Centre and State) and State Agricultural Universities (SAUs) to provide relevant information to farmers. Bulletins are issued at national, state and district levels through Integrated Agro met Advisory Services (IAAS). At the district level, bulletins provided by the agro met field units gives advisory information on crop management consisting of standard agronomic management practices under normal weather conditions and suitably modified agronomic management practices under forecast of transient weather conditions. This assists the farmers in taking appropriate farm related decisions. IMD also issues quantitative district level weather forecasts including daily forecasts and subsequent 5 day forecasts. These quantitative forecasts are for 8 weather parameters – rainfall, maximum and minimum temperatures, wind speed and direction, maximum and minimum relative humidity and cloudiness. In addition, weekly cumulative rainfall forecasts are also provided. This sort of valuable information can be retrieved from the IMD website (http://www.imdagrimet.gov.in/home_page). This information is useful for practical application under field conditions for day-to-day agricultural operations, contingency planning and crisis management in times of abnormal and adverse weather.

These advisories are further disseminated through media like the All India Radio (AIR) and Doordarshan (Government run television channel), newspapers, internet, agricultural universities, agriculture departments and Krishi Vigyan Kendras.

ii) Krishi Vigyan Kendra's (KVKs) or Farm Science Centres: There are almost 600 KVK's at the local level across the country to provide agriculture extension services to farmers. Their mandate is technology and information dissemination and they do this through frontline demonstrations on farmers fields, training of farmers to update their knowledge and skills by creating awareness about frontier technologies through large number of extension activities like farmer fairs, field days, strategic campaigns, scientists visit to farmer's fields, exposure visits etc. KVKs are an important link between research institutes and farmers. KVKs are the most accessible institution for farmers to get information and advice based on localised applied research. KVKs work in specific extension areas and with select farmers and while they are not mandated to provide information to farmers outside the farms selected – they do carry out this role if approached by farmers. A new government initiative called 'National Initiative on Climate Resilient Agriculture (NICRA)' has involved 100 KVKs to demonstrate "integrated package of proven technologies in one village *Panchayat*[1] (village level governing body) in each district for adaptation of crop production and livestock production systems to climate variability based on the available technologies".

[1] Gram Panchayats in India are local self-governments at the village or small town level in India

iii) Agricultural Technology Management Agency (ATMA): An institution that is responsible for technology dissemination at the district level is the Agricultural Technology Management Agency (ATMA). Set up under a centrally sponsored government scheme, ATMA's are nodal centres to combine research extension and marketing. The agency aims to identify location specific needs of the farming community for sustainable agricultural development and to execute and coordinate plans through line departments, training institutions, NGOs, farmers, organisations and allied institutions. Currently almost 600 ATMA's have been established. The ATMA has a provision to designate one 'farmer friend' or *Kisan Mitra* for every two villages. These *Kisan Mitras* act as facilitators to inform the farming communities about agriculture schemes and other farm related information.

2.1.2. Supporting institutions for dissemination of climate change related information

The above agencies are expected to be further strengthened by research and funds provided through programmes like National Initiative on Climate Resilient Agriculture (NICRA). The Indian Council of Agricultural Research (ICAR) launched this programme in 2011. It focuses on adaptation and mitigation. In terms of the former it aims to undertake critical assessment of different crop/zones in the country to assess vulnerability, development of heat/drought tolerant crops and an up scaling of the outputs of KVKs and the National Mission on Sustainable Agriculture for adoption by farmers.

An integration of various types of data and information is required to identify adaptation options that are relevant for the local level. While socio-economic data is easily available at the local level, some types of data are only available with specialised agencies. Meteorological and other types of data are received, and in some cases purchased, from Indian Institute of Tropical Meteorology (IITM), Indian Meteorological Department (IMD), Indian Institute of Technology (IIT), the National Remote Sensing Centre (NRSC) and various Agricultural Research Institutes. The integration of this information requires experts and cross-disciplinary teams to come together.

2.1.3. Interface institutions to inform climate resilience to the grassroots

Apart from the policy makers and scientists the adaptations in climate cannot be communicated without the representation of community voices directly vulnerable to climate change. Therefore participation of nongovernmental organizations and civil society organisations is equally important in the process. This ensures participatory approach for climate change mainstreaming because such organizations directly working at the grassroots corresponds to the ground realities thus contributing in the bottom up planning process. Currently this role of integrating various sets of climate change information to come up with robust adaptation options at a local level is being performed by organisations that play an intermediary role in bridging the information across the gap between scientists, planners and farmers. These organisations include Development Alternatives (DA), The Energy Resources Institute (TERI), Watershed Organisation Trust (WOTR) and others that are able to put together the required inter-disciplinary team with funding support from national and international sources.

3. Decision making in small scale agriculture: A survey from the Bundelkhand region of Madhya Pradesh

A primary survey was conducted in Bundelkhand to understand how local populations access agricultural information to make decisions. The survey was conducted jointly by Development Alternatives [2](DA) and Learning in Geography, Humanities, Technology & Science (LIGHTS)[3]. Farming communities in Bundelkhand were surveyed for responses on perceptions on climate variability and change and access to modes of communication and information on agriculture and climate change. Bundelkhand is a region in central India comprising of districts from Madhya Pradesh and Uttar Pradesh. Some of the relevant qualitative findings from the survey are presented in this paper based on the questions related to the sources of media that communities have access to, the sources of information they access to make decisions regarding agriculture – including sources for climate and weather related data and issues they face in agriculture which was used to draw inferences about their perception of climate change. The survey aimed to assess the situation of climate change information to the grassroots in Bundelkhand. The objective of the survey was to identify the current status of climate change information and knowledge communication at the grassroots. It intended to identify the gaps for meeting climate change information needs of the farmers.

A total of 104 households from villages in the four districts of Lalitpur, Shivpuri, Ashok Nagar and Tikamgarh were interviewed in the survey using a semi-structured questionnaire. These four districts were selected because they all have a local community radio in their vicinity as the survey wanted to study all communication media and sources of information and knowledge sharing in the area, including community radios. These community media tools act as important sources of varied information that touches different aspects of climate sensitive sectors. Since, this factor influences climate change information gaps in the region therefore the districts with community radios were given preference in the sample selection for the study. Bundelkhand region has an agri-based economy which drives the food and livelihood security in the region. This formed the basis of the survey which primarily targeted the farming communities in the region. The households were selected through a random sampling process with 20 households surveyed in each district. This is a qualitative study which is primarily targeted to identify the challenges faced by farmers in accessing climate change information in the region. Thus quantitative analysis of data obtained from limited sample size is beyond the scope of this study. Additionally, the

[2] Development Alternatives (DA) is a premier social enterprise working in the field of sustainable development. Over the last 30 years, Development Alternatives has been working to help rural communities in Bundelkhand, one of India's most drought prone and poverty ridden regions adapt to climate change.

[3] A Delhi based NGO established in 2003. It works as a research unit on environmental and developmental issues.

restriction of the sample size to merely villages with community radios is a limitation of this study.

In Bundelkhand, the impact of climate change is increasingly pronounced because of a predominantly agrarian economy, considerable poverty and regular incidences of drought (Hedger and Vaideeswaran 2010). 92% of respondents from the survey comprised of farmers and agricultural labor. According to the survey, 65% respondents were categorized under the 'other backward classes' (OBC) category. Almost 25% of the population in the sample survey was illiterate, which means they had no schooling.18% were educated to secondary school level and most people were educated only up to primary school level.

3.1. Participants' response on climate change

Respondents in the study area were not able to fully comprehend the concept of climate change. They equated climate change with shifts in weather patterns. Communities continue to take decisions as and when climate varies rather then come up with a long term strategy for coping with impacts that include a shift in the onset of the monsoon and lesser number of rainy days. Agriculture being the mainstay of this region, any impact on agriculture is of utmost importance to the community. Thus, to gauge their understanding of climate change, responses of the farmers were categorised under five main classes: rainfall behaviour, inadequacy of water resources, increase in expenditure, change in cropping patterns and increase in diseases.

'Climate Change' was not a term familiar to respondents and therefore the survey focused on agriculture, drawing inferences about climate change perceptions. Almost 70% of the respondents stated that their lands are not getting enough water. 49.03% remarked on the variability of the rains and 74.03% respondents stated that the number of rainy days has declined. 7.7% respondents who felt that the onset of the monsoon rains were later than usual. Also the pattern of rainfall has undergone a drastic change. Some of the farmers responded that, there is very intense rainfall all at one time, with the water flowing away before it percolates down. Half of the farmers noticed high variability of rains in the region. According to the elders in the village, in recent years the onset of monsoon has delayed as compared to the monsoon in the past two to three decades. A potential indicator of climate change mentioned by a small number of respondents was an increase in crop diseases.

The inadequacy of water resources with rivers running dry most of the times, as opposed to earlier times when minimal flow was reported, is affecting the lives of the people here as water resources are becoming increasingly scarce. The various rivers and rivulets that criss-cross the terrain were once adequate for sustenance of the region throughout the year, but now they run dry for most part of the year. Farmers responded that loss of traditional water management practices and insufficient water harvesting structures have further added to the cause of water scarcity in the region. Respondents have also confirmed that the groundwater table is continuously falling since there is no check dam in the vicinity. Even the vegetation of the area is also affected

due to the inadequacy of water. The villages have fewer trees than before, cited many respondents. Privately owned boring wells are being used in the region for irrigation as the traditional water points have dried up, added the respondents.

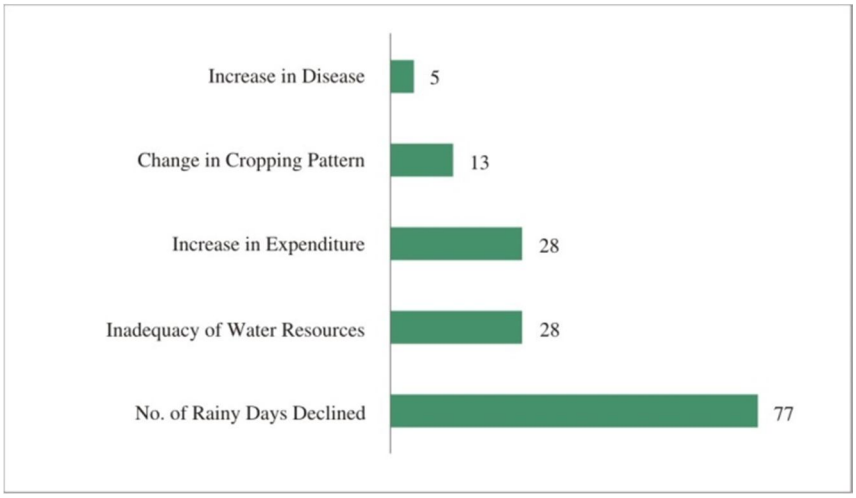

Figure 1: Responses about Climate Change Scenario

Respondents have also reported a distinct change in the cropping pattern in the recent decades, as compared to earlier generations. Respondents claim that now days the households grow only one main crop, usually wheat, whereas in past they used to grow a second crop as well, such as gram or sorghum. This is also due to the shift in the demand for wheat in the market. Cropping patterns have also undergone a tremendous change with what the respondents claim as - land going bad - meaning thereby a fall in productivity, rise in pest attacks and crop failures. A lot of respondents claimed that the sowing season for the kharif crop commenced after October festivities, but now it has changed and the sowing time has postponed to sometime later.

3.2. Use of agromet information and traditional indicators for weather forecast

Farmers were also asked in the survey about what kinds of information on climate and weather change they use to make forecast based decisions. 29.8% respondents stated that they identify a shift of season by leafing, flowering and seeding patterns in Neem trees (*Azadirachta indica*). An untimely fall of seeds or flowering alerts them to a change in the atmospheric parameters. In recent years, respondents stated that the number of such shifts are claimed to have risen as compared to the older generations.

A significant number of respondents, totaling 52.9%, claimed that they know about weather patterns changing through markers in the animal kingdom such as when they see that lizard changes their colour, or they hear the louder bird calls or observe frogs croaking, or see several eggs of butterflies on leaves. From the survey, it is clear that farmers use a variety of indicators to make decisions pertaining to their daily agriculturally activity – a wide variety of

miscellaneous indicators were mentioned including particular cloud formations, northerly winds etc. Only 15% respondents stated that they use meteorological information. There is a need to document and validate the efficacy of traditional indicators being used and scope for further research on how they can be integrated with current scientific research on climate change. Furthermore, 65% of farmers responded that the agromet information available to the farmers through radio, television and newspapers sometimes lacks accuracy. This is because the centres providing agromet services at local level are still absent. KVKs (Krishi Vigyan Kendra) have installed agromet devices in some model villages. However, the information provided by such installations is highly restricted and does not cater to the needs of other villages in the district. Lastly, farmers in the region have been identified to adapt to changing climatic conditions and extreme events to some extent. The findings highlighted that adaptation measures mainly adopted by farmers in the region are largely reactive in nature. Farmers in Bundelkhand often respond after the changes have occurred and are still struggling to increase their risk preparedness and resilience. This indicates the need of popularizing the importance of anticipatory and proactive climate change adaptation in the region.

3.3. Use of modern and traditional communication tools for climate change

The general media forms available in the survey area were street programmes, radio, television, movies (in a movie theatre) and newspapers. Television and radio both are also highly accessible to respondents of the survey. However, limited and irregular supply of electricity often limits the use of television in various parts of the region. The highest number of respondents stated that they visited the local street programmes and took part in them. While street programmes do not take place on a regular basis as compared to radio or television which respondents are able to access daily or weekly, a wider audience accesses them.

Newspapers were the least accessed medium of information and communication. Although there are several newspapers in circulation in the area – most respondents did not subscribe to any newspaper. The findings reveal that with a large illiterate population, a large number of people in Bundelkhand rely on audio-video based media for education, information and entertainment. Thus the agromet advisories and agriculture newsletters remain largely unavailable for the illiterate farming communities of Bundelkhand. This indicates the need of innovative means of media for communicating climate change to the grassroots. Furthermore, internet being a huge repository of climate change related information is negligibly used by the illiterate communities in the region. Thus, scientific knowledge about climate change vulnerability, impacts and adaptation options needs to be translated into a language that rural communities understand and converted to timescales appropriate for their decision-making process.

3.4. Information access and decision making on climate resilient agriculture

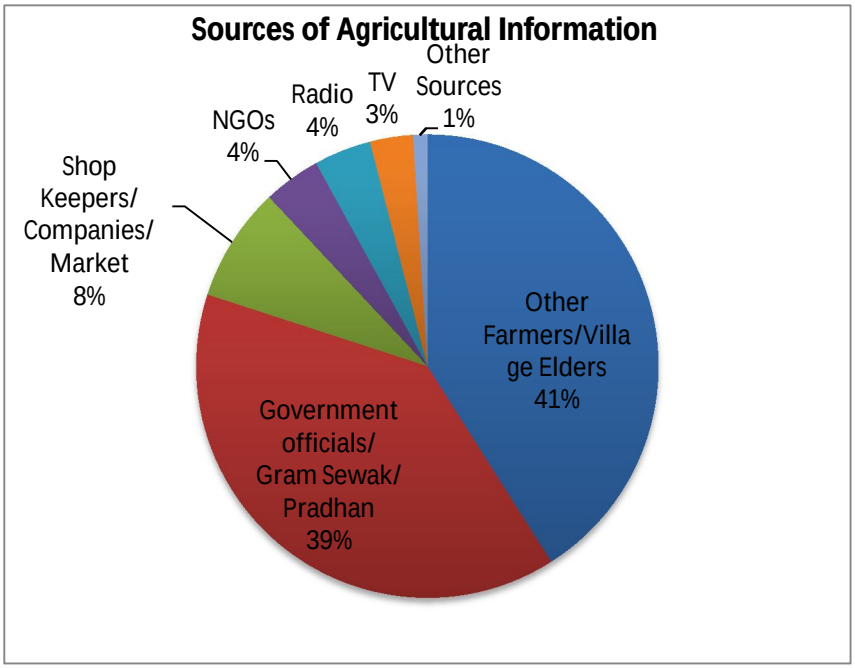

Figure 1: Sources of agricultural information for decision making among respondents

Another relevant survey finding was related to the sources of agricultural information represented in Figure 2. When it came to decision making related to agriculture, the two primary sources of information mentioned were 'other farmers' and 'elders' (41%) and government officials (39%) such as the *pradhan* (elected head of local government) and/or *gram sewak* (Rural Agriculture Extension Officer responsible for dissemination information on agriculture and related schemes); 8% respondents stated that they used market sources such as shop keepers and seed companies as a source of agricultural information. This leads to complications as the information dissemination may not only be erroneous but also partial and the person in question may withhold information. Sometimes it happens that the village leader (school teacher, unemployed youth, government officials etc.) gets information from both government and non-government organisations and spreads that in the villages. There lies a problem in this model as the village leader does not always want to reveal the full information. Sometimes villagers' get information directly from government and non-government organisations but this is very rare. Also this process is limited to higher class and higher caste rich villagers. Also information related to different farming inputs are sometimes disseminated through companies, seed or fertiliser sellers with the hidden agenda of maximising their sales.

3.5. Access of Information from Institutional Setup

A low percentage (1%) of respondents access information from other source such as the Krishi Vigyan Kendra (KVKs). For many farmers, their only option

to receive beneficial information and scheme assistance is to travel directly to the appropriate extension agency. Unfortunately, the spatial distribution of the locations where farmers can access information directly such as Krishi Vigyan Kendra (KVK), Agricultural Technology Management Agency (ATMA), or Agricultural and Irrigation Department offices is widespread. Often, farmers find that the cost (both in time and money) of travelling to these locations is not worth the perceived benefit that they will receive from their efforts.

Additionally, in order to receive assistance in many cases, farmers feel that they must navigate many administrative obstacles such as lengthy paperwork and procedures. This combined with long travel distances, further reduces farmers' interest in seeking these benefits. The other option which farmers avail is that of interpersonal communication with the 'identified' progressive farmer for dissemination of the information may be skewed and imperfect. There is ample scope of information loss and bias.

The concept of global climate change and its impacts is not one that is familiar to farmers and this could be because in India, climate change debates are covered in newspapers and on the internet and not on the radio and television channels accessed by these farmers. The survey confirms that small-scale farmers use the scientific research being generated and disseminated by local institutions to a much lesser extent compared with sources of information from within their village such as other farmers and local government officials. Also, climate and weather related agricultural decisions are predominantly made using traditional knowledge.

Table 1: Qualitative Analysis of Survey Findings

S. No.	**Factors informing the communities about climate variabilities and adaptation options available for agriculture sector**	**Current situation in the region**
1.	**Use of Agromet information**	Interactive setup available for dissemination of information through advisories. However, largely unutilised due to highly specific information at village level
2.	**Use of traditional indicators for weather forecast**	Popular among the communities.
3.	**Institutional setup for climate change information flow to the**	Poor access due to absence of localised information centres and administrative

	grassroots	hassles
4.	**Use of community based media for climate change**	No community media directly involved in disseminating climate change information

3.6. Analysis of key actors in information flow of climate change

Analysis of the institutional mechanism for climate change information in the country reveals the following observations. Secondary literature review in the study frames the findings for different stakeholders playing an importation role in the information flow. While, survey findings from the grassroots provide primary evidences for stipulating the recommendations for the same.

Stakeholders	Findings	Recommendations
Policymakers - National	Currently adaptation is a low priority overshadowed by a business-as-usual development agenda	Incorporation of agro-climatic and region specific vulnerabilities into policies and plans. A need for increased participatory research at the local level
	The government at the national level does allocate sums in the case of climate change related emergencies. For eg. the Bundelkhand Special Package for drought mitigation. However large sums of money from this package remain unutilised	A strengthening of grassroots voices and integration of grassroots priorities in planning could go a long way in ensuring that such funds are utilised to solve problems and enable adaptation. Local media and journalist including community radio networks could enable this
Policymakers - State and District Level	The State Action Plans ensured that grassroots voices were taken into account through an extensive consultation process, however the plan has not been implemented	To translate the plan into action through integration with state and district planning processes and devising relevant need based schemes that enable adaptation
	There are initiatives in the state on climate change adaptation that are increasing knowledge and working towards better integration of adaptation action in policymaking	The strengthening of the MP Climate Change Cell and the operationalisation of the Knowledge Management Centre will go a long way in ensuring that learning's and best practices on adaptation, including indigenous coping methods can be documented and shared
	District level planners at the local government (panchayat) level who have a critical role to play have poor knowledge about the impacts of climate change and prioritising adaptation	Provision of spatial, graphical data and use of community radio can play an important role in improving awareness and opening planning processes to the larger community.
Scientists and Scientific Institutions	There are several technical and institutional barriers for making robust climatic information available to the grassroots	Barriers need to be overcome by increased demonstrations in the field, better communication with the grassroots through mediums like community radio and increased dialogue between stakeholders

	Extensive research on climate science and climatology is taking place in specialised institutions, however there is no process to simplify findings for the grassroots	New investments by the government and donors are needed to establish/ strengthen and expand the ability of existing 'interface' institutions that do simplify data for use in implementing grassroots projects
	There is a well developed system to disseminate agro-meteorological data to the grassroots *on paper.* The primary survey revealed that farmers continue to rely on traditional knowledge for indicators	There needs to be a system for timely and cost effective dissemination of agro-met data. There is a need to validate indigenous indicators as well as increase awareness among farmers on accessing to agro-meteorological data that is available for adaptation to climate variability and change.
	There is an expanding network of agriculture extension services (Krishi Vigyan Kendras-KVKs) and technology dissemination institutions - Agriculture Technology Management Agency (ATMA)	Community media and other forms of mass media needs to work more closely with KVKs and ATMAs to disseminate information in a timely and cost effective manner

Thus, the qualitative study of Bundelkhand region suggests that marginal farmers are not aware of the term 'climate change' nor do they fully comprehend long term potential impacts. They continue to rely on sources of information from within their local community and traditional indicators of seasonal change and weather. Information and knowledge that could assist adaptation exists with scientific and expert institutions, however an extremely small percentage of farmers have access to these sources.

The survey confirms the growing number of studies that call for an increased scientific engagement with local and traditional ecological knowledge as a valuable source of adaptive practice and an important step in developing new approaches to adaptation (Berkes, Colding et al. 2000).

4. Conclusion

Localised and simplified information is the lifeline for climate change adaptation at grassroots. The communities need to be informed about problems and solutions related to climate change. While reactive adaptation is being undertaken by farmers in Bundelkhand – long term solutions are required to increase resilience and reduce vulnerability of small scale farmers. The analysis in the current study clearly reveals that despite of the institutional set up for informing communities on climate change, the communities are largely unable to access the information. Some of the reasons for this gap in information flow are complexities of the subject of climate change, lack of localized risk management advisories and agromet information, diminished use of community media for disseminating climate change information, limited translation of scientific information into easily comprehensible messages and limited information centres.

Additionally, validation of traditional knowledge of the communication is required to identify localised adaptation measures practiced at community level. Scientists could benefit from an improved understanding of the

traditional indicators that farmers use to make agricultural decisions in order to devise strategies that could use an intelligent mix of scientific and traditional knowledge.

The use of mass media, including traditional media, in the dissemination of information on climate change is an area that needs to be strengthened. This can enable the dissemination of information on climate change in easily understandable ways; provide early warning systems by simplifying user-relevant scientific evidence and provide real time solutions during times of extreme climatic variability.

Study also reveals the need of media tools which specifically addresses the information needs of rural communities. Moving beyond, internet, television and newspapers, the study identifies the need of community media tools which can communicate climate change in an easy and localized language. The potential of traditional communication tools such as interpersonal dialogues, wall paintings and street plays can be explored for increasing climate change awareness at the grassroots. Additionally, these tools can be combined with other ICTs (Information and Communication Technology) such as mobiles and community radios for increased outreach and dissemination of climate change related information. Radios with well-developed capacities are known to be contributing to women's empowerment (Bandelli 2011), Disaster Management and Agricultural Development (Sharma 2011), which are all related to adaptation. The use of radio provides listeners the option to provide feedback to radio reporters in real time.

Local applied research institutions such as the Krishi Vigyan Kendras (KVKs) and Agriculture Technology Management Agencies are valuable resources that can act as interface institutions between scientific institutions and policy makers to design locally appropriate adaptation options. Currently this role is being performed by specialized agencies, performing an interface role between scientific institutions and local communities. A similar role is envisaged for institutions such as KVK's and ATMA's, however there is a need for increased capacities within these institutions to integrate climate science and best practices including those that come from traditional knowledge. There is a need for wider dissemination of KVK research and findings that can enable adaptation among farmers who do not fall under their pilot studies. NGOs and CSOs can fill in this niche and interface the two way information flow to the communities.

The provision of 'farmer friend' or *Kisan Mitra* from the ATMA is an excellent mechanism to ensure that information that is significant for farmers to adapt to climate change reaches them. This will require that *Kisan Mitra's* are knowledgeable about climate change as well as the local context in which they are working. There is a need for strengthening of knowledge intermediaries that can translate scientific information into usable information that links to existing practice and knowledge in a local context.

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About the participant groups

Environment Planning and Coordination Organization (EPCO), Government of Madhya Pradesh is registered under the Housing and Environment Department of the Government of Madhya Pradesh. It connects government as well as non-government agencies in solving environmental problems. http://www.epco.in/

The Institute of Development Studies (IDS) at the University of Sussex, UK is a leading global organisation for research, teaching and communication on international development. It acts as a development research and knowledge hub, connecting and convening networks throughout the world. http://www.ids.ac.uk/

Kings College London, Humanitarian Futures Group - The Humanitarian Futures Programme (HFP), works to support organisations with humanitarian roles and responsibilities to effectively anticipate and prepare for long term future crises. www.humanitarianfutures.org/

Third Pole Project is a joint project of the Internews Earth Journalism Network and the bilingual environment news website chinadialogue.net that seeks to improve coverage of climate change issues in the Himalayan region and downstream. The Third Pole – based in New Delhi, Beijing, London and San Diego – designs curriculum and carries out media capacity building and training workshops for local and regional groups across Asia. www.thethirdpole.net/

Development Alternatives (DA) is India's leading civil society organization engaged in research and development. DA set up the first Community Radio in the Central Indian region of Bundelkhand. http://www.devalt.org/

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Climate and Development Knowledge Network (CDKN) supports decision-makers in designing and delivering climate compatible developments by combining research, advisory services and knowledge management in support of locally owned and managed policy processes. www.cdkn.org