Establishing climate information service system for climate change adaptation in Himalayan region

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The opportunities available for rural households in the Himalayan region to cope with changing climate should involve acting in shorter timescales with development agenda of the region. The present article is an attempt to propose pathways of using available climate information to solve local problems caused by climate change. Existing information systems and databases can be organized to understand the solutions of climate change which can be appropriately implemented in highland areas. The study suggests systematically capitalizing the existing indigenous wisdom, current climate variability databases and growing information technology to help highland people cope under the local climatic constraints.

Keywords: Climate change, databases, highland areas, information service systems.

THE changing dynamics of global climate change is complex and to a great extent uncertain to predict. The predicted change in global temperature can increase the frequency of mountainous hazards, and alter the ecosystem and discourse of development process. The impacts of climate change can be more severe in the Himalayas because variability of climate in different elevations fluctuates in warm and cold regimes. Scientific predictions point out that the Himalayan region has been experiencing warming at a greater pace than the global average of 0.74°C over the last 100 years[1,2]. The impacts are already tangible, as the fragile, high-altitude ecosystem has begun to erode[3–5]. The amalgamation of climate change with high rugged topography, tectonic activities and steep slopes can induce hazards like landslides, flash floods, avalanches, and glacial lake outburst floods adding significant stresses on the rural development, livelihoods, health, and productive asset of highland communities and downstream populations[3,6].

Theoretically, there are two generic response options to address climate change. First, mitigate the causes of climate change by gradually trimming down carbon emission. Second, adapt to variability in climate change and cope with irreversible changes. It refers to the changes in the behaviour and response of people to changes in their immediate natural and socio-economic systems. The impact of variability of climate change on rural livelihood of highland communities is due to both ex-post and ex-ante factors. The ex-post impact of uninsured climate-induced natural disaster can have long-term consequences on rural livelihoods of highland communities through direct loss of crop and livestock, damage to productive assets of households and sometimes problems in health and life. The vulnerable households are struggling with different adaptation strategies like mobility, drawing down inventory, diversification, depending on common property, market exchange and reducing consumption and social obligation to deal with the looming crisis. Abandonment of primary activities and migrating to urban centres are extreme examples in this region. These patterns of coping mechanism to build a better life for themsevles have high probability of long-term poverty and even destitution[7–10]. Many uncertainties are added to these challenges due to the gap in comparable data on climate change in the region causing substantial loss of opportunity of rural livelihood. Without legitimate knowledge about the next climate-induced natural hazard, vulnerable households started applying a range of precautionary ex-ante strategies to protect against probability of calamitous loss and decrease in productivity due to inefficient and exploitive resource use, which led to compromise in profitability[11]. Information is essential for informed decision, to minimize the loss from climate catastrophe and overall to facilitate the climate change adaptation. The complexity in understanding the climate phenomena leads to no end-to-end approach, therefore households' decision-making tools should be different for different regions. Therefore, this article aims

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to analyse the significance of climate information service system (CISS), particularly in rural and remote areas of the Himalayan region for adaptation at the grassroots level as innovative strategies to protect the rural livelihood of highland communities. The proposed CISS will focus not only on advance critical aspects of climate science, but also scientific understanding of the impact of climate change to user-driven needs.

Climate change adaptation and information

The dynamic nature of humans and climate and its impact on biophysical and socio-economic systems present an opportunity for developing practical adaptive capacity at the grassroots level. Theoretically, practical adaptive capacity is conceived as the ability of human systems to cope with climate change, which depends on features such as wealth, technology, education, traditional knowledge, information, skills, infrastructure, access to resources and management capabilities. It can take many forms such as bottom-up or top-down, reactive or predictive, autonomous or planned. It has been tested and thought out as an effective tool to cope with the looming crisis[12–14]. Climate change adaptation is a challenge because the scale and speed of the adjustments required is unprecedented, and the nature of the anticipated changes remains highly complex and uncertain. One of the most important components required for practical adaptation is climate information. Climate information availability at appropriate times facilitates rational decision making and enhances the capacity of rural households, where adverse impacts of extreme climatic events may be compounded by poverty, environmental degradation, inadequate social safety nets and poor governance. Effective capacity-building requires a long-term commitment to address capacity gaps in knowledge generation and its dissemination, as well as in the processes that catalyse efforts to move from knowledge to sustained action and adaptation measures. The cost of uncertainty to map the future climate variability will adversely impact the livelihoods of rural households in the Himalayan region. The degree of uncertainty of vulnerable households in the highlands can be reduced by providing climate information which can protect the rural livelihoods by enabling the households to adopt improved technology, diversifying production strategies and investing more profitable stakes when conditions are favourable. Uncertainty can be reduced by analysing historic climatic data, monitoring and predicting seasonal forecasts that match the period of many climate-sensitive decisions by rural households. The geological climatic records, real-time monitoring and short-term weather predictions have to be disseminated to rural households in local languages. Hence seasonal prediction will be the object of research in climate science that will definitely yield useful insights for rural climate information services in inaccessible rugged topography. The main pillars of practical climate change adaptation are climate information generation, information dissemination and informed action.

Conceiving a CISS for Himalayan region

The first-generation approaches of climate change adaptation are derived from global climate models downscaled to regional scenario or local scales[15–17]. These downscaled models are a simplified version of the climate of the locality, and have commonly been limited to changes in mean temperature, rainfall and sea level. The classical global models have made significant contributions to the theoretical understanding of potential climate impacts. Their deficiencies soon became apparent. For instance, crop yields are sensitive to temperature variability, seasonality, rainfall distribution and other local microclimatic effects. The scale used for crop climate models are generalized for larger areas and their limitation to mean temperature and rainfall calls into question the validity of the estimated impacts[18,19]. The second approach available is the bottom-up approach, i.e. adaptation methods relevant at the local scale or grassroots level. This approach was first articulated in the United Nations Environment Programme (UNEP) guidelines, but more fully captured in the Adaptation Policy Frameworks (APF) for Climate Change[20]. The assessment processes involve local stakeholders' empirical knowledge based on actual observation of current climate risks and how communities cope with them. The dimension of new risk can be introduced and assessed by existing knowledge of local stakeholders.

Information related to climate change like tracking meteorological patterns, forecasting impacts and assessing risks is crucial for planning climate change adaptation at the local level; for example, farmers having access to information on change in rainfall patterns or temperature and also to technology can make a difference in production. Climate information is to be combined with other information for assessing the risk, good decision for loss reduction strategies and timely information to local stakeholders; for example, forecasting and monitoring floods needs weather data to be combined with hydrological data to provide information about the likelihood of flooding and project impact according to vulnerability. Hence information, knowledge and communication that are related to climate variability will be the way and means for protecting rural livelihoods of highland communities. The proposed CISS model is expected to develop capacity of local stakeholders and decision makers for developing policy using application of climate services for socio-economic benefits of the region. Three steps need to be followed in developing CISS: generation of climate information database, information dissemination and informed action (Figure 1).

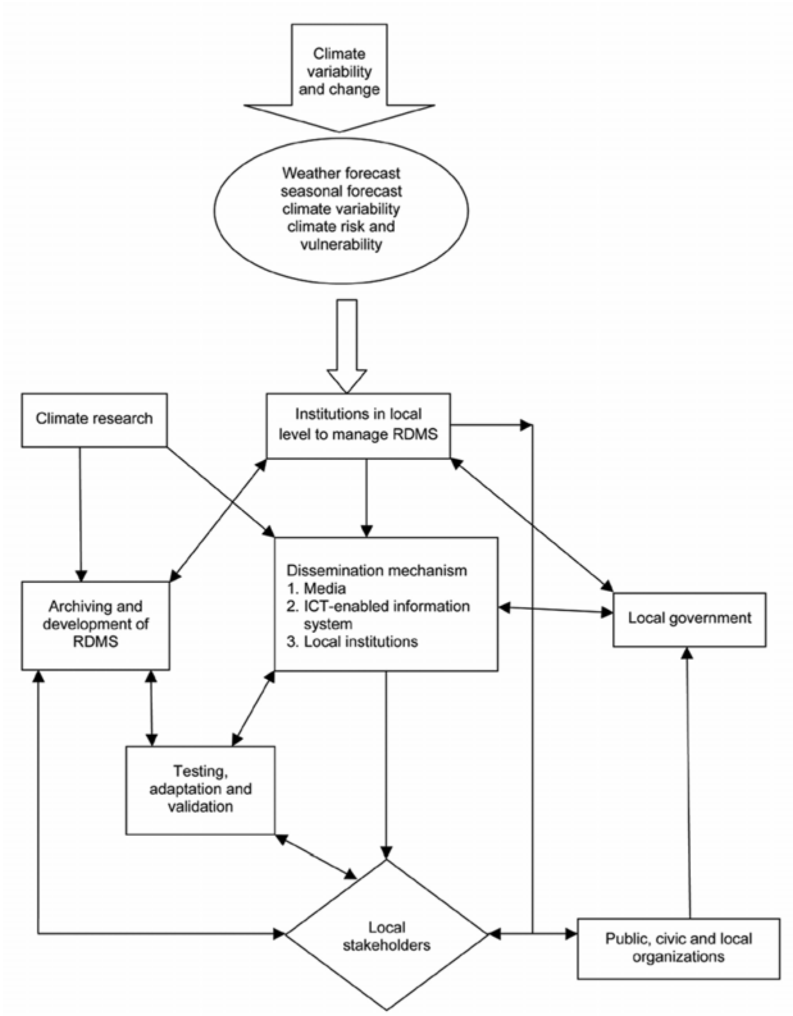

Figure 1. Climate information service system model.

Generation of climate information database

The first step for adaptation at the local level is the creation of a database of climate risks related to different timescales and different stakeholders. This will consist of both spatial and non-spatial database. Spatial information about climate variability can be captured from satellite imagery, aerial photographs, survey using remote sensing, geographic information system (GIS), cartography software and also global positioning system. The non-spatial climate data are taken from traditional station networks, perception of local stakeholders, information from eKiosks and other research organizations working on climate variables like current climate variability, current climate risks and short-term weather forecasts. Testing, validation and adaptation of these data and research findings of specific local conditions could be used for developing the best adaptation strategy. All the information needs to be combined through a rational database management system (RDMS). Institutional structures for monitoring, archiving and climate risk research must be strengthened, where none exists currently. The developed RDMS will certainly gather and recognize the scattered pages of academic journal and technical reports on climate studies and experiments that could help vulnerable groups and planning agencies at the grassroots level. Hence, a society cannot solve these looming crises by depending on external global databases, but has to develop indigenous methods to solve these problems. The RDMS of climate variables can be created following the mechanism shown in Figure 2.

Information dissemination

The second pillar of CISS is dissemination of information at the local level to adapt to climate change. There is a fast-growing domain of information on climate, including information about current climate variability, and improving global and regional models of the future climate change. Understanding of climate systems and the ability to forecast short-term and medium-term weather and seasonal climate have also improved over the past

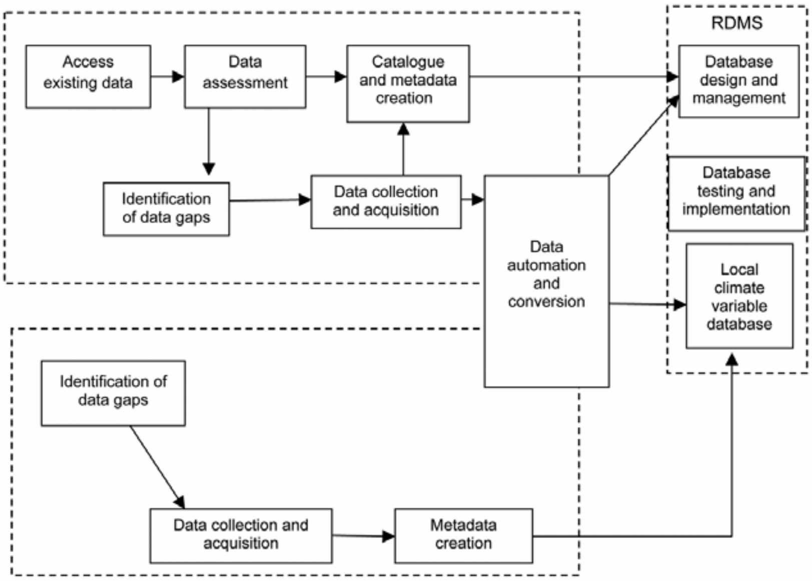

Figure 2. Generation of climatic variable database.

few decades at the global level. Decision makers at household require smaller spatially scaled climate prediction models for tracking meteorological patterns, forecasting impacts and assessing risks in the context of climate change from global to regional and eventually at local level. However, this information needs to be well targeted and disseminated to the rural households. Such information is available in research mode, but not in user-friendly format to the rural households for decision making. Correct and relevant information at the appropriate time can help understand the climate vulnerability and take appropriate decisions for coping and minimizing adverse impacts. It has been realized that climate change and climate-induced vulnerability-related information does not reach the poor, particularly in rural and remote areas. Therefore, an effective information delivery mechanism can be established with the application of information and communication technologies (ICT). They can be instrumental in providing not only the means of connectivity to isolated communities in the highlands to get the information, but also help them in knowledge-sharing and social networking. The local community can provide indigenous knowledge and can also get information about the advanced research and technologies from universities and institutions in the Himalayan States from RDMS (Figure 2). Application of ICT can improve the knowledge base, help in efficient and appropriate land use, and facilitate the preservation of natural resources inventory to provide sustained supply of life-supporting environment. Natural resources management, climate literacy, improved public health, human welfare and strengthened social, economic and governmental institutes will facilitate local-level adaptation. These are the ways and means for a practical adaptation process.

In this context, eKiosks (Telecentre, Community Information Centre, Gyan Chaupal, Common Service Center, etc.), mobile telephony, radio and social networking communication systems would be crucial in the dissemination of information to the poor and vulnerable sections of the society in remote areas. Climate-related information and knowledge can be delivered to them through establishing eKiosks which are equipped with computers and connected to the internet and data sources. Thus eKiosks can be developed as a repository of knowledge and information regarding climate, agriculture, development programmes and natural calamities for the rural populations. Mobile telephony and radio are also viable means of information dissemination. Radio is a traditional means of information dissemination, whereas mobile phone is fast and cost-effective means of delivery of information. The Census of India 2011 shows[21] that the number of mobile phones has grown to 53.2%. Therefore, spread of information in local languages is now easily possible in rural and remote areas as well.

Informed action

The third aspect is to act on the information. Action on information should be taken at both the top and bottom levels. At the top level, the decision makers should be mobilized to formulate appropriate policies and strategies. At the bottom level, people need to utilize the information and act to cope with challenges posed by climate. Capacity-building to promote the development of robust systems for climate risk communication is key. Therefore, relevant capacity-building measures include actions to assess risk communication needs and appropriate modalities, development or scaling up of risk communication tools and methods appropriate to the needs of end-user communities, training of trainers for climate risk communication, platform to assess policy needs for supporting both climate risk communication and adaptation measures identified through the sensitization process.

The most remarkable aspect of informed action is the bottom approach to involve people in the adaptation and development process. People's participation in the planning and implementation at the grassroots level in the adaptation and development process would have multiple benefits. The rationale behind the participatory approach is that local people have conventional wisdom for judicious use of natural resources. Since poor people rely on natural resources for their livelihood, they ought to be involved in mechanisms of development of the locality. Secondly, the local community is emotionally attached to the local environment. They generally do not harm the natural harmony. Thirdly, decentralized planning is the best possible way to ensure people's participation and to make them aware of the climatic problems. Fourthly, it would also strengthen the grassroots democracy and bring marginalized sections of the society in the mainstream of development. Bringing these sections of the society will promote inclusive development as well as facilitate their role in conservation of natural resources on which they heavily rely for survival. Therefore, informed action needs to involve both top and local level people to put information into action.

Challenges to CISS

Establishing the system for information delivery appears to be an elaborate process. It involves problems at both conceptual and practical levels of CISS. First, a growing amount of information on climate change in the form of weather forecasts, seasonal forecasts, climate change scenarios, climate-induced vulnerabilities, adaptation methods and so on, is available for use. However, in most of the cases, the information does not reach the potential end-users in an accessible way so that they can interpret and use it. In addition, information available on the global scale generally is not applicable for local areas. Second, in some cases, information on climate variability is available, but the process and the capacity for integrating this information into vulnerability and capacity assessments, to feed into adaptation strategies, poverty-reduction strategies and planning at the local level, etc. is lacking. Third, in many states of the Himalayan region, historic meteorological data are not available for more accurate predictions. Since it has been argued that the developing world would be the hardest hit by climate change, inaccurate predictions would certainly make the problem more complicated. Fourth, there is lack of relevant information in the local and social contexts. Information should be provided to complement the local knowledge and be locally relevant; thus people can easily practice and get accustomed to it. Fifth, risk assessment for shorter terms such as for a period of five years or a decade is essential for practical adaptation to climate variability. Currently, most of assessment has been done for longer periods, i.e. 20 years, 50 years, etc. that generally appears to be meaningless for common people who look for immediate solutions for current problems. Sixth, there is also lack of observational climate data for many inaccessible regions. Observational data are required for tracking long-term climate trends and integrating this information with approaches to deal with climate variability.

Apart from these methodological and theoretical lacunae in prediction and interpretation of climate change, there are other challenges in establishing the system of effective information delivery to the rural households in high elevation. Despite the revolution in ICT, the reach of these technologies and quality of services to common people are still low in the developing countries, including India. Internet penetration and its awareness in rural areas is poor. According to a survey conducted in 2009 by the Internet and Mobile Association of India and Indian Market Research Bureau, an overwhelming majority in rural hinterland (84%) is not even aware of the internet[22]. About, 38% is aware of the internet, but does not feel the need to use the same[22]. India's rural mobile teledensity[23] is only 35%. Therefore, narrowing the digital divide is still a challenge. Second, awareness level of people about these technologies and services is quite low. They generally rely on the traditional sources of information rather than the use of advanced technologies to tackle natural and climate-induced calamities. Third, there is lack of supporting infrastructure for building an operational information system such as electricity, skilled human resources and so on. Unfortunately, such infrastructural facilities are not available in rural and remote areas of the Himalayan region. Fourth, the problem in this context is content creation in local languages. People do not communicate or understand English in rural areas, and therefore information available in English is meaningless for them. Last but not the least, deployment of, ICT in rural areas depends on the will of the political elite of the country. Transformative impacts of ICT have the potential to erode the traditional social power balance. Therefore, the political elite are always sceptical to deployment of any system that can easily and openly provide information to people.

Conclusion

The impacts of climate change are real and its trends appear to be uncertain. To cope with climate catastrophe, a well thought-out strategy for adaptation is warranted. Information is critical for adaptation, particularly for rural households in the Himalayan region. Bottom-up approach is an appropriate and effective method to provide information and to increase awareness among the people at the grassroots level about climate change and its implications. The social security and disaster management mechanisms in the fragile ecosystem are not so strong to meet the challenges posed by climate change. The raw climate information has to be translated to quantitative terms, and uncertainties should be stated in probabilistic terms for effective decision making for rural households. Therefore, correct information and effective way of its dissemination are crucial for coping with climate change, particularly for vulnerable households who are the hardest hit by natural calamities. The conceptual framework of the CISS model structure and the flow pathways are further steps for inclusive development in fragile rugged topography as majority of the population in this area depends upon agriculture and natural resources for its livelihood. The structure of the CISS attempts to understand the impacts of climate change, broadly disseminate information about the impact, and facilitate capacity-building of vulnerable sections of the society to act upon the information.

In order to provide information to local communities and to address the current challenges, there is an urgent need for massive expansion of infrastructure such as electricity, connectivity, both internet and telephone, for the establishment of ICT-enabled systems. The local governments need to be helped not only in dissemination of information, but also in promoting people's participation at the local level. Civil society organizations should be encouraged to play a role in bridging the gap between people and government. The development programmes should be integrated with adaptation and environment to make them least detrimental to nature. This typology is a suite of innovative interventions for protecting rural livelihoods of vulnerable households and for reducing rural poverty in the face of changing climate. The comprehensive approaches of CISS depend on the action of rural households, climate monitoring institutions and response institutions in bridging the gaps among highland communities and meeting the challenges of climate-proofing of rural livelihoods in Himalayan region.

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