Indian Journal of Traditional Knowledge
Vol. 10 (1), January 2011, pp. 183-189

Cultural values and indigenous knowledge of climate change and disaster prediction in Rajasthan, India

Aparna Pareek & PC Trivedi*

Department of Botany, University of Rajasthan, Jaipur
E-mail: ptrivedi33@yahoo.com

Received 03.11.2010; revised 12.01.2011

This paper provides a case study in which Indigenous knowledge and traditional stories relating to cloud formation, lightning, wind direction, rains, drought, disaster prediction, response, mitigation, and effects of weather on crops are applied in a contemporary context by the tribal peoples of Rajasthan, India. The state of Rajasthan falls in an area of high climate sensitivity, maximum vulnerability and low adaptive capacity. The study documents how individuals in these tribal communities (including *Bhil, Meena, Banjara, Kathodi, Rabaris, Sansi* and *Kanjar*) perceive and manage natural disasters and extreme weather events, including their strategies for early detection of coming events and for coping with these events, as well as their perceptions of their short and long term impacts on biodiversity.

Keywords: Traditional knowledge, Emergency management, Natural hazards, Biodiversity, Tribal peoples, Rajasthan

IPC Int. Cl.[8] : E04H 9/16; G01W; G01W 1/10; G01W 1/14; G03C; G09G 5/00; G08B 5/00; G08B 5/36; G08B 5/38; G08B 5/40; G04B 25/02; G01P 13/02

Scientific evidence of climate variability of events such as droughts and floods suggests that climatic oscillations have occurred in the past and may occur in future, potentially with large impacts on human society and economy and on the ecosystems of which they depend[1].

There is evidence to show that slow and gradual climate changes over the the earth's history have been interspersed with abrupt climate changes such as rapid cooling, warming, wetting and drying due to the forcing of earth systems across thresholds[2].

Over the course of history and up to this day traditional local communities have continued to rely heavily on their own indigenous knowledge systems in observing the environment and dealing with natural disasters. These communities, particularly those in hazard prone areas, have collectively generated a vast body of knowledge on disaster prevention and mitigation, early warning, preparedness and response and post disaster recovery. This knowledge is acquired through observation and study, and is often based on cumulative experience handed down from generation to generation[3].

Such traditional environmental knowledge systems are important tools today in environmental conservation and natural disaster management[4].

Indigenous knowledge is now much sought after in the present context of globalization. However, while the diverse knowledge systems of the third world are claimed as heritage that belongs to all humanity, the knowledge about how to apply this diversity is often exclusive to the domain of the people who have developed it[5].

Ecological problems coupled with unequal access to resources results in human ill-being and threats to the livelihood security of the world's poorest peoples[6]. Humanity faces the exceptional challenge of eroding natural resources and declining ecosystems services due to a magnitude of threats created by unprecedented growth and consumerism. Also imperiled are the biodiversity and sustainability of the essential ecological processes and life support systems[7].

The present paper is an attempt to integrate the collective wisdom of humanity for the conservation of biodiversity, embodied both in formal science as well as local systems of knowledge, providing the best possible means of developing sustainability. It is aimed to build awareness of the immense value indigenous knowledge holds in helping to reduce risks presented by different types of hazards in diverse environmental and cultural settings throughout the state of Rajasthan, India.

*Corresponding author

Research methodology

The methodology used for this study is as follows:

The first undertook a review of various published and unpublished literature sources relating to Indigenous knowledge of weather events and major climatic disturbance, consulting traditional religious textbooks in local languages and English, and research papers and other written materials. Adaptations and coping strategies followed by tribal peoples from across the state were documented, along with oral history and ethnographic reports.

The study was carried out in the rural villages of Rajasthan where a desk study including a review of the relevant literature available on indigenous knowledge was undertaken in preparation for the collection of data in the field. Although different methods of data collection were used in the different areas, interactive discussions, open interviews, focus group discussions, meetings, cultural mappings and intensive interviews were used. In particular meetings were deemed important for informing and building community trust with the research. Cultural mapping was seen as important because it involved making use of local experts which made respondents feel that they were sharing information with fellow informants.

Community trust

The scientific value of such information was also ascertained while collecting indigenous knowledge information issues such as whether they were being accepted and trusted by local communities and individual respondents and the kind of common language and knowledge used in the transactions.

The area selected was identified on the basis of their diverse environmental, socio-cultural and economic backgrounds. The strategy for collecting information included the use of diverse approaches such as interactive interviews, focused group discussions systematic observations and documentations from oral history, reports, research publications, mass media, articles and magazines. A questionnaire was developed to guide discussions with key informants on natural resources conservation and disaster management. In each location the focused group discussions were conducted with three discussant groups defined by age as follows: 25-40, 40-60 and above 60 yrs. In some sessions discussions for men and women were separated. The focused group discussions were recorded and the information analyzed and entered into a database.

Data was also collected from local informants and respondents amongst the various tribal communities of Rajasthan. The status and availability of the data varied from one place to another but attempts were made to develop a common indigenous knowledge terminology used in environmental resources conservation and natural disaster management. In particular an attempt was made to document the linkages between application and use of indigenous knowledge and the diverse cultural and spiritual values which permeate many of the communities in the study. Tape recorders were used to ensure the fidelity of the interviews.

Most of the people we interviewed in this study valued traditional knowledge in relation to early warning and coping mechanisms for natural disasters. Only a few self confident young people who were accustomed to the use of transport vehicles said that they rely mainly on radio weather forecasts rather than on local methods of anticipating weather events.

Results

The study found that indigenous knowledge systems have enabled the various communities in the area to live in harmony with their environments for generations, and that their traditional knowledge systems are important tools in environmental conservation and natural disaster management. Based on this traditional knowledge and peoples long-standing experiences concerning cloud formation, lightning wind direction, occurrence of rains in a particular period of the lunar calendar, the Indigenous rain forecasters predict the reasonably exact nature of rainfall for the entire season, including good and undesired effects (e.g., flooding, droughts). There are well known Sutras given in the ancient books to predict the monsoon and inform people about prospects of agriculture in a given year. Even in villages it is very common for farmers to consult Brahmans about the monsoon in a year. Monsoon predictions are also made according to the nature, color, and direction of flow of clouds and lightning in the clouds. In the prediction that a particular year is likely to be a drought year, the nature of clouds is described as follows: “There would neither be prosperity nor rain in the land should the clouds be rough and small, tossed about by the wind have the shape of camels, corms, dead bodies, monkeys or other inauspicious creatures, and be silent” (Indigenous knowledge for Disaster Risk Reduction in South Asia).

The tribal peoples of Rajasthan face many natural hazards, but the major ones are drought and floods; these invariably cause famine, food insecurity and poverty. However, the people have developed a variety of measures to contend with these situations, such as growing drought-resistant and early-maturing indigenous crop varieties, gathering a diversity of wild fruits and vegetables, wetlands cultivation, livestock diversifying and splitting, that have enabled them to survive climatic hazards independently, with little or no support from the outside world. The people are well aware of the disasters they face and in most cases had the knowledge and administrative structures, or social institutions to cope with them. Some of the predictions in climate using indigenous knowledge are mentioned as:

Indegenous knowledge of the tribals forecasting climate

Ficus species : Flowering and generation of new leaves indicates near rainfall onset.

Butterfly : Appearance of many butterflies indicate early rainfall onset and also gives a prospect of good season.

Ants **:** Appearance of ants indicate imminent rainfall onset and signifies a prospect for good season

Termites : Appearance of many termites indicates near rainfall onset.

Frogs : When frogs start to make a lot noise, it indicates near rainfall onset.

Change in wind direction and temperature (Signifies imminent rainfall)

The tribals assess the probability of early warning of flood extent by observing color of clouds, their location, intensity and frequency of rainfall. The unusual sounds and changes in water flow, colour of water, direction of wind and the unusual behavior of wildlife like ants, birds, rats and Snakes also helps in the assessment of climatic variations.

The tribals of Rajasthan also have faith in the sayings of elders about the prediction of weather, for e.g "*Sukarvar ri badri,rahi shanichar jaye,barsa bina na jaya*". It means that if clouds form on Friday and remain till Saturday then they will not go without rain, such indications predict rains. In another saying "*Nada tankan,balad bikavan.mat baje tu,adhe saawan*". It means that in mid monsoon if South east wind blow then farmer of marwar region cries because it indicates famine in the particular region. Similarly "*Pawan baje Suryo,to hali halav kim puryo*" means that if winds flow in the North –west direction then farmer should not plough his field because it indicates heavy rains.

Indigenous knowledge for the people of Rajasthan is seen as a precious national resource that can facilitate the processes of disaster prevention, preparedness and response in cost effective participatory and sustainable ways. However, a blend of approaches and methods from both science and technology and traditional knowledge systems has opened avenues towards even more effective disaster prevention, preparedness, response and mitigation. As for coping with major changes in the weather, traditional indigenous knowledge of storm routes and wind patterns enables people to design their disaster management long in advance by constructing particular types of shelters, wind break structures, walls and homestead fences appropriately. Similarly, the knowledge of local rain corridors enables them to prepare for storms. Knowing the color of clouds that may carry hailstones enables people to run for cover. Knowing that prolonged drought is followed by storms, thunder and lightning during the first few rains enables people to anticipate and prepare for these events. Floods are predicted from the height of bird's nests near rivers. Moth numbers can predict drought (www.ecn.ac.uk/Publications/ECNCCI/CC1/pt06.pdf).

Indicators such as the position of the sun or the cry of a specific bird on trees near rivers help people to predict the onset of the rainy season.

Tribal communities of desert areas have often shown that they are good managers of their natural resources base through their traditional knowledge and wisdom[8]. Traditional knowledge about crop prospects was also used to predict *Jamana*, (i.e. agricultural crop prospects, mostly for rainfed crops). Prediction of crop potential is generally based on the direction and type of clouds, and on wind direction on a particular day and month. Traditional religious texts also reflect this type of knowledge, which is now also published in local languages. As a example, one of the *sutras* is as follows: "If the clouds rise in the east, there will be good crops, in the South east there will be outbreak of fires in the South, crops will decay, in the South west only partial growth of crops, in the West good rains, in the North west, stormy and sporadic rain, in the North very fine and full rain and in the North east bumper crops" (Indigenous knowledge for Disaster Risk Reduction in South Asia).

The land use strategies include avoiding flood or landslide prone locations when building a home and keeping away from hazardous places at certain times of year, such as not taking livestock to pasture up mountain valleys during the spring floods. To check erosion and flooding during the monsoon, villagers convert hillsides into level terraces and create outlets to manage water overflow from one terrace into another. They make check dams and a network of ponds to slow rain water run-off and save water for the dry season. They plant trees to stabilize slopes and prevent erosion of gullies. Housing technology is another area where indigenous knowledge is much visible in every part of the district.

In the flood prone area of the district, houses have been built on stilts so that the flood waters can pass underneath. At many places, houses are constructed on raised platform so that they remain above flood levels. In the areas prone to cyclone, homes have been traditionally constructed with light weight materials that can be easily dismantled and removed. False roofs have been built where goods can be stored, if the need arises people can also take shelter when water enter houses.

The local communities of Rajasthan provide evidence of a unique blend of ecological sense and religion. There is plenty of vegetation, forests and wildlife in this area, which is sustained by the use of people's socio-religious knowledge, values and traditions. Examples of such traditional and innovative adaptation practices include: shoreline reinforcement, improved building technologies, increased water quality testing, rainwater harvesting, supplementary irrigation, traditional farming techniques to protect watersheds, changing hunting and gathering periods and habits, crop and livelihood diversification, use of new materials, seasonal climate forecasting and community based disaster risk reduction. These methods of mitigating and coping with extreme weather and in the longer term, climate change, are effective and relatively low in cost. What's more, they help to preserve cultures and uphold local people's dignity. The main problem is that they are given little weight at the national and international levels.

In the Barmer district of the desert region in India, Indigenous knowledge and Western Science have yielded environmentally friendly shelters that are flood resistant. The communities there are living in very harsh climatic conditions and making judicious use of the sparse resources available within their surroundings for both their day-to-day requirements and for construction of houses (Building materials and Technology Promotion Council, Government of India, 2006, Vulnerability Atlas of India). A study carried out by Bharara (1980)[9] identifies traditional social indicators of drought prediction in an arid region of Rajasthan and compares the accuracy of these indicators with that of measured rainfall data, as a contribution to the discussion of the relevance of indigenous knowledge to the development process in a mainly rural society.

As the predominant wind direction in Rajasthan is South west to North east, the tendency for desertification has been more in that direction. Indeed there is clear evidence that the Thar Desert is expanding in an eastward, as well as North east direction. Thus from the climate-proofing perspective, creating plantation strips and shelter belts perpendicular to the predominant wind direction in areas spread from Ramgarh to the foothills of Mount Abu is likely to help in climate change mitigation and livelihoods improvement.

Discussion

Science-based forecasting generally consists of statistical and simulation modeling techniques that are used to develop long term projections of future water supply relative to future demand. Many utilities forecast water supply and water demand for a 50-80 yrs period. Forecasting has been used to develop flood and drought warning systems, to make predictions and projections for seasonal variability in precipitation and for modeling future climate variability.

Climatic change presents a clear challenge to this type of forecasting. Since many forecast techniques rely on historical climate data, changes to baseline conditions as a result of climate change can reduce the predictive value of historical data in determining future conditions. However, a good first step in adapting the climatic change is improving hazard and disaster management to meet current climate variability by using seasonal forecasts in lieu of annual or average year forecasts to inform decision-making. This will improve utility flexibility and leave resource managers better prepared to face future climate change impacts[10].

A desk review was made to assess how the communities have learnt to live with disasters (floods,

drought, coastal and seismic hazards) and their traditional coping mechanisms with particular reference to the following:

1. Traditional technologies including housing, land use, agriculture or other technologies adopted to reduce the disaster risks.
2. Economic practices including savings, insurance, conservation, etc for reducing the disaster risks.
3. Social practices like mutual help, community sharing and distribution, social security and protection of vulnerable groups like children, aged, handicapped, etc. to cope with the disaster situations.
4. Cultural and religious practices that strengthen social, mental and spiritual defense and resilience to face the disasters.
5. Related practices relevant to the subject.

Athrva Veda discusses drought mitigation strategies and *Arthashastra* (4th Century BC) has a section on famine relief and mitigation measures.These became part of folklore and form basis of coping mechanisms extant at community level today.

Researchers have documented a number of indigenous building practices that have prevented collapse of structures in seismic zones, for example *Koti Banal* architecture of Uttarakhand, *Dhaji Diwari* of Kashmir, *Bhongas* of Kutch, brick-nogged wood frame constructions in Himachal Pradesh and bamboo based *Ekra* constructions in Assam, India (Indegenous knowledge for Disaster Risk Reduction in South Asia).

There is abundant evidence that disasters disproportionately affect developing countries. Between 1991 and 2005, more than 90% of disaster deaths and 98% of people affected by disasters were from developing countries (OFDA/CRED International disaster Database EMDAT). Moreover, disasters are increasing in number and size every year due to a number of factors including rapid population growth, urbanization and climate change.

Drought

The study, conducted in Shergarh Tehsil, western Rajasthan, analyses the nature and extent of the drought-affected area, social changes including social and economic values, disturbances in the agrarian sector, and changes in livestock numbers. Analysis of rainfall data for 78 years (1899-1976) revealed that there were 43 mild drought years when 50 % of the crops reached maturity, 19 drought years (25 % crop maturity), and 8 disastrous yrs (zero crop maturity[9].

Climate change is the greatest challenge before the global society, impacting the ecological economy and society in several diverse ways. Changes in the climate of Rajasthan have exceeded the expected natural climate variability prevailing in this area. Studies have shown that Rajasthan falls within the areas of greatest climate sensitivity, maximum vulnerability and lowest adaptive capacity known from different parts of the globe. Rajasthan also has the maximum probability of occurrence of drought of anywhere in India. If various segments of our society fail to act in timely way and coherently, climate change is likely to affect every sphere of life in the region and may make the livelihoods of poor people even more vulnerable and less resilient. Science-based forecasting generally consists of statistical and simulation modeling techniques that are used to develop long term projections of future water supply relative to future demand. Many utilities forecast water supply and water demand for a 50-80 yrs period. Forecasting has been used to develop flood and drought warning systems, to make predictions and projections for seasonal variability in precipitation and for modeling future climate variability.

Globally there is increasing acknowledgement of the relevance of indigenous knowledge as an invaluable and underused knowledge reservoir which presents developing countries, particularly India, with a powerful asset in environmental conservation and natural disaster management[7].

On the face of climate change, adaptation and mitigation actions are critically required for cities in India where the urban population is likely to grow by around 500 million over the next 50 yrs. Addressing and adapting to the multiple risks due to climate change – temperature and precipitation variability, drought, flooding and extreme rainfall, cyclones and storm surges, sea-level rise and associated environmental health risk, is a serious public policy concern.

In Rajasthan, local communities had well developed traditional indigenous knowledge systems for environment management and coping strategies, making them more resilient to environment change[11,12,13]. It is shown that the role played by climate change scenarios is dependant on the adaptation assessment approach, availability of technical and financial capacity to handle scenario information, and the type of adaptation being considered.

Famine

Plants are used as emergency food by the people of the Rajasthan desert during periods of famine[14]. The utilization of little known foods in times of acute crisis is recognized as a form of resilience. Several indigenous crop species are described which could be grown and utilized to prevent a great deal of suffering. The information could be an indicator of the extent to which a region may be suffering silent famine. These natural phenomenon may be related to wind direction, cloud pattern, position of planets, behavior of animals, birds and changes in plants, etc.

Desert rural folk in Rajasthan perceive drought as a multi-dimensional phenomenon varying from meteorological to biophysical to socio-religious aspects. Associated with these notions, local people reported drought-induced problems, distress sales of land and livestock personal assets, set-backs to occupational caste's economy and loss of crop-livestock production. Changes in climate and vegetation characteristics, animal behaviour and social behavioral activities like color of clouds, their location, intensity and frequency of rainfall, unusual behavior of ants, birds, rats and snakes. The predictions based on these indicators and human feelings support the early warnings issued by the elders to enable the community to cope with the anticipated natural hazard are widely believed to be indicators for drought prediction[15].

This case study focuses on traditional adaptation practices used by vulnerable communities in the drought-prone areas of district, Rajasthan. Communities here already bear the burnt of drought and have learnt to cope. Successive droughts over wider geographic areas, combined with other stresses, now threaten to overwhelm coping capacity in ways that might become the norm with climate change. New adaptation strategies have been introduced in the district by local non-governmental organizations that build on existing knowledge and expertise about water, agriculture and livestock management. These include: growing new crops such as vegetables, fodder and higher value medicinal crops for commercial sale; use of environmentally sound fertilizers (vermin culture); improved storage for fodder and food grains; and improved water conservation and harvesting techniques through construction of *anicuts* and digging and deepening ponds and wells.

Bharara and Seeland (1994)[16]identified traditional social indicators of drought prediction in arid region of Rajasthan and compared their accuracy with that of rainfall data as a contribution to the discussion of the relevance of indigenous knowledge to the development process in rural society. Though Thar, the desert ecosystem is unique, with harsh climatic and terrain conditions coupled with an amazing grace that life and practices speak of that conserves natural resources. The heat generated in the atmosphere actually helps to draw the monsoon into the region. Although there is a water shortage, traditional water management has kept the desert relatively moist. The UNDP supported water conservation project in the arid Marwar region of Rajasthan has shown that traditional knowledge and community involvement goes on long way in saving every precious drop of water[17].

Conclusion

The relationship between indigenous knowledge and natural disasters has received greater interest in recent years. New discussions around indigenous knowledge highlight its potential to improve disaster risk reduction policies through integration of particular knowledge and insights into disaster education and early warning systems, both of which play a crucial role in disaster risk reduction. Various studies have revealed that a proper communication system coupled with traditional knowledge can actually mitigate the effects of disasters and can be helpful in risk reduction. It is concluded that a shift in paradigm from "top down" strategy to a "bottom up" participatory approach will be most effective and that designing a policy framework comprising both scientific and indigenous knowledge is vital to facilitate disaster risk reduction.

Since Indigenous knowledge is mainly based on relative experience and local experience, lack of benchmark makes it difficult to be harmonized and integrated into conventional forecasting system. Systematic documentation, quantification and subsequent integration of indigenous knowledge into conventional weather forecasting system is therefore recommended as one of he strategy that would help to improve the accuracy and reliability of seasonal forecasting information under a changing climate.

India has increasingly adopted holistic multidisciplinary methods for management of disasters. However, there are still a number of challenges ahead. Global Climate change is causing phenomenal challenges of its species. Although disasters are a natural phenomenon, their increasing frequency, magnitude and intensity of damage are

attributed to human activities, and must be controlled at least in part through social mechanisms. This is where application of Indigenous and local knowledge and practices can be particularly effective.

Acknowledgement

AP thanks UGC, New Delhi for providing post doctoral fellowship. Various chiefs of tribal villages and tribals for the warm hospitality and for readily sharing their knowledge and for giving their prior consent for the present study are also gratefully acknowledged.

References

1 Fisher RJIf rain doesn, come: An Anthropological study of Drought and Human Ecology in Western Rajasthan, Sydney Studies, Manohar Publishers and Distributors, 1997.

2 Bharara LP, Indegenous Knowledge-A Coping Mechanism in Drought-prone Areas, and Changes and Consequences of Accelerating Risks and Vulnerability to Desertification in Western Rajsthan, Paper presented at Seminar on control of Drought, Desertification and Famine, New Delhi, Mimeo, 1986.

3 Grenier Louise, Working with Indegenous Knowledge: A Guide for Researcher, (International development Centre: Ottawa), 1998.

4 Briggs John, The use of Indegenous knowledge in Development: Problems and Challenges, Progress in Development Studies, 5(2005)99-114.

5 Hussain Z, Human Adaptations in the Thar Desert, Geographical Review of India, *J Indian Farming*, 53 (4) (1991) 40-51.

6 Balwanera P, Conserving biodiversity and ecosystem services, *Science,* 291 (2001) 2047.

7 Chapin FS III, Zavaleta ES, Evinen VT, Naylor RL, Vitousek PM, Reynolds HL, Hooper DV, Lavorel S, Sala OE, Hobbie SE, Mack, MC & Diaz S, Consequences of changing biodiversity, *Nature,* 405(2000) 234–242.

8 Mukhopadhyay D, Indegenous knowledge and sustainable natural resource management in the Indian desert, In: *The future of Drylands*, edited by C-Leee & T-Schaaf, (Netherlands, Springer), 2008, 161-170.

9 Bharara LP, Socio economic consequences of drought in an arid tract-case study, In: *Arid Zone Research and Development,* edited by HS Mann, (Scientific Publishers, Jodhpur, India), 1980, 439–445.

10 Dekens Julie, Local knowledge for disaster preparedness-A literature Review, (International Centre for Mountain Development:Kathmandu), 2007.

11 Bokil M, Drought in Rajasthan in search of a perspective, *Econ Political Weekly*, 35(48)(2000) 4171–4175.

12 Goyal RK, Sensitivity of evapotranspiration to global warming: a case study of arid zone of Rajasthan (India), *Agr Water Manage,* 69(1) (2004)1–11.

13 Dessai S Lu X & Risbey JS, On the role of climate scenarios for adaptation planning, *Global Environmental Change,* Part A, 15(2)(2005) 87–97.

14 Bhandari MM, Famine foods in the Rajasthan Desert, *Econ Bot*, 28 (7)(1974) 73–81.

15 Indegenous knowledge for disaster Risk Reduction in South Asia.

16 Bharara LP & Seeland K, Indigenous knowledge and drought in the arid zone of Rajasthan: weather prediction as a means to cope with hazardous climate, *Internationals Asienforum,* 25(1/2) (1994) 53–71.

17 Mall RK, A Gupta, R Singh, RS Singh & LS Rathore, Water resources and climate change: An Indian perspective, *Curr Sci,* 90(2006)1610-1626.