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1 author:

Dr.S.N. Sethi
Central Institute of Freshwater Aquaculture

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Prediction and management of natural disasters through indigenous Technical Knowledge, with special reference to fisheries

SN Sethi*[1], JK Sundaray[2], A Panigrahi[2] & Subhash Chand[3]

[1]Madras Research Center of Central Marine Fisheries Research Institute, Chennai, Tamil Nadu;
[2]Central Institute of Brackish water Aquaculture, Chennai, Tamil Nadu
[3]Central Agricultural Research Institute (CARI), Port Blair, A&N Islands
E-mail:sethisatyanarayana@yahoo.co.in

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Traditional Indigenous knowledge has over the years played a significant role in solving several major social-ecological problems including those related to climate change and variability. People living close to nature often observe the circumstances around them and are the often the first to identify and adapt to any changes. The appearance of certain birds, mating of certain animals and flowering of certain plants are all seen as important signals of change with respect to timing and seasonality of natural phenomena that are well understood in traditional knowledge systems. Indigenous and local peoples have relied on biodiversity as a buffer against environmental variation, change and catastrophe. In the face of plague, if one crop fails, another will survive. In coping with risks associated with excessive rainfall, drought or crop failure, some traditional people grow a wide diversity of crop species and varieties with differential susceptibility to drought and floods and supplement their crops by hunting, fishing and collecting wild food plants. The diversity of crops and food resources is often matched by a similar diversity in the locating of fields - a safety measure to increase the likelihood that in the face of extreme weather at least some of the fields will be able to produce harvestable crops. Indigenous Technical Knowledge has three main aspects – materials, operations or practices, and institutional systems responsible for the implementation of the knowledge. The materials which are connected with the Indigenous Knowledge are the traditional seeds, medicines and pesticides collected from the plants and animals, the tools used in livelihood such as gears and crafts in fishing. Thus traditional indigenous communities will undoubtedly need additional support to coup up with the natural disastrous, their expertise will offer a great help for the effective management of natural disasters in future.

Keywords: Disaster prediction, Disaster Management, Indigenous Technical Knowledge, Fisheries

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The paper describes the importance of Indigenous Technical Knowledge (ITK) in helping communities to become more resilient in responding to major natural disturbances in India. It provides insights into the traditional, ages-old practices of prediction and management of natural disasters, with a special reference to fisheries. A disaster is the product of a hazard such as an earthquake, flood or windstorm coinciding with a vulnerable situation; it can impact at the relatively limited scale of a village, or at the scale of a city or larger. There are thus two main components of a disaster: hazard & vulnerability. India is vulnerable, in varying degrees to a large number of natural as well as human caused disasters. Nearly 59% of the land mass is prone to earthquakes of moderate to very high intensity; over 40 million hectares (12% of the land) are prone to floods and river erosion; of 8,129 km of long coastline, close to 5,700 km is rone to cyclones and tsunami; 68 % of the cultivable area is vulnerable to drought and hilly areas are at risk from landslides and avalanches[1].

*Corresponding author

Methodology

The study is an attempt to provide a comprehensive insight into the existing prediction & management of natural disasters, with a special reference to fisheries, which are being practiced generation after generation. The study is based on secondary sources collected from fishermen groups of Chouldari village, South Andaman, Andaman & Nicobar Islands and Orissa fishermen. The study undertakes a discussion on natural disaster management through indigenous knowledge in agriculture in general and fisheries in particular of India.

Result and discussion

The prediction of natural disasters, including earthquakes, droughts, tsunamis, heavy rains, and floods, through ITK was reviewed for tribal and indigenous peoples of India, in order to gain insights into approaches that might help mitigate future losses to agriculture and fisheries in the country.

Earthquakes and Tsunamis

India's high earthquake risk and vulnerability is evident from the fact that about 59% of India's land area could face moderate to severe earthquakes. During 1990-2006, more than 23,000 lives were lost in India due to 6 major earthquakes, which also caused enormous damage to properties and public infrastructure[2]. The occurrence of several devastating earthquakes in areas hitherto considered safe from earthquakes indicates that the geographical location of the country is extremely fragile and our ability to prepare ourselves and effectively respond to earthquakes is inadequate. During the International Decade for Natural Disaster Reduction (IDNDR) observed by the United Nations (UN) in the 1990s, India witnessed several earthquakes, including the Uttarkashi earthquake of 1991, the Latur earthquake of 1993, the Jabalpur earthquake of 1997, and the Chamoli earthquake of 1999. These were followed by the Bhuj earthquake of 26 January 2001 and the Jammu & Kashmir earthquake of 8th October 2005. And earthquake of 7.2 magnitude followed by a destructive tsunami struck in 26th December, 2004 in the Andaman & Nicobar Islands. One of the most devastating disasters of the 21st century was the Asian tsunami that wreaked havoc in 11 countries on December 26, 2004.

A tsunami is a series of ocean waves generated by sudden disturbances in the sea floor, landslides, or volcanic activity. In the ocean, the tsunami wave may only be a few inches high (typically 30-60 cm) but as the waves race onto shallow water regions their speed diminishes which results in increases in the height of the wave. Typical speeds in the open ocean are of the order of 600 to 800 km/hr. The tsunami's energy flux, which is dependent on both its wave speed and wave height, remains nearly constant. When it finally reaches the coast, a tsunami appears as a series of massive breaking waves. The December 2004 tsunami was triggered by an earthquake of magnitude 9.0 on the Richter scale off the coast of Sumatra in the Indonesian archipelago at 06:29 hrs IST (00:59 hrs GMT), impacting several bordering countries. In India, the eastern and southern coastal regions were impacted and 10,749 people are estimated to have died. The total death toll for all countries was more than 2, 80,000. In the post tsunami scenario, in south Andaman alone, due to the subduction of the land by earthquake about 1.25 m, the level of submergence due to tidal water influence has also increased. A survey conducted reveals that approximately 4,000 ha areas of agricultural farmlands were submerged, and are still not suitable for paddy cultivation because of sea water inundation (Figs.1 & 2.)[3].

Prediction

Unusual barking (unusual sounds and restlessness) of street dogs in groups is the most probable prediction for the onset of tremors/ earthquake in Chouldari villages, South Andaman, Andaman & Nicobar Islands.

Management

The development of "Early Warning System" must be implemented by the community systems for protective action (emergency shelter, high ground) after receiving the alert. This is especially important in the context of the geophysical characteristics of Andaman & Nicobar Islands. Due to the small size of the islands and flatness of land, people don't have many options for evacuation or fleeing upon receipt of warning. Therefore, the need for establishing emergency shelters or high grounds is critical. This will include construction of dual purpose emergency shelter cum community building, or adaptation of existing buildings. It will be worthwhile to explore the potential for elevating the overall floor level of designated areas by 2-3 meters to reduce risks from sea level rise (Fig.3).

Tsunami / Destructive Tidal waves

The 2004 tsunami was totally a new experience for the community. Though none in the community had undergone a tsunami even to the smaller amplitude ever in their living memory, at the same time the community is well conscious about the protection that mangroves offer from tidal waves, and they have always favoured the existence and conservation of mangrove forests abutting the sea. Being experienced fishermen, the members of the community, who venture sea are aware of the precautions that they are supposed to take with regard to maneuvering fishing boats during the times of storms and high waves, when entering a boat/canoe in to the sea that they sail following the direction of the wind flow. In this practice, the boat/dugout canoe must be ridden against the wind direction and if they sail in the other direction the boat/ dugout canoe will be pushed speedily in to the deep sea area and the fishermen will lose control of the boat. Immediate after the earthquake, people in Andaman used to move to an open place containing no house or plantation. It is essential that a Disaster Risk Management Program (DRMP) is developed and implemented on a priority basis in order to develop the capacity of Indian government and society to reduce the future disaster risks and sustain its development gains. Key elements of such program would include: Enhancing hazard-resilience of lifelines and infrastructure; e.g. markets, hospitals, airports, water supply and sanitation infrastructure and Jetties, storm risk assessment, preparedness and mitigation in northern atolls, and drought mitigation program including improved rainwater harvesting systems through improved run-off collection, enhanced storage and retention capacity and orientation building on hygiene and rainwater harvesting and management. This disaster risk management program must be closely synergized with the National Plans for Environmental Management (NEAP) and Climate Change Adaptation (NAPA).

Heavy rain, flood & cyclone

About 75% of the total rainfall in India is concentrated over a monsoon season of about four months (June-September). As a result, the rivers witness a heavy discharge during these months, leading to widespread floods. Floods are a regular feature of Eastern India where the Himalayan rivers inundate large parts of its catchments areas, uprooting houses, disrupting livelihoods and damaging infrastructure. The fragility of the settlements in the Himalayan mountain ranges is a continuing source of concern because they are highly vulnerable to earthquakes, landslides, floods and avalanches. The flood hazard is compounded by the problems of sediment deposition, drainage congestion and synchronization of river floods with storm surges in the coastal plains. The rivers originating in the Himalayas carry a lot of sediment and cause erosion of the banks in the upper reaches and over-topping in the lower segments. The most flood-prone areas are the Brahmaputra and Gangetic basins in the Indo-Gangetic plains. The other flood-prone areas are the Northwest region with the rivers Narmada and Tapti, Central India and the Deccan region with rivers like the Mahanadi, Krishna and Kauveri. The states most exposed to cyclone-related hazards, including strong winds, floods and storm surges, are West Bengal, Orissa, Andhra Pradesh and Tamil Nadu along the Bay of Bengal. Along the Arabian Sea on the west coast, the Gujarat and Maharashtra coasts are most vulnerable.

Prediction

Some of the predictions collected from fishermen & villagers of South Andaman through Group Discussion are as follows:

Black ants storing eggs and grains in safer places indicate that the rain follows. Screaming/croaking of frogs declares heavy rainfall. Cock lying on ground by spreading its feathers under sun is the indication for rain. Termites den in wet soil would bring rain. Appearance of red sky at Southwest direction indicates rain within 18 days. If the forests show luxurious growth of vegetation, the rainfall would be more during that year. If a snail climbs certain trees, earthworm crawls plenty in and around; Ants shift to safer places and insects fly around, all these indicates that there would be cyclonic weather followed by heavy rain. If there is spreading type lightning followed by thunder it ensures rain. Crawling of white worm over cow dung indicates heavy rain. If rainbows come in eastern side there would be chance of drought and if it comes in the western side indicates sure rain. Redness in the sky after sunset indicates cyclonic storms/ disaster within 7 days.

Management

During cyclone/strong winds the traditional knowledge have equipped the community with the foresight that strong indigenous trees (Fig. 4) such as Casuarinas (*Casuarina equisetifolia*), cashew nut (*Anacardium Occidentale*), mangrove plant (*Rhizophora* sp, *Avicennia* sp) on the seashore, *neem*, mango, jackfruit, and coconut trees, etc. in the home gardens provide sufficient protection from strong winds. Therefore the community has replanted and protected such species of trees. During heavy rains, fencing of dykes with bamboo poles to support soil erosion from the dyke and nets used to surround the dyke to avoid fish escape from ponds. Bamboo poles are used to prepare *Bhasa* (*Bhela*) for transportation during floods as a flood disaster management. By observing the redness in the sky after the sunset and predicting cyclonic storms within 7 days, fishermen avoid open deep sea fishing as preventive measures. During the Southwest monsoon in the months of June-September in most of the years floods occur due to the overflowing of the tanks in and around the village and also due to breach of and damage to the tank dyke. As per the information passed on from the elders, we do not have traditional solutions to floods. But in order to minimize the risk of flood damage, channels and water courses were regularly desilted and made clear of debris and mud. This usually assisted the smooth flow of excess water within a shorter time during rainy seasons. After flooding, early varieties of crops such as green gram, black gram and short duration paddy varieties are grown to mitigate the flood situation. Indigenous people have used biodiversity as a buffer against variation, change and catastrophe; in the face of a plague or disease, too, if one crop fails, another will survive[4, 10].

Indigenous Early Warning Systems (EWS) for Sea State Forecasting

Fishermen who venture far out to sea employ a very sophisticated system of observation of the behavior of the waves. Traditional knowledge has equipped them with hindsight on the most suitable point in the wave behavior to venture out. Members of the community, who are experienced sea fishermen stated at the Group discussions that usually they observe 7 waves of considerable crest height that land on the beach. The 8th wave is usually soft and smooth and the 9th wave will be very soft and very smooth. They know that just after the 9th wave is the most suitable time for entering the boats / catamaran / canoes in to the sea. Also when returning from sea to beach the boats loaded with fish the same observation and practice must be followed at a point of the sea 50 meters from the coast. If this traditional knowledge is not followed, the result will be dangerous and threat to the lives of fishermen. Traditional knowledge has taught the fishermen that they should observe the direction of wind flow. Also, by about 9 o'clock in the night a big star becomes visible in the sky and slowly moves towards the landward side. This star helps the fishermen to reach the coast at night.

Drought

Drought is a temporary negative deviation in the region's moisture status. Because of the variability of monsoon rains in Asia and the Pacific, the actual

Figs. 1-4 Permanent submerge of paddy fields and death of Cocanut plants with sea water intrusion at Sippighat, South Andaman and subduction of 1.25 m depth made by tsunami during December, 2004., 2 Damaged Mangrove area at Sippighat, South Andaman during tsunami, 3 A traditional Nicobari House, Andaman & Nicobar islands, 4 Mangroves - Natural Protection at Havelock Islands, Andaman & Nicobar Islands

annual rainfall is sometimes significantly below the `normal' expectation. This results in drought, which can lead to crop failure, depletion of surface and groundwater resources, large-scale human migration and loss of livestock and human lives.

Prediction

If rainbows appear in the east there could be a chance of drought, and if it appears in the west, this indicates sure rain. Water table beneath the termite mound will be high. Flowering of bamboo trees indicates an upcoming drought[5]. The presence of wild jackfruit trees in and around the field indicates the rich ground water status of the particular area. The appearance of swallows flying very low is considered an indicator of very heavy rains in the offing. For farmers, the appearance of more swallows is an indication of more rain and their non-appearance is considered a sign of an impending drought in the coming season. Swallows flying low is indication of drought[6].

Management

Drought is a natural disaster with serious and long-term socio-economic implications. It is therefore vital to develop appropriate measures to overcome it. In India, where drought has been endemic for the past 150yrs, a fairly organized management system to tackle it has emerged. However, the steps taken in the early stages were essentially ad-hoc in nature. Relief work was confined to providing employment to the distressed population rather than having any long-term perspective.

Early warning, drought monitoring and decision support systems

Rainfall distribution and its quantum are the two key factors that determine crop productivity[7]. Weather forecasts can broadly be classified into three categories, viz., short range (validity of up to 3 days), medium range (validity from 3 to 10 days), and long range (validity from 10 to 30 days). Early warning is given by the meteorological departments in many countries and relayed through the press, radio and television. The latest technological innovations to monitor droughts include remote sensing. It has reported its use along with geographic information systems (GIS) in Zambia[3]. Monitoring of spatial drought conditions (at block level) in a few villages in Rayalaseema, India using satellite data was reported[8]. The threshold Normalized Difference Vegetation Index (NDVI) was compared with moisture deficit values to assess the extent of aridity in affected areas.

Management of mid-season and terminal droughts is important as it impinges on productivity. Various methods have been devised but they could not be applied because of the lack of Early Warning System (EWS) on the onset of dry weather. Medium range weather forecasts are now in use in India as a form of EWS to control diseases and pests[9]. These, together with recommended practices to alleviate aridity can help arrive at optimal decisions for drought management. An example is the harvesting of sorghum for the fodder or ratoon crop based on physiological maturity. Groundnut, (*Arachis hypogaea*) harvesting is based on planting date and pegging. Intercropping with legumes should also take advantage of this technology. Although the yield is reduced, it is compensated for by higher prices in the market. Thus, a decision support system incorporating components such as crop growth models, advanced agricultural practices, short-term market forecast, and resource information can help produce the range of options available and assist in giving a weighted optimal decision from a number of choices. This approach can save a crop and thus assure farmers of some economic returns.

Contingency crop planning

The contingency crop plans followed during times of rainfall deficiency are:

Normal monsoon season followed by inadequate rainfall: If the less rain occurs after planting, mid-season corrections such as a reduction in plant population, the use of green fodder or for organic recycler, weeding, and soil mulching, used to be adopted to overcome water shortage. During late monsoon season followed by normal rainfall the selection of short-duration varieties are selected to accommodate the late onset of rain. Pulse and oilseed planting is recommended. Fodder and mustard used to be grown after the seasonal crop harvest to make use of the late rainfall. During, late monsoon season followed by inadequate rainfall, the leguminous crops and oilseeds perform used to be cultivated to tackle the adverse situations.

Integrated Watershed Management

The watershed is the most appropriate ecological area unit for the efficient and homogenous management of land and water resources in any arid terrain. The objective of watershed management is to conserve soil and water for productive farming in rain-fed areas. The first task of soil management is to reduce erosion by controlling runoff. The next is to conserve rainwater for plant, domestic and livestock's needs. During drought season, taking sufficient measures to ensure food security during periods of droughts is perhaps the only strategy the community has adopted to wade off the vagaries of protracted droughts. Obviously, the community did not have any strategies to prevent a drought. Among the steps they usually took to ensure food security, drying and storage of food items like dry fish, paddy in traditional baskets made up of paddy stray called *pala Olia*/ *Doli* (made of paddy straw or bamboo tats and plastered with earth), take prominence (Farmers of Puri district of Orissa).

Conclusion and policy implications

The indigenous technical knowledge found in local communities in India is an amalgamation of strategies, skills, rules, and techniques gained through shared adaptive man-environment interactions to live and survive the natural way of life. Not all the traditional knowledge still has remained relevant as some of the conditions on which ITK was based have changed considerably. There is much to learn from indigenous, traditional and community-based approaches for the natural disaster preparedness. The people have been confronted with changing environments for millennia and have developed a wide array of coping strategies, and their traditional knowledge and practices provide an important basis for facing the even greater challenges of natural disastrous. Although their strategies may not succeed completely, they are effective to some extent and that is why the people continue to follow these. While traditional indigenous communities will undoubtedly need additional support to coup up with the natural disastrous, their expertise will offer a great help for the effective management of natural disasters.

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References

1 Anonymous, National Disaster Management Guidelines, Management of Earthquake, India, April, 2007.
2 Anonymous, National Policy on Disaster Management, India, 2005.
3 Anonymous, Central Agricultural Research Institute Report, (CARI, Port Blair, A&N islands), 2006-2007.
4 Oliver JE & Fairbridge RW, *The Encyclopedia of Climatology*, (Van Nostrand Reinhold, New York), 1987.
5 Maitreyi ML, Melly, Gregarious bamboo flowering triggers famine fears, Chennai, India: The Hindu,http://www.hindu.com/ 2010/04/20/stories/ 2010042052972000. htm, (20 April 2010), retrieved 28 October 2010.
6 Arjuna de Zoyza, Interview with Prof on August 6th, 2008 at the Open University, Nawala, SriLanka.
7 Anonymous, FAO Corporate Document Repository, (Report of the FAO Asia-Pacific conference on early warning, prevention), Annex XIV, APDC/01/10 (CRIDA, Hyderabad, Andhra Pradesh),
8 Jayaseelan AT, Suresh Babu AV, Chandrasekhar K & Rupen Kumar GV, IRS/WIFS Data Use for 1999 Droughts in Rayalaseema districts of Andhra Pradesh, India, In: *Remote Sensing and Geographical Information Systems*, edited by Muralikrishna IV, (BS Publications, Hyderabad), 2001, 61-66.
9 Nawa K, Drought Monitoring in Zambia using Meteosat and AVHRR Data, 2000.
10 Salick B & Byg A, *Indigenous Peoples and Climate Change*, (Tyndall Centre for Climate Change Research, Oxford, UK), 2007.