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Livelihood Sensitivity Matrix: A Novel Technique for Mapping Vulnerability of Rural Households to Climate Change

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ABSTRACT

Almost all nations are aware of changing climatic scenario and India is not an exception and neither immune from the impact of climate change. The lives of inhabitants are most at risk from cyclone and flood than from drought and heat wave. Poor are the worst affected. Livelihood group wise as well as climatic hazard wise vulnerability index through exposure and impact matrix was developed based on the responses of selected households sampled for present study. To understand the livelihood group wise as well as climatic event wise vulnerability the exposure index and impact index were derived. Crop farmers are most exposed livelihood group followed by labourers, livestock keepers and fish farmers. Cyclone has made highest impact on livelihoods followed by flood, drought and heat wave, respectively. The outlooks for the vulnerable regions are not good unless on-farm contingency plans, both short and long-term, are adopted.

Key words: Exposure index, Impact index, Livelihood group

INTRODUCTION

Climate change is a global phenomenon but people are affected by its local impacts and acts as a major threat to livelihood of farmer. Climate change has brought widespread misery and huge economic losses to India, adversely affecting agriculture, food security, public health, water resources and biodiversity (Sarkar *et al.*, 2014). According to a report, 40 per cent farmers want to quit farming (Das and Tripathi, 2014). India being a developing nation which is majorly dependent on natural resources for livelihood and economy, any adverse effect on these will have repercussion on the nation's livelihood security and economy and widen the gap between the rich and the poor. Vulnerability of farming community extends beyond bio-physical impact and includes multiple socio-political, economic and psychological aspects (Patnaik and Narayanan, 2009; Sarkar *et al.*, 2017).

Vulnerability is the state of susceptibility to damage from exposure to stresses associated with environmental and social changes and from the absence of capacity to adapt. Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report defines vulnerability as 'the extent to which climate change may damage or harm a system; it depends not only on a system's sensitivity but also on its ability to adapt to new climatic conditions. Sensitivity, in this context, is 'the degree to which a system will respond to a change in climatic conditions'. Coastal belts are more prone to devastating impact of climate change (IPCC, 2007). The relevance to the present discussion is that vulnerability, in this classic sense, is defined primarily by the prior damage (the existing wound) and not by the future stress (any further attack). By analogy, then, the vulnerability of any individual or social grouping to some particular form of natural hazard is determined primarily by their existent state, that is, by their capacity to respond to that hazard, rather than by what may or may not happen in the future.

Climate change is often a concern along the east coast of India in view of the damages that occur from the cyclones form in the Bay of Bengal. The 1999 tropical cyclone that hit Odisha demonstrated the extreme significance of impacts on coastal agro-ecosystem. On this backdrop present study was conducted in Odisha, one of the most climatically vulnerable states in India.

METHODOLOGY

The livelihood sensitivity matrix is a novel technique, which is useful for mapping vulnerability due to loss causing events and studying the levels of exposure and the

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magnitude of impact on the livelihood groups at large. It can be employed separately for different groups, different regions - the rural population inhabiting an especially vulnerable region or area and so on. Any climate change induced event rarely affects all households equally. Some households are able to prepare for change before it happens, some tries to cope after the change, and others simply cannot take any action (i.e. 'leave it to God or time' as it is observed in study area). Therefore, in order to get a clearer generalised picture, all the households can be classified into few 'livelihood groups' based on sources of income, asset positions and trajectories.

The procedure consists of first identifying the livelihood groups or the targets groups. A sample of 120 households, 60 each from Balasore and Khurda district was surveyed following purposive and simple random sampling technique. The major livelihood types were grouped into six main categories viz. crop farming, leased farming, fishermen, livestock keepers, service and business in Balasore district. However, there were four main livelihood categories in Khurda district viz. crop farming, livestock keepers, service and business. The bulk of the households in both districts are found to be dependent on crop farming.

Having done this, the second step is to list the various situations that are the determinants of the vulnerability.

Thirdly, scrutinize the list of the exposed groups and assign an exposure value to each group, which gives an idea regarding how many in each group are likely to be affected by each driver of vulnerability. This is referred to as prevalence. Similarly, to capture the frequency of occurrence of each determinant of vulnerability, the frequency of occurrence of each is listed in number of times it occurs in a given period and this is listed in the frequency row of the matrix. The matrix presents the livelihood groups in the rows and the drivers of vulnerability in the columns.

The frequency row gives the frequency of occurrence of each vulnerability event. Care should be taken to ensure that in the case of mutually exclusive events the sum of their individual frequencies should not exceed 1. For example, heavy rainfall, moderate drought and severe drought are mutually exclusive events; hence the sum of the probability of occurrence of these events should not exceed one. However, land degradation is not a mutually exclusive with the other weather events and therefore the sum of probabilities of all the events need not sum up to unity.

After the structure of the vulnerability matrix is prepared, the fourth step is to map the degree of vulnerability of each livelihood group due to each of the drivers of vulnerability. This is done by assigning a score ranging from to 0 to 5 depending on the degree of impact. If the impact is the greatest of a particular calamity on a particular group, the cell corresponding to the calamity and the group is assigned 5. Similarly, if a particular livelihood group is unaffected by a particular calamity the cell is assigned a value of 0. For example, the dry land agriculture group is unaffected by heavy rainfall in the state hence the cell corresponding to this is assigned a value 0. But this group is seriously impacted by severe drought as livelihood critically depends on rainfall for its sustenance; accordingly, the cell corresponding to these two is assigned a value of 5. In this fashion, all the cells of the matrix are filled up duly weighing each event and for its impact on a particular livelihood group and assigning a score that captures the magnitude of impact appropriately. For greater precision of scoring, using a proxy to quantify each effect would make the scoring more objective.

The fifth step consists of analysing the data that has been generated by the vulnerability matrix. Summing up each row and column of the matrix corresponding to the livelihood groups and events respectively does this. These raw scores are a crude measure of impact.

In order to reflect the importance of each event, in step six, the scores corresponding to each event are weighted by the respective frequencies of their occurrence. That is the scores in each row are multiplied by the corresponding frequencies in each column and summed up to obtain the weighted exposure index.

Finally, in step seven, the impact of the event is assessed first through a simple sum of scores then weighted by the corresponding frequencies of occurrence and then expressed as a percentage of the maximum attainable if all the livelihood groups got the maximum score. This is called the Impact Index. Further, the weighted impact index is calculated by weighing the score in each cell by the prevalence numbers in the corresponding groups, summed up and dividing it total number exposed. This resulting quotient reflects the importance of each calamitous event shown in the last row and is referred to as the weighted impact index.

RESULTS AND DISCUSSION

The vulnerability profile of the major livelihood groups in the study area is presented in Table 1 and Table 2, respectively. The tables show the relative exposures to climatic hazards and their impact on livelihood groups. It tells what the livelihoods at risk are and which climatic

hazards are more difficult to manage by the households. The impact values as perceived by the members under each livelihood group were measured on a 5-point continuum scale, where a value of 5 is equivalent to highest impact and 1 is for lowest impact.

A perusal of Table 1 reveals that flood is most frequent climate induced natural disaster in Balasore district followed by both heatwave and cyclone. Among six livelihood groups, crop farmers, livestock keepers and fishermen are three most exposed groups being vulnerable to climate change events with highest weighted exposure index (15.12). Impact of cyclone is realized maximum with impact index of 100 and weighted impact index of 5.00 closely followed by flood.

Therefore, the cyclone and flood are two climatic events hampering the rural livelihoods as well as farming in Balasore district of Odisha. There are only four livelihood groups in Khurda district, who are exposed to climate change events with most affected group is livestock keepers. Heat wave and cyclone are two extreme climatic events impacting upon the livelihoods in general and livestock keepers in particular (Table 2).

Table 1: Livelihood Sensitivity through Exposure-Impact Matrix Mapping Vulnerability in Balasore District of Odisha

Climatic Hazards	Prevalence	Cyclone	Flood	Drought	Heat Wave	Exposure Index	Weighted Exposure Index
Livelihoods	Frequency	0.23	2.10	0.11	0.84		
Crop farming	50	5.0	5.0	1.0	4.0	15	15.12
Leased farming	3	5.0	5.0	1.0	3.0	14	14.28
Fish farming	1	5.0	5.0	1.0	4.0	15	15.12
Livestock rearing	1	5.0	5.0	1.0	4.0	15	15.12
Service	2	5.0	4.5	1.0	3.0	13.5	13.23
Business	3	5.0	5.0	1.0	3.5	14.5	14.70
Sum	60	30	29	6	21.5		
Impact Index		100	96.67	20.00	71.67		
Weighted Impact Index		5.00	4.98	1.00	3.89		

Fig. 1 depicts more exposure of various livelihood groups to climate change events in Balasore district as compared to Khurda district that reiterates relatively more vulnerability of livelihoods in coastal regions. Fig. 2 depicts flood and cyclone are two most severe climate change events impact on livelihoods in Balasore district of Odisha. Contrastingly, in Khurda district drought and heat wave use to impact more on the livelihoods. Thus, coastal regions suffer more from flood and cyclone, while non-coastal regions suffer mainly from drought and heat wave.

Table 2: Livelihood Sensitivity through Exposure-Impact Matrix Mapping Vulnerability in Khurda District of Odisha

Climatic Hazards	Prevalence	Cyclone	Flood	Drought	Heat Wave	Exposure Index	Weighted Exposure Index
Livelihoods	Frequency	0.14	0.17	0.26	0.56		
Crop Farming	49	4.0	1.0	2.0	5.0	12	4.05
Livestock rearing	3	5.0	1.0	4.0	5.0	15	4.71
Service	7	2.0	1.0	1.0	5.0	9	3.51
Business	1	4.0	1.0	3.0	5.0	13	4.31
Sum	60	15	4	10	20		
Impact Index		75	20	50	100		
Weighted Impact Index		3.82	1.00	2.00	5.00		

More exposure of various livelihood groups to climate change events is found in Balasore district as compared to Khurda district that reiterates relatively more vulnerability of livelihoods in coastal regions. Flood and cyclone are two most severe climate change events that impact on livelihoods in Balasore district of Odisha. Contrastingly, in Khurda district drought and heat wave use to impact more on the livelihoods. Thus, coastal regions suffer more from flood and cyclone, while non-coastal regions suffer mainly from drought and heat wave. According to a study conducted by Bahinipati (2014), most of the districts in Odisha are prone to both cyclones and floods. Three key observations emerged. First, components like sensitivity and adaptive capacity were found to act as the major determinants of vulnerability. Secondly, eight districts were found to have a higher vulnerability score, and surprisingly, some of the districts are non-coastal. Thirdly, factors like demography, agriculture and economic capacity emerged as the major cause for increasing vulnerability. Balasore, Bhadrak, Jajpur, Kendrapada, Malkangiri, Nabarangpur, Nuapada and Rayagada have vulnerability levels higher than the other districts of the state. Balasore, Bhadrak and Kendrapada are the coastal districts, while the remaining five districts are non-coastal districts. (n=120)

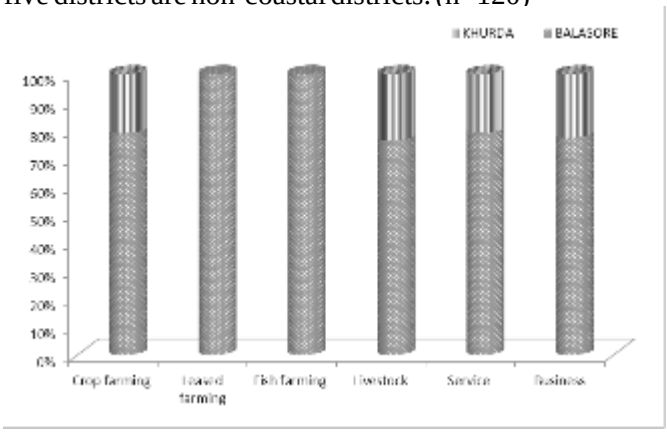

Fig. 1 Differential Exposure of Various Livelihood Groups to Climate Change Events in Balasore and Khurda Districts of Odisha

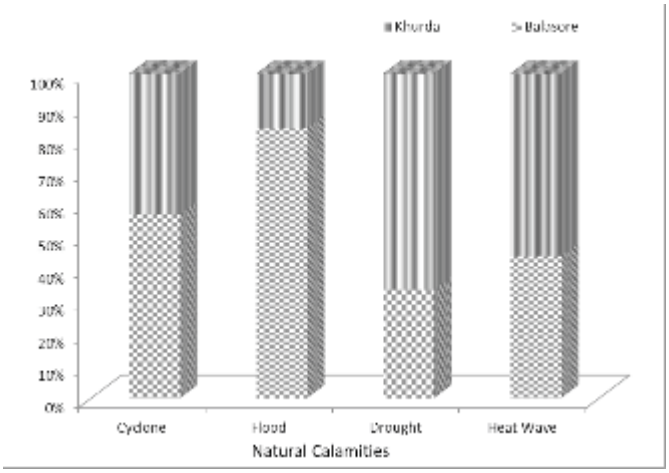

Fig.2 Differential Impact of Climate Change Events in Balasore and Khurda Districts of Odisha

CONCLUSION

In India, eastern coast is more vulnerable than the western coast with respect to the frequency of occurrence of extreme events like cyclones and depressions. Climatic hazards like cyclone, drought, flood, heat wave, etc cause damage every year in terms of human lives and livelihood, which are distributed heterogeneously across space. Vulnerability of different livelihood groups was assessed through livelihood sensitivity matrix that included both exposure index and impact index. Crop farmers are most exposed livelihood group followed by labourers, livestock keepers and fish farmers. It is evident that cyclone has made highest impact on livelihoods followed by flood, drought and heat wave, respectively. It is worth mentioning here that the coastal districts are more vulnerable to the climate change as evident from the comparative vulnerability scenario.

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REFERENCES

Bahinipati, C.S. 2014. Assessment of vulnerability to cyclones and floods in Odisha, India: a district-level analysis. *Current Science,* 107 (12): 1997-2007.

Das, S.K. and Tripathi, H. 2014. India's Green Revolution: Fact and Fallacy. *International Journal of Bio resource and Stress Management,* 5(1): 153-158.

Intergovernmental Panel on Climate Change. 2007. *Impacts, Adaptation and Vulnerability. Contribution of Working Group IPCC, 2007: Mitigation of Climate Change. Contribution of Working Group.*

Patnaik, U. and Narayanan, K. 2005. *Vulnerability and Climate Change: An analysis of the Eastern coastal districts of India.* An International Workshop on Human Security and Climate Change, Oslo.

Patnaik, U. and Narayanan, K. 2009. *Vulnerability and climate change: an analysis of the eastern coastal districts of India.* Munich Personal RePEc Archive. https://mpra.ub.unimuenchen.de/22062/1/MPRA_paper_22062.pdf.

Sarkar, S., Padaria, R.N., Vijayaragavan, K., Burman, R.R., Pathak, H., Kumar, P. and Jha, G.K. 2014. Assessing the socio-economic impacts of climate change in arid ecosystem of India. *Range Management and Agroforestry,* 35 (2): 249-255.

Sarkar, S., Padaria, R.N., and Bhowmik, A. 2017. Analyzing farmers' vulnerability and adaptation strategy to climate change in arid ecosystem of India. *Range Management and Agroforestry,* 38 (1): 127-133.