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Livelihood vulnerability to climate change in Rural Tripura, India: A Comparative Study of the Tribal and Non-Tribal Households

Niranjan Roy[1], Avijit Debnath[2], Sunil Nautiyal[3] and Munmi Sarma[4]

[1,2,4]Department of Economics, Assam University Silchar, India
[3]Centre for Ecological Economics and Natural Resources (CEENR),
Institute for Social and Economic Change (ISEC), Nagarabhavi, Bengaluru, India

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ABSTRACT

Climate change is a harsh reality that has a significant impact on livelihood strategies in general, and agricultural-based ones in particular. Agriculture is the principal source of livelihood in the majority of North Eastern states, including Tripura. In the absence of alternate employment opportunities and planned activities, people's livelihoods are likely to suffer as a result of climatic variability. In this context, the LVI-IPCC technique has been used to explain the extent of climate vulnerability among tribal viz-a-viz non-tribal population of Tripura. A total of 400 respondents from 40 villages of two districts in Tripura are surveyed based on a combination of informal interviews, a questionnaire survey, and Focused Group Discussions (FGD). The findings suggested that tribal households were more exposed to climate change. Furthermore, because of their greater sensitivity and lesser adaptation capacity, they were more likely to be vulnerable to climate change than non tribal households. The findings provide a scientific basis for policymakers in rural Tripura to priorities options to strengthen livelihood capitals and climate change adaptation ability.

Key words : *Livelihood vulnerability, Climate change, LVI, LVI-IPCC, Tripura*

Introduction

Climate change has been universally recognised as the largest environmental problem of the twenty-first century, and it will continue to be so in the future (Edame *et al.,* 2011; IPCC, 2001). The worldwide influence of climate change on both developed and developing countries is posing a threat to the existence and livelihoods (Tesso *et al.,* 2012). These changes occur as a result of unpredictable rainfall, intensifying temperature levels, extreme floods and severe droughts (Morand *et al.,* 2012; Samson *et al.,* 2011; Muller *et al*., 2006). The increasing prevalence of these climate extremes and climate uncertainty cause disruption in the entire living system by affecting people's livelihood and causing disorder in societies (Werritty *et al.,* 2007). People who are socially, economically, and politically disadvantaged, are more vulnerable to the effects of climate change as their livelihoods are threatened. Thus, securing livelihoods especially for low income households arising out of the climate variability is a prime concern (Bhattacharjee and Behera, 2018). To cope with the changing climatic pattern, well-informed poli-

([1]Professor, [2]Associate Professor, [3]Professor, [4]Research Scholar PhD)

cies and programs must be implemented to mitigate the danger. Furthermore, assessment of livelihood vulnerability is the first step towards structuring these policies and programmes (Sharma and Rabindranath, 2019).

The North-Eastern states of India could not also escape this vulnerability (Feroze *et al.,* 2019). Climate change has taken a heavy toll on this region's already undeveloped hill production practices. Due to the absence of other employment opportunities and planned initiatives in the hills, people's livelihood are likely to be severely affected owing to this climate risk (Feroze et al., 2019). Tripura, a northeastern state, is home to both tripuries and nontripuries . According to reports, the State is particularly prone to earthquakes, among other natural disasters. Tripura is located in Zone V of India's seismic zoning map, which is the most severe seismic zone. In addition, the state is vulnerable to cyclones, floods, landslides, fires, and other natural and manmade disasters. Given this background, this study aims to examine and analyse the livelihood and climatic vulnerability of two communities, the Tripuries and the non-Tripuries in the state of Tripura (Government of Tripura, 2019)

Climate change vulnerability assessment

Vulnerability assessment refers to a collection of techniques for analysing and integrating connections between people, and their physical and social environments. It has been applied to a wide range of contexts, such as, the USAID Famine Early Warning System (FEWS-NET), the World Food Programme's Vulnerability Analysis and Mapping tool for targeting food aid (Hahn *et al.,* 2009), and various geographic analyses which combine data on poverty, health, biodiversity, and globalisation (O'Brien *et al.,* 2004; , Chen *et al.,* 2006; Holt, 2007). In order to quantify how the communities will deal with changing climate, the climate vulnerability assessment has been developed. Different researchers have contributed new methodologies to fill the gap between the social, natural, and physical sciences. On the contrary, other researchers are totally dependent on the IPCC definition of vulnerability, where vulnerability is defined as the function of exposure, adaptive capacity and sensitivity (IPCC, 2001). According to Fussel and Klein (2006), the literature on vulnerability assessments are of two categories, viz, first generation and second generation assessments. The first generation studies of vulnerability assessments are based on climate impact assessments relative to baseline conditions, whereas second-generation literature include adaptive capacity. There are numerous interpretations of the second-generation literatures regarding the application of the concepts of exposure, sensitivity, and adaptive capacity to evaluate vulnerability (Sullivan, 2002; Vincent, 2004; Ebi *et al.,* 2006).

Climate Change Vulnerability in India

According to the Intergovernmental Panel on Climate Change (IPCC), increase in the temperature above the preindustrial level by 1.5 °C causes serious threats to natural and human systems (Masson-Delmotte *et al.,* 2018). In the developing countries like India, due to the heavy reliance on agriculture, climate change adds new challenges to the food systems, aggravate land degradation, and obstruct poverty eradication (Mall *et al.,* 2006; Vermeulen *et al.,* 2012). According to Mohanty and Wadhawan (2021), India is the seventh-most vulnerable country to climate extremes. In India 3 out of 4 districts are found to be extreme event hotspots, where 40% of the districts are revelling a swapping trend, which means traditionally flood prone are now-a-days experiencing severe droughts and vice versa (Council on Energy, Environment and Water) (Mohanty 2020). Furthermore, the IPCC predicts that every degree increase in temperature will result in a 3% increase in precipitation, causing cyclones and floods to become more intense. Storms are already becoming cyclones, more than half of the country are affected by droughts, and astounding floods are causing massive loss and damage (Mohanty 2020). These patterns are the result of an increase in temperature by 0.6–0.7 °C during the last century (IMD 2019).

Research Methodology

Data Source

The data for the present study have been collected through field survey from two districts: West Tripura (Non-Tribal Community) and Dhalai (Tribal Community). The majority of the population in West Tripura comprises of non-tribal community while highest number of Tribal community resides in Dhalai district. We have collected 200 households in each district based on a sample size calculation at the 95% confidence interval, ± 10% precision, 50%

prevalence, and a design effect of 2 to account for cluster sampling[2]. The probability proportional to size technique was used to choose 20 villages in each district based on information from the national 2011 census that provides data on the total population of each village. The Expanded Program on Immunization ("random walk") approach of the World Health Organization (WHO) served as a model for the household sampling technique. Community leaders were consulted after the field crew arrived in the village to explain the goals of the study and get approval to visit households.

Calculating Livelihood Vulnerability: The LVI-IPCC Approach

The Livelihood Vulnerability Index (LVI) has been used to capture the livelihood vulnerability among rural households due to the climatic changes. Here, the LVI comprises of seven major components of livelihood security, such as, socio-demographic profile, livelihood, health, social networks, water, food and natural disasters and climate variability, where each considers a number of indicators or sub-components (Hahn *et al.*, 2009). The major components and sub-components of constructing the index are given in the following Table.

Since each sub-component is assessed on a distinct scale, thus, to standardize each of the components as an index, the Human Development Index (UNDP, 2007) to calculate the life expectancy index has been used.

$$index_{sd} = \frac{S_d - S_{min}}{S_{max} - S_{min}} \quad .. (1)$$

Where, S_d is the original sub-component for the study area, and S_{min} and S_{max} are the minimum and maximum values, respectively, for each sub-component computed by using data from the study area.

After standardisation, the average of the sub-components are estimated using the following equation to get the final value of the prime components (Hahn *et al.*, 2009)

$$M_d = \frac{\sum_{i=1}^{n} index_{s_d i}}{n} \quad .. (2)$$

Where M_d is one of the seven major components for the study area d, $index_{sdi}$ denotes the ith sub-component, and n is the number of sub-components in each major component.

The LVI–IPCC is different from the LVI as the major components are combined in the former. The IPCC defined vulnerability to climate change as a consequence of a system's exposure and sensitivity to climatic shocks, as well as its capacity to adapt to their negative impacts, which corresponds to the result or end-point, i.e. vulnerability (Shah *et al.*, 2013). Following the LVI-IPCC approach, the exposure of the sample population is evaluated by the number of natural disasters that happened in the previous six years, whereas, climatic variability is calculated by the average standard deviation of maximum and minimum monthly temperatures and monthly precipitation during a ten-year period. The demographic profile of a district, the varieties of livelihood strategies adopted and the strength of social networks are all used to quantify the adaptive capability (Hahn *et al.*, 2009). Finally, sensitivity is assessed by evaluating the existing situation of food and water security, as well as its health status in the study area. Then each of the three IPCC factors is calculated based on the following equation.

$$CF_d = \frac{\sum_{i=1}^{n} W_{Mi} M_{di}}{\sum_{i=1}^{n} W_{Mi}} \quad .. (3)$$

where CF_d is an IPCC-defined contributing factor (exposure, sensitivity, or adaptive capacity) for the study area 'd', M_{di} are the major components for study area 'd', indexed by i, W_{Mi} is the weight of each primary component, and n is the number of main components in each contributing factor. Once exposure, sensitivity, and adaptive capacity are measured, the three contributing factors are combined using the following equation.

$$LVI - IPCC_d = (e_d - a_d) \times S_d \quad .. (4)$$

where $LVI–IPCC_d$ is the LVI for study area 'd', as expressed by the IPCC vulnerability framework, e is the calculated exposure score for study area 'd', 'a' is the computed adaptive capacity score for study area 'd', and 's' is the calculated sensitivity score for the study area. The LVI–IPCC ranged from -1 (least vulnerable) to 1 (most vulnerable).

Results and Discussion

West Tripura and Dhalai: A Comparison across the LVI Components

The LVI sub-component values in addition to minimum and maximum values for both the districts West Tripura and Dhalai have been presented in Table 2. We observed that the Dhalai district had a

Table 1. Major components and sub-components comprising the Livelihood Vulnerability Index (LVI)

Major components	Sub-components	Explanation of sub-components
Socio-demographic profile	Dependency ratio (DR)	Ratio of the population under 15 and over65 years of age to the population between19 and 64 years of age.
	Percent of female-headed households (FH)	Percentage of households where the primary adult is female. If a male head is away from the home >6 months per year the female is counted as the head of the household.
Livelihood	Average age of female head of household (Age)	Age in numbers
	Percent of households where head of household has not attended school (SCH)	Percentage of households where the head of the household reports that they have attended 0 years of school. Percentage of households that have at least 1 orphan living in their home. Orphans are children <18 years old who have lost one orboth parents.
	Percent of households with family member working in a different community (WDC)	Percentage of households that report atleast 1 family member who works outsideof the community for their primary work activity
	Percent of households dependent solely on agriculture as a source of income (SA)	Percentage of households that report only agriculture as a source of income.
	Average agricultural Livelihood Diversification Index (LDI)	The inverse of (the number of agriculturallivelihood activities +1) reported by ahousehold, e.g., A household that farms, raises animals, and collects natural resources will have a Livelihood Diversification Index = 1/(3 + 1) = 0.25
Health	Average time to health facility (ATH)	Average time it takes the households to getto the nearest health facility.
	Percent of households with family member with chronic illness (MCI)	Percentage of households that report atleast 1 family member with chronic illness.Chronic illness was defined subjectively by respondent.
	Percent of households where a family member had to miss work or school in the last 2 weeks due to illness (MWS)	Percentage of households that report atleast 1 family member who had to missschool of work due to illness in the last 2 weeks.
	Average Malaria Exposure*Prevention Index (MEI)	Months reported exposure tomalaria*Owning at least one bednetindicator (have bednet = 0.5, no bed net = 1)(e.g., Respondent reported malaria is a problem January–March and they do notown a bednet = 3*1 = 3).
Social Networks	Average Receive: Give ratio (RGR)	Ratio of (the number of types of helpreceived by a household in the pastmonth + 1) to (the number of types of help given by a household to someone else in thepast month + 1)
	Average Borrow: Lend Money ratio (BLR)	Ratio of a household borrowing money inthe past month to a household lendingmoney in the past month, e.g., If ahousehold borrowed money but did notlend money, the ratio = 2:1 or 2 and if theylent money but did not borrow any, theratio = 1:2 or 0.5

Table 1. *Continued ...*

Major components	Sub-components	Explanation of sub-components
	Percent of households that have not gone to their local government for assistance in the past 12 months (NGA)	Percentage of households that reported that they have not asked their local government for any assistance in the past 12 months
Food	Percent of households dependent solely on family farm for food (AD)	Percentage of households that get their food primarily from their personal farms
	Average number of months households struggle to find food (SF)	Average number of months households struggle to obtain food for their family
	Average Crop Diversity Index (CDI)	The inverse of (the number of crops grown by a household +1). e.g., A household that grows pumpkin, maize, nhemba beans, and cassava will have a Crop Diversity Index = 1/(4 + 1) = 0.20.
	Percent of households that do not save crops (NSC)	Percentage of households that do not savecrops from each harvest.
	Percent of households that do not save seeds (NSS)	Percentage of households that do not have seeds from year to year.
Water	Percent of households reporting water conflicts (WC)	Percentage of households that report having heard about conflicts over water in their community.
	Percent of households that utilize a natural water source (NWS)	Percentage of households that report acreek, river, lake, pool, or hole as their primary water source.
	Average time to water source (TWS)	Average time it takes the households to travel to their primary water source.
	Percent of households that do not have a consistent water supply (NCW)	Percentage of households that report that water is not available at their primary water source everyday
Natural disasters and climate variability	Average number of flood, drought, and cyclone events in the past 10 years (ND)	Total number of floods, droughts, and cyclones that were reported by households in the past 10 years
	Percent of households with an injury or death as a result of recent natural disasters (ID)	Percentage of households that reported either an injury to or death of one of their family members as a result of the most severe flood, drought, or cyclone in the past 10 years.
	Mean standard deviation of monthly average of average maximum daily temperature (years: 2008–2018) (SDXT)	Standard deviation of the average daily maximum temperature by month between 2008 and 2018 was averaged for each province
	Mean standard deviation of monthly average of average minimum daily temperature (years: 2008–2018) (SDMT)	Standard deviation of the average daily minimum temperature by month between 2008 and 2018 was averaged for each province
	Mean standard deviation of monthly average precipitation (years: 2008–2018) (SDPR)	Standard deviation of the average monthly precipitation between 2008 and 2018 was averaged for each province

higher dependency ratio (0.43) compared to West Tripura (0.26). While in West Tripura, a household consisted of 5 family members on an average, the figure stood 7 for Dhalai. Pointing towards the extent of female headed household in both the districts, it was observed that Dhalai district had a higher percentage of female headed households (approximately 29%) as against the West Tripura (5%). The female respondents mostly revealed their husband as the head of the household. However, the cases where husbands remain away from home for six months or more in a year, the female respon-

Table 2. Livelihood Vulnerability Index (LVI) sub-component values and minimum and maximum sub-component values for West Tripura and Dhalai Districts

Major components	Sub-components	Units	West Tripura (Non-Tribal Community)	Dhalai (Tribal Community)	Maximum Value	Minimum Value
Socio-demographic profile	Dependency ratio	Ratio	0.26	0.43	10	0
	Percent of female-headed households	Percent	5.1	29.5	100	0
	Average family member in a HHs	Count	4.57	7.25	12	0
	Percent of households where head of household has not attended school	percent	18.5	72.5	100	0
Livelihood	Percent of households with family member working in a different community	Percent	9.5	5.8	100	0
	Percent of households dependent solely on agriculture as a source of income	Percent	23.5	94.5	100	0
Livelihood	Average agricultural Diversification Index	[1/ (no. of agriculture activities + 1)]	0.23	0.45	1	0.12
Health	Average time to health facility	Minutes	95.5	126.8	324	1
	Percent of households with family member with chronic illness	Percent	25.5	8.5	100	0
	Percent of households where a family member had to miss work or school in the last 2 weeks due to illness	Percent	26.5	14	100	0
Social Networks	Average Receive: Give ratio	Ratio	1.04	1.65	7	0.23
	Average Borrow: Lend Money ratio	Ratio	0.98	1.56	3	0.25
	Percent of households that have not gone to their local government for assistance in the past 12 months	Percent	89.5	97.5	100	0
Food	Percent of households dependent solely on family farm for food	Percent	32.5	86	100	0
	Average number of months households struggle to find food	Months	2.13	4.32	12	0
	Average Crop Diversity Index	Index value	0.35	0.21	1	0.12
	Percent of households that do not save crops	Percent	18.5	14.5	100	0
	Percent of households that do not save seeds	Percent	17	11.5	100	0
Water	Percent of households reporting water conflicts	Percent	9.5	11.5	100	0
	Percent of households that utilize a natural water source	Percent	21.5	32.5	100	0

Table 2. *Continued ...*

Major components	Sub-components	Units	West Tripura (Non-Tribal Community)	Dhalai (Tribal Community)	Maximum Value	Minimum Value
	Average time to water source	Minutes	15.74	28.52	180	1
	Percent of households that do not have a consistent water supply	Percent	7.45	15.5	100	0
Natural disasters and climate variability	Average number of flood, drought, and cyclone events in the past 10 years	Count	4.78	8.5	9	0
	Percent of households with an injury or death as a result of recent natural disasters	Percent	0.75	2.35	100	0
	Mean standard deviation of monthly average of average maximum daily temperature (years: 2008–2018)	Celsius	0.24	0.35	1.14	0.02
	Mean standard deviation of monthly average of average minimum daily temperature (years: 2008–2018)	Celsius	0.21	0.38	2.13	0.04
	Mean standard deviation of monthly average precipitation (years: 2008–2018)	Millimeters	41.67	57.16	256.76	11.31

Source: Computed by the Authors

dents were taken as the households' head. We also found that in Dhalai round 72.5 percent of household heads did not attend school, which stood substantially high as against 18.5 percent in West Tripura. Additionally, the computed LVI (Table 3) revealed that in case of Socio-Demographic Profile, Dhalai district (0.42) was more vulnerable compared to West Tripura (0.16).

We found that the percentage of households with family member working in a different community was relatively more in West Tripura (9.5%) than Dhalai (5.8%). And, compared to West Tripura, a higher percentage of Dhalai households reported to rely solely on agriculture for income (Table 2). From Table 3, the average agricultural Livelihood Diversification index revealed that in comparison to West Tripura (0.23), Dhalai was more vulnerable (0.45). Dhalai district also showed a greater vulnerability on the Livelihood Strategies component (0.46) compared to West Tripura (0.15).

In terms of Social Network indicators, for both Receive: Give ratio and Borrow: Lend Money Ratio, the ratio stood higher for Dhalai compared to West Tripura. Additionally, around 97.5% of the Dhalai and 89.5% of the West Tripura households revealed that they did not approach their local government for assistance in the last 12 months. Furthermore, from table 3, we found that in case of social networks the vulnerability was relatively more for Dhalai (0.55) than West Tripura (0.43).

In case of health dimension, Table 3 revealed that Dhalai was found to be less vulnerable (0.18) compared to West Tripura (0.25). Though, West Tripura households reported lower traveling time to get to the nearest health facility than the Dhalai households, but, the percentage of households with chronic illness was found substantially higher in West Tripura (25.5). And, as expected a higher percentage of West Tripura households (26.5%) family member missed work due to illness in the past 2 weeks compared to Dhalai (14%). Furthermore, West Tripura households were also reported being

Table 3. Indexed sub-components, major components, and overall LVI for West Tripura and Dhalai Districts, Tripura.

Sub-components	West Tripura (Non-Tribal Community)	Dhalai (Tribal Community)	Major component	West Tripura (Non-Tribal Community)	Dhalai (Tribal Community)
Dependency ratio	0.03	0.04	Socio-demographic profile	0.16	0.42
Percent of female-headed households	0.07	0.30			
Average family member in a HHs	0.38	0.60			
Percent of households where head of household has not attended school	0.19	0.65			
Percent of households with family member working in a different community	0.25	0.09	Livelihood Strategies	0.15	0.46
Percent of households dependent solely on agriculture as a source of income	0.24	0.89			
Average agricultural Livelihood Diversification Index	0.36	0.40			
Average Receive: Give ratio	0.15	0.17	Social Networks	0.43	0.55
Average Borrow: Lend Money ratio	0.36	0.46			
Percent of households that have not gone to their local government for assistance in the past 12 months	0.93	0.98			
Average time to health facility	0.24	0.49	Health	**0.25**	**0.18**
Percent of households with family member with chronic illness	0.26	0.19			
Percent of households where a family member had to miss work or school in the last 2 weeks due to illness	0.27	0.18			
Average Malaria Exposure* Prevention Index	0.13	0.27			
Percent of households dependent solely on family farm for food	0.22	0.86	Food	**0.22**	**0.32**
Average number of months households struggle to find food	0.18	0.48			
Average Crop Diversity Index	0.28	0.24			
Percent of households that do not save crops	0.19	0.15			
Percent of households that do not save seeds	0.17	0.12			
Percent of households reporting water conflicts	0.08	0.17	Water	**0.12**	**0.19**
Percent of households that utilize a natural water source	0.03	0.52			

Table 3. *Continued ...*

Sub-components	West Tripura (Non-Tribal Community)	Dhalai (Tribal Community)	Major component	West Tripura (Non-Tribal Community)	Dhalai (Tribal Community)
Average time to water source	0.09	0.16			
Percent of households that do not have a consistent water supply	0.03	0.26			
Average number of flood, drought, and cyclone events in the past 10 years	0.53	0.66	Natural disasters and climate variability	**0.19**	**0.32**
Percent of households with an injury or death as a result of recent natural disasters	0.01	0.02			
Mean standard deviation of monthly average of average maximum daily temperature (years: 2008–2018)	0.21	0.19			
Mean standard deviation of monthly average of average minimum daily temperature (years: 2008–2018)	0.13	0.11			
Mean standard deviation of monthly average precipitation (years: 2008–2018)	0.19	0.20			
Overall LVI	0.21	0.33			

Source: Computed by the Authors

more vulnerable to malaria exposure than Dhalai households. The figures for malaria exposure* prevention index stood 2.62 for West Tripura as against 1.35 for Dhalai (Table 3).

We observed that though a significantly higher percentage of households from Dhalai district (86%) rely solely on their own farm for food compared to 32.5% of West Tripura households, but, to find adequate food they had to struggle relatively more months compared to West Tripura households (Table 2). As against the above mentioned two indicators, the computed index value (table 3) showed that for the rest of the three indicators; average crop diversity index, saving crops and saving seeds, the households from the West Tripura were slightly more vulnerable compared to the Dhalai households. However, the overall vulnerability for the food dimension was found to be more for Dhalai (0.32) as compared to West Tripura (0.22). This implies that the West Tripura households were less vulnerable compared to the Dhalai households.

We observed that from relying on to natural source of water, which is relatively more affected by climatic variability to not having consistent supply of water, for all the four included indicators of water dimension, the Dhalai households were at a disadvantageous situation compared to the West Tripura households (table 2). And, as expected the computed index value, reported in Table 3, revealed a greater extent of vulnerability in Dhalai (0.19) compared to West Tripura (0.12).

Table 2 demonstrates that over the last couple of years both the districts had experienced different levels of vulnerability caused by natural disaster. The households in the Dhalai district reported a higher number of flood, drought, and cyclone in the past 10 years compared to the West Tripura households. Moreover, the recent natural disaster also caused a relatively greater threat to life in terms of injury or death in the Dhalai district. And, when climate variability was integrated into Natural Disaster index, it was found that the extent of vulnerability was more for the Dhalai households (0.32) than West Tripura (0.19) households (Table 3).

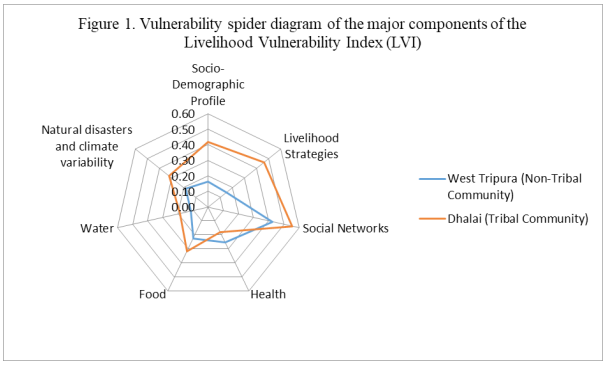
The overall LVI, reported in the last raw of the Table 3 demonstrates that Dhalai had a higher livelihood vulnerability compared to the West Tripura (0.33 versus 0.21, respectively), indicating that the

Table 4. LVI–IPCC contributing factors calculation for West Tripura and Dhalai Districts

IPCC contributing factors to vulnerability	West Tripura (Non-Tribal Community)	Dhalai (Tribal Community)
Exposure	0.19	0.32
Sensitivity	0.20	0.23
Adaptive capacity	0.82	0.68
LVI–IPCC	**-0.13**	**-0.08**

Source: Computed by the authors

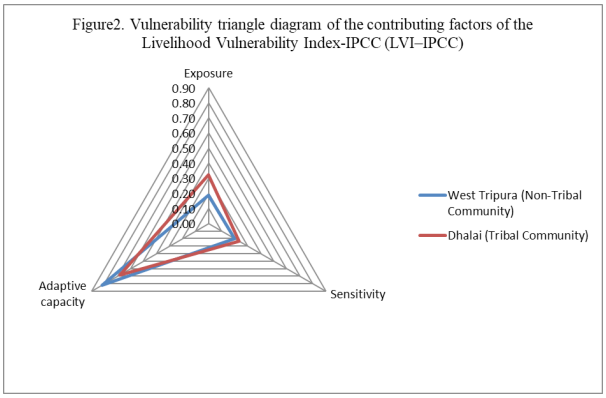
households in Dhalai districts were relatively more vulnerable to climate change as against the households of West Tripura. The spider diagram (Fig. 1) demonstrates the computed scores of the major components. The scale of the diagram ranges from 0 representing less vulnerable to 0.5, signifying more vulnerability. The spider diagram reveals that except for health dimension, the extent of vulnerability was relatively more for Dhalai district for all the rest of the major components compared to West Tripura.



Source: Prepared by the authors

LVI–IPCC: West Tripura versus Dhalai

Consistent with the livelihood vulnerability estimate (Table 3), the LVI- IPCC (reported in Table 4) also revealed a higher extent of vulnerability in Dhalai (-0.08) compared to the West Tripura (-0.13). Based on the scores of the three components of the LVI-IPCC; exposure, adaptive capacity, and sensitivity a vulnerability triangle has been drawn (Fig. 2). The triangle reveals that the households of Dhalai (Tribal Community) were more exposed (0.32) to climate change impacts than West Tripura (0.19). Accounting for the current health status as well as food and water security, the Tribal community of Tripura that is Dhalai households were also found to be more sensitive to climate change impacts than Non-Tribal Community, the West Tripura households. The figure stood 0.23 versus 0.20, respectively. Further, based on demographics, livelihood and social networks, West Tripura showed a higher adaptive capacity (0.82) than Dhalai (0.68), resulting in lower vulnerability. The overall LVI-IPCC score indicated that the households in Dhalai districts with greater exposure and sensitivity and relatively lower adaptive capacity to climate change were more vulnerable as against the West Tripura households.



Source: Prepared by the authors

Conclusion

In this study, we used the LVI and LVI-IPCC as alternative approaches to assess the vulnerability of two communities in West Tripura and Dhalai district. Each approach gave a clear illustration of the driving factors of livelihood vulnerability for each district. The LVI estimate indicated that, with the exception of the health dimension, West Tripura households were less likely to be vulnerable to climate change in terms of all the rest of the components. However, the LVI-IPCC found West Tripura households were at an advantageous position in terms of vulnerability in all three components when compared to their counterparts. Additionally, when the overall estimate of livelihood vulnerability was considered, both LVI and LVI-IPCC suggested that the Dhalai district was more vulnerable as against the West Tripura. Precisely, the households from West Tripura were found to be less vulnerable to climate change when compared to the households of Dhalai.

This study might be replicated in the same area over time to learn more about how districts' exposure, adaptive capacity, and sensitivity evolve as

adaptation measures are implemented. The Social Networks sub-components may need to be improved in future study in order to assess social relationships more precisely. In conclusion, it is envisaged that the LVI would be a useful tool for development planners to assess livelihood vulnerability to impacts of climate change in the areas in which they serve and to build programmes to enhance the most vulnerable sectors.

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