



Inter –Linkages Between Climate Change Vulnerability and Inequality an Empirical Study Across Hill, Foothill, Drought and Coastal Regions of West Bengal, India

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Received: 02.05.2021; Revised: 14.05.2021; Accepted: 29.05.2021

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Abstract: India is one of the vulnerable countries in the world in terms of climate events. The poor people and poor regions are badly affected by climate change. On the other hand, the reduction of vulnerability received a top priority in the Sustainable Development Goals of the United Nations. The present paper attempts to examine the inter-linkages between climate change vulnerability and inequality empirically across four agro-climatic regions of West Bengal like hill, foothill, drought and coastal regions. Vulnerability in the present paper is measured by adopting composite livelihood vulnerability index and income (consumption) inequality is measured by Gini coefficient. This is an empirical paper based on primary data collected from 627 households over 15 villages in different agro-climatic regions of West Bengal during 2018- 2019. The result of the paper showed that there is a positive correlation relation between income inequality (consumption) and vulnerability. The higher inequality is accompanied by higher vulnerability and vice versa. The study draws an important policy implication for reduction of vulnerability as well as reduction of inequality. The poverty reduction measures are not sufficient to reduce inequality i.e., if inequalities are on the rise the anti-poverty measures cannot reduce such inequality.

Keywords: Livelihood Vulnerability Indices • Inequality • Agro-Climatic Regions • Correlation • Gini Coefficient • Anti- Poverty Measures • JEL • Q54 • O15,

Introduction

India is one of the most climate vulnerable countries in the world and her rank in the global index is 5th with respect to extreme weather events in 2018 (Tripathi, 2019). The poorest of the poor are at risk due to climate change in India. The present paper tries to examine the nexus between climate change vulnerability and inequality within the country. The Fourth Assessment Report of Intergovernmental Panel on Climate Change (IPCC) highlighted that the victims of climate change are among socially, economically viable

and marginalized sections of the people. The negative impacts of climate change are more heavily towards the poor than the rich and the poor regions are affected more than the prosperous regions (Skoufias, 2012). The causes of vulnerability are of greater exposure to climate change hazard and low accessibility to shelter in low risk environment (Douglas et al., 2008). On the other hand, wealthier are able to sustain quickly more adaptation measures (Cutter et al., 2007). It is important to mention that some studies



are available relating to climate change vulnerability in different geographical regions in the global and national levels like flood prone coastal regions (Huyanh and Stringer, 2018), Himalayan region (Koirala 2015; Panthi et al., 2015; Ives et al., 2000; Liu and Rasul, 2007), African continent (Adu et al., 2017; IPCC, 2007), Small Caribbean Island (Schneider, 2007; McWilliams et al., 2005), and wet lands of South America (Shah et al., 2013). The term vulnerability is multidimensional nature (Alwang et al., 2001; Adger, 2006). Sustainable livelihood framework of Hahn et al. (2009) tries to integrate the interaction between the human being and its social and physical environment. On the other hand, the Intergovernmental Panel on Climate Change (IPCC) framework approach defines exposure, sensitivity and adaptive capacity as three major factors of vulnerability (Sisay, 2016).

We have gone through some literature on inequality focusing on material aspects of income inequality (Ward and Shively, 2012; Bohle et al., 1994). There are various types of inequality prevailing within the country level. First, inequality is based on demographic factors like gender, age and religion etc. Secondly, inequality may be of income and assets. Thirdly, inequality is in terms of access to public resources like health, education and housing etc. Unequal distribution of wealth may lead to vulnerability (Burton, 1997). Inequality enhanced vulnerability in a vicious cycle in which higher the inequality higher is the exclusion and higher will be vulnerability (Rothstein and Uslaner, 2005).

A large number of studies have focused on the relationship between poverty and climate change vulnerability (Ahmed et al., 2011; Hardoy and Pandiella, 2009), but the study of inequality has remained under discussion in the academic literature. Even the study of inter-linkages between climate change vulnerability and inequality has received a less attention in India in

general and West Bengal in particular. The study of inequality is significant in the context of sustainable development goals (SDGs) 10 of the United Nation Development Programme (UNDP) which emphasized the reduction of inequalities within and among countries.

Given the above backdrop, the objectives of the paper are the following.

First, is to measure the climate change vulnerability of the households with the help of livelihood vulnerability index across hill, foothill, drought and coastal regions of West Bengal.

Second, is to measure income (consumption) inequality using Gini coefficient across different agro-climatic regions of West Bengal.

Third, is to examine the nexus between climate change vulnerability and inequality across different agro-climatic regions of West Bengal.

Material and Methods

Study Area

The study has been conducted across four different agro-climatic regions of West Bengal India. The selected agro-climatic regions are hill region of Darjeeling district, foot hill region of Jalpaiguri district, drought region of Purulia district and coastal region of Indian Sundarban in South 24 Parganas district of West Bengal. These four districts are climate sensitive districts of the state of West Bengal. Darjeeling district is the northern district of West Bengal. Most of the part of Darjeeling is located in mountain range. Its ecological diversity is attractive to the tourist. Forestry, tea garden and tourism are the pillar of the economy of Darjeeling district. Jalpaiguri district is located in foothill region. It is the entry point of north eastern part of India. Due to the maximum rainfall weather is humid and moist, which is the source of vast area of evergreen and deciduous forest in this district. Rivers in this district are flood prone. Forestry, tea garden, agriculture are the main occupations to the people. Due to located in tropical zone, Purulia district is



the most drought prone area in West Bengal. Soil of the Purulia district is mainly residual formed from bed rocks by weathering and is comparatively less-fertile. Mono-cropping agriculture and forestry are the major sources of occupation. Coastal regions of Sundarban, South 24 Parganas district is characterized by tropical cyclones, storm surges, land subsidence, sea level rise, coastal erosion and coastal inundation (Dey et al. 2016). The climatic conditions in terms of

average temperature, maximum and minimum temperatures, average rainfall and average evaporation across different regions over more than 100 (1901-2002) years are presented in Table 1. Season-wise average temperature and average rainfall across different regions over more than 100 (1901-2002) years are shown in Table 2. The trends in potential evaporation, crop evaporation and vapour pressure over the period 1901 to 2002 are shown in the appendix

Table 1: Climate variables across various agro-climatic regions of West Bengal

Regions	Average temperature (°C)		Maximum temperature (°C)		Minimum temperature (°C)		Average Rainfall (mm)		Average Evaporation (mm/day)	
	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
Darjeeling	22.89	0.125	28.28	0.137	17.54	0.169	174.90	519.40	4.00	0.005
Jalpaiguri	24.35	0.129	29.57	0.139	19.16	0.178	195.23	634.06	4.06	0.005
Purulia	25.41	0.121	31.25	0.181	19.60	0.174	109.85	281.57	4.59	0.012
Sundarban	21.71	0.071	24.70	0.107	18.75	0.094	116.96	424.77	3.02	0.009

Source: author's calculation from secondary data source of Indian Meteorological Department, Pune.

Data

The study is based on primary data collected from purposively selected five agro-climatic regions of West Bengal. 15 Villages are selected on the basis climate sensitiveness and 10% of households from each village are selected in probability proportionate to different livelihood groups as per their major occupation. Thus, total 627 households have been selected from 15

villages across four different agro-climatic regions of West Bengal. An interview method has been applied to collect data. In addition to the selected households, we discussed with the local people and interviews with local experts and school teachers and other knowledgeable elders in the villages. The selection of sample villages and sample households are shown in Table 3.

**Table 2:** Season wise average temperature and average rainfall across various agro-climatic regions of West Bengal

Regions	Season wise average temperature(⁰ C)				Season wise average Rainfall (mm)			
	Pre-Monsoon (Mar-May)	Monsoon (Jun-Sep)	Post-Monsoon (Oct-Dec)	Winter (Jan-Feb)	Pre-Monsoon (Mar-May)	Monsoon (Jun-Sep)	Post-Monsoon (Oct-Dec)	Winter (Jan-Feb)
Darjeeling	24.26	26.88	20.83	15.94	86.87	424.96	38.05	12.12
Jalpaiguri	25.66	28.18	22.32	17.75	110.74	465.06	43.73	9.55
Purulia	29.52	28.29	21.49	19.34	37.15	265.87	31.75	24.02
Sundarban	23.69	23.72	19.75	17.65	48.46	262.72	58.71	15.57

Source: author's calculation from secondary data source of Indian Meteorological Department, Pune.

Table 3: Distribution of sample households (HH) across different agro-climatic regions of West Bengal

Hill Region of Darjeeling district		Foot hill region of Jalpaiguri		Drought region of Purulia		Coastal region of Sundarban in 24 Parganas		Total sample HH
Village	Sample hhs	Village	Sample hhs	Village	Sample hhs	Village	Sample hhs	
Dupka Gaon	32	Mechbasti	36	Ajodhya	44	Bhagbatpur	30	
Lamhatta	20	Detha Para	37	Banduri	51	Laxminarayanpur	68	
Banekburn Tea Estate	25	Gomasta Para	57	Ebildi	22	Madhabnagar	51	
Manebhanjanj	73			Matha	33	Paschim Dwarikapore	48	
	150		130		150		197	
							627	

Source: Calculated by authors from primary data

Analytical Methods

Livelihood Vulnerability Index

To measure the vulnerability the present paper utilizes Livelihood Vulnerability Index (LVI). It is a composite index which is constructed with 8 sub-components namely, Socio Demographic Profile (SDP), Livelihood Strategies (LS), Food,

Social Network (SN), Natural Capital (NC), Water, Health and Climatic Variables (CV) (Hahn et al., 2009). Each of the sub component indexes is again built with several indicators. The present study chooses indicators in such a way so that they can reflect the standard of living of the people of the study area. Using the methodology of Human Development Index (UNDP, 2006) the



present study normalise each indicators in unit free scale ranging 0 to 1. Following by Iyenger and Sudarshan (1982), weighted vulnerability index (\bar{y}_i) of each subcomponent is measured with following formula:

$$\bar{y}_i = \frac{\sum_{j=1}^k w_j x_{ij}}{\sum_{j=1}^k w_j} \dots\dots\dots (1)$$

Where, X_{ij} is the normalized score of j th indicator and the weights of j th indicators (w_j) is determined by $w_j = \frac{c}{\sqrt{var_i(x_{ij})}}$ such

that ($0 < w < 1$ and $\sum_{j=1}^k w_j = 1$), in which c is the normalizing constant calculated by $c = \left[\sum_{j=1}^k \frac{1}{\sqrt{var_i(x_{ij})}} \right]^{-1}$

After calculating weighted vulnerability index (\bar{y}_i) of 8 sub components, livelihood vulnerability index (LVI) is computed by weighted mean as follows:

$$LVI = \frac{\sum_{i=1}^8 w_i \bar{y}_i}{\sum_{i=1}^8 w_i} = \frac{\sum_{i=1}^8 \bar{y}_i}{8} (\because w_i = \sum_{j=1}^k w_j = 1)$$

The value of LVI varies in the scale of 0 (lowest vulnerability) to 1(highest vulnerability).

3.2 Gini coefficient: To measure inequality the present paper is based on widely used technique Gini coefficient. Inequality is measured from

income side and from consumption side. Its value varies from 0 (lowest inequality) to 1(highest inequality).

The relation between vulnerability and inequality has been measured by the correlation coefficient.

Results and Discussions

The degree of vulnerability of the households is measured by composite livelihood vulnerability index of Hahn et al.,(2009).The detailed calculation of livelihood vulnerability indices of the households across four agro-climatic regions of West Bengal is given in the appendix . The sub components of LVI consists of socio demographic profile (SDP), livelihood strategy (LS), food, social network (SN), water, health and climate variables (CV). The results of LVI of the households in different sub components and composite LVI are presented in Table 4. From this Table 4 it is found that the composite livelihood vulnerability index of the households in the drought region of Purulia district is highest (0.6076), followed by the coastal Sunderban (0.5980), hill region of Darjeeling district (0.5866) and foothill region of Jalpaiguri district (0.5505).

Table 4: Composite Livelihood Vulnerability Index (LVI) of the households across four regions of West Bengal

Sub components of LVI	Jalpaiguri	Darjeeling	Sundarban	Purulia
SDP Index	0.2628	0.3043	0.3620	0.3375
LS Index	0.7248	0.6756	0.7071	0.6664
Food Index	0.9724	0.9732	0.9137	0.8167
SN Index	0.4790	0.6614	0.6288	0.4774
NC Index	0.7885	0.7264	0.7661	0.9116
Water Index	0.3913	0.4386	0.3265	0.6286
Health Index	0.2784	0.2864	0.5161	0.4526
CV Index	0.5070	0.6270	0.5638	0.5700
Composite LVI	0.5505	0.5866	0.598	0.60761

Source: Calculated by authors from primary data



The inequality of the households across different agro-climatic regions is measured by Gini coefficient. Gini coefficient is calculated on the basis of income and consumption expenditure. The monthly per capita income (MPCE) and monthly per capita consumption expenditure (MPCE) of the households across different regions are presented in Table 5. From Table 5 it is observed that per capita income and per capita consumption is lowest for the drought region of Purulia district while they are highest for the hill region of Darjeeling district. Monthly per capita consumption expenditure on various items across different regions is shown in the appendix.

In order to calculate income Gini coefficient and consumption Gini coefficient we have arranged the households of each region in 10 groups (decile) in descending order of monthly per capita income and monthly per capita consumption respectively. The values of income Gini coefficient and consumption Gini coefficient across different regions are presented in Table 4. In terms of income Gini coefficient the households in coastal region of Sunderban is found to be highest inequality (0.587), followed by the households in the drought region of Purulia district (0.572), the hill region of Darjeeling district (0.561) and the foothill region of Jalpaiguri district (0.526). Similarly, in terms of consumption Gini coefficient values, the drought region of Purulia district is observed to be highest inequality (0.464), followed by hill region of Darjeeling district (0.45), the coastal region of

Sunderbans(0.439) and the foothill region of Jalpaiguri district(0.375)(Table 6). The cumulative percentage of households and cumulative percentage of income group for the measurement of Lornez curve is shown in Table 7 and Figure (1).

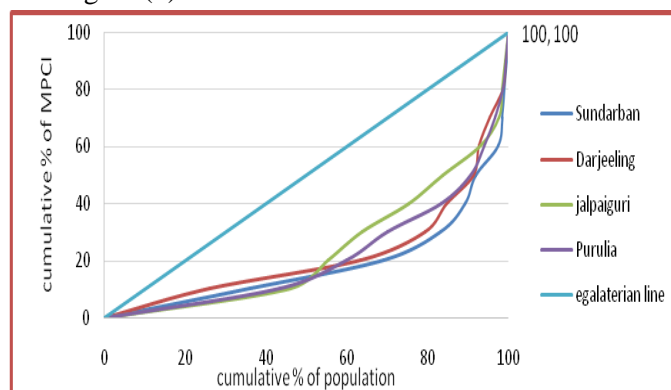


Figure 1: Lorenz curves (income distribution) of four different climatic regions of West Bengal.

Table 5: Monthly per capital income and consumption expenditure of the households across different regions of West Bengal

Regions	Monthly per capita income (Rs)	Monthly per capita consumption expenditure (Rs)
Jalpaiguri	1338.28	993.59
Darjeeling	3996.00	1811.19
Sunderban	1701.88	1102.62
Purulia	809.21	795.59

Source: Author’s calculation from primary data

Table 6: Income inequality and consumption inequality across different regions of West Bengal

Region	Income inequality (Gini coefficient)	Consumption inequality (Gini coefficient)
Jalpaiguri	0.526(4)	0.375(1)
Darjeeling	0.561(3)	0.45(2)
Sunderban	0.587(1)	0.439(3)
Purulia	0.572(2)	0.464(1)

Source: Author’s calculation from primary data, Note: () shows rank.

**Table 7:** Cumulative distribution of income and households across different regions of West Bengal

Decile groups	Cumulative % of MPC I	Sundarban	Darjeeling	Jalpaiguri	Purulia
1	≤ 10%	36.04	26.00	46.15	43.33
2	≤ 20%	69.04	63.33	55.38	60.00
3	≤ 30%	83.25	79.33	63.85	70.00
4	≤ 40%	89.34	84.67	75.38	83.33
5	≤ 50%	91.88	91.33	83.85	90.67
6	≤ 60%	97.46	92.67	93.08	94.00
7	≤ 70%	98.48	95.33	97.69	96.67
8	≤ 80%	98.98	98.67	98.46	98.67
9	≤ 90%	99.49	99.33	99.23	99.33
10	≤ 100%	100.00	100.00	100.00	100.00

Source: Calculated by authors from primary data

The cumulative percentage of households and cumulative percentage of consumption group for

the measurement of Lornex curve is shown in Table 8 and Figure (2).

Table 8: Cumulative distribution of consumption and households across different regions of West Bengal

Decile groups	Cumulative % of MPCE	Jalpaiguri	Sundarban	Darjeeling	Purulia
1	≤ 10%	7.7	23.4	18.7	10
2	≤ 20%	25.4	36.5	46	39.3
3	≤ 30%	53.8	59.9	66	68
4	≤ 40%	74.6	77.2	76	86
5	≤ 50%	89.2	85.3	82	88
6	≤ 60%	92.3	92.9	90.7	96
7	≤ 70%	96.9	96.4	98	97.3
8	≤ 80%	98.5	98.5	98.7	98
9	≤ 90%	99.2	99.5	99.3	99.3
10	≤ 100%	100	100	100	100

Relation between Vulnerability and Inequality

The relationship between inequality (income and consumption) and vulnerability is measured by the correlation coefficient. The values of the correlation coefficient between inequality and

vulnerability of the whole regions under study are presented in Table 9. From Table 9 we find that the values of correlation are positive and significant. This means that high vulnerability is accompanied by high inequality and vice-versa.

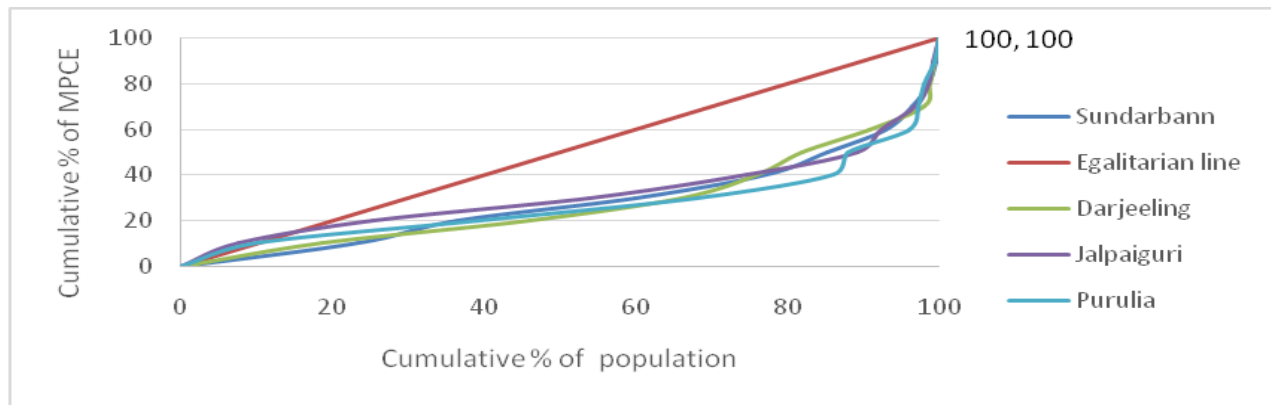


Figure 2: Lorenz curves (distribution in Consumption) of four districts

Table 9: Correlation between inequality and vulnerability of the four regions as a whole

Inequality	Vulnerability
Income inequality	0.922**
Consumption inequality	0.963***

Source: author’s calculation,

Note: *** and ** show significant at 5% level and 10% level respectively.

The vulnerability and income inequality across different regions of West Bengal is shown in

Figure 3 and vulnerability and consumption inequality is also given in Figure 4.

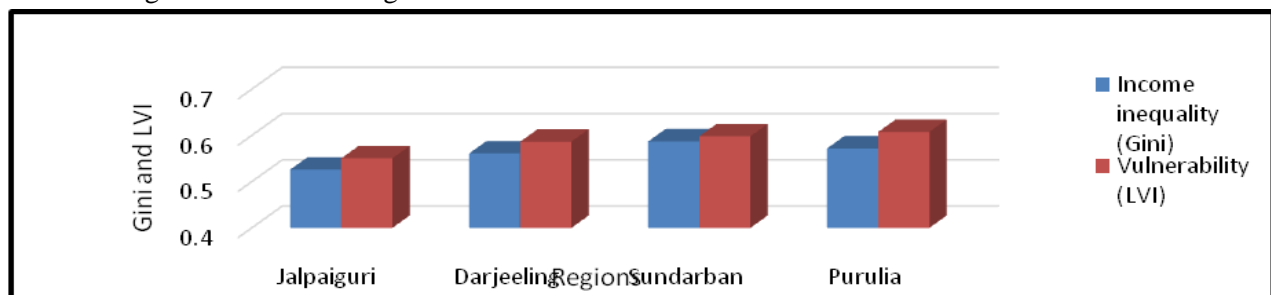


Figure 3: Income inequality and vulnerability across different regions of West Bengal



Figure 4: Consumption inequality and vulnerability across different regions of West Bengal



Table 10: Region wise calculation of different subcomponents of LVI

Sub Component	Indicators	Jalpaiguri		Darjeeling		Sundarban		Purulia	
		LVI	Weight	LVI	Weight	LVI	Weight	LVI	Weight
Socio-Demographic Profile	Percentage of dependent people <20 years, >60years	0.1	0.35	0.1	0.37	0.1	0.38	0.14	0.353
		39	2	298	73	539	48	69	4
	Percentage of female headed households	0.0	0.13	0.0	0.15	0.0	0.16	0.04	0.188
		565	59	77	39	543	47	14	3
	Percentage of illiteracy among households head	0.0	0.16	0.0	0.18	0.0	0.15	0.06	0.158
		359	09	401	79	786	49	46	8
	Percentage of female family earner	0.0	0.35	0.0	0.28	0.0	0.29	0.08	0.299
		314	11	575	09	752	57	47	6
	SDP Index	0.2		0.3		0.3		0.33	
		628		043		62		75	
Livelihood Strategies	Percentage of households with family member working outside local area	0.0	0.15	0.0	0.11	0.0	0.08	0.02	0.109
		174	06	222	91	312	3	64	9
	Percentage of households change sowing and cropping schedule	0.0	0.09	0.0	0.09	0.1	0.12	0.03	0.097
		504	64	458	28	054	07	52	8
	Livelihood diversification index	0.2	0.28	0.1	0.17	0.1	0.21	0.12	0.200
		538	04	203	86	23	3	86	2
	Average livestock diversification index	0.0	0.14	0.0	0.17	0.0	0.17	0.13	0.191
	943	71	969	58	925	61	84	4	
Monthly per capita income (Rs)	0.3	0.32	0.3	0.43	0.3	0.40	0.33	0.400	
	089	55	904	36	55	72	78	8	
	LS Index	0.7		0.6		0.7		0.66	
		248		756		071		64	



Food	Average crop diversity index = household has the capacity to grown at least 1 additional crop such as vegetables or pulse along with traditional crop	0.9	1	0.9	1	0.9	0.43	0.81	1
		724		732		137		67	
	Food Index	0.9	-	0.9	-	0.9	-	0.81	-
		724		732		137		67	
Social Network	Percentage of households not having access to communication media (like TV)	0.1	0.31	0.3	0.40	0.1	0.32	0.13	0.336
		131	97	455	8	94	66	7	9
	Percentage of households not associated with any organization (cooperative/group) i.e. in Self Help Group (SHG)	0.1	0.32	0.1	0.29	0.1	0.32	0.16	0.331
		038	9	431	41	981	8	11	1
	Percentage of households with non-member of MGNREGA	0.2	0.35	0.1	0.29	0.2	0.34	0.17	0.332
		621	13	728	79	367	54	9296	0298
	SN Index	0.4	-	0.6	-	0.6	-	0.47	-
		79		614		288		74	
Natural Capital	Percentage of households using only forest based energy for cooking	0.2	0.37	0.3	0.56	0.4	0.52	0.58	0.609
		532	09	228	97	236	82	64	8
	Percentage of marginal and small farmer households	0.5	0.62	0.4	0.43	0.3	0.47	0.32	0.390
		352	91	036	03	425	18	51	2
	NC Index	0.7	-	0.7	-	0.7	-	0.91	-
		885		264		661		16	
Water	Percentage of households not having regular drinking water supply	0.1	0.20	0.2	0.32	0.1	0.25	0.28	0.333
		546	93	886	55	059	44	01	4
	Percentage of households that utilize natural water source for drinking water	0.1	0.22	0.0	0.21	0.1	0.25	0.16	0.256
		756	38	842	06	015	64	78	8
	Percentage of households go at least 1 km to fetch water	0.0	0.56	0.0	0.46	0.1	0.48	0.18	0.409
	611	69	657	39	191	92	08	8	
	Water Index	0.3	-	0.4	-	0.3	-	0.62	-
		913		386		265		86	
Health	Percentage of households with family member suffering from chronic illness	0.0	0.34	0.1	0.27	0.1	0.33	0.16	0.263
		844	31	663	12	623	3	52	6
	Percentage of households do not receiving treatment in local health center	0.0	0.35	0.0	0.31	0.1	0.33	0.04	0.425



		809	07	729	22	76	34	25	1
	Percentage of households do not have toilet facility	0.1	0.30	0.0	0.41	0.1	0.33	0.24	0.311
		131	62	472	66	778	36	49	3
	Health Index	0.2	-	0.2	-	0.5	-	0.45	-
		784		864		161		26	
Climate Variable	Percentage of households realize reduction in rainfall in past 5 years	0.0	0.26	0.1	0.25	0.1	0.25	0.07	0.229
		391	77	769	76	511	22	97	8
	Percentage of households about the perception of landslide increased in last 5 years	0.2	0.32	0.1	0.25	0.1	0.24	0.27	0.315
		965	67	665	23	39	89	1	2
	Percentage of households about the perception of storm increased in last 5 years	0.0	0.21	0.1	0.25	0.1	0.25	0.07	0.229
		574	32	641	11	495	17	97	8
	Percentage of households that did not receive warning about natural disasters	0.1	0.19	0.1	0.23	0.1	0.24	0.13	0.225
	14	24	195	9	242	72	97	3	
	CV Index	0.5	-	0.6	-	0.5	-	0.57	-
		070		270		638		00	
	LVI	0.5	-	0.5	-	0.5	-	0.60	-
		505		866		98		76	

Source: Computed by authors from primary data

Table 11: Monthly Per Capita Consumption Expenditure (MPCE) (Rs) on different items

	Cereal	Pulses	Edible Oil	Vegetables	Egg, Meat, Fish	Spice	Fuel	Dress	Travel	Education	Medical	MPCE
Darjeeling	68	54	141	78	300	25	209	260	212	267	197	1811
Jalpaiguri	73.58	84.03	95.57	123.22	169.12	61.29	115.22	63.62	69.72	76.02	62.21	993.59
Purulia	77.5	57.2	69.69	98.41	155.3	36.3	102.35	64	59.97	37.87	37.01	795.59
Sundarban	133.2	88.8	111.6	64.11	191.71	85.77	102.7	70.71	46.58	68.98	138.38	1102.6

Source: Computed by authors from primary data



From figure 4 we find that the drought region of Purulia district has higher inequality with higher vulnerability while the foothill region of Jalpaiguri district has lower inequality with lower vulnerability.

The high consumption inequality with high vulnerability in the drought region of Purulia district seems to be higher climate exposure and lower adaptive capacity. The people in the drought region district of Purulia experiences high poverty as reflected by low per capita consumption expenditure and low per capita income. This region is characterized by deficient along with high inequality.

water and lack of irrigation and high temperate region. Agriculture is not efficient although people are dependent on it. In addition, there is a scarcity of off farm employment opportunity to the people. On the other hand, the people in Purulia district have low adaptive capacity like lack of education, lack of health facility, poor quality of housing, very low land holding, low income opportunity, low employability etc., through which they are unable to cope with the adverse effect of climate change and these led to high vulnerability

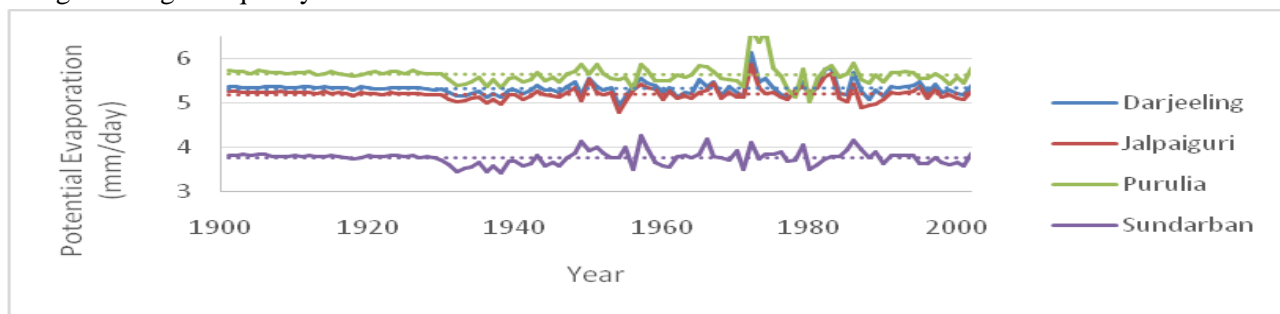


Figure 5: Trends in potential evaporation

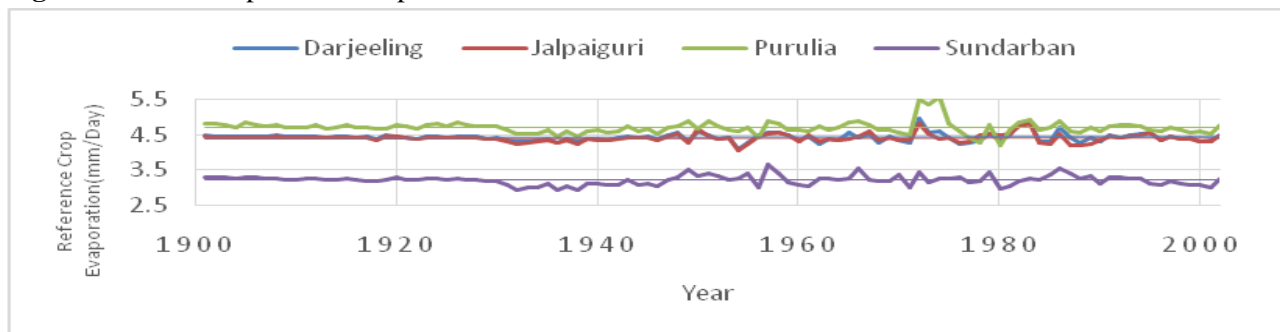


Figure 6: Trends in reference crop evaporation

Discussion

The findings of the present paper may support or contradict the results of others. The result of the present paper supports the results of (Wodon et al., 2014) in Egypt, the Surian Arab Republic, Algeria, Morocco and Yemen. In a study of mountain region of Nepal, it was revealed that low income households are of more exposed to

climate hazard than the richer households (Gentle et al., 2014). The study of Uganda, Hill and Mejia-Mantilla (2015) have shown that farmers of the lower income class have the limited capacity to alter cropping patterns, limited accessibility to water reservoirs and agriculture extension services, lesser financial ability to use water saving techniques compared to the richer farmers. As a result of the scarcity of rainfall, the low income farmers are affected much more than the



high income farmers. The study of (Patankar2015) showed that the poor households with poor quality of shelter exposed highly to flood in Mumbai and they had to incur more money for the protection of their shelters during the flood compared to the wealthy families.

The results of Carter et al., (2007) have shown that people in Honduras are affected by storm causing more damage of asset of the households. The Cyclone Aila2009 has damaged the structure of houses in Bangladesh which is reported to be greater among BPL households (Roy et al., 2007). The findings of Heinrigs(2010) revealed that livelihoods of major sections of population in Sahel region of Africa are dependent on the nature and pattern of rainfall. The findings of the present

paper also supported the results of (Adepetu and Berthe, 2007) in which assets poor households, weak health status and lack of education are more prone to hazards of climate change. It is noted that inequality is related to the vulnerability and it creates imbalances in the society (Ward and Shively 2012). The findings of the paper supported the results of (Adger, 1999) where income inequality due to climate change is explained by the lack of access to resources and income poverty. The value of income Gini coefficient (0.51) in Papua New Guinen showed high income inequality (World Bank, 2014). The poor households are more exposed and sensitive to climate hazards and have low adaptive capacity (Gallopín, 2006).

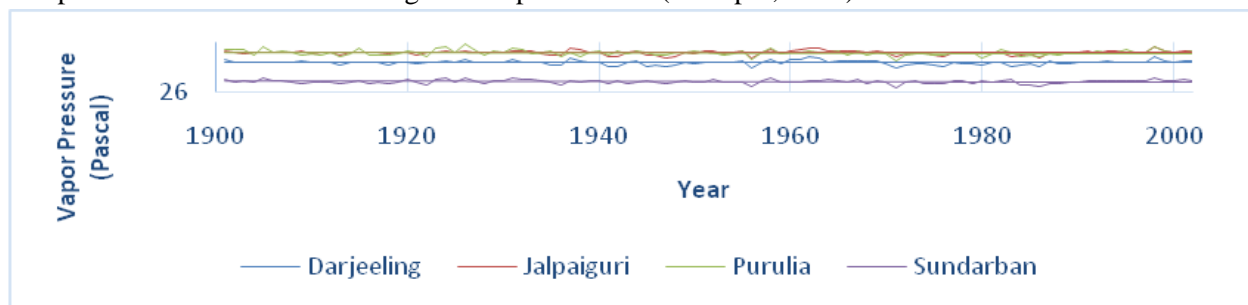


Figure 7: Trends in vapour pressure

The people who are living in the slum areas in Mumbai reported to be a greater incidence of susceptible to diseases mainly water borne in the wake of monsoon floods (Hallegatte et al., 2016). The average value of Gini coefficient in Bangladesh over 2005-2010 reached at 0.45. The value of such Gini coefficient in 2016 rose to 0.483. The finding of the present paper on the value of consumption Gini (0.464) in the drought prone district of Purulia is compatible and closer to the Bangladesh.

Conclusions and policy suggestions

1. The composite livelihood vulnerability index of the households in the drought region of Purulia district is highest (0.607), followed by the

coastal Sunderban (0.598), hill region of Darjeeling district (0.586) and foothill region of Jalpaiguri district (0.550).

2. In terms of consumption Gini coefficient, the drought region of Purulia district is observed to be highest inequality (0.464), followed by hill region of Darjeeling district (0.45), the coastal region of Sunderbans(0.439) and the foothill region of Jalpaiguri district(0.375).

3. There is a positive and significant relation between inequality and vulnerability. The drought region of Purulia district has high inequality with high vulnerability while the foothill region of Jalpaiguri district has low inequality with low vulnerability.

4. The paper identifies the key to vulnerabilities and inequalities in the drought



region. These are insufficiency of job, low adaptive capacity like lack of education, lack of health facility, poor quality of housing, very low land holding, low income opportunity, low employability etc., through which they are unable to cope with the adverse effect of climate change. The paper has an important policy implication for inequality reduction and vulnerability reduction. The poverty reduction measures are not sufficient to reduce inequality. Therefore, priorities should be given on considering with different problems into the planning model.

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