



## Gender Vulnerability to Climate Change and Adaptation Strategy: An Empirical Study in Drought prone Region of West Bengal, India

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### Abstract

The present paper attempts to measure gender vulnerability to climate change and to identify the gender-wise adaptation options at the household level in the drought prone region of West Bengal. The Livelihood Vulnerability Index (LVI) and combined LVI-IPCC index have been used to measure gender vulnerability. The paper is based on primary data collected from 150 households from four villages in the district of Purulia, one of the drought prone regions of West Bengal, in 2018 with the help of a structured questionnaire. The result of the paper shows that the female headed households are more vulnerable compared to the male headed households on the basis of both measures of vulnerability indices. The paper also identifies the gender-wise adaptation options like livestock rearing, formation of self-help groups (SHGs), migration, and diversification of livelihood and collection of non-timber forest products (NTFPs). The paper has an important policy implication for the reduction of vulnerability of the female headed households and strengthening livelihood opportunities.

**Keywords:** Livelihood vulnerability index, gender, adaptation, self-help groups, migration, livelihood opportunity.

### 1. Introduction

In the developing country 1.3 million (70%) women are living below the poverty line (Johnson, A, S. 2011). Most of the global and regional studies have focused on gender inequality which is due to climate change in the less developed regions of South Asia (Lambrou and Nelson 2010, Ovstegard et al. 2010; World Bank 2010). The causes of such gender vulnerability are the inequalities between men and women, lack of access to food, water, health, low income and limited control over decision making in the family (WEDO 2007). According to Fourth Assessment Report of IPCC, the term vulnerability is used to mean that it is the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change (IPCC 2007). In other words, vulnerability to climate change is the function of exposure, sensitivity and adaptive capacity.

There are various quantitative methods are available for the assessment of vulnerability. The

first one is indicator based and other is econometric based assessment. There are some literatures focused on indicator-based vulnerability assessment (Luers et al. 2003; Adger et al. 2004; Tonmoy et al. 2014). On the other hand, the econometric methods include vulnerability as expected poverty (VEP), vulnerability as low expected utility (VEU) and vulnerability as uninsured exposure to risk (VER) (Hoddinott and Quisumbing, 2003; Christiaensen and Subbarao, 2004; Chaudhuri et al. 2002; Ligon and Schechter, 2003). The indicator based vulnerability method is superior to econometric based method on the ground that the former takes the factors like social, economic as well as environmental into consideration of vulnerability measurement.

There has been a substantial work on gender and environmental issues (DFID, 2009). But there are limited numbers of studies available for the measurement of climate change vulnerability and gender issues especially in the context of India.

Given the above backdrop, the objectives of the paper are twofold. First is to measure vulnerability to climate change for female and male-headed households in the drought prone district of Purulia in West Bengal. Second is to investigate adaptation strategies adapted by female and male headed households to reduce vulnerability to climate change in the drought prone area in West Bengal.

### 2. Materials and Methods

#### 2.1 Study Area

The study was conducted in the district of Purulia, Western part of West Bengal and it is one of the drought prone districts of West Bengal. This district is surrounded by the three states of India like Orissa, Bihar and Jharkhand. This district is a part of Jangle Mahal, poverty ridden (poverty rate 32.7%) and tribal dominated district. As per census of 2011 the literacy rate of the district as a whole is 64.48%. The female and male literacy rates in this district are 77.86% and 50.52% respectively. Agriculture is the main source of livelihood of the district. The major agricultural crops grown in this district are rice, maize, potatoes, groundnuts, wheat, etc. The climate of this district is sub



tropical in nature. The district is known as rain fed and high temperate region of the State. The average rainfall of this district was 1189.2 mm in 2015-16. The soil condition is red laterite type. The trends of climate of this district over 100 years are presented in figures 2-6. It is found from Figure 2

that there is a fall in rainfall over 100 years. The trends of average, maximum and minimum temperature are showing increasing since 1980's (See Fig (3), Fig (4) and Fig (5)). The trend in humidity is also increasing since 1980's (See Fig (6)).



Figure1 Map of Purulia district

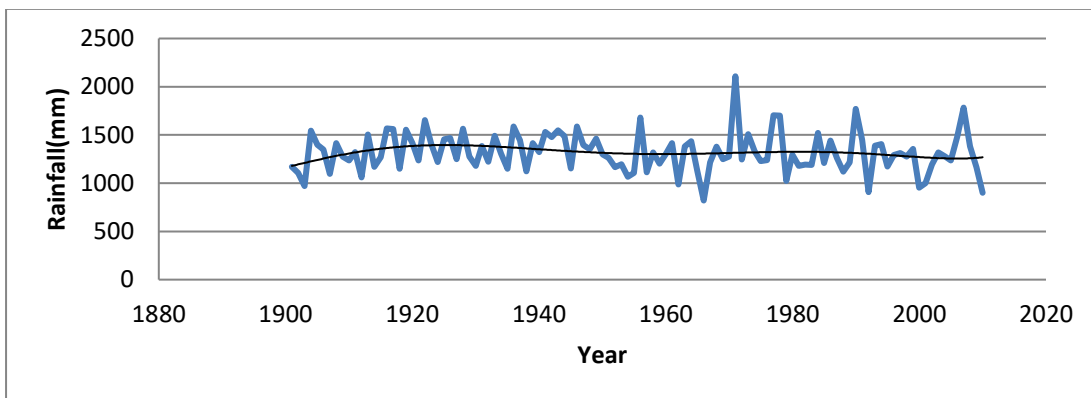


Figure 2 Trends in rainfall in the district of Purulia (1901-2010)

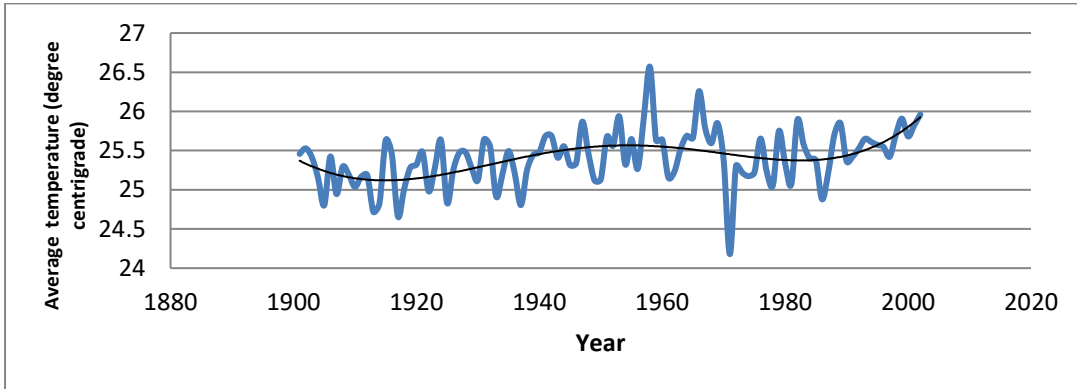


Figure 3 Trends in average temperature in the district of Purulia (1901-2002)

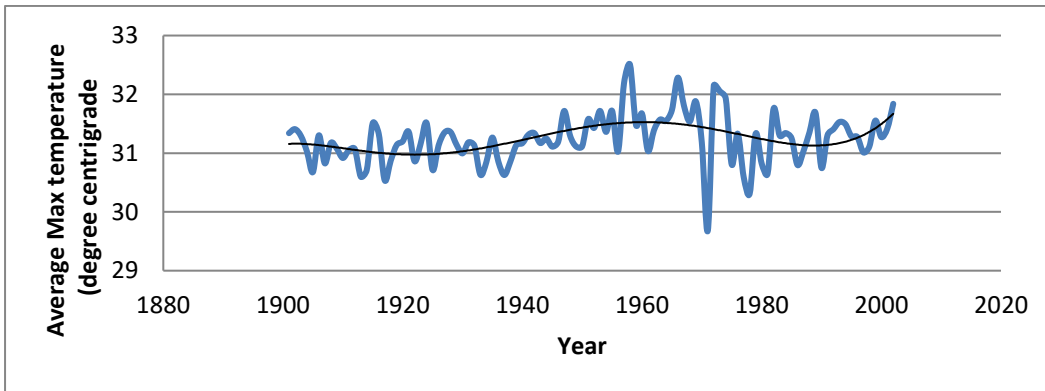


Figure 4 Trends in maximum temperature in the district of Purulia (1901-2002)

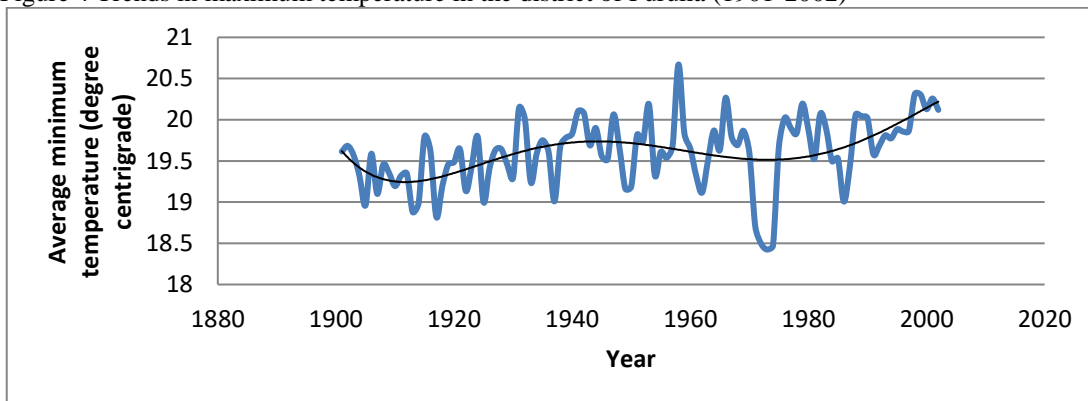


Figure 5 Trends in minimum temperature in the district of Purulia (1901-2002)

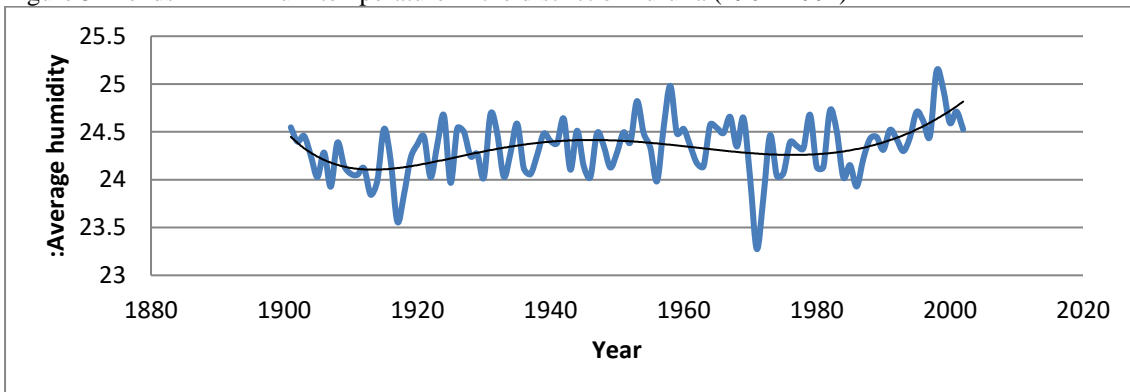


Figure 6 Trends in humidity in the district of Purulia (1901-2002)



### 2.2 Methods of data collection

The present paper is based on primary data collected from field survey. The study was carried out in four villages in Bagmundi block of the district of Purulia in 2018. Four villages are Ajodhya, Banduri, Ebildi and Matha. These villages are located in the Matha forest range office. The primary data was collected randomly from the selected villages (about 30% of the households from each village) based on direct interview method. Thus, the total sample comprises 150 households out of which 117 households are male headed and 33 households are female headed households.

### 2.3 Analytical methods

#### 2.3.1 Vulnerability Index

The present paper has utilized index based vulnerability measurement. The first one is

Livelihood vulnerability Index (LVI) of Hahn et al. (2009) and the second is the modified Livelihood vulnerability index which is known as LVI-IPCC.

In the calculation of livelihood vulnerability index (LVI) we have categorized eight sub-components of vulnerability like Socio Demographic Profile (SDP), Livelihood Strategies (LS), Food, Social Network (SN), Natural Capital (NC), Water, Health and Climatic (C). Each of the sub components index is again built with several indicators (Figure 7). The modified livelihood vulnerability index considers three contributory factors like exposure, sensitivity and adaptive capacity of vulnerability assessment (Figure 8).

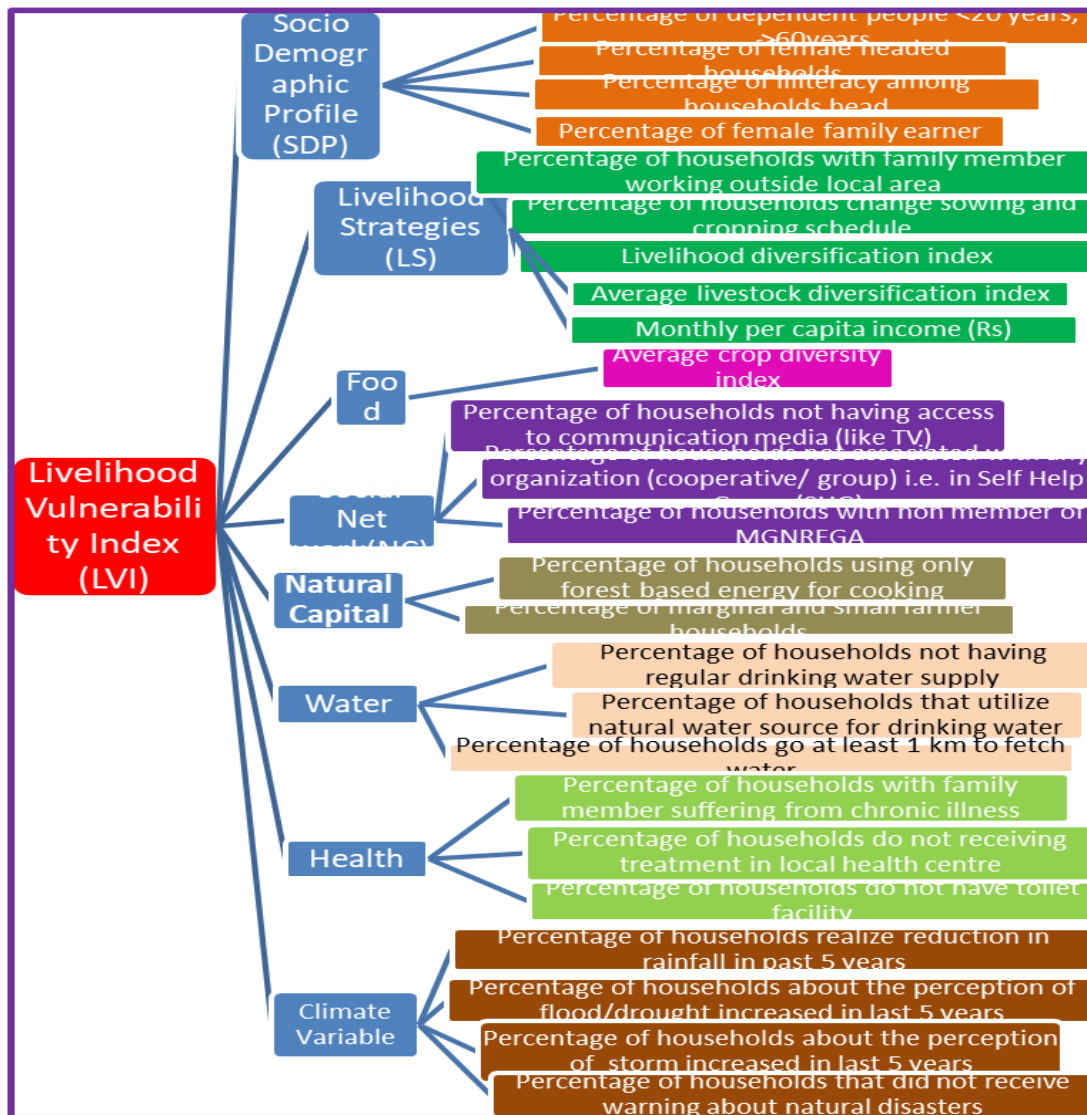
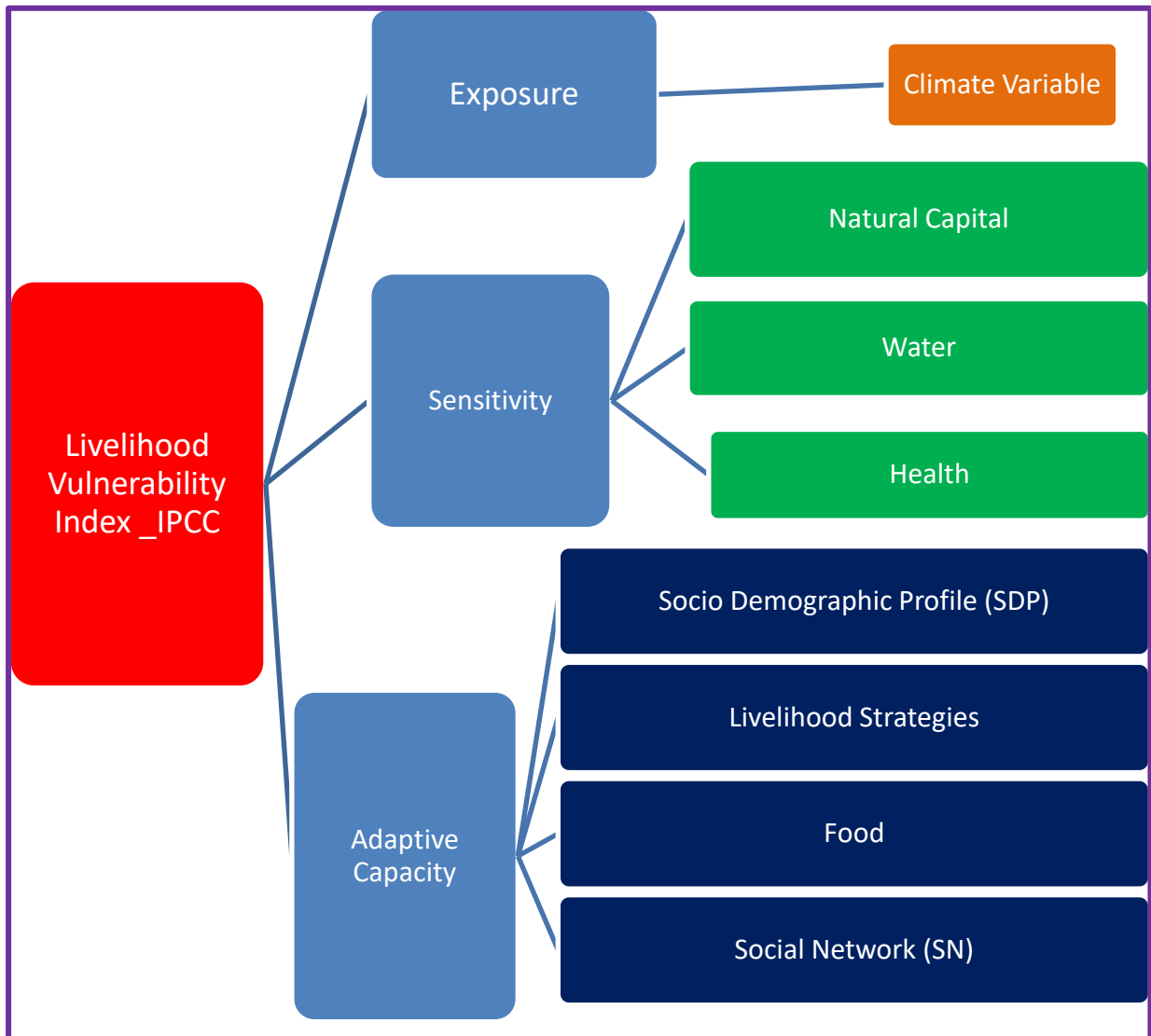


Fig (7) Schematic diagram of livelihood vulnerability Index ( LVI)



Fig(8) Schematic diagram of Livelihood Vulnerability Index\_IPCC

The chosen indicators have different units and scales. To bring them into a unit free single scale ranging 0 to 1, the study normalizes value of each and every indicator following the methodology of Human Development Index (UNDP 2006). “0” represents the minimum value whereas “1” represents maximum value. Some indicators show positive relationships with vulnerability and others have negative relationship with vulnerability. For positive relationship with vulnerability we have used the following formula.

$$X_{ij} = \frac{X_{ij} - \text{Min}(X_{ij})}{\text{Max}(X_{ij}) - \text{Min}(X_{ij})} \dots\dots\dots (1)$$

Min( $X_{ij}$ ) and Max( $X_{ij}$ ) are the minimum and maximum values of the j indicator reflecting low and high vulnerability.

On the other hand for negative relationship with vulnerability, the formula is given by

$$X_{ij} = \frac{\text{Max}(X_{ij}) - X_{ij}}{\text{Max}(X_{ij}) - \text{Min}(X_{ij})} \dots\dots\dots (2)$$

The weighted vulnerability index is constituted by Iyenger and Sudarshan (1982).



$$\bar{y}_i = \frac{\sum_{j=1}^k w_j x_{ij}}{\sum_{j=1}^k w_j} \dots\dots\dots (3)$$

Where  $\bar{y}_i$  is the vulnerability Index of the *i*th subcomponent,  $X_{ij}$  is the normalized score of *j*th indicator.  $w_j$  is the weights of *j*th indicators such that  $(0 < w < 1 \text{ and } \sum_{j=1}^k w_j = 1)$ .  $w_j x_{ij}$  is the weighted index of *j*th indicator of *i*th sub component.

Since  $\sum_{j=1}^k w_j = 1$  equation (3) can be rewritten as

$$\bar{y}_i = \sum_{j=1}^k w_j x_{ij} \dots\dots\dots (4)$$

The weight is determined by

$$w_j = \frac{c}{\sqrt{\text{var}_i(x_{ij})}} \dots\dots\dots (5)$$

Where *c* is the normalizing constant such that

$$c = \left[ \sum_{j=1}^k \frac{1}{\sqrt{\text{var}_i(x_{ij})}} \right]^{-1} \dots\dots\dots (6)$$

After calculating 8 sub components, livelihood vulnerability index (LVI) is computed by weighted mean as follows:

$$LVI = \frac{\sum_{i=1}^8 W_i \bar{y}_i}{\sum_{i=1}^8 W_i} \dots\dots\dots (7)$$

Since weight (*W<sub>i</sub>*) of *i*th sub component is 1 ( $\because w_i = \sum_{j=1}^k w_j = 1$ ), equation (7) can be simplified as

$$LVI = \frac{\sum_{i=1}^8 \bar{y}_i}{8} \dots\dots\dots (8)$$

The livelihood vulnerability index varies from 0 (lowest value) to 1(highest Value) (Pandey and Jha 2012).

**LVI-IPCC index:** It is the modified livelihood vulnerability index. The contributory factors of vulnerability are exposure, sensitivity and adaptive capacity. Adaptive Capacity is constructed with four sub components like Socio Demographic Profile (SDP), Livelihood Strategies (LS), Food and Social Network (SN).

$$\text{Adaptive capacity Index} = \frac{\sum_{i=1}^4 W_i \bar{y}_i}{\sum_{i=1}^4 W_i} = \frac{\sum_{i=1}^4 \bar{y}_i}{4} \quad (\because W_i = 1) = \frac{\bar{Y}_{sdp} + \bar{Y}_{ls} + \bar{Y}_{food} + \bar{Y}_{sn}}{4} \dots\dots\dots (8)$$

The sensitivity index is also based on three sub components like Natural Capital, Water and Health.

$$\text{Sensitivity Index} = \frac{\sum_{i=1}^3 W_i \bar{y}_i}{\sum_{i=1}^3 W_i} = \frac{\sum_{i=1}^3 \bar{y}_i}{3} \quad (\because W_i = 1) = \frac{\bar{Y}_{nc} + \bar{Y}_{water} + \bar{Y}_{health}}{3} \dots\dots\dots (9)$$

$$\text{Exposure Index} = \text{Index of climate variable} = \frac{\sum_{j=1}^4 w_j x_j}{\sum_{j=1}^4 w_j} \dots\dots\dots (10)$$

Lastly, LVI\_IPCC index is then calculated as an average of exposure, sensitivity and adaptive capacity. Symbolically,

$$LVI\_IPCC = \frac{\text{Exposure} + \text{Sensitivity} + \text{Adaptive Capacity}}{3} \dots\dots\dots(11)$$

After calculating the vulnerability indices for female and male headed households it is necessary to test whether there is a significant difference in the mean livelihood vulnerability indices along with major components for female and male headed households (Alhassan et al. 2018). To test this hypothesis, we employ t-statistic which is given below:

$$t = \frac{\mu_F - \mu_M}{\sqrt{\frac{\sigma_F^2}{N_F} + \frac{\sigma_M^2}{N_M}}}$$

Where  $\mu_F$  and  $\mu_M$  the mean values of vulnerability indices are for the female headed households respectively, while  $\sigma_F^2$  and  $\sigma_M^2$  denote the standard deviations of the vulnerability indices for the female and male headed households respectively.  $N_F$  and  $N_M$  are the sample size for female and male headed households respectively.





### 3. Results and Discussions

#### 3.1 Results on Vulnerability

The results of livelihood vulnerability indices for female and male-headed households in the drought prone district are presented in Table 1. It is revealed from Table 1 that the vulnerability indices for female and male-headed households are found to be 0.5909 and 0.5237 respectively. This means that female households are more vulnerable than male headed households in the district of Purulia. The results of two sample t test of overall vulnerability indices for female and male headed households are presented in Table 2. On the basis of t-values the result is significant. This means that the null hypothesis of no difference in vulnerability indices for female and male headed households is rejected. This further implies that the female households are more vulnerable than male headed households. It is also revealed from Table 2 that on the basis of t-values there is a significant difference results observed in computed indices of socio-demographic profile, livelihood strategy, food, social networks, natural capital, water and health except climate component for female-headed and male-headed households. The overall vulnerability index along with computed indices of different sub-components for female and male headed households are shown in the radar diagram (9).

**Table 1: Indices of Female and Male headed households in the district of Purulia, West Bengal**

Sub Component	Indicators	Weighted Index for Female	Weighted Index for Male
Socio-Demographic Profile	Percentage of dependent people <20 years, >60years	0.1410	0.1485
	Percentage of female headed households	0.1883	0.0000
	Percentage of illiteracy among households head	0.0770	0.0611
	Percentage of female family earner	0.1298	0.0720
	<b>SDP Index</b>	0.5360	0.2816
Livelihood Strategies	Percentage of households with family member working outside local area	0.0333	0.0244
	Percentage of households changed sowing and cropping schedule	0.0474	0.0318
	Livelihood diversification index <sup>a</sup>	0.0607	0.0747
	Livestock diversification index <sup>b</sup>	0.0536	0.0528
	Monthly per capita income (Rs)	0.0691	0.0612
	<b>LS Index</b>	0.2641	0.2449
Food	Average crop diversity index <sup>c</sup>	0.4545	0.3248
	<b>Food Index</b>	0.4545	0.3248
Social Network	Percentage of households received dwelling house under Indira Awas Yojana (IAY) <sup>d</sup>	0.1403	0.1736
	Percentage of households not having access to communication (like TV)	0.1213	0.0963
	Percentage of households not associated with any organization (cooperative/ group) i.e. in Self Help Group (SHG)	0.1491	0.1114
	Percentage of households not associated with Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA).	0.1570	0.1265
	<b>SN Index</b>	0.5676	0.5078
	<b>Adaptive Index</b>	0.4556	0.3397
Natural Capital	Percentage of households using only forest based energy for cooking.	0.5960	0.5838
	Percentage of marginal and small farmer households.	0.3285	0.3242
	<b>NC Index</b>	0.9245	0.9079
Water	Percentage of households not having regular drinking water.	0.3132	0.2707
	Percentage of households that utilize natural water source for drinking water.	0.1946	0.1602
	Percentages of households go at least 1 km to fetch water for drinking purposes.	0.2529	0.2222
	<b>Water Index</b>	0.7606	0.6532
Health	Percentage of households with family member suffering from chronic illness	0.1758	0.1622
	Percentage of households receiving access to local health centre.	0.0386	0.0436
	Percentage of households do not have toilet facility	0.2547	0.2421



Sub Component	Indicators	Weighted Index for Female	Weighted Index for Male
	<b>Health Index</b>	0.4691	0.4479
	<b>Sensitivity Index</b>	0.7181	0.6697
<b>Climate</b>	Percentage of households realized fall in rainfall last 5 years.	0.1184	0.0687
	Percentage of households perceived the occurrence of drought increased last 5 years.	0.2674	0.2721
	Percentage of households perceived the occurrence of storm increased last 5 years.	0.0905	0.0766
	Percentage of households who did not receive any warning about natural disasters.	0.1229	0.1444
	<b>Climate Index</b>	0.5992	0.5618
	<b>Exposure</b>	0.5992	0.5618
	<b>Over all Vulnerability Index</b>	0.5909	0.5237

Sources: Computed by author from field survey primary data

**Note:** <sup>a</sup> Construction of livelihood diversification index has been done by taking score 1 for one livelihood activity, score 2 for two livelihood activities, score 3 for three livelihood activities, score 4 for four livelihood activities, score 5 for five or more livelihood activities. Hence the lowest value is 1 and the maximum value is 5.

<sup>b</sup> Livestock diversification index was also constructed by taking score 1 for household's holding 1 species in the herd of cattle, score 2 for household's holding 2 species in the herd of cattle, score 3 for household's holding 3 species in the herd of cattle, score 4 for household's holding 4 species in the herd of cattle, score 5 for household's holding 5 or more species in the herd of cattle.

<sup>c</sup> household has the capacity to grow at least 1 additional crop such as vegetables or pulse along with traditional crop.

<sup>d</sup> Indira Awaas Yojana (IAY) is a programme of Ministry of Rural Development, Government of India, to provide shelter to the homeless people. It caters the needs of the poor people living below the poverty line (BPL) in Rural India.

Table 2: Sub-components wise Livelihood vulnerability Index with t-test

Sub-components	Index		t- test	
	Female	Male	t-value	p-value
SDP Index	0.536	0.2816	9.0305	0.0000
LS Index	0.2641	0.2449	2.17	0.03357
Food Index	0.4545	0.3248	1.9768	0.0707
SN Index	0.5676	0.5078	2.3001	0.0956
NC Index	0.9245	0.9079	1.79	0.08900
Water Index	0.7606	0.6532	2.4688	0.0100
Health Index	0.4691	0.4479	7.00	0.000
Climate Index	0.5992	0.5618	0.7459	0.4600
Overall Livelihood Vulnerability Index	0.5909	0.5237	2.9324	0.0039

Sources: Computed by author from field survey primary data



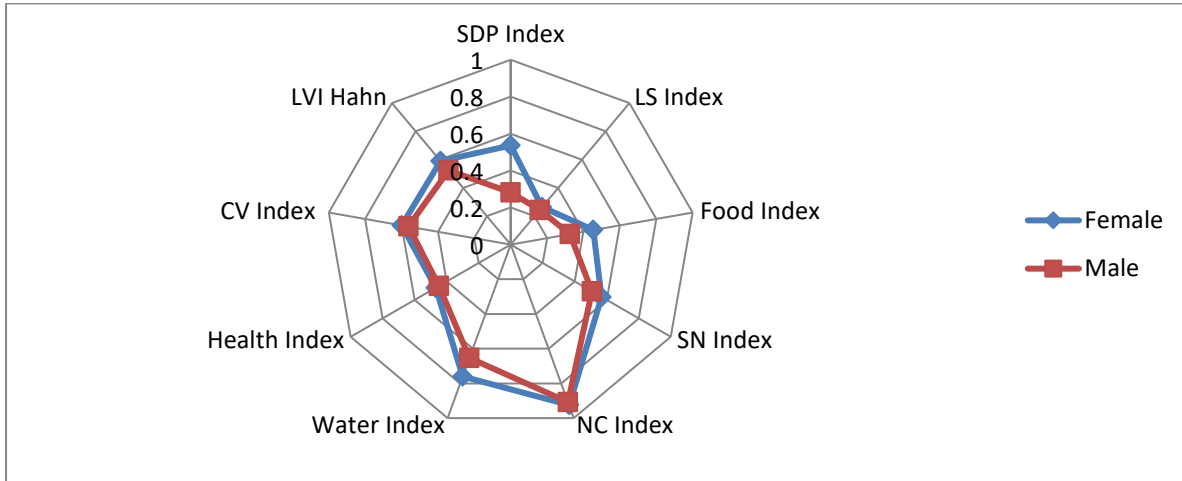


Figure 9 Gender -wise LVI and its sub-components in the district of Purulia, West Bengal

The computed vulnerability indices for socio-demographic profile (SDP), which is the sub-component of LVI, for female and male headed households, are found to be 0.5360 and 0.2816 respectively. This shows that the female are more vulnerable than male headed households. The causes of such high vulnerability in the female headed households are due to the persistence of illiteracy and involvement of female earning members in the female households than the male headed households (shown in Table 1). It is recorded from the field survey that the illiterate female households (48%) are higher than the illiterate male headed households (38%). Similarly, the female earning members (43%) in the female households are higher than that in the male headed households (24%). The implication is that the economic condition of the female households is more precarious because female family members have been involved in various non-farm activities for maintaining their subsistence standard of living. Again, the computed vulnerability indices for livelihood strategy, another sub-component of livelihood vulnerability index, for female households and male headed households are 0.2641 and 0.2449 respectively (Table 1). It is recorded from the field survey that the family members working outside the local area (30%) in the female households are higher than that in the male headed households (22%). It is also recorded that 51% female households rescheduled cropping and sowing in times while 67% male headed households are involved in rescheduling cropping and sowing in times. The female households recorded low agricultural livelihood diversification (1.91) compared to male headed households (2.21). The livestock diversification index for female households (1.1) is lower than that in the male headed households (1.12). It is also recorded from

the field survey that the monthly income for female households was Rs. 802, which is lower than male headed households (Rs. 875). On the basis of the above findings it is observed that the female households are more vulnerable than male headed households.

The computed vulnerability indices for food, which is the sub-component of LVI, for female and male headed households, are found to be 0.4545 and 0.3248 respectively (Table 1). Crop diversity index is an important indicator of food. It has been calculated that the crop diversity index for female households is 3.03 while 5.13 for male headed households. This result explains the female households are more vulnerable compared with male headed households.

The social network sub-component of the computed livelihood vulnerability index is the aggregate of four indicators like percentage of households received dwelling house under Indira Avas Yojana (IAY), percentage of households not having access to communication, percentage of households not associated with any organization like SHGs and percentage of households not associated with MGNREGA scheme. The vulnerability index of social network showed that female households (0.5676) are more vulnerable than male headed households (0.5078). It is recorded from the field survey that 48.48% female households do not have communication facilities while 38.46% for male headed households, 36.36% female households participated MGNREGA scheme while 48.72% for male headed households and 50.61% female households are not associated with the formation of SHGs while it was for 45.3% male headed households. These factors are responsible for female vulnerability in respect to social network.



Natural capital index is constituted by the aggregates of the percentage of households dependent on forest based energy for cooking and percentage of marginal and small farmers' households. The vulnerability indices of natural capital for female and male-headed households are 0.9245 and 0.9079 respectively (Table 1). On the basis of the index values it is revealed that the female-headed households are more vulnerable than male-headed households. It has been recorded from the field survey that about 90.91% female headed households are dependent on forest resources for cooking purposes while 88% of the male-headed households are dependent on forest resources for cooking. This finding showed that the high dependency of women on climate sensitive natural resource like forestry makes them more vulnerable than male headed households.

Water is one of the sub-components of LVI. It consists of three indicators like percentage of households not having regular drinking water, percentage of households who use natural water like ponds and dams etc. for drinking purposes and percentage of households who go at least one kilometer to fetch water. Aggregating these three indicators, the computed livelihood vulnerability indices of water for female households and male headed households are 0.7606 and 0.6532 respectively (Table 1). It has been revealed from field survey that 44.24% female headed households used ponds water for drinking purposes compared to 37.61% male headed households. It has also been reported from primary data that about 54.55% female households had to travel at least 1 km to fetch drinking water compared with 37.96% male headed households. On the other hands, 93.94% female households do not have regular drinking water supply compared with 81.2% male headed households. These findings explained that the female households are more vulnerable than male headed households in terms of water index.

Health, one of the sub-components of LVI, is constituted by three indicators like percentage of households who are suffering from chronic illness; percentage of households who are access to local health centre facilities and percentage of households do not have toilet facilities. The livelihood vulnerability indices of health for female and male headed households are found to be 0.4691 and 0.4479 respectively (Table 1). It is reported from the field survey that 67% female-headed households do not go for work on account of chronic illness compared to 61.54% male headed

households. Similarly, 82% female households do not have toilet facilities in their home than 70% male headed households. Unequal accessibility to health facility leads to vulnerability.

Climate also, one of the sub-components of LVI, is constituted by four indicators like percentage of households realized a fall in rainfall last 5 years, percentage of households perceived the occurrence of increased in drought last 5 years, percentage of households perceived the occurrence of storm increased last 5 years and percentage of households who did not receive any warning about natural disaster. The livelihood vulnerability indices of climate for female and male headed households are 0.5992 and 0.5618 respectively. This result shows that the female households are more vulnerable than male headed households.

The results of combined livelihood vulnerability indices (LVI\_IPCC) for female and male headed households along with t-values of the district of Purulia are presented in Table 3. Intergovernmental Panel on Climate Change (IPCC) defined vulnerability is the functions of contributory factors like adaptive capacity, sensitivity and exposure. Adaptive capacity comprises the weighted average of Socio Demographic Profile (SDP), Livelihood Strategies (LS), Food and Social Network (SN). The sensitivity index is determined by the weighted averages of Natural Capital, Water and Health while exposure index is determined by climate indicators. The study showed that the overall vulnerability indices for female and male headed households are found to be 0.572 and 0.4912 respectively (Table 3). On the basis of these values the result showed that the female households are more vulnerable than male headed households and their mean difference is also significant. The results of two sample t-test indicate that there exists a significant difference in female and male headed households in terms of sensitivity and adaptive capacity except exposure components of vulnerability (Table 3). The computed vulnerability indices for contributory factor of LVI\_IPCC for female headed and male headed households are shown in the gender vulnerability radar diagram in Figure (10). The comparative assessment of the vulnerability indices (LVI and IPCC) for female-headed and male-headed households is presented in Figure (11). From figure 11 it is found that the female households are more vulnerable than male headed households based on both measures of vulnerability assessment.



Table 3: LVI\_IPCC indices of gender by contributory factors

Contributory factor	Computed index for Female	Computed index for Male	t-value	P-value
Exposure	0.5992	0.5618	0.7459	0.4569
Sensitivity	0.7181	0.6697	1.9257	0.0561
Adaptive capacity	0.4556	0.3397	4.8132	0.000
Overall LVI_IPCC	0.572	0.4912	4.3212	0.000

Sources: Computed by author from field survey primary data

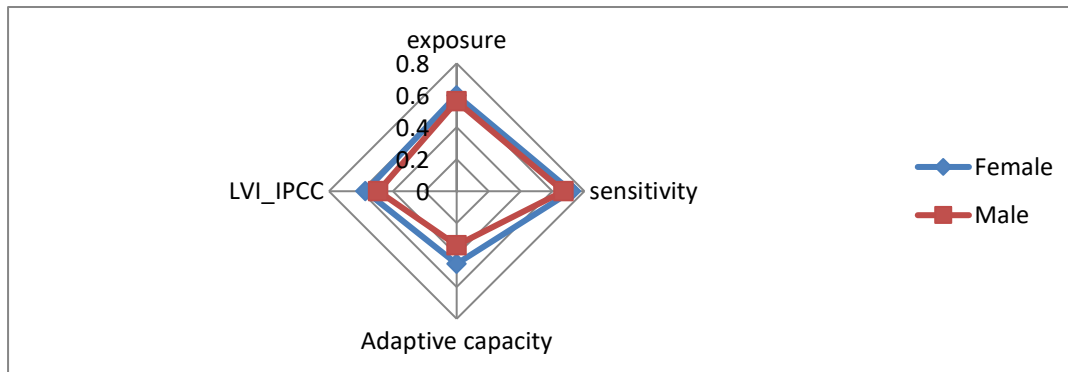


Figure 10 Gender wise LVI by LVI\_IPCC and its sub-components in the district of Purulia

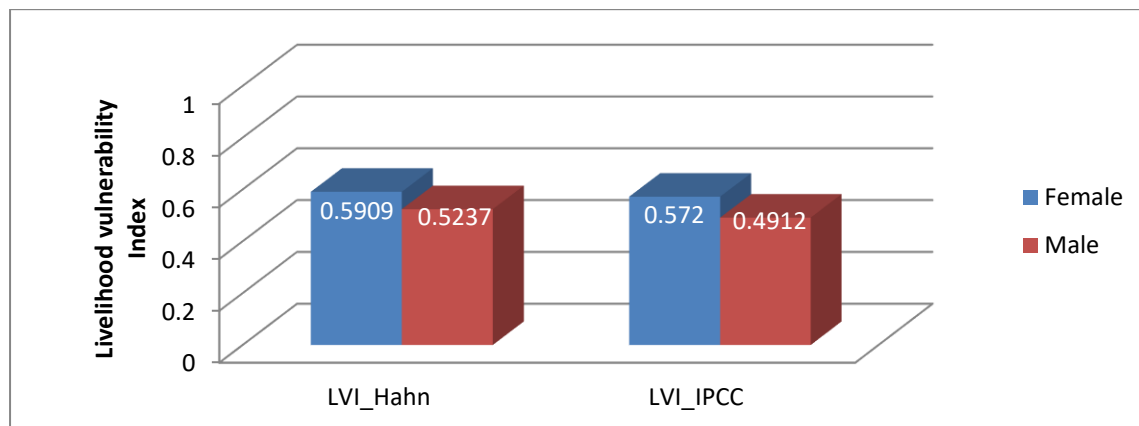


Figure 11 LVI and LVI\_IPCC for female and male in the district of Purulia

### 3.2 Results on Adaptation strategy

In order to cope with adverse effect of climate change the present paper identifies the gender-wise adaptation options. The adaptation options are livestock rearing, formation of Self Help Groups (SHGs), migration, diversification of livelihood and collection of non-timber forest products(NTFPs). The results of adaptation options by female and male headed households are presented in Table 4.

Table 4: Adaptation strategies by female and male headed households in Purulia district

Adaptation strategies	Percentage of Households	
	Female	Male
Livestock Rearing	72.73	65.81
Formation of self -help groups (SHGs)	39.39	54.70
Diversification of livelihood	12.12	16.24
Migration	30.30	22.22
Collection of non-timber forest products (NTFPs)	72.73	79.49

Sources: Computed by author from field survey primary data



Livestock rearing is one of the important adaptation strategies adapted by the female and male headed households (Table 4). Livestock rearing like cow, goat, hen, sheep and pigs is an important option for an additional income generation of the poor. The female households (72.73%) are dependent on livestock rearing to cope with adverse effect of climate change than male headed (65.81%). The result of livestock rearing as one of the adaptation strategies supports the results of Bravo-Baumann, 2000; Kechero, 2008; Njuki & Sanginga, 2013.

Formation of self help groups (SHGs) is the second most important adaptation strategy. The formation of SHGs is one of the climate risk reduction measures. Increased income from SHG helps them to mitigate climate risk. It is observed from Table 4 that the percentage of SHG members for male headed households (54.70%) is much higher compared to female headed households (39.39%).

Diversification of livelihood from climate sensitive sector to non-climate sensitive sectors is

another adaptation strategy (Table 4). About 16 % male headed households diversified their livelihood from climate sensitive sector to non-climate sector while 12% female-headed households diversified their livelihoods.

The seasonal migration is an alternative source of income during the lean period (between the two cropping seasons and between cropping and harvesting period). It is observed from Table 4 that the female migrated households and male migrated households are found to be 30.30% and 22.22% respectively.

Non-timber forest product (NTFPs) is another adaptation strategy. Non-timber forest product (NTFP) comprises food, fodder, sal leaves, fuel wood, mushroom, honey and leafy vegetables. It is reported that 80 percent male headed households are dependent on the collection of NTFPs in times of shortage of food in period of drought compared to 72.73 percent of female headed households (Table 4 and Figure12).

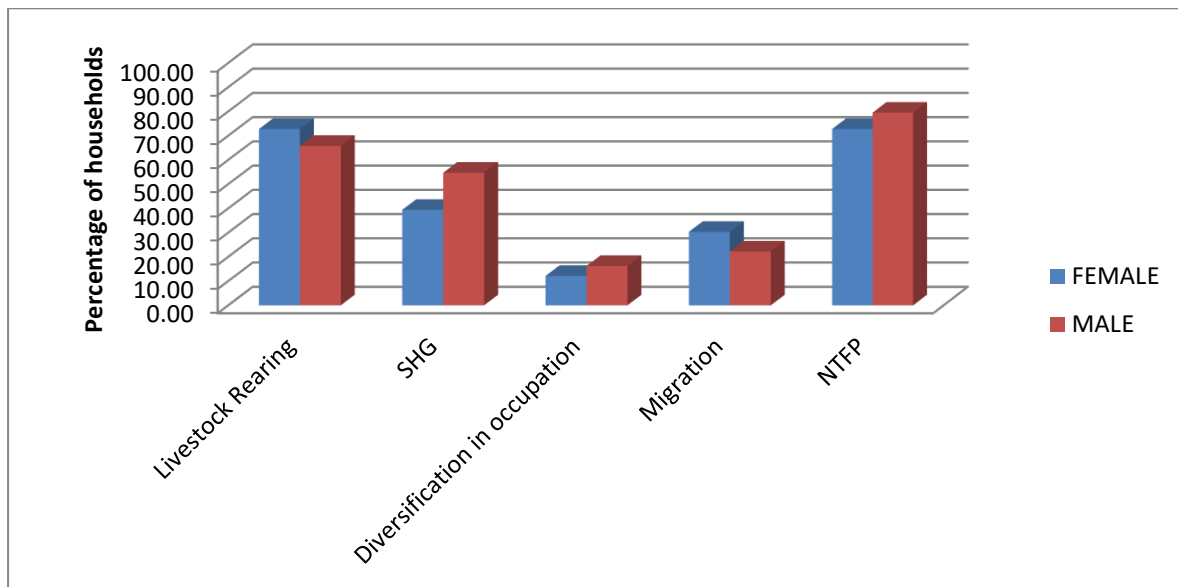


Figure 12 Gender-wise adaptation strategies in drought prone area of West Bengal

#### 4. Conclusions and policy suggestions

From the above analysis the following conclusions have been emerged.

First, the vulnerability indices for female and male headed households are observed as 0.5909 and 0.5237 respectively. In terms of modified LVI (LVI-IPCC) the vulnerability indices for female households and male headed households are found to be 0.572 and 0.4912 respectively. Both the findings showed that female headed households are more vulnerable than male headed households.

Second, the results of the paper revealed that the female households are significantly more vulnerable with respect to socio-demographic profile, livelihood strategies, social network, food, natural capital, health and water than male headed households. This makes female households are more sensitive to climate change and also more vulnerable in terms of adaptive capacity than male headed households. The results of vulnerability on gender support the results of vulnerability of Alhassan et al. 2018. Third, the paper has identified gender-wise adaptation strategies to reduce vulnerability to climate change such as the



collection of non-timber forest products, joining self-help group under microfinance program, livestock rearing, diversification of livelihoods and migration.

Fourth, paper has identified the adaptation options which are more important for male headed households like NTFPs, SHGs, and diversification of livelihoods. On the other hand, the adaptation options which are more important for female headed households are found to livestock rearing

and migration. The present paper suggests that women should be given more priority to empower and to access opportunities for income generating activities so that they can diversify their livelihoods to reduce the vulnerability.

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