Measurement of Vulnerability & Adaptation to climate change for Forest dependent communities: An Empirical study in Drought-prone area of West Bengal, India

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Abstract

The paper focuses on understanding and quantifying the vulnerability and livelihood security of forest dependent communities in West Bengal. The key goal of adaptation strategies is the reduction of vulnerability and to sustain and enhance the livelihoods of poor people. Forest as the vulnerable sector and constitute an integral part of social life of tribals and others living in and around forest areas and contribute substantially to the food supply and livelihood security of tribal populations in India. Besides, during droughts and in times of scarcity, the dependence on forests for food has found to increase. In India about 300 million rural poor are dependent on forest for livelihood and more than half of them are tribal and depend on minor forest products (non-timber forest products). The non-timber forest products comprise food, fuelwood, medicine; sal leaves, kendu leaves and mushrooms etc are very important contributors to the livelihood of the forest dependent people. The objectives of the paper are three fold. First, the paper attempts to measure quantitative vulnerability assessment for the forest dependent communities where drought hazards are prevalent. Second, the paper tries to estimate the determinants of adaptation to climate change using Heckman's two-step model. Lastly, the paper examines the role of forest policy and Governmental policy of India. This paper is an empirical study based on data collected through field survey. This study covers four villages- and Bandhgaba, Dhansimla, Rangakula, Khayarakura, both are scheduled tribe and scheduled caste based villages located in Sonamukhi forest area in the District of Bankura, one of the drought prone districts of West Bengal, consisting of 100 households in 2010. Socio-Economic vulnerability assessment for each village has been calculated. In this study, six factors i.e., sanitation, educational status; public health facility, housing condition, food sufficiency from agriculture and perception to climate change have been incorporated for socioeconomic vulnerability assessment of each village. Vulnerability indices have been calculated using Three Categorized Ranking Method (TCR)

assigning scores of 1 to 3, 1 being the least vulnerable. The paper has identified key vulnerabilities like education, health hygiene, and sanitation and food insufficiency.

In the Heckman's two-step process of adaptation the analysis considers people's perception that climate is changing and then responding to changes through adaptation. This paper has identified the household's adaptation strategies like migration; formation of Self-help Group (SHGs), accessibility of minor forest products and livestock rearing. The results of perception to climate change revealed that age of the household head; number of adult male and operational holdings have significant impact on the perception to climate change. Moreover, the analysis of factors affecting adaptation to climate change indicates that the age of the head of the households, maritial status, operational holdings, physical asset value, wage income, forestry income, temperature and family size have significant impact on adaptation to climate change. The Government of India has undertaken little policy action to reduce climate-related vulnerability particularly in the drought- prone regions of West Bengal. This paper has important policy implications for poverty reduction, livelihood, vulnerability and migration.

Key words: vulnerability, adaptation, Heckman's two-step process, self help groups, migration, non-timber forest products

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Introduction

Climate change and variability is not new, and many societies have adeptly coped with and adapted to climate variability and many other stressors during the past centuries (Nunn et al., 2007; Mertz et al., 2009a). Climate change is considered to be one of the major threats to sustainable development because of its effects on health, infrastructure, agriculture and food security, and forest ecosystem (IPCC, 2007a).The forest dwellers and adjacent farmers identified by Byron and Arnold (1999) are particularly at risk due to climate change. The impact of climate change on forest dependent communities has been documented in Bhutan (Tshering, 2003), Vietnam (Trieu, 2003), India (Sharma, 2003), China (Shougong et al., 2003), Malawi (Fisher 2004), Mozambique (Lynam et al., 2004), Ethiopia (Mamo et al., 2007) and West Java (Gunwan et al., 2004). The vulnerability of many communities in developing countries is immense and their capacity to adapt to future climate change impact is assumed to be very low (Huq et al., 2004; Mertz et al., 2009a).

Adaptation to climate change refers to adjustments in natural or human systems in response to actual or expected climatic effects. The adaptation process includes three essential stages (1) vulnerability assessment; 2) capacity building; and 3) implementation of adaptation measures.

Some studies indicate that farmers do perceive that climate is changing and adapt to reduce the negative impacts of climate change (David et al., 2007; Ishaya and Abaje, 2008; Mertz et al., 2009). Studies further show that the perception or awareness of climate change (Sampei and Aoyagi-Usui 2009; Akter and Bennett, 2009) and taking adaptive measures (Maddison, 2006; Hassan and Nhemachena, 2008) are influenced by different socio-economic and environmental factors.

An emerging literature on the institutional requirements for adaptation suggests that there is an important role for public policy in facilitating adaptation to climate change (Tompkins and Adger, 2005). This includes reducing vulnerability of people and infrastructure, providing information on risks for private and public investments and decision-making, and protecting public goods such as habitats, species and culturally important resources (Tompkins and Adger, 2005). In

addition, further literature sets out the case for international financial and technology transfers from countries with high greenhouse gas emissions to countries that are most vulnerable to present and future impacts, for use in adapting to the impacts of climate change (Simms et al., 2004; Baer, 2006; Dow et al., 2006;). Spittlehouse and Stewart (2003) presented an extensive list of adaptive actions proposed in the literature for forest protection, forest regeneration, silvicultural management, forest operations, non-timber resources, and park and wilderness area management. Microfinance is a tool that can reduce the vulnerability of the poor and the possibility of linking this tool to climate change adaptation is of considerable importance (Hammill et.al. 2008). A wide range of microfinance services is available to help poor individuals and households undertake ex ante risk management and *ex* post coping measures. For example, the Self Employed Women's Association (SEWA) in India offers housing loans to repair or replace roofs, reinforce walls, or rebuild houses to reduce vulnerability to extreme events such as floods, droughts and storms (Pantoja, 2002). Migration by the poor as a response to natural calamities and other shocks have been documented (Murthy, 1991; Mukherjee 2001). This migration is called distressed migration (Mukherjee, 2001).

In the Indian context we have some literature on the impact of climate change on the forest eco-system (Rupa Kumat at al., 2006, Gosain et al. 2006, Ravindranath et al. 2006, Unnikrishnan et al. 2006, Shukla, P.R et al., 2002) that predicts that either through direct effects due to changes in temperature, precipitation or CO_2 concentrations or indirect effects through changes in soils.

However, the most of the above studies fail to provide critical insights in terms of effective adaptation strategies at the micro or household level. Studies on the impact of climatic change (in particular rainfall and temperature) and climate-related adaptation measures on forest dependent people are very scanty in India. In addition, much of the early research work on adaptation focused on identifying potential impact of future climate change using General Circulation Models (GCMs). But the models proved to be extremely limited in telling us about regional impacts of climate change and therefore did not really provide a basis for catalyzing immediate and practical action on local level adaptation.

Given the backdrops, the objectives of the paper are three fold. First, the paper attempts to measure quantitative vulnerability assessment for the forest dependent communities where drought hazards are prevalent. Second, the paper tries to estimate the determinants of adaptation

to climate change using Heckman's two-step model. Lastly, the paper examines the role of forest policy and development policy of the Government of India and the role of institution to enhance income generating activities.

The paper is organized as follows. In section 1 analysis of climate change vulnerability assessment is presented. Section 2 discusses methodology and data. Section 3 utilizes socio-economic vulnerability assessment of four forest dependent villages in the drought prone district of West Bengal and adaptation options taken by households. Section 4 discusses the Heckman's two-step process of adaptation. Forest policy of the Government of India and the role played by large scale multi product societies (LAMPS) are in Section 5 and conclusions in Section 6.

Section 1 Analysis of climate change vulnerability according to IPCC

There are two ways of assessing vulnerability and determining appropriate adaptation options. One is hazards-based adaptation approach while other is vulnerability reduction- based adaptation approach. In the hazards-based adaptation approach, adaptation is carried out in response to the observed and experienced impacts of climate change on society (including ecosystems). These responses ensure that the vulnerability to the impacts is reduced. This in turn risk is reduced. With reduced risk, development can be more sustainable. In short, the process is given below:

Adaptation to climate change impacts → Vulnerability reduction → Development

On the other hand, vulnerability-based approach is referred to as "second-generation vulnerability assessments", gives explicit consideration to various non climatic determinants of vulnerability and adaptive capacity, including poverty, economic inequality, health, effectiveness of government institutions, literacy, and education levels. The primary advantage of this approach is that it allows for incorporating a range of both climatic and non climatic vulnerability factors into adaptation planning. In this view, development processes help reduce vulnerability to climate change. By reducing the vulnerability, impacts of climate hazards are also reduced, as there is less sensitivity and exposure to the hazards. This translates into a process of adaptation to climate change.

Climate-aware development → Vulnerability reduction → Impact reduction → Adaptation

Understanding the vulnerability of forest dependent people is a first step towards designing effective adaptation. Two main approaches to vulnerability assessments are generally applied to

social-ecological systems. One is impact-based approaches (or impact studies) and other is vulnerability-based approaches. Impact-based approaches start with assessing the potential impacts of climate change on forest or forest people under different climate scenarios. Vulnerability-based approaches start with assessing social sensitivity and adaptive capacity to respond to stresses and, if necessary, combine this information with impact studies (Kelly and Adger 2000). With vulnerability-based approaches, vulnerability is determined by the existing capacity rather than by any predicted future impacts (Ribot 2009). To facilitate adaptation processes for forest dependent people, vulnerability-based approaches seem more adequate than impact studies (Burton et al. 2002).

According to the conceptualization of IPCC, vulnerability to climate stimuli is a broader concept than potential impact of climate change as determined by climate impact assessments.

Vulnerability assessment is an extension of a climate change impact assessment. This assessment is discussed under two headings, viz. first generation vulnerability and second generation vulnerability. Figure 1 describes the main components of the first generation vulnerability assessment.

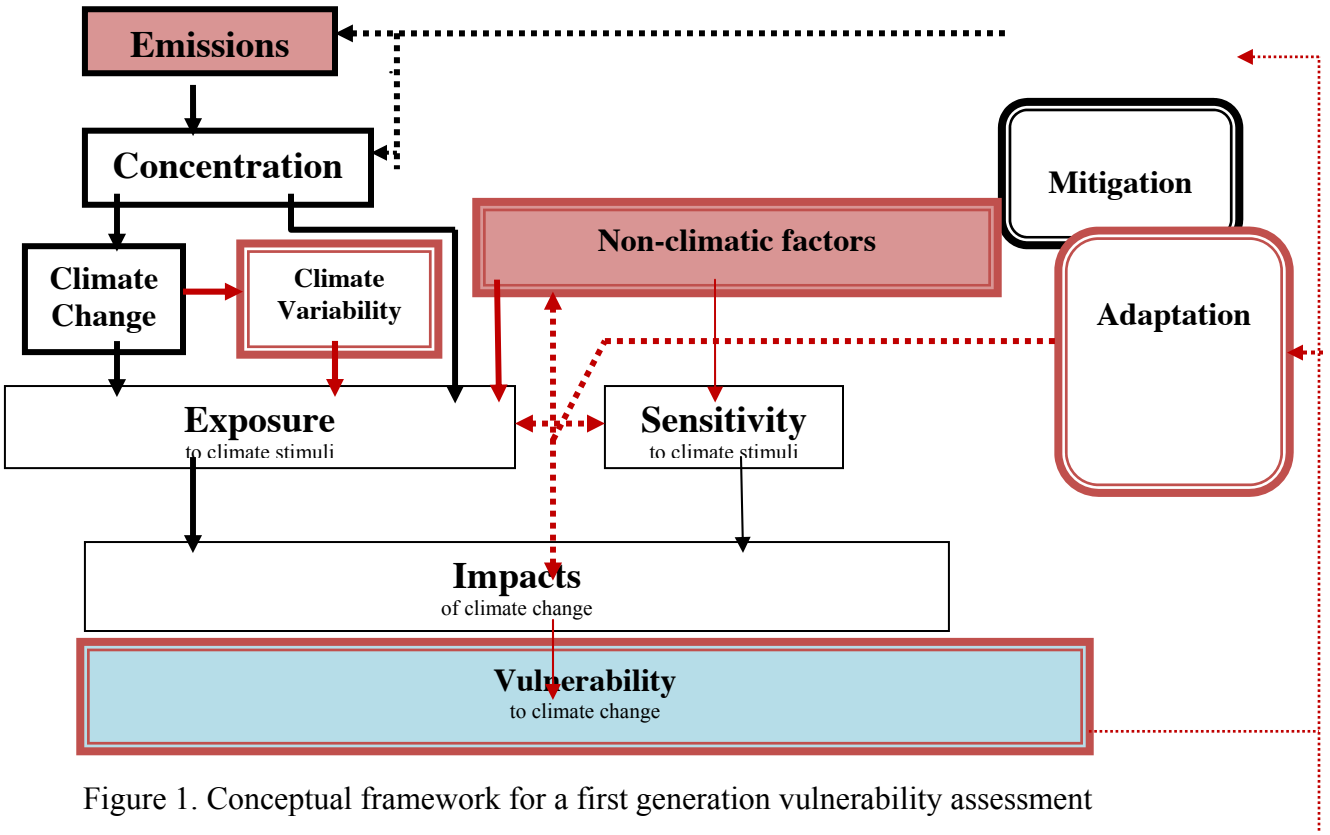


Figure 1. Conceptual framework for a first generation vulnerability assessment

Climate variability is a new component in the above diagram implying variations in the mean state and other statistics of the climate on all temporal a spatial scales beyond that of individual weather events. It is an important component of a system's exposure to climate stimuli. Global climate change will affect climate variability in terms of frequency, intensity and location of extreme events. Non-climatic factors consists a wide range of environmental, economic, social, demographic, technological and political factors. These factors affect both sensitivity and exposure to climate change stimuli.

Second generation vulnerability assessments determine realistically the vulnerability of certain systems or regions to climate changes, along with other stress factors. The following figure 2 describes the components of second generation vulnerability assessments. It adds two components, viz. 'Non-climatic drivers' and 'Adaptive Capacity' to the previous diagram.

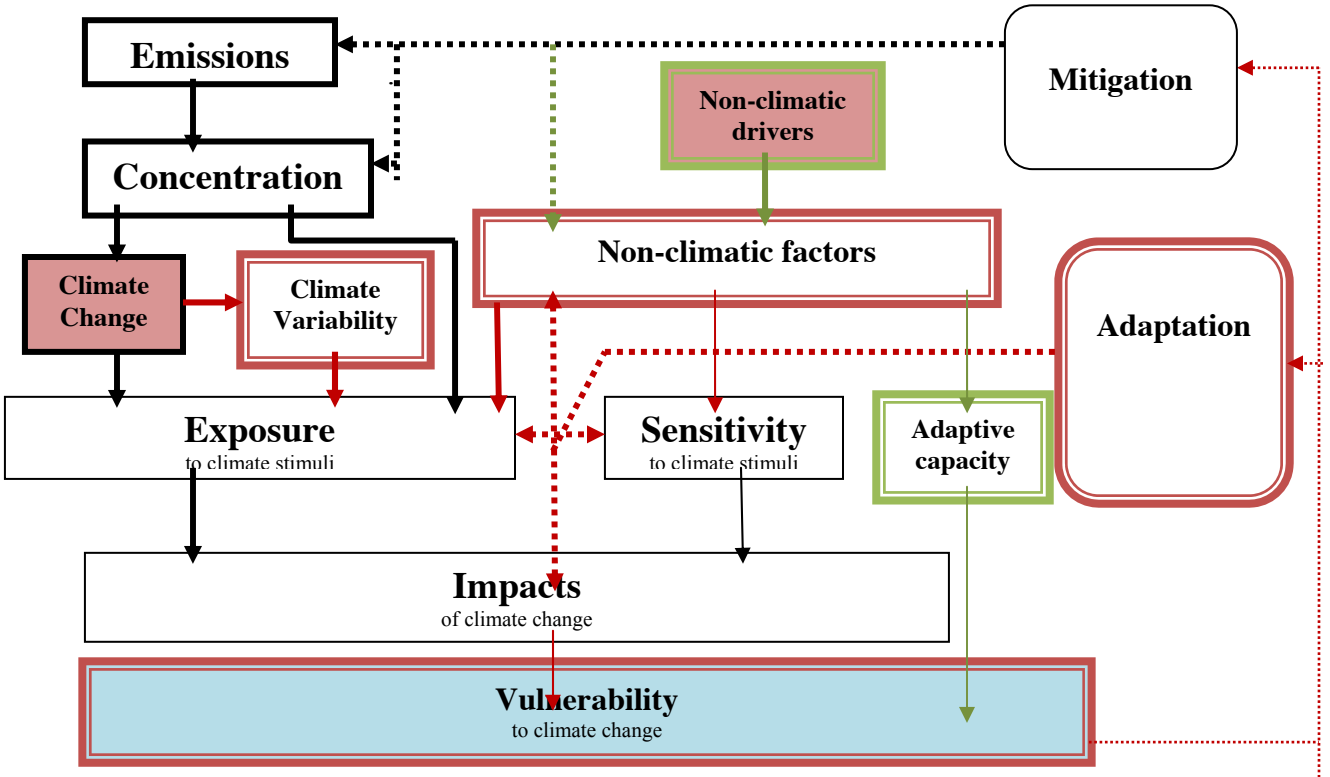


Figure 2. Conceptual framework for a second generation vulnerability assessment

The adaptive capacity of a system or society refers to its ability to modify its characteristics or behavior according to the changes to the external factors. According to figure 2, non-climatic factors determine adaptive capacity of a system or society. IPCC definition of adaptive capacity

does not segregate between social and natural system. However, Brooks (2002) classifies factors that determine adaptive capacity into hazard specific and generic factors, and into endogenous and exogenous factors. Generic determinants of adaptive capacity in social systems comprise such non-climatic factors as economic resources, technology, information and skills, infrastructure, institutions, and equity (Smit and Pilifosova, 2001; Yohe and Tol, 2002). Non-climatic drivers affect relevant non-climatic factors which in turn determine the sensitivity of a system to climate change. In this context globalization and urbanization are two non-climatic drivers and mitigation also influences non-climatic factors (Fussel & Klein 2006).

The main purpose of the adaptation policy assessment is to provide specific recommendations to planners and policy makers on the enhancement of adaptive capacity and the implementation of adaptation policies. According to Scheraga and Furlow (2001) decision-makers require very specific types of information in order to design and implement effective adaptive responses, and that uncertainties about future climate change and its impacts are a crucial issue in this context.

The following figure 3 shows the components of this final stage.

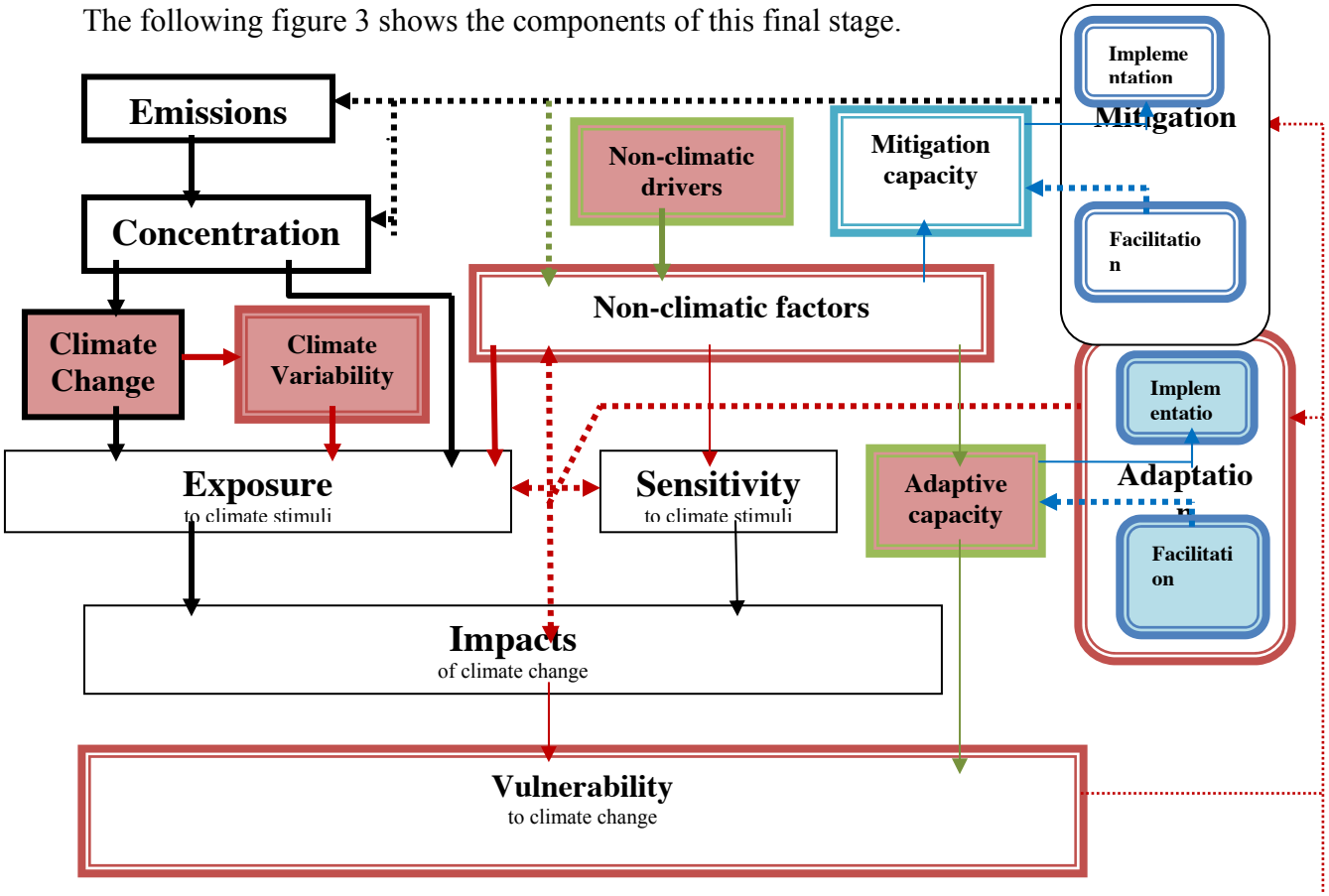


Figure 3. Conceptual framework for a second generation adaptation policy assessment

The above figure 3 distinguishes two types of adaptation activities, viz. facilitation and implementation. Facilitation refers to activities that enhance adaptive capacity such as scientific research, data collection, awareness raising, capacity building, and the establishment of institutions, information networks, and legal frameworks for action. Implementation refers to activities that actually avoid adverse climate impacts on a system by reducing its exposure or sensitivity to climatic hazards, or by moderating relevant non-climatic factors. The relationship between adaptive capacity and adaptation in the conceptual framework is two-fold. Adaptive capacity determines the feasibility of the implementation of adaptation, and it is itself influenced by measures that would be considered as facilitation of adaptation.

Section 2 Methodology and Data

Methodology

This study was conducted in four villages- Bandhgaba, Dhansimla, Rangakula, Khayarakura, both are tribal based villages located in Sonamukhi forest area in the District of Bankura, one of the drought prone districts of West Bengal, consisting of 100 households in 2010. 25 households from each village have been selected on the basis of random sampling. The field work combined interviews and discussions with the local people and interviews with local experts and school teachers and other knowledgeable elders in the village. A total of 100 structured household interviews were conducted. In most households the interviewees were mixed gender. Although women were in some cases formally considered the head of household, most often male members responded to the questions. In addition, data on socio-economic variables, like age, sex, education, land holdings, sources of credit, physical assets, livestock assets, income from various sources, public health facilities, adaptation measures like migration, non-timber forest products; self-help groups have been collected from the field survey. The socio-economic indicators and adaptation diagram of four villages are presented in the Appendix.

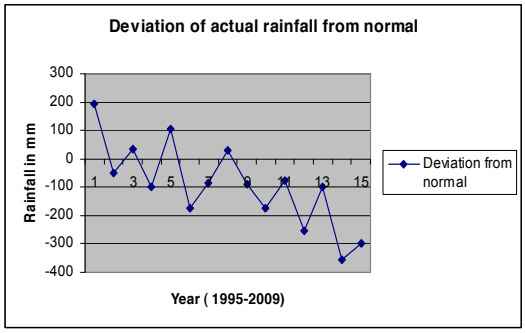
Basic Profile of the Drought prone district of Bankura

The socio-economic condition of the district of Bankura is shown in table 1. It is observed from table 1 that 71.1% of households use safe drinking water and 11.9% households have toilet facilities. On the other hand, the district has 27.7% electrified households and 79 per 1000 are under five mortality rate. The female literacy rate is 48.9%. Fifteen years' (1995-2009) average actual rainfall is 1285 mm but normal rainfall is 1378 mm. Fifteen years' (1995-2009) average maximum temperature is 44.36 degree Celsius and minimum temperature is 8.2 degree Celsius. Agro-climatically, the region mainly occupies red and laterite soil zone. The trend of rainfall over fifteen year is declining (see Fig.4). The trend in maximum and minimum temperature for the district of Bankura is on the rise (see Fig.5 and Fig.6).

Table 1: Socio-economic indicators of the district of Bankura in all India perspective

Indicators	%	Rank in India	Index value
% of households using safe drinking water	71.1	373	0.69878
% of households with toilet facility	11.9	538	0.07741
% of Electrified households	27.7	451	0.25508
Under –five mortality rate per 1000	79.0	122	0.83776
% of female literacy rate	49.8	341	0.40364

Source: International Institute for population sciences, India, 2006



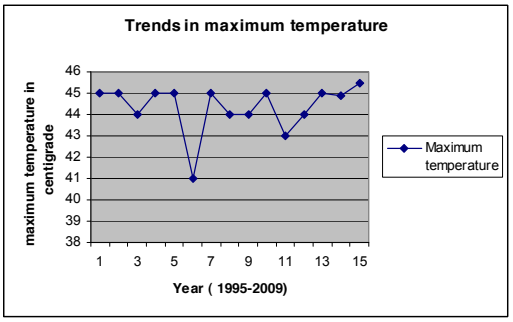


Figure 4 Trends in rainfall in the District of Bankura Figure 5 Trends in max temperature

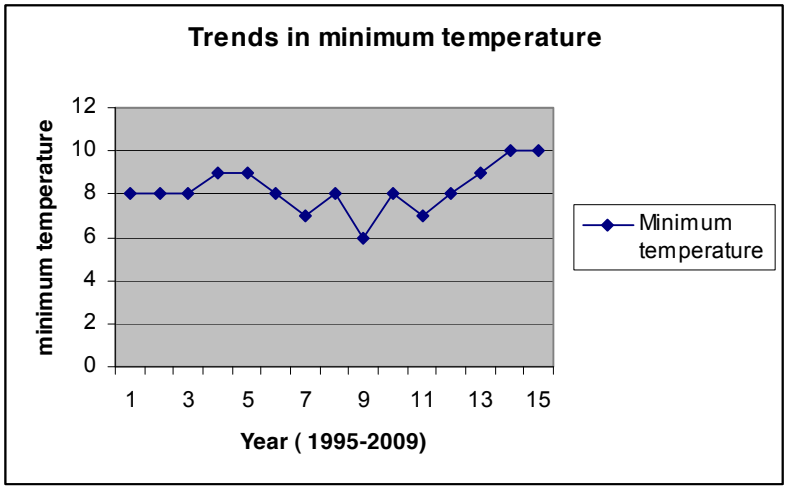


Figure 6 Trends in minimum temperature

Section 3: **Socio-economic Vulnerability and Adaptation**

For the study of socio-economic vulnerability, six factors like public health facilities, sanitation, educational status; live stock assets, food sufficiency from agriculture and awareness to climate change have been incorporated of each village. Vulnerability Indices have been calculated using Three Categorized Ranking Method (TCR) assigning scores of 1 to 3, 1 being the least vulnerable. The basic assumptions are the following;

First, lower level of educational facilities is associated with higher vulnerability
Second, lower level of sanitation is associated with higher vulnerability
Third, higher level of livestock assets is associated with lower vulnerability
Fourth, lower level of awareness to climate change is associated with higher vulnerability
Fifth, higher food insufficiency is associated with higher vulnerability
Sixth, higher health care facility is associated with lower vulnerability.

The socio-economic vulnerability was assessed which identified Bandhgava village as the highest vulnerable among four villages, because of its weak adaptive capacity including highest (92%) illiteracy, almost 100 % of village respondents had less than three months food sufficiency to sustain their livelihood and 100% of households do not have any health care facilities(Table 2).

Table 2 Vulnerability Assessment for four villages in West Bengal

Village	Education	Sanitation	Livestock assets	Climate awareness	Food sufficiency < 3 months	Health care facility	Combined	Vulnerability.
Bandhgaba	3	3	1	1	3	3	2.33	H
Dhansimla	3	2	1	1	3	1	1.84	L
Rangakula	2	3	1	1	2	3	2.00	M
Khairakura	2	3	1	1	2	3	2.00	M

Source: Field Survey

Note: H stands for high, M stands for medium and L stands for low.

Analysis of Adaptation options by the households

We asked the sample households as to how they adapted with the adverse effect of climate change. They answered the accessibility minor forest products (say non-timber forest products), water harvesting by means of digging and drilling for drinking water, distress migration, formation of self- help group (SHGs) in the micro finance program, livestock rearing are the possible adaptation options. These options are presented in Table 3. The distress migration is acute in the village Bandhgaba. It is also found from Table 3 that the adaptation capacity of the village Bandhgaba is low due to lack formation of SHGs and the occurrence of maximum migration in that village.

Table 3 Adaptation strategy by the households in the four villages of the District Bankura

Adaptation strategy	Bandhgaba Village (% of household responses (Yes)	Dhansimla Village (% of household responses (Yes)	Rangakula Village (% of household responses (Yes)	Khairakura Village (% of household responses (Yes)
Water harvesting in the form of digging and drilling for drinking water	100	20	100	100
Distress migration	76	56	4	8
Collection and sale of non-timber forest products	84	92	76	84
Formation of Self-Help Groups	4	8	24	24
Livestock rearing	92	88	92	92

Source: Field Survey

In terms of income generation, the optimum adaptation option is the collection of non-timber forest products in both villages (Table 4).

Table 4: Yearly Mean Income of the households from different sources (1$= Rs 44)

Name of the Villages	Mean annual income from agriculture (Rs)	Mean annual income from wage labour (Rs)	Mean annual income from non-timber forest products (Rs)	Mean annual income from livestock (Rs)	Mean annual income from others (Rs)	Mean annual total income (Rs)	
Bandgaba	1808	6213	15945	532	72	24571	
Dhansimla	1136	5337	11333	42	5712	23560	
Khairakura	728	5393	14184	2298	0	22604	
Rangakula	792	7162	13058	965	1920	23896	

Source: Field Survey

Section 4: Heckman's two-step process of adaptation

Empirical model

Adaptation to climate change is a two-stage process involving perception and adaptation stages. The first stage is whether the respondent perceived there was climate change or not, and the second stage is whether the respondent adapted to climate change conditional on the first stage that he/she had perceived climate change. Because the second stage of adaptation is a sub-sample of the first stage, it is likely that our second stage sub-sample is non-random and different from those who did not perceive climate change creating sample selection bias. We therefore used the well known maximum likelihood Heckman's two-step procedure (Heckman, 1976) to correct for this selectivity bias.

Heckman's sample selection model assumes that there exists an underlying relationship which consists of:

The latent equation given by:

$$Yj^* = Xj\,\beta + U_{1j} \qquad (1)$$

Such that we observe only the binary outcome given by the probit model as:

$$Yj^{\,probit} = (Yj^* > 0) \qquad (2)$$

The dependent variable is observed only if the observation *j* is observed in the selection equation:

$$Yj^{\,select} = (Zj\,\delta + U_{2j} > 0) \qquad (3)$$

$$U_1 \sim N(0,1)$$

$$U_2 \sim N(0,1)$$

$$\text{Corr}(U_1, U_2) = \rho$$

Where, x is a k- vector of explanatory variables which include different factors hypothesized to affect adaptation and z is an m vector of explanatory variables which include different factors hypothesized to affect perception; U_1 and U_2 are error terms. The first stage of the Heckman's sample selection model is the perceptions of changes in climate and this is the selection model (Equation 3). The second stage, which is the outcome model (Equation 1), is whether the people

adapted to climate change, conditional on the first stage that she/he perceived a change in climate.

When, standard probit techniques applied to equation (1) yield biased results. Thus, the Heckman probit provides consistent, asymptotically efficient estimates for all parameters in such models (Van de Ven and Van Praag, 1981). The Heckman probit selection model is employed to analyze the perception and adaptation to climate change for the forest dependent people in the drought prone area of West Bengal.

Model variables

The variables hypothesized as affecting perceptions and adaptations to changes in climatic conditions along with their respective dependent variables as indicated below (Table 5).

Dependent variables for the outcome equation

This study has identified the dependent variables for adaptations are migration, formation of Self-help Group (SHGs), accessibility of minor forest products (i.e., non-timber forest products) and livestock rearing. The adaptation measures reported by households might be profit driven rather than climate change. In terms of annual income generation we have chosen the accessibility of non-timber forest products as the dependent variable for the outcome model.

Explanatory variables for the outcome equation

As indicated in Table 5 below, the explanatory variables for this study include: age of the head of the households, maritial status, operational holdings, physical asset value, livestock asset value, farm income, wage income, forestry income, temperature and family size.

Dependent variable for the selection Equation

The analyses of the perception of the forest dependent communities to climate change indicate that most of them for this study are aware of the fact that temperature is increasing. To get information on their perceptions to climate change, people were asked two sets of questions. The first was asking people if they have observed any change on the amount of temperature over the 10 years. The second set consisted of asking the people if the numbers of hot have increased over the 10 years.

Explanatory variables for the Selection equation

For the selection equation, it is hypothesized that, education, age of head of the household, maritial status, adult male in the family, operational holdings, physical asset value, livestock asset value and family size influence the awareness of the people to climate change.

Results and discussion

The Heckman probit model was run and tested for its appropriateness over the standard probit model. The results indicated that the likelihood function of the Heckman probit model was significant (Wald $\chi^2 = 88.25$, with $p < 0.0000$) showing strong explanatory power of the model.

The results from regression indicated that most of the explanatory variables affected the probability of adaptation as expected. Variables that positively and significantly influenced the adaptation to climate change include the age of the household, farm income, forestry income, temperature and family size (Table 6).

Age positively influence the decision to adopt. Because the elder people have more experience and are better assess to the non-timber forest products than younger one, and hence a higher probability of adopting the practice.

Family size also influences decision to adapt. There is a possibility that the households with many family members may be forced to collect forest products to earn income to ease the consumption pressure imposed by a large family size.

Adaptation to climate change increases with increasing temperature. The increasing temperature has damaging effect on agriculture and raises the food insecurity. They respond to this through the adoption of different adaptation methods. This result supports the results of Kurukulasuriya and Mendelsohn 2006.

Income from forestry has significant and positive impact on adaptation. With higher income from forestry there is a possibility to enhance adaptation in order to minimize the risk of climate change. There is a negative association between operation holdings and adaptation. This means that the low holding farms have greater adaptation compared to the large holding farms. The negative association is also true in the case of physical asset value and wage income. These findings are contrary to the adaptation in the case of agricultural farmers. Variables say age, the numbers of adult male and operational holdings are found to be significant and positive impact on the perception of temperature increased (Table 6).

Table 5: Description of model variables for the Heckman probit model

Outcome Equation (Adaptation Model)			**Selection Equation (Perception Model)**		
Dependent variable			Dependent variable		
Description	People reported to have adapted (%)	People reported not adapted (%)	Description	People perceived change in temperature (%)	People not perceived change in temperature (%)
Accessibility of non-timber forest products	93	07	Perception of temperature increased	97	03
Independent variables			Independent variables		
Description	Mean	Standard deviation	Description	Mean	Standard deviation
Age (in years)	42.04	11.03065	Age(in years)	42.04	11.03065
Education (in years)	1.69	3.280475	Education (in years)	1.69	3.280475
Maritial status (Yes=1, No=0)	.96	.1969464	Maritial status (Yes=1, No=0)	.96	.1969464
Operational holdings (in acres)	.2804	.4572777	Adult male (in number)	1.74	.9808263
Physical asset value (in rupees)	2503	4361.11	Operational holdings (in acres)	.2804	.4572777
Livestock asset value(in rupees)	7034	7341.551	Physical asset value (in rupees)	2503	4361.11
Farm income(in rupees)	558	1565.033	Livestock asset value (in rupees)	7034	7341.551
Wage income(in rupees)	2012.2	959.6796			
Forestry income (in rupees)	9180.32	5358.226			
Family size(in number)	4.05	1.217507			
Temperature (in degree centigrade)	42.716	1.31769			

Source: Field survey

Table 6: Results of the Heckman probit selection model

	Estimated coefficients outcome equation : adaptation model (Accessibility of non-timber forest products)		Estimated coefficients selection equation: perception model (Perception of temperature increased)	
	Regression		Regression	
Explanatory variables	Coefficients	P-level	Coefficients	P-level
Age	.0071718*	.051	.0051122*	0.084
Education	-.0105356	.326	-.1283213	.340
Maritial status	-.3440105*	.061	3.397025	.587
Adult male			1.570946**	.031
Operational holdings	-.189778*	.075	1.54126***	.001
Physical asset value	-.0000219**	.017	.0002927	.665
Livestock asset value	-3.23e-06	.544	-.0000769	.179
Farm income	.0000336	.267		
Wage income	-.0000648*	.084		
Forestry income	.0000259***	.001		
Temperature	.0686993**	.014		
Family size	.0789276**	.031		
Cons	-2.237576	.066	-8.750143	.204
Total observations	100			
Censored observations	59			
Uncensored observations	41			
Wald chi square(zero slopes)	88.25***	0.000		

Note: *** significant at 1% level, ** significant at 5% level and * significant at 10% level
Source: Field survey

Section 5: Role of forest policy & Developmental policy of the Government of India

India is one of the first countries in the world to have begun scientific management of forests as early as in 1864. It formulated later National Forest Policies during 1894, 1952 and 1988 that have shown clear shift from thrust on agriculture to bringing the one third of geographical area of the country under forest and tree cover adopting people centered approach. Forest Policies include National Forest policy (1988), (2) Joint Forest Management (JFM, 1990).

India has implemented a very large Joint Forest Management (JFM) programme covering nearly 85,000 villages and more than 17 million hectares, 10 Mha of irrigated area under commercial agro-forestry, 18 Mha of rain fed area under subsistence agro forestry. Under JFM, the village community gets a greater access to a number of Non Timber Forest Products (NTFPs) and a share in timber revenue in return for greater responsibility for its protection from fire, grazing and illicit harvesting . India follows a strong and rapidly growing afforestation program. The afforestation process was accelerated by the enactment of the Forest Conservation Act of 1980, which aimed at stopping the clearing and degradation of forests through a strict, centralized control of the right to use forest land.

Some of the measures pursued so far to foster this include adaptation of forest conservation Act of 1980, preparation of environmental impact assessments for significant development projects, reduction of subsidies to forest –based industries beginning in the late 1970s, more concrete industry-farmer links, which have encouraged production of tree crops, decentralized political decision -making by empowering village – and district level authorities and biomass fuel conservation programs.

Developmental efforts by the Government of India help to build adaptive capacity through two levels of interventions. First, climate specific interventions such as drought proofing, rainwater harvesting, campaigning awareness about available drought-resistant varieties , better access to medium / long range weather forecasts, and possibly early warning networks. Secondly, to building up broader capacity through education, access to agricultural credit, health care, and infrastructure, etc. Micro-insurance and weather indexed insurance are providing services to marginalized section of the community in the developing countries including India.

For developing countries like India, adaptation requires assisting the vulnerable population during adverse climate conditions and empowering them to cope with climate risks in the long-run for better living. The Government of India implements a series of central and centrally sponsored schemes under different ministries and departments for achieving social and economic development. At present, while none of the schemes is explicitly referred to as Adaptation schemes; many contain elements (objectives and targets) that clearly relate to risks from climate variability. A recent initiative by the Department of International Development (DFID) and the World Bank in India seeks to identify how to integrate adaptation and risk reduction into their portfolio of programs. The programs include National Rural water and Sanitation Program,

National Elementary Education Program (Sarva Shiksa Abhiyan), National Reproductive and Child Health Program Phase II, Kolkata Urban Services for the Poor, West Bengal Support to Rural Decentralization, West Bengal Health Systems Development Initiatives, Andra Pradesh Rural Livelihoods Program, Madhya Pradesh Rural Livelihood Program, and Madhya Pradesh Urban Services for the Poor, and Western Orissa Rural Livelihood Project. Besides, the housing scheme, Indira Awas Yojana, the Food for Work Programme, and the rural road building scheme, Pradhan Mantri Grameen Sadak Yojana. These schemes have provided relief in the aftermath of floods and cyclones, enabled recovery and rebuilding, and helped improve connectivity selling produce and finding alternative employment. The key message is that Government policies, public-private partnerships, corporate and voluntary initiatives all can be meaningfully harnessed to build resilience to climate change.

Role of Institution: We mention here the role played by large scale multi product societies (LAMPS). The main activities of large scale multi product societies (LAMPS) in West Bengal for tribal development are as follows. First, procurement of Non Timber forest produces (NTFP). Top priority is given to non-timber forest products operation. The operation is confined to Bankura, Purulia and West Medinipur only and relates to kendu leaf and sal seeds collection. While the kendu leaves collection including pruning provides employment to the tribal people most of whom are women, for a period of 90 days(pruning-January & February, collection of kendu leaves-mid April to May),Sal seeds collection gives employment for 30 days from middle of May to end of June. On an average a collector (kendu leaves as well as Sal seeds earn an amount of Rs.98/- per day (Office, WBTDC, Kolkata).

Second is Sabai (Babui) grass cultivation. Sabai (Babui) grass cultivation in 1932 acres of fallow lands in Gopiballavpur-1 and Noyagram blocks in the Jhargram subdivision of West Medinipur taken up. Being a drought tolerant plant, it requires no irrigation facilities. The produce has got a shape and ready market. The land belongs to 1493 beneficiaries. During the harvesting and post harvesting processing periods the scheme will be generating huge number of man days.

Third is the implementation of Adibasi Mahila Shashaktikaran Yojana (AMSY)) schemes. AMSY is a micro credit project, implemented by LAMPS since 2003-2004 for empowering the poor tribal woman, offering loans as well as subsidy facilities on easy terms for poverty alleviation and generating self employment. The maximum project cost involved is Rs.50, 000/- with the provision for subsidy upto 50 percent, subject to a maximum of Rs.10,000/-.The loan is

granted at an interest rate of only 3%. The AMSY covers schemes like sal leaf plate making, grocery, paddy husking, goatery, piggery, house dairy, and various such schemes suitable and cost effective for the tribals. Technical trainings are also provided facilitate proper implementation of the projects. 21670 families have been brought under AMSY during the period from 2003-04 to 2009-10 involving the total project cost of Rs. 43.5 crores.

Fourth is the establishment of Village Gramin bank. The concept of Gramin bank came into being a view to safeguard the poor tribal people against starvation during any natural calamity or lean season where they do not have any earning opportunity and hence no income to obtain even their daily requirement. Such people in need of food may borrow food from their village gramin bank set up within the locality and again repay back when they start earning .Each Gramin bank caters to the need of 30-40 tribal families .One quintal of food grain is allotted per family as a one time grant. So far we are having 955 such grain banks operating under LAMPS throughout West Bengal.

Section 6 Conclusions

The paper has made an attempt to quantitative assessment of vulnerability to climate change and adaptation action taken by the households in the drought prone area of West Bengal. Socio-economic vulnerability assessment has been used to measure vulnerability. In terms of the socio-economic vulnerability, the village Bandhgava has been identified as the highest vulnerable among four villages. The key vulnerabilities are identified as education, health hygiene and food insufficiency. This paper has also identified the household's adaptation options like migration; formation of Self-help Group (SHGs), water harvesting and accessibility of non-timber forest products and livestock rearing. The results of perception to climate change revealed that age of the household head; number of adult male and operational holdings have significant impact on the perception to climate change. Moreover, the analysis of factors affecting adaptation to climate change indicates that the age of the head of the households, maritial status, operational holdings, physical asset value, forestry income, temperature and family size have significant impact on adaptation to climate change. The Joint forest management and the LAMPS have limited role for the development of forest dependent people in West Bengal. This paper has important policy implications for poverty reduction, livelihood, vulnerability and migration.

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Appendix

Socio-economic indicators of the households for four villages

Table 7 Distribution of households by age

Age(in years)	Bandhgaba	Dhansimla	Khairakure	Rangakula
≤30	4(16%)	6(24%)	5(20%)	5(20%)
31-40	11(44%)	6(24%)	5(20%)	9(36%)
41-50	7(28%)	8(32%)	7(28%)	9(36%)
51-60	1(4%)	5(20%)	7(28%)	1(4%)
Above60	2(8%)	-	1(4%)	1(4%)
Total	25(100%)	25(100%)	25(100%)	25(100%)

Source: Field Survey

Table 8 Distribution of households by family size

Family size	Bandhgaba	Dhansimla	Khairakure	Rangakula
Male	39(37.86%)	36(37.89%)	55(52.38%)	44(43.13%)
Female	38(36.80%)	44(46.33%)	35(33.33%)	40(39.21%)
Children	26(25.34%)	15(15.78%)	15(14.29%)	18(17.66%)
Total	103(100%)	95(100%)	103(100%)	102(100%)

Source: Field Survey

Table 9 Distribution of households by land holdings

Landholding(in acre)	Bandhgaba	Dhansimla	Khairakure	Rangakula
Landless	17(68%)	18(72%)	9(36%)	14(56%)
≤2	8(32%)	7(28%)	16(64%)	11(44%)
Total	25(100%)	25(100%)	25(100%)	25(100%)

Source: Field Survey

Table 10 Distribution of households by sex

Sex	Bandhgaba	Dhansimla	Khairakure	Rangakula
Male	21(84%)	19(76%)	19(76%)	22(88%)
Female	4(16%)	6(24%)	6(24%)	3(12%)
Total	25(100%)	25(100%)	25(100%)	25(100%)

Source: Field Survey

Table 11 Distribution of households by electricity facilities

Electricity facility	Bandhgaba	Dhansimla	Khairakure	Rangakula
Have	17(68%)	0(0%)	0(0%)	5(20%)
Haven't	8(32%)	25(100%)	25(100%)	20(80%)
Total	25(100%)	25(100%)	25(100%)	25(100%)

Source: Field Survey

Table 12 Distribution of households by housing status

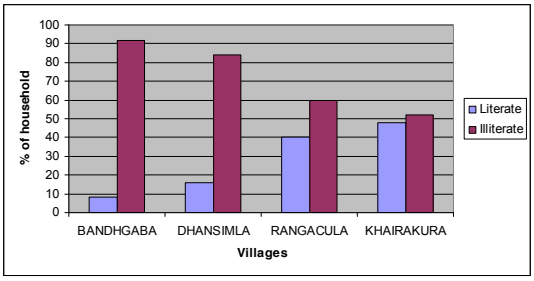
Housing status	Bandhgaba	Dhansimla	Khairakure	Rangakula
Mud	25(100%)	24(96%)	25(100%)	23(92%)
Pacca	0(0%)	1(4%)	0(0%)	0(0%)
Tiles	0(0%)	0(0%)	0(0%)	2(8%)
Total	25(100%)	25(100%)	25(100%)	25(100%)

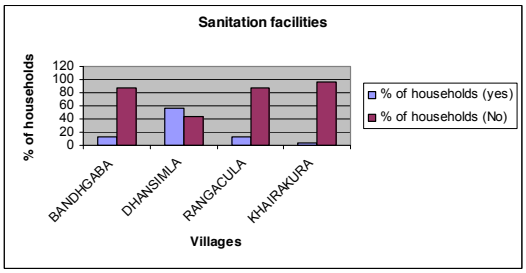
Source: Field Survey

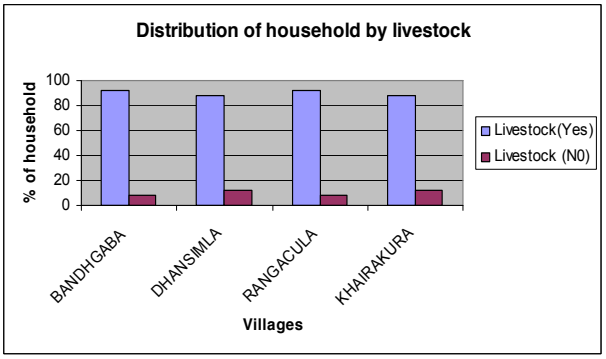
Table 13 Distribution of households by assets holding

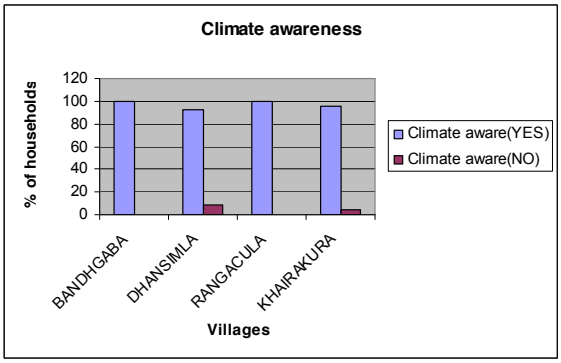
Assets	Bandhgaba	Dhansimla	Rangakula	Khairakure
Physical Assets	18(72%)	17(68%)	24(96%)	22(88%)
Livestock Assets	23(92%)	22(88%)	23(92%)	23(92%)
Land Assets	8(32%)	7(28%)	11(44%)	16(64%)

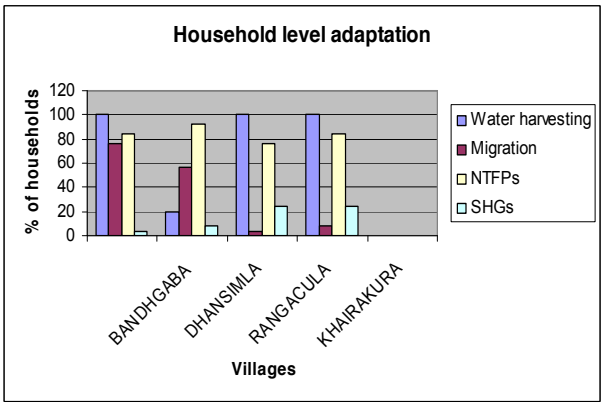
Source: Field Survey

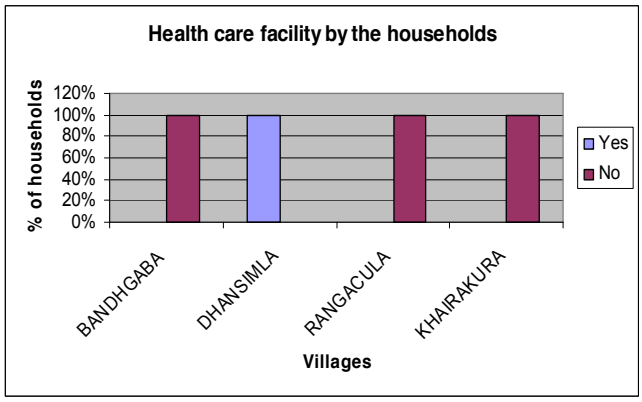

% of household
Literate
Illiterate
BANDHGABA
DHANSIMLA
RANGACULA
KHAIRAKURA
Villages


Sanitation facilities
% of households
% of households (yes)
% of households (No)
BANDHGABA
DHANSIMLA
RANGACULA
KHAIRAKURA
Villages


Distribution of household by livestock
% of household
Livestock(Yes)
Livestock (N0)
BANDHGABA
DHANSIMLA
RANGACULA
KHAIRAKURA
Villages


Climate awareness
% of households
Climate aware(YES)
Climate aware(NO)
BANDHGABA
DHANSIMLA
RANGACULA
KHAIRAKURA
Villages


Household level adaptation
% of households
Water harvesting
Migration
NTFPs
SHGs
BANDHGABA
DHANSIMLA
RANGACULA
KHAIRAKURA
Villages


Health care facility by the households
% of households
Yes
No
BANDHGABA
DHANSIMLA
RANGACULA
KHAIRAKURA
Villages