UNDERSTANDING THE VULNERABILITY OF RURAL LIVELIHOODS OF EAST AND SOUTH SIKKIM ACROSS THE DIFFERENT SEASONS

Major Project Thesis

Submitted by

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For the partial fulfillment of the

Degree of Master of Science in
CLIMATE SCIENCE AND POLICY

Submitted to
Department of Natural Resources
TERI University

May 2015

DECLARATION

This is to certify that the work embodied in this thesis "UNDERSTANDING THE VULNERABILITY OF THE RURAL LIVELIHOODS OF EAST AND SOUTH SIKKIM ACROSS THE DIFFERENT SEASONS" is an original work carried out by me and has not been submitted anywhere else for the award of any degree.

I certify that all sources of information and data are fully acknowledged in the project thesis.

VISHAKA GULATI

Date:

CERTIFICATE

This is to certify that VISHAKA GULATI has carried out her major project in partial fulfillment of the requirement for the degree of Master of Science in CLIMATE SCIENCE AND POLICY on the topic "UNDERSTANDING THE VULNERABILITY OF THE RURAL LIVELIHOODS OF EAST AND SOUTH SIKKIM ACROSS THE DIFFERENT SEASONS" during January 2015 to May 2015. The project was carried out at the THE ENERGY AND RESOURCES INSTITUTE.

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List of Abbreviations

UNFCCC: United Nations Framework Convention on Climate Change

SAPCC: Sikkim Action Plan on Climate Change

KCC: Kisan Credit Card

SWOT: Strengths, Weaknesses, Opportunities and Threats

MoDoNER: Ministry of Development of North Eastern Region

ICAR: Indian Council of Agricultural Research

ATMA: Agricultural Technology and Management Agency

BDO: Block Development Office

RMDD: Rural Management and Development Department

NABARD: National Bank for Agriculture and Rural Development

NYK: Nehru Yuva Kendra

NGO: Non-governmental Organisation

SHG: Self Help Group

PRA: Participatory Rural Appraisal

FGD: Focus Group Discussion

KII: Key Informant Interview

SSI: Semi-Structured Interviews

GPU: Gram Panchayat Unit

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Abstract

There is a clear indication through various studies that mountain areas, especially those situated in the Northern Hemisphere are among the ecosystems are expected to be most vulnerable to climate change. The variability in the climatic factors impacts almost every other aspect of the environment and human enterprise including biodiversity, hydrology and livelihood. The local communities in the study area have already started coping with the changes and variability in the climate using their traditional skill sets and knowledge, as well as with the help from various governmental and non-governmental institutes present in the region. However, in this region not many studies have been carried out to assess the impact of environmental change and variability on the livelihoods of the rural communities. In this study, Participatory Rural Appraisal (PRA) tools like transect walks, focus group discussions (FGDs), semi structured interviews (SSIs) etc. were used to understand the effect of climate variability and change on the major livelihood activities of the local communities. The study shows that the vulnerability of livelihoods does not remain same throughout the year but varies seasonally. Using the same PRA tools, institutional mapping was carried out in both the districts to identify the major governmental and non-governmental institutions helping the people in adapting to the changes. SWOT analysis for the institutional capacity in the region reveals that a considerable number of government institutes such as agriculture, horticulture, tourism and, RMD departments and few Non-governmental organisations (NGOs) are quite active in both the regions and are helping people in adapting to the changes.

Keywords: *climate change, Participatory Rural Appraisal, SWOT, adaptation strategies, Sikkim*

1. Introduction

Mountain ecosystems are amongst the most fragile environments on the earth and are "characterised by a high degree of poverty, fragility, marginalization and low accessibility" (Macchi et al., 2009). They are a rich source of biodiversity and also providers of many ecosystems goods and services. Major rivers in the world originate from the mountains and play a very important role in providing water to the communities living downstream. People living in the mountains are highly dependent on natural resources for their basic needs as well as livelihood and are comparatively more exposed to extreme events thereby making them even more vulnerable to the changing climate. Changes related to global warming can be seen in the form of increasing temperatures at higher altitudes, erratic rainfall patterns, retreating glaciers and thawing of the permafrost. These changes can affect not only the mountain communities but also those living downstream. Climate change acts as an additional stress to the problem of increasing pressures on natural resources like water, land, energy etc. because of the growing population and socio-economic development and also further limits their capacity to adapt to the changes. But highly inaccessible landscapes, scattered settlements and poor infrastructure act as a hindrance to carry out the research to study how the changes are affecting the mountain communities, how their livelihood is being affected. This is the case with the entire Hind Kush-Himalayas which are situated in the developing and least developed countries of the world. Nevertheless not much research has been carried out to assess the impacts of the changing climate on the livelihoods of the people or how the people perceive these changes and to what extent are the people capable of coping up to these changes.

Sikkim is a small hilly state is situated in the eastern Himalayas and since it is a part of inner ranges of the Himalayan Mountains, there are no open valleys and plains and the altitude of the terrain varies from 300 m to 8598 m above mean sea level (Tambe et al., 2012). Total population of Sikkim located in the 4 districts of the state is 0.61 million out of which rural population accounts for 0.46 million, with the rest 0.15 million being the urban population (Tambe et al., 2012). Also according to the 2011 census, the rural population decreased by 14% in the past decade (Tambe et al., 2012). A state level study for analysing climate change trends (1951-2010) in India showed significant increasing trends in

Sikkim's temperature. Among all the Indian states, increase in mean annual temperature was found maximum for Sikkim (+0.05◦ C per year) (L S Rathore, 2013) (L S Rathore, 2013). As far as the rainfall patterns are considered a considerable variation has been observed in that also. According to the rainfall patterns between 1983 and 2009, a decrease of 250 mm was observed in the annual rainfall of the state (Sikkim SAPCC, 2011). A marked decline has also been observed in winter rainfall over the past few years. As a result of which winters are becoming progressively drier and warmer. For e.g. the winter of 2008-2009 was one of the driest winters experienced by the people of Sikkim (Sikkim SAPCC, 2011). The present study aims to understand the impacts of the climate variability and change on the livelihood activities of the people living the rural areas of South and East Sikkim, how they perceive these changes and what are the adaptation strategies being adopted by them to cope up with these changes. It is necessary to identify the impacts of the changes, the vulnerable groups, the underlying reasons behind their vulnerability and also their adaptation measure to cope up with the changes in order to plan the future adaptation measures and policies effectively and making them resilient to future changes in the climate.

Climate change adaptation basically means "adjustment of a system moderate the impacts of climate change to take advantages of new opportunities or to cope with the consequences" (Macchi et al., 2009). For the adaptation mechanisms to be effective it is important to have premeditated and effective co-ordination between the active institutes and the policies implemented by the government otherwise the impacts of the climate change can aggravate if both don't go hand in hand. This study also aims to spot light on the active institutions in the region which are helping people in adapting to these changes by ensuring the sustainability of their livelihoods since very little is known about the impacts of these changes on the livelihoods of the mountain communities, how they perceive and adapt those changes. This Institutional Capacity analysis helps in identifying the key institutes whether governmental or Non-Governmental organisations which would help people in adapting to the changes. It is very important that such institutes should be approachable and active and also should consider the needs and the opinions of the stakeholders in decision making.

2. Background and Rationale

2.1 Climate Variability and Changes

Climate change impacts according to United Nations Framework Convention on Climate Change (UNFCCC) means, "*changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health welfare"*.

Altitude variations across the Sikkim landscape play a major role in governing the climatic and weather conditions of the region. It is necessary to have a continuous long term data (spanning more than 30 years at least) to evaluate variability and change in climatic trends. As far as Sikkim is considered, continuous and reliable data is available only for two stations i.e. Gangtok and Tadong (Sikkim SAPCC, 2011).

A study analysed that the mean annul temperature in Sikkim rose by 0.05 ˚C per year which is the highest among all the states. Moreover it was for Sikkim again that the rise in annual mean minimum temperature was the highest (+0.07 ˚C per year) (L S Rathore, 2013). According to Indian Meteorological Department, Sikkim, 2009 was the warmest year recorded in the century. The variation in rainfall pattern is quite high both in terms of frequency and intensity. According to the Sikkim SAPCC (2011), a decrease of 250 mm was observed in the rainfall between 1983 and 2009.

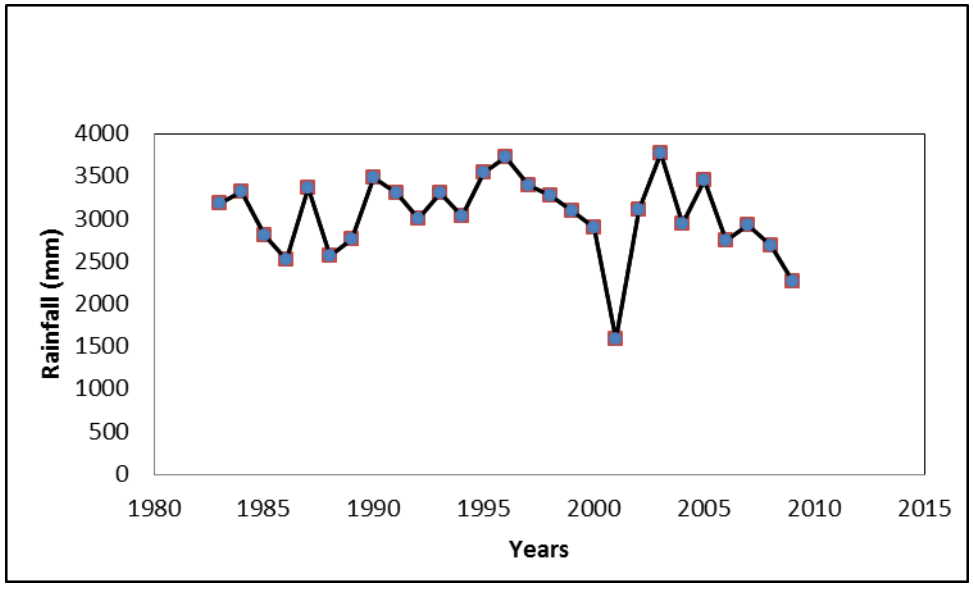

Figure 1: Rainfall trends of Sikkim (*Source:* Sikkim SAPCC, 2011)

From the Figure 1 it can be seen that an increase in the annual rainfall of Sikkim was recorded for a while but it has been continuously decreasing since the past few years. (Sikkim SAPCC, 2011).

Winter rainfall in Sikkim has also decreased remarkably because of which the winters have become much warmer and drier. During 2008 and 2009, the state experienced one of the driest winters ever. Also during 1951-2010 increase in the winter mean minimum temperature was highest for Sikkim among all the states (+0.08 $^{\circ}$C per year) (L S Rathore, 2013).

District level studies show that as compared to North and East districts, South and West districts are more vulnerable to climate change. Certain blocks like Jorethang, Sikkip, Melli, Namchi, Soreng and Kaluk of West and South districts are extremely vulnerable to the climate change and variability (Tambe et al., 2011).

Hence it is very important to gain better understanding about how the people in Sikkim are affected by the changes and variability in the climatic variables and their understanding of such changes. Further it is also important to understand how the communities are adapting to such changes. Climate change is not a new phenomenon and mountain communities have developed their adaptation strategies but the augmented pace of climatic and socio-economic changes may exceed their capacity to adapt. Hence it becomes imperative to get a better understanding as to what measures could be taken to improve their resilience to the changing climate.

2.2 Current Scenario

2.2.1 Water

People in mid-hills of Sikkim are entirely dependent on springs and streams to meet their water demands. With erratic rainfall pattern and reduced discharge from the springs (*dhara*) and streams (*kholas*), majority of the people living in mid-hills are now facing the issue of water shortage.

Approximately 80% of the rural population in Sikkim is dependent on natural springs not only for drinking but for agricultural purposes as well (Sharma et al., 2013). Certain blocks in Sikkim are drought prone as they fall in the rain shadow areas of Darjeeling hills. Since the blocks like Melli, Kaluk, Namchi, Duga,

Khamdong Jorethang, Soreng, lie in rain shadow areas in lower belt of South, West and East districts, the effects of the reduced discharge from the springs and streams is felt even more in these regions. Figure 2 shows the difference in discharge values of springs between drought prone and other regions of Sikkim.

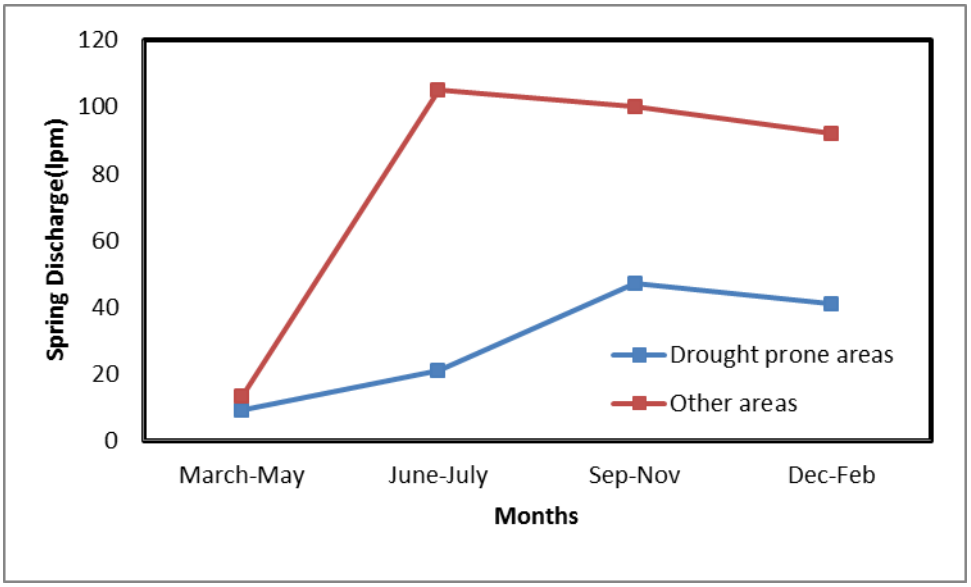

Figure 2: Hydrograph showing the difference in discharge from springs in drought prone and other regions of Sikkim. (*Source:* Tambe et al., 2013)

It is a growing perception among the people that since the past few years, water supply from springs and streams reduces drastically during the lean season. According to an analysis, the mean discharge from springs during monsoons is around 42 litres per minute which reduces to 8 litres per minute during springs **(Tambe et al., 2013)**. In the Mid-Hills of Sikkim, the main source of water supply is through the private/government pipelines from the nearby springs and streams. In the lean period due to the decreased discharge from the source, people are facing the issue of severe water shortage. The terrain of the state does not allow the construction of canals and farmers are dependent either on rainwater or they have their own pipelines connected to the source for the irrigation water supply

Erratic and more intense rainfall, longer winter droughts, increase in developmental activities and population, soil erosion, decrease in forested land leading to poor seepage of rainwater have a combined impact on ground water recharge.

2.2.2 Agriculture

Agricultural sector is highly sensitive to changes in climatic conditions and it is the main source of livelihood for people living in mid-hills of Sikkim. Hence it becomes important to study the effect of climate change on this sector as a large part of the population depends on it. Farming system in the mid hills of the basins includes agriculture, horticulture and livestock rearing. Generally in this region, wheat, mustard, maize, ginger, soybean, oranges, legumes, peas, potatoes are grown. Cash crops like cardamom is also grown under forest cover in certain regions.

More than 64% of the population of Sikkim is dependent on agriculture for their income and it accounts for 17% state GDP. Around 69% of the people are engaged in agriculture directly or indirectly (Sikkim SAPCC, 2011).

The changing climatic variables i.e. rise in temperature and erratic rainfall patters adversely affects the crop productivity. A marked decline in productivity of certain crops has been observed because of increasing incidences of infestation by various pests and diseases with changing climate. For e.g. there has been a marked decline in the productivity of various crops like Cardamom (viral diseases like Chirkey, Furkey), Ginger, Mandarin orange (citrus dieback, red rust, colonisation of ants in twigs and roots etc.) etc. (Kumar, 2012). Increase in rainfall intensity results in high runoff and less infiltration which affects the soil moisture and nutrient content thereby affecting the productivity. Winters are becoming drier and warmer as a result of which wheat productivity is also decreasing (Sikkim SAPCC, 2011).

2.2.3 Health

Health has always been a cause of concern in hilly areas due to the irascibility issue. Villages are situated in far distances with limited or no road connectivity. Over the past few years, the status of health and sanitation has improved greatly in the mid hills. Along with the government health institutions many local NGOs are also coming up to help in improving the health conditions of the people.

From having only four district hospitals along with the Central Referral Hospital at Gangtok in 1979, Sikkim at present has completed the national standard of "1 primary health centre for 20,000 people and 1 Primary Health Sub-Centre (PHSC) for 3,000 people" (Lama, 2001). Though Sikkim has achieved this

national standard, but having 1 PHSC for 3000 people is not enough in mountainous terrain.

According to the Annual Report by Health & Family Welfare Department, Govt. of Sikkim (2008-2009), the district wise infrastructure of various health Institutions in Sikkim is shown in (Table 1).

Table 1: Number of health institutes in Sikkim as of 2008-09

Health Institutions	East	West	North	South	State
State Referral Hospital/ STNM Hospital	1	-	-	-	1
Community Health Centre	1	1	1	1	4
Primary Health Centre	8	7	3	6	24
Central Referral Hospital (Manipal Tadong Private)	1	-	-	-	1
District Tuberculosis Centre, Namchi, South Sikkim	-	-	-	1	1

(Source: State profile of Sikkim, 2010-2011)

Against the initial phase of the 1970s, when these PHCs lacked doctors and nurses, at present the situation has greatly improved. Out of the total 174 registered doctors and 160 staff nurses, "East district alone has 107 registered doctors and 125 nurses. The North, South and West districts have 16, 31 and 20 doctors and 10, 15 and 10 nurses respectively" (Choudhury, 2010).

According to State Human Development Report lack of sanitation, goitre, tuberculosis and alcoholism are still a major health issue in the state. Also recurring malaria and new problems like HIV/AIDS are also coming up (Lama, 2001).

Since the past few years status of health institutions has improved greatly although proper medical assistance at some places is still missing. Certain diseases like tuberculosis or goitre which are still prevalent in Sikkim were not reported from the study areas but other diseases like kidney stone, diarrhoea, jaundice etc. have been reported.

2.2.4 Urban/Rural Habitat

This section mainly focuses upon the households, transportation conditions; forest cover and change in land use and land cover in the mid-elevation regions of the Teesta Basin. Climate Change would act as an additional stress in urban areas with more and more people migrating from rural areas (both temporary and

permanent). Hence with the unplanned development and population growth, the impacts of climate change are likely to intensify.

Increase in the population of the rural and urban areas of Sikkim is shown in figure 3. There has been a drastic increase in the urban population of Sikkim since 2001.

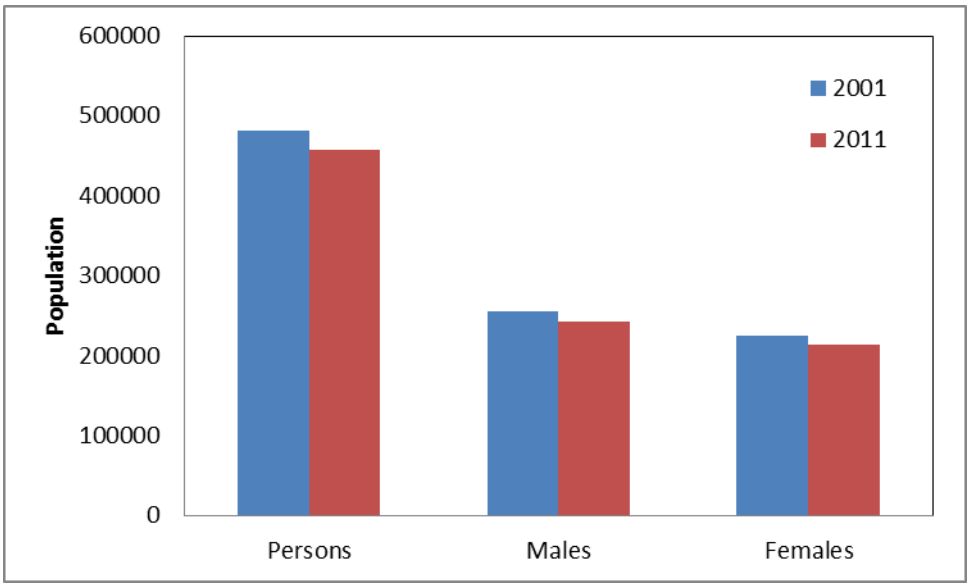

Figure 3: Increase in population in urban and rural areas in the last decade
(Source: Sikkim Census, 2011)

It has been observed that over the past few years with rapid urbanisation and development, forest area in Gangtok has reduced considerably. A major part of forest area has been cleared for developmental purposes and terrace farming.

Table 2: Land use change in Gangtok.

Land Use/ Land Cover classes	Area in 1990 (km2)	Area in 2000 (km2)	Area in 2010 (km2)
Built up and bare land	25.93	29.44	35.11
Step cultivation	84.49	117.13	139.53
Forests	189.05	152.90	124.83

*(Source:*Mukhopadhyay et al., August 2014)

Overall, a decrease of approximately 33% was observed in the total forest cover of Gangtok with major part of forest being cleared for agricultural purposes i.e. step cultivation.

2.2.5 Energy

Main sources of energy in Mid-hills of Sikkim are mainly firewood, LPG and electricity for cooking, lighting and heating. Use of kerosene is quite limited; mainly it is used for lighting in those areas where there is inconsistent supply of electricity. In current scenario use of LPG is replacing the dependency on firewood for cooking in rural areas as well.

The government of Sikkim is promoting the use of renewable sources of energy like biogas and solar power, but they are still not so popular in the state. According to the records, Sikkim has achieved 100% rural electrification but not everyone can afford it. In rural areas of Sikkim, electricity is subsidised and being distributed in minimal cost still some areas have the power shortage and reach issue.

Table 3: Households having access to electricity and clean source of energy for cooking

District	**Households having electricity (%)**	**Households using clean source of energy for cooking (%)**
South	96.0	28.6
East	99.2	72.7

(*Source:* District Level Household and Facility survey -4)

From Table 3 it can be seen that in both the East and South district the percentages of households receiving electricity is more than 95%. Electricity in these districts is mainly used for lighting purposes only. But the percentage of households using clean sources of energy like LPG is very less in South district as compared to East district. The reason behind this gap needs to be explored further.

Hence, it can be inferred that the major sources of energy in Sikkim are fuel wood, electricity, hydropower and LPGs where rural areas rely heavily on wood and to some extent gas cylinders while in urban areas, hydroelectricity though in its developing stage, is emerging as an important source of power.

With the help of the literature survey conducted, it can be seen that the average temperature of Sikkim has increased since the past few years and the variability in the rainfall has also increased. Since the past years, the intensity of rainfall has

increased but the overall spread has decreased. It is because of this reason that water problems in East and South districts which lie in the rain shadow region have increased considerably. Since the farmers in both the districts are more or less dependent on rainfall for agriculture, have to change their cropping patterns. Productivity of many crops like wheat and oranges has declined drastically in these regions. Hence the changes in the climatic parameters are affecting the livelihoods of the rural communities. For proper policy implementation, it becomes imperative to understand the perception of the local communities regarding such changes and the adaptation strategies being undertaken by them.

3. Study Area

Sikkim is located between longitude 88° 00'58" and 88° 55'25" East and latitude 27° 04' and 28° 07'48" North. The total land area of Sikkim is 7096 km^2 (Anon., 2011-2012) which consists of four districts (Table 4).

Figure 4: Map highlighting the four districts of Sikkim

Teesta is the single major river in Sikkim and it bisects the state in North-South direction draining approximately 95% of the total area of the state.

Table 4: Area covered by each district in Sikkim

District	**Area (km^2)**
North	4226
West	1166
East	954
South	750

(*Source:* Anon., 2011-2012)

The river systems in Sikkim are roughly classified into three different zones (Nepal et al., 2013):

1. **Source zone (headwater zone)** - This zone is the point of origin of the rivers in the Himalayas. It consists of high mountains with very high ridges and deep valleys and has vast areas covered with glaciers and snow.

2. **Transition zone (transfer zone) -** This zone consists of comparatively lower mountains and has mixed vegetation. Agricultural activities are quite prevalent in this region.
3. **Floodplains (depositional zone) -** This zone begins at the point where the river leaves the hills. Because of the low gradient in this region, the river deposits the sediment from the upstream regions in the floodplains

The classification of sites into upstream and downstream were done following the above criteria and the thumb rule for site selection was such that the altitude greater than 1500m AMSL are considered as "High Altitude Regions" while those having the altitude ranging between 500-1500m AMSL are grouped under the category of "Mid-Hills/Altitude Regions".

The study area has been selected on the basis of the altitude. This research deals with the mid elevation (500-1500m) regions of South and East Sikkim. Within the study area, the study sites were selected on the basis of the situational analysis carried out in the initial phase of the study.

After the transect walks and grouped discussions with the locals, various wards lying in the mid-elevation regions of in East and South ditricts of Sikkim were finally selected to carry out further analysis (Figure 5).

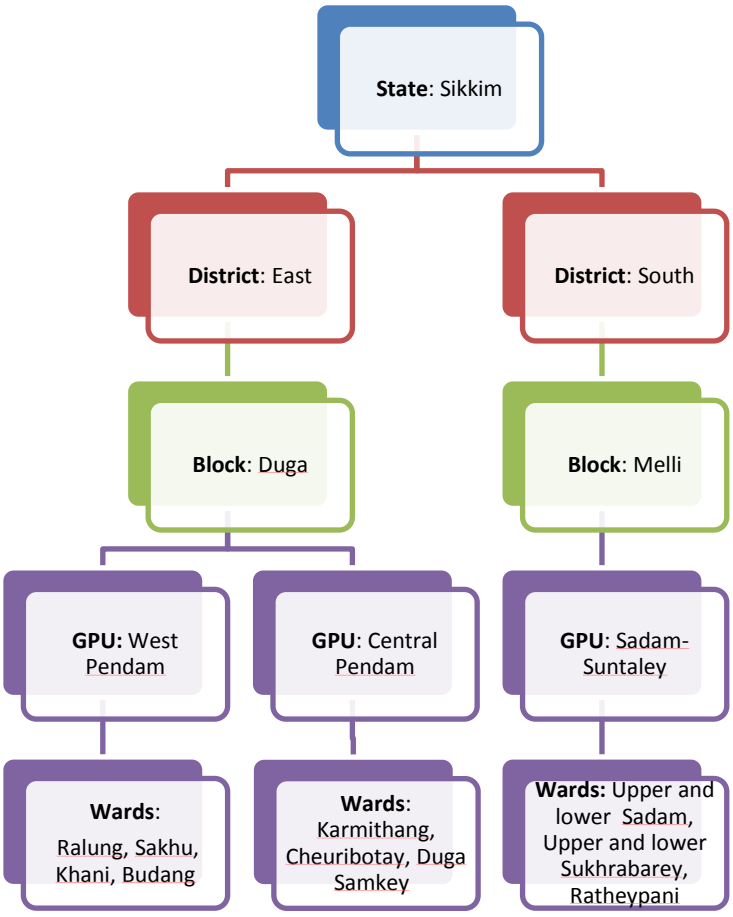

Figure 5: Selected wards for the study

In the above selected wards, investigation about the impacts of the climate variability and change on the people living in the mid elevation rural areas of South and East Sikkim and their opinion about such changes was done. It also enquires the best course of actions by learning about community attitude and practices regarding climate change impacts and mitigations and find out what already has been done to address these issues.

4. Objectives

1. To analyse the impacts of climate change on the major rural livelihood activities.
2. Identifying the adaptation mechanisms undertaken by the rural communities.
3. Identification of the important institutions in the region and to understand their institutional capacity.

5. Methodology

The methodology and the tools used in this study rely greatly on the information collected through exhaustive literature survey as well as from the extensive field visits to different villages of South and East districts of Sikkim in order to gain knowledge on the nature of the problems faced by the local communities.

To achieve all the three objectives i.e. to collect on field information about how climate change and variability are affecting the livelihoods of the local communities in South and East district of Sikkim, their perception and capacity to cope and adapt to such changes, Participatory Rural Appraisal (PRA) approach was used.

5.1 Participatory Rural Appraisal

PRA or Participatory Rural Appraisal developed somewhere in early 1990s is one of the most widely used approaches to carry out qualitative research in rural areas with the basic purpose being learning from the rural communities. It is a bottom-up approach which facilitates the local communities to carry out their own analysis and the actions that could be taken for further planning since it is based on the principle that "local people are creative and capable and can do their own investigations, analysis, and planning (Cavestro, 2003)." The researchers basically act as catalysts in this process to help the local communities to carry out their own analysis.

Robert Chambers defined PRA as "as an approach and methods for learning about rural life and conditions from, with and by rural people (Cavestro, 2003)". This approach not only involves local communities but also the local officials and can be applied in various fields like natural resource management, health, agriculture and various other social programs. It enables the people to prepare themselves to the changes taking place and their effects on their livelihoods.

The PRA tools used to conduct this study are as follows:

5.1.1 Secondary Sources

Purpose:

Initially an extensive literature survey was carried out to get concrete information on the topic and the characteristics of the study site before collecting

the data on field using participatory approach and tools. It helped in assessing what is already known and the gaps in the existing literature.

Source of Information:

The secondary data sources included collection of the climatic data and climatic trends, journal articles, reports and grey literature relating to the impacts of the climate change and variability on the natural resources of the two districts and the various policies and adaptation mechanisms helping the people in coping and adapting to these changes.

5.1.2 Transect Walk

Purpose:

Transect walk is a participatory observation tool for learning more about a particular study site by understanding the distribution of the resources, their location, landscape features and the major land uses in that particular region. This method was used in the beginning of the field visit and helped in getting a glimpse about the landscape features like topography, land use, community assets etc. of the study site.

Source of information:

Transect walks were usually conducted along with a key informant by observing, listening asking and discussions with the locals of that area.

5.1.3 Focus Group Discussions (FGDs)

Purpose:

FGDs or Focus Group Discussions are used to collect exhaustive information about various concepts and perceptions of the local communities. Overall in South and East district, 18 FGDs were conducted which helped in gaining a better insight into the various livelihood practices of the people, their perception of the climatic change and its impacts on their livelihood i.e. their income and social status. They also helped in understanding the adaptive capacity of the people and also about the various institutions helping them in coping and adapting to such changes.

5.1.4 Semi-Structured Interviewing (SSIs)

Purpose:

SSIs are regarded as the "core" of good PRAs (Chambers, 1994). This qualitative research technique "allows person-to person discussion" (Macchi, 2011). It helps in getting a better knowledge of the issue of interest. Overall in both south and east districts of Sikkim, 13 semi-structured interviews were conducted. These SSIs helped in gaining an even better perspective of the impacts of climatic variability and change on the livelihood of the local people. In contrast to the questioners and surveys in which structured questions are asked, the semi-structured interviews are open ended and the respondents can easily talk in length about the subject since in these interviews general questions are asked which do not limit the conversation. Moreover new questions arising out of the discussion are also encouraged. They are more like an informal discussion.

Source of information:

The SSIs were carried out with the key informants i.e. with those who are the experts in the field of interest. They were also carried out with the reps of different active institutes helping the people in coping with the changes.

5.1.5 Seasonal Calendar (Time Chart)

Purpose:

This PRA method helps in documenting patterns and significant events that influence the local communities throughout the year. The calendar helps in understanding the perception of the local communities since the marking major climatic patterns and hazards are marked in the calendar according to them. It is basically a two dimensional matrix, on one axis time period is written (in months or year according to the requirement) and on the other axis various climatic patterns and hazards are marked. According to the requirement of the present study two seasonal calendars were made. One calendar represented the perception of the people about the various seasons and hazards 10-15 years back and the second calendar represented their perception regarding the seasons and hazards according to the changes that they have observed. The two tables were merged together (table 7) which helped in analysing the results in a better way.

The analysis of the merged tables helped in understanding how the people perceive the changes in the climate.

Source of information:

The seasonal calendars were made with the help of information gathered during the Focus Group Discussions and also during the Semi-Structured Interviews with the representatives of the active institutes.

5.1.6 Livelihood Seasonal Monitoring Calendar

Purpose:

The idea behind the livelihood seasonal monitoring calendar is more or less the same as the seasonal calendar. It basically documents the main livelihood activities of the local communities throughout the year. it is also a two dimensional matrix with the time period marked on one axis (horizontal axis) and the major livelihood activities on the other axis (vertical axis). To carry out this study, different livelihood seasonal monitoring calendars were made for different livelihood activities observed in both the districts. It helped in identifying the crucial periods for the people involved in those livelihood activities.

Source of information:

The seasonal calendars were made with the help of information gathered during the Focus Group Discussions and also during the Semi-Structured Interviews with the representatives of the active institutes

5.2 Data Analysis and Interpretation

The data collected through the above PRA tools were documented in a concise form and were coded into themes and that data was analysed using qualitative methods. To analyse the results, the seasonal calendar (Table **6**) and the livelihood seasonal monitoring calendar of the various livelihoods seasonal monitoring calendars were merged together. This helped in identifying the periods during which the particular livelihoods are more vulnerable because of the change in the climatic factors and the impact those changes have on those particular livelihood activities. Further analysis of the adaptation mechanisms adopted by the local communities was done and also the active institutes helping

the people in adapting to such changes were explored through institutional mapping.

5.3 SWOT (Strengths, Weaknesses, Opportunities, and Threats) Analysis

After the institutional mapping or the identification of the various institutes helping the people in adapting to the changes in the environment using the PRA tools, institutional capacity was analysed through SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis. Institutional capacity analysis helps in a better understanding of the roles of the governmental and non-governmental institutions which are helping the local communities in adapting to the changes in the climatic parameters. It helps in identifying the institutions that would most likely play a very important role in implementing the adaptation measures.

The SWOT framework is a 2×2 matrix in which the Strengths and Weaknesses are the internal factors which represent the present advantages and disadvantages of any institution or policy respectively. On the other hand, Opportunities and Threats are the external factors which represent the future policies that can be exploited in the future drawbacks that need to be taken care of respectively.

Strengths have been identified as those aspects which put any institution in valuable position for working towards climate change adaptation and Weaknesses as those which would create unfavourable situations for them. The elements which any institution could use for its benefit in the future were seen as Opportunities whereas future obstacles in the pathway of any institution were identified as Threats.

6. Results:

The local communities of South and East Sikkim are quite aware about the changes in the climatic patterns. The rural communities have even started coping with the climatic changes using their traditional knowledge and skill sets. Mostly the communities have observed changes in the climatic patterns of three major seasons i.e. winter, summer and rainfall.

Table 5: People's perception of the changes in the climatic patterns

District	**GPU**	**Ward**	**Winter season**	**Summer season**	**Overall Rainfall**
East Sikkim	West Pendam	Ralung, Sakhu, Khani, Budang	Decrease	Increase	Decrease
	Central Pendam	Karmithang, Cheuribotay, Duga Samkey	Decrease	Increase	Decrease
South Sikkim	Sadam-Suntaley	Upper and lower Sadam, Upper and lower Sukhrabarey, Ratheypani	Decrease	Increase	Decrease

To summarise the perception of the majority of the people in different wards of both the districts were of the opinion that the overall temperature in the region has increased and have observed a considerable decrease in the duration of the winter months. Also according to them, average rainfall in these districts has also decreased since the past 10-15 years.

6.1 People's Perception of Climate Variability, Hazards and Trends

The perception of the local people regarding the climatic variability and changes is recorded in the form of seasonal calendar. For proper policy implementation in the future, it is important to take into consideration the perception of the stakeholders, the stakeholders in this study being the local communities of East and South district. According to them not only they have observed changes in the overall rainfall and temperature patterns but also in hailstorms patterns. Frequency and intensity of the hailstorms has increased considerably since the past 10-15 years.

Since in both the East and South districts, mid-elevation sites are the ones that have been considered for the study, the views of the local communities were found to be more or less similar.

Table 6: People's perception of the changes in the climatic factors[1]

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March
Rainfall (Past)	**	**	** *	** *	***	***			**	**	**	**
Rainfall (Present)	**	**	** *	** *	***	***			*	*	*	*
Hailstorm (Past)	**	**									**	**
Hailstorm (Present)	***	***									***	***
Landslide (Past)	*	*	**	**	**	**			*	*	*	*
Landslide (Present)	*	*	** *	** *	***	***			*	*	*	*
Crop pest and diseases (Past)				*	*	*				*	*	*

[1] Past = 10-15 years back

Present = current situation (2015)

Intensity= *=low; **= medium; ***= high

Crop pest and diseases (Present)				*	*	*			**	**	**	**
Livestock diseases and pests (Past)			**	**	**	**						
Livestock diseases and pests (Present)			**	**	**	**			*	*	*	
Human-Wildlife Conflict (Past)	*	*	*	*	*	*	*	*	*	*	*	*
Human Wildlife Conflict (Present)	**	**	**	**	**	**	**	**	**	**	**	**
Water Shortage (Past)	**	**	*	*	*	*	*	*	**	**	**	**
Water Shortage (Present)	***	***	**	**	*	*	*	*	**	**	**	***

By conducting an analysis of Table 6, following conclusions about the perception of the people about the changing climatic scenario in the South and East districts of Sikkim can be drawn.

Table 7: people's perception on climate change and its associated impacts

Climate Events	Community Perceptions on Climate Change
Rainfall	People believe that overall the rainfall has decreased i.e. its overall extent has decreased but its intensity has increased. In the past rainfall during the monsoons used to be continuous and also of low intensity but now the rainfall during the monsoon season is quite scattered and of comparatively higher intensity. Moreover considerable reduction has been observed in the winter rainfall with almost no or little rainfall from October to March.
Hail storm	Even the hailstorms have become unpredictable and more intense as the people reported that the size of the hail has also increased.
Winter Season	Winters have not only become drier but have also become warmer. People have felt a considerable increase in the winter temperature and feel that the duration of winter season has reduced.
High temperature	Overall the temperature of South and East Sikkim has increased considerably.
Dry season	Both the districts receive very little or no winter rainfall thereby increasing the overall dry period experienced by the districts.

When a comparison of the perception of the local communities about the changing climatic variables is made with the changes reported in the literature, it can be seen that the perception of the people is more or less in accordance with the scientific studies that have been conducted in the region. To summarise the overall situation, the average temperature has increased with winters becoming shorter and the though the intensity of rainfall has increased but average rainfall in the state has decreased with a considerable reduction in the winter rainfall.

6.2 Impact of Changing Climatic Factors on Various Livelihood Activities

6.2.1 Agriculture

Crops in Sikkim are grown in the three major seasons:

1. Pre-kharif or pre-monsoon
2. Kharif or monsoon
3. Rabi or winter crops

The major crops grown during these seasons are shown in the table below.

Table 8: Major Crops Grown in Mid-Hills of Sikkim

Elevation	**Climate**	**Crops Grown**
300-500 m	Tropical	Major crops grown in these regions are maize, paddy, wheat, ginger, soyabean, potato, turmeric, mustard, mandarin orange, Dalle Chilli etc.
500-1500 m	Sub-tropical	

With the help of agricultural seasonal monitoring calendar Table 9**,** identification of key agricultural production periods can be easily done. Comparison of Table 6 and Table 9 helps us in identifying the climatic factors responsible for the dwindling production of crops like maize, ginger, paddy, oranges etc.

Table 9: Agriculture Seasonal Monitoring Calendar of East and South Districts of Sikkim[2]

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March
Paddy			■	■	■	■						
Wheat							■	■	■	■	■	■
Maize	■	■	■								■	■
Ginger	■									■	■	■
Orange								■	■	■		
Dalle (Chilli)	■										■	■
Soyabean			■	■	■	■	■					
Mustard							■	■	■	■	■	
Potato	■									■	■	■
Floriculture	■	■	■									■

Agricultural sector is highly sensitive to changes in climatic conditions and it is the main source of livelihood for people living in these regions. Most of the farmers are generally dependent on rainfall and very few of them use the water

[2] The Green coloured cells indicate the months when the particular crops are grown.

from the springs or streams for irrigation thus making them even more vulnerable to even a slight change in the rainfall patterns.

The changing climatic variables i.e. rise in temperature and erratic rainfall patters adversely affects the crop productivity. Rainfall patterns in this region have become quite irregular and more intense. The frequency of winter droughts has increased with the region receiving very little or no rainfall for the 6 months i.e. from October to March as can be seen in Table **6**. Farmers in this region reported it is important for them to harvest maize by June end or July first week so that they can grow paddy afterwards. But because of erratic rainfall patterns and increasing winter drought, they sometimes have to sow maize multiple times. As a result sometimes they have to cut the crop before it grows completely and use it as fodder for the cattle so that they can sow paddy on time (first week of July). It becomes very important to them for the monsoon rains to be regular otherwise they would have to face double loss.

Some of the farmers in these regions have completely stopped the cultivation of potato and mustard because of lack of sufficient water during the winter season (lean season).

Only a few farmers in East Sikkim were engaged in the production of cardamom but again because of insufficient winter rains farmers were facing losses in its productivity.

Hailstorms in the region generally occur from March to May but since the past 10 years, the hailstorms have become quite erratic and more intense. People even reported that the size of the hail has also increased which causes even more damage to the pre-kharif crops sown in February. Even small changes in the temporal or spatial patterns of the hailstorms can cause severe damage to crops like maize and affect their productivity. Last year many farmers had to bear considerable loss in the productivity of their crops only because of more intense and erratic hailstorms.

Increased incidences of pests, diseases and weeds were also reported in the region owing to much drier and warmer winters causing drastic decline in the production of ginger, oranges and tomatoes. Even storage of seeds is becoming difficult because of this.

Overall the farmers in the region reported that with the changing climatic conditions i.e. higher temperatures, erratic rainfall and hailstorm patterns, not only crop productivity but also its quality have declined drastically.

6.2.2 Animal Husbandry

With the help of the Participatory Rural Appraisal tools like Focus Group discussions and Semi Structured interviews, the following livelihood seasonal monitoring calendar was made for various livelihood activities like Dairy farming and Poultry Farming.

Table 10: Animal Husbandry seasonal monitoring calendar of East and South Districts of Sikkim[3]

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Dairy Farming												
Poultry Farming												

6.2.2.1 Dairy Farming:

Dairy sector in the rural areas of mid-hills is a well-known alternate source of income for the people. It is not only a source of income but also a source of organic manure for the farmers. More than 80% households own livestock either for their own purpose or as an alternate source of income and are generally involved in the selling of milk and butter throughout the year.

A. Quality of milk:

The dairy farmers are facing many problems because the souring of milk has increased since the past few years thereby increasing the economic loss faced by the people in this business. Even with the initiatives taken by the Sikkim government, souring of milk has increased considerably since the past few years and changes in the climatic patterns can be attributed as one of the few factors.

[3] Blue coloured cells indicate the months when animal husbandry is practiced.

According the milk co-operative, with increasing summer temperature it is becoming even more difficult to collect good quality milk. Moreover with rainfall becoming more erratic and intense, the frequency of the landslides in the region has increased which further delays the transportation of milk and the collection vans are not able to reach the collection centres on time. Both the factors combined together contribute to the spoiling of milk.

Farmers in East Sikkim reported that if the milk gets spoiled during the transportation, they have to bear 40% economic loss as the sour milk is then used for recovering butter or *churpi*.

Moreover there are certain villages in this district where there is no proper road connectivity because of which the dairy farmers have to carry milk on their back up to the collection centres. This further increase the chances of milk getting spoiled before reaching the collection centre and reduce its economic value.

B. Reduction in Quantity of milk:

With increasing temperatures, people reported that the availability of green fodder reduces which in turn affects the health of the cattle thereby reducing overall milk productivity.

People also reported that during the winter season since the past few years with the decreasing rainfall, the availability of the fodder reduces because of which also the milk production also decreases.

Moreover with the winters becoming warmer since the past few years, it has increased the probability of cattle getting affected by diseases since the probability of the vectors like ticks and fleas surviving increases with warmer climate.

6.2.2.2 Poultry Farming:

Being extremely resilient to diseases, poultry farming is slowly being adopted as an alternate source of income by the people. The enormous demand of the poultry products in the state is because of the high tourist flow in the region. To meet this demand, poultry farming is being highly promoted and is also serving as an alternate source of income.

People in mid hills of south and east Sikkim generally prefer to engage in poultry farming during the summers as during the winters the poultry chicks tend to die

because of the cold stress and need utmost care. In south Sikkim during March-April when the temperatures are comparatively higher, approximately 200 light bulbs are required to keep 500 chicks warm.

The problem faced by the poultry farmers in East Sikkim is lack of proper road connectivity in the area especially during the rainy season. Lack of proper road connectivity and transportation causes the loss of broilers because of which the farmers have to face severe losses.

In South Sikkim farmers reported that even though the prices offered by the government are quite less, still they prefer to sell the broilers to Sikkim Denzong's Cooperative Society since it gives them market security. The Denzong's Cooperative Society collects their poultry products and sends it to the army.

The farmers reported that since the past few years, the problem of transportation of broiler is becoming even more difficult during the monsoons i.e. from May to September in both the districts because of the increased intensity of rainfall during this season which escalates the chances of landslides thereby causing roadblocks.

With increasing awareness among the people and enhanced support from the government, the rural people are shifting towards other alternative sources of income like apiculture, floriculture and tourism.

6.2.3 Apiculture

Sikkim has a wide range of flora because of its vast range of altitudes varying from 300 m to more than 8000 m. approximately 5000 plant species have been identified in the state. Thus the state has rich forage for the bees and can sustain large bee populations. Bee keeping is slowly gaining momentum as an alternative source of income.

The bee variety cultured by the farmers in East Sikkim is '*Api cerenie'* because this specie is less prone to diseases and can adapt to any temperature.

Since the past few years the production of the honey has declined in this region and the farmers attributed the reason behind this to the rising temperatures. According to them bee farming is better suited to cooler climate and they believe that productivity of bees is less in warmer climate.

Moreover because of decrease in winter rainfall, flowering of various plants is delayed which reduces the bee forage available thereby affecting the overall honey production.

6.2.4 Floriculture

Sikkim is quite favourable for setting up of green industries like floriculture owing to its geographical location. Sikkim has rich and dense forests along with exotic floral treasure many of which are indigenous to the state. The state is endowed with huge varieties of ornamental plants like Rose, Gerbera, Carnations and Orchids like Anthurium and Cymbidium and it is the only state in the country which is producing Good quality and high priced Cymbidium.

The state shares its borders with Bhutan, China and Nepal thereby providing amazing prospects for export of these ornamental plants and orchids to these neighbouring countries and this would also serve as a sustainable livelihood option for the people of Sikkim.

Floriculture has been taken up as an alternative source of income by many people in South Sikkim. People sell these ornamental plants either to the private gardens or in the local markets where the prices are set according to the quality of the flowers.

Changing climatic scenarios have both direct and indirect impacts on this business. With increasing climatic variability the hailstorms have become erratic and more intense which is affecting the quality and quantity of the produce. The main season of cultivating the flowers in South Sikkim is from March to June (Table **9**). It is during this time only that the district encounters hailstorms which are affecting the quality and quantity of the harvest because of which the farmers have to bear losses.

The main season for the cultivation of these ornamental plants and orchids is from March to June but since the government has provided the people with green houses, it is possible for them to cultivate them even during off-seasons (August-November). But it is during this time that the farmers have to face losses because of lack of proper transportation and road network and increased incidences of road blocks because of landslides during the rainy season.

6.2.5 Tourism

Special focus is being given to the development of Village Eco-tourism with the government focusing on the construction of homestays in lesser settlements where more cultural and natural wealth subsists. State government is focusing on tourism related to pilgrimage, culture, tradition & heritage, adventure, eco-tourism, wellness Tourism as was also seen in South Sikkim. Village tourism also helps in reducing the gap between urban and rural population. The major tourist season in South district is shown in the Table 11.

Table 11: Tourism seasonal monitoring calendar of East and South Sikkim[4]

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Running Home stays												
Daily wages (guiding, pottering etc)												

To promote village tourism in South district government has taken many initiatives like construction of Char-Dham in Namchi acts as a major hub for attracting pilgrimage tourists and has also built helipad in the region to improve the transportation facilities thereby attracting tourists. The government is also providing financial assistance to the people for the construction of the homestays which not only would help in enhancing their income but would also lead to the conservation of the environment.

More and more people in Sadam-Suntaley (South District) are getting involved in tourism through the construction of homestays and also by working as guides and potters during the tourist season. People believe that it is a profitable alternate source of income since the impact of climate variability has still not been seen in this sector. It is only during the winter tourist season they believe that the tourism in this region could be affected because of water shortage in the future.

Overall from the above analysis it can be seen that the vulnerability of the different livelihoods does not remain same throughout the year. Agricultural

[4] Orange coloured cells indicate the tourist season in East and South district.

farmers in both the districts are found to face more losses during December to February. Those involved in Dairy and Poultry farming are more vulnerable during the monsoon period i.e. from June to September. As of now very small percentage of the people in both the districts are involved in apiculture, floriculture and tourism. But with increasing awareness and support from the government, people are taking the initiatives to involve in these seasonal livelihood options to enhance their income.

6.3 Local Adaptation Practices and Institutional Mapping

After the analysis of the seasonal calendar and the livelihood seasonal monitoring calendar for the major livelihood activities undertaken by the people in rural areas of both the districts of Sikkim, different coping and adaptation mechanisms were identified which the people have adopted through their traditional skills and knowledge.

Moreover there are many governmental and non-governmental institutes in both South and East districts that are also playing a major role in helping the local communities to adapt to climatic variability and changes by providing alternative sustainable sources of enhancing their income and living standards. Institutional mapping helped in the identification of the active institutions in both the districts (Figure **6**).

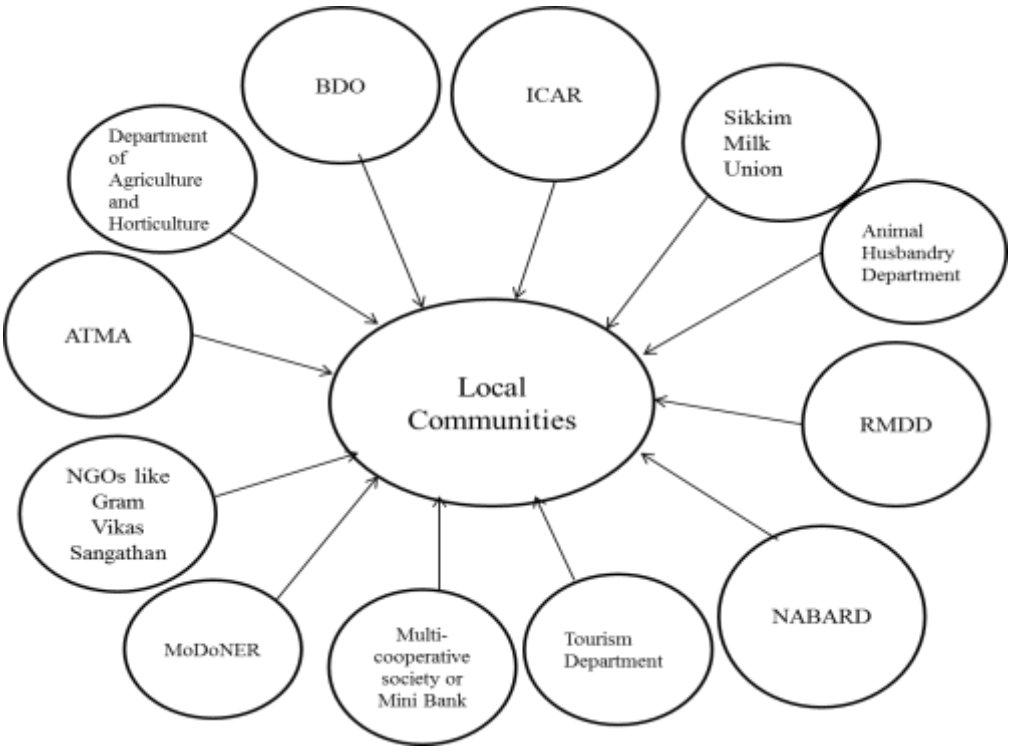

Figure 6: Active institutes in East and South districts

Various adaptation practices being implemented by the local communities and the measures taken by the various institutes identified through different Participatory Rural Appraisal tools are shown in the Table **12**. The categorisation of the responses and the institutions has been adopted from Sud et al., 2015.

Table 12: Response, Institutions and Policies in East and South District of Sikkim

LIVELIHOOD ACTIVITIES	RESPONSE OF THE LOCAL PEOPLE	INSTITUTIONS	POLICIES
Agriculture • Because of unpredictable monsoons overall productivity and quality of agricultural crops has reduced. • During the lean season i.e. winter months because of lack of water, people have stopped growing crops like potato and mustard. • Hailstorms affect the pre-kharif crops like ginger and maize. • With increasing temperatures, productivity of crops like ginger and orange has reduced drastically. • With winters becoming warmer and drier there are increased incidences of pests, diseases and weeds and storage of various crops like ginger has also become difficult.	• Delayed sowing of crops like maize owing to unpredictable monsoons. • People have even started harvesting water (collecting rain water) for irrigation purposes in these regions. • In some places, people have constructed water storage infrastructures. They are developed in such a way that the discharge from the springs during the night time get collected in these tanks and the stored water can be used for agricultural purposes as well. • To protect the crops like dale chilli from the hailstorms, farmers have started using double sheet over the greenhouse. • To protect ginger during dry winters, it is stored	• Department of Agriculture and Horticulture • Agricultural Technology and Management Agency (ATMA) • Block Development Office (BDO) • Indian Council of Agricultural Research (ICAR) • Rural Management And Development Department (RMDD) • National Bank for Agriculture and Rural Development (NABARD) • Multi-cooperative society or Mini Bank (South Sikkim) • NGOs like Gram Vikas Sangathan and Nehru Yuva Kendra (NYK) (East Sikkim)	• Department of agriculture and horticulture helps the farmers in adjusting to organic farming by providing seeds, organic pesticides and medicines, pits for vermicomposting, greenhouse and other tools. • It also buys the produce from the farmers, thereby ensuring a safe market for them • Department provides assistance to the farmers clubs and the farmers' co-operative formed by the people of the village to. It helps them by providing monetary assistance for the various activities like construction of water tanks, vermicomposting tanks etc. • Help in overcoming the problem of water scarcity by promoting rain water harvesting and also by providing tanks and pipelines. • Training schools have also been established by ATMA

	underground. • To protect the fruit trees from the insects and various diseases, farmers apply either kerosene or camphor in the holes of the trees. • Farmers in West Pendam (East district) have started using a new technology called "root stock" to improve the productivity and quality of mandarin orange. • Farmers are shifting to more climate resilient crops with people in many places shifting toward the cultivation of broom grass since it can be used for multiple purposes like fuel wood and fodder.		where experts provide training to the farmers. • Also, Dhara Vikas Yojna by RMDD has already been implemented in many wards of South district and there are plans for its implementation in East district also. • Informed about new technologies and has also provided farmers with instruments like grinding machines. • NABARD helps in issuing Kisan Credit Cards (KCC) to the farmers. • Mini bank established by the government in South Sikkim also ensures safe markets for the local people. • It also helps the people by providing them with loans and also urges people to open their savings account. • The NGOs in South Sikkim play the role of a mediator and a facilitator between the Government and the stakeholders.

Animal Husbandry • Increasing milk souring because of higher temperature and landslides during the rainy season. • Lack of fodder and sufficient water for the cattle. • Poultry- broilers getting spoiled because of landslides during the rainy season.	• More and more people are shifting towards poultry farming from dairy farming because of its high resilience towards climatic variability. • Farmers are shifting towards hybrid and better yielding varieties of cattle	• Department of Animal Husbandry • Milk Producers Co-operative Society under Sikkim Milk Union • Indian Council of Agricultural Research (ICAR)	• The department is helping the farmers by providing Cow insurance. • It is even promoting the adoption of poultry farming in the drought prone areas of south district. • ICAR under Indian Dairy Development Project (IDDP) provided the milk co-operative with various equipments like cold storage and weighing machines. The cold storage helped in reducing the problem of milk souring. • They were the first to introduce online payment systems for dairy farmers in East Sikkim. • Problem of market accessibility and transportation was solved. • Also to promote dairy and poultry farming, the department is providing financial assistance to the people for the construction of cow and pig sheds.
Floriculture • The quality and quantity of the ornamental plants and the orchids is affected because of the increasing intensity of the hailstorms.		• Horticulture department	• It has provided the farers with the green houses to cultivate flowers during the off season i.e. from September to November. • It is also providing the farmers

			with seeds for growing different varieties flowers.
Tourism		• Department of tourism	• Promoting village Tourism in Sadam (South Sikkim). • Department is also financially helping people in construction of the homestays which would serve as an alternate source of income.
Other livelihood options		• MoDoNER	• Helping in women empowerment through a scheme called North Eastern Rural Livelihood Project (NERLP) under which women SHGs have been initiated through which women not only engage in agricultural activities but also other alternate livelihood activities like pickle making, handicrafts and handlooms etc.

Agriculture being the main source of income in both East and South districts, there are many governmental institutions like Department of Agriculture, ICAR, RMDD and NGOs like Gram Vikas Sangathan (East district) which are helping the people extensively in adapting to the climatic changes. As far as other livelihood activities are considered, various government institutions have started taking even more initiatives to increase awareness among the people and also to train them to involve in other livelihood activities apart from agriculture. This has greatly helped in improving the economic stability of the people.

6.4 Institutional Capacity

With the help of the institutional mapping done through various Participatory Rural Appraisal tools, a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was carried out to perceive the institutional capacity of both the districts.

SWOT analysis of the government departments and ministries obtained from institutional mapping shows that the various government departments like department of agriculture and horticulture, department of animal husbandry, RMDD and other institutes like NABARD, ICAR etc. are playing an important role in improving the income of the local communities by providing them with the capacity to engage in alternate sources of livelihood. But still, more training programs are required to provide the local people with more knowledge and skill sets to adapt to the changing climate. Moreover proper policy implementation is still lacking at some levels. It was reported in East Sikkim that size of the cow shed being constructed by the department is very small and not appropriate for cattle rearing whereas the size of the pig shed being constructed is very large.

The state government can further help in improving the implementation of the policies through the collaboration with international organisations like World Bank. It should be noted that the insufficient resources and lack of proper policy measures would hamper the efforts taken for the capacity building of the rural communities especially with the extra burden of increasing population.

Table 13: SWOT analysis of institutes in South and East Sikkim

STRENGHTS **Government Departments and Ministries:** 1. Co-ordination between the different departments is quite good. 2. Government is able to promote organic farming and is also able to develop the agriculture sector economically. 3. Farmers receive extensive services and training programs from the government 4. Promoting alternate sources of livelihoods like poultry farming, tourism, handicraft and handlooms etc. 5. Provides assistance to those affected by natural calamities. 6. Government has good links with international organisations. For e.g. NERLP by MoDoner is funded by World Bank. 7. Helps in improving the economic status of the people (no kuccha house) **NGOs and SHGs:** 1. They act as a mediator between the various stakeholders and the government departments. 2. Increasing community empowerment by promoting alternative source of income 3. Supported by local people and the government authorities.	**WEAKNESSES** **Government Departments and Ministries:** 1. Mismanagement and lack of funds in some areas. 2. Not enough training centers to provide people with sufficient training for alternative livelihood options like handicrafts and handlooms. 3. Training days are not sufficient to gain sufficient skill sets for engaging in new alternate livelihood practices. 4. Insufficient planning for policy implementation **NGOs and SHGs:** 1. Lack of well-trained experts in certain sectors. 2. Inadequate infrastructure 3. Lack of markets
OPPURTUNITIES **Government Departments and Ministries:** 1. Implementation of various adaptation strategies in collaboration with international organisations. 2. Increase in the funds available for further research and necessary actions required to manage environment and climate change impacts. **NGOs and SHGs:** 1. Increasing awareness among the local communities. 2. Increasing support from the government in the form of better infrastructure and better prices for their products.	**THREATS** **Government Departments and Ministries:** **1.** Lack of resources with growing population and increasing environmental problems. **2.** Programs and policies not being proportional with the growing problems. **3.** Insufficient training opportunities to help people to cope with climate change **NGOs and SHGs:** **1.** Lack of financial resources. **2.** Insufficient markets

As far as the NGOs and the SHGs are considered, they play a major role as mediators between the government departments and the various stakeholders. For example, they inform the people about the various training programmes

being conducted by the various departments. Through the various SHGs, women in South Sikkim are able to engage in other sources of livelihood apart from agriculture like handicrafts and handlooms, pickle making etc. But the lack of appropriate infrastructure and markets creates hindrances in their attempts of helping the local communities.

With increasing awareness regarding the impacts of climate change and variability and support from the government, the SHGs and the NGOs should try to improve their market accessibility as well as the infrastructure required for engaging in alternate livelihood options.

Overall it appears that there is a sufficient network of the institutions in both the districts which can help in dealing with impacts of the changing climate on the livelihood activities of the local communities. The various government departments like the department of agriculture, horticulture, RMDD etc. support other organisations (NGOs) and SHGs in building their overall adaptive capacity by providing them with training, tools and equipments and also by providing monetary assistance.

7. Discussion and Conclusion

This study uses the Participatory Rural Appraisal tools to carry out the analysis of the effect of climate change and variability on the livelihoods of the rural communities in the mid-hill sites of Teesta Basin. The results show that the perceptions of the people regarding the changing climatic variables are similar to the various scientific studies recording these changes. Also, the vulnerability of the different livelihood activities to the changing climatic parameters like rainfall, temperature etc., varies throughout the year. Agricultural farmers are more vulnerable during the winter season because of the reduced rainfall and enhanced temperatures during that time. A study carried out by Sandeep Tambe shows that the subtropical zone in Sikkim (< 1000m) used to be a productive area with multiple cropping systems But now with reduced rainfall especially winter rainfall, farmers have shifted to single cropping system because which the production has reduced (Tambe et al., 2011). Those involved in dairy farming are facing the impacts of the changes both directly and indirectly. With the winters becoming drier, the milk productivity from the cows is being affected and increased intensity of the rainfall during the monsoons especially is affecting the milk quality because of increased incidences of landslides. This result is consistent with various studies which show that the percentage of sour milk received by the Sikkim milk union has increased from 2.05% in 2007-08 to 3.79% in 2010-11 (Kumar, 2012). The value of sour milk is only 30% of the normal milk since it can be converted into butter and *churpi* as was reported in the literature also. People in these regions are being encouraged to adopt poultry farming as a supplementary source of income. Poultry farmers like the dairy farmers generally have to face economic losses during the monsoons because of the increasing probability of the landslides since the last few years. With the increasing awareness, more and more local people with the support from the government are also adopting apiculture, floriculture and tourism as their alternative sources of income since they are quite profitable. However, the long-term sustainability of these livelihoods is questionable especially tourism as it takes a lot of resources to maintain these homestays like water, energy, etc. For example, a study carried out by Chhetri et al. 2006, to ascertain region wise fuel wood demand, indicates that the gap that exists between firewood demand and supply, is increasing due to population growth and growing tourism. Thus more

research still needs to be carried out to understand how sustainable these alternate sources of livelihood actually are.

Further using the same PRA tools, institutional mapping was done to identify the active institutions in both the districts on the basis of which SWOT analysis was carried out. According to the SWOT analysis, a sufficient network of the institutions in both the districts is available which are helping the local communities in coping and adapting to the impacts of the changing climate on the livelihood activities of the local communities. By working on their current weaknesses and grabbing the future opportunities by keeping in mind the future threats, both governmental and non-governmental institutions can greatly enhance their institutional capacity.

This study has the limitation of only considering the effects of the climatic variables on the different livelihood activities and not taking into account the socio-economic factors. Further, inter relationships between the various actives institutes needs to explored more.

To sum up, though this study focuses only on the climatic variables and not the socio-economic factors, shows that the vulnerability of the mountain communities does not remain same throughout the year. There are certain times during which the vulnerability of their livelihood activities increases because of the enhanced impacts of climate change and variability. In the East and South districts of Sikkim, communities have not only started adapting to the climatic changes using their traditional knowledge but also the government is providing them with extensive support to adapt to the changes in the environment. In the future, the results of this study can be combined with the socio-economic studies of the region which would help in a better assessment of the vulnerability of the various livelihoods.

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Annexures

Annexure 1: Checklist for the field work

Water

- Drinking water-sources, access, variance in quality and quality and its impacts (health), coping mechanisms
- Irrigation-sources, variance and its impacts (crops), coping mechanisms
- Proactive adaptation measures that have been tried or are being tried by individuals or groups. For example, any actions related to water harvesting, storage, recharge/revival of sources, demand management, reuse.
    - Whose idea was it to adopt these measures (govt extension officer, NGO, local leader, individual / family, etc) and how did this change come about?
    - Why are others not adopting it?
    - If there is no such action taken within the village, do they know of any such action from some other place?

Farm practices

- Kind of crops, kind of farm practices, livestock
- Changes in crops, patterns of cropping, reasons for it
- Kind of fodder, changes, reasons and coping mechanisms
- Farm products, changes if any, connections to market and its influence on time
- Proactive adaptation measures that have been tried or are being tried by individuals or groups to improve agricultural productivity, reduce cost of cultivation, or reduce farm losses. For example, any actions related to:
    (i) Different kinds of cropping practices – irrigation, soil management
    (ii) Seed banks, storage
    (iii) Using technology – mobiles, refrigeration, renewables, new kinds of farm equipment, etc

- Whose idea was it to adopt these measures (govt extension officer, NGO, local leader, individual / family, etc) and how did this change come about?
- Why are others not adopting it?
- If there is no such action taken within the village, do they know of any such action from some other place?

Settlements

- Type of settlements, changes if any and reasons,
- type and amount of land holdings, changes and reasons
- Exploration of issues of land loss if any
- Proactive adaptation measures that have been tried or are being tried by individuals or groups to improve living conditions or protect from climate hazards – e.g. changes to the house structure, changes in the house location, or changes around the house or neighbourhood
  - Why are others not adopting it?
  - If there is no such action taken within the village, do they know of any such action from some other place?

Forests/ecosystems

- type of dependence-products
- access and coping mechanisms
- land use and changes and reasons

Hazards

- kinds of hazards faced and changes in them if observed
- impacts and changes in them along with reasons, coping mechanisms and changes
- new hazards if any and possible reasons

Livelihood

- apart from farming practices, what are secondary sources of livelihood and how do they augment household income
- any changes and its influence on household income, coping mechanisms

- Proactive adaptation measures that have been tried or are being tried by individuals or groups to increase income or diversify livelihoods. For example:
    - (i) new value-added agricultural products,
    - (ii) better market access, better information about prices, better warehousing or transportation,
    - (iii) new forms of contract farming or agri-business contracts for export,
    - (iv) seed banks,
    - (v) self-help groups, cooperatives
    - (vi) Training
    - (vii) Using technology for new purposes – mobiles , renewables, , etc
    - Whose idea was it to adopt these measures (govt officer, NGO, local leader, individual / family, etc) and how did this change come about?
    - Why are others not adopting it?
    - If there is no such action taken within the village, do they know of any such action from some other place?

Services

- status of public services-water, sanitation, health, education, banks, etc
- major schemes and formal institutions providing services
- impacts and feedbacks of such provisioning
- informal institutions and their influences for the services and all of above

Annexure 2: Images taken on field

Rain Water Harvesting Structures

Image 1: Tank constructed for harvesting water and to be used during lean season

Image 2: Rain water harvesting initiative taken by the locals

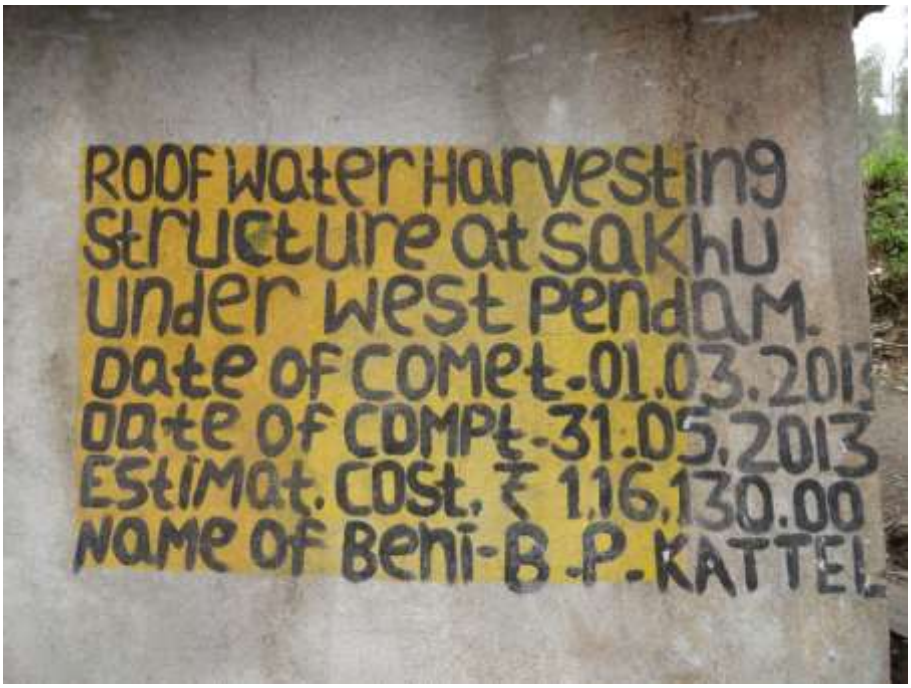

Image 3: Roof Top Rain Harvesting Structure Provided by the Government

Various equipment's provided to the Milk Producer's Co-operative Society by ICAR under IDDP Scheme

Image 4: Cold Storage to store milk to avoid milk souring

Image 5: Sampling Machine

Apiculture as an alternate source of livelihood:

Image 6: Traditional Way of Bee Keeping

Image 7: Bee keeping using Modern Equipments

Floriculture:

Image 8: Floriculture (Orchid Plantations)

Mushroom Cultivation:

Image 9: Mushroom Cultivation in South Sikkim

Various Self-Help Groups engaged in alternate livelihood options:

Image 10: Pickle Making

Image 11: Handicrafts and Handlooms

Some other initiatives taken by the government:

Image 12: Construction of Cow Sheds by the Government

Image 13: training centres for capacity building

Image 14: Grinding machine provided to a group of farmers in South Sikkim

Image 15: Grinding machine provided to a group of farmers in South Sikkim