Madhav Giri[48]

17 Household Level Vulnerability to Climate Change in Nepal – A Comparison of a Semi-urban and a Rural Village Development Committee

Abstract: Climate change-related events have emerged in recent years in Nepal. The effects of climate change are particularly adverse for sectors like agriculture and water management, which are dependent on climatic variables. Subsistence farmers in developing countries like Nepal, where agriculture is mainly rain-fed, and who have very few resources, and have weak adaptive capacity, and may be unable to cope with changing climatic conditions. These factors increase farmers' vulnerability to climate change. Local level vulnerability assessment is very important to formulate suitable policy measures to address their livelihood. Household level vulnerability to climate change depends on different factors, so there is still uncertainty in methodology to measure vulnerability. However, this research has adopted the concept of integrated vulnerability assessment and the indicator method to analyze the vulnerability of farmers of semi-urban areas-Pragatinagar Village Development Committee (VDC) of Nawalparasi, and rural areas – Kagbeni VDC of Mustang districts of Nepal utilizing the data collected from 155 households and VDC profiles from these 2 VDCs. Different socioeconomic and biophysical factors were collected and classified into three classes (exposure, sensitivity and adaptive capacity). Principal component analysis (PCA) was used to prioritize the indicators. Household analysis of vulnerability indicated that poor households are vulnerable anywhere due to low adaptive capacity, regardless of where they are located. Policy measures should focus on improving the adaptive capacity of rural households.

Keywords: Climate change, Vulnerability, Adaptive capacity, Exposure, Sensitivity, Principal Component Analysis (PCA)

17.1 Introduction

The impact of climate change affects developing countries more severely than developed countries because of their generally low adaptive capacities (IPCC, 2007). Rural communities in developing countries like Nepal are more vulnerable to the climate change and its impacts due to their limited capacity to cope with hazards associated with changes in climate (UNFCCC 2009).

48 Madhav Giri is a PhD student in Environment and territory at DIST-Politecnico and University of Turin, Italy, madhav.giri@polito.it

Vulnerability has been considered as a function of adaptive capacity, sensitivity and exposure (Fussel and Klein 2006; Adger 2006; IPCC 2001; Kelly and Adger 2000). Adaptive capacity is the ability of people to cope with or adjust to the changing context. It is explained mainly by socioeconomic indicators. Sensitivity is the degree to which a system is affected adversely or beneficially – by climate stimuli, and exposure is the nature and degree to which a system is exposed to significant climatic variation (IPCC 2001).

Vulnerability literature has mainly been concentrated on contributing to theoretical measurement at a regional or national scale, with selected indicators for each region or state, and identifying adaptation strategies that might have implications for national or regional adaptation planning (Brooks *et al.* 2005; Paavola 2008; Thomas 2008; Salami *et al.* 2009). However, assessing vulnerability at household and community level is urgent for local-level planning and prioritization of adaptation strategies.

Nepal is geographically fragile due to rugged terrain. It is situated in between India and China with an area of 147,181 km^2. Though its average width is only about 150 km, altitude varies from 60 meters above sea level (masl) to 8,848 masl (CBS 2004). The southern part of Nepal is low land and covers 23% of the area of Nepal. Around 40% of the land is under cultivation. The middle region of Nepal consists of 42% of the land area, where only 10% of the land is suitable for agriculture. The northern part covers one third of total area, where only 2% land is cultivable (Maharjan 2003). A large portion of Nepalese populations depend on natural resource based livelihoods, and they have low levels of adaptive capacity because of higher incidence of poverty. So, Nepal is placed among the most vulnerable countries to climate change (Oxfam 2009). It is vulnerable to natural disasters, mainly drought, floods and landslides. If poverty exists, the adverse impacts of climate change and extreme events will certainly increase the vulnerability.

This chapter focuses on the community of semi-urban and rural areas of Nepal. Vulnerability to climate change depends upon adaptive capacity of a wide range of attributes, and adaptive capacity is explained by socio-economic indicators. The importance of indicators varies from place to place. The study intends to compare the vulnerability and importance of adaptive capacity of semi-urban and rural areas of Nepal. So, Pragatinagar VDC of Nawalparasi was chosen as a semi-urban area and Kagbeni VDC of Mustang district as a rural area of Nepal. Both of these study areas lie in the same political region of Nepal but are in different geographic regions. Pragatinagar lies in the southern region of Nepal where population density is increasing due to suitable weather for settlement, fertile land and access to services and facilities. Instead, Kagbeni lies in mountain district-Mustang, northern part of Nepal where the temperature is cold, and it is a semi-arid region. Their adaptive capacity and adaptation practices are different than Pragatinagar. This paper will conduct in-depth analysis of the ward level vulnerabilities of both areas by using quantitative analysis with qualitative information obtained from primary field surveys and secondary data.

17.2 Methodology

17.2.1 Study Area and Data Source

This study covers 2 Village Development Committees (VDC) – Pragatinagar VDC of Nawalparasi district and Kagbeni VDC of Mustang district. VDCs are the lowest administrative tiers in Nepal which are composed of nine wards. These two VDCs were selected on the basis of their location, settlement of the people and access to services and facility. The southern part of Nepal has plain areas, and has access to services and facilities. So, the population density is also higher in Pragatinagar compared to Kagbeni.

Pragatinagar VDC has a total area of 15.77 square kilometers and the total population is 15,494, with a large favorable agricultural land (12.3 km^2). Climatically it lies in a sub-tropical zone. On average, 2,300 ml rain occurs annually. People have migrated from different places to Pragatinagar. So, it has a heterogeneous ethnic composition, but Kagbeni has a homogenous and indigenous Gurung community. Kagbeni VDC is situated in the Lower Mustang, with an area of 285.45 km^2 and the total population of only 1,140. The cultivated irrigated land constitutes 2.98 square kilometers. Climatically, Kagbeni falls in alpine climatic zone (CBS 2011).

This study is based on the primary data collected by household surveys conducted in two phases, and secondary data collected from respective VDC offices. Eighty-four

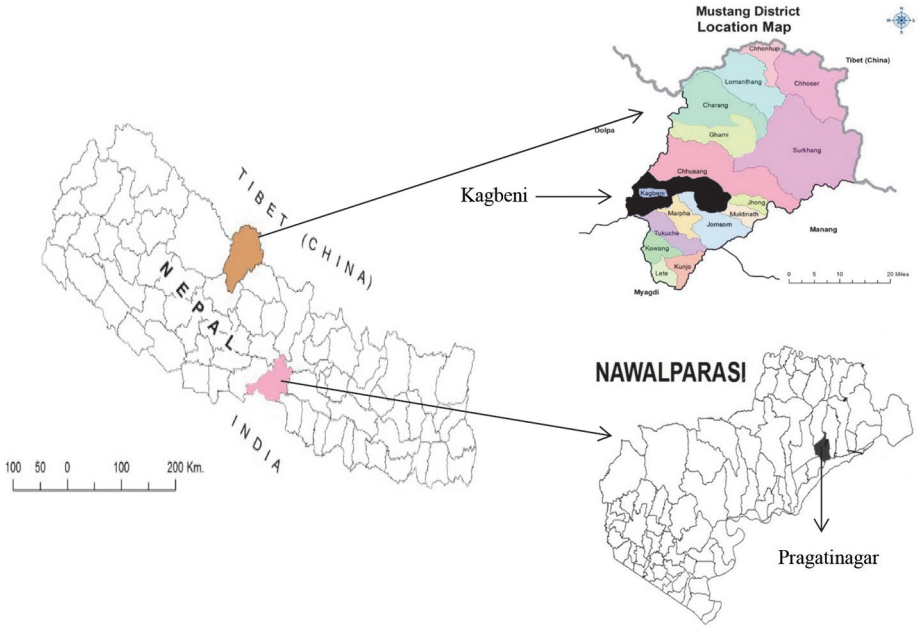

Figure 17.1: Map of study districts with VDCs (Pragatinagar and Kagbeni).

households from Pragatinagar and 64 households from Kagbeni VDC were selected using the following formula given by Arkin and Colton (1963):

$$\text{Sample size } (n) = \frac{N * Z^2 * P(1-P)}{N * d^2 + z^2 * P(1-P)}$$

N = Total number of households; z = Value of standard variation at 95% confidence level (1.96); P = Estimated population proportion (0.05); d = Error limit of 10% (0.1)

All the respondents were over the age of 30. Since wards are considered as the unit of analysis, information was collected about every housess of each ward from the VDC office. To analyze exposure of the study area, meteorological parameters data were obtained from Department of Hydrology and Meteorology (DHM) in Kathmandu, Nepal for the time period of 30 years, from 1981–2010. The nearest meteorological stations-Dumkauli for Pragatinagar (500meters east from study area) and Jomsom for Kagbeni (four km south from study area) were taken to analyze the climatic variables. Missing data were less than one percent which was interpolated using ordinary kriging method in ArcGIS10.

17.2.2 Selection of Vulnerability Indicators

Vulnerability to climate change was analyzed at the ward level by a complex interrelationship of multiple factors: exposure, sensitivity and adaptive capacity. Many variables of these components cannot be quantified directly. In this study, selection of indicators for adaptive capacity was based on the CARE climatic vulnerability and capacity analysis methods and DFID sustainable livelihoods framework, where adaptive capacity is taken as a function of asset possession by the households (Nelson *et al.* 2010b).

17.2.2.1 Exposure

Exposure is the nature and degree to which a system is exposed to significant climatic variation (IPCC 2001). Historical changes in climate variables (maximum and minimum temperature, rainfall amount, rainfall days and 24-hour extreme rainfall) and occurrence of extreme climatic events were taken as indicators of exposure for this study. The coefficient of the trends of climate variables was calculated. This chapter has considered floods and drought as climate change events for this study.

17.2.2.2 Sensitivity

Sensitivity is the degree to which a system will respond to a change in climatic conditions (IPCC 2001; Paavola 2008). Marshall *et al.* (2009) and Daze, Ambrose, and

Ehrhart (2009) have taken sensitivity indicators based on the livelihood impacts of climate change related disasters. Fatalities due to natural disasters, property damage (land, houses and crop) due to natural disasters and share of non-agricultural income of a family are considered as sensitivity of a household.

17.2.2.3 Adaptive Capacity

Adaptive capacity is the ability of people to cope with or adjust to the changing context and is explained by socioeconomic indicators. These indicators have been divided into five types of livelihood assets- human, social, physical, natural and financial. All of these indicators are not directly related to climate shocks only, but support to combat climatic shocks through different ways.

Table 17.1: Indicators for adaptive capacity.

S.No.	Assets	Indicators
1	Human	Knowledge of climate risk, Agriculture and vocational training, education level of family members
2	Social	Women's savings and loans groups, membership in CBOs
3	Physical	Access to services and facilities (road, market, school and medical centre), Irrigated Land, House type, device to access information
4	Natural	Reliable water resources, settlement in un-inhabitant areas
5	Financial	Livelihood Diversification Index, Diversified Income Sources

Financial assets are important. If all income is derived from agriculture only, then such income suffers during the bad weather. Instead, if the income is derived from other sources as well, the risk is reduced because risk is distributed among the sources. The Herfindahl index of diversification is used to calculate Livelihood Diversification Index (LDI) using the formula:

$$D_k = \sum_{i=1}^{N} (S_{i,k})^2$$

where D_k is the diversification index, i is the specific livelihood activity, N is the total number of activities being considered, k is the particular ward, and $S_{i,k}$ is the share of ith activity to the total income for particular ward.

17.2.3 Calculation of the Vulnerability Index

Data in this study were at different scales, from zero to hundred. So, Normalization was done by using the formula:

$$Normalized\ Value = \frac{Actual\ value - Mean}{Standard\ deviation}$$

Then, weights should be allocated to these indicators. The literature indicates that there are three methods used to assign weights to indicators: (1) arbitrary choice of equal weight (Lucas and Hilderink 2004), (2) expert judgment (Brooks *et al.* 2005); and (3) statistical methods such as principal component analysis or factor analysis (Cutter *et al.* 2003). Assigning equal weights is too subjective. The literature also shows that all indicators do not affect vulnerability equally (Hebb and Mortsch 2007). The assigning of weights through expert judgment is often criticized because of the availability of experts in the particular field (Lowry *et al.* 1995). Therefore assigning weight by Principal Component Analysis (PCA) to generate weights was thus chosen over compared to the previous two methods (Nelson *et al.* 2010b; Cutter *et al.* 2003). PCA is a technique used to extract few orthogonal linear combinations of variables which most successfully capture information from a set of variables (Gbetibouo and Ringler 2009). The purpose of using PCA use is to reduce the data dimensions and prioritize the indicators.

PCA was run to prioritize the important indicators for the selected indicators of exposure, sensitivity and adaptive capacity separately using Statistical Package for Social Science (SPSS22). As the cumulative percentage of the Eigen value of first component was more than 65%, the loadings from the first PCA component used as the weights for the indicators. A two-step PCA was run separately. The first step PCA was run for each asset group separately to calculate the weight of each asset type. The second step PCA was run using the index values for the five asset groups to analyze the total adaptive capacity. This formula was used to construct all three indices (exposure, sensitivity and adaptive capacity):

$$I_j = \sum_{i=1}^{k} b1\left(\frac{a_{j,i} - x_i}{s_i}\right)$$

where, I is the index value, b is the loadings from first component from PCA for respective indicators, a is the indicator value, x is the mean indicator value, and s is the standard deviation of the indicators. Finally, the vulnerability index was calculated as: $V = E + S - AC$, where, V is the vulnerability index, E is the exposure index, S is the sensitivity index and AC is the adaptive capacity index for respective wards. A higher value of the vulnerability index indicates higher vulnerability.

17.3 Results and Discussion

17.3.1 Exposure

Table two shows the weights and coefficient trend of the exposure indicators across the two study sites. Weights represent the importance and relation of indicators to exposure. For instance: when the weight of rainfall amount, rainfall days and extreme rainfall is high, it means they impact more on exposure of these areas. The coefficient of both maximum and minimum temperature parameters show increasing trends in both areas but Kagbeni shows a slow decreasing trend for annual maximum temperature. The minimum temperature shows a rapid increasing trend relative to the maximum temperature in Pragatinagar, which is supported by the household questionnaire survey where 88% of the respondents feel that temperatures have risen in last decade. The summer maximum temperature is increasing in Pragatinagar, but minimum temperature is decreasing, meaning the gap between maximum and minimum temperature is increasing which is not good for summer crops as well. In contrast, just opposite situation is found in Kagbeni, Mustang. It is very important to notice that both maximum and minimum temperatures in winter are increasing in both areas, except the winter maximum temperature shows a slightly negative trend in Pragatinagar.

Table 17.2: Weights and coefficients for indicators of exposure.

Indicators	Pragatinagar	Kagbeni
Annual maximum temperature	−0.663 (0.006)	−0.559 (−0.001)
Annual minimum temperature	0.026 (0.016)	−0.079 (0.07)
Rainfall amount	0.797 (7.119)	0.920 (1.508)
Rainfall days	0.546 (−1)	0.846 (−0.05)
Extreme rainfall	0.730 (0.233)	0.554 (0.1)
Natural disasters	0.27 (1.75)	0.41 (2.1)

Source: Department of Hydrology and Meteorology, Nepal, Field survey 2012/13
Note: Figures in parenthesis indicate the coefficient trend of indicators.

There is a clear indication of temperature change in Kagbeni. It shows that the summer maximum temperature is in a decreasing trend for the last three decades. In contrast, the summer minimum temperature increased dramatically. After 1993, the minimum temperature is above average minimum temperature except in 2008 and 2009. Winter temperatures are drastically changed in Kagbeni VDC. Since 1994, the winter

minimum temperature was always above the average temperature for 16 years. The winter temperature in 1981 was –3.01°C but it increased to –0.33°C in 2010. Overall, the minimum temperature in last three decades was –1°C, but the average minimum temperatures for 1981–1990, 1991–2000 and 2001–2010 were –2.41°C, –0.55°C and –0.05°C respectively. It clearly shows an increasing trend in the minimum temperature for Kagbeni VDC.

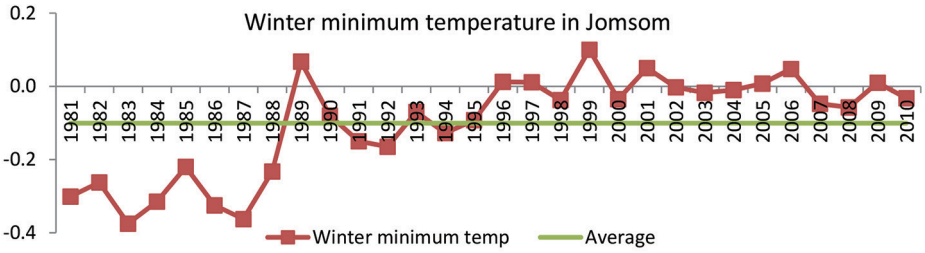

Figure 17.2: Winter minimum temperature in Kagbeni (1981–2010).

Rainfall is one of the main meteorological indicators which affects people and crops directly. The annual rainfall in Pragatinagar is 2379 mm. The rainfall coefficient shows rainfall with an increasing trend amount of 7.12 mm per year; however the data show uneven rainfall in those years. The summer rainfall data also shows an increasing trend with the coefficient of three mm, but winter rainfall show a slow decreasing trend. However, the rainfall days show an opposite trend to the rainfall amount, which is a big problem farmers are currently facing. The rainfall trend was almost constant for the last three decades, but the rainfall days decreased extremely in the last 30 years. The rainfall day's trend coefficient shows that rainfall days is decreasing by one day every year in Pragatinagar and 0.05 days in Kagbeni.

Though average annual rainfall days in Nawalparasi from 1981–2010 was 113.4 days, it was only 94.4 days in last decade (2001–2010). The data also show that rainfall days decreased immensely in last 10 years. The total rainfall days in 1981 was 115 days, but it decreased to 64 days in 2010. Rainfall days were always less than 100 days in last six years. The average for summer rainfall days was 80 days. Surprisingly, the summer average rainfall was only 67.2 days in last decade.

Mountainous VDC-Kagbeni shows almost desert like characteristics for rainfall. Average annual rainfall was only 267 mm during last 30 years. Annual, summer and winter rainfall shows an increasing trend but rainfall days are decreasing remarkably constant. It could lead to landslides and flooding in the study area. Annual rainfall in 1981 was 83 days but it was only 46 in 2010. Similarly, 48 days rainfall occurred in summer, 1981, but decreased to 24 days in 2010.

17.3.2 Sensitivity

Table 17.3: Weights and VDC mean values for indicators of sensitivity.

Indicators	Pragatinagar	Kagbeni
Fatalities	0.910 (1)	0.95 (1.18)
Land damage	0.968 (48.33)	0.93 (27.09)
Household damage	0.998 (14.44)	0.93 (2.1)
Crop damage	0.996 (466.67)	0.99 (230.5)
Non-agriculture based income	−0.231 (56)	−0.491 (75.76)

Table three shows that indicators of sensitivity have contributed to the sensitivity index as per the assumption. Although the number of natural disasters and damage looks high in Pragatinagar, all the indicators show high values in Kagbeni if we compare it by percentage. Household damage, land and crop damage due to flooding and drought in Pragatinagar and Kagbeni are the major problems related to sensitivity. Both VDCs are facing drought frequently in recent years. Over the last decades, they tackled drought 8 times during the summer season in Pragatinagar. More than two-third of the populations of both the VDCs are engaged in agriculture. Agriculture based income is around 38% in Pragatinagar. It may be due to fertile land and favorable weather condition for rice and other crops. The weather is very cold and snow falls heavily in winter in Kagbeni. Agricultural based income is only 24.24%. The weight of non-agriculture based income is negative in both VDCs. It indicates that if non-agriculture income is high, vulnerability decreases due to a high diversified source of income. The main sources of income in Kagbeni are remittances from abroad. Only 14.54% of the total population works abroad but it covers 66.57% of the total income of the family in Kagbeni. In contrast, 17.39% of total populations of Pragatinagar work abroad, mainly in the gulf countries, and their remittance covers around 25% of the total income. During survey, 67% respondents of Pragatinagar and 75% of the respondents of Kagbeni answered that their family members went abroad to work because of decreasing agriculture production and change in climate.

17.3.3 Adaptive Capacity

Figure three and four describes the separate index score for every asset. First step PCA defines the impact of individual indicators within each asset group, while the second step PCA shows the relative importance of the five types of assets which define the overall adaptive capacity.

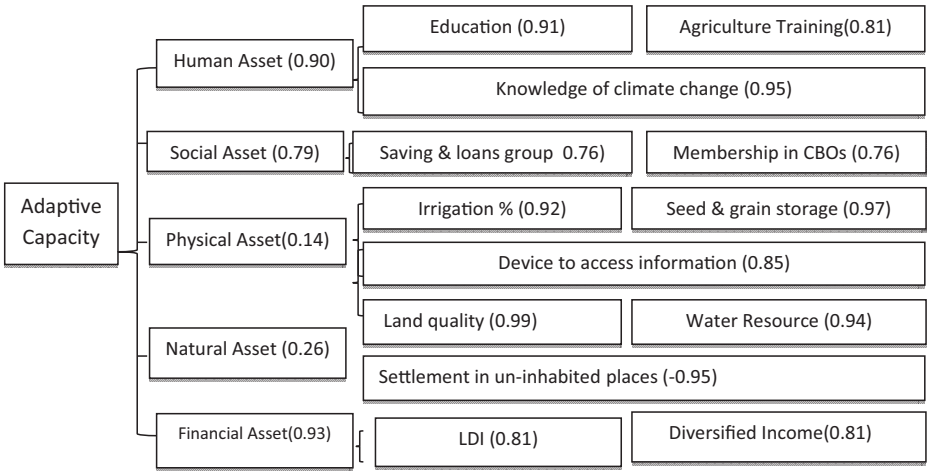

Figure 17.3: Weight of indicators and assets to structure the aggregate adaptive capacity index in Pragatinagar VDC.

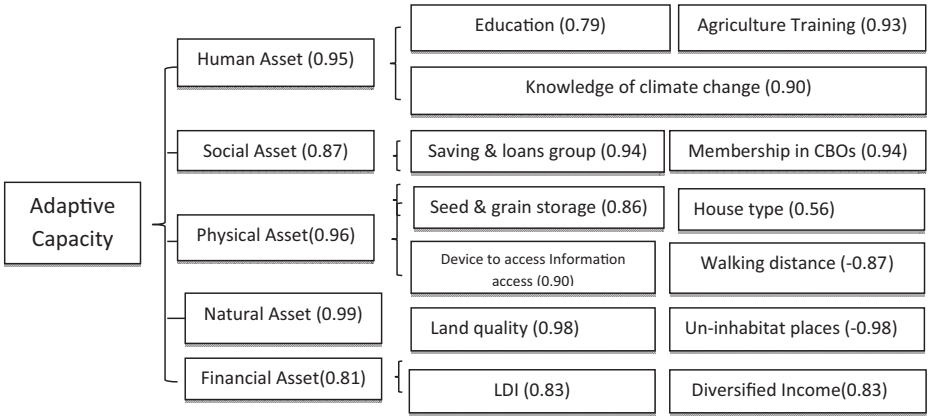

Figure 17.4: Weight of indicators and assets to structure the aggregate adaptive capacity index in Kagbeni VDC.

The higher the score, the higher the impact of indicators in each asset. For instance – for the human assets, knowledge on climate change and highest qualification of the family members received higher weights, which means they are more important indicators in human assets followed by agriculture and vocational training taken by any family members. All three indicators increase the adaptive capacity as shown by the strong positive sign of the weight.

Figure three and four show that financial assets and human assets are the two most important determinants of overall adaptive capacity in Pragatinagar, followed by social assets. Financial assets are the most convenient assets which can be converted

into other forms of assets if needed. Indicators of human assets such as – education, knowledge about climate change and skill development trainings are essential to be able to utilize physical and financial assets properly. Besides, Women's savings and loans group and membership in CBOs are also important indicators of social assets. Likewise, as all assets have weights of more than 0.8 in Kagbeni, all assets are important determinants to measure adaptive capacity. However, natural assets, physical assets and human assets are main important indicators in Kagbeni.

17.3.4 Adaptive Capacity Index and Vulnerability Index

17.3.4.1 Pragatinagar

Figure five and six displays the ward-wise index values for adaptive capacity and its five components and vulnerability of Pragatinagar. Most of the assets types are positive in ward number 8, 5 and 6 in Pragatinagar, so the overall adaptive capacity is also high in those wards. As second-step PCA shows that financial assets and human assets are the two most important determinants of adaptive capacity, followed by social assets in Pragatingar,- households of ward number 1, 5 and 8 have positive score on those assets.

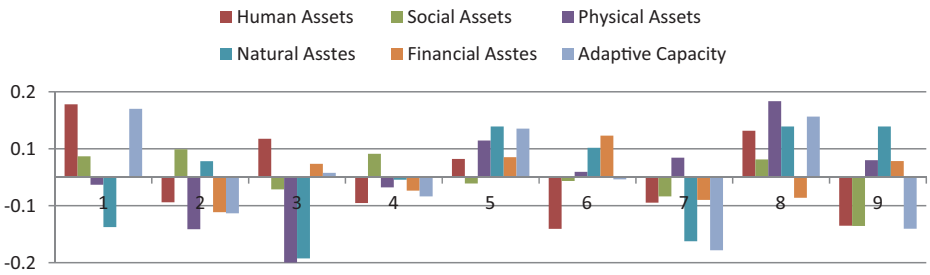

Figure 17.5: Ward-wise index scores for adaptive capacity and it's components in Pragatinagar VDC.

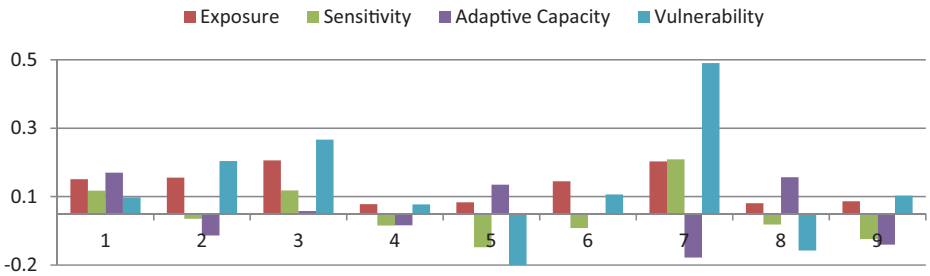

Figure 17.6: Ward-wise index scores for vulnerability and it's components in Pragatinagar VDC.

The higher the value of vulnerability index, the higher the vulnerability of wards. According to the ward-wise vulnerability index of Pragatinagar VDC, ward number 7 and 3 are the most vulnerable wards, while number 5 and 8 are the least vulnerable. Ward numbers 3 and 7 are along the river. The frequency of natural disasters, for instance, as well as house, land and crop damage due to disasters are common in these wards. So, they have high exposure and sensitivity with low adaptive capacity, resulting increased vulnerability.

17.3.4.2 Kagbeni

The mean values of individual indicators in figure seven shows that ward number 7 and 8 rank first and second in terms of possession of all assets, followed by ward number 9 and 6 in Kagbeni VDC. Ward number 1 stands last in terms of all the asset categories (except financial assets) and thus has the least adaptive capacity.

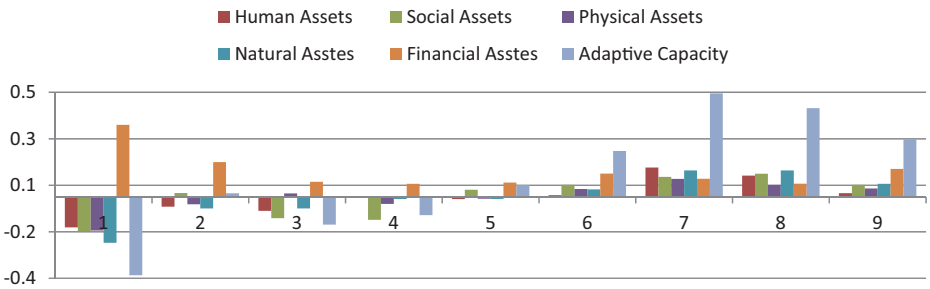

Figure 17.7: Ward-wise index scores for adaptive capacity and it's components in Kagbeni VDC.

All wards of Kagbeni VDC are highly exposed to climate change parameters and sensitive to climate related disasters. Different wards have different adaptive capacities. Based on that, the vulnerability of wards is different to one another. Ward number 1 has highest vulnerability index followed by ward number 3 and 4, as adaptive capacity is low in those wards. In contrast, adaptive capacity is high in ward number 7 and 8, so they are less vulnerable to climate change.

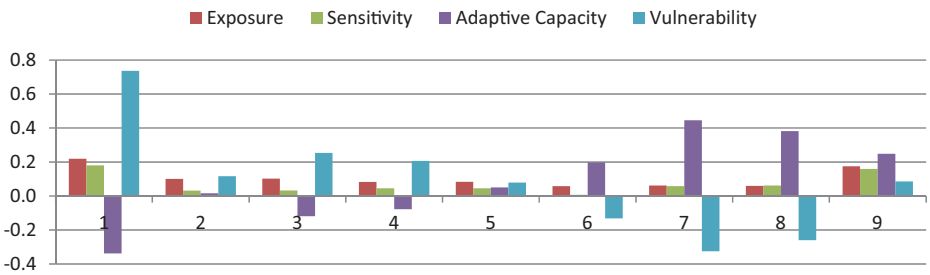

Figure 17.8: Ward-wise index scores for vulnerability and it's components in Kagbeni VDC.

17.4 Household Adaptive Capacity

Financial assets and human assets are the two most important determinants of overall adaptive capacity in Pragatinagar followed by social assets. However, natural assets, physical assets and human assets are the main important indicators in Kagbeni. This indicates that the priority of semi urban-Pragatinagar and rural area-Kagbeni have different priorities of adaptive capacity. Pragatinagar needs to focus mainly on improving financial assets. Agriculture based income is the main source of income (38%) in Pragatinagar. It may be due to fertile land and favorable weather condition for rice and other crops. Weather is very cold and snow falls heavily in winter in Kagbeni. So, agricultural based income is only 24.24%. The main source of income in Kagbeni is remittance from abroad. Only 14.54% of total population work abroad but it covers 66.57% of the total income of the family in Kagbeni. In contrast, 17.39% of the total populations of Pragatinagar work abroad mainly in the gulf countries and their remittance cover around 25% of the total income. 67% respondents of Pragatinagar and 75% respondents of Kagbeni answered that their family members went abroad to work because of decreasing agriculture production and change in climate. Farmers of Pragatinagar have less diversified income sources compared to Kagbeni. Fruit farming, livestock farming, and tourism are other sources of income in Kagbeni.

Secondly, human assets are equally important in both of the study areas. Only one-third and one-fifth of people in Pragatinagar and Kagbeni respectively, have heard about climate change and its effects. The number of literate people is also much less. Only 21% of adult people in Pragatinagar and 18% in Kagbeni have passed grade 10. Similarly, the number of people taking vocational training is also very few, only 7% in Pragatinagar and 12% in Kagbeni. Due to the lack of skilled and vocational training, 92% of the people who work abroad from Pragatinagar works as an unskilled manpower in gulf countries and their salary is 180 dollars a month in an average where as 83% of the people who work abroad from Kagbeni are literate and skilled manpower. So, they all are working in USA, Europe, Japan or India. No one from Kagbeni works in Gulf country as an unskilled labor. Women's savings and loans networks are strong in Pragatinagar. Every ward has Women's organizations, but Kagbeni has weak women's savings and loan networks. Numbers of community based organizations are increasing in recent years.

Rural VDC-Kagbeni needs to be focused mainly on access to services and facility. Access to transportation, medical and market are the main constraints for adaptive capacity in Kagbeni. Only ward number 7 and 8 have road access. Farmers living in Syangtang (ward number 1) need to walk about 10 hours to get road access, high schools, markets and health facilities. Farmers living in Ward number 2, 3, 4 and 5 also need to walk about one hour for road access. House type is also an important indicator to be focused on in Kagbeni. Eightyeigth % of the houses have mud roofs. There was continuing rainfall for 42 hours in Kagbeni in July, 2012. After that, some

of the farmers have converted the roof of house from mud roof to stones. Land quality has a higher impact in determining the adaptive capacity. More than half (54.7%) of the land is barren and only 1.05% of the land is cultivable in Kagbeni, but most of the land (80%) is agricultural land in Pragatinagar.

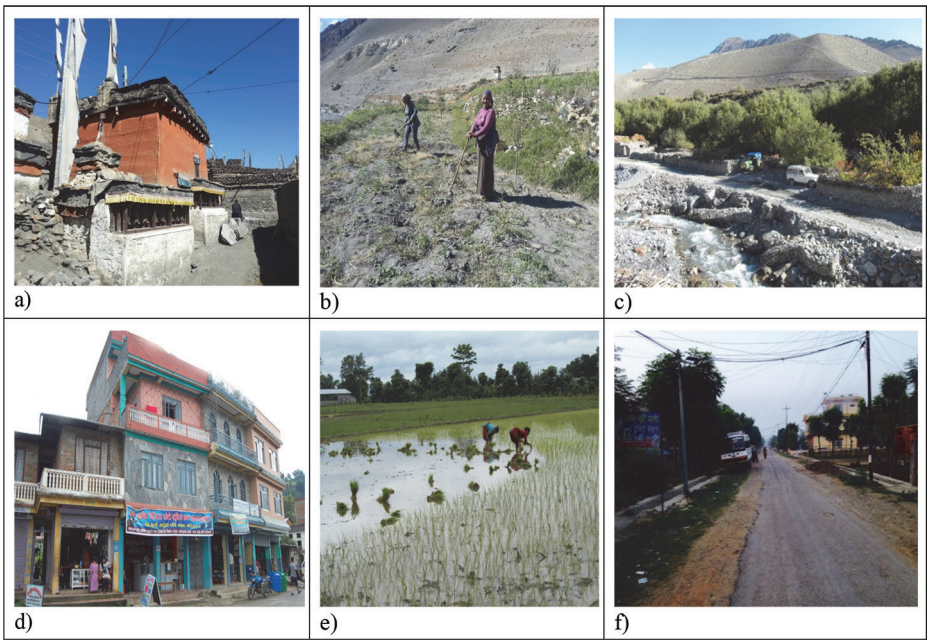

Figure 17.9: a) Traditional house in Ward number 2, Kagbeni; b) Farmers in the field in Ward number 9, Kagbeni; c) Local road in ward number 7, Kagbeni; d) Modern house in ward number 3, Pragatinagar; e) Farmers in the field ward number 1, Pragatinagar; f) Local road in ward number 8, Pragatinagar.

17.5 Conclusion and Recommendations

The results indicate that exposure of a community to long term changes in climate variables and occurrences of natural disasters are important components to determine the overall vulnerability of the study areas. The past 30 years' meteorological data shows that though the rainfall amount is increasing slightly, rainfall days are decreasing remarkably in both the study areas, mainly in Pragatinagar. Rainfall days are decreasing by one day every year in Pragatinagar and 0.05 days in Kagbeni, which is a big problem for farmers nowadays. Annual rainfall days as well as summer rainfall days decreased immensely in last decades. As such, drought and flood increased in last decades.

Both maximum and minimum temperatures show an increasing trend in both study areas. Minimum temperature is increasing significantly, mainly during the winter in Kagbeni. Since 1993, the minimum temperature is always above than average minimum temperature for 16 years. Overall, minimum temperature in last three decades was –1°C, but the average minimum temperature in 1981–1990, 1991–2000 and 2001–2010 were –2.41°C, –0.55°C and –0.05°C respectively. It clearly shows an increasing trend in the minimum temperature in Kagbeni VDC.

Fatalities, land damage, household damage and affected crops have a very strong relationship with sensitivity, and non-agriculture based income has the opposite influence on sensitivity. Kagbeni is more sensitive than the semi-urban area – Pragatingar. Both VDCs are different in nature. Pragatinagar lies in plain area, so flood and drought are the major disasters related to climate change. In contrast, Kagbeni is the mountainous VDC, where more than half of the land is barren, and snowfall, flood and wind are the main problems. Due to this, flood, drought, landslides and soil erosion are the common disasters. Both VDCs are facing drought frequently in recent years. Over the last decades, Pragatinagar and Kagbeni tackled drought eight and six times, respectively, in the summer season.

However, biophysical elements that determine the exposure for instance, temperature, rainfall, rainfall days, extreme rainfall and natural disasters are the most important components to determine the vulnerability; – they are beyond the immediate influence of the policy makers. Adaptive capacity is the component which is directly focused on for policy implications, out of three components. Adaptive capacity has indirect implications on sensitivity. Improving adaptive capacity helps to improve the sensitivity of the community. For instance, improving knowledge of farmers about climate change and literacy rate (physical assets) may decrease fatality, land and crop damage in the community. Improving the irrigation facilities (physical assets) in the community decreases the sensitivity of crops to droughts.

Financial assets and human assets are the two most important determinants of overall adaptive capacity in Pragatinagar followed by social assets. Indicators of human assets are – education, knowledge about climate change and skill development trainings; it is essential to be able to utilize physical and financial assets properly. Around 1,000 young people go abroad daily from Nepal to work as unskilled manpower. So, vocational training should be given to the people. Plumbers, electricians, basic computer training, cooking, and language training would all have a great impact to reduce vulnerability. Also, public awareness training on climate change and its effects on health as well as family planning, gender equality, leadership programs, safe drinking water and sanitation would also help to increase adaptive capacity. Besides, Women's savings and loans group and membership in CBOs are also important indicators of social assets. However, the case of Kagbeni is different. Natural assets, physical assets and human assets are the main important indicators in Kagbeni. As the ward level is considered as the unit of analysis, results show that wards having high exposure and sensitivity and low adaptive

capacity are more vulnerable to climate change (ward number 3 and 7 of Pragatinagar). Thus, vulnerability of the households of these wards can be decreased by improving the adaptive capacity, which will indirectly lower sensitivity. Though financial assets are the most convenient assets, other assets are also equally important. Ward number 1 of Kagbeni has very high financial assets, but it is considered to be the highest vulnerable ward of Kagbeni VDC due to the lower value of other assets and indicators.

Both VDCs are similar in terms of exposure to flooding and drought, but different for sensitivity and adaptive capacity. The semi-urban area- Pragatinagar, is less sensitive and has high adaptive capacity, but the mountainous rural VDC – Kagbeni, is more sensitive to climatic disasters and has low adaptive capacity. So, Kagbeni is more vulnerable than Pragatinagar. Kagbeni is far behind, mainly for transportation facility, access to technology, social networks, hospitals and markets. So, efforts from government or non-governmental organizations in Kagbeni should be geared towards improving road facilities and house types (physical assets). Human capacity should be improved in both the VDCs through education and trainings, which would facilitate adoption of non-agriculture income sources. Policy needs to focus on increasing poor people's access to technologies, skills for sustainable agriculture production. To manage natural resources such as soil, land and water is also another challenge. Agriculture is still the backbone of Pragatinagar VDC, thus irrigation facilities should be established as this would help facilitate higher production and the possibility of growing cash-crops. Also, policy should emphasize the non-agriculture livelihoods option because it helps to improve the cash income of the community and reduce their dependency on natural resources.

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