

Impact of Climate Change on the Farm-based Adaptive Strategies in Bhaktapur District

Suman Kumar Shrestha (Principal Author)*

Shambhu Prasad Khatiwada, PhD (Corresponding Author)**

Abstract

This paper explores the impact of climate change on the farm-based adaptive strategies of the communities in Suryabinayak Municipality, Bhaktapur district. The mixed-method (QUAN-QUL) research design was applied to data collection, although, quantitative method is predominant. There were 107 households sampled purposively from Ward No. 5 and 9. Primary data were collected from field observation, personal interviews, focus group discussion (FGD), and Key informant survey (KIS) methods. Then these data have been analyzed through triangulation. Secondary data were collected from archives and e-resources. Individual experiences, perceptions and views have been analyzed from the Likert (1-5) scale and the Cronbach alpha was applied to the significant test. The findings showed that more than 65 percent of households said they received information on climate change from Radio, TV, and Newspapers. One of the Key persons stated that for almost two decades, cereal crop production is declining since the last two decades. In this regard, more than 72 percent of households reported that the temperature rise is the main reason for declining in yielding of cereal crops. It has followed by the frequent floods in the second (19.6%) and droughts in the least (8.4%). They seem to have adapted diversified livelihood strategies to mitigate the adverse conditions of climate change, such as vegetable farming, floriculture, mushroom farming, poultry, animal husbandry, and fishing according to their socioeconomic systems. However, their responses are varying across time and space based on the adaptive capacity of the local community. In this situation, the cooperation of local governments, non-governmental organizations, financial institutions, and other external supports need to increase adaptive capacity. But there does not seem to be any cooperation between the stakeholders to mitigate the effects of climate change. As a result, the majority of the community still has to rely on traditional farming methods. Thus, the farm-based adaptive strategy seems to be at risk day-by-day.

*Mr Shrestha is working as the Lecturer in Geography at Sanothimi Campus, Tribhuvan University.

** Prof. Khatiwada is working in the Central Department of Education, Tribhuvan University, Kirtipur, Nepal

Keywords: Local knowledge, adaptive strategies, climate change, natural resources, and harvesting times.

Introduction

Climate change is one of the most significant environmental challenges facing humankind today. Therefore, both social and natural sciences have analyzed climate change as a cross-cutting issue. Like other subjects, geographers seem to have been analyzing the issue of climate change as an integrated subject since the earliest times. They seem to have been analyzing the theme on the perspective of human-environment interrelationships. However, the process of human adaptation is varying across times and spaces due to climate change. For this reason, geographers have been involved in scientific studies on the effects of climate change on human life since the early 19th century. Critchfield (1966) integrates the issues of climate change and their interrelationships with the global distribution and physical properties of climatic elements between the earth and atmosphere over a long period. Geographers define weather, climate and climate change in this way: the weather is the condition of the atmosphere at a particular place over a short period, and climate includes the weather pattern, using statistical data over a long enough period (at least 32 years) to yield meaningful averages. Climate change includes an increase in temperature, erratic and extreme rainfall patterns, and the increased frequency of floods, landslides, and droughts that annually result in the massive loss of lives and properties (Critchfield, 1966; Wilson, 1967; UNDP, 2009; FAO, 2014; Carbone, 2016; Rohli, 2018). At present, various meetings and conferences on geography seem to be making climate change an integral part of geographic studies since the Bali Action Plan for climate change adaptation (2009), the Meeting in Tampa (2014), and the Copenhagen Agreement. The AAG is engaged with young people and academics, the general public, and policymakers to improve understanding of climate change and share climate change in geographical research (AAG, 2014). Indeed, geographers have studied climate and its various interlinkages factors for a long time. They have understood the complex nature and spatial dimensions of climate change in an integrative and interdisciplinary research approach. Climate change also spans spatial, temporal, and organizational scales and has links with many other strong and persistent geographic themes, including nature-society relationships, environmental dynamics, and vulnerability (Aspinall, 2010, p. 715).

Rohli (2018) has examined the tremendous effects of climatic change that forcing from both biophysical conditions such as land-use and land-cover change, deforestation, and desertification) and *anthropogenic* (increasing urbanization, greenhouse effect, air pollution) conditions on human activities. Carbone (2016) argues

that the spatial and temporal nature of drought and climate change is used in decision-making processes. In this context, the Central Bureau of Statics of Nepal defines climate change as a change in the state of the climate that can be identified by the mean or the variable properties and that persists or extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or persistence anthropogenic change in the composition of the atmosphere or land use (CBS, 2016).

Climate change means that the range of climatic conditions that have expected to stress both biophysical and anthropogenic factors in the adaptation strategy of a community in a particular time and space. Humans have evolved a wide range of adaptation strategies in response to localised environmental changes, which have contributed strongly to both biological and cultural diversity. UNDP (2009) claims that people living in the poorest and most vulnerable areas are affected by climate change. They have mainly been influencing by poverty and inequalities based on wealth, gender, location, and markets. Thus, integrated adaptive strategies require empowering the adaptive capacities of vulnerable groups on the one hand and increasing investment in social protection, health, education, and other measures on the other.

Climate change has affected to decline in agricultural production and food insecurity in vulnerable areas. Losses in agricultural productivity can reduce income and diminish access to health and education, reinforcing cycles of poverty and vulnerability (UNDP, 2009). Since climate change is a global problem, and it requires global action to adapt to adverse conditions of climate change. Thus, adaptation is considered one of the aspects of climate change to develop a strategy along with mitigation. In this case, local knowledge of farmers can be considered a way to adapt to climate change. Their knowledge and experiences are tested and adapted to their cultural environments over the centuries (Woodward, 2008; Aspinall, 2010; Rohli, 2018).

Agriculture is the largest sector of the economy in Nepal, accounting for some 26.98 percent of the GDP and 64.5 percent of the labor force in 2018/19 (GoNMoF, 2019). Increasing agricultural production is essential for food security and household needs due to thousandsof people are entering in labor market annually in Nepalese. However, the effects of climate change such as increasing temperature, changes in rainfall patterns, and variation in intensity and frequency of extreme events of droughts and floods decreasing the production of crops-rice, maize, and vegetables in Nepal (CBS, 2016; CBS, 2019; GoNMoF, 2019). The government has taken various steps to adapt to the effect of climate change, such as the Everest Declaration of the Cabinet (2009), Prime Minister Agriculture Modernization Project (PMAMP), Agricultural Development Strategy (2016/17-2035), the Fifteenth Periodic plan (2019/20- 2023/24), and the Green development for sustainable agricultural

development and food security. Their efforts have addressed the impact of climate change fruitfully on the farm-based adaptive strategy of the communities doesn't seem to be very successful due to the lack of coordination between the governments and the stakeholders (Shrestha, 2009; ADS, 2015-2035; cBS, 2019; Shrestha, 2020).

On the other hand, the Nepali community has been adopting various strategies to mitigate the impacts of climate change since time immemorial, such as shifting cultivation into more resilient agroforestry, conversion of sloping terraced into irrigated level-terraced (*Bari* into *Khet*), change in cropping calendar, selecting of drought resisting seeds, and multiple cropping (Khatiwada, 2014; 2019). MOSTE (n.d.) demonstrates five cases related to local communities who were collectively engaged in utilizing indigenous, traditional, and local knowledge to deal climatic stresses. Nowadays, local communities used footing different adaptive strategies, such as the introduction of high-yielding varieties of seeds, chemical fertilizers, and pesticides, although it is still in its infancy stage in Nepal. At the same time, local governments, non-governmental organizations, financial institutions, and external supports have not properly mitigated the impacts of climate change. These factors determine the adaptive capacity of local communities that relate to their biophysical, socioeconomic, institutional, and technological conditions that replicate to adaptive measures in a particular area, like Suryabinayak Municipality. UNDP's definition of climate change has also justified the importance of this study in this Municipality. World is experiencing greater weather extremes, changes in rainfall patterns, heat and cold waves, and increasing droughts and floods. These phenomena have a negative impact on the environment and on people's lives and livelihoods (2009).

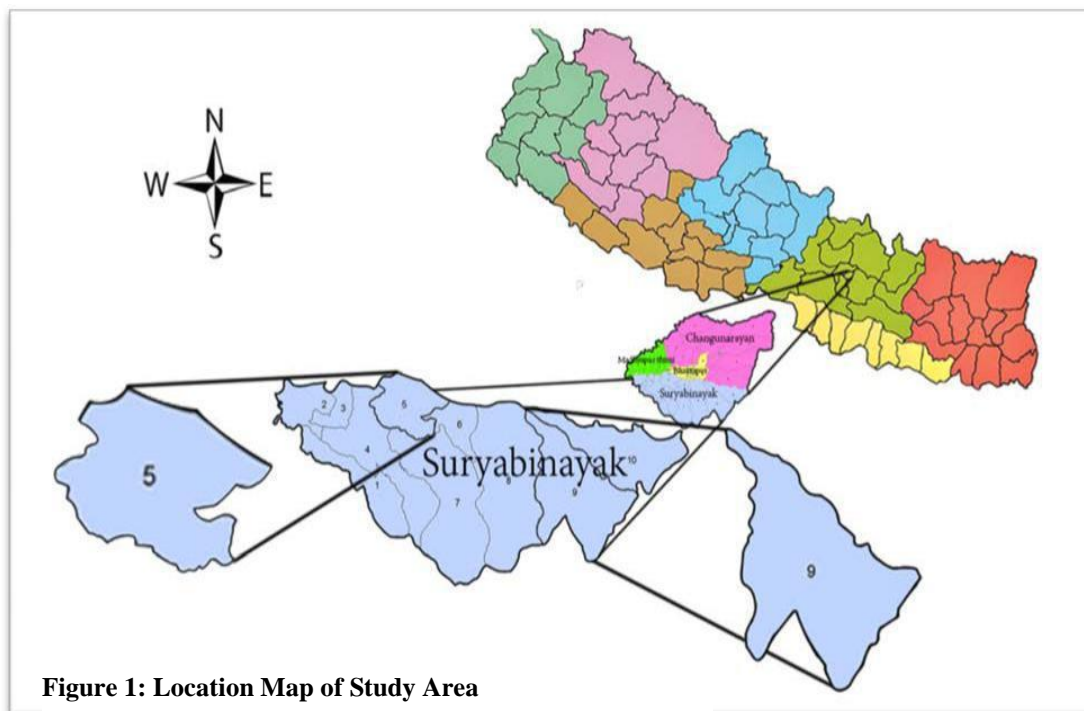
The bowl-shaped location of the study area provides a unique climatic phenomenon where both natural and human-induced factors are playing a significant role in climate change. So it seems necessary to study the impact of climate change on the farm-based adaptive strategy in geography. In this context, the focus of this paper is seeking the answer to unravel questions about why do local communities adopt a wide variety of livelihood strategies? And how they recover the adverse conditions of climate change in farm-based livelihood activities in the study area.

Methods and Materials

Study Area

Suryabinayak Municipality of Bhaktapur District has been taking as a study area, which became a municipal government after the incorporation of the village development committees (VDCs) of Katunje, Siphadol, Nankhel, Chitpol, Sirutar, Gundu, Dadhikot, and Balkot in 2014. The name of the Suryabinayak Municipality stems from the local Suryabinayak Temple. Katunje is the center of this Municipality.

Nowadays, the Municipality has divided into ten Wards (Fig.1), and the study area covers only 5 and 9 Wards. Geographically, it lies in the 27°39' N and 85°25' E and has covered an area of 42.45 Sq.km. with an altitude more than 1300 meters above mean sea level. Suryabinayak Municipality had a population of 78,490 with 1,848.99/km² densities in 2011. Increasing outmigration in search of cash income in urban areas as well abroad is one of the significant trends in the change in the demographic patterns. The government defines the municipality as an urban area, but the majority of households here still seem to be based on traditional and subsistence farming. Thus, agriculture is the source of livelihood of the Suryabinayak Municipality. Rapid urbanization and environmental degradation of the valley is one of the causes of climate change. The implementation of an integrated action plan is required for the valley to address the impact of climate change in the municipality. As a result, the proportion of people engaged in agriculture has gone down significantly.



Data collection Methods and tools

The mixed-method research design was applied to data collection, although, quantitative method is predominant. The concept of mixing of different methods probably originated in 1959, when Campbell & Fiske used multiple methodologies to study the validity of psychological traits. It is useful to triangulate data sources- as a

means for seeking convergence cross of qualitative and quantitative methods (Creswell, 2014).

A multistage sampling method was applied to identify sample size and number of households. The households involved in agriculture (from Ward No. 5 and 9 of the municipality) have identified. Out of them, only those households have selected who adopt this occupation for more than three years. There were 107 households sampled purposively from Ward No. 5 and 9.

Primary data were collected from field observation, personal interviews, focus group discussion (FGD), and Key informant survey (KIS), structured, and semi-structured questionnaire surveys. Then these data have been analyzed through triangulation for quality control. For this purpose, checklist, observation protocol sheets, questionnaires were applied to data collection tools. Secondary data were collected from different sources, such as archive documents, official records, CBS reports, national and international publications, and e-resources. Creswell and Clark (2007) provides the trustworthiness of qualitative research in a smaller sample size as compared to a larger sample size. Based on their suggestion, we have taken interview from those communities who involved in farm-based livelihood activities. Other activities like key informant survey and focus group discussion were also applied to triangulate data. Both descriptive and analytical methods were applying to data analysis. Individual experiences, perceptions and views have been analyzed from the Likert (1-5) scale and the Cronbach alpha was applied to the significant test. Maps, tables, diagrams, and descriptive statistics are using to test the significance of this paper.

Result and Discussions

Suryabinayak Municipality seems to have been inhabited by both the caste and ethnic groups since time immemorial. They are also known as indigenous people/ communities. Traditionally, these communities have adapted to diversified livelihood strategies, like agriculture, animal husbandry, cottage industry, and petty trading. Subsistence agriculture is a mainstay of livelihood (Photo 1).



Photo 1: Cropping pattern of Suryabinayak Municipality

However, traditional agricultural systems have not

been able to meet food and other households' needs. It is determined by the constrain

over access to cultivated land. As a result, they have maintained their integrated subsistence resource use strategies such as cropping calendar, seed preservation, selection of drought resisting crops, cropping, irrigation, horticulture, animal husbandry, and fertilizing with compost. They have also needed additional inputs, such as multiple cropping, crop diversification, and intensification for food security.

Nowadays, the traditional adaptive strategies have been undergoing a transformation with urbanization and improved access to market and support services. As a result, local communities have been benefiting from diversified strategies such as vegetables, floriculture, poultry, animal husbandry, and fishing. These adaptive strategies seemed to be influenced by three factors: urbanization, globalization, and climate change.

Local Knowledge and Perception on Climate Change

In this paper, the knowledge generated and continued from the community of the Suryabinayak Municipality has known as local knowledge. This knowledge is based on their experience, tested and adapted to their cultural environments over centuries. *They have considered that local knowledge is their capital to adapt to adverse conditions of climate change.* Communities that lived in both the urban and rural areas have aware of their way of life.

One of the key informants stated that local knowledge has popularly been practicing in this area through their experience in diversifying agriculture activities to mitigate crop failure in an adverse condition. However, Suryabinayak Municipality is located in an urban area, but the majority of the communities are still involved in agricultural activities. Thus, agriculture is a mainstay of their livelihoods. *It seems to be using local knowledge to increase soil fertility, cultivate weeds, increase humidity, and manage wild species.*

They have been employing their knowledge to manage natural resources, such as fertility of the soils and management of wild species. Their knowledge related to the selection of cropping varieties, cropping calendar, intercropping, planting, and harvesting times to address the effects of climate change (drought, risks, and hazards). It is also equally important to manage tiny agricultural resources to reduce poverty and to secure sustainable survival strategies through the better use of local resources. Local communities select wide varieties of adaptive strategies that turn the impact into opportunities. These strategies are vegetable farming, floriculture, mushroom farming, floriculture, poultry, fishing, and dairy. These strategies show a combination of modern and traditional knowledge to adopt adverse conditions. However, with the increasing use of modern knowledge, their traditional adaptive strategy seems to be eroding day-

by-day. Many farmers seem to agree that their traditional knowledge was backward, weak, inferior, and not be able to meet the growing needs as compared to modern ones. This finding is similar to the study of primitive Moseley, Perramond, Hapke, and Laris in 2014.

It is equally important to know how local communities find out information about climate change. They reported that they would get information about climate change from the radio, Television, and News Papers. The nature of information can be divided into three sources, such as audio, audio-video, and printed media. One of the key informants reported that the source of information as follows:

I often watch radio and television and also frequently read daily newspapers. These are just some of the reliable sources of information about climate change. Nowadays, the Internet, Facebook, and other means of social media have also been used to get information. The news provides daily weather information such as temperature, rainfall, sunrise, sunset, clouds, humidity, etc. This information gives us a lot of knowledge about climate change. Not being able to plant crops on time due to drought, erratic rainfall, fluctuation of floods in the river, are also give information about climate change.

This paper has also revealed the households' responses regarding sources of information about climate change by gender (Table 1).

Table 1
Source of the information about climate change

Sources of Climate Change	Gender				
	Male	Percent	Female	Percent	Total Percent
Newspaper	49	45.8	21	19.6	65.4
Radio, Television	8	7.5	5	4.7	12.1
Internet	15	14	9	8.4	22.4
Other	-	-	-	-	-
Total	72	67.3	35	32.7	100

Source: Field survey, 2020.

Table 1 shows the source of the information about climate change in the study area. The result indicates that newspapers as the prime source of knowledge about climate change which covers the largest percentage of the households (65.4%). It is followed by the Internet and Facebook in the second (22.4%) and Radio and Television in the least (12.1%). Gender-based responses are similar to these findings, such as male (45.8%) and females (19.6%) for newspaper in the first and Internet and Facebook in the second males (14%) and females (8.45%).

Climate and Climate Change

The urbanization process of the Kathmandu valley started in historical times, and accelerated growth has taken place since the 1970s. Nowadays, Kathmandu valley comprises two metropolises, sub-metropolises, and municipalities including Suryabinayak Municipality. Suryabinayak Municipality has changed dramatically in the last three decades. Under the influence of urbanization process, the cultivable land is declining day-by-day. The findings of Dongol & Shrestha (2017) on the impact of urbanization on arable land in Madhyapur Municipality seem to be similar in the study area. Their estimation shows that 17 ha per year of agricultural land has been depleting from 2000 to 2014.

Most of the expanded settlements do not have sanitation facilities. Due to the lack of a proper drainage system, water has polluted the river, which causes irrigation problems. Other factors such as increasing the incidence of floods by encroaching on river banks, lack of waste management, unregulated industrial development, and manufacturing establishment, air pollution etc. have also contributed to climate change. The increasing number of vehicles and the expansion of roads are also accompanying emissions of CO₂, SO₂, and NO_x consumption of ozone-depleting substances in the study area.

The average temperature condition of the Kathmandu valley has recorded 19.2 and 19.7 degrees C in 2003 and 2017 respectively and it was 20.3 degrees C in 2010. The above mentioned three years' average temperature (19.8 degrees C), this figure shows that the temperatures in this municipality have been changing for the last two decades. The mean annual precipitation of the valley has recorded at 1454.84 mm from 1981-2010, and it was 1439.7 mm from 1971 to 2000. The fluctuation of precipitation has determined by the onset of the monsoon. Both environmental statistics of the temperature and precipitation indicate the situation of climate change in this municipality. In addition, when the drought, frequent rains, hail, and floods reduce the production of food grains, local communities have been considering an indicator of climate change. They involved in the farm-based livelihood activities seem to have received information about climate change in various ways, such as drought, excess rainfall, intermittent rains, crop failure, declining yields, fluctuation of water level in local rivers and tube wells.

The community's response to the effects of climate change is of great importance. A Likert scale is applied to measure their perceptions and views. It was devised by Likert in 1932 and assumed that the intensity of an individual attitude is a linear progression on the strong agreement or strong disagreement. For this purpose, a 5-point scale was used to express an individual perception, such as 1 for strongly disagree, 2, 3, 4, and 5 for disagree, undecided, agree and strongly agree (Table 2). The table used

abbreviation symbolized SD for strongly disagree, D for disagree, U for undecided, A for agree and SA for strongly agree.

Table 2: Households' perception on climate change

Symbol	Gender				
	Male	Percent	Female	Percent	Total Percent
SD	2	1.9	1	0.9	2.8
D	8	7.5	4	3.7	11.2
U	6	5.6	4	3.7	9.3
A	40	37.4	24	22.4	59.8
SA	16	15	2	1.9	16.9
Total	72	67.3	35	32.7	100

Source: Field survey, 2020.

Table 2 shows the households' perception on climate change in the study area. The Likert scale result indicates that the largest percentage of the households (59.8 %) were agreed on the impact of climate change in their farm-based livelihood activities. It is followed by the percentage of agreement in the second (16.9%) and least by the strongly disagreement (1.9%). Gender-based responses are similar to the households' perception on climate change.

Agreeing on the impact of climate change, one of the key informant said: Now we have changed our traditional subsistence farming due to frequent effect of drought, erratic rainfall, and diseases. When there is no rain in time, planting has delayed, lack of irrigation has the effect of drought when there is a lot of rain, hail comes, and when the disease destroys the crop. It requires rainfall on time or irrigation facility, compost and cow dung. However, under the pressure of urbanization the number of animal is below productivity their profession with the change of weather. Therefore, we have changed our traditional practices into market-oriented cash crops, such as vegetable farming, floriculture, poultry, mushroom farming, fishing, and animal husbandry.

According to him, change in the nature of the crop has increased both labor and expenses. The cost of improved varieties of fertilizers, seeds, pesticides, deep boring, and human labor have increased. All of these changes may be due to climate change.

Deforestation and Climate Change

Forest is an important natural resource of Suryabinayak Municipality. The forest area has covered about 245.17 ha of the total area. The Cabinet in February 2015, had

decided to construct National Zoological Garden in Suryabinayak. However, deforestation is a major problem in this Municipality due to collection of firewood, fodder, and litter, grazing, and cutting down of trees. The local community seems to agree that deforestation will reduce water and increase temperatures. The perceptions of the local community about deforestation have shown in Table 3.

One of key informant stated that:

A decade ago, it used to be very cold in winter, the sun would shine the only afternoon, but now the sun comes in the morning, it doesn't feel so cold in the afternoon. Deforestation, construction of concrete houses and roads, and pollution of river water have played a role in climate change. Brick kilns, vehicles, and dust particles are also other contributing factors.

Table 3: Local perception of deforestation and climate change

Symbol	Gender				
	Male	Percent	Female	Percent	Total Percent
SD	-	-	-	-	-
D	1	0.9	-	-	0.9
U	2	1.9	-	-	1.9
A	44	41.1	20	18.7	59.8
SA	25	23.4	15	14	37.4
Total	72	67.3	35	32.7	100

Source: Field survey, 2020

Table: 3 shows the local perception of deforestation and climate change. The perception of the local community that deforestation will increase the temperature and decrease the rainfall has measured on Likert scale. The result indicates that 59.8 % of communities have found agreeing and 37.4% strongly agreeing with the relationship between deforestation and climate change.

Adaptive Strategies of Climate Change

The local communities of the Suryabinayak Municipality are involved in diversified livelihood activities to earn their living. They have adopted a new market-oriented cash crop in changing situations. They seem to have two main reasons for changing traditional farming: urbanization and climate change. The size of our arable land is declining day-by-day due to urbanization, and it became difficult to fulfill family needs from traditional farming. As a result, they need additional inputs to increase productivity for addressing the growing demand. Thus, Thus, market-oriented cash crops, such as vegetables, poultry, animal husbandry, floriculture, and fishing, are better

alternatives to meet their food shortage (Table 4). However, the changing strategies are varying over space, and time depends on the amount and types of land (Subedi & Pandey, 2002; Khatiwada, 2014).

Table 4: Households involved in farm-based livelihood

Particulars	Gender				Total Percent
	Male	Percent	Female	Percent	
Vegetables	41	38.3	26	24.3	62.6
Poultry Farm	12	11.2	4	3.7	15
Animal Husbandry	12	11.2	3	2.8	14
Floriculture	2	1.9	-	-	1.9
Fish Farm	1	0.9	2	1.9	2.8
Others	4	3.7	-	-	3.7
Total	72	67.3	35	32.7	100

Source: Field survey, 2020

Table 4 shows the households involved in farm-based livelihood activities in the Suryabinayak Municipality. The result indicates that the majority of households (62.6%) have adopted vegetable farming as a source of income in the first. It has followed by poultry in the second (15%) and floriculture in the least (1.9%). The result of gender participation in the farm-based activities are also similar to the involvement of vegetable farming. One of the key informants reported:

The local community stated that we are involved in vegetable farming to generate better income than traditional farming practices. It requires a low amount of investment as compared to other occupations. It can operate by the involvement of one's family members. If the weather conditions and market prices are supporting, we take a better profit from this occupation. I am also involved in this profession over the generations. Now I am satisfied with this profession family member are directly or indirectly involved in vegetable farming.'

However, the next farmer said:

Farm-based livelihood activities are often considered a very high labor-intensive endeavor that is difficult to operate by the labor of women, older, and children for hoeing, manuring, weeding, irrigating, harvesting, grading, and marketing. Sometimes, we hired additional helping hands from outside when there is a lot of work. On the other hand, it requires investment to purchase high-yielding varieties (HYV) of seeds, chemical fertilizers, pesticides, irrigation, power supply, tools, and equipment.

The above two statements clarify the local adaptive strategy of the communities of the Suryabinayak Municipality is changing over the last two centuries. Denevan (1983) argues that 'lots of potential adaptations existed within any given livelihood system as there were always individuals in the group who would undertake slightly different approaches to farming' is still valid in the study area (cited in Moseley, Perramond, Hapke, & Laris, 2014, p. 96).

Investment in farm inputs

Investment in agricultural inputs has increased after the adoption of market-oriented cash crops. They seem to have invested in buying chemical fertilizers, improved varieties of seeds, pesticides. Hiring labor in agricultural works, irrigation, and the sale of farm products will also increase the additional cost. They are discussed as follows:

Chemical Fertilizers: Chemical fertilizers have been extensively using to increase agricultural production in the region for the past four decades. They have been using different types of chemical fertilizers, such as phosphorus, potash, nitrogen, and urea. This paper the use of chemical fertilizers by farm-households in Suryabinayak Municipality. The result indicates that the majority of households (31.7 %) have been using chemical fertilizers. More than 30 percent seem to agree that the use of chemical fertilizers increases production.

High Yielding Varieties Seeds and pesticides: With the adoption of chemical fertilizers, improved varieties of seeds and pesticides have also been used to increased production in this area. One of the key informant reported that 'we cannot get better income from farming without the application of improved varieties of seeds and pesticides. So, we will give equal importance to purchase a high-yielding variety of seeds, fertilizers, and pesticides'.

The result indicates that the largest percentage of households (50.5%) using HYV seeds and pesticides to meet their food deficit. They seem to strongly agree that agricultural inputs are essential to the alternate impact of climate change.

Impact of Climate Change on Farm-based Adaptive Strategies

Climate change seems to have affected the agricultural livelihoods of the municipal community. Their microeconomics of activity has comprised a process of producing food, fiber, and other products by cultivating fields and domesticating livestock. They are still dependent on agricultural activities such as vegetables, poultry, fishing, animal husbandry, etc. earn income. However, the spatial patterns of their livelihood activities are varies based on wealth, farm size, and level of education. Besides, municipalities and stakeholders do not seem to be able to promote the

agricultural sector. FAO (2009) projected the relationship between population growth and food production. For example, if the population grows by 30% in 2050, 70% of food products will require to meet that demand.

The perceptions of local communities are also important to analyze the possible impacts of climate change. As far as they know, most of the farms became barren due to the drought three years ago. There was no rain at the time of planting, but later that year, heavy rains flooded the area and had destroyed people, wealth, and crops.

The result indicates that 72 percent of households' report rising temperatures in the first, landslides in the second (8.4%), and drought in the least to affect farm-base livelihoods. One of the key informant said that:

We often analyze some of the attributes, such as droughts, exceed rainfall, diseases, crop failure, declining yields, and decreasing food security are an indicator of the effects of climate change. Besides, when water is scarce, more water needs in the fields. When production decreases, the price of food grains increases in the market, and our livelihoods are at risk.

Household Income: Household income has taken another example of the impact of climate change. When the community chooses market-oriented cash crops, their income also starts to increase. But their income varies from house to house, depending on the family's social status, culture, nature of crops, and amount and type of arable land. For example, the household income seems to be between Rs 500,000 (74%) and Rs 6 million (1.9%). Other factors like drought, disease, excess rainfall, lack of improved varieties of fertilizers, seeds, and pesticides, market prices are equally important to reduce production and productivity.

Air pollution: Air pollution and climate change are also closely related. It is mainly due to excessive pressure of vehicles, lack of sewerage system, lack of garbage management, lack of regulation of smoke control in brick kilns and factories, burning of agricultural residues, and emission of carbon dioxide. These factors support to depletion of the ozone layer and lower temperatures. Based on the Likert scale, 50.5 percent of households agree that air pollution affects climate change and crop production.

Discussion

The Cronbach alphas used to analyze the validity and reliability test on the impact of climate change on local adaptive strategies in the study area. It is based on the precision and accuracy of measurement that represents sampling procedures suggested by Cohen, Manion, and Morrison in 2007. The Cronbach alpha provides a coefficient of

inter-item correlations that measures the internal consistency among the items. These statistics have measured by using the following formula:

Alpha= $\frac{\sum r_{ii}}{1+(n-1) \bar{r}_{ii}}$
 Where, n stands for the number of items in the test or questionnaires
 \bar{r}_{ii} for the average of all the inter-item correlations.

Let us imagine that the number of items in the survey is ten, then the computed average correlation is 0.738

Therefore, $\alpha = \frac{\sum r_{ii}}{1+(n-1) \bar{r}_{ii}}$
 $= \frac{10(0.738)}{1+(10-1) 0.738} = \frac{7.38}{7.64} = 0.97$

The computed alpha ranges from 0.60 to 0.90 and characterized to:

1. >0.90 very highly reliable
2. 0.80–0.90 highly reliable
3. 0.70–0.79 reliable
4. 0.60–0.69 marginally/minimally reliable
5. <0.60 unacceptably low reliability

Table 5 shows the Cronbach alpha to test reliability statistics.

Table 5

Cronbach alpha to test reliability statistic

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.199	.060	42
Field Survey, 2020		

Table 5 shows the computed Cronbach alpha index. The standardized value of 0.97 is less than the table value (0.90). So, the legitimacy analysis of the impact of climate change on local adaptive strategies shows highly reliable. Because, the **alpha** coefficient for the items is 0. 839, suggesting that the items have relatively high internal consistency. However, Cronbach's alpha simply provides us with an overall reliability coefficient for a set of variables (e.g., questions). Our questions reflect different underlying conditions based both biophysical and anthropogenic dimensions. In this situation, Cronbach's alpha will not be able to distinguish between these.

Conclusion

Geographic studies are mainly seeking the causal relationship between two variables, like the farm-based livelihood activities and the impact of climate change.

Nowadays, the adaptation of climate change in agricultural activities has been paying interest not only to academic research but also in policy levels of national and international organizations, like the Suryabinayak Municipality, where more than 50 percent of the population dependent on this sectors. Among them, the largest number of people is moving towards miserable conditions due to climate change. The largest number of communities exposed to the impact of climate change through increased temperature, changes in rainfall patterns, and variations in intensity and frequency of extreme events of droughts and floods and ultimately influences food security due to crop failure.

The local communities of the Suryabinayak Municipality have been paying different adaptive strategies to mitigate the adverse effects of climate change. Their knowledge seems to be a useful asset for planning adaptation and mitigation of climatic threats in the study area. However, the issue of climate change is comprising a national as well as a global concern. The local communities seem to be aware to mitigate the impact of climate change by adopting alternative farming practices, such as vegetable farming, floriculture, poultry, fishing, mushroom farming and animal husbandry. The impact of climate change is a dynamic and evolving process. Thus, it requires a collaborative measure to address adverse conditions of climate change. For example, supply of higher-yielding and short growing vegetable seeds, chemical fertilizers, pesticides and other inputs like loan, irrigation facilities and mechanization tools to increase food security and household incomes.

This paper concludes that when weather conditions are favorable, then a high-yielding variety of seeds proved a success to generate considerable income. The majority of the community believes that local knowledge and skills are more effective than modern knowledge to address extreme conditions of the frequent droughts. Cronbach's alpha index and Likert scale have used to conclude the legitimacy analysis of the impact of climate change on local adaptive strategies shows highly reliable in the study area. However, there are no alternative livelihood strategies to adapt to the growing population as well as in impervious conditions. As a result, the participation of young people in these livelihood activities was gradually decreasing day-by-day. They were seeking alternative jobs in non-farm sectors, and most of them preferring foreign employment as a reliable source of income. Thus, the Local Government should promote local knowledge that is suitable in this locality.

References

- Aspinall, R. (2010). Geographical perspectives on climate change. *Annals of the Association of American Geographers*, 100 (4), pp. 715–718.

- ADS, (2013). *Preparation of the agriculture development strategy (ADS): Assessment Report*. Kathmandu: Agriculture Development Strategy (ADS).
- Beckford, C. L. & Rhiney, K. (Eds.) (2016). *Globalization, agriculture and food in the Caribbean: Climate change, gender and geography*. London: Palgrave Macmillan Publishers Ltd.
- Carbone, G. (2016). *Exercises for weather and climate*. USA: Pearson Education, Inc.
- Critchfield, H. J. (1966). *General climatology*. New Jersey: Prentice-Hall, Inc.
- CBS (2019). *Environment statistics of Nepal*. Kathmandu: Government of Nepal Central Bureau of Statistics (CBS).
- CBS (2016). *Compendium of environmental statistics, Nepal*. Kathmandu: Government of Nepal Central Bureau of Statistics (CBS).
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative and mixed methods approaches*. New Delhi: SAGE Publication Inc.
- Dongol, R. & Shrestha, R. (2017). *Land use change due to urbanization and its impact on local food security: Case of Madhyapur Thimi Municipality*. Paper presentation in International Conference on Sustainable Development at Dhaka.
- FAO (2014) *Managing climate risks and adapting to climate change in the agriculture sector in Nepal*. Rome: Food and Agriculture Organization of the United Nations (FAO).
- GoNMoF (2019). *Economic survey 2018/19*. Kathmandu: Government of Nepal, Ministry of Finance.
- GoNMoI (n.d.). *Agriculture sector profile*. Kathmandu: Government of Nepal, Ministry of Industry.
- Khatriwada, S. P. (2014). *Spatial patterns of the agro-based livelihoods of the communities of the Tankhuwakhola watershed, eastern hills, Nepal*. Kathmandu: Unpublished PhD Thesis, Deans Office, Faculty of Humanity and Social Sciences.
- Moseley, W. G., Perramond, E., Hapke, H. M. & Laris, P. (2014). *An introduction to human-environment geography: Local dynamics and global processes*. UK: Wiley-Blackwell Publishing Ltd.
- MOSTE (nd). *Understanding indigenous and traditional social institutions for climate change adaptation in Nepal*. Kathmandu: Ministry of Science, Technology and Environment (MOSTE), Mainstreaming Climate Change Risk Management in Development Project.
- Rohli, R. V. (2018). *Climatology*. Massachusetts: Jones & Bartlett Learning, Company
- Shrestha, S. K. (2020). *Impact of climate change on farm based livelihood activities of the community of Suryabinayak Municipality, Bhaktapur District*. An

unpublished mini-research report submitted to the Research Directorate, Office of the Rector, Tribhuvan University Kathmandu.

UNDP (2009). *Linking climate change policies to human development analysis and advocacy*. United Nations Development Programme Human Development Report Office.