

**People's Perception on Climate Change and Adaptation Strategy
(A Study in Dudhauri Municipality, Sindhuli, Nepal)**



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LETTER OF DECLARATION

I hereby declare that the work presented in this dissertation is a genuine work done originally by me and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

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LETTER OF RECOMMENDATION

This is to certify that **Mr. Ram Chandra Subedi** has completed this dissertation work entitled “**People’s perception on Climate Change and Adaptation Strategy**” as partial fulfillment of the requirement for the degree of Masters of Arts in Sociology under my supervision and guidance. To my knowledge, this research has not been submitted for any other degree, anywhere else. I therefore, recommend the dissertation for acceptance and approval.

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ABSTRACT

This study entitled “People’s perception on Climate Change and Adaptation Strategy, A study in Dudhauri Municipality, Sindhuli, Nepal” was conducted from January 2019 to February 2019 with the broad objective to assess the perception of peoples on climate change and adaptation strategies adopted by the local people of Dudhauri municipality.

Human-caused climate change is clearly one of the most important issues of the twenty-first century, and understanding climate change its sources, impacts, and potential amelioration is an inherently sociological concern. It is well established that the primary drivers of global climate change are social-structural and sociocultural phenomena.

Hundred and sixteen households were surveyed with semi-structured questionnaire to document the people’s perception and adaptation strategy along with focus group discussion to assess the perception of people on climate change. The data were analyzed by qualitative as well as quantitative methods. The farmer’s perception on climate change was presented in bar diagram, pie-chart and tables.

The study concluded that, climatic variation has been observed with increasing temperature and unpredictable rainfall. Mosquitoes are sustain all the month, flowering season of different plants shift earlier than past, new pests and diseases are introduced are the sign of Climate Change face by the community and it has adverse impact on different component of the environment and society. Most of the respondents reported changes in climate and agriculture production practices. Farmers had shifted from large animals to smaller ones as a coping strategy. It shows its impacts on agriculture via Flood, drought and landslide etc. Adoption of new crop varieties, crop rotation, use of plastic tunnel in vegetable farming, water collection from kitchen sink were the major new practices introduced in the area which have a greater potential for out- and up-scaling. In response of these climatic variation and its impacts, local community developed the coping measures on the basis of event specific local knowledge and innovation.

Key words: Adaptation, Adaptive measures, Climate Change, Flood, Perception

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ACRONYMS AND ABBREVIATIONS

APCAS	Asia and Pacific Commission on Agricultural Statistics
APN	Asia Pacific Network
CBS	Central Bureau of Statistics
CC	Climate Change
DFID	Department for International Development
DHM	Department of Hydrology and Meteorology
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GHG	Greenhouse gas
GO	Governmental Organization
HH	Household
ICIMOD	International Centre of Integrated Mountain Development
IPCC	Intergovernmental Panel on Climate Change
LAPA	Local Adaptation Plan of Action
MoE	Ministry of Environment
MoEST	Ministry of Environmental Science and Technology
NAPA	National Adaptation Programme of Action
NCVST	Nepal Climate Vulnerability Study Team
NGO	Non-Governmental Organization
PAN	Practical Action Nepal
TAR	Third Assessment Report
UNFCCC	United Nation Framework Convention on Climate Change
VDC	Village Development Committee
WHO	World Health Organization

LOCAL TERMS AND UNITS

Kattha	Nepali land area equivalent to 0.03ha per Kattha
Gt	Gega ton
ha	Hectare
mm	Millimeter
ppm	Parts Per Million
sq. km	Square kilometer
1 sq.km	100ha
1ha	29.58 Kattha

CHAPTER I: INTRODUCTION

1.1 Background

Climate change is a clear example of the dialectical of nature and society therefore it is central for sociology (Bhatasara, 2015). Global climate change is a social problem as much as it is a physical one; purely technical responses to climate change will not address the complex social, cultural, and behavioral changes that must occur if humans are to successfully confront the potential complex environmental challenges ahead (Nagel et al., 2009). According to open education sociology dictionary climate change refers to long term shifts in temperature and climate due to human activity.

Human-caused climate change is clearly one of the most important issues of the twenty-first century, and understanding climate change its sources, impacts, and potential amelioration is an inherently sociological concern. It is well established that the primary drivers of global climate change are social-structural and sociocultural phenomena. Since sociology possesses considerable knowledge of social and cultural systems, it has a great deal to offer in helping understand the societal origins of climate change, as well as how social, economic, political, and cultural factors are likely to affect efforts to both mitigate and adapt to climate change. Sociology can also make important contributions to clarifying the adverse social impacts of increasing climate change, such as forced migration, increased social conflict, and growing levels of injustice (Dunlap and RJ. 2015).

Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the framework convention on climate change, where climate change refers to the change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. (IPCC, 2007a). Globally, Nepal ranks as fourth most vulnerable country to the impact of climate change (maplecroft.com). Climate change is expected to have serious environmental, economic, and social impacts on South Asia in particular, where rural farmers whose livelihoods depend on the use of natural resources are likely to bear the brunt of its adverse impacts (ICIMOD, 2009). Climatic variability in this fragile ecosystem and nature based livelihood system of the rural communities has further threatened the livelihood

of the local people. Study also indicates that the observed warming trend is not uniform across the country. Heavy precipitation events have intensified and the reoccurrence of cold nights, cold days, and frost have become lesser while hot days and hot nights are reoccurring more often over the past 50 years (Field *et al.*, 2014).

Climate change is the change of climate which is contributed directly or indirectly to human activity. It is one of the most serious challenges of this century. It is affecting people, animals, plants and natural environments-from the deepest ocean to the highest mountain. (Shrestha *et al.*, 1999). People are not only the victims of negative impacts of climate change; they are the drivers of climate change and the essential agents for redirecting development trajectories. The impacts of climate change will increasingly affect the daily lives of people everywhere in terms of employment and livelihoods, health, housing, water, food security and nutrition, and the realization of gender equality and other human rights.

Most of perception based studies show that local peoples' perception matches with these trends of temperature and precipitation (Devkota, 2014). However; change in climatic factors, its impacts and perception at different regions are still remained to be documented (Shrestha *et al.*, 2012) which are fundamental to identify local and global contexts, and for constructing generalized theory around how people response towards changing environment and associated risks (Crona *et al.*, 2013). Sociological studies gives the shape and operation of the global climate change, provides strong foundation for the scarcity, resource allocation and environmental decision making. Sociological study on climate change drawing on globalization, world system and political economy models have the potential offer insights into questions of conflict and security and effects on civil society of militarized response to climate change (Nagel *et al.*, 2009).

Adaptation is processes through which societies make themselves better to cope with an uncertain future. Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes (UNFCCC, 2006). Grundmann *et al.*, 2012 posited that, whether we want to protect climate from society (mitigation) or society from climate (adaptation) what is clear is that social conduct alters natural process and these in turn alter social relations. Adaption methods are those strategies that enable the individual or the community to cope with or adjust to the impact and effect of the climate in the local areas. Such strategy

includes the adaption of the efficient environment resource management practices, as planting of early maturing crops, hardly varieties of crops and selective keeping of livestock. The Chure hills are the most recent mountain system of the Himalayan orogeny. The fragile geology makes the Chure more susceptible to any form of human disturbances. The Chure range receives a greater amount and higher intensities of rainfall (Ghimire, 2012 cited from neupane and dhakal, 2017). As a result, rainfall induced landslides, slope degradation, and floods are major hazards in Chure. The land use change and the climatic changes occurring in the Chure region have had adverse implications on both the environment and the livelihood of populations residing in the region. Since 1950s, a huge population has inhabited the Chure range. Settlements and agricultural activities are predominantly located on the flatlands and the river valleys. The slopes are susceptible to debris flow, landslides, bank cutting, and soil erosion, along with flood problems (Neupane and Dhakal, 2017). Climate change indicators and impacts include unpredictable and heavy rainfall events, ravaging flood waters from all the three major rivers –Sun Koshi, Roshi, and Kamala, and decreasing agriculture production in Sindhuli district (MOSTE, 2017).

1.2 Rationale of the Research

Climate change is an emerging problem of global scale having deep impacts at local scale. Contribution of Nepal to climate change is very low but the impact is very high. Climate change represents one of the urgent, catastrophic issues that sociologists need to tackle (Bhatasara, 2015). A small changes in the climatic conditions for a short period could largely affect the livelihood of the people. Increasing temperature more variation in summer and winter temperature, more erratic and higher intensity of rainfall indicates the possibility of drought and flood/landslide more often with greater damage to crops. Study done by CBS 2017 found that most of the household observed change in temperature as well as decrease in monsoon duration and winter rain, increase in invasive species of shrubs. Due to increasing temperature peoples observed early flowering/fruited of plants. The people in chitwan related the case of increase in temperature with appearance of mosquito earlier after winter (Maskey, 2013).

Increasing drought events in the recent decades is the major issues throughout the country and the poor farmers, women and rainfed farming systems have got affected adversely to a great extent. Inhabitants of rural areas are still not known about climate change and its

impacts on various aspects but they perceive unexpected events to their surroundings (Chaudhary and Bawa, 2011). People are good observers of their local environment who can identify and interpret changes occurring in their surroundings, which can play a key role in shaping collective response to climate change (Byg and Salick, 2009). As there is much to learn from community-based approaches in different geographical locations about climate change. Micro level studies to the impact of climate change on people's livelihood and their consequent responses are relatively few.

The social sciences, and sociology, play a central role in analyzing the effects of human activities on natural systems. Social sciences can scrutinize those phenomena and relations that, within human societies, produce social structures that ultimately have negative impacts on the environment. Very few research study has been done in the field of climate change in study area, thus this study is important in a way that it takes into account the local people's perception on climate change and aims at understanding the localized impact of the climate which is not directly visible but nevertheless are happening indirectly.

1.3 Research Questions

The answers of the following research questions will be found out through this study.

- ✓ How the climate is changing in the study area: people's experience?
- ✓ What adaptation strategies do the local people pursue to respond to these changes?

1.4 Objectives

The general objective of this study is to assess the perception of peoples on climate change and adaptation strategies adopt by the local people. The specific objectives of the study are:

- To assess the perception of peoples on climate change
- To explore the adaptation strategies practiced by local people to minimize the impact of climate change.

1.5 Limitations

This research has the following limitations

- The study was based on household interviews within the short period of time. There is always a scope of in-depth study.
- It was assumed that sample size is adequate, but there is scope of better representation, provided more time is given.

1.6 Significance of the study

The study area was conducting in Dudhauri Municipality. Study area is selected for the following criteria:

- The study area lies in the Chure and Mahabharat range. Chure is the youngest mountain of the world which is very fragile and vulnerable region.
- There is no any study related to climate change
- Impacts of climate change related issues seen by the people yet not assessed at study site.

CHAPTER II: LITERATURE REVIEW

2.1 Climate Change Scenarios and People's Perception

Sociology, science of society trigger towards climate change. Sociologist believes that climate change is inherently a social problem, traditionally focused on peoples behaviors rather than environment but now attention goes on slowly towards the climate change UNFCCC defines climate change as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of global atmosphere and which is in addition to natural climate variability observed over comparable time period”. Inhabitants of rural areas are still not known about climate change and its impacts on various aspects but they perceive unexpected events to their surroundings (Chaudhary and Bawa, 2011). Although climate change is a universal phenomenon, its indicators and manifestations are entirely local, so are the adaptation choices, strategies and practices. There has, thus, been increasing emphasis on the bottom-up approaches that climate change studies should be conducted at the local level where adaptations ultimately take place (Smit and Wandel, 2006). Due to existing social marginalization, discrimination or insufficient protective policies and institutions, the impacts of climate change are also likely to be unevenly distributed among different social groups. Certain characteristics such as age, gender, ethnicity, social class and caste are strongly associated with social vulnerability.

Increasing carbon emissions and diminishing carbon sinks around the world underline the ‘anthropogenic’ nature of climate change and reflect the ways human societies function and change over time. Given the breadth of factors associated with vulnerability to climate change, and how pervasive social dimensions are among those factors, the wide range of potential impacts of climate change should not come as a surprise. Due to existing social marginalization, discrimination or insufficient protective policies and institutions, the impacts of climate change are also likely to be unevenly distributed among different social groups. Certain characteristics such as age, gender, ethnicity, social class and caste are strongly associated with social vulnerability. For example, gender norms, roles and relations already determine different impacts on women and men, including in relation to health (WHO, 2011).

According to FAO (2007) agriculture, forestry, and fisheries are highly sensitive to climate change and climate change is very likely to have a serious impact on their productive

functions. As a consequence, production of food, fiber, energy, or industrial crops, livestock, poultry, fish and forest products may decrease. Central and South Asia is projected to be a highly vulnerable zone to changes in agricultural outputs and up to 30% decrease in crop production is projected due to temperature rises and water stress.

It is reported that the developing countries are more susceptible to climate change impacts as they have limited capacity to adapt. It is clear that climate change will, in many parts of the world, adversely affect socio-economic sectors, including water resources, agriculture, forestry, fisheries and human settlements, ecological systems and human health with development countries being the most vulnerable (IPCC, 2001). The least developed countries are among the most vulnerable to extreme weather events and the adverse effects of climate change. Also, these countries have a very least capacity to cope with and adapt to adverse effects of climate change. The major risk reduction approach is adaptation to global change (UNFCCC, 2006).

IPCC (2007a) has listed food and fiber, land degradation and biodiversity as the most vulnerable sectors to climate change in the South Asian region. The most vulnerable population to climate change and variability has been rural communities with few resources to cope with extreme weather events like landslides, floods, erosion, and droughts (IPCC, 2007a).

Projected longer drought periods may cause more land degradation, lower agricultural yields, crop damage/failure, increased livestock deaths, increase risk of wildfire, more widespread water stresses. Similarly, longer drought periods may result in increased risk of food and water shortages, increased risk of malnutrition, increased risk of food and waterborne diseases, reduced hydropower generation potentials and potential for migration. Impacts due to altered frequencies and intensities of extreme events have the potential to cause very large impacts, especially after the 21st century. Impacts of climate change will vary regionally but aggregated and discounted to the present, they are very likely to impose net annual costs which will increase over time as global temperatures increase (IPCC, 2007a).

Indeed, climate change will weaken the livelihoods of poor people by eroding their livelihood assets. Poor people are vulnerable to loss of physical capital (because of damage

to shelter and infrastructure), human capital (because of malnutrition and diseases), social capital (because of displacement of communities), natural capital (because of loss of productivity in agriculture and fisheries) and financial capital (because of more disasters and lower income). Degradation of livelihoods by climate change will thus leave poor people with less of the assets they need to withstand shocks and stresses (ADB, 2009).

IPCC, 2007a has listed three key sectors, food and fiber, land degradation and biodiversity as the most vulnerable to climate change in the South Asian region. The most vulnerable population to climate change and variability have been rural communities with few resources to cope with extreme weather events like landslides, erosion, and drought (IPCC, 2007a) particularly, in the mountain and flooding, sedimentation as well as drought in the low land regions of Nepal. Assessing the potential climate change impacts and economic analysis are urgently needed for the survival of these rural communities. The impact on agriculture and natural resources will directly affect the livelihood of the local communities. Developing countries are the most vulnerable to natural disasters that have serious economic impacts (WWF Nepal, 2005).

Local people, though they have no access to or knowledge of scientific data and analysis, are capable of identifying changes which have undermined their ability to earn a livelihood from natural endowments such as air, land, water, vegetation, crops, and livestock. While it is difficult for them to assume a macro perspective on climate change (i.e., eagle's eye view), they are much better positioned than the global community of scientists to provide real observations (i.e., a toad's eye view) of what climate change means on the ground and how it has affected their lives (NCVST, 2009).

Environmental sociologists have learned and focused on climate change related research states that climate change is complex and multifaceted relationship between human beings and natural environment, concentrate on social and political dynamics of environment movement and studying how people organize, reacts and adapts environmental change. Environmental sociologist highlights the motivation, behaviors and organizing mechanism underlying society's relationship with nature and physical change ((Nagel et al., 2009).

Temperatures are likely to warm more than the global mean in South Asia and especially on the Tibetan Plateau and in central Asia, with the highest warming at the highest altitudes. In mountain areas, precipitation will be increasingly in the form of rain instead of snow, with

a predicted rise in the snow line by 150 meters per degree Celsius temperature increase (IPCC, 2007a). The trend of temperature in Nepal are similar to the global trend but concerning precipitation, a significant variability have been observed in the country (Shrestha et al., 1999, 2000; Tiwari *et al.*, 2010). Although the past rainfall data indicate decreasing trend in precipitation, Sindhuli has suffered devastating floods in 1954, 1972, 1993, and 2010 due to heavy events including cloud burst in 1993. Lack of proper rehabilitation of past flood damages and continuous threat of future floods as a result of unplanned development work, especially road and settlements, combined with lack of awareness, are the major concerns of the local people. Although categorized as a 'moderately vulnerable' district by the NAPA process, it is one of the three most hazard prone districts in Nepal (due to its fragile geology with both Mahabharat and Chure hills being parts of its geography). According to the IPCC synthesis report (2007), there has been an unprecedented warming trend during the 20th century. The current average global surface temperature of 15°C is increasing nearly by 0.6°C per 100 year which is higher than it was 100 years ago. The most of the increase has been the consequence of human activity. Also a further increase of 1.5°C to 6°C is projected for the period up to 2100. Most of the observed increase in globally averaged temperature since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentration (IPCC, 2007b).

A significant variability on annual and decadal time scale was noted in the rainfall record from 1959 to 1994 (Shrestha et al., 2000). The analysis of 166 stations of Nepal (1976-2005) done by Practical Action Nepal (PAN) in 2009 shows that the 80 percent of annual rainfall occurs during monsoon season where as 4.2, 3.5 and 12.7 percent occur during post monsoon, winter and pre-monsoon season respectively. The annual rainfall of Nepal was found to be 1858mm. Nepal receives the highest monthly rainfall in July and the lowest in November (PAN, 2009).

The year 2006 and 2009 are reported to be the driest years in terms of rainfall during winter. Based on the data from 35 meteorological stations in Nepal, reports that eleven stations could not receive any rainfall during this period (DHM, 2009). The reported rainfall was less than 20 percent of normal in more than half of the country, highest recorded being less than 70 percent of normal at Okhaldhunga (DHM, 2009). Besides dry winter, the year 2009 was also extreme in terms of temperature records and delayed monsoon. The recorded temperature is higher than normal at almost all 35 stations. Some locations report the

maximum temperature exceeding 6°C above the normal (DHM, 2009). The time of onset of monsoon in Nepal was between 10 and 12 June in Nepal; however the monsoon in 2009 entered Nepal from the eastern part on 23 June in 2009.

The global temperature rise in 100 year is 0.74°C (IPCC, 2007a) but Nepal's maximum temperature continues to rise at an annual rate of 0.04-0.08°C (MoE, 2010). A later study of temperatures recorded at 44 stations between 1976 and 2005 indicated consistent and continuous warming, but at a slightly lower annual rate, 0.04°C (PAN, 2009). The annual mean temperature over Nepal increased steadily at a linear rate of 0.4°C per decade from 1975 to 2005 (APN, 2007).

Change in temperature and rainfall resulted in changes in plant behavior like early flowering, shift in vegetation line (i.e. expansion of habitat of crops and species) and loss of valuable species. These changes indicate that unpredictable climate variability will be a major obstacle for subsistence based livelihoods in rural areas of Nepal (SAGUN, 2009).

The livelihoods of most poor people, especially in rural areas, depend on natural resources and climate sensitive sectors such as agriculture, forestry and fisheries. They have few options for diversifying livelihoods away from these sensitive sectors and reducing vulnerability. Poor people often do not have enough assets to sustain or rebuild livelihoods after the impact of hazards, because of low financial resources, poor health, lack of clean water and sanitation, weak physical infrastructure and remoteness from government services. Lack of access and ability to use technology reduces their speed of recovery and options for livelihood strategies (Baral, 2009).

2.2 Adaptation Measures

Adaptation refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007a). While this definition is useful, it offers little practical way to translate into the daily lives of those affected. Adaptation is more than "coping." Adaptive capacity is determined by community characteristics such as income, wealth, equality, political and social stability, access to infrastructure and natural resources, institutional support and social capital, all of which either facilitates or constraint the ability of the community to deal with climate related risks (Sutherland et al., 2005). According to Defra

(2009) cited from Dixit and Moench, 2010 "Adapting to climate change means adapting the way we do things - in all areas of our lives - to respond to the changing circumstances. It means not only protecting against negative impacts, but also making us better able to take advantage of any benefits." IPCC (2007a) use the terms "autonomous" and "planned" adaptation. In well-adapted systems, people are "doing well" despite changing conditions. They are doing well either because they shift strategies or because the underlying systems on which their livelihoods are based are sufficiently resilient and flexible to absorb the impact of changes. As a result, at its core, adaptation is about the capacity to shift strategies and develop systems that are resilient yet sufficiently flexible to enable vulnerable people to respond to change. At the same time it is also about pursuing alternative livelihood. Shifting strategy can be facilitated by planned and autonomous adaptation. The difference between the two can be conceptualized by using the analogy of an iceberg: the submerged invisible part representing autonomous adaptation is much larger than the visible tip above the water level which is akin to planned adaptation.

Planned Adaptation: Planned adaptation includes programs and projects that governments, NGOs, and international donors implement as a result of specific climate impacts and vulnerability assessments. Planned and autonomous adaptation can be further conceived as attributed planned adaptation and systemic adaptation.

Attributed Planned Adaptation: Such planned adaptations are generally made to respond, to predict impacts on ecosystem and hydrological system and to minimize human vulnerability by focusing on sectoral interventions, such as those related to water management and flood control. Attribution of impact to climate change is necessary. It is the result of deliberate policy decision taken by government or public sector agencies.

Systemic Adaptation: Systemic adaptation may not necessarily require attribution but involves creating arrangements that enable people to switch strategy and do well.

Autonomous Adaptation: Autonomous adaptation includes actions that individuals, communities, businesses and other organizations undertake on their own, in response to the opportunities and constraints they face as the climate changes. Autonomous actions are individual or collective responses, almost entirely in the poorly recorded informal sector. These may involve changes in practices and technologies, diversification of livelihood systems, access to financial resources (e.g. micro-insurance, micro-credit), migration, reconfiguring labor allocation or resource rights and collective action to access services, resources or markets. Social capital and access to skills and knowledge can be particularly

important to enable these responses. Autonomous adaptation takes place at the community and household levels while planned adaptation includes those strategies and actions initiated by a government to shape its policies, programs and projects in response to global climate change impacts. Most planning decisions work in the long term and are path-dependent, whereas autonomous or indigenous adaptation is short term and spontaneous as communities or households respond immediately to the social, political and institutional stresses associated with the changing climate. The market, both formal and informal, is an important avenue where the response is autonomous; and many of the opportunities are visible and available but at the household's level it is often invisible or beyond the ken of national or international level of planning (Dixit and Moench, 2010).

Climate change adaptation measures aim to reduce existing and future vulnerability, commonly viewed as comprising three elements: exposure, sensitivity, and adaptive capacity (Parry *et al.*, 2007). Vulnerability is thus a combination of the stress faced by an entity, such as a physical system, social system, organization, or individual; the extent to which the entity will be affected; and the degree to which the entity can resist, cope with, or respond to stressors. With respect to the social aspects of vulnerability, some individuals and groups are more vulnerable than others, owing to their limited capacity to prepare for or cope with stresses (Dunlap and R.J., 2015).

The impacts of climate change will increasingly affect the daily lives of people everywhere in terms of employment and livelihoods, health, housing, water, food security and nutrition, and the realization of gender equality and other human rights. Impacts are expected to hit those living in poverty the hardest, partly due to their more prevalent dependency on the very natural resources affected by climate change and also because they have less capacity to protect themselves, adapt or recuperate losses. A few efforts have been made to mitigate and adapt climate change impacts in agriculture sector. These include research on flood and drought tolerant varieties of crops, adoption of reduced tillage practices and agro-forestry, promotion of zero energy storage structures, gravity ripe ways, plastic house farming, solar driers, ovens, micro-and drip irrigation, rainwater harvesting ponds; improved water management; crop rotation and diversification; discouraging slash and burn practices; development of early warning system etc. Some 213 varieties of crops adapting to various climate change conditions have been developed and released. However, climate change factor is not addressed in any livestock sector till date (MoEST, 2008).

CHAPTER III: RESEARCH METHODS

3.1 Study Area

Sindhuli district is situated at the 3 no province of Nepal north of Mahabharat range and south of Chure range covers an area of 2491 sq.km, out of which 1435 Sq.km is covered by Chure range. It has 9 local level. The present study is focused in Dudhauri municipality of Sindhuli district. Dudhauri municipality is situated north of Mahabharat range and south of Chure range. The climate of Dudhauri is tropical to temperate. The municipality is demarked by Udaypur district in east, Kamalamai municipality and Tinpatan rural municipality in west, Fikkal rural municipality and Tinpatan rural municipality in north and Dhanusa district and Udaypur district in South. The municipality lies between 27°04' 20.81" N 86°02' 58.085" E to 27°01' 45.98" N 86°23' 09.82" E. The elevation of municipality ranges from 140 m at Dhansari of Ward 11 to 2160 m of Jinakhu (Thulo Nagi Danda) bordering Fikkal Rural Municipality. The total area of Dudhauri municipality is 390.39 Sq.km out of which 278.806 sq.km is covered by Chure range and the total population of municipality is 65,302 (47.64% male and 52.36% female) within 13065 household (CBS, 2012). It has total 14 wards. Most of the area of Dudhauri municipality lies in chure region which is the youngest mountain of the world. The fragile geology makes the chure region more vulnerable to the impact of climate change. The Kamala River flow from the center part of municipality. During monsoon season due to large flood cut the large amount of cultivated land and converted it to beach and loss of large amount of property and loss of lives. Drought and flood are the major problem of this area due to which livelihood of the people is affecting.

Table 1: Dudhauri Municipality in brief

Name	Dudhauri Municipality
District	Sindhuli
Province	3
Ecological Belt	Lower Siwaliks, Upper Siwaliks, Dun valley and Mahabharat
Number of Wards	14
Population	65302 (CBS 2012)
Households	13065 (CBS 2012)
Area	390.39 Sq. Km.
Market centres	Dudhauri, Dakaha, Sanibare, Gagan

Wards of Dudhauri Municipality and associated former VDCs with households are presented below.

Table 2: Wards of Dudhauri Municipality, Area and Households

Ward No.		Area (Sq.km)	Area %	Households
1	Hatpate	24.07	6.17	807
2	Hatpate	28.76	7.37	766
3	Nipane	18.98	4.86	702
4	Sirrhoul	21.46	5.50	872
5	Sirrhoul	26.61	6.82	801
6	Harshai	23.38	5.99	973
7	Dudhauri	13.61	3.49	904
8	Dudhauri	16.42	4.21	681
9	Dudhauri	10.03	2.57	1185
10	Dudhauri	19.84	5.08	1071
11	Dudhauri	29.17	7.47	1349
12	Jinakhu	41.81	10.71	949
13	Arunthakur	48.19	12.34	1010
14	Kakurthakur	68.06	17.43	995
Total		390.39	100	13065

(Municipality, 2018)

3.1.1 Climate:

The climate of the municipality is predominantly subtropical. The mean annual temperature is averaged between 23-25°C based on data from nearby stations. The average annual rainfall is about 1681mm. The seasonal variation of rainfall is very high where 80% of the rainfall occurs during monsoon season (Municipality, 2018).

3.1.2 Land Use:

Dudhauri municipality is extended from Chure in the South to Mahabharata in the North. Majority of the municipality area is covered with broadleaved closed forest with the percentage sharing of 39.21% followed by broadleaved open forest with 20.50%.

Agricultural land which is 31.81% which also includes the settlements with less than 1% of area coverage of the municipality.

Table 3: Land use classification of Dudhauri Municipality

S.N	Classification	Area Coverage (%)
1	Needle leaved closed forest	2.89
2	Needle leaved open forest	1.83
3	Broadleaved closed forest	38.21
4	Broadleaved open forest	20.5
5	Shrub land	0.97
6	Grassland	0.63
7	Agriculture land	31.81
8	Barren land	1.84
9	River	1.33

(Municipality, 2018)

3.1.3 Socio-economic and Demographic Profile:

Agriculture is the main profession of the people in the municipality. About 30 % of the total area of the municipality is cultivable land (Municipality, 2018). Plain lands alongside the Kamala River are the major area of cultivation in the Kamala valley. Apart from agriculture people are engaged in business, labor, government services and foreign employment. There is no industrial development in the municipality thus there is no such opportunity of mass employment. Major food crops are the Paddy, Maize, Wheat, and Mustard. The population of Dudhauri municipality as per census of 2011 is 65302 and is constituted by 31004 (47.64%) males and 34298 (52.36%) females within 13065 households. Cheetri, Magar, Tamang and Sunuwar are major casts in the hilly areas whereas Bramhin, Chhetri, Danuwar, Majhi, Musahar are major casts in the valley areas. Nepali, Tamang, Magar, and Sunuwar languages are major spoken languages in hilly areas. Nepali, Maithili, Tamang, Danuwar, Magar languages are major languages in kamala valley areas of municipality (Municipality, 2018).

3.2 Research Design

The selection of methodology is one of the most important part of any research. To study the perception of peoples on climate change and adaptation strategy the study has taken household as the unit of analysis. Firstly site was selected as Dudhauri municipality for this

research then randomly selected 3 wards out of 14 wards as 2 from chure region and 1 from mahabharat region. Different technique were used to collect the data i.e. primary source and secondary source. Primary data collect through field observation, household survey and from focus group discussion. Secondary data collected through the report of different organization, journal article etc. Consult with supervisor during the whole research period from starting to the end. Literature review from different journal articles, books and many other papers from starting of the research to the end of the research. After the completion of data collection data entry, interpretation and analysis of data by using MS-Excel-2013. Draft report was prepared and submit to the supervisor for the review of research, after the review by supervisor incorporate all the comments and suggestions in the report and submit it again to the supervisor and complete the process of research.

3.3 Methods of Sampling and Data Collection

The study blended both qualitative and quantitative techniques of data collection and analysis. A combination of data collection methods including both primary and secondary methods. Primary methods include direct field observations, focus group discussion and a household survey whereas secondary methods include desk reviews of different publication Journal, articles etc. Information from respondents was taken from sedentary peoples (age more than 30 years).

3.3.1 Sampling method

The whole Municipality was divided into different strata and then into substrata to minimize heterogeneity. Out of 14 wards 3 wards (6, 7 and 13) were randomly selected for this study based on geographical location two from Chure range and one from Mahabharata range. Random sampling was done from each sub-stratum. Since the study aims at finding the perception of peoples on climatic variables, socio-economic characteristics, long-term climatic variability, aberrant weather events and their impacts on agriculture production in the area, adaptation practice done by community, one should attempt to select samples in such a way that respondents are sedentary and engaged full time/partially in farming profession. These criteria were seriously considered while selecting the required sample size. Number of sample size required for the whole Study area was first determined by using the formula given by Arkin and Colton (1966) as mentioned below. Among the 13065 households, 116 households were selected for the study. 10% sample was considered as non-response rate.

$$\text{Sample size (n)} = \frac{NZ^2 \cdot P(1-P)}{[Nd^2 + Z^2 \cdot P(1-P)]}$$

Where, n= Sample size
N=Total number of households
Z= Confidence level at 95 percent, Z=1.96
P= Estimated population proportion (0.5)
d= desired error, (0.1)

3.3.2 Primary Data Collection

a.) Reconnaissance Survey

To get the overview of the study area, perception on impact of climate change and adaptation practice, a reconnaissance survey was carried out before starting the detail research. Informal interactions was done during this phase with the peoples. The information gathered during this phase was used in preparing the interview schedule and designing a sampling technique. The research elicits the information by staying in close proximity of the study area. This survey was performed on January 2019.

b) Household survey

Data related to climatic variability, different weather events, the effects of those events on agriculture, changes in phenology, adaptive strategies to minimize the risks associated with climatic uncertainties was collect through semi-structured questionnaire administered through personal interviews with head of the households. Before interview written consent was taken from participants. This survey was carried out on January-February, 2019. By using the above methods and considering the heterogeneity of population distribution, the number of households survey taken 39 households from ward no 6, 36 households from ward no 7 and 41 households from ward no 13.

c) Focus group discussion

Focus group discussions was conducting with people from a set of representative Tole level organizations with the aim of triangulating the information obtained from household survey. Peoples who reside in the study area more than 30 years and engaged in farming are participated in one focus group discussion. In each FGD 10 people are participated. Total 6 FGD was conduct 2 in each ward. Focus group discussions was conducting to obtain additional information on perception of Climate change, various community based adaptation strategies, different effect observed in the present and past regarding the farming practices.

Table 4: FGD locations and dates

Ward no.	Date	Location	Number of Participants
7	2019-01-23	Ward office	10
7	2019-01-24	Pargati school tole	10
6	2019-01-28	Ward Office	10
6	2019-01-29	Jagadi	10
13	2019-02-5	Ward Office	10
13	2019-02-6	Arundanda	10

3.3.3 Secondary Data:

a.) Socio-economic and other data:

Data published in authentic publications like journals, books, symposium proceedings, magazine, internet papers, municipality reports, newspapers, research publications etc. will also consulted and relevant data are used. The socio-economic data and perception is presented in percentile are calculated along with graphical and tabulation presentation is made for the perception using closed ended questions.

3.4. Data Processing, Analysis and Interpretation:

Data obtained through different sources are processed, analyzed and interpreted. All data so far collected are entered and analyze using EXCEL.

CHAPTER IV: RESULTS

4.1 Socio-demographic information of the households

Farming is a major occupation of the people in the area as responded by around 84 percent of the farm households. Other occupations are government service, business, off-farm wage work and business (Table 5). However, it should be understood that the people who are engaged in the job are also partially involved in agriculture. Almost all farm households operate in subsistence mode. A large number of respondents were male (59 percent). The percentage of male respondent was high simply because females are involved mostly in indoor activities and are either hesitant to respond to the interviewer or don't have time to participate in the interview or both. The average family size of the respondent was 6 (with a range from 2 to 13) (Table 5), which is higher than national average (4.88) (CBS, 2012). Around 60 percent were economically active. The education level of the respondent shows that most of the people are literate (44 percent) followed by 21 percent have up to 10th grade of education, 18 percent have intermediate, 12 percent who do not have any formal education and 5 percent have university level education.

The study area is enriched with several ethnic groups. A dominant group is cheetri with around 23 percent of the total population in the study area followed by Cheetri are Brahmins (17 percent), Danuwar (16 percent), Dalits (11 percent), Magar (9 percent), Tamang (9 percent), Sunuwar (8 percent), Majhi (5 percent) and Rai (3 percent) (Figure 1).

Table 5: Socio-demographic characteristics of the respondents

Gender	No of respondents	Percentage
Male	69	59
Female	47	41
Profession		
Farmer	97	84
Government Services	4	3
Daily Wages	3	3
Private Services	6	5
Business	6	5
Family Size		
Less than 5	54	46.55
5-10	55	47.41
More than 10	7	6.03

Education Level		
No formal education	14	12
Literate	52	44
SLC	25	21
Intermediate	19	18
Bachelor	4	3
Master	2	2

Economic status of population	
Economically active population	Economically inactive population
60 percent	40 percent

(Field study, 2019)

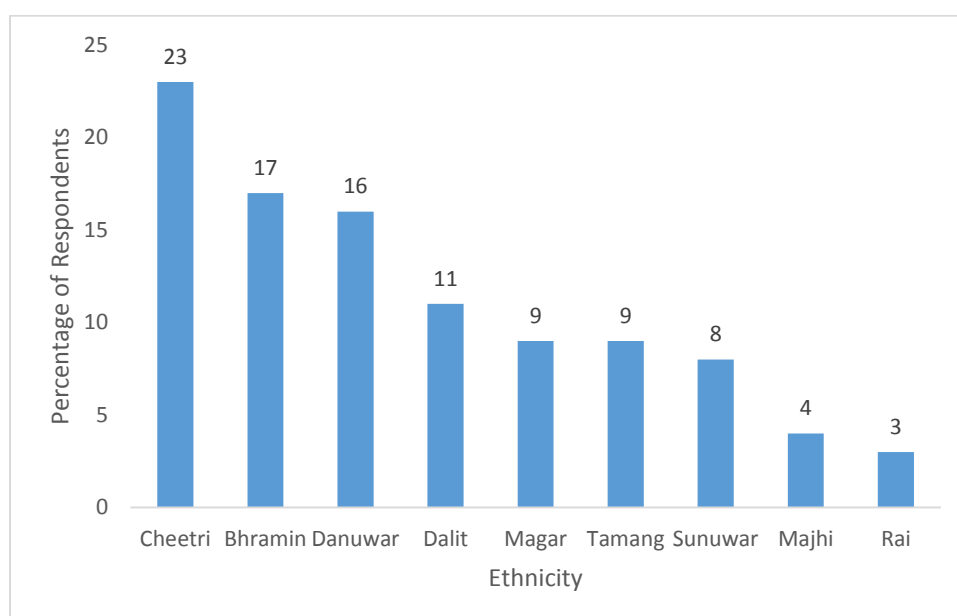


Figure 1: Ethnicity of the respondent

(Field study, 2019)

4.1.1 Major Sources of Income of the respondents

The major sources of income of the respondent's family were agriculture (79 percent), followed by business (8 percent), jobs abroad (6 percent), daily wages (4 percent) and government services (3 percent) (Figure 2).

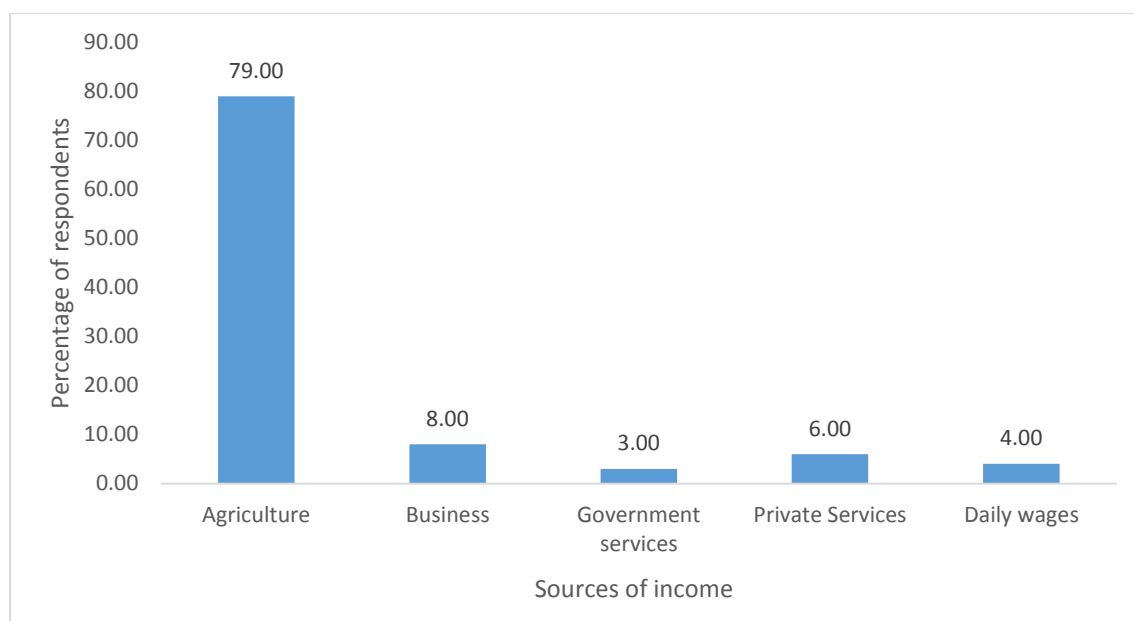


Figure 2: Major sources of income of the respondents

(Field study, 2019)

Most of the respondents reported that they do not have sufficient land of their own. Since agriculture production doesn't suffice household food demands, farm households have to find alternative means to be food secure. These alternative sources of income are government services, migration to foreign soils to earn money, work in the private sector, on and off-farm wage work. Livestock was considered to be an important source of cash in the village and goat was important livestock species owned by most of the households.

4.1.2 Landholding size

The landholding size of the respondent ranged from 0.03 to 2.7 ha. The average landholding size of the respondent was 0.60 ha which is less than the national average landholding size (0.68 ha) (CBS, 2012). Almost eight out of 10 farm families are marginal farmers (<1 ha of farm), followed by fourteen percent who are smallholder (1-2 ha) and the rest are semi-medium holders (2-4 ha) (Table 6).

Table 6: Land size class of the respondents

Land size (Ha)	No. of Households	Percent of Households	Remarks
0-1	95	82	Marginal farmers
1-2	14	12	Small farmers
2-4	7	6	Semi-medium farmers

(Reference: APCAS, 2010)

4.1.3 On-farm food availability

As stated above, half of the farm families in the municipality operate in subsistence mode and often on-farm production was not sufficient to meet the household food demands throughout the year. Therefore, they have to depend on external sources to fulfill household food requirements. About 13 percent of the respondent said that crop produced in their field was sufficient for less than 3 months, 15 percent said for 3-6 months, 16 percent said for 6-9 months, 22 percent said for 9-12 months and 34 percent said for more than 12 months (Figure 3). The results also entail that almost 44 percent of the households are food deficit half a year (Figure 3).

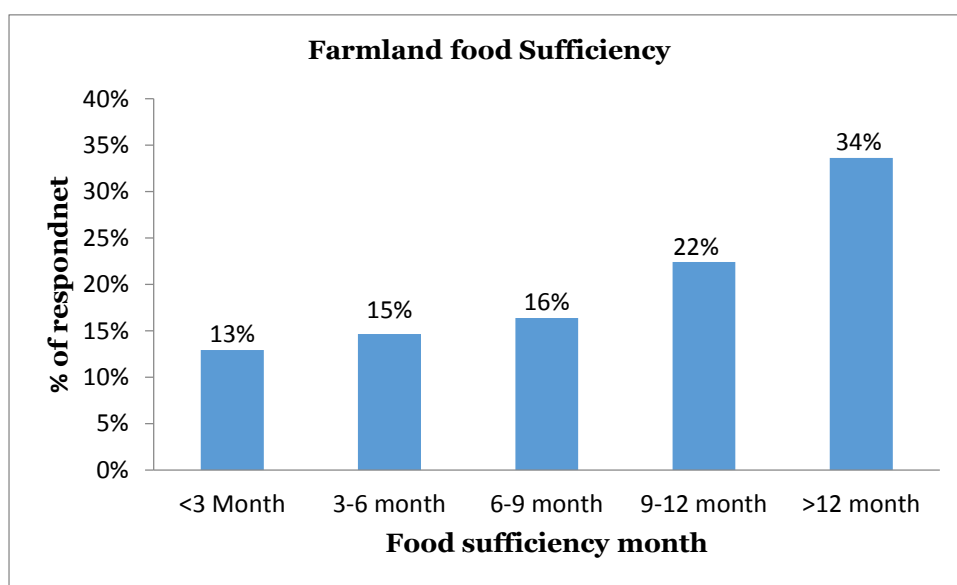


Figure 3: Farmland food availability

(Field study, 2019)

4.1.4 Irrigation status in the study area

About thirty six percent of the respondents completely depend on rain for their agricultural production due to lack of irrigation facility in the study area. Remaining respondents have facility of irrigation in some way or the other. Respondents with rain-fed agricultural land cultivated only two crops (Rice and Maize) a year. In seasonal-irrigated and irrigated land, respondents cultivated three crops like rice, wheat and maize along with vegetables and pulses. Irrigated and semi-irrigated lands lie in southern border of the study area whereas rain-fed land lies in northern side attached with churia region. Irrigation status is presented in Figure 4.

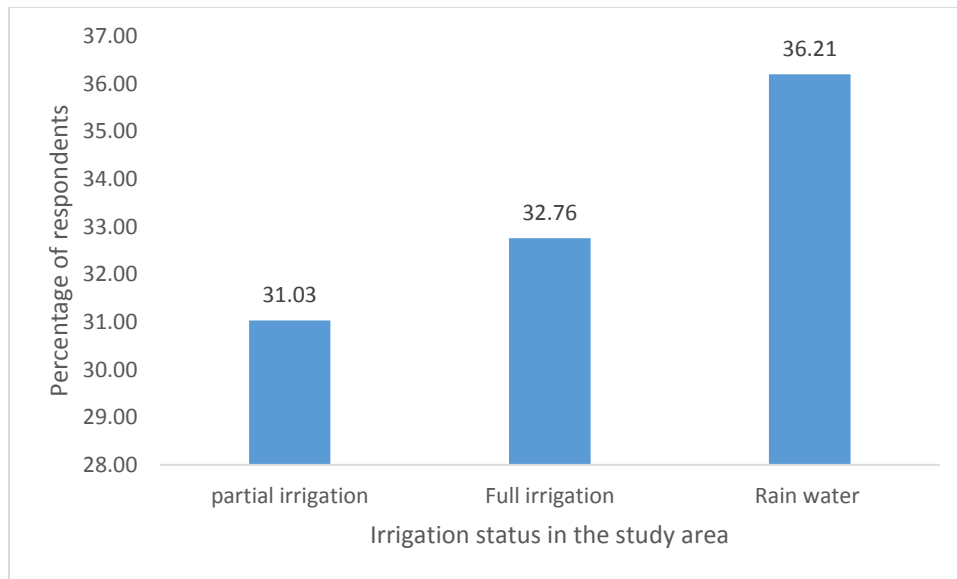


Figure 4: Irrigation status in the study area

(Field study, 2019)

4.2 Perceptions of respondents on climate change and related issues

4.2.1 Climate change

The respondents were asked whether they have heard of climate change. 72 percent of the respondents have given affirmative answer.

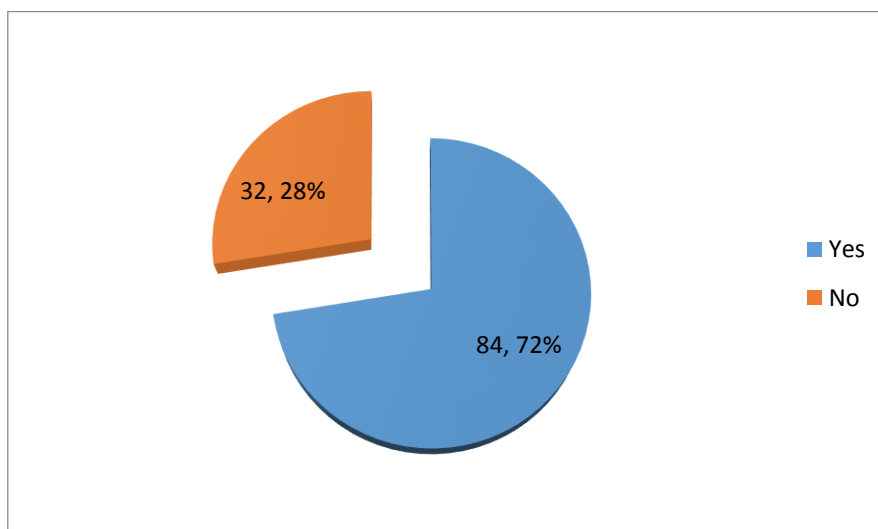


Figure 5: Composition of respondents on the basis whether they had heard about climate change

Sources of knowledge about climate change did vary. Out of the 72 percent of respondents, said they have heard of climate change, a large proportion (41 percent) have heard from radio and 30 percent by television, 18 percent by NGOs/GOs 5 percent through self-study and 6 percent through newspaper (Figure 6).

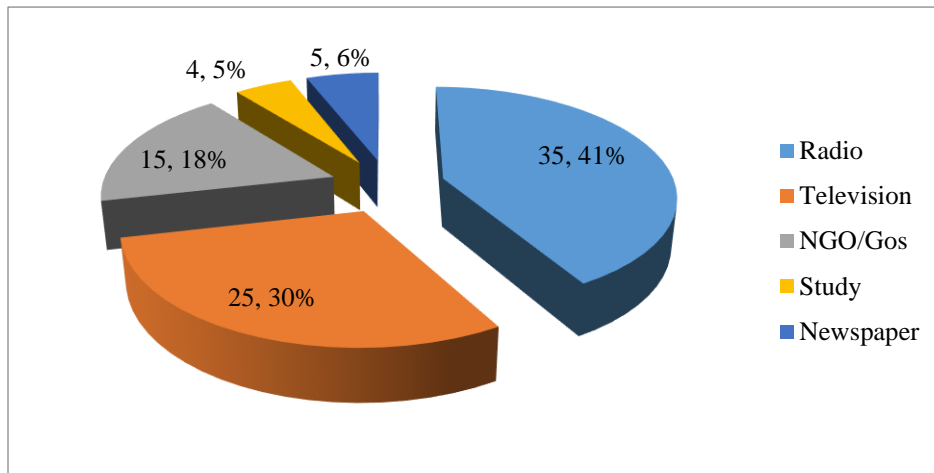


Figure 6: sources of respondents heard about climate change

(Field study, 2019)

a. Temperature and rainfall

Most of the respondents think that temperature has been increasing in recent decades (84 percent) and 16 percent said that there is no change in temperature (Figure 7). Similarly, in terms of changing seasonal (summer and winter) temperatures, 95 percent of the respondents said that the summer temperature has been in increasing order and only 5 percent said that there was no change in summer temperature (Figure 8). Similarly almost 9/10th of the respondents said that the winter temperature is increasing, 3 percent said that decreasing and 8 percent said that there is no change (Figure 8). Further discussion in focus group discussion also substantiates that the temperature is in increasing trend. Nowadays mosquitoes are resist all the month due to increasing temperature winter is more favorable time than summer but in past only in summer season mosquitoes are seen. Snake biting problem is severe nowadays the data from the health post of Dudhauri also verify that the no of patient are increasing nowadays as compared to the past. Due to increasing temperature snake are seen more in the ground, during winter snake hibernate below the ground according to the people. Diseases and pests are increasing due to which local variety of crops such as rice bean, horse gram and local species of cucumber are extinct. Nowadays, local species are less resistant to diseases and pest. Various diseases are recently observed on food crops, fruits and vegetables. New species of weeds and pests are seen which affect the crop production

Most of the respondent said that the rainfall pattern is also changing and amount of rainfall is decreasing (84 percent), 11 percent respondent said that there is fluctuate in rainfall pattern and 5 percent said that there is no change (Figure 7). Further discussion with

respondents also confirm that the rainy day is decreasing but rainfall amount in short period is increased; the last four years have been drought leading to drying of the local sources of drinking water. Flood and drought both are problem for the study area. During rainy season large amount of property loss due to flood who reside in the river bank area, during winter drought affecting the rain-fed area.

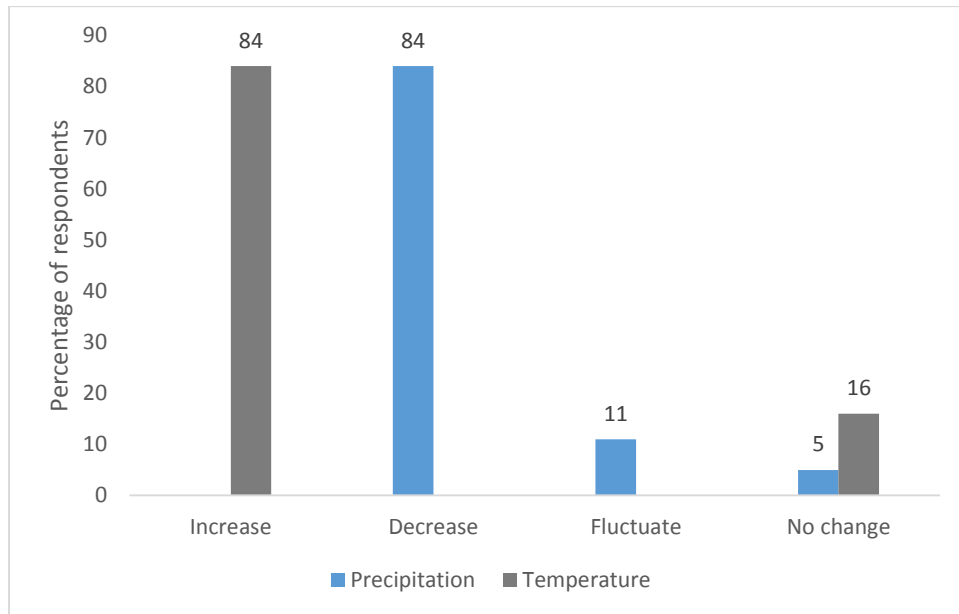


Figure 7: Response of respondent on change in annual temperature and rainfall

(Field study, 2019)

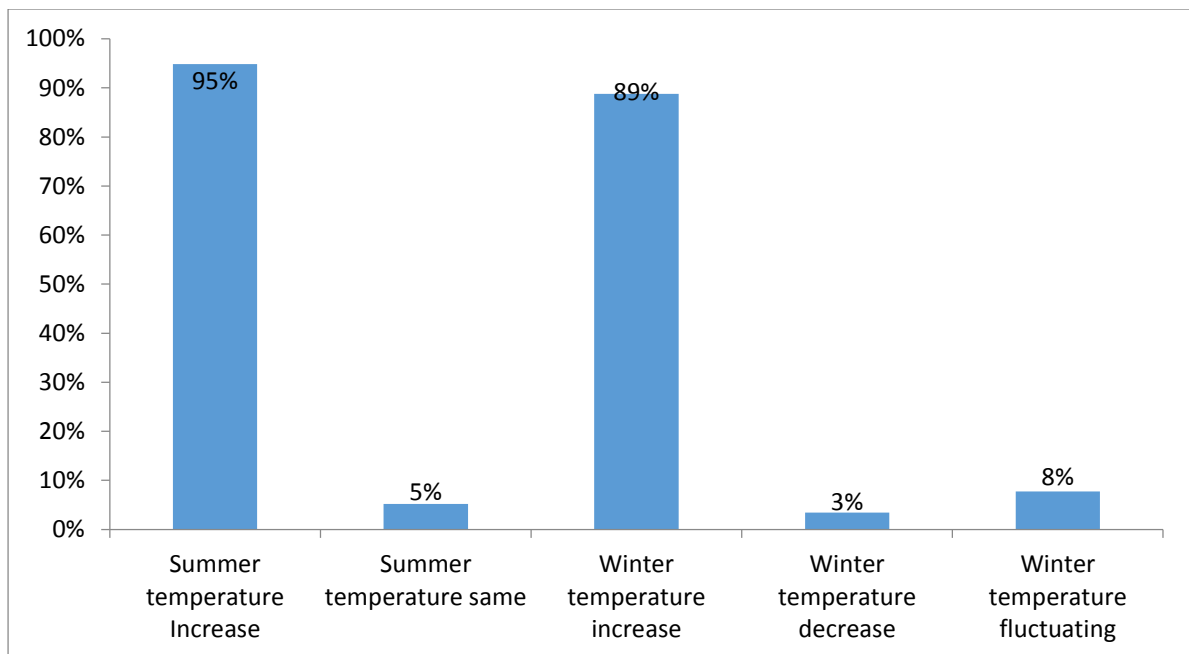


Figure 8: Response of respondents on change in seasonal temperature

(Field study, 2019)

b. Changes in number of cloudy days

Regarding the number of cloudy days, more than half of the respondent said that such days are decreasing, 25 percent said increasing and 13 percent said no change (Figure 9). While during FGD most of the respondent said that the cloudy days are decreasing. They opined that there used to be high cloudy days in past from August to January, but nowadays this pattern has shifted to November to February. It is the season of winter crops such as potato, tomato, mustard, wheat, maize. Potato is the most affected by the cloud, yield declined and impact on food security. Due to decrease in cloudy day's positive impact seen in the winter crops.

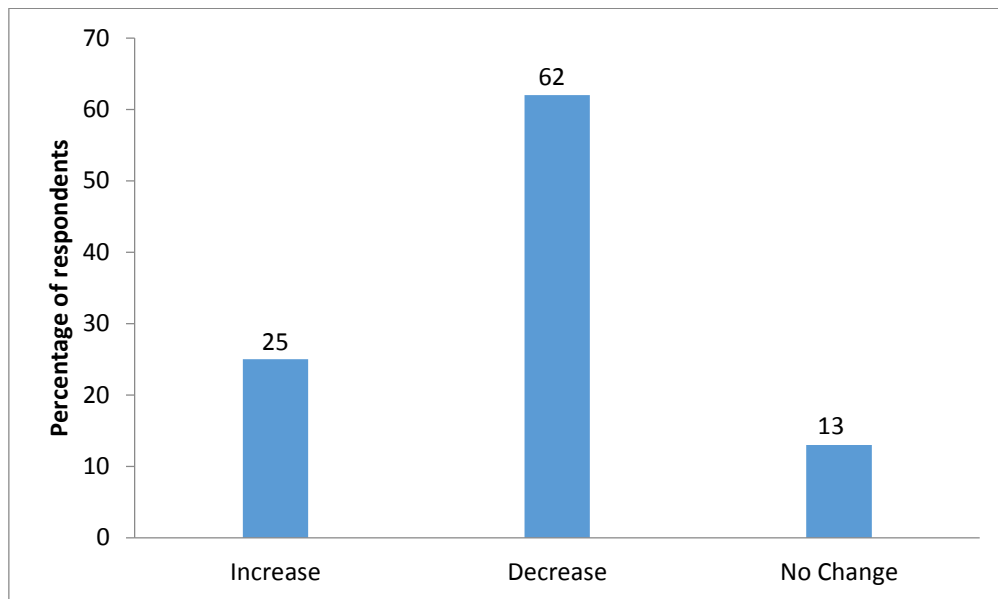


Figure 9: Response of respondents on change in number of cloudy days

(Field study, 2019)

c. Flood Events

Most of the respondents said that there were changes in flood events. 89% of the respondents reported that there is increase in flood events, 2.3% said that there is no change in flood events and 8.7% said that there is decrease in flood events (Figure 10). In recent years due to flood loss of lives, loss of large amount of productive land and properties were the adverse impact of the flood events. Due to flood in Kamala River, Tawa River and seasonal rivulets (Khahare khola) large amount of productive land is convert into river bank and somewhere the river is flow in productive land. Flood events were observed in 1972, 1984, 1993, 2004, 2007, 2010, 2014, and 2016. Encroachment of forest land, forest degradation and haphazard excavation of natural resources from river and rivulets in Chure region are the major cause of flooding according to the people. Lowland area is severely affected by the flood.

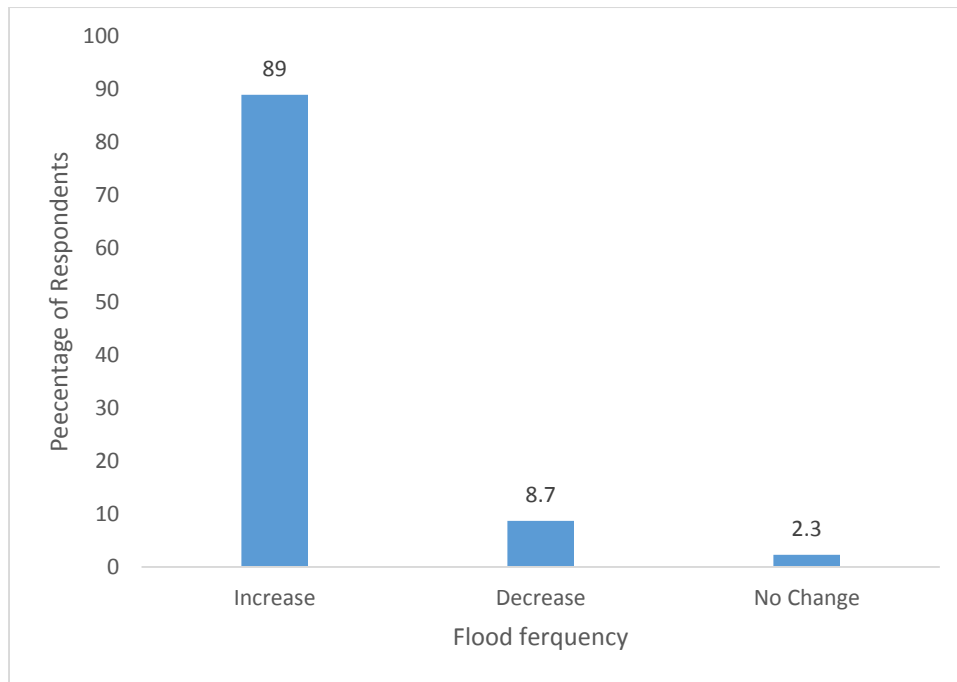


Figure 10: Changes in occurrence of flood as perceived by local people

(Field study, 2019)

d. Drought events and hailstorm/windstorm

Most of the respondents said that the drought events are increasing (91 percent) and 9 percent said no change (Figure 11). Further discussion on FGD also confirmed that the drought is increasing for last 10 years and after earthquake in 2015 witnessed severe drought, during which most of the water sources are dried out. Upper region of the municipality is mostly rainfed and is affected by the delay of monsoon in rainy season and very low rain in winter season. Due to drought new pest and diseases seen in crops and livestock.

As hailstorm and windstorm are the rare events, the responses of these events are reported mixed. About 62 percent respondents said that the events are decreasing, 8 percent said that the events are fluctuating, 13 percent said that same as before and 17 percent said that the events are increasing (Figure 11). The FGD concluded that the event of hailstorm is decreasing, but windstorm is occurring in few time intervals.

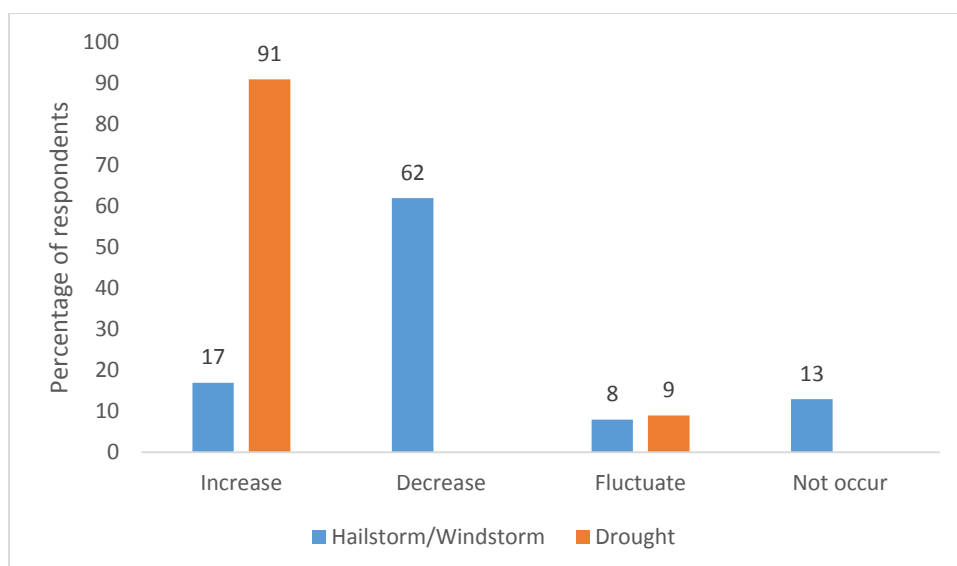


Figure 11: Response of respondents on change in drought and hailstorm/windstorm

Source: Field Study, 2019

Box: 1 Impact of Climate change seen at Dudhauri municipality

General Impact of Climate change at Dudhauri municipality

- Different plant species were flowering and fruiting irregularly, Mango flowering one month earlier and ripen in Jestha instead of Asad, Early fruiting of Kimbu.
- In agriculture system they are observing some unusual phenomena such as fast maturity of Maize and Rice, introduction of new types of pests, short stalk of rice and wheat.
- Rising temperature, erratic rainfall.
- Increasing disastrous events like flash floods, drought, landslide etc.
- Agricultural land cut down by flash flood in river and rivulets
- Increasing temperature help to cultivate lowland crop in upland.
- Lowland tree species shift in upland area (eg. Sal, Simal, Khayer etc.)
- Decreasing agricultural productivity in water scarce areas and increasing productivity in water available area.
- Declining water sources.
- Mosquito density is increased, winter season also favourable due to increasing temperature.
- Hibernating time of snake is shortening.

Source: Field Study, 2019

4.2.2 Impact on agriculture

Due to changing climatic variables, farmers have noticed a reduction in agricultural production. About twenty percent of the respondent said that agricultural production is increasing, 66 percent respondent said that decreasing and 14 percent respondent said that there is no significant change (Figure 12). As compared to the 10 years before the yield is increased due to change in crop species but in between 10 years the yield is in declining trend. Further discussion in FGD concluded that the productivity of crop is decreasing. Drought and flood happens to be a major factor in declining crop productivity. Precarious weather has made appearance of new diseases, pest and weeds leading to more crop damage than ever before. For instance, new pest **false armyworm** recently observed, which has rapidly spread in the farmland and damage the crop at rapid rate. The respondents said that this pest damage the winter crop in large scale due to drought since three years. Most of the rainfed land has now converted to one time crops (Paddy) land due to lack of assured rainfall and/or more variable rainfall pattern, in past people can cultivate the crops up to three times a year. Some people are shifting from traditional farming practice to vegetable farming, waged labor, and employment outside country and off-farm businesses due to insecurity in agriculture.

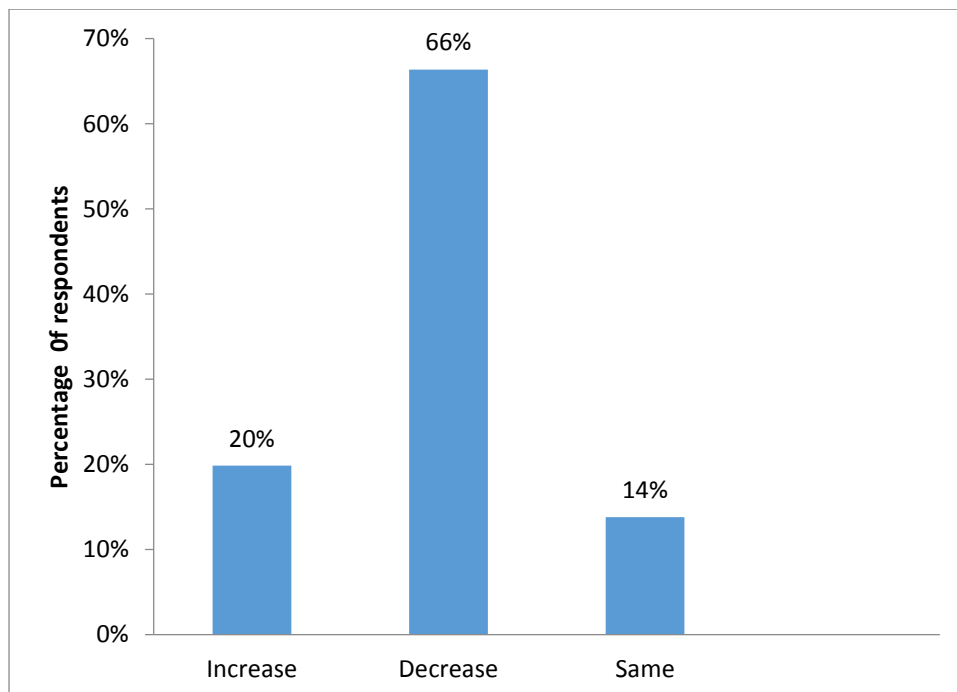


Figure 12: Perception of respondents on agricultural production

Source: Field Study, 2019

Box 2: Impacts of Climate Change on Agriculture

Impacts of Climate Change on Agriculture at Dudhauri Municipality:

- Mango flowering one month earlier and ripen in Jestha instead of Asad .
- Decreasing productivity in water scarce area and slightly increase in water available area.
- Sal tree flowering one month earlier in Magh
- Quality of agricultural products deteriorating.
- Introduction of new unknown pests and insects.
- Increase in agriculture land loss due to increasing drought, flood and landslide events.
- Shifting of paddy cultivation due to the monsoon shift.
- Erosion of fertile top soil due to erratic rainfall.

Source: Field study, 2019

4.2.3 Impact on livestock due to climate variable

Livestock is an important source of income of the people. Farmers in risk prone areas take livestock as an alternative means of generating income under the situation of climatic risks such as droughts and floods. Growing of water scarcity and appearance of unknown diseases, livestock population in the area started declining. Farmers have shifted from large animals to smaller ones (buffalo to goat and poultry farming). Mostly in ward no. 7 and 13 farmers shift from agriculture to livestock farming due to scarcity of water, but nowadays changing climatic conditions also shows its impacts on livestock reported from the field are shown below:

- Deteriorating health of livestock because of
 - i) Decrease in rainfall harms the forage production.
 - ii) Introduction of invasive species results in decline of grass variety.
- Introduction of unknown diseases.
- Death of livestock without showing any symptom.

4.3 Adaptation Strategies

At the community level, people have been constantly exploring options to adapt to changing climate knowingly or unknowingly and have developed extensive knowledge in

order to cope with the situations. Some of the strategies adopted by the farmers are switching to new crop and/or varieties, crop rotation, plastic tunnel technology in vegetable farming and using genetically modified varieties such as hybrid seeds in order to increase the agricultural production, replacing larger species of livestock by more productive smaller species such as goats and chicken, using improved cooking stoves, biogas attached with toilet. Construction of irrigation canal through small irrigation project, water collect from kitchen sink and soil and river bank cutting conservation through embankment construction. The new crop varieties are more drought resistant than that of past. Although farmers felt that the measures they were adopting to mitigate the effects of changing climate were not effective due to lack of resources at both household and community level.

Most of the people were aware about soil fertility degradation. Use of inorganic fertilizer is in decreasing trend. Farmers are aware and using only manure and bio-fertilizer. To suppress the pest, farmers are using integrated pest management methods such as crop rotation, inter cropping, green manure, hand picking of pests or hand weeding etc. on the basis of landholding size adaptation practices is different, due to lack of land availability marginal farmers are practicing more adaptation measures as compared to small farmers and semi-medium farmers. Only 56% of the marginal farmers were practicing adaptation measures while the only 29% and 14% of the small farmers and semi medium farmers are respectively practicing adaptation measures (Figure 13).

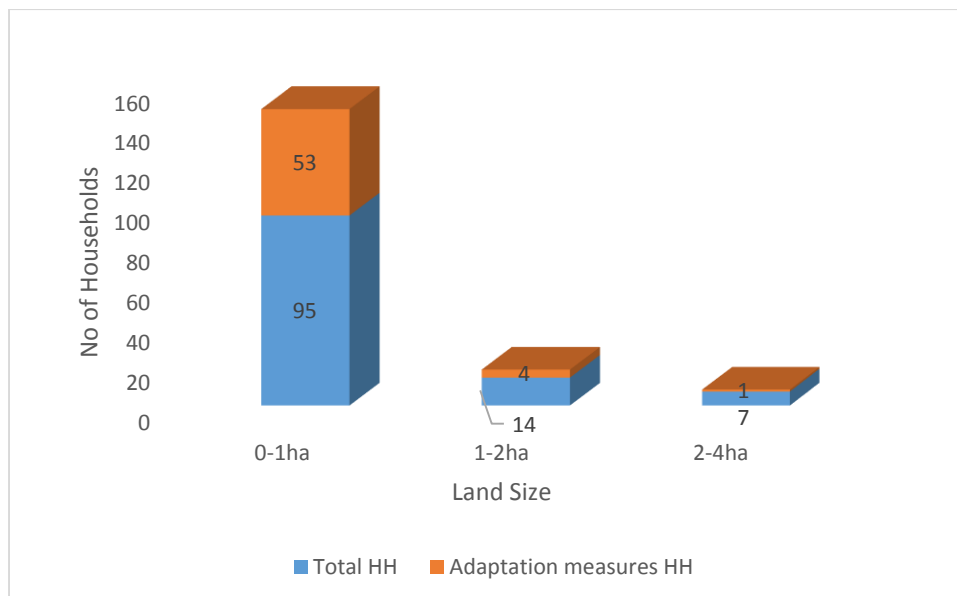


Figure 13: Adaptation practices on the basis of land size

Source: Field Study, 2019

4.3.1 Change in Crop Production Process

In response to current climatic changes, people have changed the process of crop production. About 21% of the households in municipality have changed the timings of the seeding and harvesting of the staple crops. Paddy cultivation is delayed where the farmers depend on rain by 2-3 weeks on average depending upon the onset of monsoon.

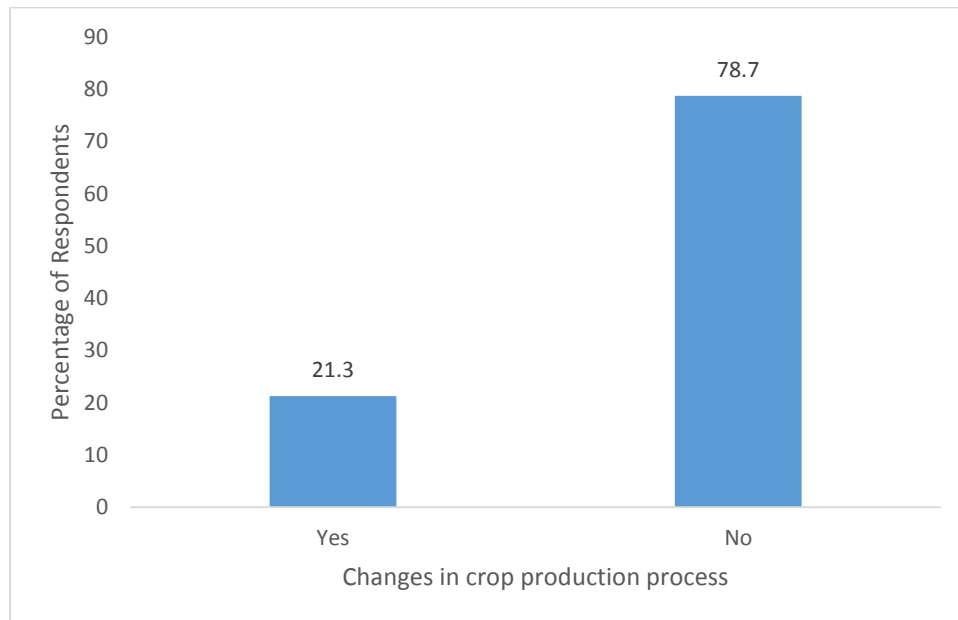


Figure 14: Change in crop production process

Source: Field Study, 2019

4.3.2. Changes in crops grown

Local rice and maize has been replaced by hybrid varieties of rice and maize in order to increase production, to resist pests and to get earlier harvest. People have started growing vegetables in place of wheat and maize. Farmers have started growing cash crops instead of the traditional staple crops, because these are more demanding and are income generative. This is another adaptation strategy in farming due to change in climate resulting to better income which could reduce the food insecurity problems.

Table 7: Changes in crops grown in the study area

S.N.	Crops grown before	Crops grown now	Reason for change
1	Local rice (Local masino, Jhumka, Ate, Bagadi)	Hybrid rice (rambilas, sabitri, sornachap, katarni)	To increase production, for earlier harvest

2	Local maize (Local pahelo, seto)	Hybrid maize (Rampur pahelo, Rampur seto/composite, makawnapur, shankar, Hybrid-7282)	To increase production
3	Traditional crops	Vegetable, fruits and cash crops (Ginger, Turmeric, Cardamom) farming	Easy to income cash

Source: Field Study, 2019

4.3.3 Change in Cropping Techniques

Fertilizers and pesticides are used to increase the yield. For irrigation, canals are plastered with cement to reduce seepage loss and are thus efficient as well as effective for irrigation, such scheme has been supported by government and different international organizations. Some people use ground water for irrigation by constructing deep well where river water not available has been supported by government bodies. The major changes in the use of farming include the practice of machineries and modern techniques these days instead of traditional methods for rice, wheat, maize cultivation. Tractors are used for ploughing saving time and for convenience.

CHAPTER V: DISCUSSION

The core of the results is the analysis came from field observations, household survey and focus group discussion. This showed that there was variation in local climate such as rising temperature, rainfall variability and increasing climatic events and appearance of new pest and diseases in crops and livestock species. These variations also have direct or indirect impacts on agriculture. Furthermore, the adaptation measures adopted in the study area were reported and those which need to adopt for further course of action were explored out.

5.1 Climate change scenario and people's perception

Most of the people are aware about climate change. Communication/media is one of the major reason for their awareness and involvement in project initiated by various NGOs/INGOs. The people who are aware about climate change do not actually know the causes of it. They are unaware about the scientific fact and information regarding climate change but they have the experiences of the effects of the climate change in terms of the changes in natural phenomena like erratic rainfall, increased temperature, flood, drought, cold and frost, intense rainfall for short duration, unpredictable rainfall pattern and decreasing natural water sources, they practice autonomous adaptation. The study done by CBS in 2016 found that the peoples experiences significant changes in monsoon, winter rainfall and temperature in the recent decades. Majority of the households opined that deforestation was the main cause of climate change.

The temperature of both the winter and summer season has been in increasing trend. The number of cold days and night has decreased and the number of warm days and night has increased on the global scale (IPCC, 2013). In many parts of the country, farmers have been experiencing increase in number of hot days and decrease in number of cold days (Regmi *et al.*, 2008). The rise in temperature was particularly felt since 5-6 years. The people related the case of increase in temperature with appearance of mosquito earlier after winter (FGD). Similarly (Maskey, 2013) in chitwan reported the same case. Higher temperatures and droughts will reduce agricultural production (Dixit *et al.*, 2013) and also intensify pest and disease problem (Fischer *et al.*, 2002). With respect to the droughts, almost all respondents observed increased drought events now than before. Higher temperature and decreased rainfall have contributed to increased drought (PAN, 2009). Results from FGD also confirm this. It was also noted that last four years after earthquake in 2015 observed

higher intensity of droughts. Most of the drought events happen in the rainy season, a crucial period for food production point of view. Since a majority of the farmers are marginal and rain fed subsistence based, increasing drought events marginalizes own farm food production. Similarly, drought events appearing during winter further adds to woe. Any drought events coupled with high temperature accelerates catabolic activity in the plants, lowering net assimilation and eventually yields reduction.

The recent year's precipitation pattern has become more erratic with increased rainfall intensity and untimely rainfall resulting to decrease in crop yield. Supporting this, it has been reported that Nepal has been experiencing change in rainfall pattern which proved true as per the climatic data and farmers' perception (Shrestha *et al.*, 1999).

The analysis of perception of local farmers from household surveys, focus group discussion (FGD) and observation revealed that the responses from the area indicates the significant changes happened in the local climatic conditions. The major source of livelihood of the people of the study area was agriculture. Due to changes in temperature and rainfall has an effect on local agro-biodiversity, for instance, local crop paddy, horse gram and local species of vegetables are about to extinct. So hybrid and new varieties of crops should be planted. For the new variety of crops inorganic fertilizer must be used, without the use of inorganic fertilizer it will not grow well and production will decrease. By the use of inorganic fertilizer the soil of the agricultural land must be paralyzed, so nowadays people minimize the use of inorganic fertilizer. New diseases and pest are observed on cereals and fruits. New alien species/weeds are appearing affecting the normal farming operation and eventually crop yields. Remarkable changes in farming was shifting from traditional food crops to vegetable production. Although it has less to do with climate change, farmers would like to follow diversification as a risk management strategy. People also follow off-farm diversification, such as pursuing wage earning, migrating to the satellite towns/cities for finding employment opportunities since agriculture remains less lucrative profession for the farmers. Changes in the growing season, losses of agriculture production, decline in livestock species all attribute to livelihood issue of the farmers. Although an economic analysis was not done, one can easily argue that climatic variability has changed the entire dimension of food production, food security and local livelihoods.

Climate change will directly impact animals through heat stress, changes in water availability (with droughts affecting livestock in particular) and a greater range of livestock diseases and disease carriers (Thornton et al., 2009).

Weather and climate are the key determinant of the productivity of crops grown (Joshi et al., 2011) in that region where agriculture depends on rainfall. Due to the changing climate, farmers have noticed reduced in agricultural production. Farmers also observed new strains of diseases, pests and weeds in the farmlands. Since agriculture production is governed by several biotic and abiotic factors, any variation in climatic resources such as rainfall, temperature, humidity, wind etc. also leads to a variation in agricultural production by interacting with so many other factors in crop production. Weeds in the farmlands, for example, are equipped to derive inputs and possessed higher competitive ability even under precarious situation, most of our domesticated plants are deprived with the required nutrients and other inputs applied to the crops.

5.2 Adaptation Strategies to Climate Change

In recent times, adaptation has become the key focus of the scientific and policy making communities and is now a major area of discussion in the multilateral climate change process (MOE/NAPA, 2010). Adaptation is associated with planned action, either anticipating a threat or averting its impacts and infers some measure of progress or consistency of response (FAO, 2007). Several studies report that farmers from both flood and landslide affected area have been practicing local level adaptation processes to reduce the hazardous effects of climate change (Ellios, 2000). Local knowledge, practices and innovation are important for community based coping and adaptation mechanisms. The adaptation strategies for agriculture were the shifts in the timing of seeding and harvesting of crops, changing the crops, vegetable farming, using hybrid and resistant seed varieties and change in farming techniques. At the community level people have been constantly exploring options to adapt to changing climate knowingly or unknowingly and have developed extensive knowledge in order to cope with the situations. Some of the strategies adopted by the farmers are switching to new crop and/or varieties, crop rotation, plastic tunnel technology in vegetable farming and using genetically modified varieties such as hybrid seeds in order to increase the agricultural production. Farmers in risk prone areas take livestock as an alternative means of generating income under the situation of climatic risks such as drought and floods. Livestock species provide benefit in different ways

(income, manure, meat and milk) in integrated farming system, a predominant system in Dudhauri. Replacing larger species of livestock by more productive smaller species such as goats and chicken and this was considered a coping strategy. Goats are increasingly being preferred because they are more drought tolerant and suited for the browse, the species that survive in extended dry conditions and drought (Musimba et al., 2004). In a few cases, the new crop varieties are more drought resistant than that of the past. Although farmers felt that the measures they were adapting to mitigate the effects of changing climate were not effective due to lack of resources at both household and community level.

CHAPTER VI: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions:

This research provides an insight into climatic variability that farmers have been facing over the period of time, what are the common adaptive strategies and how farming systems and local livelihoods get affected by this variability. It is clear that the farmers were facing climatic variability (such as increasing drought events, increasing temperature and decreasing overall rainfall, cold spells and severity of cloudiness etc.) over time and the frequency of such variability have been on an increasing trend. This variability has brought several risks in agriculture production leading to household food insecurity. Although agriculture production obviously gets affected due to the weather risks, farmers continue exploring options to adapt to adversity. Some of the options which have potency for out- and up-scaling under similar agro-ecological and socio-economic situations are replacing less productive livestock species by smaller but productive species, adoption of drought tolerant varieties of the crops, diversification on and off-farms. However, further research is required to delve deep into socio-economic aspects of agriculture production amid climate change and institutional supports to be required to build adaptive capacity of the farmers and to build the capacity to experiment adaptive strategies to upscale these local innovation.

6.2 Recommendations

The study area have been facing increasing climatic variability is one of the most important factors affecting agricultural livelihoods of the farmers. Given the increasing climatic risks and dwindling resources base, following points could be worth recommended for future research and development.

- Diversification is very important under volatile climatic conditions. Farmers should diversify on the farm and off-farm in order to ensure local livelihoods.
- A set of social safety nets should be provided to the poor and marginal farmers and their adaptive capacity strengthened.
- Water storage tanks and rainwater harvesting should be promote at community level where scarcity of water.
- Action research on testing risk resistant varieties of crops should be conducted as a priority research area.

- Local and national government including NGOs should establish community seed bank for conservation of local crop varieties.
- Institutional support should be ensured to aware and adapt community level climate change adaptation.
- In-depth research efforts are required to find the innovative ideas that are the resultant of extreme weather events. For instance, how farmers adjust to extreme rainfall condition (high rain or very low rain or droughts). Farmers' adaptive measures under such circumstance could provide adaptive options for other areas as well.

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APPENDICES

Appendix 1: Questionnaire Questionnaire for Household Survey

Namaste,

I am Ram Chandra Subedi from Central Department of Sociology, Tribhuvan University. This questionnaire is being implemented to provide information on “*People’s perception on climate change and adaptation strategy among people in Dudhauri municipality, Sindhuli of Nepal*”. It is entirely for an educational purpose i.e. for a thesis as a part of requirement leading to the award of a M. A. in Sociology from Tribhuvan University, Kathmandu, Nepal. I appreciate your kind cooperation in answering the following questions, which will be very much helpful for carrying out this study. Moreover, information given by you will totally be confidential will only be used for my research study. Your participation is totally voluntary.

A) GENERAL INFORMATION OF RESPONDENT:

Date:
Name of the respondent:
Age:
Sex: Male () Female ()
Caste:
Ward No:
Tole:
Family Size:
Occupation:
Religion:
Educational Qualification:

1) What is the major source of living?

- a) Agriculture () b) Business () c) Government Service () d) Private Service ()
e) Job Abroad () f) Daily wages () g) other specify please.....

If agriculture, since how many years are you doing farming?

.....

2) How many members in your household are economically active?

.....

- 3) How much land do you have?
 a) Less than 5 kattha b) 5-10 kattha c) 10-20 kattha d) 20-30 Kattha
 e) more than 30 kattha

Units: Common land Measurement in Chure region is in Katha:
 29.58 Katha = 1Hectare= 0.01km²

- 4) Do you have livestock
 a) Yes () b) No ()

If yes, can you provide your livestock holding status?

Cow..... Buffalo..... Goat..... Pig..... Poultry.....

- 5) Which system you apply for the management of livestock?
 a) Stall feeding b) Grazing in public land c) Community farm land d) others
- 6) What type of farming is practiced?
 a) Rainfed () b) Irrigated () c) Partially irrigated ()
- 7) What major crops do you grow in a year?
 a) Paddy..... b) Maize..... c) Mustard..... d) Wheat.....
 e) Vegetable..... f) others

B) PEOPLES'S PERCEPTION ON CLIMATE CHANGE:

8. Have you ever heard about Climate change?

- a) Yes () b) No ()

If yes, what is your source of information?

- a) Radio b) Newspaper c) Television d) GO/NGO bodies
 e) Teacher f) Study g) Others specify please

9. Could you tell your experience on the changes in the following parameter in recent 10 years?

S.N.	Climatic parameter		Yes-1, No-2	If yes, Inc-1/Dec-2/const-3 from when	Remarks
1	Temperature	Summer			
		Winter			
2	Rainfall	Changes in timing			
		Frequency of drought			

16. Have you noticed increased in crop pest/diseases

- a. Yes () b. No ()

17. What are the different diseases that are hampering the crop growth?

.....

18. Is crop production Increase/Decrease nowadays: Yes () No ()

19. Have you noticed any change in the fruiting and flowering time of crops and fruits

- a) Yes b) No

If yes

Crops/Fruits	Before	Now

20. Have you notices any changes on fishing/natural based livelihood due to climate change?

- a) Yes b) No

If yes how.....

ADAPTATION MEASURES:

21. Have you taken any adaptation measures to deal with the effects of climate change?

- Yes-1 () No-2 ()

If No, why?

.....

If Yes, What measures.....

i) Agricultural Adaptations (For major crops)

22. Have you changed your sowing, planting and harvesting time of the crops?

	Crops	If yes Present	Past
Sowing time			
Planting time			
Harvesting time			

23. Have you changed the crop variety due to climate change?

Yes-1 () No-2 ()

If yes,

	Past	Present
Crop		

24. Is there any changes in frequency of use of irrigation water?

- a. Increased ()
- b. Decreased ()
- c. No change ()

25. Have you decreased the scale of farming and shifted to non-farming activities?

- a. Yes ()
- b. No ()

If yes, from when and why?

.....

Household food Surplus:

26. Do you think your agricultural production is sufficient for your family?

- a) Yes ()
- b) No ()

a) More than 12 months b) 9-12 months c) 6-9 months d) 3-6 months e) less than 3 months

i) If not enough production then how do you manage for rest of the year?

.....

27. Have you faced food shortage in the past?

- a) Yes ()
- b) No

If yes, When? To what extent?

.....

28. What were the causes of food shortage?

- a) Drought ()
- b) Flood ()
- c) Hailstorm/ Windstorm ()
- d) Others, Specify please.....

29. How did you address the food shortage issues in the past?

.....

Interviewer information:

Name:

Signature:

Date of Interview:

Thank you for your co-operation!!!

Appendix II: Checklist for Focus Group Discussion

A. Information about the climate change and its impacts

1. Do you feel or observe temperature and rainfall change in the past few years
2. What are the consequences of changes in temperature and rainfall? (based upon your experience)
3. What are you doing to cope with these changes?
4. Do you know about the impact of climate change? (if not we have to clear on it)
5. What are the changes you have been noticed during recent 20 years in your communities?
6. What are the major livelihoods of the people of the area? (Agriculture, Poultry, Fishing, Livestock, Horticulture, Business, Gov. Job, others)
7. What are the major impacts of climate change (Impact on their income and livelihood) (Impact on Agriculture, Dairy, Poultry, Vegetable farming, Livestock, Fishery, Horticulture, Business.)
8. Have you noticed any change in the fruiting and flowering time of crops and fruits
9. What are the major natural hazards of the area?
(Flood, Landslide, Drought, Snake biting, Firing, Hailstorm, Windstorm, Cold wave, Heat wave)
10. Are there any differences in the timing of seasons and events as compared to 20 years ago?

11. Cropping Calendar

Months /Crop(major)	Year	Baisakh	Jestha	Ashad	Sarawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra
1.	Before												
	After												
2	Before												
	After												
3	Before												
	After												

1-Sowing, 2-weeding, 3-Harvesting, 4-Flowering, 5-Fruiting

12. Are there any changes in crop yield (Comparing to past)?

Products	Productivity(Inc-1/Dec-2/Same-3)	Quality(Inc-1/Dec-2/Same-3)	Variety(Change-1/Unch-2)	Place(Change-1/Unch-2)

Thank you for your Co-operation

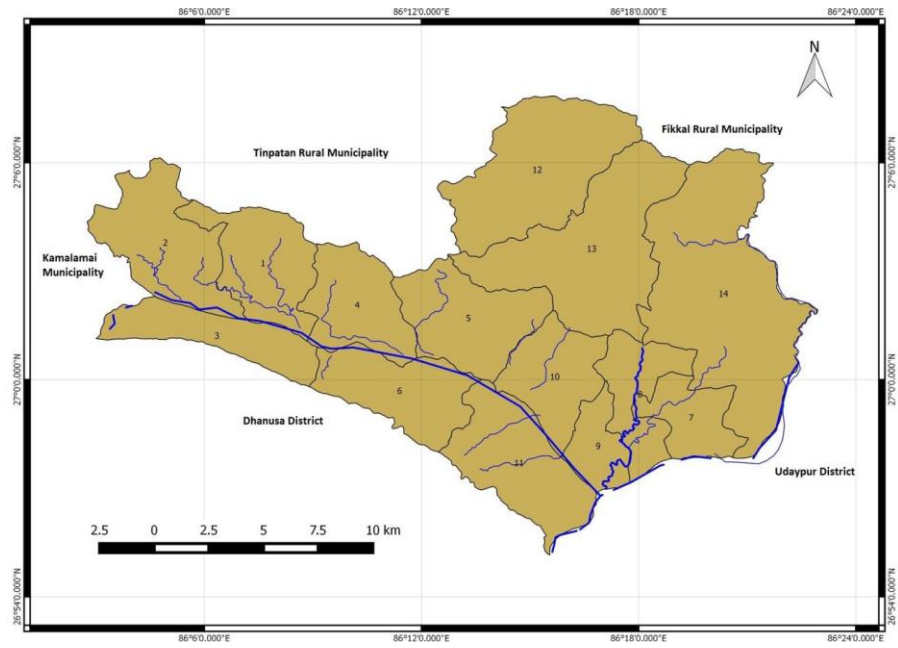
Appendix III: Case study

Case study

Badri Kumar Dahal, 54 a permanent resident of Dudhauri municipality-7 is a farmer and a chairman of Rameshworham Tole development organization, first environment friendly tole of Sindhuli district. He feels various changes in climate. As a farmer, he saw that there are various changes in the environment. The rainfall pattern is changing in these days, He feels so many changes which are as follows:

- Summer days are hotter than previous year and winter are less cold.
- Rainfall pattern is changing. In the past every month rainfall was occurring, but nowadays during monsoon season is also very low rainfall and in short span of time large amount of rainfall create flood. In the past during monsoon season there are seen enough stream with a high flow of water before 15 years ago, but nowadays water flow in rivulets only in the rainy season.
- Declining in water sources.
- Different plant species were flowering and fruiting irregularly like mango, litchi, and jackfruit. Mango flowering in Poush (one month earlier) and ripen in jeshth instead of asar.
- Due to drought, various diseases are seen in fruits and crops. Winter season crops are most affected by the pest due to drought Three seasons crop land is limited to one season's crop land due to lack of rainfall; local species of fruits and cereal are extinct, such as cucumber, horse gram, rice bean, local paddy species etc. The disease was seen in fruits such as in pomegranate, jack fruit and banana.
- Productivity of crop is in decreasing trend in water scarce area as compared to the past and increasing productivity in water available area. High dose of insecticide and pesticide should be necessary to suppress pest and diseases.
- Mosquitoes are seen in the winter season also but in past seen only in summer season

Appendix IV: Map of the Study Area



Appendix V: Photographs



Platel: Interview with respondents



Palte2: Stakeholder's participation in focus group discussion



Plate3: Stakeholder's participation in focus group discussion



Plate 4: Water collection from kitchen sink by constructing cemented pond as adaptive measures



Plate5: Recently seen false army worms (Invasive pest) in winter crops