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A case study on changing trends of population parameters and climate change adaptation practices in Foot Hill region, Nepal

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Abstract

Rapid population growth has driven by high fertility, large household size and high migration rate in Dubiya village. Deterioration of climate sensitive ecosystem services such as agriculture, water resource and forest affects the livelihood of population. Local people perceived change in temperature and precipitation pattern of the area with erratic rainfall and extreme events. Local people are mostly exposed to flood, forest fire and frost events. The incidence of declining ground water level and droughts are fairly common. Agriculture was found to be the most vulnerable sector affected by change in population dynamics and climate change with decrease productivity and incidence of disease, pest and weeds. The vulnerability of local people is enhanced by land fragmentation and distribution, large household size, and lack of income diversification, low education status, and food insecurity. Awareness on climate change and capacity building to diversify the livelihood source will help to strengthen the resilience of people.

Keywords: Population growth, Climate change, Adaption.

1 Introduction

The threat of human induced climate change presents a difficult challenge to society over the coming decade. The potential impacts of this change are many and varied. More frequent and intense heat waves, changes in the frequency of drought and floods and more damaging storm surges are a few common impacts of climate change.

Rapidly growing population is being increasingly accepted as a major contributor to climate change. World population is projected to reach 9.1 billion by 2050, with most of this growth in developing countries (Population Reference Bureau, 2011). More people mean more demand for conventional fuel which emit greenhouse gases such as carbon dioxide (CO_2) into the atmosphere and induce warming (Stephenson et al., 2010). It ultimately stresses upon human health, agriculture, economic activity, biodiversity and ecosystem functioning. Rapid population growth is responsible for increasing demand and overuse of natural resources. Large migration can lead to agricultural intensification which may lower soil quality. Global climate change is affecting Nepal (INC, 2004) and various recent studies show that Nepal is highly vulnerable to the potential negative impacts of climate change. Climate change is expected to threaten agriculture, water resource and biodiversity in Nepal (Shrestha, 2010). The basic need of growing population is dependent on healthy environment (ICPD, 1994).

Migration is an adaptive strategy employed by many rural communities. Migration associated with environmental decline is usually characterized by short distance and long-term movements (Stephenson et al., 2010). Large-scale population movement is likely to intensify as changing climate may lead to the abandonment of flooded, arid and inhospitable settlements. The resulting mass migration will lead to many serious health problems both directly, from the various stresses of the migration process, and indirectly, from the possible civil strife that could result from disordered movement of people.

Population dynamics are especially relevant to the debate related to coping with-or adapting to – climate change. The high population growth pressures contribute to colonization of forested area for human settlement, expansion of cropland, harvesting of wood and fuel, commercial logging of forests etc. leading to deforestation and hence environmental degradation. Population growth, migration, population structure and distribution may stress upon resources that help to fulfil basic requirements such as water, food, clothing, shelter and energy and thus directly or indirectly may affect the ecosystem.

2 Rationale and significance of the study

Population dynamics have not been systematically integrated into climate change science. Research is urgently needed to clarify the contribution of population growth, migration, urbanisation, ageing and household composition on climate change mitigation and adaptation programmes. Rapid population growth endangers human development, provision of basic services and poverty eradication and weakens the capacity of poor communities to adapt to climate change (Michael, 2006). Significant mass migration is likely to occur in response to climate change and should be regarded as a legitimate response to the effects of climate change. Study of relationship of population parameters with global climate change is indeed necessary as distinct populations groups and pattern (age structure, household size) and standards of living of Terai people are often associated with per capita emissions. There is need of integration and linkage to climate change research and policy.

The mountain and hill zones lost their proportionate share of population while the Terai gained this share since 1950's (CBS, 2003). Terai constitutes 50.15% of population (Central Bureau of Statistics, 2011). Eco-demographic factors such as population density, carrying capacity, and population pressure on resources may have a negative impact on climate change in the Terai region. The growth of population can contribute to fresh water scarcity or degradation of cropland, which may in turn exacerbate the impact of climate change (UNFPA, 2009). So, it is necessary to establish the link between population dynamics and climate change.

There lies uncertainty in temporal and spatial climatic variation. The local impacts are also uncertain, but they are expected to influence at wider scale and tend to be potentially severe. Extreme climate- related events, such as floods, windstorms and droughts may become more intense and occur more frequently. Due to such uncertainty, the consequences are likely to be more negative and their impact on the people's livelihood at local level may be significant.

3 Objective of the Study

1.1 Main Objective

- To document the population dynamics and climate change adaption in Dubiya village.

1.2 Specific Objectives

- To determine major causes of population dynamics in the study area.
- To identify the perception and practice of local people towards climate change and its impact on livelihood.
- To document the climate change adaption practices in the study area.

4 Scope and Limitation

Major causes of changing population in Kapilvastu district have been identified. This study explores the link between population dynamics and climate change in Kapilvastu. Awareness level, people's attitude and practices helped us understand their vulnerability status. General population of Kapilvastu and other regions will be informed about findings through dissemination and publication of research paper in national and international level. Result is expected to be useful in formulating policy related to climate change. Specifically, it is expected that results of study will be able to guide and formulate population control measure. Moreover, results of study will be made available to researcher and policy makers through publication in journals. And moreover, this study covers:

- Documentation of the experiences of people affected by climate change, including adaptation strategies.

- How demographic factors (e.g. growth rates, composition, spatial distribution and education levels) affect the adaptive potential of populations.
- Exploration of the effects of rapid population growth in people's livelihood in the study area (involving, for example, population structure, water availability, food and condition of settlement) to support better adaptation strategies.

5 Limitation of the study

It is important to recognise the distinct ways in which population issues can be linked to climate change adaptation (reducing vulnerability to the adverse effects of climate change). Few experts doubt the importance of population in relation to climate change adaptation. Some of the limitations of this study are as follows:-

- The detailed and timely studied data of population parameter such as fertility, mortality and migration of the studied site were not available for correlating the population dynamics with climate change.
- The study was restricted to review of available few literatures in the Nepalese context.
- The study period was short as only post monsoon period was taken into account.

6 Methodology

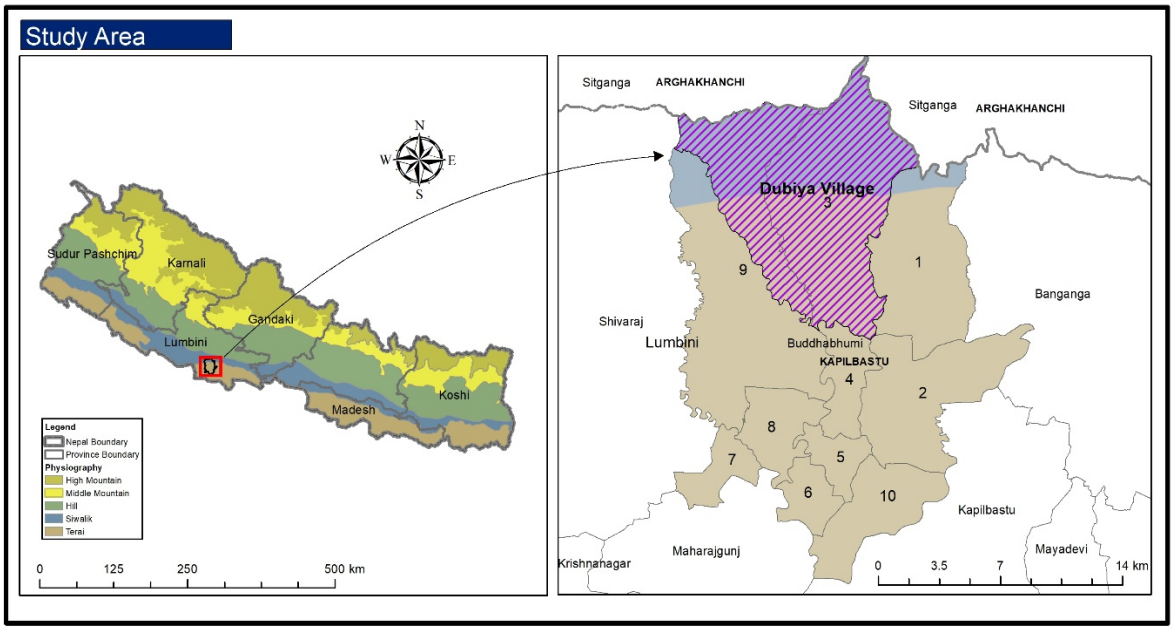
6.1 Study Area

Climate Vulnerable village named Dubiya from Kapilvastu district was selected for study. Kapilvastu district is the westernmost section of the contiguous region of the northern Indo-Gangetic Plain. It lies within the Rohini, Tinau, and Banganga river basin. Kapilvastu stretches between 82°41'E and 84° 14'E longitude and 27°25'N and 27°49'N latitude and its area of 1,738 km^2 encompasses three distinct geographical zones: the lower Chure and the Bhabar, middle Terai and lower Terai, which is 1.18% of total land of Nepal.

This district has tropical climate. Total area of Siwalik and Terai within district occupy 27283 ha and 50555 ha respectively. Terai region has fertile land for agriculture. The major agriculture products are rice 'wheat, and pulses etc.

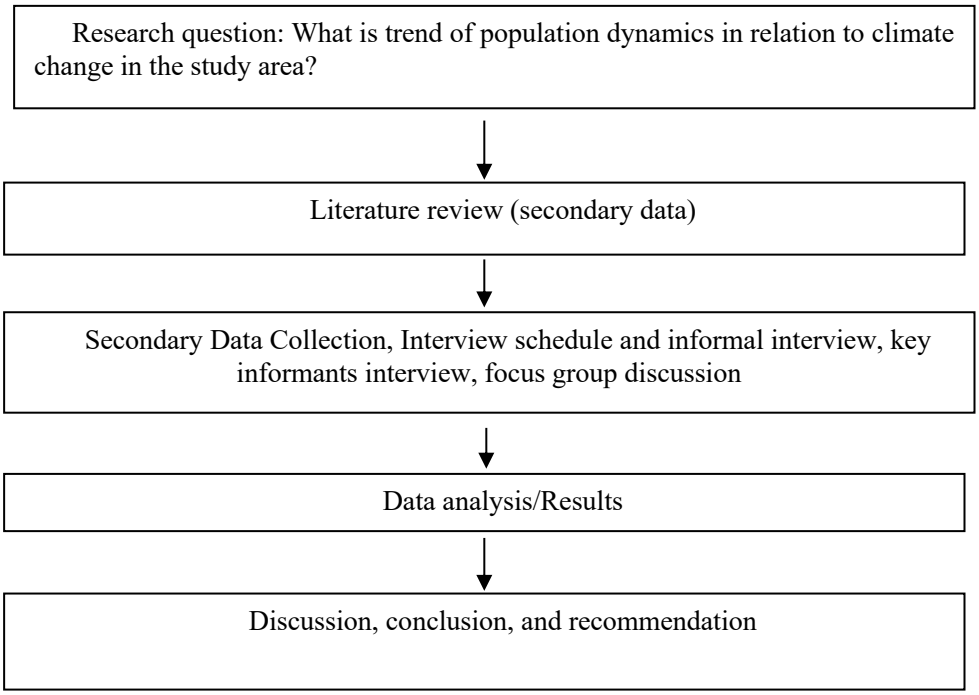
Population of the district is 481,976 out of which 247,875 (51.43%) are male and 234101 (48.57%) are female. District has total households 83,513 and average household size is 8. Population growth is 3.20 and density is 293 per sq km. Literacy rate of the district is 42%. Major cast / ethnic groups are Muslim (19.4%), Tharu (12.6%), Yadav (9.7%), Brahmin 8.4%), Kumal (6.4%), Chamar/Jarijan/Ram (5.4%), Chhetri (4.0%), Dushadh/Pashwan/Pasi (3.6%) and others (30.6%) (CBS, 2001).

Dubiya village lies in the Chure foothills and Bhabar zone north of the East-West Highway. Tharus are the dominant ethnic group, but there are several migrants of diverse ethnic groups from the hills. Though the zone has various natural resources, it is socially and economically marginalised.



6.2 Research Design

Descriptive and exploratory research design was used in this study. For the study, following process has been performed:



6.3 Data Collection Tools

To fulfil the objectives of this study, interview schedule and focus group discussion format were developed to collect the required information. After the preparation of interview schedule, it was pre-tested by administrating 10 people to identify the practicability. On the basis of the pre-test result and feedback offered by the supervisor, the interview schedule was modified and finally used in the study site.

6.4 Sample Size and Sampling Procedure

The detailed study was carried out in the month of June, 2012. The stratified random sampling method was adopted for the household survey. Then the whole village was divided into nine strata in reference to administrative boundary of that village. The survey was carried out among the local people of the study area. Out of 933 households, 94 households, representing ten %sample from each ward were randomly selected for household survey. 10 %samples from each ward were taken to maintain homogeneity of the data and to minimise the bias between the samples.

6.5 Nature and Sources of Data

Both primary and secondary data and information were collected from the study area.

6.6 Primary Data

Primary data was collected from field survey with the help of direct observation, interview, and focus group discussion, transect walk and informal interview.

a. Household survey: The interview schedule was developed in Nepali language for the conduction of household survey. It mainly focused on demographic and socio-economic status, perception and practice of local people toward climate change, climate change and its impact on livelihood measures or ecosystem services (agriculture, water and forest), climate induced disasters and adaptation strategies. The interview schedules were administrated to the sampled household of the study area.
b. Focus group discussion: Focus group discussions were held. The focus group reflected the social structure of the village. In each focus group session, 12-18 people (82 people in total) participated and five focus group discussions were organised with a very general and open discussion about climate related problems faced by the group or the village. Participants were asked to identify climatic events from the past that were especially problematic for the village. The implications and effects of these climate related risks on livelihoods and wellbeing were discussed. The adaptation measures were also

the part of discussion. Focus group sessions ended with a discussion on the effectiveness of such adaptation strategies.

c. Transect walks: Transect walk refer to "walking with or by local people through an area, observing, asking, listening, discussing identifying local and introduced technologies, etc seeking problems, solutions and opportunities"(Marscarenhas, 1990). Direct observation and simultaneous discussion about physical phenomenon (such as droughts and floods) during the Transect walk help people to recall and explore more information regarding climate change impacts and adaptation.

6.7 Secondary Data

The recorded temperature and rain fall data of the nearest were collected from ISET Nepal. The village profile prepared by Dubiya village and Gramin Bikash Shanstha was collected from the Ward office. Published data of the Central Bureau of Statistics and different national level reports were also referred. The relevant study materials were collected by consulting various published and unpublished books, thesis, reports, journals, papers, bulletins, magazine, symposium, newsletter, records, websites, etc. for required qualitative and quantitative information.

6.8 Data Analysis and Interpretation

Data obtained through primary and secondary sources was processed, analysed and interpreted by using appropriate statistical tools, graphs tabulated forms and boxes. All the statistical data were entered and analysed using Statistical Package for Social Science (SPSS) and excel.

7 Result and discussion

The demographic and socio-economic condition of local people of Dubiya village were revealed from the household survey. The sampled household size was 94. Out of total respondents, 73.64% were male whereas female respondent's accounted for 26.60%. The median age of the respondents was 44, with minimum age of 18 and maximums of 74 years old.

7.1 Socio demographic status

7.1.1 Occupation

About 71.3 %of the local people depend on agriculture for subsistence livelihood, 7.4 %of respondents were engaged in fisheries and 13.8 %respondents have jobs. Very few respondents (2.1%) were involved in business and other activities (5.3%).

7.1.2 Education

The study revealed that 39.4 %of respondents was illiterate. About 29.8 %respondents have completed their primary level. Likewise, about 18.1 %respondents have completed their secondary level. Only 12.8 %of respondents have completed college level. An efficient and well-trained community plays crucial role to minimise the death related incidences and offers physical and psychological assistance during the climatic events. Massive awareness raising is essential to convert study site into climate change safe community.

7.1.3 Population growth

The population growth rate of Dubiya village during the year 1981-1991 was found to be 2.14 %and in the year 1991-2001, the growth rate was found to be same i.e. 2.14% but during the year 2001-2011 the population growth rate increased to 4.13%. This shows that population is increasing rapidly in this village and thus it is projected that the growth rate in the year 2011-2021 is expected to be 4.13 %with 9,413 people.

Now comparing the growth rate of Dubiya village with Nepal's national growth rate, it was found that the population growth rate of Nepal in the year 1981-1991 was 2.08 %while the growth rate of the specific Village in the same year was 2.14%. In the same way, the population growth rate of Nepal in the year 1991-2001 was 2.25 %while in the same period the growth rate of Dubiya village was 2.14%. The growth rate of Nepal in the year 2001-2011 was 1.40% while that of Dubiya was 4.13%.

The above data show that the population growth rate of Nepal is increasing rapidly per 10 years and comparing the growth rate of Dubiya village with Nepal's population growth rate, it was found that population is increasing more rapidly in this village.

One significant question is whether rapidly growing populations are more vulnerable to the impact of climate change than slowly growing ones. It is important to identify the expected impacts of climate change on agriculture, human health and environmental security, focusing on vulnerable populations (O'Neill 2001). Population growth's may influence GHG emissions leading to consumption demands which may further increase demand for energy (particularly fossil fuels and traditional biomass fuels), agricultural products, and goods whose production is associated with deforestation (O'Neill 2001).

Meeting the basic human needs of growing population is dependent on a healthy environment. Demographic factors combined with poverty and exploitation of resource in the study areas and excessive

consumption and wasteful production patterns in the other areas, cause or exacerbate problems of environmental degradation and resource depletion and thus inhibit sustainable development.

One of the most important direct effects of population growth is increase in demand for food and fiber; at the same time, one of the most important indirect effects is influence in agriculture practice and technology, the way that people provide themselves with food and fiber.

7.1.4 Migration

Among the total population, 52.13% of people have migrated to different places and 47.87% of people have moved within the study area. Concentration of population can increase susceptibility to the disasters that are likely to become more frequent and more intense as a result of climate change.

7.1.5 Origin of Migration

About 41.5% respondents have migrated from mountain and 11.7% respondents have migrated from same village and other parts of Terai region. The mountain and the hill lack infrastructure development. People in mountain and hilly area still depend on marginal agriculture, animal husbandry and exploitation of natural resources for survival. Difficult life in such area prompted migration process. Migration is an adaptation strategy employed by many rural communities. Migration associated with environmental decline is usually characterised by short distance and long-term movements within same village. People prefer short distance for permanent migration. Migration is a crucial aspect of the link between population and climate change. Large-scale population movement is likely to be intensified as changing climate leads to the abandonment of flooded or arid and inhospitable environments in local area.

7.1.6 Cause of Migration

Among the total migrants (52.13%), about 17.0% households migrated due to food scarcity problem and 12.8% households migrated due to lack of basic facilities such as water supply. Likewise, migrations resulting from the low production and flood were 11.7% and 8.5%, respectively. Only 3.2% households migrated from the other cause of migration. Thus, climate change influences migration from more vulnerable area to another area to sustain their life. This situation may create problems both in area of origin and destination in physical, social and psychological dimension.

7.2 Agriculture System

7.2.1 Change in Land Use Pattern

Terai is the basic crop producing area in the country. The plain terrain has fertile soil with subtropical monsoon climate that facilitates crop production in this region. Land is the primary resources for agrarian economics. Over the past decade, population has grown rapidly in the study area. The cultivated land is the main environmental resource on which majority of population depends for livelihood.

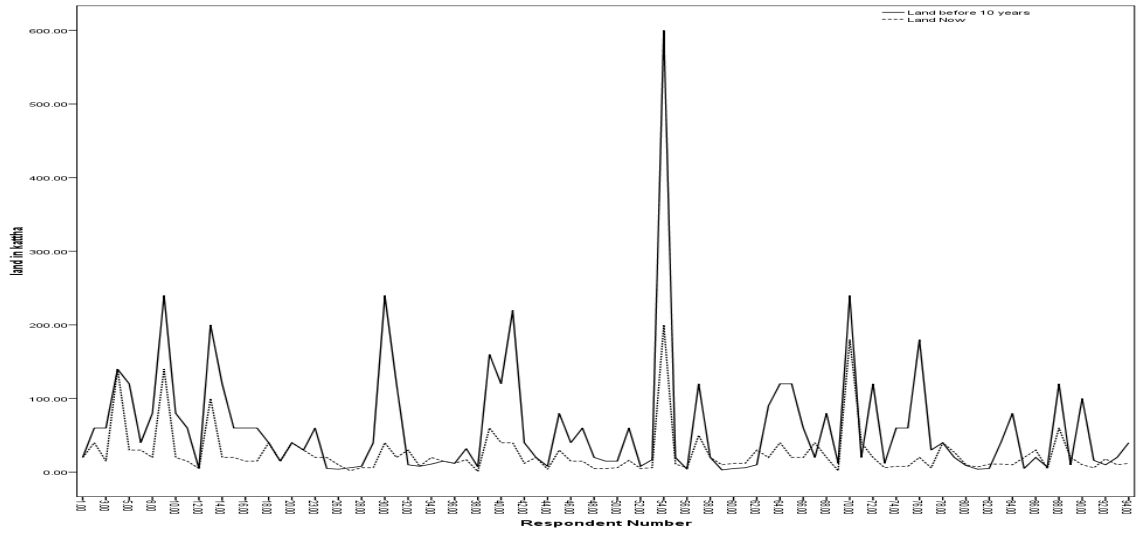


Figure No. 1 Agricultural land use

Figure No.1: shows the status of land of local people 10 years ago and now. The figure shows very high fluctuation in ownership of agricultural land from household to household at various time intervals. Increasing population exerts pressure on land resource. Boserup (1981) expressed that over population can lead to unsustainable farming practice which may degrade the land. Rapid population growth and increasing pressure on land resources to earn the much-needed calorie are the major challenge in the study area.

7.2.2 Irrigation System

As water became scarce and rainfall became less frequent, people experienced decreasing crop productivity. Thus, they search alternate water resource to irrigate their fields. Water scarcity is a critical problem in the winter and pre monsoon. Local people have focused their attention towards conservation of local and traditional lake to build the capacity of irrigation. However, people have faced the problem of long drought in recent years. At present, there are increasing cases of ground water extraction through the use of traditional and new technology like Dhiki nall, pump set and others.

7.2.3 Use of Fertiliser

Increasing presence of people on the finite territory of Nepal has multifaceted implication. The use of natural fertiliser or manure promotes agricultural production. However, high food production in limited land area may reduce the nutrients available in soil (Malla, 2008).

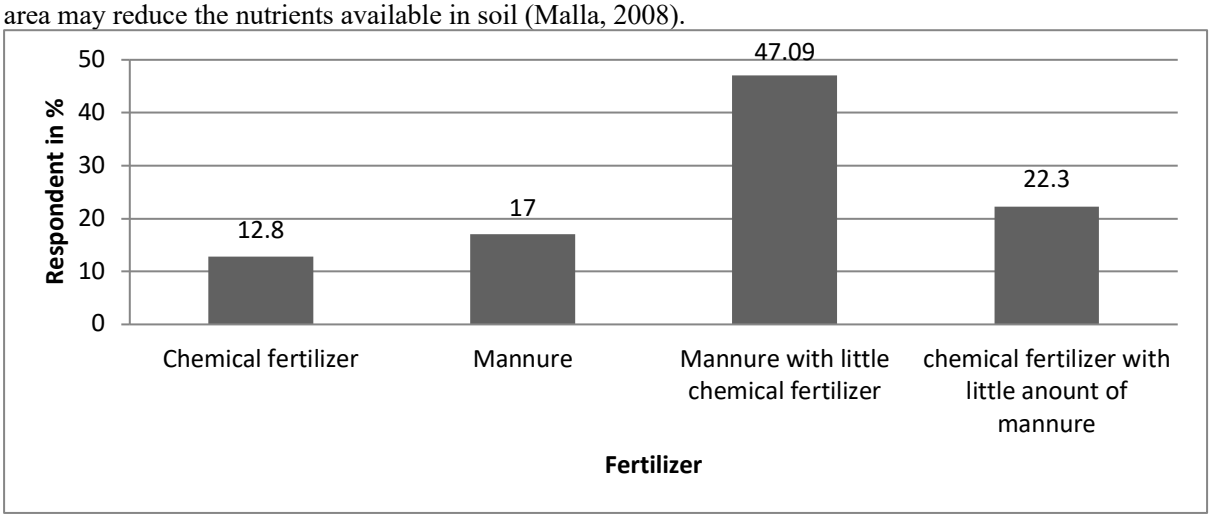


Figure No. 2: Use of fertilizer

The above bar diagram shows the use of fertiliser by the people of Dubiya village. The above diagram shows that only 12.8% people of Dubiya village use chemical fertiliser in their land and 17.0% of total population of this village use homemade manure in their land, but large percentage the respondents (47.9%) use homemade manure with the little amount of chemical fertiliser. 22.3%people use more chemical fertiliser with little amount of manure.

This shows that a smaller number of populations are using only homemade manure or only chemical fertiliser. However, people using the combination of both is very high (using the combination of high amount of manure with little chemical fertiliser).

During focus group discussion, it was found that the trend of using homemade manure is reducing and people of this village are relying more on chemical fertiliser in their land due to ease in availability, but they are not aware about the adverse effect of chemical fertiliser in their land.

7.2.4 Status of Pests

Climate change parameters: temperature, rainfall pattern and humidity effects the development and distribution of pests and diseases. Increasing temperature and CO2 may increase population of pests and severity of disease and add pressure on host plant.

The above pie chart shows the effects of pests in the crop of Dubiya village. The above chart shows that 79.79% population agree with the fact of increasing pests and 20.21% population assumes that the pests' condition is same as before. In focus group discussion, people of Dubiya village said that the pests are increasing rapidly and these days they are encountering very new and extremely disastrous pests which are destroying their crops significantly.

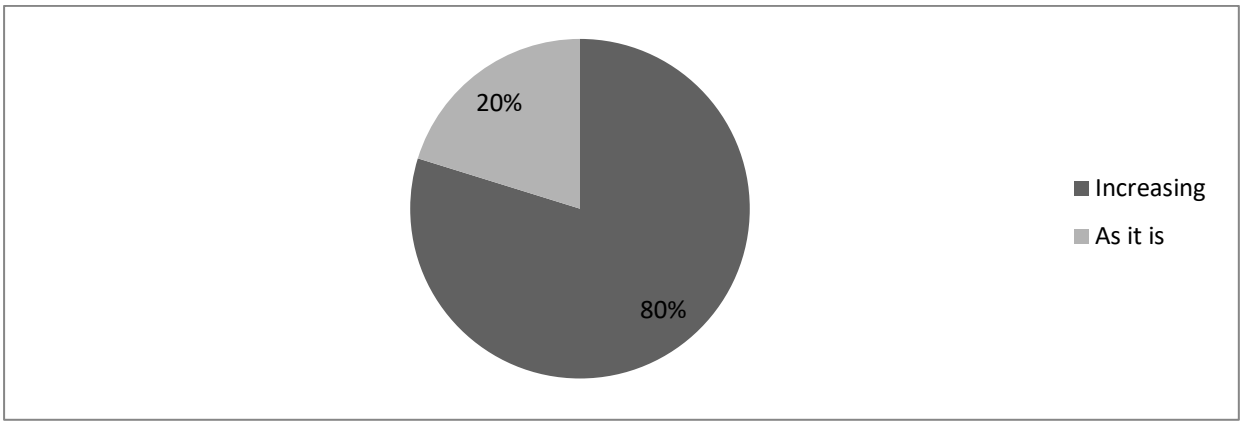


Figure No. 3: Status of pest

Most of the local people are totally dependent on agriculture without other additional sources of income. In context to Nepal, over 80% of the total population engage in agriculture (MOF). The main crops are rice, wheat, and maize. Agriculture is the main field where impacts of climate change can be easily observed. More than 79% of the respondents shared that they have experienced increase in a number of invasive pests and insects than the previous years in their farmyards so they need to use more pesticide and insecticide in their farm to get rid of such pests and insects. Along with this, they reported that there is the need of improved varieties of seed for better production.

7.2.5 Use of Pesticide

Population growth may encourage intensive production that results in negative consequence for soil. As a result, the population-environment issues have gained attention in the public policy in Nepal over the past few decades.

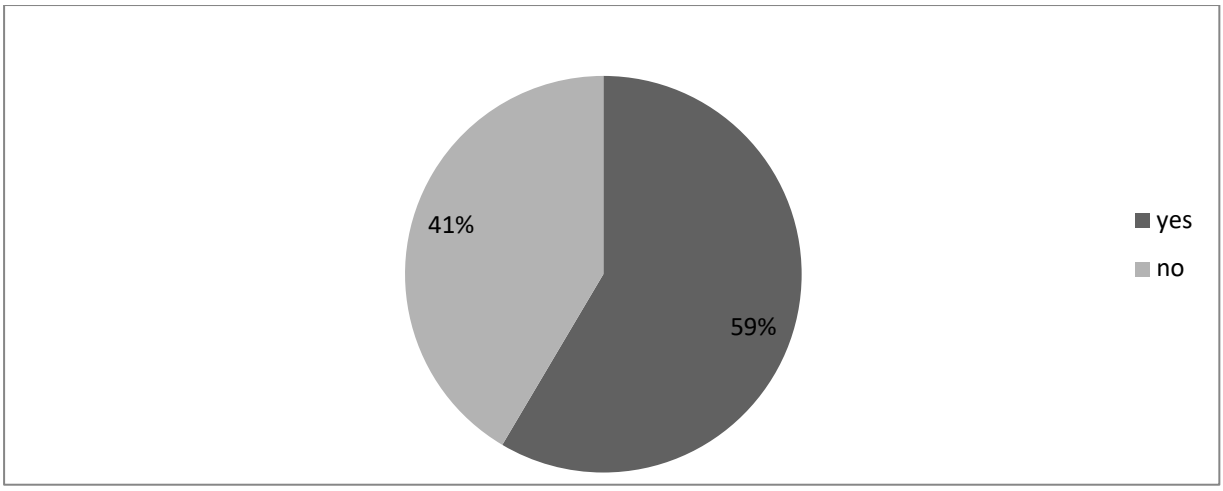


Figure No. 4: Use of pesticides

The above figure 4 shows that 58.51% of the people in this village use pesticides while 41.49% of the people do not use any kind of pesticides to kill pests in their land.

During the focus group discussion, it was found that most people are using pesticides in their land to control the pests, and majority lack knowledge on adverse effect of pesticides on crops. There are people who extensively use pesticides despite being aware about its negative consequences.

7.2.6 Status of Weeds

The above figure 5 shows the status of weeds in the land. It shows that 34.04% respondents state that normal weeds are found in the land and 65.96% respondents experienced the emergence of new and unidentified weeds of invasive nature that are causing severe loss of crops especially paddy. The respondents also reported drastic increase in number of grasshoppers in recent years.

The above figure 5 shows the status of weeds in the land. It shows that 34.04% respondents state that normal weeds are found in the land and 65.96% respondents experienced the emergence of new and unidentified weeds of invasive nature that are causing severe loss of crops especially paddy. The respondents also reported drastic increase in number of grasshoppers in recent years.

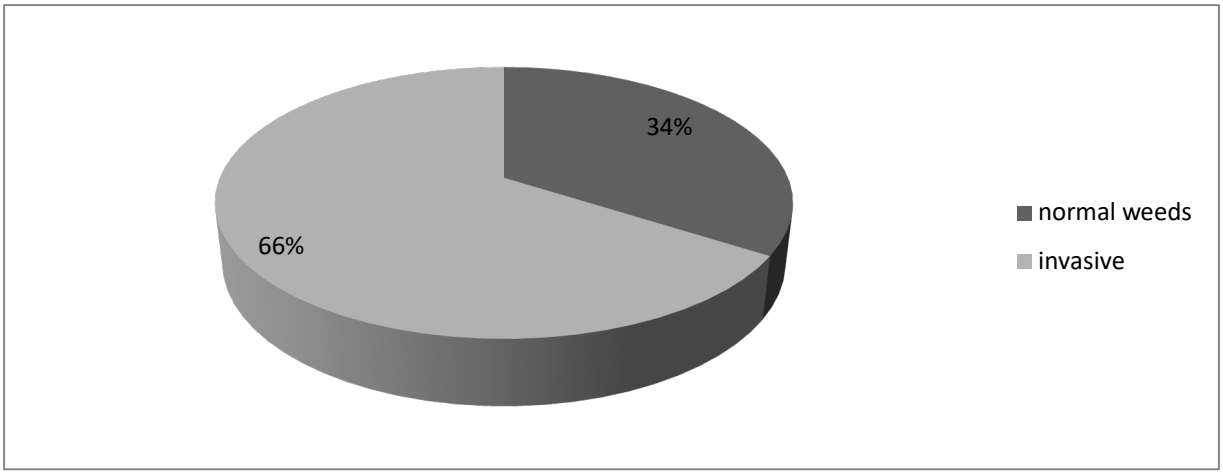


Figure No. 5: Appearance of weeds in field

During the focus group discussion, the participants mentioned the increasing population of invasive weeds due to erratic rainfall which caused damage on local crops.

7.2.7 Crop Intensive

Available research thus suggests that global climate may add challenges to depleting world food system. Malthus (1967) argued that, over the long run, equilibrium between population and agriculture resources is determined by technology of food production and the minimum living standard. As Malthus assumed agriculture resource base to remain fix without any technological progress, his conclusions were not convincing. Boserup (1965, 1981), however, argued that increasing population pressure itself induces technological changes, leading to more intensive use of land.

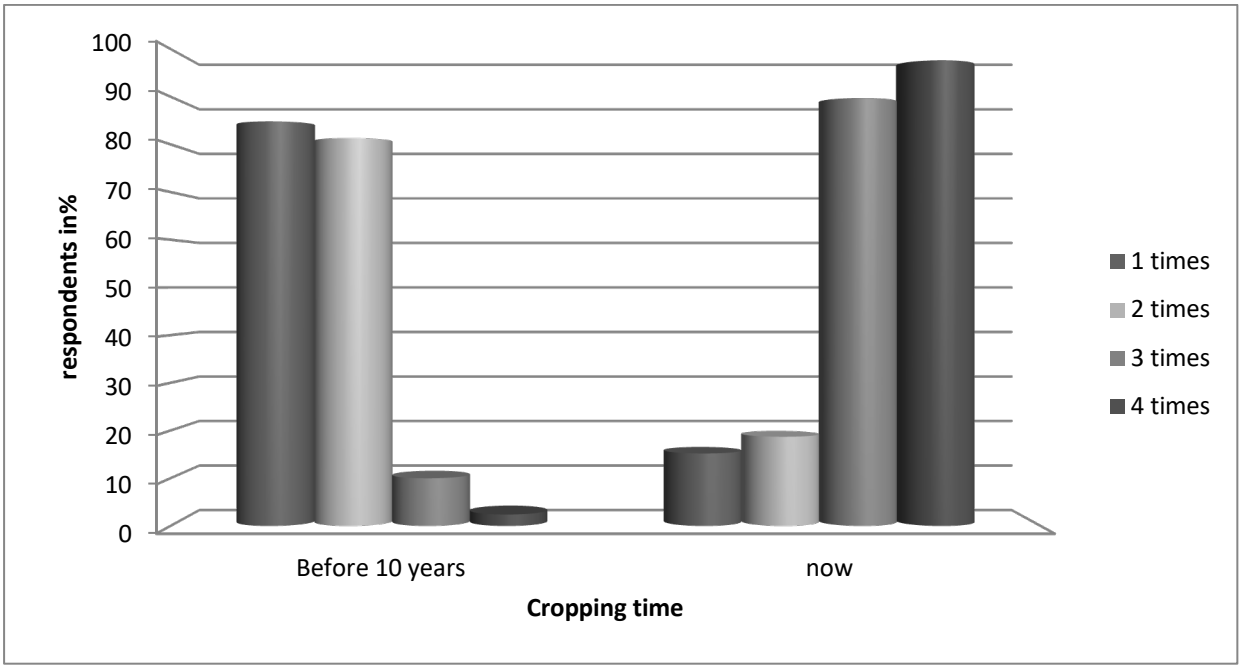


Figure No. 6: Status of cropping time before and now

10 years before, 84.8% population cultivated only one type of crop in their land but nowadays only 15.2% population cultivate single type of crop in their field. Percentage of population cultivating two types of crops before 10 years was 81.3% while now only 18.7% population cultivate two types of crops. 10.3% population used to cultivate three different types of crops 10 years back while the trend is increasing now and 89.7% of populations cultivate three different types of crops these days. The above diagram also indicates that 10 years before only 2.4% of total population used to cultivate four different types of crops in their field but it is

increasing rapidly and now 97.6% of total populations cultivate four different types of crops in their field these days.

During focus group discussion with people of Dubiya village, it was discussed that 10 years back population was less with slow growth rate. The available land was enough so the percentage of people growing only one type of crop was very high. People did not have to grow different varieties as single crop was sufficient to sustain their livelihood. Nowadays population is increasing rapidly, and the growth rate is also high. Land is decreasing due to fragmentation and people are experiencing scarcity of food. Therefore, they are compelled to grow different types of crops in different seasons in the same limited land to sustain their livelihood. The area of land used for crop is approximately three times the area currently under cultivation (Bongaarts, 1993) but much of this land is of inherently low productivity and is prone to environmental damage.

7.2.8 Status of Production

In Nepal more than 80% of the precipitation occurs in the monsoon from June to September. Increase in temperature and erratic rainfall directly affect the agriculture and food supply by affecting crop production. Insufficient rain and increasing temperature cause drought whereas intense rain in short period reduces ground water recharge by accelerating runoff and cause floods, soil erosion and landslides. Both of the situations impart negative effect on agriculture.

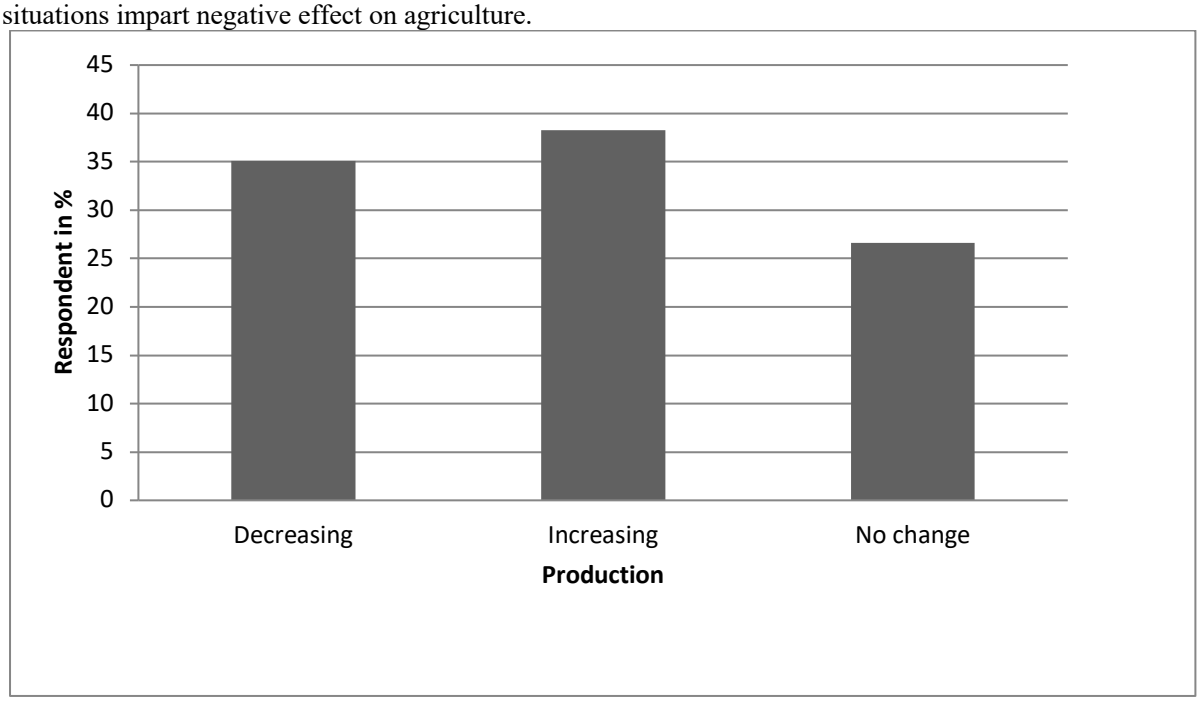


Figure No. 7: Status of food production

The above figure 7 shows the status of production. Around 35.11% of respondents said that production is decreasing when compared to past 15 years while 38.3% respondents view that the production is increasing than past 15 years ago. 26.6% respondents replied that production level is same as the past.

During our focus group discussion, it is observed that the number of people who claim that the production is decreasing due to change in seasons, erratic rainfall, and drought and lack of chemical fertiliser. Then the other group of people expressed the case of increasing production due to availability of hybrid seeds and chemical fertiliser. Large participants claim the absence of agriculture trainers. Proper use of agricultural techniques is very essential for high production. Agricultural techniques provide farmers with skill and new techniques applicable in the healthy growing of crops.

7.3 Water Resources

Population growth increases pressure on water resource. Biswas (1994) wrote in the Asian Case that, since priority is either explicitly or implicitly given to domestic use of water, the irrigation sector will simply have to achieve more with fewer resources. Rapid population growth will offset itself by encouraging the rationalisation of water use.

7.3.1 Source of Drinking Water

The result of the questionnaire survey showed that almost all the respondents have noticed decrease in water availability in various water resources in recent years. According to respondents, depth of well, water

springs/pond has decreased in recent years and they are facing problem of drinking water and water for irrigation. They witnessed decrease water level in nearby spring and ponds or lake. Water availability is expected to decline with projected climate change impacts (IPCC, 2007; Ministry of Environment 2010).

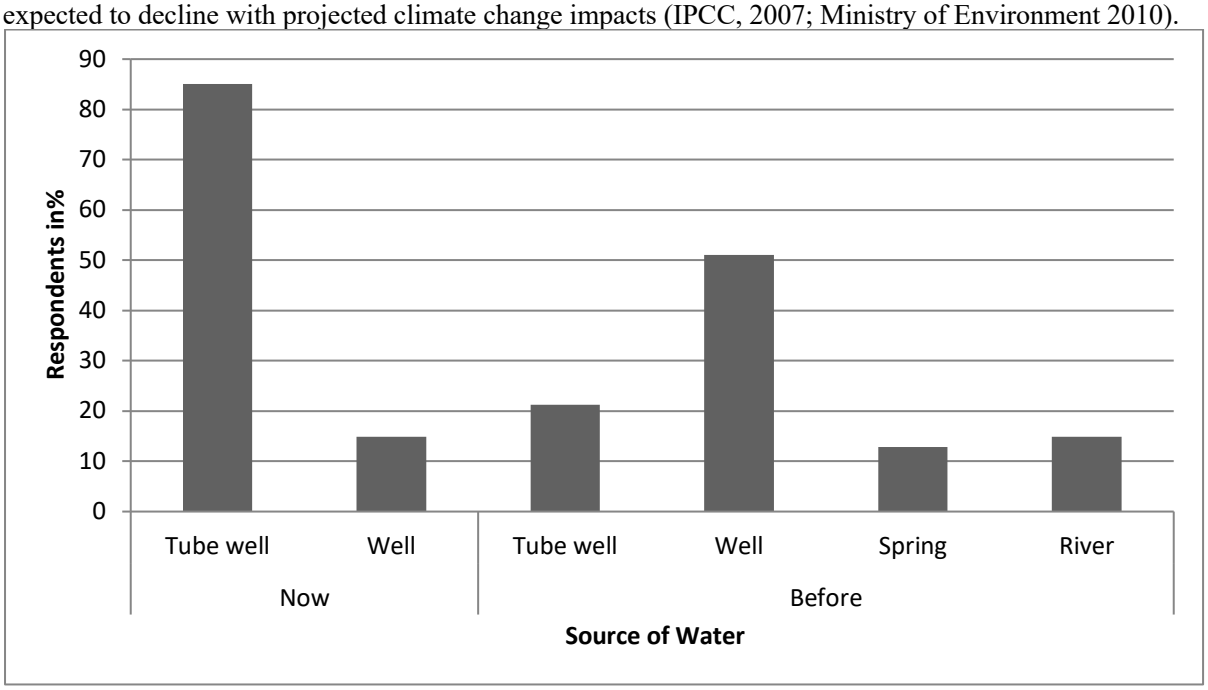


Figure No. 8: Sources of drinking water at present and before

The above figure 8 indicates the main sources of water for household uses. Ground water is a potential source of water in the village for different purposes including irrigation but water availability has decreased in recent years. It describes that 85.11% population depends on tube well and 14.89% population depends on well (kuwa) for the household purpose.

The above bar diagram describes the uses of different sources of water by the people before 10 years. It describes that 21.13% population used tube well, 51.1% population used Kuwa, 12.8% people used spring and 14.9% of total population used river water for household purposes.

During focus group discussion, people of Dubiya village said that river, kuwa and spring are drying these days so resident in this village are using tube well.

7.3.2 Sufficient of water

Water use has been growing far faster than the number of people. During the 20th century the world population increased fourfold, but use of freshwater increased nine times (www.independent.co.uk).

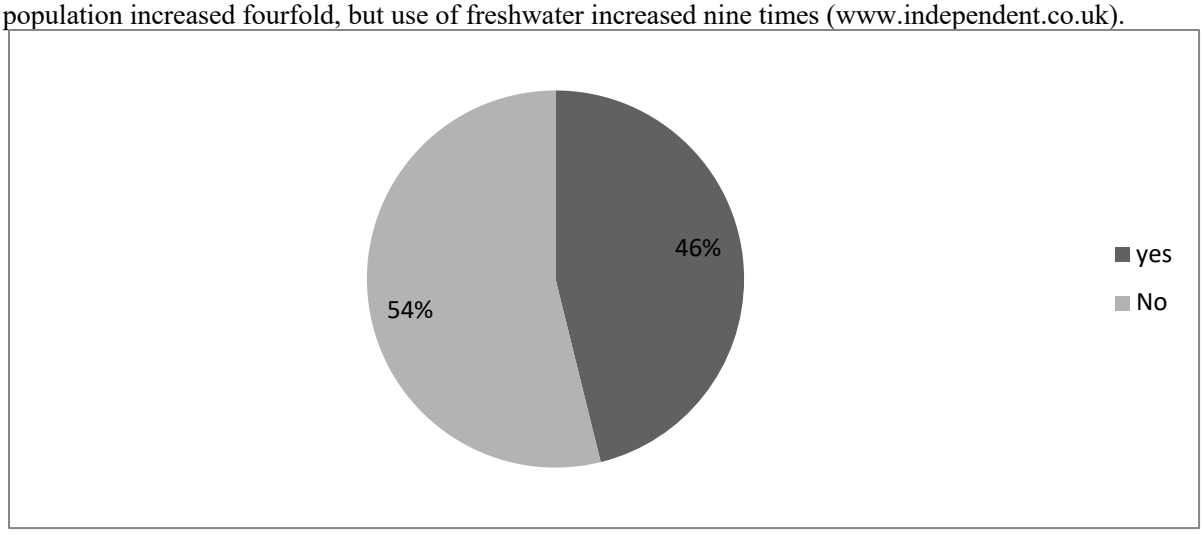


Figure No. 9: Status of water availability

The above pie chart shows the sufficiency of drinking water in Dubiya village. It shows that 53.85% houses lack sufficiency while 46.15% houses have sufficient supply.

7.3.3 Alternative Source of Water

Drinking water is the basic needs for the human beings to sustain their life. Climate change in Nepal threatens the water resources. The increasing population exerts pressure on water demand.

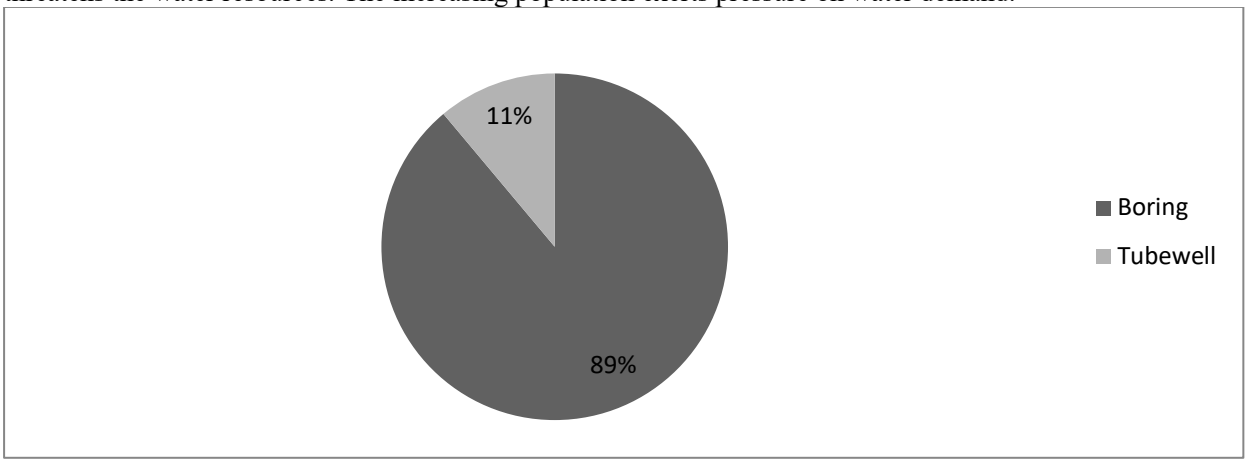


Figure No. 10: Alternative sources of water

Figure 10 presents the alternative source of water during the period of scarcity. When water is scarce, ground water acts as alternative source. About 11.1% of respondents use tube well, while 88.9% respondents use bored water (which is still ground water extraction, however, is dug deeper than tube well). Some local people said that almost all spring (Jharua) and river (khola) water are now dry. There is problem of water for drinking, irrigation and the other activities mainly during summer.

7.3.4 Cause of Insufficient of water

Decrease in forest covered area and rainfall frequency have reduced the availability of water for rapidly growing population. Many water resources have dried up and many have lesser flow than the past. The decline in forest and plant density, increase in runoff of rainwater reduce infiltration and thus contribute to drying of water resources.

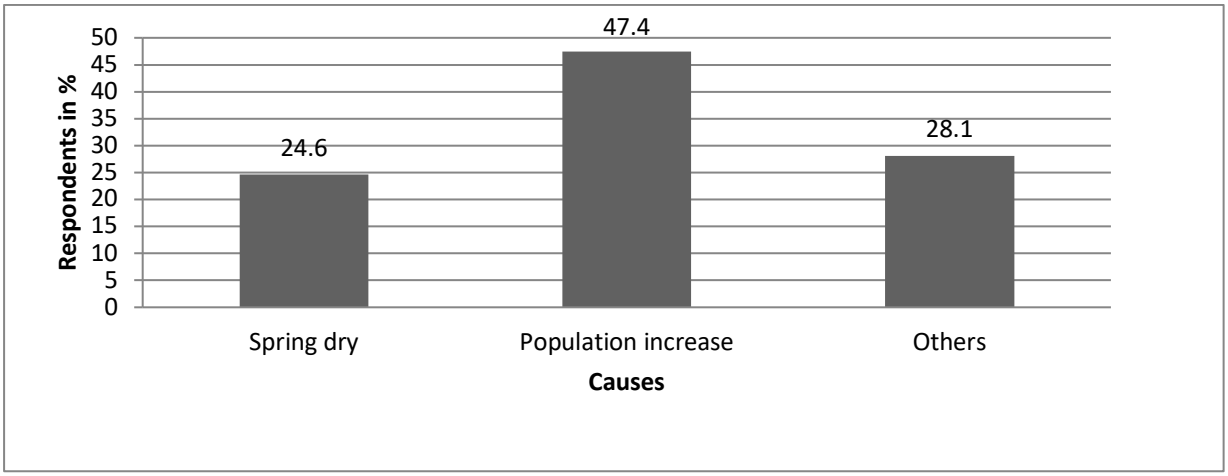


Figure No. 11: Causes of water scarcity

Figure 11 points out the cause of insufficiency of water in study area. About 47.4% respondents think that the cause of water insufficiency is due to population increase. 24.6% respondents explained that the drying of springs has resulted in water related problems and 24.6% respondent said that there are other causes for water scarcity. Among the respondents some expressed that arsenic is the one of the components for water scarcity.

7.3.5 Water Level

Higher the concentration of population, higher the decreasing trend of forest and plant density. Thus, over land flow increases, filtration decreases and further decreases the level of water surface.

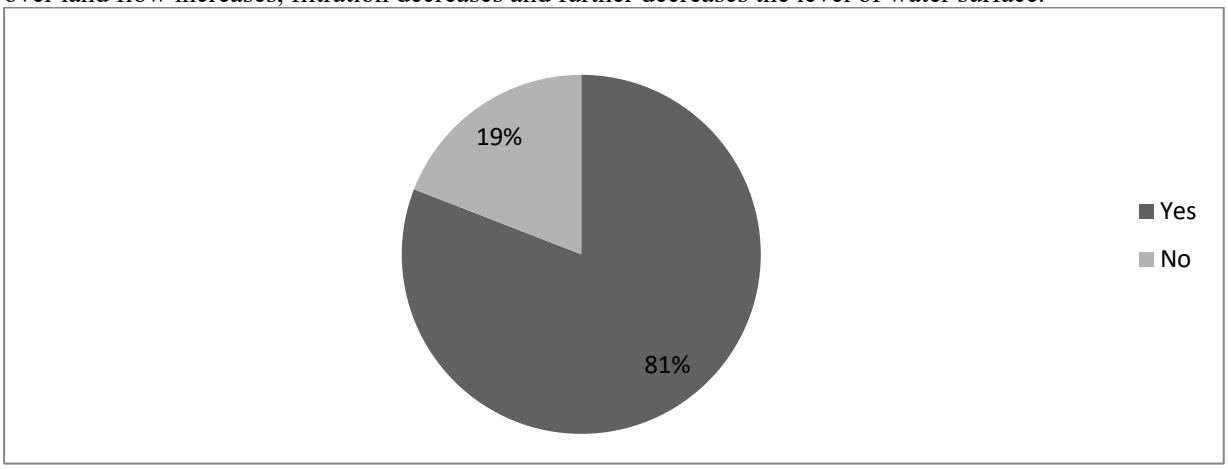


Figure No. 12: People's perception on water level change

Ground water is the potential source of water in village used for different purposes including irrigation. But the water availability has decreased in recent years. 80.9% of respondents pointed out the increased depth of water level and 19.1% respondents did not observe change in the depth of water level.

7.4 Forest Resources

7.4.1 Status of Tree

Forest conversion for agriculture expansion is the most salient signature of human occupation of the land surface. Population growth and deforestation are significantly associated at the global and regional scales (David L. Car).

Figure No. 13: Number of trees in open land at present and before

Figure 13 showed that the status of tree in open land and field before 10 years and now. About 71.1% of respondents said that trees were present in open land 10 years ago and 30.6% respondents didn't have tree in open land. But the condition has now changed. About 28.9% of respondents have tree in open land but 69.4% have no tree in open land.

One of the principle causes of deforestation is a process of agriculture extensification in which impoverished, landless cultivators encroach mostly upon open land (United Nation Secretariat, 1991, 1994). Agricultural extensification of this type through the expansion of traditional shifting cultivation is not a result of demographic growth in the indigenous rural population, but of an increase in the number of households practicing shifting cultivation due to the arrival of new settlers (Dove, 1993, for the case of Borneo; Pfaff, 1999, for the case of the case of Amazon). People are currently experiencing rapid population growth through migration combined with low standard of living.

7.4.2 Fuel for Cooking

Timber harvesting is often a common practice in rural area as households rely on biomass fuel. Despite expressing reservations about the magnitude of the problem, the United Nations Secretariat (1991) wrote that the contribution of population to desertification through the effect on demand for fuel wood was "fairly clear".

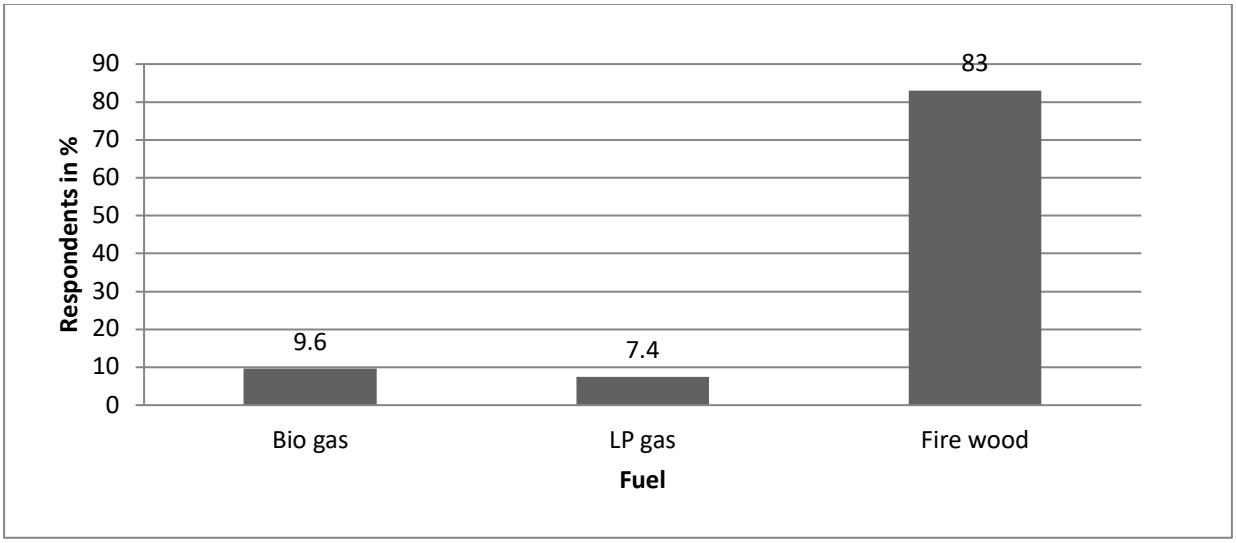


Figure No. 14: Fuel for cooking

Figure 14 showed the dependency of fuel for cooking in the study area. Maximum numbers of respondents i.e. 83 depend on firewood. 9.6 respondents use biogas and only 7.4 respondents' use LP gas.

The bulk of energy used in study area comes from biomass. Although the burning of biomass is considered carbon neutral, it is equal to the carbon absorbed as biomass grows. However, it has a major negative impact on the health of users and over exploitation can put an additional stress on the natural resource (NCVST, 2009). This could mean more impacts in populations' health.

7.4.3 Source of Firewood

Rural forest is the main livelihood option for local people. Due to the rapidly growing population and arrival of new settlers, demand for fuel wood is very high.

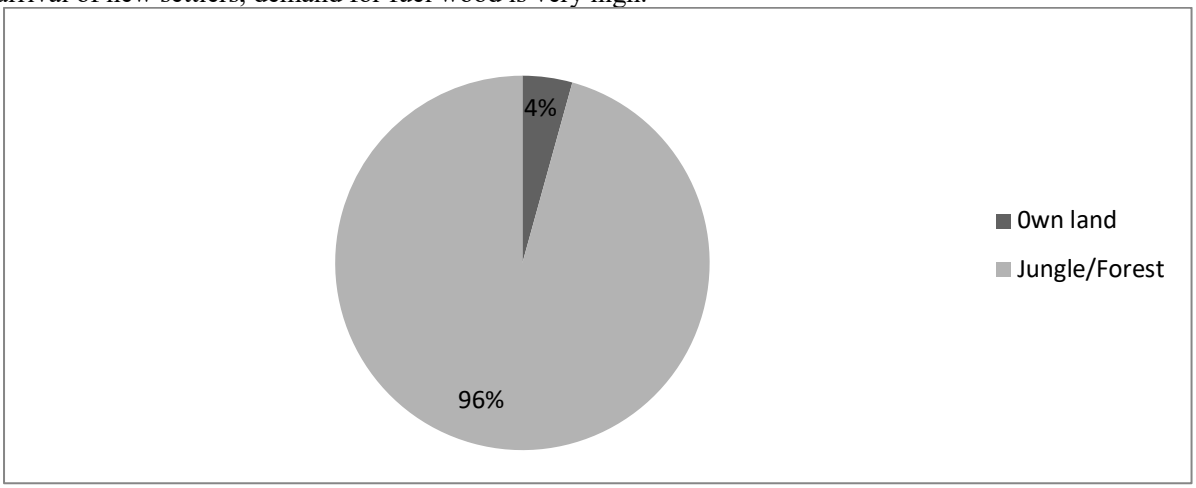


Figure No. 15: Sources of firewood

Figure 15 presents the source of firewood collection for fuel in the study area. The main source of firewood in rural area is forest. About 95.7% respondents said that they have been collecting firewood from forest/jungle. Only 4.3% respondents are collecting firewood from their own land.

7.4.4 Change in Forest Accessibility

People perceived that their travel distance to the jungle is increasing day to day. Deforestation is growing rapidly with increasing number of populations. Almost all people depend on the forest for fodder and firewood collection and grazing their livestock. Landless populations are encroaching the forest area. Forest

fire is also the main problem in the study site especially in pre monsoon and fire is further depleting the forest and its surrounding environment.

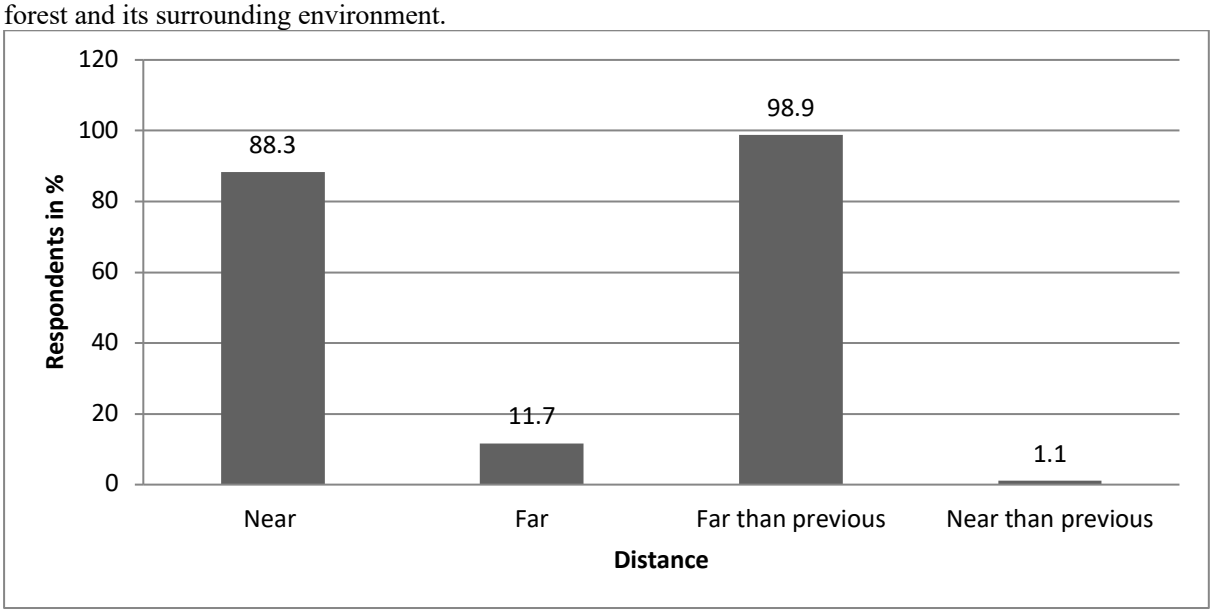


Figure No. 16: Status of distance to jungle for collecting firewood

Figure 16 compares travel distance to jungle/forest 10/15 year ago and at present for firewood collection, grazing, and encroachment and so on. About 88.3% respondents said that the forest is at near distance; 11.7 % respondent said the distance to forest is far, 98.9% respondent said that the distance to forest is far than previous and 1.1% respondents said that forest is nearer than previous.

Boserup (1981) argued that the opportunities for land extensification, that is, rural- migration are exhausted before intensification commences. This might be called Ricardian adjustment, after the economist David Ricardo, who described an economy in which the very best land is cultivated first, then the next best, and so on until all arable land has been brought under cultivation.

In Nepal, substantial environment degradation has occurred from deforestation by the expansion of agricultural land and fuel wood harvest. However, some researchers argue that in specific regions, population growth has provided imputes for improved land management – in Jhapa, Chitwan, and Morang districts, crop production has outpaced population growth (Subedi, 1997).

7.5 Climatic Analysis

7.5.1 Rainfall trends of Taulihawa

Following graph shows the annual rainfall trends of Taulihawa station from 1986 to 2009. They graph showed that the rainfall is decreasing at the rate of 19.70 mm annually in the study area. The highest annual rainfall occurred in year 1989 (2200.5 mm) and minimum annual rainfall occurred in the year 2004 (526 mm).

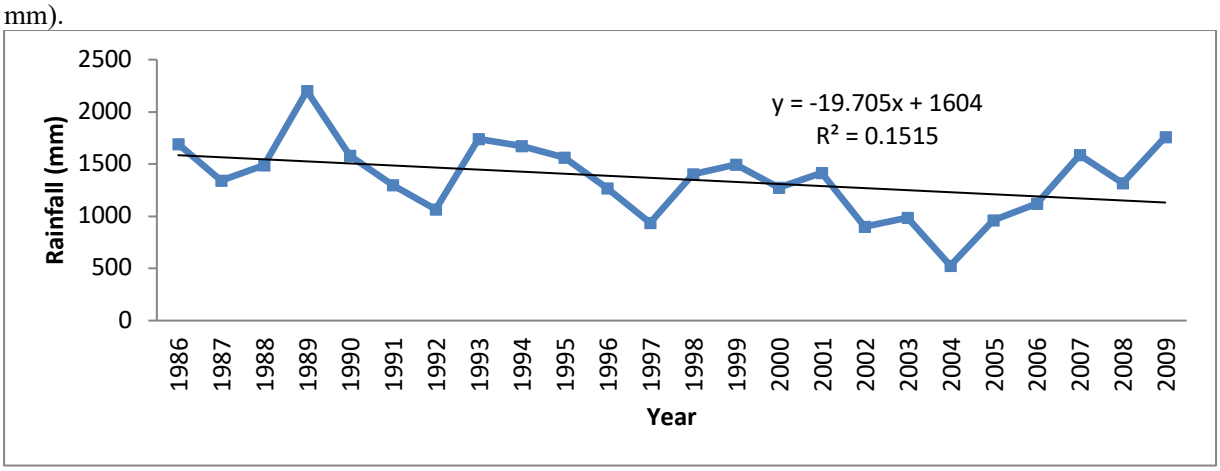


Figure No. 17: Annual rainfall trend

Source; ISET-Nepal, 2012

The graph of maximum rainfall showed that the maximum rainfall is decreasing. The trend line equation showed that the maximum rainfall pattern is in decreasing trend with 8.733 mm/year.

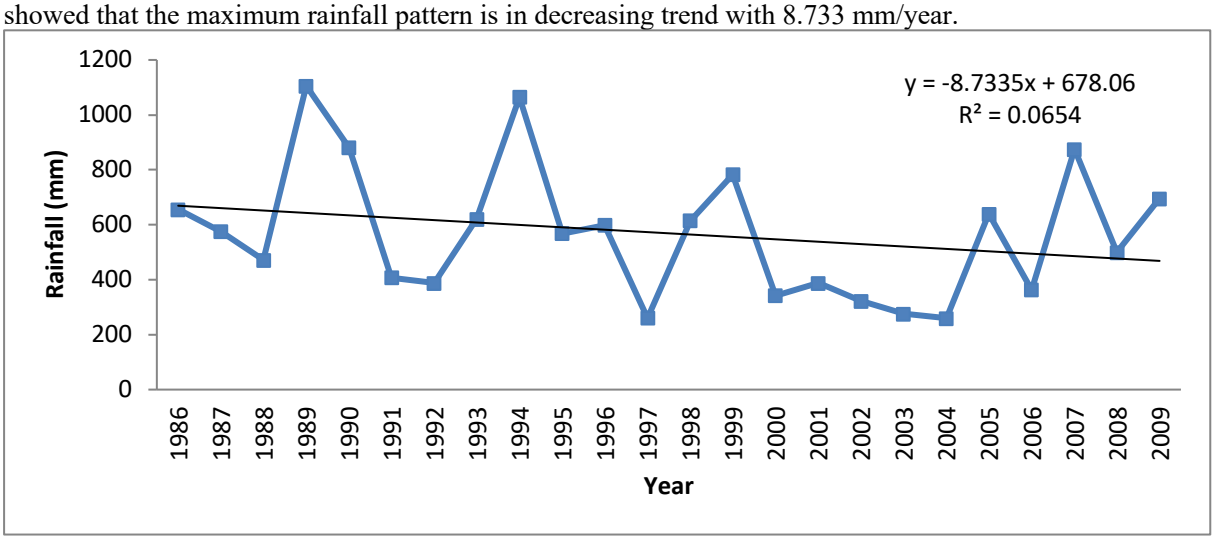


Figure No. 18: Maximum rainfall trend

Source; ISET-Nepal, 2012

7.5.2 Temperature trend of Taulihawa

(Data period: 1986-2009 with missing year 1995-2000)

The annual mean temperature of Taulihawa is given in following Figure 19. The trend line equation showed that the temperature is increasing with 0.021oC/year. Graph shows that the highest annual mean temperature was observed as 25.830 C in 2004, and the lowest annual mean temperature was observed as 20.8670 C in 1994. The regression equation showed that there is high fluctuation in annual temperature, and it is increasing from 1986 to 2009.

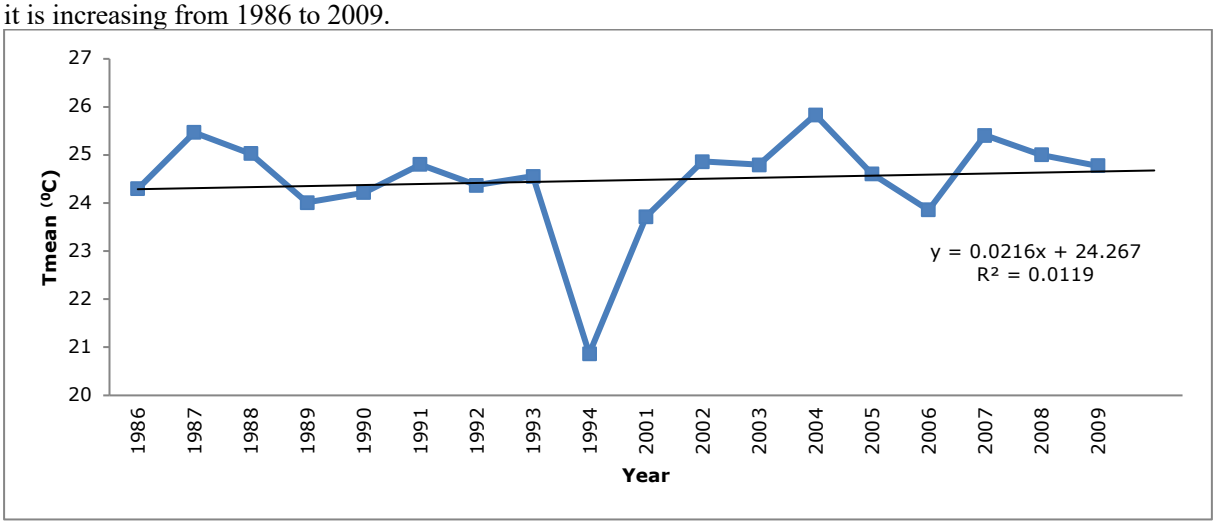


Figure No. 19: Annual mean temperature trend

Source; ISET-Nepal, 2012

7.5.3 Rainfall trends Patharkot

Figure 20 presents rainfall trend from 1975 to 2008. Between the periods of 1982 to 1994, there is less fluctuation in annual rainfall, but in other years there is high fluctuation. The highest annual rainfall was observed as 3,524.4 mm in 1998, and the lowest annual rainfall was observed as 688.5 mm in 1976. From Figure 21, intensity of maximum rainfall fluctuates greatly from year 1990 to onwards. The highest peak

rainfall was observed as 1,252.5 mm in 1994, and minimum peak rainfall was observed as 400.7 mm in 2002. Source; ISET Nepal, 2012

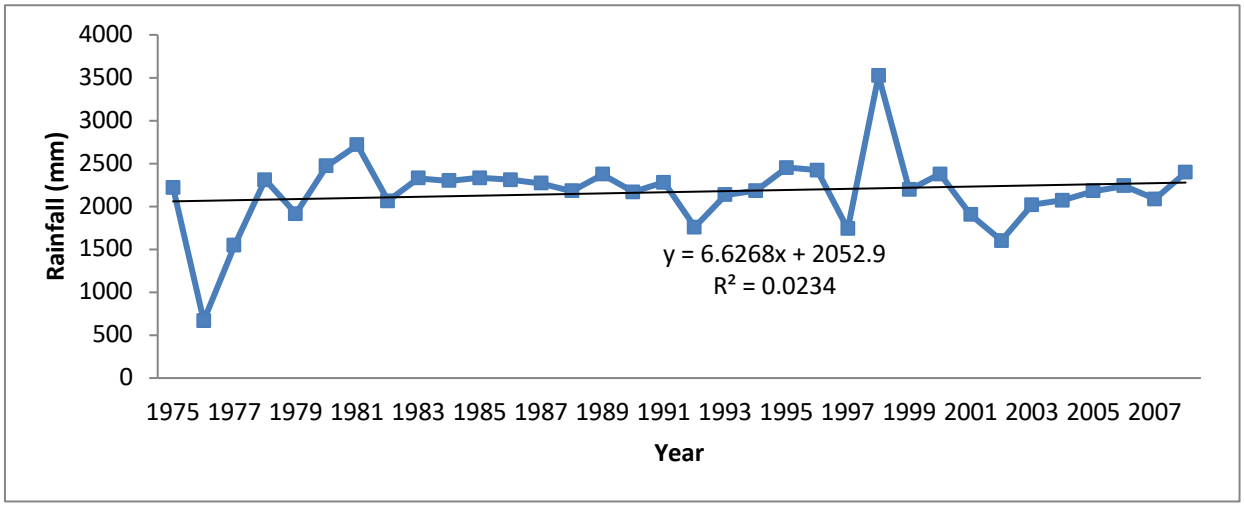


Figure No. 20: Annual rainfall trend

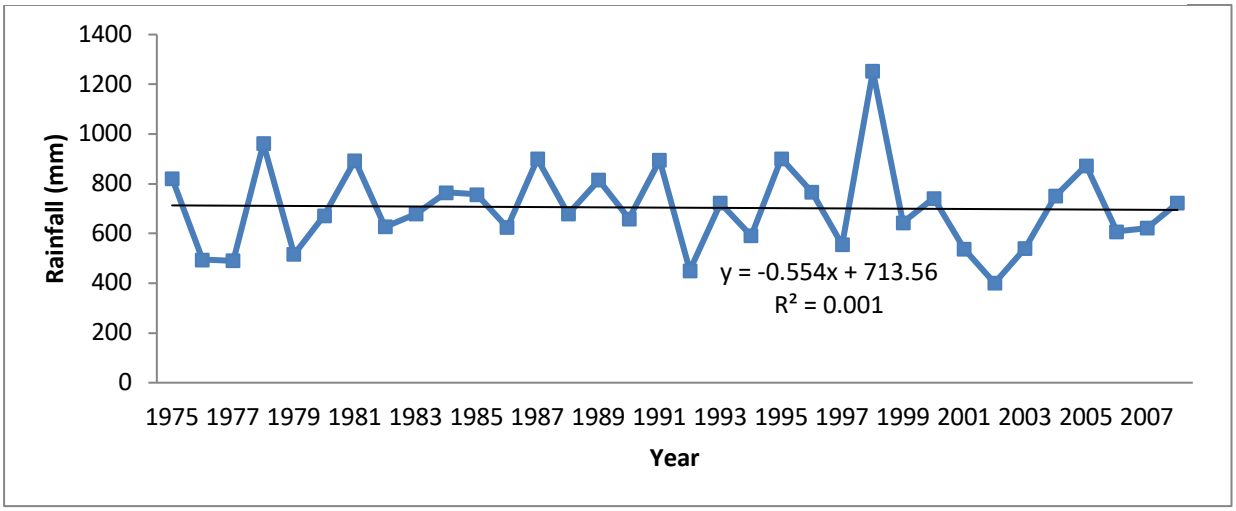


Figure No. 21: Maximum rainfall trend

Source; ISET-Nepal, 2012

7.5.4 Rainfall trends Bhagwanpur

Graph 22 shows the annual rainfall trends of Bhagwanpur stations between the periods of 1975 to 2008. The highest annual rainfall was observed as 2,991 mm in 1998 and minimum rainfall was observed as 1,044.5mm in 1992. Graph 22 showed that peak maximum rainfall was observed as 1,037.9mm in 1978 and lowest peak rainfall was observed as 295.4 mm in 1992. From Figure 22 and 23, we can say that intensity and amount of rainfall decreased from year 1975 to 2008.

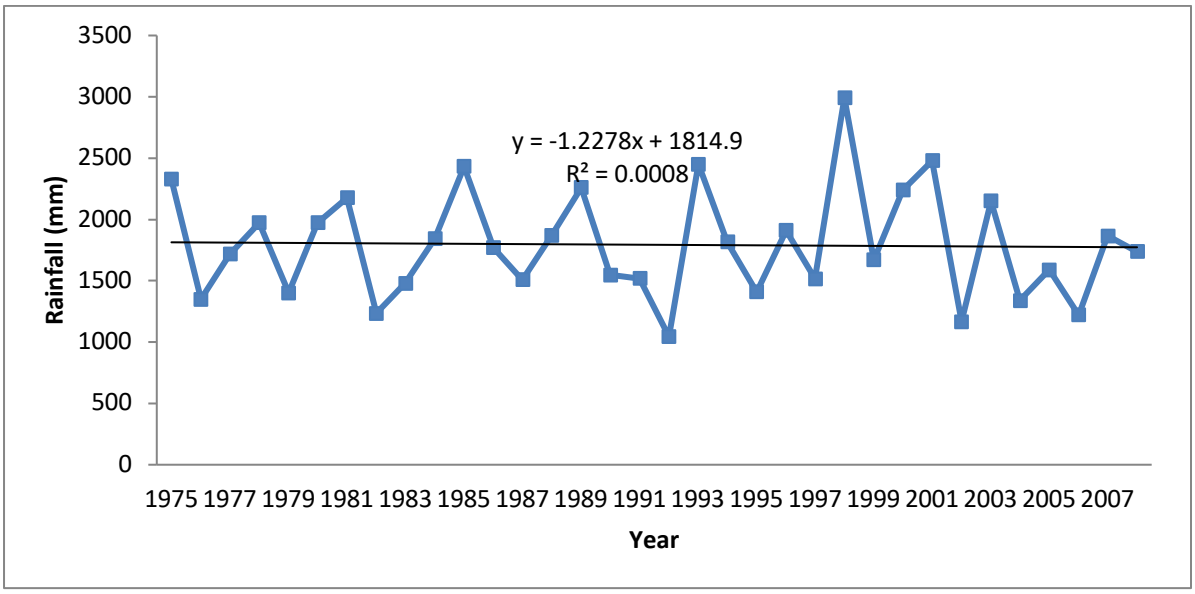


Figure No. 22: Annual rainfall trend

Source; ISET-Nepal, 2012

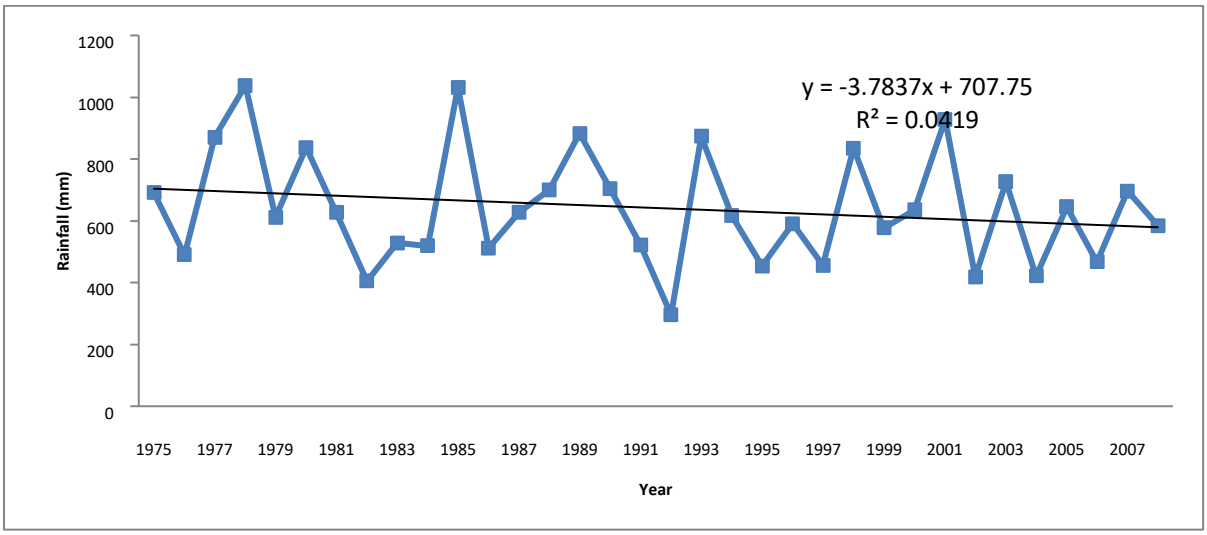


Figure No. 23: Maximum rainfall trend

Source; ISET-Nepal, 2012

7.5.5 Monthly Rainfall and Comparison of Rainfall Pattern of 3 stations

Graph 24 presents the monthly rainfall patterns of 3 stations. For all stations, rainfall amount was maximum between the periods of June to September and very less for other months. Maximum rainfall was observed in Patharkot stations followed by Bhagwanpur and Taulihawa. The annual rainfall has been slightly decreasing compared to past decades at the Taulihawa and Bhagwanpur stations. However reverse trends were observed in Patharkot stations.

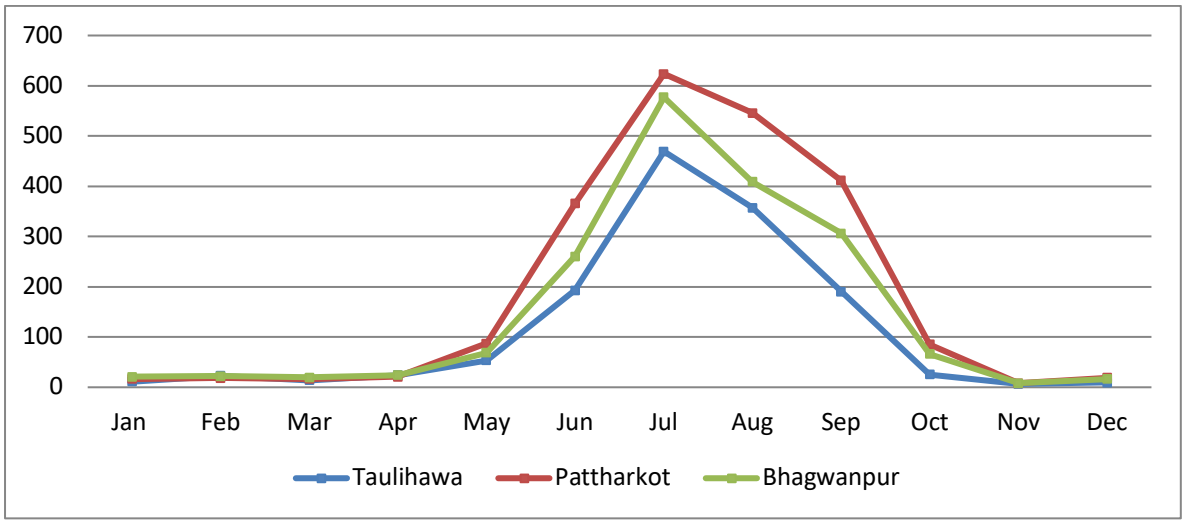


Figure No. 24: Monthly rainfall of three stations

Source; ISET-Nepal, 2012

7.6 Local Perception on Climate Change

Form the household survey; it was found that the perception of local people in the study area differ from one another, but most of them perceived change in climate pattern i.e. change in temperature, delay in the onset of rain, erratic, heavy and untimely rainfall and occurrence of climate related extreme events like flood, drought and windstorm over the previous 10 to 15 years. Given below is the graphical representation of the findings.

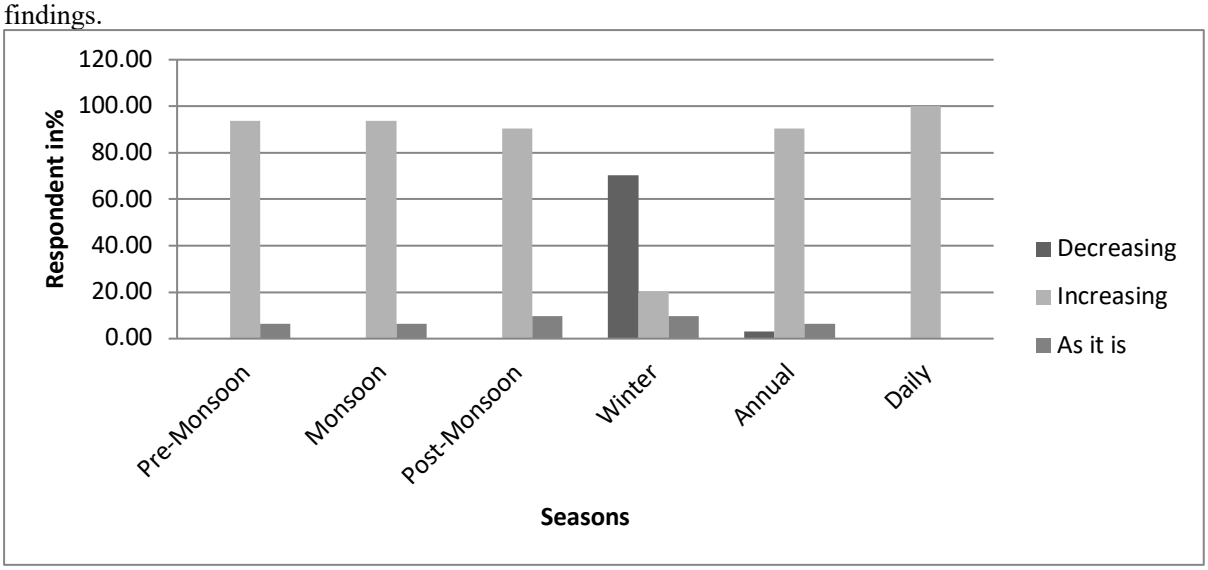


Figure No. 25: People's perception on change in temperature

Figure 25 shows the perception of local people on temperature change. Majority of local people indicated that they observed increase in temperature in different seasons except winter. About 93.62% of the respondents observed that temperature is increasing in pre-monsoon and monsoon and 90.43% observed temperature increase in post monsoon. 20.21% perceived increase in winter temperature. 90.43% respondents observed increase in annual temperature and all the respondents' perceived increase in temperature in every season. Maximum numbers of the respondent's perceived decrease in temperature in all seasons but about the 70.20% of respondents expressed decrease in temperature in winter season.

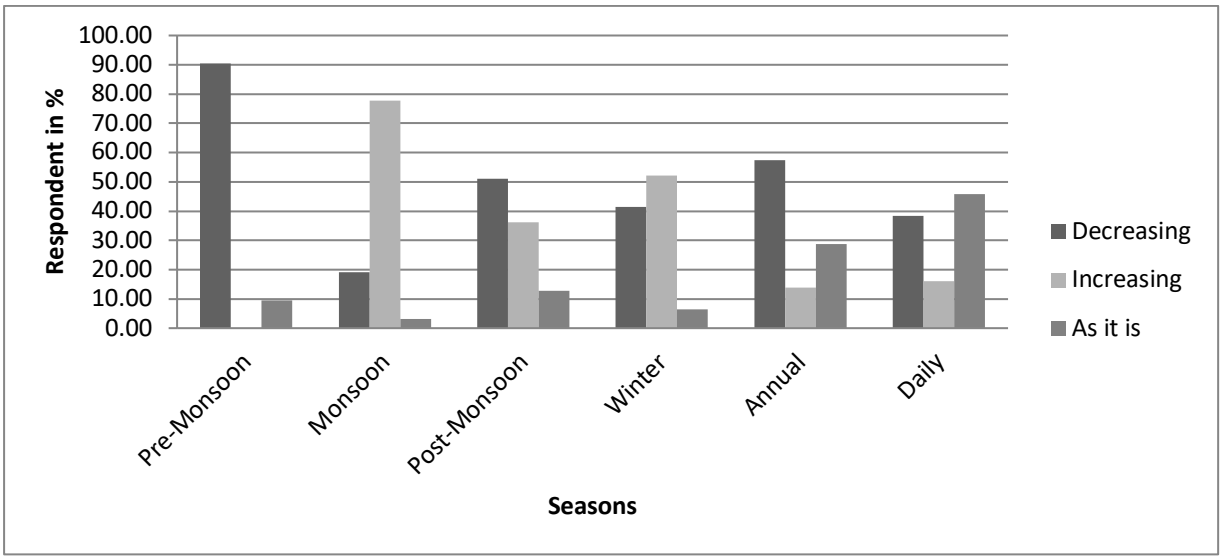


Figure No. 26: People's perception on precipitation

Figure 26 showed the local perception on precipitation in different seasons. Maximum number of local people accepted that the rainfall is decreasing in all seasons except for monsoon and winter season. About 90.43% respondents expressed that rainfall is decreasing in pre-monsoon, 51.06% perceived decreasing rainfall in post-monsoon and 57.45% perceived decreasing rainfall in post monsoon. But only 19.14%, 41.49% and 38.30% respondents think that rainfall is decreasing in monsoon, winter and daily respectively. None of the respondents favoured the fact of increasing rainfall in pre-monsoon. About 77.66% respondents expressed increasing rainfall in monsoon and 52.13% observed increasing rainfall in winter. But only 36.17%, 13.83% and 15.96% respondents perceived increase in post monsoon, annual and daily rainfall respectively. Some of the respondents observed rainfall in all seasons. About 45.74% respondents expressed that daily rainfall is similar to past 15 years. According to some local people, rainfall cannot be predicated and can occur at unusual times as compared to the past. They also experienced cases of untimely rainfall. They accepted that the amount of rainfall varied from year to year and is more erratic.

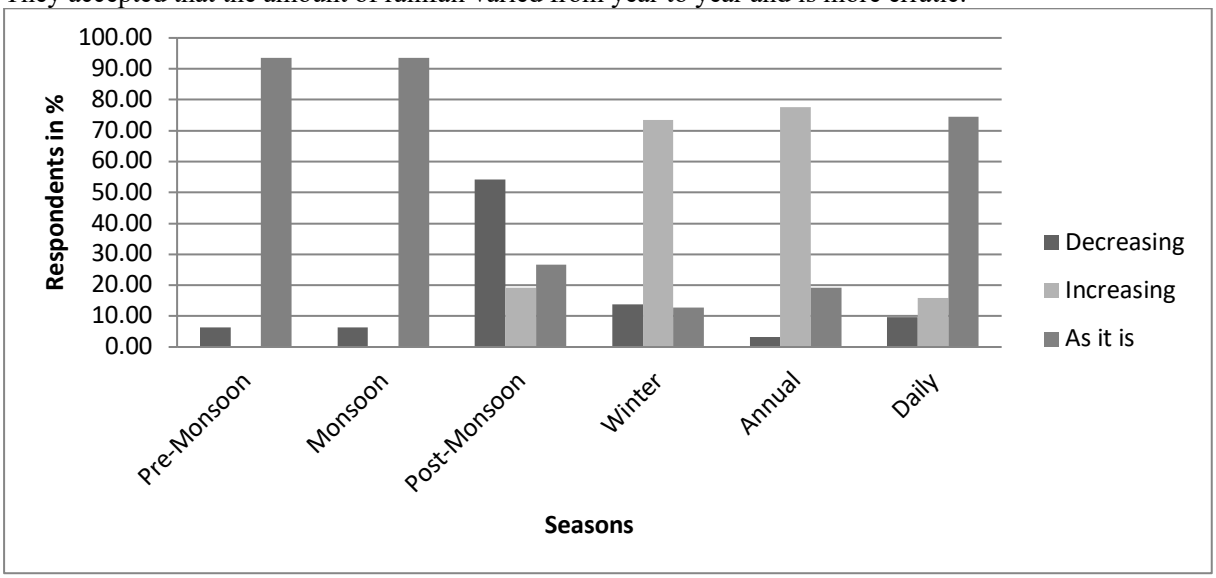


Figure No. 27: People's perception on change in cold wave

Figure 27 shows the perception of local people on cold wave. Significant increase of cold wave has occurred in winter season and annually. Most of the respondents perceived the occurrence of the cold wave in pre-monsoon, monsoon, post monsoon and on daily basis. About 73.40% of the respondents noticed increasing cold wave in winter season and 77.66% respondents noticed increasing the cold wave annually. Some people said it is responsible for reduction of agricultural production.

Cold wave in Nepal in 1979/1998 had negative impact on agricultural productivity and showed reduction in the production of crops by 27.8%, 36.5%, 11.2%, 30.0%, 37.6% and 38.0% in potato, toria (Brassica rapa), sarson (Brassica campestris), rayo (Brassica juncea), lentil and chikpea respectively (source: NARC annual reports from 1987/88 to 1997/98).

7.6.1 People's Perception on Shifting Climatic Pattern

The perception of local people on climate changes is consistent with temperature and precipitation data analysis. Most of the interviewee perceived increasing temperature during summer days and decreasing numbers of cold winter days while they perceived rainfall pattern to be erratic with incidence of unusual and heavy precipitation. The expected monsoon rain has decreased with the late onset of monsoon season. While discussing on drought pattern, almost all the respondents agreed that drought pattern has changed in recent years, and they have been facing prolong drought periods for the last few years. Baral (2009) mentioned that there has been change in drought pattern in recent years. In the past drought length used to be at most two months prior to monsoon.

Table No. 1: People's Perception on Climatic Pattern Shifting

Season		Baishak (Apr)	Jestha (May)	Aasha d (Jun)	Srawan (July)	Vadra (Aug)	Aswin (Sept)	Kartik (Oct)	Mangsir (Nov)	Poush (Dec)	Magh (Jan)	Falgun (Feb)	Chitra (Mar)	Highest frequency (%)
Summer	Now	■	■	■	■	■	■						■	55.3
	Previous		■	■	■	■								51.06
Winter	Now								■	■	■			58.51
	Previous							■	■	■	■	■		56.38
Heavy Rain	Now			■	■									56.38
	Previous		■	■	■									59.57
Monsoon	Now			■	■	■								55.31
	Previous		■	■	■	■	■							57.45
Frost	Now								■	■				60.64
	Previous							■	■	■	■			56.39
Drought	Now	■	■									■	■	58.52
	Previous	■											■	52.13

Notes: All shadows represent the past and present climatic events.

Above table clearly presents shifting climatic pattern on the basis of high frequencies on people perception. About 53.3% of local people perceived that the summer season has now extended from Chitra to Aswin (March to September) and then 51.06% people said that the time of summer season was from Jestha to Vadra (May to August) in the past. The numbers of winter days are decreasing. Around 58.51% of people argued that the period of winter season is now Mangsir to Magh (November to January) whereas 56.38% of people pointed that the winter used to occur from Kartik to Falgun (October to February) in past. In the case of heavy rain, 59.75% respondents said that heavy rainfall used to occur in Jestha to Srawan (May to July) but 56.38% of respondents replied that heavy rainfall now occur during Aashad to Srawan (June to July). According to 57.54% respondents, monsoon used to occur between Jestha to Aswin (May to September) in 10 to 15 year previous and 55.31% of respondents perceived shift between Aashad to Vadra (June to August). 56.39% of respondents think that the frost previously occurred between Kartik to Magh (October to January) and 60.64% of respondent perceived frost occurrence between Mangsir to Poush (November to December) at present. About 52.13% respondents agreed that drought used to occur between Chaitra and Baisakh (March to April) but 58.52% of local people perceived drought occurrence between Falgun to Jestha (February to May) in present context.

7.6.2 Local Perception on Climate Hazard

Figure 28 presents the perception of local people on climate hazards. Most of the respondents have indicated that the frequency and intensity of extreme events have increased with the change in climate. Local people are experiencing more extreme climate events such as flood, drought, fire and fog. Most of the

respondents think that climatic hazards are increasing in recent times. About 86.17% of respondents emphasised that the drought events are increasing, 52.13% indicated that flood events are increasing, 78.72% expressed that the fire (forest fire) events are increasing and 78.72%of respondents observed that the fog is increasing. But in the case of windstorm and lightening, most of the respondents observed no change (53.32%, 63.83% respectively). But most of the local people pointed increasing hazard of windstorm and lightening in forest area.

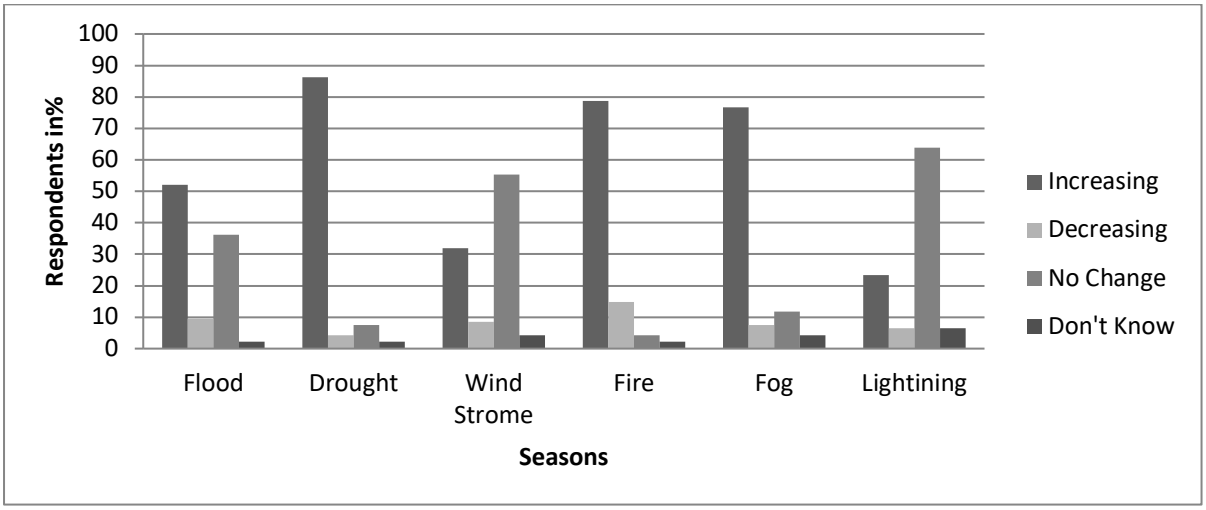


Figure No. 28: Local perception on climate hazard

Forest fires have long term effects; nature takes a long time to recover. The context of a flood also highlights both conceptual and methodological difficulties. Flood generally affects crops in land close to rivers and in low lying areas, livelihood and human capital development such as education and health (NCVST, 2009).

7.6.3 Migration and Food Sufficient

Rapid population growth and increasing pressure on land to earn the much-needed calorie are the major challenge in the study area. One of the major contributors of population growth is the migration in the study area.

Table No. 2: Migration and Food sufficient

Status	Food Sufficiency							
	Less than 6 months		6-12months		Surplus		Total	
	No	Percent (%)	No	Percent (%)	No	Percent (%)	No	Percent (%)
Indigenous	6	6.38	22	23.40	17	18.09	45	47.87
Migrated	18	19.15	23	24.47	8	8.51	49	52.13
Total	24	25.53	45	47.87	25	26.60	94	100.00

Table 2 shows the status of food sufficiency among migrant and non-migrant (indigenous) population in the study area. 52.13% of respondents (migrants) and 19.15% respondent have enough food for six months only. 24.47% respondents have sufficient food for 6-12 months and only 8.51 % respondent have surplus. Among 47.87% of the total respondents comprising non migrants or indigenous respondents, 6.38% respondents have sufficient food for six months only, 23.40% respondents have food for 6-12 month and 18.09% of respondents have surplus food. The situation analysis of population, land and food sufficiency in the study area implies that there is need of appropriate population regulation with ecological, social and economic sustainability.

7.6.4 Education and Use of Pesticide

Studies showed that developing countries are more vulnerable to climate change than developed countries and are expected to suffer more from the adverse climatic impacts because of the low level of education. Adaptive capacity is determined by community characteristics such as education, income, wealth, equity, political and social stability, access to natural resources, institutional support and social capital, all of which either facilitate or constraint the ability of the community to deal with climate related risks.

Table No.3: Level of Education and Use of Pesticide

Education	Used of pesticide					
	Yes		No		Total	
	Number	Percent (%)	Number	Percent (%)	Number	Percent (%)
Illiterate	19	20.21	18	19.15	37	39.36
Primary	16	17.02	12	12.77	28	29.79
Secondary	11	11.70	6	6.38	17	18.09
College	9	9.57	3	3.19	12	12.77
Total	55	58.51	39	41.49	94	100.00

Table 3 presents the status of education and use of pesticide in the agricultural land in the study area. About 58.51% of people in the study area use pesticides while 41.49% of people do not use any pesticide to kill the pests in their land. Among the total pesticide users (58.51% respondents), only 20.21% of illiterate respondents have used the pesticide and among the non-users (41.41% respondents), only 3.19% college level respondents have not used the pesticide in their land. Lower awareness level on disasters, climate change, adaptation and mitigation options are associated with higher vulnerability (WWF Nepal, 2008).

7.6.5 Family Size and Source of Firewood

Forest resource is one of the most important livelihood options to sustain livelihood for rural people. Larger household size is one of the characteristics in rural area but it is decreasing in Nepal.

Table No.4: Family Size and Source of Firewood

Family Size	Source of firewood			
	Own Land		Jungle	
	Number	Percent (%)	Number	Percent (%)
2-.4	3	3.19	4	4.67
5-.6	1	1.06	31	32.54
7+	0	0	55	58.79

Table 4 presents the status of family size and source of firewood for cooking in the study area. Larger the family size, larger the dependency for firewood obtained from forest and smaller the family size, lower the dependency of forest products. About 85.79% of the larger households (7+) responded that their main source of firewood is forest and none of the larger households collect firewood from their own land. In case of small family (2-4), about 3.19% respondent collect firewood from their own land and 4.67% respondents are dependent on forest for firewood.

7.7 Vulnerability to Climate Change

The local people are not prepared for the extreme climate events and are exposed to potential climate related disasters like flood, drought and cold wave which were identified during household survey, focus group discussion and key informant interview.

The local people are exposed to extremes climatic events like flood, drought and cold wave which have several impacts in their livelihood resources. Result showed that poverty increases vulnerability to climate change. Poor people are more vulnerable as they have limited resilience and lack of access to resources. Due to lower education status, residents do not have sufficient resources and knowledge on how to minimise the worse impact of climate induced disasters. Agriculture is the main source of income for majority of sampled households. Lack of income diversification is another major indicator of vulnerability for local livelihood. Land fragmentation is at rapid pace. Therefore, deforestation and crop production are vulnerable to climate change with increasing incidence of crop pests, disease and weeds which have decreased the crop production. Quality of housing is an important determinant of vulnerability. About 20.21% respondents have mud house, 27.66% have wood house, 25.53% have semi concrete and only 26.6% respondents have concrete type house. Similarly, fishery, forest, water resources are vulnerable to climate change.

Greater the exposure or sensitivity, greater is the vulnerability. While greater is the adaptive capacity, lesser is the vulnerability (IPCC, 2007). Resource limitations coupled with household characteristics and

poor infrastructure impact negatively on the ability of most of rural communities to take up adaption measures and increase vulnerability (Nhemachena, 2006). The first priority of the local community is to get support in agriculture. The interventions include improving the capacity to build irrigation, diversify crop species and varieties that are capable of withstanding erratic rainfall and fluctuating water conditions.

Adaptation practices should be designed and implemented at community level as the climate change and its impacts are localised. The major population adaptation measures to climate change include population management with family planning, diversification of agriculture crops and search for alternative livelihood, disaster reduction measures and natural resource conservation. Improving communities with information, strengthening local institutions, active participation of those at risk, enhanced technological skills, education and employment is the best way to address vulnerability of local livelihood.

Similar result has been observed from the focus group discussion (FGD), transect walks and informant interview (KII). The main conclusion from FGD, TW and KII are as follows:

- Population and household are increasing day by day. Migration from mountain and hill is exerting pressure on livelihood options.
- Most of the local people accept that they use contraceptive to control fertility but majority lack knowledge. They believed that larger family creates difficulty to maintain food, energy, shelter and standard of living. However, they still have larger family size.
- Some people left their property and house due to fear of flood in recent year. Now they live life as landless (sukumbasi).
- Encroachment has increased due to landlessness and deforestation has increased simultaneously.
- Hot summer days are increasing while cold winter days are decreasing with less frosty days due to increasing temperature.
- The expected rain during monsoon season has decreased because the onset of the monsoon has been delayed, which has affected cropping time and harvesting time thus affecting crop rotation, while unexpected, erratic and unusual heavy rainfall have increased with flooding events affecting agricultural lands, infrastructure and livelihood resource.
- The unidentified new crop pests have been observed in variety of crops creating problem for paddy cultivation.
- Some natives have noticed loss of local paddy due to climate change. They stated that local paddy requires longer rainy season, and the duration of rainfall have decreased as compared to past 15 years. These local paddies are now replaced by short duration modern varieties with high yields.
- The significant effect of climate change is observed in mustard as its production has now reduced. Many people said that they used to sell mustard 10 years ago but now most of the people buy oil.
- The impact of drought has decreased to some extent as deep tube well facilities are now available for household as well as irrigation purpose.

7.8 Climate Adaptation Practice in Local Area

Community efforts and adaptive strategies were developed to address the challenges of climate change. Incidences of extreme climatic events are common so local adaptation practices are not enough to restore livelihood resources.

Most people in the study area are associated to local group like Aama shamuha (Mothers group) self-help group, community forest group, agriculture group, lake conservation group and so on. Local people have become successful in improving the condition of local traditional lake through their joint effort. Recently, they experienced long drought, so they cleaned the lake, built dam and planted trees around the lake to conserve the water for irrigation and for livestock during drought period. People have taken initiative to conserve spring (Jharuwa) for drinking. Local or indigenous crop are either marginalised or eliminated due to the climate change. Therefore, more fertilisers are used for hybrid seed to promote agriculture production. In recent time, people used pesticide and herbicide to minimise the impact of pest and invasive weeds to increase food availability. Almost all people have changed their traditional food storage system Deherry (Mud store) and vakari (Bamboo store) to drum of plastic or tin. Despite the cases of increasing encroachment, deforestation and forest fire, people have shown active participation in conservation of community forest.

8 Conclusion

The concept of vulnerability is the major focus of this research which aims to understand the impact of climate change on population dynamics and vice-versa. The study thus explores the link between population dynamics and climate change and examines the perception of local people towards the local climate trends and its impacts on the livelihood resources and adaptation. The study area Dubiya comprises marginalised and vulnerable population. Joint family system, high fertility and migration contribute to increase in total population and may affect local climate to certain extent. These variables are affecting the livelihood of local people directly and indirectly by exerting pressure on local natural resource. Rapid population growth and climate change impacts may deplete natural resource in the study area.

Demographic factors combined with poverty and exploitation of resource in the study areas and excessive consumption and wasteful production patterns exacerbate problems of environmental degradation and resource depletion and thus inhibit sustainable development. Increase in temperature and erratic rainfall are the two main variables of climate change that are active in the study area. Both variables are affecting the livelihood of local people. Local respondents perceived change in local climate which is affecting local environment and their livelihood.

Temperature analysis indicated that the mean annual temperature is increasing with 0.021oC/year. The regression equation showed that annual temperature is increasing from 1986 to 2009. Annual and maximum rainfall pattern of the study area has fluctuated in amount, time, and intensity.

The local community is mostly exposed to drought, forest fire and frost events while lightening, windstorm events have also been observed. The impacts of such climatic hazards threaten the livelihood of local people through change in agroecosystem, agricultural fields, infrastructure, settlements and food security.

Population and climate related policies, such as voluntary family planning and small family size, investment education and diversify income resource improve individual welfare among the least well-off member of the present generation. They also tend to lower fertility and slow population growth reducing over exploitation of natural resources in a long run and improving the resilience of the vulnerable population.

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