Original Research Article

People's Perception on Climate Change, its Impact and Adaptive Strategies in Kaligandaki Rural Municipality, Syangja, Nepal

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Abstract: Climate change is the major, overriding environmental issue of our time, and the single greatest challenge facing decision makers at many levels. Without drastic action today, adapting to the impacts in the future will be more difficult and costly. Key informant interview, focus group discussion (n=7) and household survey (n=150) were undertaken to assess local peoples' perception on Climate Change, its impact and adaptive strategies. Meteorological data from 1987 to 2017 were used to analyze climatic trends. These data shows that average temperature has increased from 1987-2017 by 0.0146 °C/yr. and annual rainfall has decreased from 1987-2017 by 0.6507 mm/yr. Majority of the respondents (56%) were unknown about climate change. Weather related disasters, mosquito/other insects, invasive species were found highly increased compared to before. The most common adaptation options include using weed control, compost manure, economic diversification, storage of energy, changing planting and harvesting date, crop diversification etc. However, lack of information concerning climate change, agricultural pests and diseases, lack of education, no access to sufficient seeds and fertilizers, no access to sufficient land, no access to credit were major constraints of adaptation and institutions such as School, Mother's group and Rural Municipality, DFO, INGO like UNDP, WASH are assisting in Climate Change adaptation.

Keywords: Adaptation, Climate, Diversification, Livelihood, Perception, Disasters.

INTRODUCTION

Today, climate change is increasingly recognized as a critical challenge to ecological health, human well-being and future development [1]. IPCC reported between 1906 to 2005 the global temperature increased by about 0.74 °C with a more rapid increase in the past 50 years [2]. Further increase of 1.5 °C -0.6 °C is projected until the end of 2100 A.D. The impact of climate change are witnessed more decisively in different region globally, in the form of rise of sea level, change in the precipitation pattern, vegetation shift from lower to higher altitude, retreat of glacier and increase in the incidences of climatic hazard. In Nepal, average temperature increase was recorded as 0.06 °C/yr. and that in Terai and Himalayas was 0.04 °C/yr. and 0.08 °C/yr. respectively [3].

Nepal is substantially affected by climate change and urgently addressing the issue by formulating policy and implementing programs [4]. Although Nepal is responsible for only about 0.025% of the total annual GHG emissions of the world Nepal cannot escape the rapidly increasing influence of climate and global changes [5]. Nepal ranks as the 4th most climate-vulnerable country in the world [4]. Disasters brought on by the climate have caused damage and loss of life, property and livelihood [6]. Overall, about 37% of the country's population is considered exposed to climate-related factors, particularly through economic and related activities such as agriculture, forestry, water and energy, health, infrastructure and tourism [7].

It has become common knowledge that the poor are likely to be hit hardest by climate change, and their capacity to respond to climate change is lowest in the developing countries and among the poorest people in those countries [9]. The difficulty in the understanding of the public perception obstructs the development of the climate change adaptation policies [8]. It is therefore necessary to integrate and study the perceptions of the local communities in theclimate change debate and adaptation policies [10-12]. Therefore, this study was carried out with the focus on understanding the local people's perception on climate change, its impact and adaptive strategies in Kaligandaki Rural Municipality of Syangja, Nepal.

MATERIALS AND METHODS
Study area

The research was conducted on Kaligandaki Rural Municipality, Syangja district in the Gandaki provenance of central Nepal with an area covering 73.51 km². Kaligandaki is village council created by merging Alamdevi, Birgha Archale, Chandibhanjyang and Shreekrishna Gandaki. Kaligandaki is divided into 7 Wards. It is surrounded by Gulmi District at northern side, Galyang Municipality from east, Gulmi District & Palpa District from west and south. The total number of household in the Rural Municipality is 4972. The Kaligandaki Rural municipality of Syangja district is one of the most sensitive rural municipalities for landslide and other water induced problems. According to NAPA 2010, Syangja district is ranked as area with high risk of landslide or exposure.
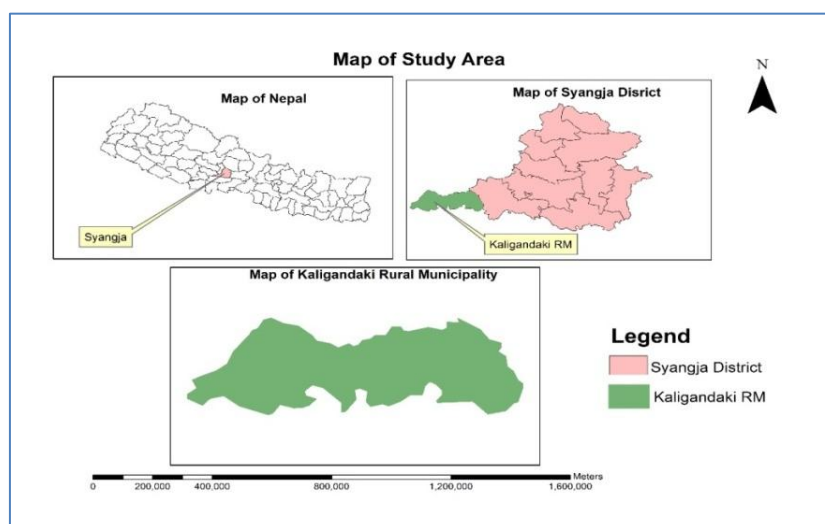

Fig-1: Location map of the study area

DATA COLLECTION

Direct observation of the sites was done to see the impacts of climatic hazards, and household level adaptation strategies. A field observation was also carried out to cross check the information gathered during group discussions and questionnaires surveys. Purposive sampling was used for household questionnaire survey. Out of 4972, altogether 150 HHs were taken from the Rural Municipality that covers all 7 wards. Key informant interviews were conducted with elderly individuals, local leaders, teachers, social workers, and heads of government and non-government organizations such as Ward Chairpersons, Rural Municipality Chairperson and other NGOs. Focus group discussions (n=7) were conducted to gather information about differential perception across social groupings, climate change impacts, community level adaptation strategies and barriers to implement community level adaptation plan. Meteorological data of 30 years（from 1987 to 2017）were collected from the nearest meteorological station.

DATA ANALYSIS

Collected data from the field were analyzed both qualitatively and quantitatively with the help of Microsoft-Excel 2016 spreadsheets Frequency Tables and Figures were generated for general information. Likert scale was used to assess the perception of the local people towards the impact of climate change.

The trends of temporal and spatial variations of temperature and rainfall were analyzed using linear regression. Secular trend method was used to comprehend the general tendency of the time series data to increase or decrease or stagnate during a long period. Least square curve finding technique was used to fit linear trend in the data. The linear trend between the time series data (y) and time (t) is given in the equation below.
$y = a + bt$ Where

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y = temp / rainfall
t = time (year)
"a" and "b" are the constants estimated by the principle of least squares

The average annual temperature, average annual rainfall and average monthly rainfall were analyzed and their trends were studied [13].

RESULTS AND DISCUSSION

Perception of the respondents: Our study shows that out of 150 respondents, 56% respondents were unknown about climate change and 44% of the respondents were known about climate change. The three categories of scale were increase, same, decrease fixed for the purpose to know the perception of the respondent on climatic variables. On the basis of analysis, percentage respondents saying decrease in frequency of rainfall as 82.66%, decreases in amount of rainfall as 72.67%, increase in hotness in summer as 86.66%, decrease in coldness in winter as 85% and increase in climatic hazard as 83.33% respectively over 30 years. Thus, the majority of respondents perceived that rainfall is decreasing and temperature is increasing in the area. The similar type of study carried out by Nepal Hydrological and Metrological Research center and consultancy P. ltd. [14] that showed the temperature is increasing in Nepal, and rainfall is becoming more variable, thus supports the result. Another study conducted by Jaiswal [15], indicates that 98.67% of the surveyed population have observed increase in temperature over the past 34 years where as 96.67% of them have observed decrease in rainfall over the past 34 years which supports my findings in research.
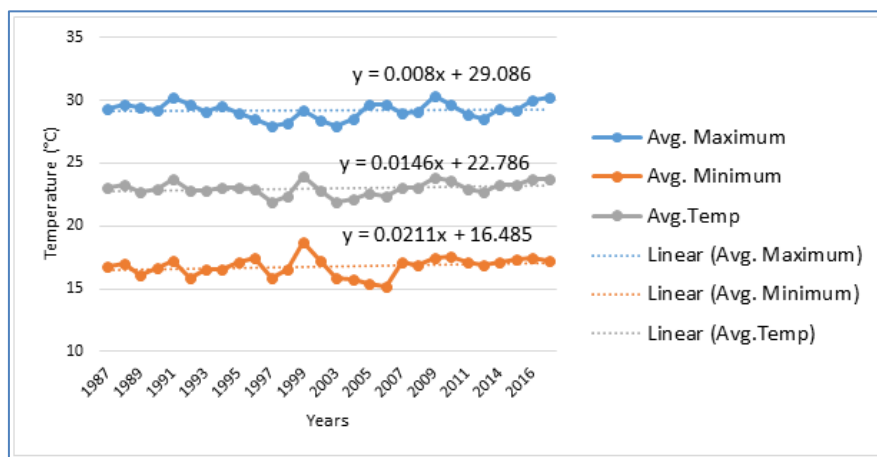
Variation in Temperature

Fig-2: Trend of average annual temperature from 1987 to 2017

Temperature change is the direct indicator of climate change. The study carried out by Gautam *et al.* [16] from Pokhara also concluded that the temperature is increasing. For this Study, maximum, minimum and annual temperature trends were calculated. Figure illustrates that the average maximum temperature is increasing at a rate of 0.008 °C per year while average minimum temperature is increasing 0.0211 °C per year. Similarly, the average temperature is increasing 0.0146 °C per year. The study revealed that 86.66% respondents experience the hotness increased in summer days and 85% experienced decrease in coldness in winter. Thus the result from the above graph supports that the perception the people towards rise in temperature was right.

Variation in Precipitation

The average annual monsoon rainfall showed variation in amount, intensity and form. Erratic rainfall events with equal amount of total precipitation have been experienced. Sharma *et al*. [17] also concluded that the rainfall is erratic in Makwanpur, Nepal. Such event increases the possibility of extremes like irregular monsoon patterns and droughts. The rainfall trend of Kaligandaki Rural Municipality is in decreasing trend of 0.650 mm/yr. As 72.67% of the respondent felt the rainfall amount is decreased, which shows that their perception towards decrease in amount of rainfall is right. Graph showed that average annual rainfall of study area was lowest (drought prone) in 2006 with only 90.76 mm of rainfall whereas 2013 was the wettest year with 225.89 mm of rainfall.
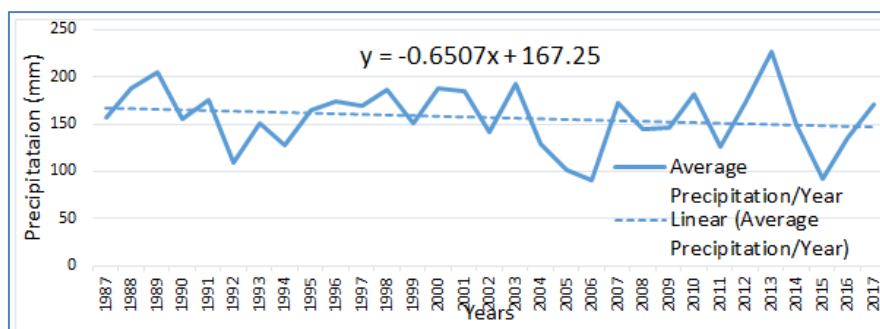
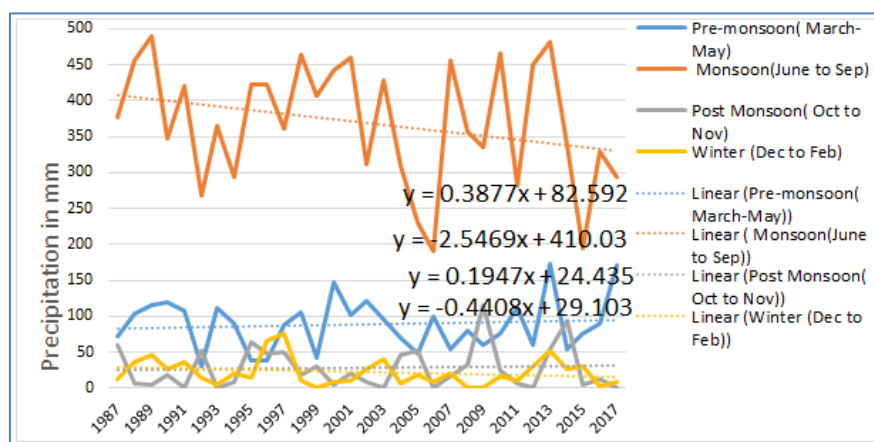**Fig-3: Average annual rainfall of Chapkot station**

Fig-4: Average seasonal precipitation trend of consecutive years

The average rainfall of pre-monsoon (March to May), monsoon (June to September), post-monsoon (October to November), winter (December to February) were also analyzed. It has been found that the pre- monsoon and post monsoon is increasing at the rate of 0.3877 mm/yr. and 0.1947 mm/yr. respectively while the monsoon and winter rain are decreasing at the rate of -2.5469 mm/yr. and -0.44 mm per/yr. respectively as shown in figure 4 above. The result obtained is also supported by the earlier studies of Practical Action Nepal [13], which shows that Pre-monsoon and Post-monsoon rainfall are in increasing trend and monsoon and winter rainfall are in decreasing trend in western Nepal.

Impacts of climate change

Gautam *et al*. [16] concluded that there are many sectors affected by climate change directly or indirectly. The study showed that the impacts of climate change fall on various sectors. The major impact area of climate change was agricultural production, water resources, invasive species, human health related diseases, wild animals in the study area. People perceived that impact of climate change in agriculture production is high. The production is slightly decreased due to lack of irrigation facility and human work force's. Similarly, people also perceived that there is decrease in water resources. In addition, mosquito and invasive species are highly increased. Local people noticed different types of invasive weeds in the agricultural field and forest as well like Banmara (*Eupatorium adenophorum*), Gandhe (*Ageratum Spp*), Ganauneyjhar, Pati has been increased. The invasive species like *Lantena camera*, pirrejhar, and nilogandhe are affecting agricultural crops. The insects and pests are damaging the agricultural crops. Similarly, various kinds of human diseases and animal diseases have increased in the past 30 years. Various animal diseases like kheutey, bhayagutey, Jhirkhorey has been seen in animals. Native animals Cow were almost replaced by buffalos and hybrid cows. People changed the traditional agricultural crop species of paddy by Hybrid Paddy, maize namely setomakai, buckwheat species and noticed that the use of hybrids rather than the native paddy leads to the increase in production however, most of the respondent responded that the hybrid paddy is not as nutritious as native paddy. The local pests in crop species were Lae, Dhaduwa, Cancer, Dathkuhine, Falkuhine, Pahele and others. The weather related disasters prevalent in the study area were flood, landslide, hailstorm and windstorm, erosion. Their occurrence's was severe and slightly increased more compared to past 30 years and now. The forest fire was highly decreased compared to before in the study area. The result is similar to study carried out by Gentle and Maraseni [18] in Jumla, Nepal that found that most vulnerable hazards is decreasing and erratic rainfall patterns and drought directly affecting rain-fed agriculture practices and result a massive reduction in agriculture production. Pokhrel *et al*. [19] also found that almost all species have occurred naturally except Water Hyacinth (*Eichhornia crassipes),* Water chestnut (*Trapa natans),* Water Lily (*Nymphoides peltata*), Water Lotus (*Nymphaea nouchali*), Azolla spps and Lemna spps in the Rupa Lake- A Lake of international significant.

Local Adaptation strategy

Integration of local knowledge with additional Scientific and technical knowledge can improve disaster risk reduction and climate change adaptation. Most of the people are still unknown about climate change and adaptation strategies to be practiced. However, with their local experiences, most of the people are using weed control, compost manure, economic diversification, storage of energy, changing planting and harvesting date, crop diversification, improved livestock, planting trees and grasses, change from crops to vegetable respectively. Plantation of sisoo, bamboo, amliso species etc. are followed up by the local people in order to stop the river cutting and soil erosion. Most of the people have gone abroad in search for work and practiced alternative source of income through poultry farming and vegetable farming etc. Vegetable includes tomato, cabbage, potato, cauliflower and other pulses including beans, soya beans and others. The invasive species like *Lantana camera,* pirrejhar, nilogandhe are affecting agricultural crops. The insects and pest are damaging agricultural crops. Heavy use of the chemical fertilizers and insecticides /pesticides has been practiced by the farmer in the agricultural field. The result is similar to study carried by Tiwari [20] which showed that adaptation measures such as use of water source, community forest management, planting trees and grasses in the farm land, crop diversification were practiced by the local people in their farm as well as communal land.

Barriers to adaptation strategies

The study also assessed people perceived barriers to using various adaptation measures. The results from our study indicate that lack of information concerning climate change, agricultural pests and diseases, lack of education, shortage of labor, no access to sufficient seeds and fertilizers, no access to sufficient land, no access to credit, lack of market and no access to water limit the ability of farmers to get the necessary resources and technologies they might want in order to adapt their activities to changing climatic conditions. According to our study, nearly 91% people perceived the lack of knowledge as the main barrier to adoption of adaptation strategies.

Role of major institutions regarding climate change adaptation

The major institutions in the study area helping in climate change adaptation are found to be school, Rural Municipality, Mothers' group, DFO, youth club, UNDP and others that includes co-operates, public deposit, INGO'S, NGOs etc. Programs conducted by Rural Municipality are construction of taps, toilet, road, bridges. They conduct repeatedly awareness and plantation campaign in the study area. They provide seed of the various crops with low cost. School can provide education to people. Schools are organizing various programs like debate competition, singing competition related to climate change to foster the consequences and adaptive measures of climate change. Mothers' group and local youth clubs are actively working in the area by conducting different programs related to awareness and cleanliness program. UNDP is playing a vital role in construction of ponds, supply of drinking water and awareness programs related to the environment. DFO provides seeds and plant of various trees free of cost and even organizes various plantation and environmental programs. Other institutions are also actively organizing programs and are making the livelihood of people comfortable. However, at local level, many of the people are still unknown about environmental problems and the adaptation measures to adapt to the climate change. Gautam *et al*. [21] concluded that knowledge of climate change issue would be beneficial to adopt in the changing climate.

CONCLUSION

From the study we can conclude that there was noticeable change in the rainfall pattern which is also felt by the respondent. Climatic data also showed that the average annual rainfall was found to be in decreasing trend at the rate of 0.6507 mm/yr. Drought, erratic rainfall and invasive weeds (*Lantena camera, Ageratum species*, *Eupatorium species etc.*) in agricultural filed as well as forested area was found to be the most harmful hazards. Other impacts in the study area were increase in insects and pest, increase of disease in human and animals and decreased in agricultural production, water resources, forest fire etc. Weed control, use of compost manure, economic diversification, storage of energy, changing planting and harvesting date, crop diversification, improved livestock, planting trees and grasses, change from crops to vegetable were found as the major adaptation practices. Majority of the people were unknown about climate change which is main barrier to climate change adaptation including others like lack of education, shortage of labor, no access to sufficient seeds and fertilizers, no access to sufficient land etc. School, Rural Municipality, Mothers' group, DFO, youth club, UNDP and others that includes co-operates, public deposit, INGO'S, NGOs have been supporting local people in order to adapt to climate change.

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