Climate change perception: A case study of Bardiya National Park (BNP), Thakurdwara, Bardiya, Nepal

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ABSTRACT

This study presents an account of Climate change trends and their implications in Thakurdwara V.D.C. located at buffer zone of Bardiya National Park, Nepal. This study has adopted place based community vulnerability assessment approach which is based on participatory case studies. Primary data were collected through focused group discussion, household survey and interview where as climatological analysis was done with data obtained from Department of Hydrology and Meteorology (DHM). Trend Analysis of DHM data and survey result has clearly spelled that the study area has experienced changes over precipitation and temperature pattern. In case of Rani Jaruwa Nursery and Gulariya stations, which are near to the study area, precipitation is decreasing at the rate of 1.006 mm/yr and 0.315 mm/yr respectively. Whereas the temperature in both of Rani jaruwa Nursery station and Chisapani station is increasing at the rate of 0.004^{o}C per year and 0.067^{o}C per year respectively. Natural disasters, water scarcity, decrease in food production, change in vegetation composition and adverse health impacts are the major risks identified by the community. Therefore, our further action should be to formulate appropriate adaptation strategies and strengthen the community to better cope climate change.

Key words: **:** Bardiya National Park (BNP), Climate Change, Community, Nepal, Vulnerability

INTRODUCTION

According to the latest, Fourth Assessment Report of Intergovernmental Panel on Climate Change (IPCC), the global mean temperature of the Earth has been rising by 0.76^{o}C over the past 100 years. Scientists have estimated that the global mean temperature of the Earth will increase by 1.4^{0}C to 5.8^{0}C by 2100 relative to 1990 (IPCC, 2001). A study carried out by Department of Hydrology and Meteorology (DHM) showed that Nepal is warming at a rate of 0.06^{0}C per year. However the same is higher in Himalayan regions. A rise in temperature from 1975 to 2006 by 1.8^{0} C has been recorded in the Country (Malla, 2008). Siwalik and Terai (Southern low land plain) regions show warming trend of 0.038^{0}C per year (Shrestha *et al.,* 1999). The impact of Climate Change is not experienced equally throughout the world. Developing countries are considered to be particularly vulnerable to climate change due to their limited capacity to cope with hazards associated with changes in climate (Adger, 2000; Huq *et al.,* 2002 and Kates, 2000). According to Third Assessment Report (McCarthy *et al.,* 2001), vulnerability is "the extent to which a natural or social system is susceptible to sustaining damage from climate change". Being a developing Country, Nepal has low adaptive capacity to cope with the effects of climate change. Water resource, agriculture, forestry, biodiversity and heath sector have been identified as Nepal's key sectors which are vulnerable to climate change (MoPE, 2004).

Mountain Ecosystems are definitely indicators of climate change. But low lands also can't remain unaffected. Moreover, low lands of Nepal are more prone to flood and water borne disasters. To mitigate the problems, we need conceptually sound knowledge of the matter. In this context, our study aimed to capture the scenario of climate change at microclimatic level of low land lying protected area, Bardiya National Park (BNP).

Studies have shown that climate change will be associated with spreading of invasive alien species, change in vegetation composition and tree line. Similarly, it can trigger ecological processes including the loss of rare and endangered species (ICIMOD, 2008). Invasive alien species disrupt the ecology of natural ecosystem, displace the native plant and animal species as well as degrade the landscapes unique and diverse biological resources (Tiwari *et al.,* 2005). Therefore, protected areas can be suitable sites to observe such impact, if any. Developing country like Nepal lacks a sound scientific data base on climate change both at local level as well as national level. So, only way to fill up this gap and understand the phenomenon of climate change could be through the scientific studies and which are necessary at microclimatic level. This will enable local communities to take appropriate action.

In these contexts, the overall objective of the study was to reveal the local people's perceptions on climate change. The specific objectives were to identify the anecdotal evidences of climate changes and trace their correlation with facts spelled by climatic data of the region, to identify the present impacts faced and to identify any change in species biodiversity triggered by climate change.

MATERIALS AND METHODS

Study was carried in Bardiya National Park (BNP), Thakurdwara area and its surrounding Buffer zone. Public survey was carried out at Thakurdwara and Surya Patuwa VDCs. This is the largest protected area of Terai (Southern Lowland Plain), covering an area of 968 sq. km and buffer zone of 327 sq.km. The latitude and longitude of national park is N 28° 21' 53.64"/ E 81° 33' 34.56". The altitude ranges from 1441m (Sukramala Danda) to 152m (Manau Ghat, Karnali). The Park includes alluvial flood plains, created by Karnali River, Babai River and Orai Khola. It falls in Subtropical bioclimatic zone covering three districts namely; Bardiya, Banke and Surkhet. About 90% of rainfall occurs in the month of July, August and September. Average temperature is 35° C. But, temperature sometimes peaks up to 45^{o} C in May/June. BNP comprises diverse ecosystems ranging from alluvial flood plains grassland ecosystem of early succession stages to climax Sal forest. It has 2 main Landuses; Forest area (59%) and Cultivated land (41%).

This research has followed climate change vulnerability approach (Kelly and Adger, 2001 as quoted in Sutherland, 2004). This approach uses participatory case-study methods for assessing vulnerability to better understand the nature of vulnerability of communities to climate change. Methodology applied in this study comprises of three stages as follows:

Data analysis

Temperature and precipitation data were analyzed as they are the significant climatic parameters. All the available station data in and around BNP were attempted to study so as to cover the microclimate of the region. But due to data unavailability only 4 meteorological stations were taken. This includes 15 years data i.e. from 1993 to 2007 for each meteorological station. Data source was Department of Hydrology and Meteorology (DHM) of Government of Nepal. Temperature data were available as monthly mean of daily maxima and minima. From the available data we determined Annual and Seasonal averages for both temperature and precipitations. We focused the seasonal average for winter season only. And Mann-Kendall trend tests using Addin software XLSTAT in Microsoft Excel 2007 was used in order observe the hidden trend in data.

Public survey

It was basically for the assessment of people's perception on climate change. The questionnaire survey was carried out in two different groups of people. First group included people who were directly or indirectly involved in the Park management. And another group included people who were dwelling there for decades and were engaged basically in agricultural practices.

Field observation

A keen field observation was carried out in both the core and buffer zone area of the park. Observation visit was made into the core area such as Khauraha Phanta, Namaktal, Karnali river flood plain and Orai Khola flood plain. The visit was aimed to know the invasion of vegetation if any and to assess the floral and faunal diversity. Observation around buffer zone was basically aimed to identify adaptation measures applied by locals if any.

RESULTS AND DISCUSSION

Bardiya National Park (BNP) and the surrounding area was also not exception to Climate Change. Temperature and precipitation data analysis of four stations around BNP supports the perception of locals to be real.

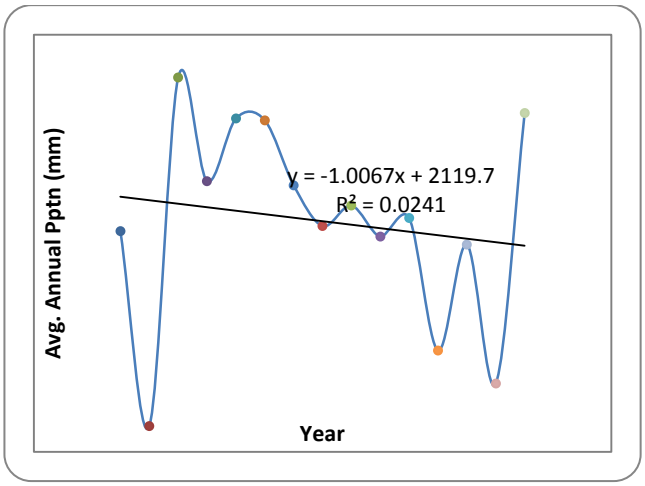

Fig. 1: Average Annual Precipitation at Rani Jaruwa Nursery Station (1993-2007)

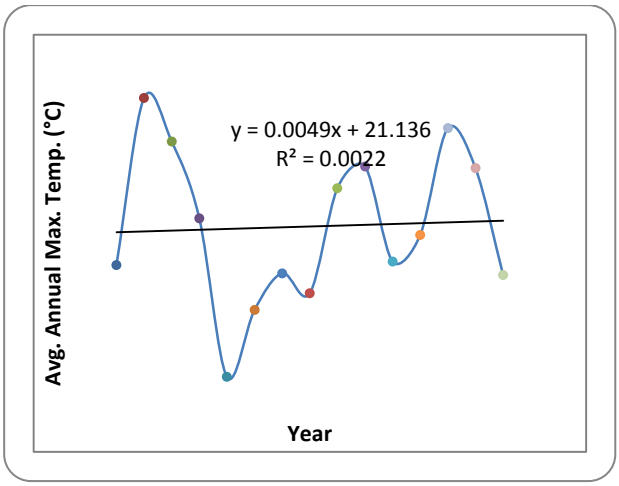

Fig. 2: Average Annual Maximum Temperature at Rani Jaruwa Nursery Station (1993-2007)

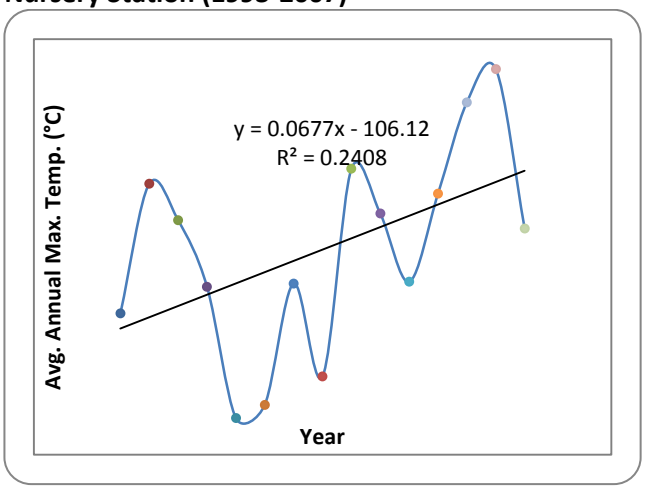

Fig. 3: Average Annual Maximum Temperature at Chisapani Station (1993-2007)

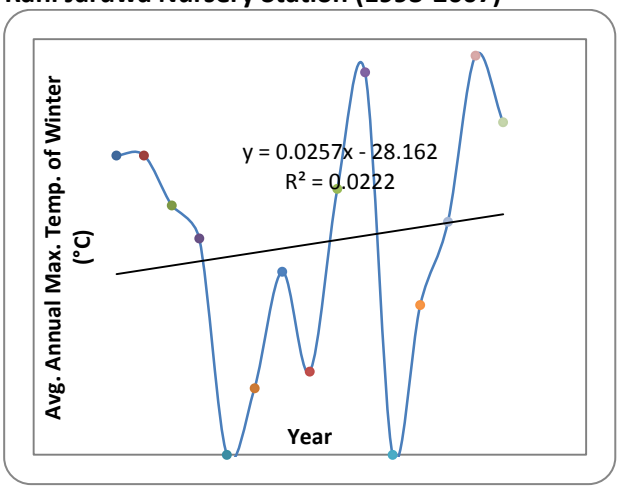

Fig. 4: Average Annual Maximum Temperature of Winter Season at Chisapani Station (1993-2007)

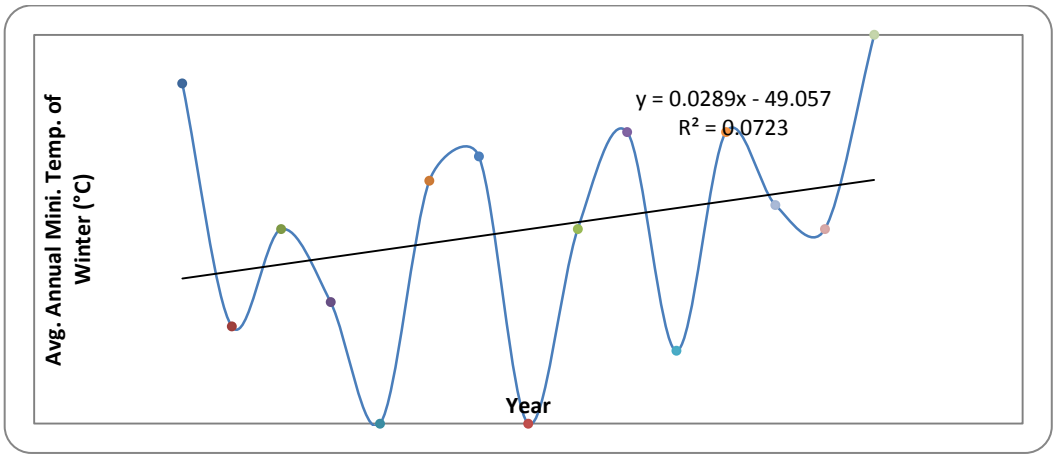

Fig. 5: Average Annual Minimum Temperature of Winter Season at Chisapani Station (1993-2007)

Data analysis clearly suggests that the trends are changing. Untimely, intense rainfalls, floods and delayed monsoon are the visible changes in the region. Much of the perception on climate change which where common among majority of surveyed people were very interesting. They were saying that monsoon was starting late; traditional monsoon which starts at June of every year has shifted somehow to late July to august. Unusual rainfall pattern are prominent nowadays. Rainy days have decreased but events of intense rainfall at once are frequent creating heavy rain and floods. Winter period seems to be shorter and comparatively warmer such that aged people feel comfortable in winter.

As supportive to local's perception, the average annual precipitation is in decreasing trend in the region. The trend analysis based on annual precipitation record of 1993-2007 at 4 stations clearly showed that Tikapur has the highest increasing precipitation trend of 1.628 mm/ yr. On the other hand, Rani Jaruwa Nursery and Gulariya stations, which are near to the study area, have the decreasing trend of 1.006 mm/yr and 0.315 mm/yr respectively. From this, we can assume that the study area has negative trend for precipitation.

Similarly, the average annual temperature in Rani Jaruwa Nursery station and Chisapani station is found to be 30.85^{o}C and 29.23^{o}C respectively. The trend line has clearly indicated that the average annual maximum temperature in both of Rani Jaruwa Nursery station and Chisapani station has positive trend of 0.004^{o}C per year and 0.067^{o}C per year respectively.

And the average maximum and minimum temperature of winter season at Chisapani station has increasing trend of 0.025°C per year and 0.028°C per year respectively. In conclusion, we can say that the study area is getting warmer in compare to the past decades.

Table 1: Summary of Climatic data trend of 4 meteorological stations for 6 climatic parameters of BNP for 15 years data (1993-2007)

S.N.	Station / Parameter	Ranijaruwa Nursery	Tikapur	Chisapani	Gulariya
1	Average annual precipitation	Decreasing	Increasing	Decreasing	Decreasing
2	Average winter seasonal precipitation	Increasing	Increasing	Decreasing	Increasing
3	Average annual Max. temperature	Increasing	Increasing	Increasing	DNA
4	Average annual Min. temperature	Increasing	Increasing	Increasing	DNA
5	Average Max. temperature of winter	Fluctuating	Increasing	Increasing	DNA
6	Average Min. temperature of winter	Increasing	Increasing	Increasing	DNA

* **DNA** implies Data Not Available.

As shown on Table 1, six climatic parameters were taken for trend analysis from four meteorological stations. Out of these six parameters, Figure; 2, 3, 4, 5 and 6 shows the climate trend for four parameters; Average Annual Precipitation, Average Annual Maximum Temperature, Average Annual Maximum temperature of winter and Average Annual Minimum Temperature of winter respectively as they are the effective parameters in order assess climatic trend as compare to others.

Though people may not know the term "Climate Change", they have experienced impacts of climate change in one way or the other. People are sure that climate has changed over the decades.

They have perceived one or more impacts in their daily life. Farming being the major occupation of this region, locals feel themselves to be highly affected by the change. Farmers require rainwater during the mid *June* month which is the time for planting rice. Due to late start of monsoon, people are compelled to find alternatives like pumping ground water for irrigation. When it is time to plant rice seedlings, the monsoon prevails and creates flood that hampers rice cultivation. Especially, events of heavy rainfall at once troubles more by creating flood, and damaging rice just flowering. As climatic patterns change, so also do the spatial distribution of agro ecological zones, habitats, distribution patterns of plant diseases and pests which can have significant impacts on agriculture and food production (FAO, 2007). People claimed that they were not using mosquito nets in winters just 10 to 15 years ago. But now, mosquitoes trouble indifferently in both the summer and winter season. Malaria, Kala-azar, and arboviral diseases are common in Nepal (DoHS, 2005). Scientists and health experts have suggested that these diseases are heavily influenced by climate change.

People also reported unavailability of Supariphul *(Gomphrena globosa)* flower during the festival time i.e. flowering after September-October. This matter needs further research to confirm it and blame climate change. This is one of the important aspects of climate change because it talks about impact of climate change on phenology of flowering plant which can be important part of research for climate change impacts on ecosystem. These phenological changes provide a highly sensitive and easily observed indicator of biosphere dynamics (Menzel and Fabian, 1999) and can be regarded as the 'fingerprints' of climate change (Menzel *et al.,* 2001). No significant impacts on Biodiversity of BNP were noted. However, some of the Invasive alien plant species like *Mikania micrantha, Lantana camara* and *Chromolaena odorata* were present in and around the BNP. As, climate change is also associated with presence and expansion of these kind of plant species and biological invasion worldwide threatens biodiversity, ecosystem dynamics, resource availability, national economy and human health (Ricciardi, 2000 and Bam *et al.,* 2013), a detailed and specific study on this matter is a must.

The socioeconomic status of buffer zone is closely associated with sustainable conservation. So, the consequences should not be under estimated. As it is clear to all, studies on climate change in communities of Terai Arc Landscape-Nepal are lacking, due to various constraints. So it is recommended to generate different kinds of effective research program because impact of climate change is clearly open to all and a kind of evidence is also provided by our study. Various mitigation measures such as Carbon sequestration in growing forests is known to be a cost-effective option for mitigation of global warming and global climatic change (Chavan and Rasal, 2012). Further, the community needs to be well informed and empowered to enable them to act for lessening the adverse impacts of climate change. Community based loss sharing mechanism such as insurance of crops, properties and human life against natural disaster can play a vital role on increasing the community resilience.

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