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Local People's Perception on Climate Change, its Indicators and Adaptation Strategies in the Chitwan-Annapurna Landscape, Nepal

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Abstract

Climate change is regarded as one of the main obstacles to the environment conservation and people's economy, agriculture and livelihood in undeveloped countries like Nepal. Understanding people's perception and indicators of climate change are fundamental knowledge for developing various adaptation strategies. This study was based on the questionnaire survey with respondents of 204 households in the study area- Chitwan Annapurna Landscape, Nepal. More than 92% of the respondents were perceived the problems of climate change such as low or unprecedented rainfall, the rate of dryness of the land, dryness of wetlands, change crop pattern and phenology. These indicators of climate change were significantly increased in the recent years. Local people have been facing various levels of impacts caused by invasive alien plant species in their farmlands and forests (87.7%) and that also replaced the pasture or grasslands (69.1%). Besides, local people have experienced the increased rate of tropical disease vectors (e.g., house flies and mosquitoes), pests on crops and livestock diseases over the last 15 years. The rain water harvesting technology adopted by local people is the major adaptation strategy during low rainfall and dry periods. Likewise, the local people use invasive alien plant species to make bio-briquettes, fodders, cattle beds and compost manures. However, the lack of sufficient knowledge and resources, people's livelihood is vulnerable under such worst situation due to climate change. Therefore, it is necessary to focus on capacity building of local people to adapt with changing climate.

Keywords: Climate Change; Adaptation Strategy; People's Perceptions; Midhill; Nepal

Introduction

The recent researches have shown human facing the challenges for their socio-economic activities, health, livelihood, and food security due to climate change [1-5]. The climate change has been seriously affected developed and undeveloped countries, poor and rich people [6]. Undeveloped countries are more vulnerable than

developed countries as the developed countries can develop various adaptive measures to cope with the climate change [7]. Rural people are likely to be more vulnerable to climate change, particularly because of compounding challenges of poverty, low infrastructural and technological development and high dependence on rain-fed agriculture [1,8,9]. More than 80% of agricultural production in Hilly region of Nepal is rain-fed [10]. The mountain and midhill regions of Nepal is greatly affected by the climate change than in Terai [3]. The solution to cope with climate change for the marginal people of Nepal seems to develop adaptation strategies. The recent studies have been indicated that there is a large deficit of knowledge and information about the climate change and related adaptation strategies to mitigate risk of climate change [8,10]. Present study highlights responses of people towards the indicators of climate change and status of public awareness in human dominated midhill landscape- Chitwan Annapurna Landscape.

Materials and Methods

Study Area

The study area encompasses landscape that connects the Chitwan National Park in lowland Terai with the Annapurna Conservation Area in the high mountain region. This region lies in the centre of the central Himalayas and represents globally outstanding biodiversity. It includes three WWF 200 global eco–regions (Terai–duar savanna and grasslands, Himalayan subtropical broadleaf forests, alpine shrubs and meadows), and two Ramsar sites (Beeshazari lake, Chitwan and lake clusters in Pokhara valley) [11] http://nepallake.gov.np/. The area is key habitats for many species such as tiger, rhinoceros, common/clouded/snow leopards, sloth/Himalayan black bears, sambar deer, spotted deer, musk deer, Himalayan goral, Himalayan tahr etc. The major forest patches that make the potential vertical corridor in this area are Barandabhar corridor forest, Gaighat area, Seti and Kali Gandaki river basin and Panchase protected forest area. The intensive study area covers Tanahun, Kaski and a part of Syanja and Parbat districts with an area of 2742.84 km^2 (Figure 1). The whole study area is divided into three different study blocks depending upon altitude, geography, location and accessibility. They are: Block A: Panchase area Block B: Rishing and Ghiring area, Block C: Devghat and Gaighat area. This area is highly human dominated and fragmented ranges from 175m to 2250m altitude. Most of people depend upon the agriculture and animal husbandry. The ethnic community of the study area feel different types of climatic and biological changes to their localities due to climate change.

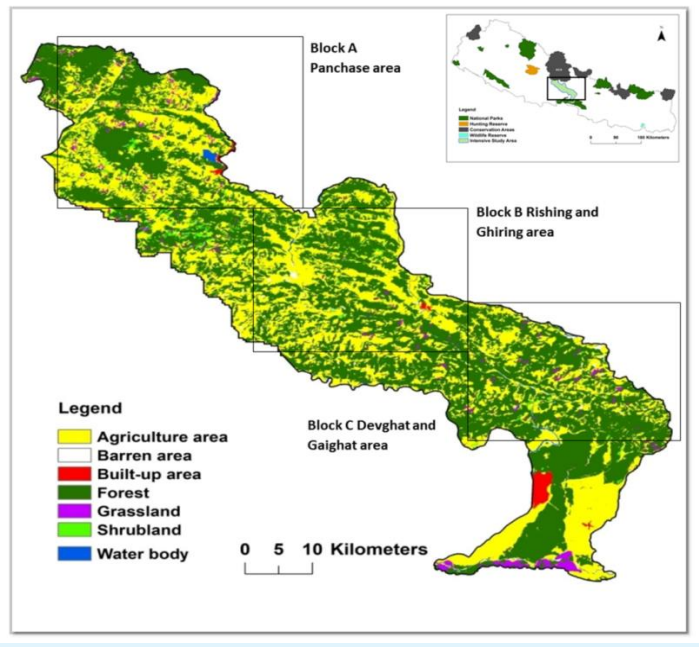

Figure 1: Map showing the intensive study area which links two biodiversity significant areas- CNP and ACA (Source: ICIMOD/DNPWC 2018).

Methods

Sampling Size and Techniques

This study was based on the questionnaire survey among the local people in three study blocks. The participants (respondents) for this survey were randomly selected [12,13]. A total of 204 respondents (86 from Block A, 69 from Block B and 49 from Block C) were sampled by using the structured questionnaires related to the indicators and perceptions on climate change. From the sampling frame, the sample units were selected above the age of 30 years, so that they can able to recall signs of patterns of climate changes in their communities. Structural questionnaire was the major tools of data collection. The questionnaire was translated into the Nepali language by interviewers. In Nepal, males are the head of the family and therefore most of the respondents involved in this sampling were males than females (*Male=134, Female=70, SD=45.25*). But during the interview, no hints on climate change were provided to the respondents to avoid possible biasness as indicated by Mertz O, et al. [14]. If the discussion was made on their perceptions of climate change, they had made some changes on their original view of climate change and adaptive measures when in fact they had not [15,16].

Data Analysis

Data obtained from the questionnaires and interviews were categorized on the basis of people's perceptions on climate change and their mitigation methods into tabular forms. The data were analysed by using the PAST software. Multi variant ANOVA was used to measure the significant level of the perceptions of change in climate.

Results and Discussion

Descriptive Information of the Respondents

The personal, social and economic characteristics of the respondents of the study area (such as age, occupations, gender, education status, caste system, economic status) are presented in Table 1. The results of the questionnaires found that the respondents in the study area were 32 to 83 years (Mean=51.04, SD=10.91). Most of the respondents were literate (37.75%) have more experience on agriculture, animal husbandry and local society. The average annual income of the respondents was 25862.75 NRs (USD 253.75) which is very low than national per capita income (USD 682.22) [17]. Similar pattern of income of the respondents were found in the Nepalese Ruler communities [17,18]. The major income sources of respondents were agriculture, business, government job, wedges and remittances. Remittance covered 32.13% of the total income (Table 1). Most popular ethnic groups that inhabitant in Midhill Nepal are Gurung, Magar, Tamnag, Dalit, Braman, Chhetri, Ghale etc [19]. Most of the respondents were Gurung (27.94%) followed by Dalit (22.55%) and Magar (21.57%).

Respondents features	Categories	Scoring method	No of respondents	%	Range		Mean	Standard Deviation
					Max	Min		
Age	30-39	Years	29	14.22	83	32	51.04	10.91
	40-49		64	31.37				
	50-59		78	38.23				
	60-69		19	9.31				
	70-79		12	5.88				
	Above 80		2	0.98				
Occupation	Farmer	Number	83	40.69				25.002
	Students		17	8.33				
	Teacher		25	12.25				
	Social workers		22	10.78				
	Govern. Employer		16	7.84				
	Hotel owner		8	3.92				
	Business		33	16.18				
Gender	Female	Number	70	34.31				45.25
	Male		134	65.69				
Education status	Iliterate	Year of schooling	24	11.76				23.99
	Literate		77	37.75				

	Secondary		54	26.47		
	Intermediate		26	12.75		
	University		23	11.27		
Caste system	Dalit	Number	46	22.55		20.45
	Gurung		57	27.94		
	Magar		44	21.57		
	Newar		11	5.39		
	Tamang		14	6.86		
	Darai		2	0.98		
	Sanyasi		15	7.35		
	Braman		12	5.88		
	Gharti		3	1.47		
Income	Service	NRs	644000	12.21		618496.7
	Business		1335000	25.30		
	Agriculture		1411000	26.74		
	Remit		1695000	32.13		
	Wedges		191000	3.62		

Table 1: Descriptive information of the respondents.

People's Perceptions on Climate Change

The respondents of the study area were asked dichotomous questions (Yes/No question) about whether they felt or perceived the experiences of climate change or not? More than 92% of the respondents were perceived the experience of climate change in their area (Figure 2). These types of the studies conducted in Bangaldesh [20], India [21,22] and Nepal [3,23-25] also found the similar results.

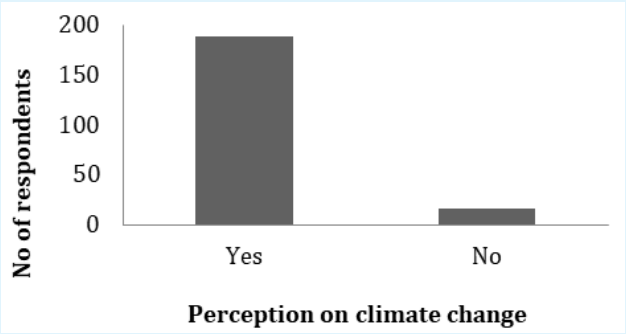

Figure 2: Do you feel the climate change?

The local peoples of the study area perceived direct feeling of climate change present days and past years. The questions were designed if they are feeling the condition of climate change these days and past years by giving four options- bad, very bad, constant and good. More than 80% of the respondents said the good condition of the climate before past 15 years, but now they felt bad (51.4%) and very bad (37.25%) climate. The relationship between the feeling of such climatic condition in the past and the present showed very bad situation of climate in these days. Similar researches in different parts of Nepal also indicated the similar type of the feelings [10,23,26,27].

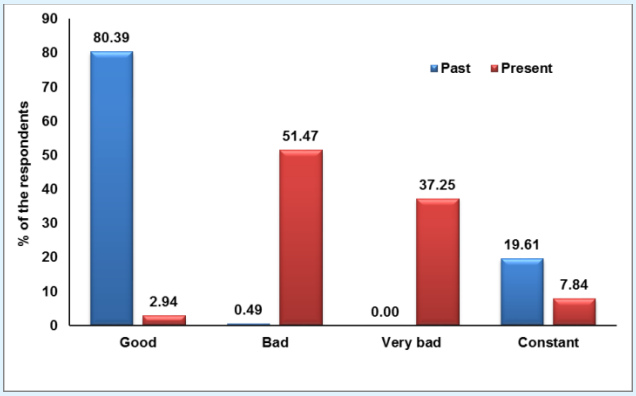

Figure 3: Relation between feelings of the respondents on climate- past (15 years ago) and present.

Locals' Perception on Experiences on Climate Change

Some climatic variables such as temperature, unpredictable rainfall, wind or storm rate, solar radiation, dryness of the land and dryness of the rivers and streams or wetlands were fixed and asked to the respondents by

providing the options of increased, decreased, constant and don't know. Majority of the locals felt increasing the temperature (98%) and solar radiation (79.9%). Rainfall is also another major indicator of climate change. But in this category, local people were not able to express the exact feeling due to unpredictable rainfall; however, more respondents were agreed on decreasing unpredictable rainfall (46.1%). There is no clear view about the rate of storms and winds. Most of the local people felt on decreasing the wind velocity due to increase of forest area, they believed that tall trees blocked the speed of the wind. Due to low rainfall, the rate of dryness of the land and dryness of streams, rivers and other wetlands were significantly increased in the recent years (*F=4.95, df=23, p=0.009*) (Table 2). As found in our study area, the perceptions of the respondents coincide with the trends observed in many parts of the world suggesting that temperature is rising and precipitation is falling Tambo & Abdoulaye [29], Roco, et al. [30]. Similar findings have been reported in the studies conducted in Ethiopia [28], Bangladesh [20], Nigeria [29], Chile [30], India [6,31], Bhutan [32] and other parts of Nepal [26].

Climatic events	% of respondents			
	Increased	Decreased	Constant	Don't know
Temperature	98.0	0.0	0.0	2.0
Unpredictable rainfall	1.0	46.1	24.5	29.4
Rate winds/storms	19.6	49.0	0.0	31.4
Solar radiation	79.9	1.0	12.3	6.9
Rate of dryness of lands	72.1	0.0	11.3	17.2
Dry rate of rivers and streams	72.1	0.5	12.3	15.7

Table 2: Distribution of the responses perceived by the respondents about climatic events (n=204).

People's Perception on Biological Changes

Most of the respondents of the study area felt on the biological changes directly and indirectly due to climate change. Eight variables of biological changes had been identified and asked to the respondents by providing the four options increased, decreased, constant and don't know. The responses of the respondents on biological changes of the surrounding showed the significant results on analysing in multivariate ANOVA (*F=17.08, df=31, p=0.0001*). Most of the respondents felt on increasing prevalence on crops (73%), livestock (82.4%) and human (83.8%). They also had the bitter feeling about the invasion of invasive alien plant species in their farms and forests (87.7%) and decreased on the pasture or grasslands (69.1%). According to the respondents, the occurrence rate of mosquitoes and house fly was increased (85.3%) in these days. Most of the respondent of midhills had the bitter experiences on changing the plant phenology (55.9%) (Table 3). Many research conducted in different parts of the world suggested similar type of increases in infection rate of the diseases on crops, livestock and man [33-36].

Biological changes	Increased		Decreased		Constant		Don't know	
	F	%	F	%	F	%	F	%
Infection of disease on crops	149	73.0	0	0.0	21	10.3	35	17.2
Infection of disease on livestock	168	82.4	0	0.0	10	4.9	25	12.3
Infection of disease on human	171	83.8	0	0.0	15	7.4	18	8.8
Pasture/grassland	0	0.0	141	69.1	37	18.1	26	12.7
Tropical disease vectors	174	85.3	0	0.0	16	7.8	14	6.9
Invasive and alien plant species	179	87.7	0	0.0	12	5.9	11	5.4
Crop pests	148	72.5	0	0.0	29	14.2	27	13.2
Change in plant phenology	114	55.9	1	0.5	36	17.6	53	26.0

Table 3: Responses of respondents on biological change of the surrounding due to climate change. (Where F is the frequency or number of the respondents).

Adaptation Strategy

Undeveloped countries like Nepal are more vulnerable than the developed countries as the developed countries can develop problem focussed adaptive measures to cope with the climate change. Local people in Nepal use different indigenous and traditional strategies to manage risks related to climate. However, this is essential for famers and herders not only to cope with the impacts of the climate change but also to adapt to reduce negative impact of climate change. Socioeconomic and environmental factors have played the vital role to adapt with the impacts of a changing climate [33,37]. The respondents were asked about the 12 different variables related with climatic and biological changes providing multiple options of adaptation strategies. Most of the respondents felt the low crop production due to increased temperature, decreased rainfall and dryness of lands and think in changing the crops (Table 4). They also initiated the rain water harvesting technology for irrigation and drinking during decreased water level in the rivers and streams. For controlling the alien and invasive plant species in the farms and forests, the local people initiated the controlling mechanisms such as removal of these plants and used to make bio-briquettes, compose manures and also used as fodders. Some community leaders felt on the change in plant phenology and said fast blooming of the fruiting plants than their regular time and now they are thinking to change the fruiting plants and crops (n=109). The respondents made a plan to use insects and disease resistant varieties of the crops to cope with infections of diseases and insects on crops. The respondents thought that there were no options of treatments of diseases on livestock and man. Adaptive capacity of small farmers to cope with changes in climatic events is usually low due to dependence on natural resources, poor infrastructure and low income rate [3,10,38]. Similar type of the problem was also observed in our study area. In some parts of the study area, the people have strong faith in spiritual interventions and perform rain calling rituals and marriage of the frogs to make their gods happy so that the god rewards the rain and good harvests (Personal communication with Jash Bahadur Gurung, Chairman of Kyadigaura Community forest, Ghiring-3, Archalbot, Tanahun). Similar types of adaptation strategy to cope with climate change were reported by the researchers from the different parts of the country [4,10,26].

Variables	F	Adaptation measures	F	Adaptation measures	F	Adaptation measures	F
Temperature increased	179	Changing on the crops	145	Plantation	122		
Unpredictable rainfall	204	Changing on the crops	180	Planting fruit plants	45		
Increased dryness of lands	147	Changing on the crops	135	Planting fruit plants	55		
Decreased water level on Rivers and streams	154	Think for alternative irrigation method	100	Search for crops that adapt on dry	50	Rain water harvesting	87
Increased infection rate of disease on crops	149	Using medicine	145	Using disease resistance variety	56		
Increased infection of disease on livestock	168	Treatment	168				
Increased infection rate of disease on human	171	Treatment	171				
Decreased pasture/grassland	141	Pasture management	141				
Increased mosquito and house fly	174	Using mosquito nets	174	Use repellents	55		
Increased alien and invasive plants	179	Remove and use to make bio-briquettes	115	Use as fodder for animals	55	Use as compost manure	80
Increased crop damage rate by	14	Changing on the	14	Using insecticides	1		

insects	8	crops	3		34		
Changing on plant phenology	114	Changing on the crops	109				

Table 4: Indicators and local people's adaptation strategies to cope with climate change (n=204), Total Number is more than 204 because of multiple responses.

Conclusion

Results from the descriptive analysis of respondents interviewed, key informant interaction and focus group discussion revealed that the most of local people in the study area were perceived the effects of climate change. The respondents felt change in temperature, drying of land, drying of streams and rivers had increased while rainfall was also decreased over last 15 years. The respondents argued that low wind velocity was due to the increase of forest area. People also had the bitter experiences about the invasion of alien and exotic species in their farms and nearby forests (87.7%) and decrease of area of pasture or grasslands (69.1%), increased diseases on crops and livestock. Hence, the local people planned to use different adaptation strategies such as harvesting rain water, controlling alien and invasive plant species by making bio briquette, compost manures; farming the resistance varieties of crops to cope with increased rate of insects and disease. However, the lack of sufficient knowledge and sources, people's livelihood are under grave threat due to climate change impacts. Therefore, it's urgent to focus on capacity building of the famers to cope with changing climate and the policy makers, planners and donor agencies should develop area focussed research and development strategies.

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