World Academy of Science, Engineering and Technology
International Journal of Agricultural and Biosystems Engineering
Vol:8, No:8, 2014

Perceptions of Climate Change Risk to Forest Ecosystems: A Case Study of Patale Community Forestry User Group, Nepal

N. R. P Withana, E. Auch

***Abstract*—**The purpose of this study was to investigate perceptions of climate change risk to forest ecosystems and forest-based communities as well as perceived effectiveness of adaptation strategies for climate change as well as challenges for adaptation. Data was gathered using a pre-tested semi-structured questionnaire. Simple random selection technique was applied. For the majority of issues, the responses were obtained on multi-point likert scales, and the scores provided were, in turn, used to estimate the means and other useful estimates. A composite knowledge index developed using correct responses to a set of self-rated statements were used to evaluate the issues. The mean of the knowledge index was 0.64. Also all respondents recorded values of the knowledge index above 0.25. Increase forest fire was perceived by respondents as the greatest risk to forest eco-system. Decrease access to water supplies was perceived as the greatest risk to livelihoods of forest based communities. The most effective adaptation strategy relevant to climate change risks to forest eco-systems and forest based communities livelihoods in Kathmandu valley in Nepal as perceived by the respondents was reforestation and afforestation. As well, lack of public awareness was perceived as the major limitation for climate change adaptation. However, perceived risks as well as effective adaptation strategies showed an inconsistent association with knowledge indicators and social-cultural variables. The results provide useful information to any party who involve with climate change issues in Nepal, since such attempts would be more effective once the people's perceptions on these aspects are taken into account.

***Keywords*—**Climate change, forest ecosystems, forest-based communities, risk perceptions.

I. Introduction

WITH the growth of scientific knowledge about climate change, it becomes the most popular critical issue discussed by various parties represented by policy makers, NGO activists, academics, researches, as well as general public. According to the Intergovernmental Panel on Climate Change (IPCC) Report [1], earth is facing the problems of rising of global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. The impacts of climate change are expected to be higher for some areas than for others because of their geographic location; the degree of association with climate-sensitive environments; and the unique economic, political, and cultural characteristics of particular areas [2]. Impacts may be positive or negative. According to the most of the studies, overall net effect on forestry sector is negative. It is estimated that climate change in the Nepal would have negative impacts on agriculture, forestry, and biodiversity [3]. Hence, forest-based communities may in turn be impacted due to their strong connections to forest ecosystems [4]. Therefore, when viewed at a broad scale, climate change can be viewed as a significant risk factor [5]. In Nepal, forestry area occupies 39.6% of total land area [6] and it consists of 35 forest types that provide habitat for large number of plants and wildlife and in terms of biodiversity richness, it is ranked as the 25th place in the world [7]. Primarily, Nepal is an agrarian society and forestry act as an integral part of the agricultural based economy. Normally, about 85% of people in Nepal [8] are being engaged in subsistence farming. Also, around 88% of the population of Nepal depends on the forests for daily fuel wood supply, which is considered as main source of rural energy and 42% population depends on forest for fodder for livestock. Almost one-third of forest area in Nepal is under community-based forest management systems including, community forest, collaborative forest, leasehold forest, buffer zone community forest, and conservation areas [9]. This illustrates the scale of participation of communities in forest management. Hence, highly forest depending communities in Nepal are being affected by climate change.

Adaptation can reduce or moderate exposure to the impact of climate change on forest and its dependent communities. The capacity to adapt to climate change is rarely determined by physical impacts alone, rather by a combination of factors, including socio-economic dynamics. Therefore, community and ecosystem based approaches are needed to collectively underpin good adaptation policy, planning and delivery, and are especially significant to communities and people directly dependent on natural resources for their livelihoods [10]. Public perception of climate change is one of the factors that determine the adaptive capacity [11], which is an important component of vulnerability assessment. Risk perception contributes vulnerability assessment in two ways such as (1) understand the real risk associated with climate change according to the local information and (2) identification of over and under estimation of risk. Currently, government of Nepal is considering about integrating climate change concerns with development planning. It will be quite difficult to implement any policies and measures unless the public has

Niranjan Ravindra Prasad Withana is Assistant Conservator of Forest, Forest Department, Rajamalwatta Road, Sampathpaya, Battaramulla, Sri Lanka (e-mail: wdnrprasad@yahoo.com).

Eckhard Auch is lecturer from Technical University of Dresden, Institute of International Forestry and Forest product, Germany (e-mail: Eckhard.auch@tu-dresden.de).

deep perceptions and appreciations of the climate change issues [12].

Therefore, an understanding of risk perception by forest-based communities relevant to climate change is important to expecting and evaluating actual and potential adaptive responses. Moreover, it is vital to formulate policy level decision. In addition, knowledge of how members of forest-based communities perceive climate risk will be an important predictor of community adaptation. Likewise, this understanding can also promote better dissemination of information and greater community discussion about the risks associated with climate change. Several studies have been done relevant to assessing risks perception with reference to climate change in Nepal, but these studies have focused on ecosystem in general term and there are no studies found that mainly examine the perception of forest-based communities with regard to the forest ecosystem. This study had been addressed this gap by some extent.

According to the Global Climate Risk Index that is based on the most reliable data of extreme weather events and associated socio-economic data, Nepal has been ranked as 17 place (CRI score: 37.17) [13] in the world. Furthermore, according to the Nepal districts ranked with regard to an overall climate change vulnerability index, Kathmandu valley records the highest risk range from 0.787 to 1.000. Hence, this study was mainly focused on the most vulnerable area in Nepal. As well, Nepal NAPA report stated that data limitation is another problem and further researches are required on the sensitivity, risk and exposure, and adaptation capacity. Therefore, this case study was trying to address some of these issues and revealing the local level perspective for bottom-up approach of policy designing. Followings objectives were investigated under this case study (1) assess the knowledge and familiarity of people, whose livelihood is associated with a forest, towards the concept of climate change, (2) assess perceptions of climate change effects as a risk to forest-based communities' livelihoods, (3) assess risk of climate change caused hazards, perceived by forest-based communities with regard to the forest ecosystems, (4) assess forest-based communities perceptions on the effectiveness of various adaptation strategies used to manage or cope the climate change risks and barriers, (5) identify the underlying factors influencing risk perception by forest-based communities associated with forest ecosystem.

II. Methodology

A. Study Site

Patale Community Forest (CF) village is in Lalitpur district and located between 26° 22' and 30° 27' North latitudes and 80° 40' and 88° 12' East longitudes of Kathmandu valley of land - locked country of Nepal. It belongs to the middle mountain physiographic region and hill ecological belt. Moreover, cold/warm type climate prevails with mean annual precipitation of 275 mm - 2300 mm and a mean annual temperature of 10°C - 20°C. The community forest consists of 104.6 ha land covering, 162 households within a community forest user group (CFUG) with 881 total populations in which 430 are female and 451 are male members. The vegetation type is a mixed one with Chilaune (*Schima castanopsis*), Katus (*Castanopsis indica*) and Utis (*Alnus nepalensis*) as the dominant species [14].

B. The Survey

Survey method was adopted from [15]-[19]. Primary and secondary data were collected. Secondary data were obtained from divisional forest office of Lalitpur district with regarded to total number of households, management of adjacent forest. As well, other necessary information was gathered from Ministry of Environment and Ministry of Forests and Soil conservation of Nepal. Primary data relevant to knowledge and general belief with regard to climate change, perceptions of risk to forest ecosystem as well as community livelihood, perceptions of effective adaptation strategies, and barriers for adaptation and the socio-economic characters (age, household monthly income, gender, level of education, occupation, and family size, etc.) were gathered using a pre-tested semi-structured questionnaire.

A sample of the communities in the village was obtained through a simple random selection covering more than 10% of 162 households. Survey had been carried out from the end of February to mid of March 2013 to acquire sufficient number of respondents. There were 31 households interviewed during that time. Due to certain issues with regarded to the self-administrated questionnaires such as low response rates and possible clarity, language and literacy issues and time constrains, interviewer-based face-to-face survey was used. In addition, formal and informal discussions with both village governing body and responsible officers of relevant government bodies were carried out to collect data with regard to governance system of village, the management of forest and its resources.

C. Knowledge

Knowledge relevant to climate change and its related issues, especially to Kathmandu valley in Nepal was measured using self-rated familiarity. Four categories ranging from completely unfamiliar to completely familiar were used. Familiarity with climate change issues was measured using 10 statements that had been answered by respondents as true, false, or not sure. In the questionnaire certain statements were inverted purposely to avoid giving answers hurriedly. Knowledge index was calculated by summing the number of correct answers. The number of correct answers out of 10 different questions was used to develop a composite index ("*knowledge index*") where the values were ranging from "0" (i.e. no question was answered correctly) to "1" (i.e. answer all the questions correctly).

D. Risk to Forest and Biodiversity

Risk perceptions on forest and biodiversity due to climate change effects were assessed by 5- point scale. Respondents were asked to rating 11 statements from not an effect at all to great effect. 5-point scale ranging from 1 "not a threat at all" to 5 "a great threat", with 3 = risk neutral. If mean value of

rated items was greater than 3 (M > 3.0), the items were considered as a threat.

E. Risks to Livelihoods of Forest Based Communities

11 statements were used to assess, how forest-based communities were perceived risks from climate change effects on their livelihood in Kathmandu valley. Here, also, 5-point scale was used from not an effect at all to great effects.

F. Effectiveness of Adaptation Strategies

Perceptions of effectiveness of adaptation strategies of climate change with regard to forest and livelihood context were assessed using 13 strategies. 5-point scale was used and respondents had been asked to rating statements from 1 "not at all effective" to 5 "fully effective". Statements with regard to adaptation strategies were adapted from literature review.

G. Challenges and Barriers to Adaptation

10 statements that were prior identified in details literature survey were used for recognizing challenges and barriers to adaptation in forestry and livelihood context. Also, 5- point scale ranging from 5 "strong agree" to 1 "strongly disagree" was used.

H. Social-Cultural Factors

Social variables such as age, sex, education level, occupation were considered. Coding system was used for data entering. Years were used for measuring age. For gender, women = 0 and men = 1 were used. Education level was measured using 7 categories according to the education system of Nepal. Occupation was measured in eight categories such as wage labour, agriculture, business, public service, private service, mix of mentioned occupations and none. Apart from that, data with regard to household income, household size, and membership of environmental organizations were gathered.

I. Analysis

Data analysis was performed using Statistical Package for Social Sciences (SPSS, version 19.00) for Windows 7. To test the reliability analysis of psychometric test, especially for internal consistency, Cronbach's coefficient alpha (CCA) was used. This score indicates high internal consistency among variables [20]. In addition, mean and standard deviation with reference to the perceived risks on forest and biodiversity, livelihoods, effectiveness of adaptation strategies and limitations for adaptation were estimated. Firstly, due to the parametric and non-parametric nature of data, the bivariate correlations procedure was performed to compute Pearson's correlation coefficient for parametric data and Kendall's tau-*b* for binary data with their significance levels with perceived risks and effective strategies relevant to climate change. However, binary data was not shown strong strength of association with perceived risks and effective strategies at the 0.05 significant levels. After those independent variables, which correlation coefficients were significant at the 0.05 levels were added to a linear regression.

III. Results

A. People's Knowledge about Climate Change and Related issue in Kathmandu Valley

Several key insights emerged when respondents were asked about their understandings of climate change. The results show that only five out of 31 participants (16%) to the study judged that they possess a sufficient knowledge on the concepts and issues of climate change. Interestingly, as seen in Fig. 1, any respondents had not indicated that they were completely unfamiliar with these concepts. The distribution of values of the "knowledge index", which was derived to assess the real knowledge of respondents on matters related to climate change concept, is shown in Fig. 2. The mean of the knowledge index was 0.64. All respondents also recorded values of the knowledge index above 0.25. It shows that almost 100% of respondents possess a sufficient knowledge with respect to the various aspects related to the climate change, and that of 29% respondents was very satisfactory. In addition, Pearson's correlation coefficients for education (0.376) and composite knowledge (0.367) were statistically significant with perceived risks to forest & biodiversity while perceived effectiveness of adaptation strategies was related to education (0.345). The results indicated a weak and positive linear relationship.

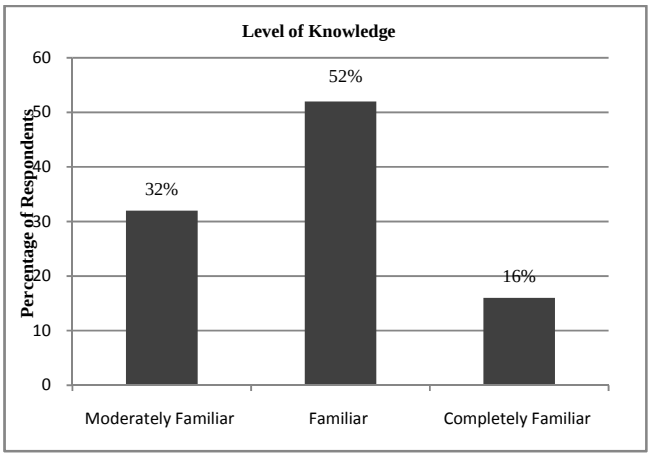

Fig. 1 Self-rated familiarity of respondents

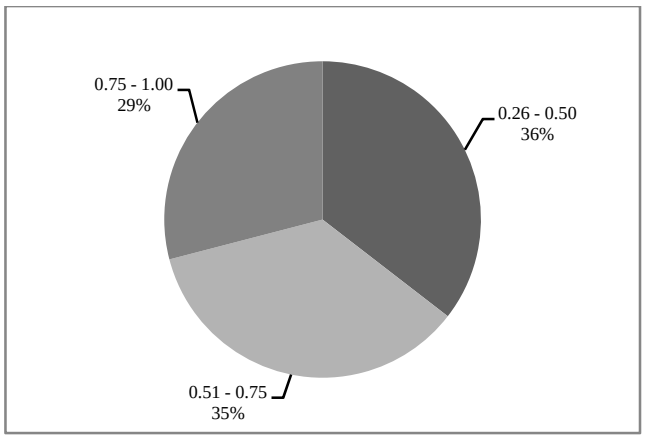

Fig. 2 Distribution of values of the knowledge index

B. Perceived Risks to Forest and Biodiversity due to Climate Change

Table I presents the means of perceived risk to forest eco-system due to climate change in Kathmandu valley in Nepal. 10 statements out of identified eleven were rated as a threat (M > 3.0). The outcomes of analysis show that *increase forest fire* (4.32) was perceived by respondents as the greatest risk to forest eco-system followed by *seasonal changes (delay/early flowering and fruiting)* (4.12). Interestingly, these villagers living adjacent to a forest rated the *species and habitats loss* (4.00) as the third major risk to the forest and biodiversity in the Kathmandu valley. A number of other factors, including *soil erosion and loss of soil fertility*, *green grass have decline (fodder & forage)* and *increase dryness in forest* were also rated at higher positions. However, *change of forest composition, structure and productivity* (2.87) was rated as non-risk issue in Kathmandu valley.

TABLE I
DISTRIBUTION OF PERCEIVED RISKS TO FOREST & BIODIVERSITY DUE TO CLIMATE CHANGE AMONG VILLAGERS OF PATALE COMMUNITY FOREST VILLAGE IN LALITPUR DISTRICT OF KATHMANDU VALLEY IN NEPAL

Issue	Mean[a]	Std. D
Increase Forest fire	4.32	0.70
Seasonal changes (delay/early flowering and fruiting)	4.12	1.23
Species and habitats loss	4.00	1.12
Soil erosion and loss of soil fertility	3.96	1.04
Green grass have decline (Fodder & forage)	3.83	1.03
Increase dryness in forest	3.74	1.31
Reduce the value of tourist potentials	3.58	1.36
Distribution of new invasive alien species	3.41	1.33
Outbreak of insect calamities and disease	3.32	1.22
Decline the ecosystem services	3.09	1.27
Change of forest composition, structure and productivity	2.87	1.11

[a] Rated on a scale of 1 to 5, where 1 = not a threat at all and 5 = a great threat, sample size (n=31) Cronbach's Alpha 0.762

C. Perceived Risks to Livelihoods of Forest Based Communities due to Climate Change

TABLE II
DISTRIBUTION OF PERCEIVED RISKS TO LIVELIHOODS OF FOREST BASED COMMUNITIES DUE TO CLIMATE CHANGE AMONG VILLAGERS OF PATALE COMMUNITY FOREST VILLAGE IN LALITPUR DISTRICT IN KATHMANDU VALLEY OF NEPAL

Issue	Mean[a]	Std. D
Decrease access to water supplies	4.41	0.71
Declining crops and livestock's production (food security)	4.09	0.97
Decrease income (forestry)	3.80	1.10
Loss of some local land races crops varieties	3.67	1.19
Decline supply of NTFPs (fuel wood, Medicinal plants etc)	3.58	1.14
Early mature crop, crop failure and reduce agriculture productivity	3.48	1.31
Affect negatively on better marketing opportunities and prices for agricultural and forest products	3.38	1.08
Susceptible to climate induced disaster (flood, landslides and drought)	3.25	1.29
Conflict over natural resources	2.93	1.28
Increase migration of people	2.19	1.04
Severe impacts on infrastructures	2.16	1.06

[a] Rated on a scale of 1 to 5, where 1 = not a threat at all and 5 = a great threat, sample size (n=31) Cronbach's Alpha 0.553

Table II summarizes the responses for the questions about the means of perceived risks to livelihoods of forest-based communities due to climate change in Kathmandu valley in Nepal. Eight statements out of identified eleven issues were rated as risks (M > 3.0) while three were not rated as threats by respondents. *Decrease access to water supplies* was perceived as the greatest risk to livelihoods of forest based communities (4.41), followed by *declining crops and livestock's production (food security)* (4.09), *decrease income (forestry)* (3.80) and *loss of some local land race varieties of crops* (3.67). However, identified three issues such as *conflict over natural resources* (2.93), *increase migration of people* (2.19) and *severe impacts on infrastructures* (2.16) were not rated as threats on forest based communities' livelihoods.

D. Effectiveness of Adaptation Strategies

TABLE III
DISTRIBUTION OF PERCEIVED EFFECTIVE ADAPTATION STRATEGIES RELEVANT TO CLIMATE CHANGE RISK TO FOREST ECO-SYSTEMS AND FOREST BASED COMMUNITIES' LIVELIHOOD AMONG VILLAGERS OF PATALE COMMUNITY FOREST VILLAGE IN LALITPUR DISTRICT IN KATHMANDU VALLEY OF NEPAL

Issue	Mean[a]	Std. D
Reforestation and afforestation	4.54	0.67
Community-based forest fire control	4.38	0.76
Awareness and capacity building of communities	3.93	0.81
Promote rain water harvesting structure and technologies	3.87	1.11
Use improved crop varieties, livestock and fertilizers	3.70	1.07
Use of local knowledge and technologies	3.61	0.98
Conserve, promotion and domestication of NTFPs and medicinal plants	3.38	1.22
Promote agro- forestry (Tree outside forest)	2.93	1.03
Provision of insurance	2.74	1.06
Community adaptation fund	2.70	1.37
Livelihood diversification	2.45	1.05
Increase the use of efficient biomass energy technologies for less fuel wood consumptions	2.25	1.12
Managing biological corridor in Terai and mountains	1.77	0.99

[a] Rated on a scale of 1 to 5, where 1 = not a effective at all and 5 = fully effective, sample size (n=31) Cronbach's Alpha 0.680

The most effective adaptation strategy relevant to climate change risks to forest eco-systems and forest based communities livelihoods in Kathmandu valley in Nepal as perceived by the respondents was *reforestation and afforestation* (4.54), (Table III). *Community-based forest fire control* (4.38) was placed at the second place, while *awareness and capacity building of communities* (3.93) and *promote rain water harvesting structure and technologies* were rated as third and fourth places respectively. *Managing biological corridor in Terai and mountains* (1.77) was perceived as the most least effective strategy. In addition, *community adaptation fund* (2.70), *livelihood diversification* (2.45), and *increase the use of efficient biomass energy technologies for less fuel wood consumptions* (2.25) were rated as less effective adaptation strategies.

E. Challenges and Barriers to Adaptation

TABLE IV
DISTRIBUTION OF PERCEIVED LIMITATIONS FOR ADAPTATION STRATEGIES OF CLIMATE CHANGE AMONG VILLAGERS OF PATALE COMMUNITY FOREST VILLAGE IN LALITPUR DISTRICT IN KATHMANDU VALLEY OF NEPAL

Issue	Mean[a]	Std. D
Lack of public awareness	4.22	0.88
Poverty of people	4.19	0.83
Lack of proper agriculture and forestry extension service	3.80	0.98
Lack of access to credit market	3.29	0.97
Lack of finance, technology and human resource	3.00	1.21
Lack of insurance schemes	2.77	0.92
Weak inter-departmental coordination among government institutes	2.58	1.05
Weak governance system	2.51	1.28
Insufficient and weak coordination among local communities	2.29	1.32
Gender issues	1.74	0.81

[a] Rated on a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, sample size (n=31) Cronbach's Alpha 0.460

Table IV summarizes responses about perceived limitations for climate change adaptation of Kathmandu valley in Nepal. When the respondents were asked, how they felt about main limitations, *lack of public awareness* (4.22) was rated as the most serious barrier for adaptation strategies relevant to climate change effects on forest ecosystem and livelihoods of depending communities on forest. *Poverty of people* (4.19) was placed at the second place followed by *lack of proper agriculture and forestry extension service* (3.80) and *lack of access to credit market* (3.29). However, they did not view *weak governance system* (2.51), *insufficient and weak coordination among local communities* (2.29) and *gender issues* (1.74) as limitations to climate change adaptations which are considered as most challenging issues in most research findings.

F. Determinants of Perceptions of Climate Change

Cronbach's alpha is most commonly used when multiple likert questions are in a survey/questionnaire that forms a scale. It is a measure of internal consistency, that is, how closely related a set of items are as a group [21], [22]. A reliability coefficient of 0.70 or higher is considered acceptable in most social science research environments [23]. The alpha coefficient for the perceived risks to forest & biodiversity due to climate change (Table I) is 0.762, suggesting that the items have relatively high internal consistency. However, perceived risks for livelihoods of forest based-communities due to climate change (Table II), perceived effective adaptation strategies relevant to climate change (Table III) and perceived limitations for climate change adaptation (Table IV) showed low reliability coefficients 0.553, 0.680, and 0.460 respectively. Moreover, the standard deviations for some likert scale questions were relatively high, suggesting greater disagreement among the respondents. According to the correlation analysis, Kendall's tau-*b correlation coefficient was not significant* at the 0.05 significant levels of perceived risks and effective strategies with binary data which represented of gender, membership of environmental organization and office bearer of the organization. However, Pearson's correlation coefficients for education (0.376), household size (- 0.463) and composite knowledge (0.367) were statistically significant with perceived risks to forest & biodiversity. Moreover, all social-cultural variables such as the knowledge indicator (composite knowledge) were statistically insignificant with perceived risks to livelihoods of forest based communities. In addition, perceived effectiveness of adaptation strategies had correlation with household size (-0.531) and education (0.345) at the 0.05 significant levels.

To examine influences on risk perceptions of forest-based communities, perceived risks on forest ecosystem was regressed on knowledge of climate change, and social-cultural variables such as education and household size. According to the results from linear regression, household size ($p = 0.010$) was the only social-cultural variable that showed a consistent relationship with the perceived risks on forest ecosystem. As well an examination of the factors influencing, only household size ($p = 0.005$) was associated with the perceptions of adaptation strategies of climate change.

IV. DISCUSSIONS

These results suggested that every interviewed respondent received information about climate change. According to the [24] reported that only 11.8% of the respondents replied that they have heard about climate change and related issues in Chepang communities in rural mid-hills of Nepal. In addition, Byg & Salick [25] reported similar situation in Tibet where the respondents have never heard the term climate change. According to the another study carried out in Lumale and Ghandruk villages of Kaski district in Nepal with regard to farmer's perceptions, Bhusal [26] reported that the most of the respondents were not aware about climate change instead they understand only rainfall and warming system. Moreover, respondents were totally unaware about changing climate and its impacts.

However, revealed results from Patale community is completely different from above mentioned studies. All respondents were members of Patale CFUG and residents of semi-urban area of Kathmandu city. When consider the perception risks on forest ecosystem, since 1970, Patale forest has been degrading gradually due to anthropogenic pressure. However, the situation was worsen in 1985, this forest faced the incident of big forest fire resulting complete loss of vegetation wildlife and converting forest into a denuded hill due to anthropogenic activities. After that forest fires were recorded regular intervals according to the data from CFUG records. Villagers deem that climate change could drive the natural forest fire rhythm out of control owing to large declining trends of pre-monsoon and monsoon precipitation and significant warming, particularly at Kathmandu valley. Due to this fire threat, forest is divided into six blocks, all of which include a fire line to protect from forest fires. This is the reason that villagers perceived *increase forest fire* as the greatest risk to forest ecosystem due to climate change.

The respondents revealed that the changing of flowering and fruiting of existing trees in forest due to climate change indirectly affects livelihood of communities by means of altering collections of wild edible fruits and vegetables. It was negatively affected to price of item. This leads to seasonal change in forest which was placed at the second place.

When consider the recent past studies in Nepal with regard to perceptions of climate change risk impacts on forest ecosystem, according to the another research the high Himalayas [27], it is reported that the community perceived *loss of native species* and *decrease soil fertility* as high-risk impacts while *new invasive species* as medium risk impact due to climate change. According to the another study [28] in Thotne Khola community forest in Kaski district of Pokhara, reported that community perceived about *generating new pest and disease* as well as *distribution of invasive plant species* as low risk impacts relevant to climate change. Above mentioned results are similar to those reported by present study done in Patale community forest in Nepal. However, other study in Nepal also reported that the most respondents perceived *new plant species seen* as very high-risk impact result of climate change.

In other studies with regard to perceived risks to livelihoods of forest-based communities due to climate change, there are also significant proportions of the respondents perceived *decreasing of water source and availability* as the greatest risk for livelihoods of communities in Nepal. This result is very similar to Patale communities perceptions with regard to climate change induce impacts on livelihoods of communities. Consequence of erratic weather pattern, water sources also disappeared and people of Patale village faced the problem of having to walk 8-10 hours even to transport a single jar of water. Hence, communities have ranked this as a huge problem for their livelihoods. However, revealed result is in contradiction with the findings of Bhusal and Maharaj et al. where it is reported that *increasing of incidents of drought* as a severe impact. Table III represented about adaptation strategies, general people perceived proposed establishment of biological corridor between Terai and mountains in as less effective adaptation strategies. It is contradiction with biologist aspiration in Nepal.

In other ways, results relevant to adaptation strategies are broadly similar to those observed in other studies. For example, reforestation is a key component of the National Climate Change Strategy in Costa Rica, which may also contribute to the perception of the importance of forests for climate change [29]. Furthermore, increasing forest cover is also perceived by respondents as a key mechanism for promoting cost-effective carbon banking which mitigates greenhouse gas emissions, while providing local populations with an array of products that help them to adapt the climate change. During the transect appraisal exercise in preparation of National Adaptation Plan for Action (NAPA) for identifying perceptions of climatic hazards and climatic change, *community based forest fire control* was ranked as the most priority adaptation option for forest and biodiversity protection. Therefore, revealed result is more similar to NAPA revealed. Most of research findings have been reported significant of *livelihood diversification* in climate change adaptations [30]. However, Patale community did not perceive it as effective adaptation strategy.

Awareness of climate change and the direct involvement of communities in workshops, meetings, and activities where the identification of adaptation options is conducted is a key pillar in responding to climate change risks [31]. Therefore, it is essential to investing in raising public awareness on issues of climate change. As, it is perceived the greatest limitation by Patale communities for adaptation due to limited communication channels and the lack of materials available in the requisite local languages as well as low literacy rate of Nepal (53%).

Another research [32] showed that adaptation practices to climate change in Himalaya to Terai regions of Nepal is significantly limited by poverty and livelihood shock. These findings reinforced the findings of present study. The influence on perceived risk does not show a clear pattern. According to the results, unexplained part (error term) was very high. This was caused by omitted variable bias, low data availability, and data quality. Moreover, statistical significance is largely influenced by sample size. Hence, this was affected to receive inconsistent associations on different perceptions scenarios in current study. In addition, recent studies showed that environmental value orientation, subdivided as bio-centric and anthropocentric orientation have been found to be instrumental in people's assessment and response to environmental risk [33], [34] and preferences for natural resource management. Furthermore, value orientation had been a greater effect on risk perceptions than knowledge or social-cultural factors. Hence, omitting of this variable is due to time constraints may be affected greatly on revealed results.

V. Conclusion

The outcome of analysis suggest, in contradictory to the general belief and other research findings, that a majority of people who live in villages adjacent to forests in the Patale maintain high level of awareness and knowledge with regard to climate change concept and related issues. In addition, the results also prove that despite the relatively low level of formal education received by respondents, they possess a sufficient knowledge on various aspects related climate change.

While accepting that outbreak of insect calamities and disease, distribution of new invasive alien species etc. can impose a risk to forest and biodiversity, there was a common perception that the damages caused by increase forest fire and seasonal changes (delay/early flowering and fruiting) were the greatest risk to forest ecosystem. Likewise affect negatively on better marketing opportunities and prices for agricultural and forest products, and early mature crop, crop failure and reduce agriculture productivity were accepted as general risks to livelihoods of forest-based communities while decrease access to water supplies and declining crops and livestock's production were considered as severe threat on livelihoods.

Increasing forest cover is also perceived as a key adaptation strategy among the most effective adaptation strategies rated by members of CFUGs while followed by community involvement in forest fire prevention, control and management. Moreover, constraints faced in the implementation of adaptation strategies with regard to climate change, lack of public awareness and widespread poverty were acknowledged as the most limitations.

Results did not provide consistent relationships between perceptions of risk on forest ecosystem, forest-based communities as well as effective adaptation strategies with cognition and social-cultural variables even within same sample. Moreover, household size is the only significant determinants of perceived risks on forest ecosystem as well as perceptions of adaptation strategies of climate change. It may be due to small sample size, interview process etc. The respondents in current survey also perceived the effects of climate change on forest ecosystem and communities different from policy makers and forest managers. Although, there are some similarities as well as dissimilarities of respondent's thinking irrespective to location of studies.

Ultimately, this study provides some preliminary information on the perceptions of public about the risk to forest ecosystems and forest-based communities posed by climate change as well as adaptation strategies and barriers for implementation. Also, study revealed negative association between household size with perceived risks on forest ecosystem and perceptions of adaptation strategies of climate change. It gives useful insight to both policymakers for formulating suitable sector programs and interventions. Also, this information is useful for scientists, researchers and policy makers to design and implement appropriate adaptation strategies for climate change in Nepal that is especially vulnerable.

However, this study was limited to a small sample of forest-based communities primarily from Kathmandu valley in Nepal. To determine if these results are representative of a larger population, the study should be repeated with forest-based communities from other areas in Nepal. Also, value-orientation as well as the risk perceptions of outsiders to the forests (i.e. urban communities) who may be presumed to possess anthropometric value orientation towards a climate change should also be taken into account.

REFERENCES

[1] Climate change 2007, "Synthesis Report Contribution of Working Group 1,11 and 111 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Core Writing team, Pachauri, R. K and Reisinger, A.(eds), Intergovernmental Panel on Climate Change, Geneva.

[2] T. B. Williamson, D. T. Price, J. L. Beverly, P. M. Bothwell, J. R. Parkins, M. N. Patriquin, C.V. Pearce, R.C. Stedman and W.J.A. Volney, "A framework for assessing vulnerability of forest-based communities to climate change" *Information report nor-X-414*. Northern Forestry Centre, Canadian Forest Service, Edmonton, Alberta, 2007.

[3] FAO,"Nepal forestry outlook study", *Working Paper No. APFSOS II/WP/2009/05*, Food and Agriculture Organization, Rome, 2009.

[4] D. J. Davidson, T. B.Williamson, and J. R. Parkins, "Understanding climate change risk and vulnerability in northern forest-based communities", *Canadian Journal* of Forest *Research*, 2003, vol. 33, pp. 2252–2261.

[5] W. Leiss, "In the chamber of risks", McGill-Queen's University Press, Montreal, Quebec, 2001.

[6] DFRS, "Forest resources of Nepal (1987-1998)", Department of Forest Research and Survey, Kathmandu, 1999.

[7] A. Rajal, "Climate change mitigation in the forestry sector of Nepal", United National Development Program, Nepal, 2010.

[8] UNDP, "Nepal Human Development Report 2009", United National Development Programme, Nepal, 2009.

[9] Ministry of Environment"National Adaptation Program of Action to Climate Change", Kathmandu, Nepal, 2010.

[10] World Wide Fund, Climate Change: a global concern impacting Nepal, Kathmandu,Nepal,2012,http://www.wwfnepal.org/about_wwf/conservation_nepal/shl/ thematic_solutions_nepal2/climate_change_nepal/, 09, December 2012.

[11] J.J. McCarthy, O. F. Canziani, N.A. Leary, D. J. Dokken and K.S. White, "Climate change 2001: impacts, adaptation and vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change", Cambridge Univ. Press, Cambridge, 2001.

[12] B. Regmi and A. Adhikari, "Climate change and human development - risk and vulnerability in a warming world", *Human Development Report 2007/2008*, Country Case Study – Nepal, 2007.

[13] S. Harmeling, "Global Climate Risk Index 2012", *Briefing paper*, Germanwatch, Germany, 2011, http://www.germanywatch.org/cri , 29 November 2012.

[14] S. Adhikari, "Community Forestry in Nepal, Ministry of Forests and Soil Conservation", Nepal, 2011, http://satoyama-initiative.org/en/case_studies-2/area_asia-2/community-forestry-in-nepal-shankar-adhikari-forest-officer-district-forest-office-lalitpur-nepal/, 14 December 2012.

[15] T.B. Williamson, J.R. Parkins, and B.L. Mcfarlane, "Perceptions of climate change risk to forest ecosystems and forest-based communities", *Forestry Chronicle*, 2005, vol. 81, pp 710–716.

[16] B. L. McFarlane, "Public perceptions of risk to forest biodiversity", *Risk Analysis*, 2005, vol, 25(3), pp. 543-553.

[17] S. J. Colombo, "How OMNR Staff Perceive Risks Related to Climate Change and Forests". *Climate change research information note 2*,pp. 1-8, 2006.

[18] N. R. P. Withana and U. K. Jayasinghe-Mudalige, "Assessing the public perceptions towards risk to biodiversity of dry zone forests in the Anuradhapura District", *The Sri Lanka Forester*, 2007/2008, vol. 30&31, pp. 49-61.

[19] M. R. Guariguata, B. Locatelli and F. Haupt, "Adapting tropical production forests to global climate change: risk perceptions and actions", *International forestry Review*, 2012, vol. 14(1), pp.27-37.

[20] E. G. Carmines and R. A. Zeller," Reliability and validity assessment", Beverly Hills, CA: Sage Publications, 1979.

[21] D. George and P. Mallery, "SPSS for Windows step by step: A simple guide and reference", 11.0 update (4th ed.), Allyn & Bacon: Boston, 2003.

[22] J. M. Cortina, "What is coefficient alpha? An examination of theory and applications". *Applied Psychology*, 1993, vol.78, pp.98–104.

[23] J. W. Creswell, "Educational research: Planning, conducting, and evaluating quantitative and qualitative research", Upper Saddle River, NJ: Prentice Hall, 2002.

[24] L. Piya, K. L. Maharjan and N. P. Joshi, "Perceptions and Realities of Climate Change among the Chepang Communities in Rural Mid-Hills of Nepal". *Journal of Contemporary India Studies: Space and Society*, 2012, vol. 2, pp. 35-50.

[25] A. Byg and J. Salick, "Local perspectives on a global phenomenon - Climate change in Eastern Tibetan villages", *Global Environment Change*, 2009, vol, 19, pp.156-166.

[26] Y. R. Bhusal, Local Peoples' Perceptions on Climate Change, Its Impacts and Adaptation Measures in Mid-Mountain Region of Nepal (A Case study from Kaski District), B.Sc. Forestry Research Thesis Submitted to Tribhubhan University, Institute of Forestry, Pokhara, Nepal, 2009.

[27] S. K. Maharjan, E. R. Sigdel, B. R. Sthapit and B. R. Regmi, "Tharu community's perception on climate changes and their adaptive initiations to withstand its impacts in Western Terai of Nepal", *International NGO Journal*, 2011, vol, 6(2), pp. 35-42.

[28] A. Mohammed, "Attitude and Adaptations to Climate Change: A Case Study from Community Forest User Group, Nepal", MSc, Forestry

Research Thesis Submitted to Dresden University, Institute for International Forestry and Forest Products, 2011.

[29] R. Vignola, S. Klinsky, J. Tam and T. McDaniels, "Public perception, knowledge and policy support for mitigation and adaption to Climate Change in Costa Rica: Comparisons with North American and European studies", *Mitigation and Adaptation Strategies for Global Change*, 2005,vol, 10, pp.1-23.

[30] A. Newsham and D. Thomas, "Agricultural adaptation, local knowledge and livelihoods diversification in North-Central Namibia", *Tyndall Centre Working Paper* 140, 2009.

[31] WB, "Vulnerability, Risk Reduction, and Adaptation to Climate Change, Climate Risk and Adaptation Country Profile, Nepal", World Bank Climate Change Knowledge, The World Bank, Washington, D.C, 2011, http://sdwebx.worldbank.org, 02 May 2013.

[32] K. R. Tiwari, K. D. Awasthi, M. K. Balla, and B. K. Sitaula," Local people's perception on climate change, its impact and adaptation practices in Himalaya to Terai regions of Nepal", Nepal Study Center, *Himalayan Research papers Archive*, 2010, The University of New Mexico. http://repository.unm.edu/bitstream/handle/1928/11324, 19 December 2012.

[33] R.E. O'Connor, R.J. Bord, and A. Fisher, "Risk perceptions, general environmental beliefs, and willingness to address climate change", *Risk Analysis*, 1999, vol, 19, pp. 461–471.

[34] R.C. Stedman, D. Davidson and A. Wellstead, "Risk and climate change: Perceptions of key policy actors in Canada", *Risk Analysis*, 2004,*v*ol, 24(5), pp.1393–1404.