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Evaluating climate change resilience capacity of community forests users in Terhathum districts, Nepal

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ABSTRACT

Nepal is implementing the national adaptation programme of action (NAPA) through local adaptation plan of action (LAPA) to address issues of climate change. Therefore, this research was objectively carried out to explore the climate change impacts and

susceptibility of community forest users and assess and compare their resilience capacity. Three community forests and users namely Dhangere Pakha, Saleri and Pathibhara of Terhathum district, Nepal were selected for the study. The stratified random sampling was used to gather the data applying randomized block experimental design (RBD). Altogether, ninety two households were interviewed. In addition, nine meetings, three field observations and four workshops were done to list out impacts of climate change and rank them. Besides, interactions were carried out to find the availability of human, social, financial, natural and institutional capacity and assess its susceptibility, resilience capacity and effectiveness. The vulnerability scoring was assessed using Likert scale. Statistically available resources and resilience capacity of users of community forests were assessed and then compared applying Kruskal Wallis and Mann- Whitney U test. The major climate change impacts like drought, invasion of *Lantana camara* and drying water sources were listed and ranked as 1st, 2nd and 3rd respectively. The resilience capacity was scored 4 to control fire, medium nearly 1.33 to 2.67 to manage water and it was the least to fight against invasion of *Lantana camara* only 0.67. The statistical tests showed that there were no significant differences in livelihood resources among and between the users at 5 % level of significant.

Key words: climate change, efficacy, capacity, vulnerability

1. INTRODUCTION

The conferences of the parties are interested to achieve the global goal to maintain the average temperature below 2 ^{0}C in this century (IPCC, 2014). The message is clear to ensure the climate smart sustainable development (Schelling, 1992) in developing countries. However, the increasing trend of temperature and varying rainfall are challenging issues. The consequences are serious damages at local, subnational, national, regional and international level. Thus, the long-term global policies and local practices are needed to conserve ecosystems, to reduce the impacts of climate change and promote the livelihoods of vulnerable people (Roy and Hossain, 2015). The climate change adaptation efforts are essential since the developing countries are the most susceptible to climate change. The efforts will help to cope against the climate change impacts (Suarez and Jennifer, 2015). Therefore, most of the parties are implementing the national adaptation programme of action (NAPA).

Agriculture practice is the main occupation of rural people in Nepal. However, this occupation is in threat these days because of several causes. One of the important causes is impacts of climate change (Kasahun Kitila Hunde, 2015). Then questions rose in our mind that; will agriculture production be able to feed additional 2, 3, or 4 billion people? Will it be possible to produce plenty of crops for 8 to 10 billion people? In fact, increasing issues of droughts causes the crop damage and creates great problems in farming system generally in Africa and Asia (Afunmilayo, 2016; Ale et al. 2016). The population increase recorded by 60 % in Asia but the cultivation land increased only by 21 % (i.e. from 355 to 430 million hectares) in between 1980 to 2010 (Alexandratos and Bruinsma, 2012). Besides, the lowest projection scenario showed that the population may increase by 50 % while the highest projection predicted that it might be double by 2030 of 1990's level. The population increase may be more than 95 % in developing countries. In this context, the gross domestic product (GDP) might be high 3.5 times of 1990's level or 15 times of 1950's level. Globally, average available land is 0.26 ha per person while it is only 0.16 ha in Asia (FAO, 2011). Nepal's population was 26,494,504 in 2011 but the growth rate was 1.35 % in between 2001 to 2011. However, only 20% land was cultivable in Nepal (CBS, 2011). Prominently, the World Food Summit had target to halve the number of undernourished population by 2015 of 1990's level since

about 925 million people recorded hungry in the world (FAO, 2011). Most of the population of Africa and Asia are undernourished and about 25 % population was under the poverty line in Nepal (NPC, 2015).

The climate change is one of serious calamity generally for ultra poor citizens in poor countries like Nepal. So the secure and sincere climate policies are compulsory needed. The deprived people especially living at river bank have been facing the composite catastrophe especially high risk of drought. Besides, Nepal's fragile hilly terrain and its structure favor such risky disaster. Annually, poor people are dreadfully afraid of flood, erosion, drought and landslides which kill dozen of people and damage millions of wealth. So, the climate change adaptation measures specifically national adaptation programme of action (NAPA) is national priority. Moreover local adaptation plan of action (LAPA) is the major component of NAPA framework at local level. Obviously, evaluation of climate change impacts and efficacy of adaptation measures at local level are current demanding research. Though, the research work associated with these issues is considerably noteworthy, it is uncovered by the scientific community in Nepal. Therefore this study was objectively carried out to assess the climate change impacts, its vulnerability level in community forests users as well as evaluate the coping and adaptation strategies and its effectiveness.

2. MATERIALS AND METHODS

2.1. Study area description

This study was done in Terhathum district which is situated at 27° 7' 0" N and 87° 32' 0" E and the altitude ranges from 354 to 2963 m. Maximum temperature recorded between 12 to 21 ^{0}C and minimum temperature varies from 5 to 12 ^{0}C. Similarly, average rainfall record shows 120 mm in July. Out of 322 community forest users the three were randomly selected for the study. They were Dhangere Pakha, Pathibhara, and Saleri community forest users (Fig. 1).

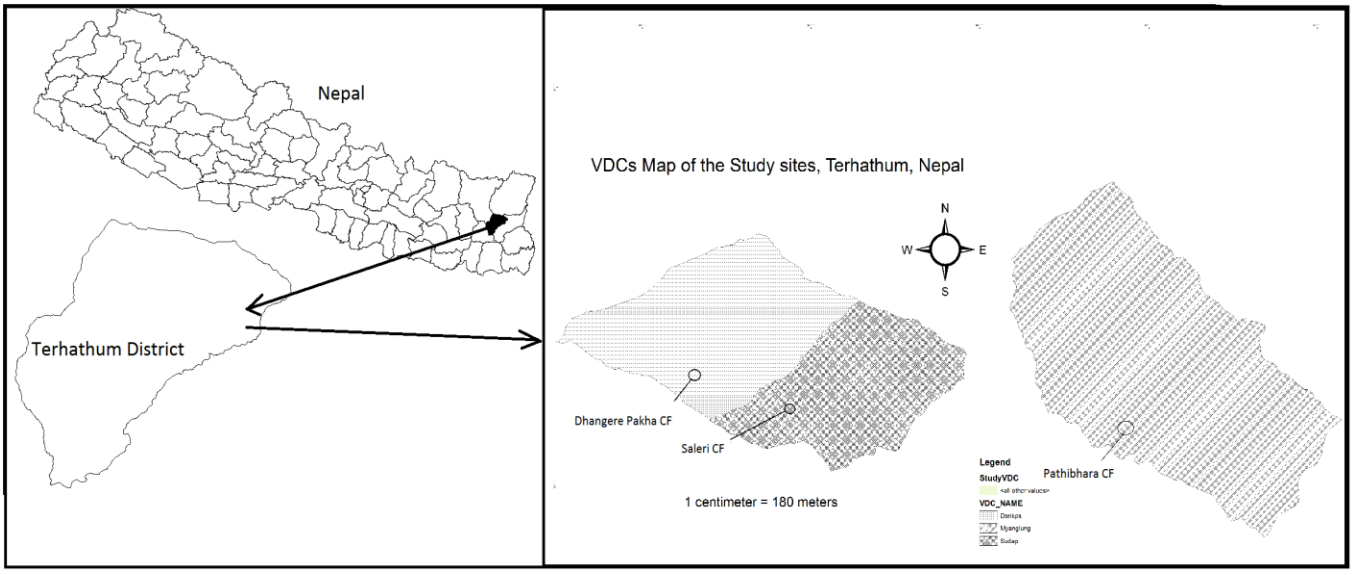

Figure 1 Map of the research sites

Altogether 420 households were the users of the community forests. There are one hundred sixteen households in Dhangere Pakha community forest (D CF). This community forest is about 9.5 ha and users group belong to ward no 8 of Sudap village development committee. In addition, there were one hundred thirteen households in Saleri community forest (S CF) and they are living at ward number 1,2,3 and 5 of Dangpa village development committee. The forest area is 50.73 ha. Moreover around one

hundred ninety one households were managing Pathibhara community forest (P CF) which is situated near to headquarter of this district. These all sites are very dry where *Pinus roxburghii* is very common species. In addition, *Alnus nepalensis* and *Bambusa balcooa* are generally found in moist sites of the community forest.

2.2. Experimental design and sampling

The randomized block design (RBD) was set as an experimental design hence stratified random sampling was applied to gather the samples (Gupta and Kapoor, 1984). Total users of the community forest were listed and they were categorized into rich, medium and poor strata based on set criteria of well being ranking like areas of land owned, roof of their house, annual income, number and types of cattle keeping, crop available for food (Augusta Ayotamuno and Akuro Ephraim Gobo, 2016). Next, about 20 % households were selected randomly to carry out household survey. The check list was prepared for household survey and it was tested before field work. Altogether, 92 households were interviewed specifically 32, 23 and 38 households from Dhangere Pakha, Saleri and Pathibhara community forest users group (CFUG) respectively. Meanwhile, 9 meetings, three field observations and four workshops and several interactions were also done to collect the field data.

2.3. Data collection

The data collection process was started with household survey. The survey was emphasized on to list out the climate change impacts. Next, the impacts were ranked and vulnerability contexts were scored. Additionally, meeting and workshop were organized to find the availability of human, social, financial, natural and institutional capacity of the local people to cope against the climate change impacts. Meanwhile, susceptible areas, resilience capacity of users and effectiveness of the adaptation measures at local level were also identified. Besides, researchers observed research areas to record the impacts and condition of natural resources.

2.4. Data Analysis

Collected data were organized to list the climate change impacts. Then the Likert scale was used to show the magnitude of potential damage due to climate change. In fact, the answers were very high and high, medium, low and very low damage so the scores were assigned 5, 4, 3, 2, and 1 respectively for these categories. Moreover the analysis also covered to find the frequency of impacts and number of affected sites. Finally, they were summed to show the vulnerability score of each impact (formula i). Subsequently, average resilience capacity was also estimated (formula ii). In the mean time availability of human, social, financial, natural and institutional capacity were analyzed and scored like 4, 3, 2 and1for the very high, high, medium and low capacity respectively.

Formula i. Vulnerability score = Frequency + Number of affected areas × Potential Damage Magnitude

Formula ii. Average resilience capacity = Availability of (economic resources+ human capital + social and institutional capacity) / 3
(This tool was first time used by Regmi et al., 2010 for climate change adaptation assessment in Livelihood and Forestry Programme in Nepal)

2.5. Statistical comparison

The Kolmogorov-Smirnov and Shapiro-Wilk tests were applied to evaluate the normality of the data set regarding the economic resource, human capital and social and institutional and average capacity to cope against the climate change impacts. The data sets

were not normal; hence the Kruskal Wallis and Mann- Whitney U test were applied to compare the available resources and capacity of the users group of community forests (Gupta and Kapoor, 1984).

3. RESULTS

The analysis showed that impacts of climate change, vulnerability level of impacts and coping and adaptation strategies and its effectiveness were differed in the community forests and users.

3.1. Climate change impacts at local level

Many impacts were listed at local level. Some of them are listed in table 1. They are i. damage due to insects and pest, ii. biological invasion and colonization of *Lantana camara*, iii. drying of water sources, iv. drought, v. forest fire, vi. flood, vii. snowfall, viii. earthquake and ix. diseases.

3.1.1. Insects and pest

The growth of *Alnus nepalensis* and *Bambusa balcooa* was affected due to insects and pest in the forest in summer season. Local people noticed the effect of insects and pests on the plants in the community forest since 2009 in these sites. Particularly, larvae of *Zezera species* (Cossid moth) has been damaging growing staged plant *Alnus nepalensis*. Moreover, cotton-like deposits which are larvae of *Balanococcus kwoni* (meal bugs) killed the bamboo.

3.1.2. Invasion and colonization of Lantana camara

The local people shared that *Lantana camara* was not found 12/13 years ago in these areas. Specifically, invasive species like *Eupatorium odoratum* and *Ageratina adenophora* have been infesting these areas and the situation is more panic these days. Another alien species is *Lantana camara* which is aggressively spreading in open sites creating many problems. The *Lantana camara* hinders the regeneration process of other plants impeding the seeds to reach in soil. Though all three invaders have been creating the extra burden for the local people, *Lantana camara* is more problematic for local people because it is difficult to control. Every year, farmers have been paying huge money for labours, and resources to control this species mechanically. The invasion of *Lntana camara* was ranked 2nd by users of Pathibhara and Dhangere Pakha community forests but this was ranked 3rd by the users of Saleri community forest (Table 1).

3.1.3. Dried water source

There were four water sources in Pathibhara community forest which were completely dried since 2008. In addition, three water sources were dried in each Dhangere Pakha and Saleri community forests and villages since 2009. The effect was so serious that the people used to fetch the water from 4-5 kilometers distant and also reduce the number of cattle. These days, the government managed to supply the drinking water for local people but it is still problem for keeping cattle.

3.1.4. Drought

This is challenging issue in the community forests and for users as well. In fact, drought was experienced four times more since 2000 so the users have shifted their cropping system. Noticeably, the drought was so serious in 1983 that the government of Nepal used helicopter for food supply. Continuous droughts affect the production of paddy and maize so they buy food materials like rice, flour

and vegetable from the market. Importantly, sometimes dying of seedling and sapling was also observed. Besides, users have been worried seriously about the pest in soil since 2013 so they ranked it in first position.

3.1.5. Forest fire

Community forest users are active to manage the forests so this is not big problem here. The fire damaged seedling and saplings in the forest three years ago but users, Nepal army and staff of district forest office controlled it timely.

3.1.6. Flood

it is not serious these days because of less frequency and intensity of rainfall. The damage of landslide in 1969 was unbelievable for the local users because they lost their wealth and cattle. The bridge, path and their paddy fields were damaged and houses were destroyed. Other effect of landslide was reported in 2012 but it was not so harmful for local community.

3.1.7. Snowfall

This was once recorded in 1965 but there is no any sign of snowfall again.

3.1.8. Earthquake

The local people shared that several houses were damaged and many cattle were killed because of earthquake in 1990 but there was no record of human casualty.

3.1.9. Diseases in animals

Dystocia disease is very common in buffalo and cow these days. Similarly goats have been facing complication of diarrhea.

3.1.10. Other

Sometimes monkeys destroyed the crops and vegetables in the farmers' field. The highest damage was recorded in 2013.

Table 1 Ranking of impacts and their affected areas

Impacts	Affected areas	Impacts ranking by CFUG		
		Pathibhara	Dhangere Pakha	Saleri
Insects/ pests	Disease in *Alnus nepalensis* and *Bambusa balcooa*	4th	5th	5th
Invasion of *Lantana Camara*	Other species are affected and locally lost Additional labour to clear the farm Grasses are affected Open areas are covered	2nd	2nd	3rd
Dried water source	Walked 4/5 km to fetch the water No Irrigation and low yield	3rd	3rd	2nd
Drought	Drying of forest plants Low yield of paddy and maize	1st	1st	1st

	Pests in soil			
Fire	Damage the small plants and grasses	5th	4th	4th
Snow fall	Damage the paddy	8th	8th	8th
Flood	Damage in forest	6th	9th	9th
Earth quake	Damage health and wealth	10th	10th	10th
Disease	Disease in buffalo/cow/goat/chick	7th	7th	7th
	Disease in wild animals/birds			
Others	Monkeys damaged the crops and vegetables	9th	6th	6th

3.2. Vulnerability level of impacts of climate change in community forests and users

The level of vulnerability of different climate change impacts was differed in the community forests and to users. Specifically, the vulnerability score showed that it was the highest impacts of invasion of *Lantana camara* with 13 in Saleri community forest which scored about 12 in Dhangere Pakha community forest. After that, it was scored 12 for damage caused by insects/pests in Saleri community forest and same score was for harm due to drought in Dhangere Pakaha community forest. So, the most vulnerable impact was because of invasion of *Lantana camara* and second and third impacts were due to effects of drought and insects and pests respectively (Table 2).

Table 2 Vulnerability score of impacts o climate change

Local impacts	Frequency			Number of affected area			Magnitude of potential damage			Vulnerability score		
	P. CF	D. CF	S. CF	P. CF	D. CF	S. CF	P. CF	D. CF	S. CF	P. CF	D. CF	S. CF
Insects and pests	4	3	4	5	3	4	3	3	4	12	9	12
Invasion of *Lantana Camara*	5	4	5	3	4	4	3	4	4	11	12	13
Dried water source	5	4	4	4	3	3	4	3	3	13	10	10
Drought	3	4	3	4	4	3	3	4	3	10	12	9
Fire	1	1	1	1	1	1	1	1	1	3	3	3
Snow fall	1	1	1	1	1	1	1	1	1	3	3	3
Flood	1	1	1	2	2	2	1	1	1	4	4	4
Earth quake	1	1	1	1	1	1	1	1	1	3	3	3
Disease	1	1	1	2	2	2	1	1	1	4	4	4
Others	1	1	1	1	1	1	1	1	1	3	3	3

3.3. Resilience capacity and effectiveness of important impacts

The overall resilience capacity of community forest users was not significantly differed. The overall resilience capacity ranges from 1.4 to 1.8. The users have the highest resilience capacity to control forest fire with score 4 while the lowest was against each insects and pests as well as invasion of *Lantana camara* with score 0.67. Besides, the capacity was also low only 1.67 to fight against the effects of drought. The reason behind this was, users were active and aware about the fire control but the insect pests and invasion of *Lantana camara* were out of their control.

Table 3 Vulnerability Matrix and Average Resilience Capacity

Hazard context	Community forests user group	Types of livelihood resources available to cope with impacts (1 –4)			Average resilience capacity
		Availability of economic resources	Availability of human capital	Availability of social and institutional capacity	
Insects and pests	P. CFUG	0	1	1	0.67
	D. CFUG	0	1	1	0.67
	S. CFUG	0	2	1	1
Invasion of	P. CFUG	0	1	1	0.67
Lantana camara	D. CFUG	0	1	1	0.67
	S. CFUG	0	1	1	0.67
Dried water	P. CFUG	3	2	3	2.67
source	D. CFUG	2	1	1	1.33
	S. CFUG	2	1	2	1.67
Drought	P. CFUG	1	1	2	1.33
	D. CFUG	1	1	1	1
	S. CFUG	1	1	1	1
Fire	P. CFUG	4	4	4	4
	D. CFUG	4	4	4	4
	S. CFUG	4	4	2	3.33
Overall Average	P. CFUG	1.60	1.80	2.20	1.87
resilience	D. CFUG	1.40	1.60	1.60	1.53
capacity	S. CFUG	1.40	1.80	1.40	1.53

Note: Snow fall, flood, earth quake, disease and others were not so serious climate change impacts for users of these communities so they are not presented in the above table.

3.4. Statistical analysis of resilience capacity of users group of community forests

The hypothesis was set to show whether there were differences in resilience capacity of users of these community forests. Since the data were not normal the Kruskal Wallis and Mann-Whitney U test were applied. These tests showed that there were no significant

differences in livelihood resources available to cope against climate change among and between the users of community forests at 5 % level of significant (Table 4).

Table 4 Comparison of resources available to users of community forests

Types of Livelihood resource available to cope with climate change	Significance (P-value) value of applied statistical tests		Decision
	Kruskal Wallis	Mann- Whitney U test	
Economic resource	0.99	Unable to compare	No significant differences at 5 % level of significance
Human capital	0.82		
Social and Institutional capital	0.49		
Overall capacity	0.93		

3.5. Coping and Adaptation Strategies and its effectiveness

The effectiveness of strategy against climate change impacts was not same among users of all community forests. Average effectiveness of strategy of Pathibhara community forest users was the highest about 2.89 but it was the lowest about 2.44 in Dhangere Pakha community forest users. In most of the context the effectiveness of the coping strategies was higher than the average level in Pathibhara community forest. For instance, it was about 4 points for efficacy of user to climate change adaptation measures in order to face the disease in goats in Pathibhara community forest; it was due to availability of good veterinary facility. The effectiveness of strategy also depends on the available supports of different institutions like community forest users, federation of community forest users, Nepal, district forest office, soil conservation office, irrigation office, administration office, development office, veterinary office, development office, Myanglung municipality and Multi Stakeholder Forestry Programme (MSFP).

Table 4 Efficacy of community forest users

Hazard context	Impacts	Coping and adaptation strategies (capability in terms of physical, economic and social assets)	Efficacy of user to climate change adaptation measures		
			P. CF	D. CF	S. CF
Insects and pests	Attack in *Alnus nepalensis* and *Bambusa balcooa*	Find the best solutions	3	3	2
		Find and Plant the adaptive species	2	3	3
Invasion of *Lantana camara*	Damaging plants and reduce crop yield	Remove *Lantana camara*	2	2	1
	Open area covered	Plant the big sized plants and do not leave fallow land	3	3	3
	Disease in goats	Keep goats away	4	3	3
Water source dry	Used to fetch water from distant	Used alternatives (tap water)	3	3	3
	Reduce cattle				

Drought	Leave cattle keeping	Adopting rainwater harvesting	3	2	3
	Low yield of paddy and maize	Adopting the millet farming	3	2	2
Fire	Forest seedling damage	Adopting the warning system action immediately	3	2	2
Average Effectiveness			2.89	2.56	2.44

4. DISCUSSION

4.1. Climate change impacts

The climate change has detrimental impact especially on crop production systems and cattle keeping. The most victims were the poor citizens because of less access to the natural assets. The poor communities are living at the bank of the rivers where the risk is extremely high because they have no safe land to live (Richard et al, 2013). In addition, the drought is also great problems these days in the world. For examples, about 2.5 million people migrate from mid-west of United States to California because of serious drought (Reuveny 2008).

Though, hilly terrain has high geographical value in Nepal, this area is more vulnerable to climate change impacts. At the same time biological invasion has been noticed harmful. So, both climate change impacts and biological invasion are serious problems in Nepal. The flood and drought are serious problems in mountainous terrain like Nepal (Nathan, 2008). These events were also noticed in the community forests and by the users. In addition, *Lantana camara* has been observed in and around the community forests which destroys aggressively the natural habitats of native flora and fauna (Sarah and Carol, 2000, Sankaran, 2011; Ashwini A Waoo et al. 2015).

The community based adaptation practices have been significance for development efforts (Hickey and Mohan, 2004; Wamsler, 2015). Though poor community and nation mostly affected due to climate change impacts (O'Brien et al., 2008), there are many community based practices as well to combat against these impacts. This idea was also supported by Riziki (2011) who strongly justified that participatory adaptation strategies are effective than any other practices. The community forest users of Pathibhara, Dhangere Pakha and Saleri community forests have good experience to work in group adopting the traditional practices. However, the vulnerability level associated with the impacts of climate change affects the users unanimously.

The vulnerability level of impacts depends up on the frequency of climatic events, number and areas of potential damage so these are used as the main indicators of vulnerability level of climate change impacts. Besides, vulnerability level also differed according to the local level impacts (Ader, 2006). Thus, the Marshall and Picou (2008) emphasized that local adaptation and disaster risk management practices are useful tool against the climate change impacts.

4.2. Resilience capacity of the community

The resilience capacity of social and institutional capacity was higher than the average resilience capacity of users of Pathibhara community forest. There was lower resilience capacity of users of both Dhangere Pakha and Saleri community forests with score 1.53 while this was 1.87 to the users of Pathibhara community forest. Indeed, Pathibhara community forest users have high access to the government and non government organizations because the users are very close to the district head quarter. Some users are employee in these organizations. These are the major advantages to pool the resource to address the climate change impacts. However, the resilience capacity depends up on the socio-demographic conditions, economics status of the people, use of natural

resource, governance and policy (Manyena, 2006, Malone, 2009). The insect and pests (Linker and Barbercheck, 2009) as well as biological invasions are serious problem these days (Vitousek et al., 1997, Suarez Andrew and Tsutsui 2008). The socio economic status and dependency to use natural resources are varied among users so their resilience capacity obviously differed.

4.3. Efficacy of users group in community forests

The diffusion theory is effectively working as a decision making process tool in community participation (Reed et al., 2013). Same theory is applied in climate change adaptation at local level too. There is a good connection of this theory with the working mechanism of community forest users in Nepal. According to forest act and regulation, community forest users group is an autonomous organization where the users raise the issues, put their views and decide to act accordingly. This is democratic exercise in community forest users (MoFSC, 1992, MoFSC, 1994). They learn by interaction and fusion which is translated among them. However, the adaptation capacity, resource availability and enabling environment effectively work to manage the issues of climate change. So, the efficacy is differed among the users of the community forests.

5. CONCLUSION AND RECOMMENDATIONS

Increasing level of damage due to insects and pest, invasion and colonization of *Lantana camara*, drying of water resources, drought, forest fire, flood, snowfall, earthquake and diseases are the major problems of community forest users. Average resilience capacity and efficacy to climate change adaptation measures were differed among the users.

However, intensive research is needed on climate change adaptation measures which may contribute to design quality planning at local level. Moreover, the effectiveness of the resource availability tool should be tested while dealing with the climate change adaptation.

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REFERENCES

1. Ale AB, Okogbue EC, Alfred SDY. Information needs of extension agents in climate change management. Climate Change, 2016, 2(6), 110-119
2. Alexandratos N. Bruinsma J. World agriculture Towards 2030/2050: The 2012 Revision. ESA Working paper No. 12-03. Rome, Food Agriculture and Organization. 2012.
3. Ader W N. Vulnerability Global Environmental Change. Human and Policy Dimension 2006, 16, 268-281.
4. Afunmilayo O. Africa's Shrinking Forests: A peep into Nigerian situation and its implications on socio-economic development. Climate Change, 2016, 2(6), 93-103
5. Ashwini A Waoo, Swati Khare, Sujata Ganguly. *In vitro* Studies on Effect of Chromium on *Lantana camara*. Climate Change, 2015, 1(1), 45-48
6. Augusta Ayotamuno, Akuro Ephraim Gobo. The effect of climatic changes on land use and land cover in spatial development in Port Harcourt: Nigeria. Climate Change, 2016, 2(7), 223-234
7. O'Brien G. O'Keefe P. Meena, H. Rose J. Wilson L. Climate adaptation from a poverty perspective. Climate Policy 2008, 8, 194-201.
8. CBS. National Population and Housing Census 2011 (National Report). Government of Nepal National Planning

Commission Secretariat Central Bureau of Statistics Kathmandu, Nepal, 2011.

9. FAO. The state of the world's land and water resources for food and agriculture (SOLAW) – Managing systems at risk. Food and Agriculture Organization of the United Nations, Rome and Earthscan, London, 2011.
10. Gupta S C., Kapoor V K. Fundamentals of Applied Statistics. Sultan Chand and Sons 23 Dary Ganj, New Delhi, 1984.
11. Hickey S. Mohan G. Towards participation as transformation: Critical themes and challenges. In Participation: From Tyranny to Transformation, London and New York: Zed Books, 2004.
12. IPCC. Working Group I Contribution to the IPCC Fifth Assessment Report Climate Change 2013:The Physical Science Basis Summary for Policymakers. Intergovernmental Panel on Climate Change. IPCC Secretariat. C/O World eteorological Organization. 7bis Avenue de la Paix. C.P. 2300. CH- 1211 Geneva 2, Switzerland, 2014.
13. Kasahun Kitila Hunde. The role of Agroforestry system as strategy to adapt and mitigate climate change: A review with examples from Tropical and Temperate regions. Climate Change, 2015, 1(1), 20-25
14. Linker H M.. Orr D B. Barbercheck M E. Insect Management on Organic Farms. North Carolina Cooperative Extension Service. United States, 2009.
15. Malone EL. Vulnerability and Resilience in the Face of Climate Change: Current Research and Needs for Population Information. Population Action International 1300 19th Street, Suite 200 Washington, DC 20036, 2009.
16. Manyena S B. The concept of resilience revisited. Disasters 2006, 30, 433-450.
17. MoFSC. Forest Act, Ministry of Forests and Soil Conservation, Singhadurbar, Kathmandu, Nepal, 1992.
18. MoFSC. Forest Regulation, Ministry of Forests and Soil Conservation, Singhadurbar, Kathmandu, Nepal, 1994.
19. Marshall B K. Picou J S. Postnormal science, precautionary principle, and worst cases: The challenge of twenty-first century catastrophes. Sociological Enquiry 2008, 78, 230-247.
20. Reed M S. Podesta G. Fazey I. Geeson N. Hessel R. Hubacek K. Letson D. Nainggolan D. Prell C. Rickenbach M G. Ritsema C. Schwilch G. Stringer L C. Thomas A D. Combining analytical frameworks to assess livelihood vulnerability to climate change and analyse adaptation options. Ecological Economics, 2013, 94, 66–77.
21. Regmi B R. Morcrette A. Paudyal A. Bastakoti R. Pradhan S. Participatory Tools and Techniques for Assessing Climate Change Impacts and Exploring Adaptation Options. A Community Based Tool Kit for Practitioners. Livelihood and forestry programme, Kathmandu, Nepal, 2010.
22. Reuveny R. Ecomigration and violent conflict: Case studies and public policy implications. Human Ecology, 2008, 35, 1–13.
23. Richard B. Kniveton D.Kerstin S V. Migration and Climate Change: Toward an Integrated Assessment of Sensitivity. Springer Science+ Business Media Dordrecht. Science. 2013,1-30.
24. Riziki S S. Tracking Effective Indigenous Adaptation Strategies on Impacts of Climate Variability on Food Security and Health of Subsistence Farmers in Tanzania Institute of Human Settlements Studies. Ardhi University, Dares Salaam, Tanzania, 2011.
25. Roy TK, Hossain ST. Role of Sundarbans in Protecting Climate Vulnerable Coastal People of Bangladesh. Climate Change, 2015, 1(1), 40-44
26. Nathan F. Risk perception, risk management and vulnerability to landslides in the hill slopes in the city of La Paz, Bolivia. Disasters 2008, 32, 337-357.
27. NPC. The Poverty in Nepal. National Planning Commission, Singhdurbar Kathmandu Nepal, 2015.
28. Sankaran KV. Lantana camara. Asia-Pacific Forest Invasive Species Network, 2011.
29. Schelling T C. Some Economics of Global Warming. The American Economic Review 1992, 82, 1-14.
30. Sarah E T. Carol A. Ellison A Century of Classical Biological Control of Lantana camara. In: Can Pathogens Make a Significant Difference? Proceedings of the X International

Symposium on Biological Control of Weeds, 2000, 1, 97-104.

31. Suarez A V. Tsutsui N D. The evolutionary consequences of biological invasions. Molecular Ecology, 2008, 17, 351–360.
32. Suarez I. Huang Progresum Jennifer. Addressing Adaptation in a 2015 climate agreement, Center for Climate and Energy Solutions. Perish France, 2015
33. Vitousek PM. D'Antonio C M. Loope L L. Rejmanek M. Westerbrooks R. Introduced species: a significant component of human-caused global change. New Zealand. Journal of Ecology, 1997, 21, 1–16
34. Wamsler C. Mainstreaming ecosystem-based adaptation: transformation toward sustainability in urban governance and planning. Ecology and Society, 2015, 20, 30-41.