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Impacts of Earthquake and Earthquake-induced Disasters on Community Forests in Nepal

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Abstract

Managing the commons is a challenging issue during crisis such as earthquakes. We considered four community forests, two from Gorkha and one from each of Dolakha and Sindupalchowk districts that were major earthquake affected areas. The study made use of ecological and socioeconomic survey techniques to assess the impacts of earthquake on community forests and management status of those forests. We calculated density of seedling, sapling and tree species and diameter size distribution of trees. We also analysed the forest status changes before and after the earthquake events and distribution of timber and fire wood in the community forest user groups. Seedling, sapling and adult trees number wise regeneration status of trees was good in all the studied forest whereas DBH size class diagram were bell shaped indicating unsustainable regeneration. Most of the respondents reported poor forest management after the earthquake and wood distribution has drastically increased after the earthquake 2015. From this study it is recommended that community forest management practices should be resilient to disasters and prepare alternative solutions to lower the pressure on forest products so as to maintain sustainable regeneration of forest trees and regular supplies of resources in future.

Keywords: *Commons, Community Forest, Earthquake, Trees*

Introduction

Natural resources management is a challenging problem (Ullah et al., 2021). Commons means public property, most of the natural resources is commons and these commons face more risk during the crisis. In developing countries like Nepal community forest is always at the risk as it has played or can play an important role in addressing poverty of the households (Singh et al., 2021). The critical role of community forestry in environmental protection in general and in fostering social and economic development in particular in Nepal's rural areas has already drawn some attention (Chhetri & Jackson, 1995; Lamichhane et al 2021; Malla, 2000).

Poverty of the people is the result of the state failure. The socio-economic disparity is the long term impact of top down policy or lack of decentralization and devolution (Torado & Smith, 2005). Nepal has been suffering vast socio-economic disparity and the cumulative impact is experienced as a form of political violence (CHRGJ, 2006). Socio-economic disparity and inequality is a global problem but the magnitude of disparity is very high in Nepal compared to other under-developed countries of the world. The unequal distribution of resources or inappropriate sharing of benefit is a major cause of discrepancy by which almost all of the socio-economic conflicts have been emerged (Sen, 2004). Forest resource is one of the means of living for rural livelihoods (Baidhya, et al., 2021; Niraula, 2005), so the reasonable distribution of forest resource can play a crucial role in poverty reduction in rural community (Pokharel, 1997). Although there are many positive implications of the community forestry, the past decades of implementation has not addressed poverty alleviation and equity in benefit sharing effectively. However, the implementation of community forestry is failing to address these second generation issues (Kanel & Kandel, 2004).

While trends towards resource degradation have been arrested and in much case forest covers are reported to be improved, the livelihoods of the local forest dependent communities have not improved as expected. In worst cases, in fact, the implementation of CF policy has inflicted added costs to the poor, such as reduced access to forest products and forced allocation of household resources for communal forest management with insecurity over the benefits.

Mega-earthquakes of April 25 (7.8 in Richter Scale) and May 12 with epicentre in and around Barpak of Gorkha and Sindhupalchok, Nepal heavily destroyed lives and property of the people. The earthquake has been a terrible calamity for Nepal as they affected almost half of its districts, including hard-to-reach isolated mountainous areas. Over 8, 790 people lost their lives and more than 22, 300 people were injured (NPC, 2015). The scale of destruction remained immense. Nature itself suffered massively due the earthquake and aftershocks following the major earthquake. There are no concrete accounts of the impacts and scale of the disasters on community forests. This is massively important as millions of people of the affected areas depend directly on natural resources for their subsistence. The people of the areas are some of the poorest and most-disadvantaged groups far from the reach of the mainstream economical and developmental endeavours.

A comprehensive assessment of the damages and losses caused by the earthquake was undertaken as the first step towards recovery planning. However, the assessment virtually neglected to assess the impacts on the natural resources especially the forests. It is especially important as the resources required for reconstruction of the damaged infrastructures heavily involves harvesting of the forest products. And it is not difficult to trace the sources of the resources being non-other than community forests. It is therefore, imperative to study the impacts of such harvesting on future sustainability of the resources. On top of this it is also important to assess the situation of the access to resources of the poor and disadvantaged groups in the times of crisis and also the management and governance in times of crisis. The information thus derived will be helpful in managing resources sustainably in the future disaster scenarios as Nepal is prone to several categories of natural disasters.

Materials and Methods

Gorkha, Sindhupalchok and Dolakha (Figure 1) are the epicenter of 2015 Gorkha Earthquake and vicinity. Gorkha is a district of Gandaki Province. This district looks like ladder, which varies from Mahabharat region to High Himalaya. It is bordered by Dhading District (Budhi Gandaki River) in east; Tanahun, Lamjung, Manang, (Chepe River) in west, Tibet of China in North and Tanahun and Chitwan District in South. Gorkha District has an area of 3610 km^2, which is fourth biggest district among 77 district of Nepal. Gorkha district varies from 228 meter to 2500 meter above mean sea level. These are the nearest community forest to the epicentre of earthquake 2015 in Gorkha. Milijuli community forest's area is 144 hectare and Tasarpakha Community forest's area is 93.18 hectare. Both forests lie in Warpak village.

Sindhupalchowk district, a part of Bagmati Zone is one of the seventy-seven districts of Nepal located in a central development region. The district with Chautara as its headquarter, covers an area of 2542 km^2 and has a population of 2,87, 798 (CBS, 2011). It extends between the latitudes 27^0 27' and 28^0 13' North and longitudes 85^0 27' and 85^0 06' East (CBS, 2011). Maitar-Kawase Community Forest (MKCF) was selected from Sindhupalchowk district.

Dolakha district, with Charikot as its district headquarter, covers an area of 2,191 km^2 and has a population of 1,86,557 (CBS 2011) Mixed forest types of *Quercus*, *Rhododendron*, *Schima-Castanopsis* and *Shorea* are found in both community forest. Maithan-Harisiddhi Community Forest (MHCF) was selected from Dolakha

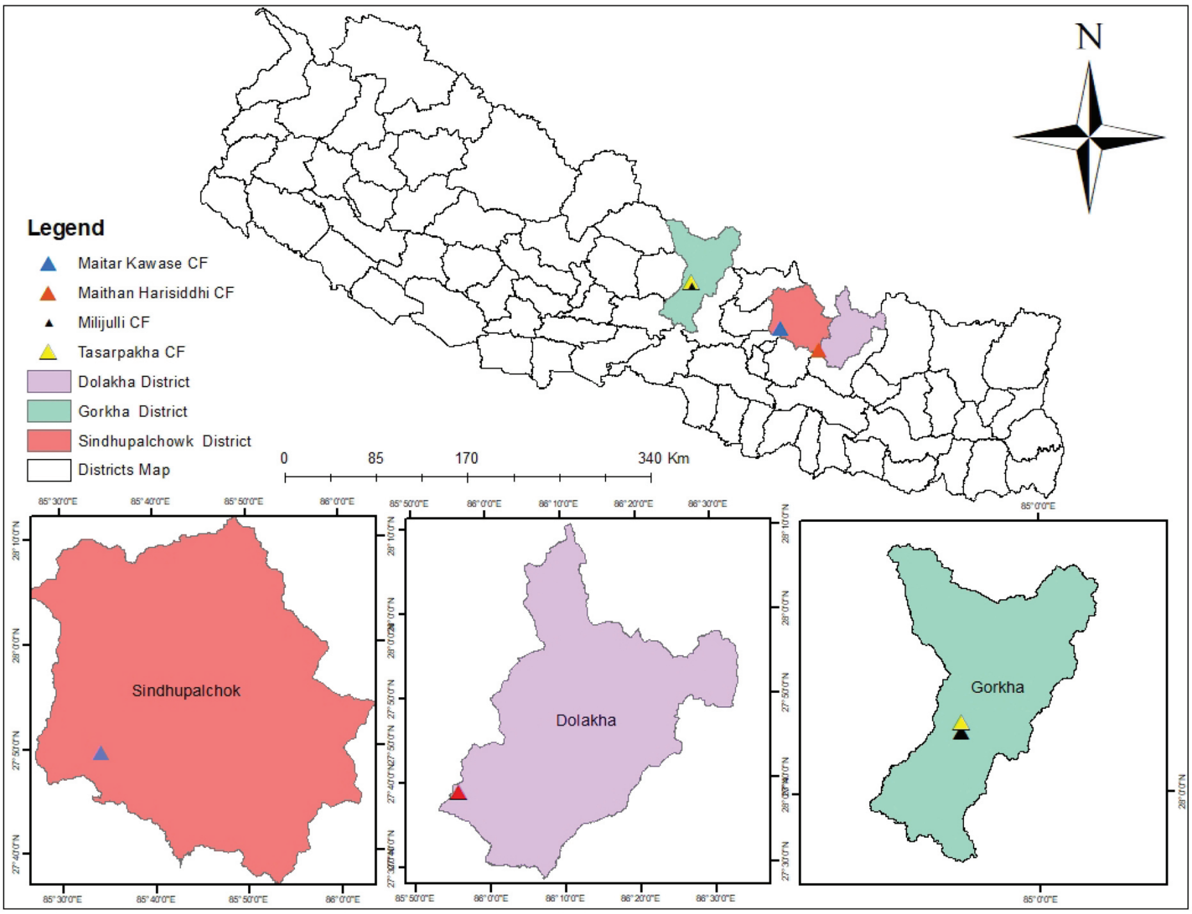

Figure 1: Map showing locations of studied community forests

Data Collection

Ecological survey was conducted using square plots of 20m x 20m in which saplings were measured in 25 m^2 plots on two opposite corners and seedlings were sampled in four 1 m^2 plots at four corners of tree plot following Kent (2012). A total of 60 plots, 15 plots in each of the studied community forest were sampled for the study. The total surveyed area was 2.4 hectare equal to 0.5% of the total area. Individuals of tree species were divided into three growth stages: trees (DBH≥5 cm), saplings (DBH<5 cm, height > 1.3 m) and seedling (height < 1.3 cm). All the trees on the sample plots were measured for their height (m) using clinometer and DBH (cm) using diameter tape. The seedlings and saplings were counted and identified in the field for each plot. Canopy cover was visually estimated by averaging values obtained for four corners and the centre of each plot. The local names of the species were recorded in the plot when their scientific names were not known immediately. The local names were later tallied with Shrestha (1998) to identify the species.

We surveyed 90 households 45 in MHCF/MKCF and 45 in MHCF/ MKCF. We compiled the records of wood- timber distributions from MHF and MKF only as we could not get the records from other forest user groups. Therefore we used only these two forests data for wood distributions trend analysis.

Data Analysis

Impact of earthquake was seen through the analysis of regeneration status of trees (seedling, sapling and adult count, DBH size class diagram), increase and decrease perception of forest management, wood distribution trend and governance.

Density of Adults, Saplings and Seedlings were determined for regeneration trees assessment.

$$\text{Density (Number/hectare)} = \frac{\text{Total number of individual of species in all plot}}{\text{Total number of plot sample} \times \text{size of quadrat}} \times (10000)$$

Table 1: Structural Parameters of studied Community Forests

Variables	T CF	MCF	MHCF	MKCF
Adult (ind./ha)	456	550	527	1345
Sapling (ind/ha)	1867	1950	700	1413
Seedling (ind/ha)	15417	27083	8010	26450
Canopy (%)	51	50.44	50	75
Tree species richness	9	12	5	7
Dominant sp.	*Engelhardtia spicata*	*Shorea robusta*	*Pinus roxburghii*	*Shorea robusta*

The DBH of adults were grouped into different size keeping 5cm class interval and DBH size class diagram of each studied forests were made separately to see the population structures.

The information about local wood distribution is shown in a graph with regression line fitted to the data. Local people responses on management status of forest before and after 2015 Gorkha Earthquake are given in percentage (%) and presented in bar graphs.

Results and Discussion

We recorded more number of seedlings followed by saplings and adults respectively in the studied forests. Among the four sites the tree richness was most in MCF 12 followed by TCF 9, MKCF 7 and MHCF 5 respectively. The MCF and MKCF forests were dominated by *Shorea robusta* whereas, TCF was dominated by *Engelhardtia spicata* and MHCF was dominated by *Pinus roxburghii*. The average canopy cover of TCF, MCF, MHCF and MKCF were 51%, 50.44%, 50%, and 75 % in respectively (Table 1).

We found hump shaped DBH size class diagram for the adults of four studied CFs. More trees were in DBH size class 20-25cm in TCF and MCF. In MHCF, more trees were in DBH size class 15cm-20cm and 35-40cm in in MKCF (Figure 2)..

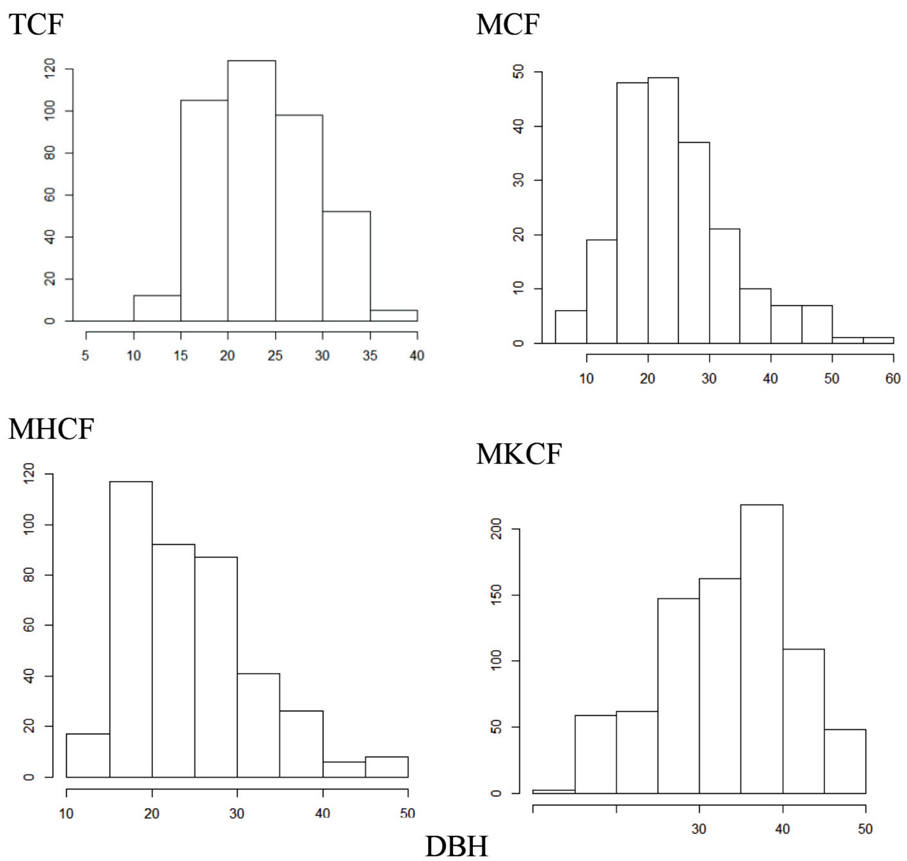

Figure 2: DBH size class diagram of tree in different forest.

Perception of Local People CF Management

Perceptions of local people on community forest management were not so positive after the earthquake and subsequent resource distribution experience. Before earthquake, the perceptions looked more positive. The negative perception after the earthquake was highest in MHCH and lowest in TCF (Figure 3).

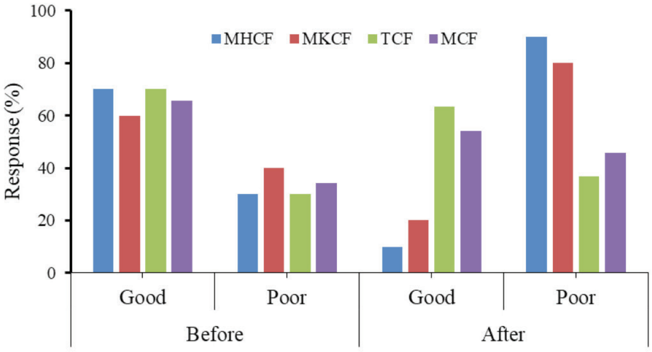

Figure 3: Perception of users on CF management before and after the earthquake

Resources Distribution

The average wood distribution trend was in increasing trend both in MHF and MKF since 2010 to 2017.The polynomial equation showed good fit with $R^2 = 0.8723$ and 0.9192 respectively. The average wood distribution trend was increasing more than before earthquake. The average amount distribution of wood per year in MHF was 252 cubic feet per from 2010 to 2015 whereas after 2015 the wood distribution was 600 cubic foot per year which is above 100% in compare to average wood distribution from 2010 to 2014. Similarly average distribution of wood in MKF was 261.67cubic foot per year till 2015 but after it increased to 2300 cubic foot per year (Figure 4).

Regeneration of trees is a major attribute to show forest structure and composition. The number of seedling - sapling presence is more than tree number indicating fair regeneration in the studied community forest (Shankar, 2001). The species richness is low in all the three forests as the two forests were *Shorea robusta* dominated forest and one with the dominance of *Pinus roxburghii* and *Shorea robusta* dominated forest is species poor forest (Stainton, 1972).

Shorea robusta is one of the most common species in the studied forests. The number of sapling development from seedling similar to other studies in *Shorea robusta* forest (Mishra & Garkoti 2014). The forest will be sustainable if the seedlings and sapling are protected and conserved in a long run.

The DBH size class diagram showed bell shaped distribution indicating that the forest is not continuously regenerating (Shrestha, 2005). This type of structure might be due to the cutting of trees to make temporary houses as post disaster recovery activities (Liu et al., 2021) and also to supply firewood.Clear disturbances was seen in low DBH size classes (5cm-15cm).The disturbances seen in smaller adult tree size class might be due to the easy wood preference of people during rapid construction of temporary houses

Local perception on community forest management was rather low after the earthquake. This could be the reason that the human interest and potential goes towards getting the most basic things during post disaster conditions so that issues of forest protection and management can't be realized as important. At this phase the resettlement of people was the common and basic need in Nepal (Rieger,

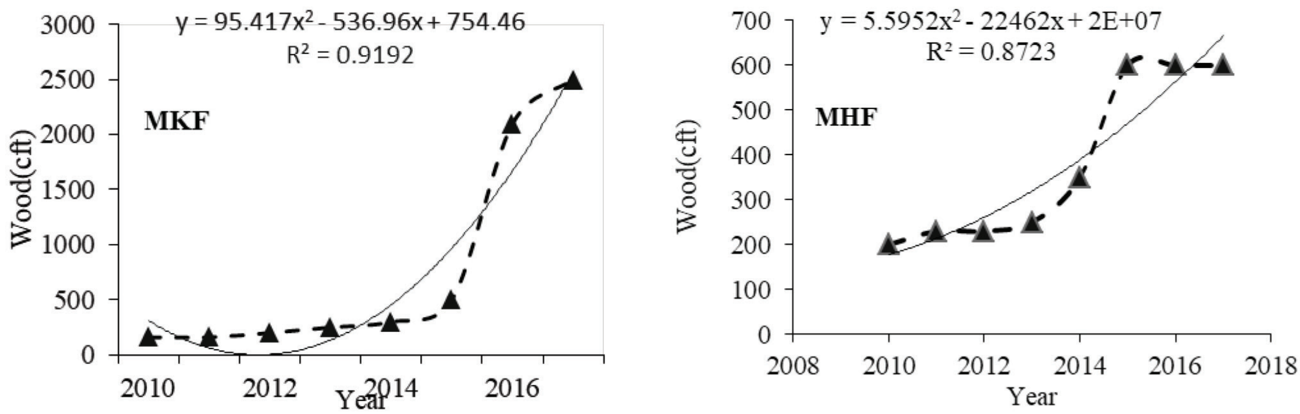

Figure 4: The distribution of wood in MHF and MKF. The markers represent the annual amount of wood distribution. The polynomial line represent non-linear trend in consumption.

2021). Before earthquake, the perception towards forest management was highly positive meaning the users were satisfied with the forest management activities. This shifted to negative perception after the earthquake indicating the users' dissatisfaction with the activities of the user groups in managing forest resources. The resource distribution, in terms of timber and wood, showed rise of wood distribution after 2015 in the studied forest as wood and timber resources are essential for reconstruction work and for livelihood recovery in different places of Nepal (Gentle et al., 2020). This increase wood consumption might create pressure on wood and lead to shortage of wood (Paudel et al., 2015). If tree cutting is unregulated and protection measures are not put in place, the sustainability of the forests and thereby, the resource supplies are highly compromised to the users.

Conclusion

The research revealed good regeneration status of forests in all the four study sites in terms of seedlings and saplings but unsustainable state of tree sizes due to tree cuttings for wood supplies aftermath of 2015 Gorkha earthquake. The CFs under consideration are habitats for important and valuable tree species such as *Shorea robusta*. Resource use pattern in terms of timber in two CFs for which the data were available showed an increasing trend of uses after the earthquake. This might be because of the increased demand for reconstruction and might also be due to mismanagement of resource in times of crisis. The users didn't report serious negative attitudes but were not happy towards CF management practices after earthquake. Locals suggested the need of a careful further investigation viewing potential negative attitude towards management practices could be detrimental in resource management in the long run.

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