



## Article

# Earthquake Impacts on the Livelihoods of Community Forest Users in Sindhupalchok District, Nepal, and Their Perceptions towards Forest Conservation

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**Abstract:** Community forests are a crucial component of farming systems and people's livelihoods in the rural middle hills of Nepal, where the population depends upon the forest for fuelwood, fodder, and leaf litter for their daily needs. This study aims to assess the perception of community forest user groups towards their postearthquake situations by using the five forms of capital from the sustainable livelihood framework. It further analyzes whether forest user's attitudes towards forest conservation have changed or not. In addition to household interviews with 68 earthquake-affected households and extensive visits to the study area, key informant interviews and focus group discussions were conducted. This study confirms that the community forest user groups perceived negative effects on the natural, physical, human, and financial capitals, whereas they perceived a positive effect on social capital after the earthquake. Controlled access to forest products, such as timber collection during the recovery phase, restricted their resilience, although nontimber forest products supported it. Low agricultural production because of the scarcity of water for irrigation, as well as the soil infertility because of the landslides, caused local people to shift towards nonagricultural activities for income generation. Further, out-migration for job opportunities resulted in an inflow of remittances and, thus, manpower shortages were observed. Our results show that, despite facing the postdisaster impact on their livelihoods, 92% of the respondents were found to be positive towards forest conservation. This was because of their emotional attachment to the forest and the benefits received from the forest in the past. Local institutional policies and mechanisms must be strengthened to provide communities with the knowledge, skills, and practices for effective postdisaster recovery or for upcoming disasters, as well as the benefits of promoting sustainable forest conservation.



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## 1. Introduction

Disasters can trigger unprecedented pressure on forests and may result in forest degradation and deforestation as survivors and displaced people are forced to forage in the residual forest for food, timber, fuelwood, fodder, and other products [1]. Furthermore, such disasters may disrupt the supply of forest products and environmental services, threatening the subsistence and livelihoods of local communities and allied forest industries. However, a disaster affects different communities in different ways. Communities reliant on subsistence and small-scale production are typically among the most vulnerable to disasters such as earthquakes [2]. Furthermore, the demand for forest products in reconstruction and the resilience in the aftermath of disasters, such as earthquakes, has serious impacts on forests, as most communities in Nepal are either fully or partially dependent on the forest for their livelihoods.

On 25 April 2015, Nepal experienced a 7.8 magnitude earthquake in 14 districts [3,4], followed by a series of aftershocks that affected 8 million people and resulted in the degradation of 23,000 ha of forestland by the landslide and human encroachment for

the resettlement [5]. In particular, the Sindhupalchok district was one of the districts that was most affected by the earthquake in 2015 [3–5]. In total, 3075 people, including 1230 children, lost their lives, and 1450 people were injured. In addition to the loss of lives and destruction of property, the disaster had consequences for the ecological health, geology, and biodiversity, as well as for the wildlife and freshwater resources in the area [4].

Community forestry (CF) is a popular approach to landscape restoration, forest management, biodiversity conservation, and support for rural livelihoods [6–11]. Nepal has been at the forefront of the community forest movement for more than four decades, with almost 40% of the total population directly involved in protecting and managing more than 32% of the country's forest land [6,12,13]. The movement forms part of the national strategy for livelihood improvement and environmental conservation in Nepal [14–16], an agricultural country with almost 66% of people directly engaged in agriculture and livestock production activities for their livelihoods [17]. Moreover, in the middle hills of Nepal, the integration of fodder trees and grasses with the livestock system has been an important source of livelihoods [8,9,14].

### *Theoretical Framework*

A sustainable livelihood is defined as the means, capabilities, assets (both material and social), activities, and entitlements by which people build their living [18–20]. Furthermore, a livelihood can only be sustainable if it can cope with or recover from shocks, stress; maintain and enhance its capabilities and assets, both now and in future, while not undermining the natural resources [21]. The sustainable livelihoods framework highlights five capitals upon which livelihood impacts can be assessed. These are the natural, financial, physical, social, and human capitals [21]. The framework emphasizes that, for households to achieve positive livelihood outcomes, a range of capital categories are required because no single category can sufficiently meet the multiple and varied livelihood needs of households. A household that is unable to fulfill its basic need for livelihood capital is not sustainable [22]. The sustainable use of forests can reduce the risks and vulnerabilities that local communities face since forest resources are an important safety net for livelihood survival. Research on the earthquake impact on the Nepalese economy and women [23], the social and human capital [24,25], and the pattern of forest resource use [26] has been conducted and has revealed the vulnerability of the livelihoods of residents. However, there have been no studies on the perceptions and attitudes towards forest conservation of community forest user groups, who depend on the forest and local resources for their livelihood survival, after the earthquake in the Sindhupalchok district of Nepal, where community forestry practices started for the first time. When people do not receive the benefits of natural resource management, they lose their motivation for conservation [27]. Thus, our study affirms that the people's attitudes towards forest conservation after the earthquake impacted their livelihoods because they stopped receiving the benefits obtained from the forest.

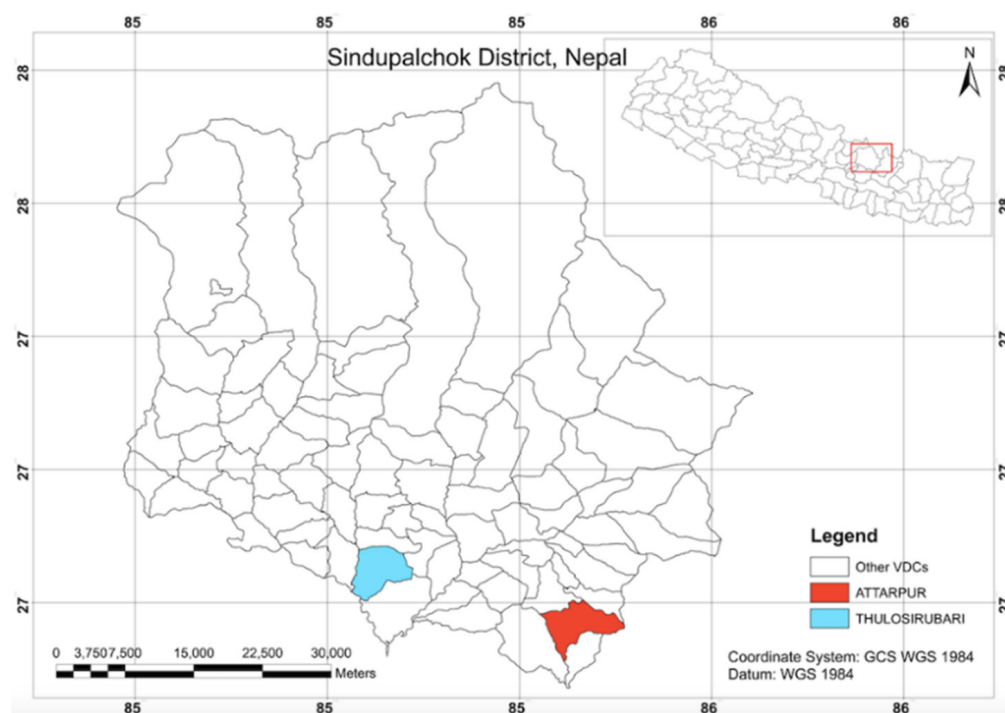
Community forest products were sources of livelihoods at the study sites, and we hypothesize that the decrease in the utilization of forest products might have changed the attitudes of people towards forest conservation. Forest product availability and the local environmental conditions are aspects of natural capital, and people's other daily necessities, such as finance, social relationships, good health, education, and shelter are examples of other types of capital. The reliance on these capitals at the study sites was the reason why the sustainable livelihood framework was chosen for the study. The five forms of capital of the sustainable livelihood framework, as well as perceptions on forest conservation, were evaluated in the study. The sustainable livelihoods framework is particularly relevant to understanding the vulnerability to earthquakes because it provides a framework for analyzing both the key components that make up livelihoods and the contextual factors that influence them [21]. Understanding the perceptions and expectations of local residents with respect to the postearthquake forest evaluation of forest product supplies is essential as it may affect subsequent forest activity, both in Nepal and elsewhere. Therefore, this

study aims to offer valuable insights into the local residents' support for forest conservation and postdisaster recovery.

## 2. Materials and Methods

### 2.1. Study Area

This study was conducted in two community forests of the Sindhupalchok district in the Bagmati province of Nepal. The Sindhupalchok district was selected for this study as it was one of the major affected districts during the 2015 earthquake. The district covers an area of 2542 km<sup>2</sup> and had a population of 287,798 [17]. It extends between the latitude 27027' and 28013' north, and the longitude 85027' and 85006' east. Two community forests: Bhanjyang in Attarpur Gaupalika (formerly the Attarpur Village Development Committee (VDC), and Shreechhap in the Thulosirubari municipality (Formerly the Thulosirubari VDC) were selected for the study (Figure 1). The Shreechhap Community Forest was awarded the "Best Community Forest Award" before the 2015 earthquake; and the Bhanjyang CF consisted of only female executive CFUG members at the time of the study. Both community forests have successfully completed their two decades of establishment and are natural and plantation-type forests on degraded hills (Table 1). Figure 2 represents the situation of forest after earthquake during the field visit at the study sites. Nepal, being a developing country, has its challenges in managing resources, corruption being the most prevalent one [24]. Thus, on the basis of the dedication, and the vision and action of both communities towards forest conservation, they were selected as the representative sample. The livelihood systems of both areas were characterized by agricultural production, livestock rearing, and daily labor (primarily unskilled and farm-related) activities. However, because of the shorter distance to the district headquarters in Chautara, and the capital city, Kathmandu, people in the Thulosirubari municipality had more diversified livelihood options compared to those of the Attarpur Gaupalika CFUG.



**Figure 1.** Location map of study area in the Sindhupalchok district.

**Table 1.** Attributes of the two community forests.

	Bhanjyang CF	Shreechap CF
Location	Attarpur Gaupalika	Thulosirubari municipality
Area	35.65 ha	78.30 ha
Altitude	2100–2500 m	1300–1600 m
Slope	18–40 degrees	15–35 degrees
Forest type	Plantation, natural	Plantation, natural
Forest soil type	Sandy, clay soil	Loam, sandy, and clay
Year started	1995 AD	1998 AD
Major species	<i>Alnus nepalensis</i> , <i>Taxus baccata</i>	<i>Shorea robusta</i> , <i>Taxus wallichiana</i> , <i>Schima wallichii</i>

**Figure 2.** The figure (a,b) shows the forest situation of the studied CF due to landslide after the 2015 earthquake.

## 2.2. Study Design and Data Collection

We used a combination of methods to explore the research goals, including an extensive formal survey of households, as well as more intensive observations and interviews with forest users, government officials, and allied stakeholders. The interviews were conducted with a total of 68 households, which were selected following discussion with the local elite person and government officials. The selection criteria were households who had been a member community forest user for more than 10 years. A total of  $n = 34$  of the Bhanjyang CF households, and  $n = 34$  of the Shreechap CF households were interviewed with the purposive sampling method.

For the five capitals, we assessed the impacts on the natural capital based on the local people's perceived changes in the availability and quantity of the forest resources, agricultural production, water availability, and changes in the local environmental conditions. The impacts on financial capital were evaluated in terms of their perceived changes in income flows and access to loans. Physical capital was evaluated on the basis of the ability to construct new earthquake-resistant houses and livestock sheds. For the social impacts, we evaluated the degree of improved relationships and cooperation between the members after the earthquake. Human capital was evaluated according to education training and knowledge development. For the perceptions of people towards forest conservation, we asked about their satisfaction on the rules of forest resource extraction, benefit from the forest, participation in forest management, and the importance of forest management for the future.

The key informant interviews with the leaders of the community forest, government officials of Gaupalika, and well-informed elderly people were conducted to gain an overall

view for the selection of the households. Observations were made on the lifestyles of the earthquake-affected people and other situations, such as settlements, agricultural production, livestock sheds, etc. After that, the most affected forest-dependent households were chosen for the household interviews. The respondents compared the variables before and after the earthquake based on their experiences and indicated “yes” or “no” as a response. To evaluate the consistency of the concepts, the questionnaire was pretested on five forest users who were not included as respondents in the main study. All the study participants provided informed verbal consents. All the data were analyzed by statistical program SPSS version 23 [28].

### 3. Results

#### 3.1. Respondents' Characteristics

In the Bhanjyang CFUG, the number of male respondents was lower (41%), but in the Shreechap CFUG, the number was higher (71%) (Table 2). The respondents ranged in the age group from 20 to 80 years old, with the respondent average age being 50 years old. The respondent age bracket of 50 years and above was the highest in Bhanjyang, followed by 36 to 49 years, and 20 to 35 years; whereas, in Shreechap, the 36 to 49 years age group was highest, followed by 50 years and above, and then the 20 to 35 years age group. Most respondents belong to the Newar community (87% in Bhanjyang and 83% in Shreechap) followed by the Gurung/Magar and Brahmin/Chettri communities. The major sources of livelihood survival were remittance (36%), followed by agriculture (27%) in the Bhanjyang CFUG, and agriculture (33%) and remittance (27%) in the Shreechap CFUG (Table 2). The focus group discussion also revealed that, in search of income diversification, most of the youths had moved to the capital city or a foreign country, and this was replicated in our data, where the age group of respondents over 50 years old was the most abundant population group. Furthermore, because of the male member migration for income opportunities, a higher involvement of females in community forestry management was observed. The focus group discussion and the in-depth interviews with stakeholders mentioned that, because of the migration of youths for employment, there were problems with forest management regarding pruning and the clearance of fell logs. The focus group discussion pointed to the fact that these demographic characteristics might lead to a foreseeable risk for passive community participation in the future.

**Table 2.** Demographic characteristics of the respondents.

Characteristics		Number of Respondents (%)	
		Bhanjyang	Shreechap
Gender	Female	20 (59)	10 (29)
	Male	14 (41)	24 (71)
Age	20–35 years	4 (12)	6 (17)
	36–49 years	12 (36)	16 (47)
	50 years and over	18 (52)	12 (36)
Caste/Ethnic group	Brahmin/Chettri	1 (3)	3 (9)
	Newar	29 (87)	29 (83)
	Gurung/Magar	4 (10)	2 (8)
Income source	Agriculture	9 (27)	11 (33)
	Remittance	12 (36)	9 (27)
	Government service	3 (8)	3 (8)
	Business	3 (8)	6 (17)
	Daily wages	7 (21)	5 (15)



### 3.2. Perception of CFUG Households on Impact of Earthquake on Livelihood Capitals

#### Overview of Earthquake Impact on Livelihood Capitals

In both the study areas, the earthquake had severely affected the livelihood of community forest user groups. The fuelwood, fodder, and timber availability decreased; however, on the other hand, NTFPs supported the resilience of the local people. Landslide, soil erosion, and an increased number of wildlife populations created a fear among the local people upon entering the forest. This fear of entering the community forest has decreased the forest dependency and has led to the search for alternative livelihood measures. Sixteen water sources (springs) were dried or buried because of the landslide, and this has created the drinking and irrigation water scarcity. Problems with irrigation have affected agricultural production. Low agricultural production has decreased incomes, which affect financial capital. People have shifted to other income-generating alternatives, such as daily wage work, driving, masonry, and the operation of small tea shops. Most of the respondent family members have emigrated to cities and overseas in order to earn money, which has also decreased the youth numbers in the village. Remittances became the major source of cashflows, but this has created a shortage of manpower for forest management and development activities in the villages. The closures of schools impacted the children's education and their mental health. The migration of people who were earlier experienced in forest management has impacted the human capital as well. There were few people left with a deep knowledge of forest management. Similarly, the lack of a proper education for children and training facilities might hamper human capital in the future as well. All of the houses were damaged and all of the respondents lost valuable items; when houses collapsed, the items were buried. The exchange of help and care in the difficulty has improved social relationships and cooperation among the community members.

#### Earthquake Impact on Individual Livelihood Capitals

##### 3.2.1. Natural Capital

The term "natural capital" includes access to the forest, land, and water from which households engage in agricultural pursuits and resource collection for sustenance and income generation. In both villages, the situation of natural capital had deteriorated since the earthquake. The occurrences of landslides, soil erosion, and wildlife encroachment into the village had increased. A total of 79% of the respondents in the Bhanjyang CFUG, and 85% of the respondents in the Shreechhap CFUG, stated that the local environment had been degraded after the earthquake. Because of the occurrence of landslides and soil erosion, the soil quality had decreased. Water springs had been buried or had dried up, resulting in a huge scarcity in the water supply in the villages. A total of 100% of the respondents in both of the CFUGs stated that the water availability decreased after the earthquake. Water scarcity created shortages for both clean drinking water as well as for irrigation for agricultural production. A total of 70% of the respondents in the Bhanjyang CFUG, and 35% of the respondents in the Shreechhap CFUG, reported decreased agricultural production after the earthquake (Table 3). The differences in the responses within the village occurred because of their geographical differences. The Shreechhap CFUG had access to river water for irrigation, but the Bhanjyang CFUG relied on water springs, so they shifted their farming practices to low-irrigation agricultural practices.

The landslides, obstructed pathways, dead wood, unnecessary sprawling bushes, and increased wildlife numbers sparked fear among the CFUG members with regard to entering into the forest, which then shifted the people's dependency away from the community forest towards other income sources. People were compelled to use their private land (Khet /Bari) (Khet: "rice field" in Nepalese language; Bari: "vegetable garden" in Nepalese language) to fulfill their daily needs for fuel wood and fodder. In the Bhanjyang CFUG, 82% the respondents, and 85% of the respondents in Shreechhap (Table 3), stated that fuelwood and fodder utilization from the community forest had decreased. The community forest completely banned timber utilization after the earthquake to control the overexploitation of timber. As a consequence, 100% of the respondents of both CFUGs stated that the

availability of timber decreased after the earthquake. On the other hand, the utilization of nontimber forest products (NTFPs) increased, and 53% of the Bhanjyang CFUG and 65% of the Shreechap CFUG stated that the increased use of NTFPs helped them for their resilience.

**Table 3.** Perception of respondents of both CFUGs on livelihood capitals.

Capitals	Statement	Bhanjyang n = 34 (%)		Shreechap n = 34 (%)	
		Yes	No	Yes	No
Natural	Has the fuelwood supply and utilization decreased in the forest compared to before the earthquake?	28 (82)	6 (18)	29 (85)	5 (15)
	Has the availability of timber from the forest decreased from before?	34 (100)	0 (0)	34 (100)	0(0)
	Has the supply of NTFPs from the forest decreased from before?	16 (47)	18 (53)	12 (35)	22(65)
	Are the sources of water, such as springs, damaged because of the earthquake?	34 (100)	0(0)	34 (100)	0 (0)
	Do you feel that agricultural production decreased after the earthquake?	22 (70)	12 (30)	10 (35)	24 (65)
	Do you feel that the environmental conditions have deteriorated after the earthquake (e.g., landslide and soil erosion occurrence)?	27 (79)	7 (21)	28 (82)	6 (18)
Physical	Did you build new houses after the earthquake?	26 (76)	8 (24)	30 (88)	4 (12)
	Have the numbers of livestock decreased after the earthquake?	23 (65)	11 (35)	12 (32)	22 (68)
Financial	Has your income source from the forest changed after the earthquake?	22 (64)	12 (36)	13 (38)	21 (62)
	Did you have increased access to loans after the earthquake?	34 (100)	0 (0)	34 (100)	0 (0)
Social	Has the amount of social organization support increased after the earthquake?	34 (100)	0 (0)	34 (100)	0 (0)
	Do you find that the members in the social group are increasing their collaboration?	34 (100)	0 (0)	34 (100)	0 (0)
Human	Have you received new training regarding healthcare and income generation after the earthquake?	11 (32)	23 (68)	12 (35)	22 (65)

Decreased agricultural production caused people to shift to other income generation for recovery, resulting in manpower shortages. The lack of manpower caused difficulties with forest management, as men who had previously contributed more to the thinning and pruning activities were busy with other recovery work, and the female members could not actively participate in forest management activities because they were busy with their own household responsibilities. The conservation strategy of the government, rather than utilization in the difficulties, disheartened the local people. One government official said that the community forestry groups were not as active in the forest as they had been before the earthquake. Forest operational plans had not been renewed and passive forest management could be a major problem in the future.

### 3.2.2. Physical Capital

The earthquake destroyed the houses and school buildings in both the studied villages. Different international and national organizations were helping to rebuild those houses and schools. Our study demonstrates that 76% of the respondents in the Bhanjyang CFUG, and 88% of the respondents in the Shreechap CFUG, had rebuilt their houses (Table 3), while 24% of the respondents in Bhanjyang (Figure 3 shows the housing conditions of a respondent), and 12% in Shreechap, were still waiting for financial support to do so. The roads were also damaged by landslides, which broke the water pipes, creating water scarcity and problems in the transportation of food supplies.



**Figure 3.** The figure shows the condition of temporary housing of the respondent after the 2015 earthquake.

Under the Nepalese Government, the National Reconstruction Authority launched a program to support earthquake-affected families by providing cash to them to rebuild their houses. The fund allocated to each earthquake-affected household was NPR 300,000 (approximately USD 2500). The Government of Nepal's Department of Forestry had allocated 50 cu ft of wood for a completely damaged house, and 20 cu ft for a partially damaged house, to be provided for free for the reconstruction process. Similarly, for public buildings, the allocated wood was 100 cu ft for completely damaged buildings, and 40 cu ft for partially damaged buildings. Although the actual amount of wood required was more varied among the households, the government came to this decision based on the concept that more than 50% of the wood from damaged buildings could be reused, thus reducing the pressure on the forest. Different local and international organizations supported the earthquake-affected families in constructing earthquake-resistant houses. School building reconstruction was planned through the Project Implementation Unit, chaired by the Department of Education Director General, and the District Implementation Unit at the district level. Engineering students were volunteering on the design and construction of an earthquake-resistant school as well as health posts.

The earthquake also changed the numbers of livestock in both villages. A total of 65% of the respondents in the Bhanjyang CFUG, and 32% of the respondents in the Shreechap CFUG, reported decreased numbers of livestock after the earthquake (Table 3). This was because the availability of fodder from the community forest had decreased, and also because the livestock sheds were damaged by the earthquake. The livestock sheds also required repairs so people were reluctant to keep animals. Some of the respondents from the Bhanjyang CFUG also stated that wildlife had started to encroach upon the village in search of food as the biodiversity in the forest was also disturbed. The immediate consequence of the earthquake was that people had serious cash shortages and sold their livestock to generate cash.

### 3.2.3. Social Capital

It is not easy to precisely grasp or quantify the concept of social capital. In our study, we measured it as participation in community activities, whether loosely organized or characterized by formal membership. The focus group discussions revealed that people had developed a sense of mutual trust and that they helped each other after the earthquake, with an increase in informal socializing and participation in social activities. All respondents (100%) reported that their relations with neighbors had improved since the earthquake (Table 3). The relations of local people with government officials were also improved because of the frequent visits, monitoring, and guidance by officials. Before the earthquake, the locals were merely informed about local development projects; however, after the earthquake, there was a rise in the interest towards such projects as to how and where to focus.



The group members were involved in collective training for capacity-building and income-generation skills as a result of the increased social cooperation among members. In both CFUGs, a financial cooperative had been established, where members deposited money periodically. Members were more actively involved in cooperatives after the earthquake. Members can withdraw money from the fund on a need-evaluation basis, with the need evaluation conducted collectively by the members themselves. Social bonding and cooperation were observed to have increased after the earthquake.

#### 3.2.4. Financial Capital

Our study demonstrated that 64% of the respondents in the Bhanjyang CFUG, and 38% in the Shreechap CFUG, stated their change in income source, as they had changed their occupation from agriculture to other activities (Table 3). Increased outmigration to bigger cities or overseas in search of jobs after the earthquake was the major observation in both cities. Remittances were also a major source of cashflow in those villages, with 36% of respondents in the Bhanjyang CFUG, and 27% in the Shreechap CFUG, stating remittances as their source of income (Table 2). More people started working as daily wage labor for house building and reconstruction works. Another major problem was that wild animals encroaching on human habitat near the forest threatened their survival because they damaged property, raided crops, and preyed on livestock. The respondents said that they had not previously experienced this problem and that they did not know how to solve it.

People with livestock sold them soon after the disaster as they were uncertain of finding other livelihood options. People in Bhanjyang, which is comparatively rural, had fewer livelihood options and were, thus, striving hard to earn their livelihoods through livestock farming, despite the hardships. The functional establishment of small cottage industries based on NTFP collection, such as plums and ginger in the Shreechap CFUG (Figure 4), and charcoal briquette production from forest weed plants, such as Banmara (*Eupatorium sp.*) in Bhanjyang, helped to improve their livelihoods. Because of the approaching cold and monsoon season, the income from briquettes was higher than before the earthquake. Each woman received NPR 1.5–3 per briquette. After the earthquake, the local financial cooperatives of the community forest user groups were also providing loans to those who wanted to build their houses at a lower interest rate than other financial banking institutions. A total of 100% of the respondents of both CFUGs stated that they had better access to loans after the earthquake. They did not need to deposit any collateral for the loans, as the money is lent based on the recommendations of community members. A certain amount of these funds were allocated for income-generating activities, such as vegetable, cardamom, and livestock farming.



**Figure 4.** The figure (a,b) shows the NTFPs from small cottage industry in the Shreechap CFUG.

### 3.2.5. Human Capital

Human capital represents the skills, knowledge, ability for labor, and good health that, together, enable people to perform different livelihood activities and achieve their livelihood objectives. Literacy and health have major influences on human capital. Free health camps were frequently conducted to provide basic health services to the local people in both villages. Every community school, in both villages, had suffered damage and the schools were closed for several months. As the earthquake occurred at midday on a Saturday, the schools were closed and none of the students were injured. The situation would be more tragic if the students had been at school. After the earthquake, temporary schools were established, and the students studied in the school playgrounds. However, the open classroom was distracting and had a psychological impact that reduced the children's performance. Parents were also reluctant to send their children to damaged schools. If this situation were to continue for a long time, it would certainly impact the human capital in the earthquake-affected areas, which could be measured with long-term research.

With regard to the forest and its management, district forest offices were providing lectures to students and training to women's groups about different forest management techniques that could be used during forest fires and times of natural disaster. A total of 32% of the respondents in the Bhanjyang CFUG, and 35% in the Shreechhap CFUG (Table 3), stated that they received training related to healthcare and income generation. Income-generating trainings, such as those used for briquette and plum production, were helping their resilience.

### 3.3. Perception of CFUG Household on Forest Conservation

More than 90% of the respondents from both of the villages agreed on the conservation of the forest, which indicated their strong commitment towards the conservation of natural resources. A total of 21 (62%) respondents from the Bhanjyang CFUG, and only 12 (35%) from the Shreechhap CFUG (Table 4), were not satisfied with the rules imposed on the extraction of forest products from the community forest. In the Shreechhap CFUG, the majority of the respondents thought that these rules helped to protect the forest from overutilization and its deterioration.

**Table 4.** Attitudes of CFUG households on forest conservation.

S. No.	Statement	Bhanjyang n = 34 (%)		Shreechhap n = 34 (%)	
		Yes	No	Yes	No
1.	Are you satisfied with the rules on the extraction of timber after the earthquake?	13 (38)	21 (62)	22 (65)	12 (35)
2.	Do you think that these rules help to protect the forest for the future?	33 (97)	1 (3)	31 (91)	3 (9)
3.	Did the forest help to increase your income before the earthquake?	29 (85)	5 (15)	21 (62)	13 (38)
4.	Did you actively participate in forest management before the earthquake?	26 (76)	8 (24)	20 (60)	14 (40)
5.	Do you still think the forest should be conserved?	32 (94)	2 (6)	31 (91)	3 (9)

The respondents from both of the community forests believed that the forests had provided various benefits in the past, and also agreed on the fact that the forests had provided them with income-generating opportunities, with a higher percentage in Bhanjyang, accounting for about 85% of the respondents (Table 4). In both of the community forests, more than 60% of the respondents claimed that they had actively participated in the forest management program before the earthquake. Because of their active participation in the past, they are aware of the benefits from the forest. During the focus group discussions, they stated that their wishes were to hand over the properly managed forest to the next generation. The presence of the forest increased the reoccurrence of previously unavailable water springs and the natural environment was the main reason for forest conservation.

We can say from our results that the Bhanjyang CFUG was more affected and more forest-dependent than the Shreechap CFUG. This was because of the geographical differences between the two community forests. The Shreechap CFUG had alternative livelihood options because of its nearer proximity to the district's headquarters.

#### 4. Discussion

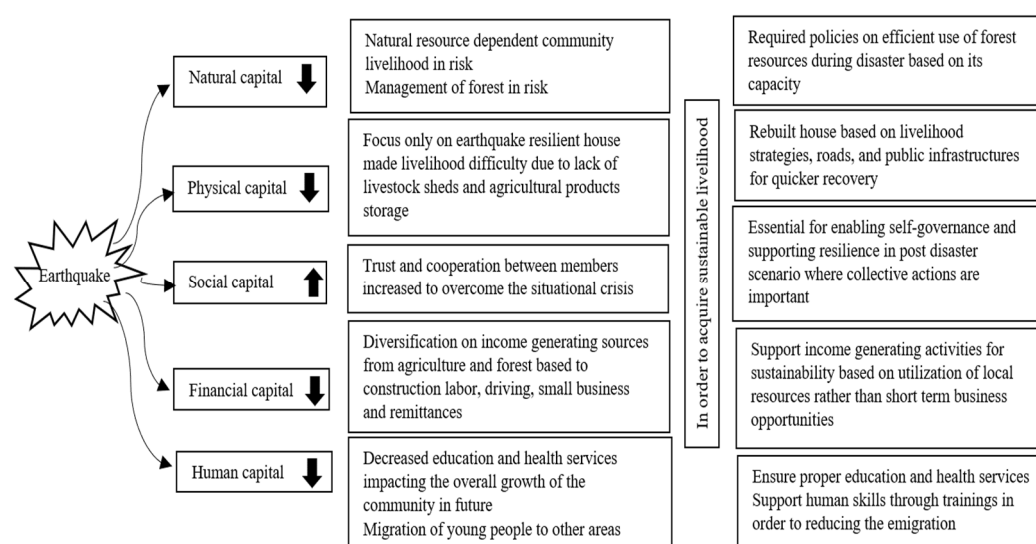
##### 4.1. Impact on Five Livelihood Capitals

The study showed that the natural, physical, human, social, and financial capitals of both study sites were equally affected because of the homogeneity in the contributing factors to vulnerability. We found that the people's perception of natural capital decreased in both of the community forest user groups after the earthquake. Other researchers have also observed a decline in the status of the forest and pasture lands six months after an earthquake, but substantial recovery was observed within a year [2]. Timber was a high-demand product in both community forests because it is one of the main structural components of rural houses in Nepal, approximately 80% of which are wooden-framed houses and rubble stone constructions [29]. The immediate ripple effect of the earthquake in the community forest of Nepal was a government ban on the extraction of timber to protect the unwanted extraction of timber from the forest. In developing countries such as Nepal, communities are strong while governments are weak [30]. Commonly pooled resources are the most vulnerable assets in the aftermath of disasters and, thus, community acceptance drives the outcome of government policies. After disasters, people tend to collect more resources from the forest [26]; however, during the 2015 earthquake, a restricted access to forest products was observed in our study.

Approximately 65% of the people in Nepal work in agriculture, which contributes approximately 33% of the national GDP [17]. Rural households in the hilly areas of Nepal primarily depend on natural springs near forests for agricultural production. During the earthquake, water springs were buried or had dried up because of the landslides. Thus, there was a huge scarcity in the water supplies of the villages. Livelihoods dependent mainly on agriculture and livestock are highly dependent on the availability of water and this is even more pronounced in rural hilly areas [31]. Water scarcity created the shortage of clean drinking water as well as of the irrigation water for agricultural production. In a study in the Dolakha district, 86% of the households reported damaged springs and wells and that access to drinking water was difficult [2]. Without an income from crop production and animal farming, the people's ability to feed their families was affected. Purna Bahadur Shrestha in Bhanjyang CF stated that "16 springs around the villages dried up due to the earthquake and landslides. This has created a huge scarcity of drinking water in the village. Similarly, the agricultural production has also been affected due to shortage of water and we are also doing different farming practices that need less water."

Besides the impact on the natural resources, the earthquake also created physical and social disturbances in the community. After the 2015 earthquake, all of the socioeconomic indices, including the production section which includes agricultural activity, decreased, except for the health and social sectors, which increased [23]. Losses in the production sector impact employment levels and lead to increased migration [2]. In our study, there was a high percentage of people over 50 years old and we also observed that both villages lacked young male manpower. This is due to the migration to bigger cities or Middle Eastern countries for employment, and will inevitably lead to passive participation in community forestry activities, such as pruning and tree felling, which require manual labor. The families with members abroad who send remittances had decreased dependencies on forest resources, as they collected less amounts of timber [26]. This can have both positive and negative consequences; thus, a balance is necessary for benefit-sharing from the forest. A lower dependency on the forest for livelihoods may generate less interest in the management issues of the forest, which ultimately hinders the maximum utilization of forest resources.

Our study shows that the earthquake damaged roads and disrupted transportation. In disasters, whether natural or human-made, transportation disruption is one of the major sources of social and economic losses [32]. Therefore, for a speedy recovery after an earthquake, the importance of the transportation sector should not be neglected. Likewise, in developing countries such as Nepal, where corruption runs deep, public institutions frequently attract relief funds and crowd out private institutes [24,33]. Social capital is essential for rehabilitating, relieving, and recovering a community after a disaster [34]. The effective management of collective action and the existence of the strong social capital of CFUGs helps them to enhance social cohesiveness and networking to strengthen relationships with other actors [35]. Bonding social capital has the mediating effect of engendering mutual trust and, in turn, enabling collective action, which is essential for enabling self-governance and fostering resilience in postdisaster scenarios [24]. Natural disasters in developing country settings can deteriorate human capital in the long run, which potentially affects labor market outcomes [25]. Our study also claims that decreased education and health services will impact the overall growth of the community in the future, and that the migration of youth will create labor shortages. The Figure 5 shows the conceptual diagram on impacts of earthquake on livelihood capitals and necessary actions required for community to be resilient.



**Figure 5.** Conceptual diagram representing impacts of the earthquake on livelihood capital assets and options for sustainable livelihoods in the study area.

Most of the capitals (natural, physical, financial, and human) were negatively affected, whereas positive effects were seen only in social capital. Forest and agriculture are the key elements of natural capital, and those are the sources of livelihood survival in most of the households of the study area. In order to acquire a sustainable livelihood, natural capital should be prioritized.

#### 4.2. Forest Conservation

Our results show that community forest households had a strong commitment towards the conservation of the forest. The community forest user group policy to accord with the ban on timber extraction can also be praised for the fact that, because of the ban, the natural resources were preserved. This is an example of the community-driven governance of the resources, an example of the concept of “the commons” proposed by Ostrum [36], which is contrary to the “tragedy of commons” promoted by Hardin [37]. In developing countries, especially ones such as Nepal, the communities are strong while governments are weak. Commonly pooled resources are the most vulnerable assets during disaster aftereffects. Our results show that most people were not satisfied with the rules on the

extraction of timber. Informal discussions with stakeholders indicated that the people would have been satisfied if they had been allowed to extract more, but if people were freely allowed to extract timber from the forest, incidences of illegal extraction and the reselling of timber for income generation would have occurred among poor people; thus, controls on extraction were validated as a good option for conserving the forests. The research on community forests in Nepal reveals considerable evidence of improved forest protection and regeneration, with positive impacts on livelihoods [7,10,38], and has proposed that the improvement in livelihoods motivates forest conservation. The limits on community forest access, thus, deprived people of such incentives after the earthquake, as most of the indicators for the forest product supplies were decreased; nevertheless, they remained positive about forest conservation. It can be argued that this is because people have not only become financially attached to forest management but are also driven by emotional attachment. Older people had more confidence about participating in forest conservation and a more supportive attitude towards it. Older members consider the forests to be part of their homes, possessed more knowledge about the forests, and wanted to share their traditional knowledge of forest conservation [39]. Our study also supports this statement, as the majority of respondents were from an older age group. Identification with nature leads to an expanded sense of self and the greater valuing of nonhuman species, thus fostering proenvironmental behavior [40].

A previous study [35] stated that the CFUGs distributed forest products for reconstruction works and as immediate sources of energy and livestock feed after the earthquake; conversely, our study shows that there was a greater decreased availability of forest products for reconstruction than before the earthquake. This was because the study sites were more severely affected than other districts, and also because the forest users were more focused on conservation. Bishnumaya Shrestha, a respondent, quoted that “The green forest that we see now was just a barren land with no vegetation. We have planted trees with our hands and taken care of them for decades. We always took care of the forest with the dream of handing it to the coming generation. If the ban on access to community forest was for reasons of conservation, then it’s ok.” In the Shreechhap CFUG, priority towards conservation was also prompted by the award presented earlier, which motivated them to conserve the forest. In Bhanjyang, the forest was seen more as the means of livelihoods, and people wanted to use it in the crisis scenario. The Bhanjyang CFUG had fewer male members, which might have had an impact on the forest management as forest management requires trimming and log felling. Previous studies have shown that, in female-only-managed forests, more forest protection is observed; however, during disasters, the situation is opposite. Thus, the approach of conservation during earthquakes needs to be changed to take into consideration livelihood sustainability. People have different perceptions regarding the value of the forest, which is seen less as a direct source of livelihoods, and more as a natural resource that needs to be conserved. This is a significant change and one that needs to be recognized by community forestry policies and legislation in order to maintain community forestry as relevant and useful for forest management in the future.

## 5. Conclusions

Our research concludes that the community forest user groups perceived negative effects on four capitals, which are the natural, physical, financial, and human capitals, whereas the social capital improved as social relationships and interactions increased within the community after the earthquake. Controlled access to community forest products during the recovery phase did not affect attitudes towards forest conservation, as people were aware that they had previously benefitted from the forest, and they had an emotional attachment towards the forest. However, the challenges in such communities after an earthquake, including the lack of jobs and economic diversification, as well as young people leaving the community, might ultimately affect forest management activity. Thus, for forest management and conservation, the livelihood options in a disaster-struck community play



a vital role. Local institutional policies and mechanisms should be strengthened to provide communities with the necessary knowledge, skills, and practices for smoother and more effective postdisaster recovery.

In areas such as rural Nepal, where people depend on agriculture and livestock for their livelihoods, we suggest that policies be implemented and adopted earlier to strengthen livelihood options. Nontimber forest products could be another source of local employment, and the promotion of NTFPs should be prioritized. These should primarily aim to encourage the youth to return to farming and to introduce new agricultural policies and programs that will help them to adopt new technologies and to access resources, including land, credit, and markets. This will motivate the youth to stay in their villages, rather than emigrate for employment opportunities, and would synchronously help in further conservation.

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