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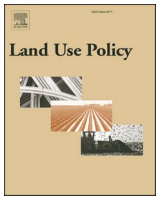

Impact of COVID-19 in the forestry sector: A case of lowland region of Nepal

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ABSTRACT

All walks of life have been affected by COVID-19 but smallholders from developing countries have been impacted more than others as they are heavily reliant on forest and agriculture for their livelihoods and have limited capacity to deal with COVID-19. Scholars are heavily engaged in assessing the impacts of COVID-19 on health and wellbeing, gender, food production and supply, stock market and the overall economy but not on the forestry sector. Using questionnaire surveys and key informant interviews—informed by grey literature and published articles— representing Division Forest Offices, Provincial Forest Directorates, and the Ministry of Forests and Environment in Nepal, this study assessed the impact of COVID-19 on the forestry sector of Nepal. Our analysis suggests that: (1) nature-based tourism is more severely affected than other sectors; (2) private, religious and leasehold forests faced minimal impacts of COVID-19 than that of community and government-managed forests; (3) wild boar (Sus scrofa), different species of deer, and birds have been more impacted than other wild animals; (4) the price of the timber has increased significantly whereas the price of non-timber forests products (NTFPs) has decreased; and (5) illegal logging and poaching have increased but the incidence of forest encroachment has been reduced. Our study further reveals that agroforestry practices in home gardens, borrowing money from neighbors/banks/landlords and liquidating livestock remained key alternatives for smallholders during COVID-19. Many studies reported that reverse migration could create chaos in Nepal, but our study suggests that it may enhance rural innovation and productivity, as returnees may use their acquired knowledge and skills to develop new opportunities. As COVID-19 has created a war-like situation worldwide, Nepal should come up with a forward-looking fiscal response with alternative income generation packages to local living to counter the impacts of COVID-19 on the forestry sector. One of the options could be implementing similar programs to that of India's US$ 800 Compensatory Afforestation Program and Pakistan's 10 Billion Tree Tsunami Program, which will create a win-win situation, i.e., generate employment for reverse migrants and promotes forest restoration.

1. Introduction

Animals are the vector of over 60% of infectious diseases worldwide and about 75% of new or emerging infectious diseases are zoonotic (Nasi and Fa, 2020). Many of them turned into the pandemic stage. Three major global pandemics are all thought to be zoonotic: (1) the plague in the 14th century that killed more than 50 million people in Europe; (2) the Spanish flu during 1918–1919 that killed about 40 million people worldwide; and (3) the COVID-19 has now already killed over six million worldwide (WHO, 2022). In a way or other, such diseases are related to deforestation and forest degradations, creating a scarcity of resources. Thus, people venture into forests for resources and animals venture out of their habitats for forages/crops, which in turn, accelerates human-wildlife interaction and causes more zoonotic diseases (Stanford University, 2020). It is reported that about a billion of the global population depend on wild foods from forests and nearly 2.4 billion use wood-based energy for cooking (FAO and UNEP, 2020). However, despite the decreased rate of deforestation over the past 30 years, overall deforestation is still significant at 10 million hectares per year between 2015 and 2020 (FAO and UNEP, 2020). Hence, protection and wise

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management of forests is more important than ever for people's livelihood and avoiding zoonotic diseases.

Pandemics have larger impacts on both developed and developing countries; however, developing countries suffer more as compared to the developed ones due to their limited capacity to deal with such impacts and so the COVID-19 (Ahmed et al., 2020; Barbier and Burgess, 2020; Dixon et al., 2021). Lack of employment safeguards and financial security as of the high-income countries, people of developing countries should continue depending on natural resources, primarily on agriculture and forests, for their livelihoods (Laudari et al., 2022, 2021; Rahman et al., 2021). COVID-19 could have massive impacts on such essential livelihood resources and the resource-dependent people. In this perspective, it is crucial to assess such impacts for effective future planning so that livelihood resources could be better managed and at the same time global and national policy could be designed to balance peoples' livelihoods and resource sustainability as aimed by the sustainable development goals (SDGs).

As the COVID-19 impact would be multi-sectoral, the extent and diversity of impact to different sectors could be different. Immediately after its emergence in late 2019, scholars are heavily engaged in the assessment of the impacts from COVID-19 with higher attention towards health and wellbeing, gender, food production and supply, stock market and the overall economy (Feber et al., 2020; Wenham et al., 2020; Li et al., 2020; Bartik et al., 2020; Laborde et al., 2020; Baker et al., 2020; Atkeson, 2020) and of course such impact assessments are primarily focused on developed nation. There are very few studies on the impact of COVID-19 in the forestry sector of the countries with higher dependency on forest resources (Laudari et al., 2021; Amador-Jiménez et al., 2020; Lindsey et al., 2020). Impacts of COVID-19 in the forestry sector might be completely different as per various responses from specific activities, management regimes and their level of interactions among people. In addition, continuing effects of COVID-19, limited public movement (i.e., lockdown and prohibition) and stunted economic activities might have multi-fold impacts on forest management and development activities, wildlife habitats, forest encroachment and illegal felling, value chain of forest products, and ultimately the livelihood alternatives of forest-dependent people.

Nepal's forestry sector plays a significant role in people's livelihoods and socio-economic development of the country, contributing about 9% of the national GDP (NFA, 2008a, 2008b). Forestry is one of the most promising contributer in Nepal's economy that timber and fuelwood alone generated an annual average revenue of USD 3.3 million in the last fifteen years (2003–2018) (Bhatt et al., 2021). In the recent days, forestry has been considered beyond the forest and non-forest goods such as non-timber forest products (NTFPs) —which alone shares the total export value of over US$700 million, and accounts for over 11% of the total Nepalese export (DFRS, 2015)—and recognized as the source of multiple services, including tourism and carbon sequestration. Accordingly, the forestry sub-sectors have been widened and many initiatives such as homestay business, wildlife farming, eco-tourism and park management are being implemented. These initiatives demand active interaction between entrepreneurs, local people/forest user groups, forest management officials and more importantly flow of the visitors. Moreover, active forest management requires more forestry workers/labourers, technicians and management officials in the field site (Poudyal et al., 2020). As all these activities are heavily contributing to the local and national economy and livelihoods of the communities, as well as the conservation of forests and forest resources, it is crucial to assess how the ongoing pandemic COVID-19 has impacted these activities.

In the case of Nepal, few studies (Basnyat et al., 2020; Khadka et al., 2020; Paudel, 2020; Laudari et al., 2021) have linked the forestry sector and COVID-19. For example, Basnyat et al. (2020) assessed likelihood of COVID-19 impact on timber import, forest harvesting and employment, Khadka et al. (2020) linked COVID-19 with tourism sector, including nature-based tourism, Paudel (2020) argued for short-term environmental benefits (i.e., less likelihood of forest fire), and Laudari et al. (2021) focused on negative impact of COVID-19 on forest-based enterprises. Those literatures however assessed only the likely impacts on a sectoral basis rather than the actual impacts experienced by the stakeholders. Very little is known about the impact of COVID-19 in Nepal's forestry sectors based on its management regimes, sustainable forestry management, development activities, and overall management challenges of the forestry sector. On top of that, we aim to bridge the knowledge gap of how forestry stakeholders have perceived the impacts; what are the underlying factors that exacerbate or reduce such impacts; and how forest-dependent people are coping with the impacts of COVID-19.

In this pretext, we have assessed the impact of COVID-19 in the forestry sector of Nepal capturing the real ground experiences of key forestry officials/stakeholders from national to local levels engaged in forest management of lowland region of Nepal. The overarching aim of this study is to answer three key questions: (a) what are the hardest hit forest sub-sectors and activities by COVID-19 in Nepal's lowland (b) What are the responsible factors to create such impacts and (c) How the forest-dependent people are coping with those impacts? The findings of this assessment will help policymakers and forestry stakeholders to understand the risks and uncertainties triggered by pandemics such as COVID-19 while designing and implementing forest management policies and their implementation.

2. Methodology

The study was carried out in Nepal, focusing on how COVID-19 impacted the forest management aspects of the southern lowland region. Map 1 shows the distribution of forestlands throughout the country which is extracted from the global land cover map produced by ESRI, Microsoft & Impact Observatory (2021). Lowland region of Nepal includes Tarai and Siwalik area of the southern part of Nepal (Map 1), which harbor critical forest based ecosystems. Lowland region was selected considering the challenges in the management of commercially high-valued forest resources due to illegal logging, fire, encroachment as well as being a hub for nature-based tourism (Aryal et al., 2021b, 2021a; Joshi et al., 2018). Moreover, COVID-19 was initially spreading in this region of Nepal, and yet, this is highly affected region by the pandemic. Furthermore, approximately 8 million Nepalese people work abroad as labourers and some of them are returning to Nepal, particularly from India, and settling in this area, putting enormous pressure on forests resources (Bhattarai et al., 2020; Singh, et.al, 2020).

This assessment followed both qualitative and quantitative approaches of research in data collection and analysis. Key methods of data collection include questionnaire survey, telephone interview, participatory observation and tracking of (social) media data. A set of 8 semi-structured questionnaires were designed and commissioned to the respondents as attached in Annex 1 of this paper. Almost all the

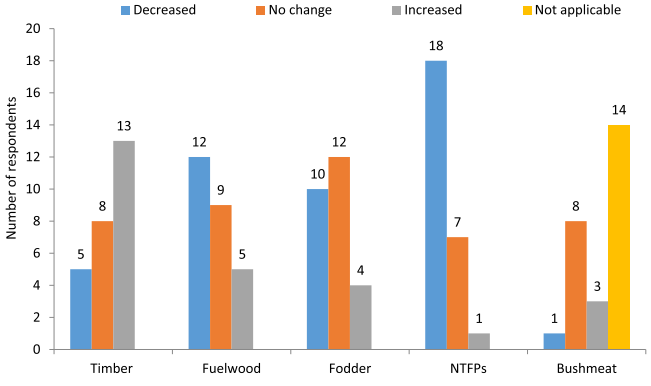
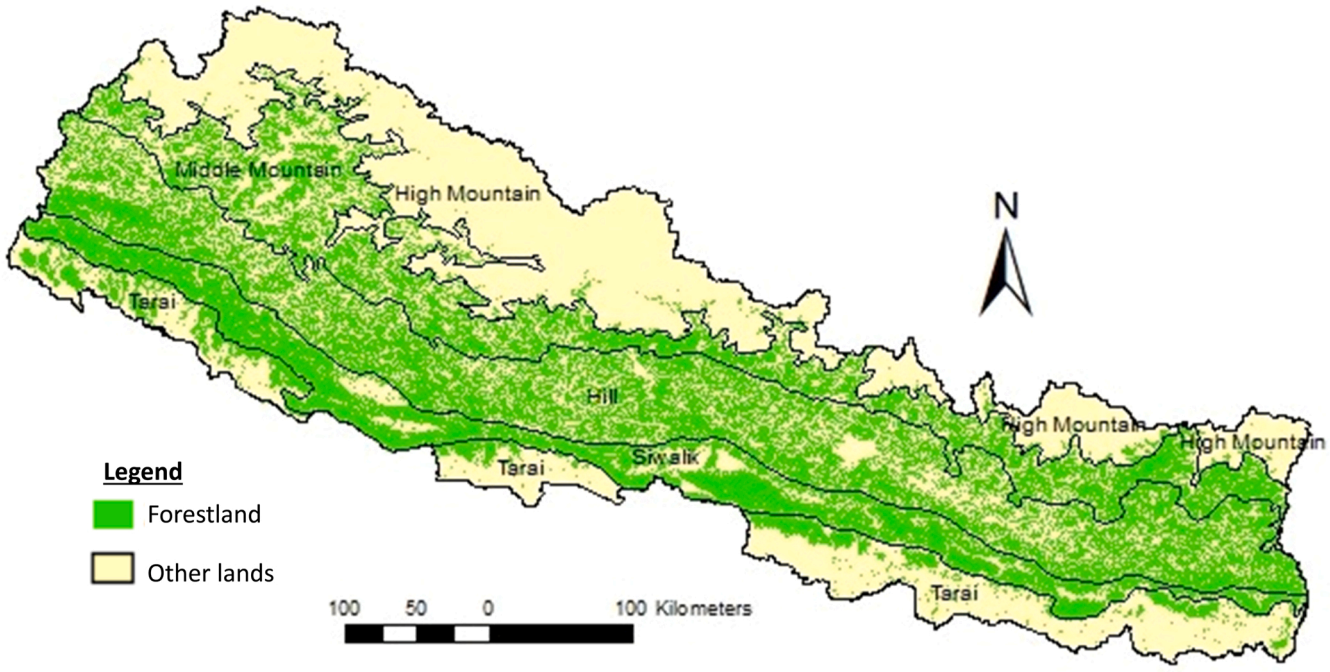


Fig. 1. Forest products and their market prices during COVID-19.



Map 1. Forest map of Nepal, showing its physiographic distribution.

questionnaires were open-ended so that respondents could have enough room to reflect on the real ground situation as well as highlight the key strategies adopted for forest management and coping with the COVID-19 pandemic. While one of the questions was to choose their agreement or disagreement on the statements. The framing of the questions was inspired by previous literatures about the impact of COVID-19 in various sector (Basnyat et al., 2020; Paudel, 2020; Laudari et al., 2021), and structured through experts' consultation. Those statements were finalized after rigorous discussions among the authors and were also based on the experiences and ground situation of the study region. We designed the questionnaire to assess the impact of COVID-19 in various dimensions, including most impacted forestry sub-sector, management regimes, livelihood strategies, wildlife conservation and others. Altogether 26 respondents, representing divisional forest offices of 18 southern lowland districts (n = 18), 5 provincial forest directorates (n = 5), and the Ministry of Forests and Environment (n = 3) at the national level, responded to the questionnaires. While selecting the respondents, we first aimed to gather information from the head of the respective organization, and in the absence of the head, we collected information from the deputy head. A distance interview was conducted for the same respondents to verify the responses gathered from division forest offices. To get the additional information regarding COVID-19 impact on forestry (sub) sectors and validate the response gathered in the survey, we followed the national media, including the national newspaper (online) and tracked the data related to COVID-19 impact in various subsectors of forestry. Participant observation from one of the authors working in the region and experiences of all the authors has enriched the discussions. And finally, the information gathered were tabulated and interpreted based on the response of the respondents.

3. Results

3.1. Perceived impact of COVID-19 in forestry sectors

COVID-19 is supposed to impose various effects on natural resource sectors, and forestry-related activities are prone to be negatively affected by COVID-19, ranging from seedling production through nursery operation to indirect values (recreational) of forests. Table 1 presents the list of forestry activities/sectors impacted by COVID-19 and the level of impact as categorized by the respondents. We found nine major forest-related activities that were more or less impacted by COVID-19. As per the respondents' observation, ecotourism/recreation in general and homestay business, in particular, was on the top list of being severely impacted. More than 85% of the respondents rated nature-based tourism (ecotourism/recreation/homestay) as a severe and highly impacted sector. Sawmill operations and resin collection activities were the second hardest hit by COVID-19, followed by the furniture industry.

Table 1
Hardest-hit forest related activities and the extent of impacts (N = 26).

Hardest hit forests-related sectors	Number of responses		
	Severely impacted	Highly impacted	Moderately impacted
Ecotourism/recreation/ homestay	8	10	3
Sawmills/resin collection	5	6	3
Furniture industry	4	5	1
Forest-based laboring	3	1	–
Forest protection/ harvesting logging	2	–	1
Forest training/Capacity Building	2	–	–
Forests Product Distribution	2	–	–
Collection of NTFPs	–	2	1
Nursery operation	–	–	1

Note: We requested respondents to suggest forests-related sectors that have been hardest hit by COVID-19, and order them most impacted first, and so on. Therefore, the sum of the number of responses is not 26.

3.2. COVID-19 impact on the forest management regime

The intensity and scale of COVID-19 impact on different forest management regimes were inconsistent. Table 2 presents the level of impacts perceived by the respondents on different forest management

Table 2
Level of COVID-19 impacts on different forest management regimes (N = 26).

Forest management regimes	Number of responses		
	Least impacted	Moderately impacted	Highly impacted
Private forests	7	3	1
Religious forests	6	3	2
Leasehold Forests	5	3	1
Community Forests	3	2	5
National parks	3	1	1
Collaborative Forests	2	1	
Government managed forests			1

Note: We requested respondents to suggest forests-management regimes that have been hardest hit by COVID-19 and order them from highly impacted to least impacted. Therefore, the sum of the number of responses is not 26.

regimes. Findings revealed that private, religious and leasehold forest management regimes faced minimal impacts of COVID-19, whereas the community forest management regime was one of the highly impacted management regimes. Nearly 70% of the respondents viewed that private and religious forests were among the least impacted from COVID-19, whereas 27% of respondents reported that community forest is either highly or moderately impacted. Only one respondent mentioned that the government-managed forests were highly impacted.

3.3. The most impacted wild animals during COVID-19

All the respondents of our study agreed that the cases of wildlife poaching, including rare and endangered animal and bird species are on the rise in the southern lowlands of Nepal during the COVID-19 pandemic. Table 3 illustrates the type of animals and the extent of COVID-19 impacts on it as perceived by the respondents. Approximately 62% of the respondents reported wild boar as either severely or highly impacted animals. Respondents also listed different species of deer, fishes and birds as one of the severely impacted wildlife. Blue bull (*Boselaphus tragocamelus*), reptiles, one-horned rhino (*Rhinoceros unicornis*), elephant (*Elephas maximus*), bison (*Bos gaurus*) and pangolin (*Pholidota species*) were also included as impacted animals during COVID-19 but by very few respondents.

3.4. Impact of COVID-19 on the market prices of different forest products

One of the key areas impacted by COVID-19 is the market of forest products. The study revealed that the price of forest products in the market was affected substantially. Among the five categories of forest products listed in Fig. 1, the majority of respondents viewed that price of the timber was increased significantly whereas fuelwood and fodder market price were decreased or no changed. However, more than 75% of respondents experienced that the market price of NTFPs was decreased.

Table 3
The most impacted/poached animals (N = 26).

Impacted animals	Number of responses		
	Severely impacted	Highly impacted	Moderately impacted
Wild boar	10	6	
Dears (different species)	8	6	1
Fishes	6	4	2
Birds	3	2	1
Blue bull	1	2	
Reptiles, including gharial (a species of crocodile)	1	2	1
Rhino	1		1
Elephant	1		1
Bison	1	1	
Pangolin		1	

3.5. Factors responsible for impacts on the forestry sector

Respondents were asked to rate their observations in the statements (Table 4) about the factors affecting forestry activities. The results revealed that mobility restriction induced by COVID-19 lockdown impacted the ground monitoring capacity of the forest offices. Consequently, it resulted in higher cases of illegal logging and poaching whereas respondents viewed that forest encroachment has not increased even in this difficult time. Likewise, respondents disagreed on the view that the government has increased development works in forest land during COVID-19 taking advantage of minimum surveillance from civil society organizations. Moreover, respondents suspect increased deforestation and forest degradation after settling down of COVID-19 as they believe the government would have more forest-based activities that are focused to increase financial returns i.e., income and employment resulting in heavy pressure on the forest resources. Likewise, respondents reported that more people have returned to the village after COVID-19 and put more pressure on forest resources. But at the same time, the respondents agreed that it is highly likely to (potential)

Table 4
Respondents reflection on immediate and potential future impacts of COVID-19 in forestry activities (N = 26).

Statements	Percentage of respondents				
	Strongly disagree	Disagree mildly	Neither agree nor disagree	Agree mildly	Strongly agree
Illegal logging is growing	0	12	19	35	35
Forest encroachment is growing	8	38	31	12	12
Poaching is growing	0	4	12	54	31
The government think that this is an appropriate time for accelerating development activities on forest land	19	38	15	12	15
When COVID-19 is over, government may prioritize employment & financial returns, which could result in increased rates of deforestation and forest degradation	4	15	31	35	15
Community forests are less impacted by COVID-19 responses compared to government forests	4	4	19	46	27
Tree planting time is delayed or suspended	0	15	54	15	15
COVID-19 is accelerating migration to rural areas. This will put stress on forests resources.	0	4	12	46	38
In the long run, reverse migration may enhance rural innovation and productivity	8	8	15	31	38

increase agricultural productivity because of (reverse) migration-led innovation and workforce.

3.6. Alternatives adopted by smallholders and local communities

As noted earlier, access to forest products was impacted in the difficult times of COVID-19. Since forests have been an indispensable resource for the livelihoods of smallholders and local communities and forest-dependent people had to fulfill their urgent needs by adopting different strategies based on the available options and their socio-economic capacity. Our findings revealed that agroforestry practices in their home garden remained a key alternative for local communities (Table 5). Likewise, borrowing money from neighbors/banks/landlords was viewed as the second option adopted followed by liquidating livestock to manage the livelihoods during COVID-19. Other options mentioned by the respondents include laboring in other's fields, collection of non-timber forest products in and around the community and private lands, and requesting municipal support.

4. Discussion

In general, there are two reasons why the forestry sector would be highly vulnerable from COVID-19: (1) forests supply raw materials for several essential health products for COVID-19 (FAO, 2020a), but the forestry sector itself is considered non-essential in many Asia-pacific countries during lockdown; and (2) due to COVID-19 response, most of the forest-related activities are ceased off and, thus, affected the entire value chain. Approximately, 80–90% of global forest enterprises are small and micro forest enterprises and 75% of forest production is informal (Mayers, 2006; FAO, 2020a). These enterprises provide jobs to millions of people but are highly vulnerable to this type of disaster (IIED, 2016; PROFOR, 2019), as they do not have access to social security and economic incentives. In this section, we have discussed specific (possible) reasons behind the findings of this study and their potential implications to the forestry sector of Nepal.

4.1. Perceived impact, possible reasons and consequences in the socio-economic and environmental sustainability of forest-based enterprises

Findings revealed that ecotourism and homestay businesses are the most impacted sector by COVID-19 in Nepal. Since nature-based tourism and homestay business are being one of the primary sources of livelihood for the people inhabiting nearby forests and protected areas for the last few decades, enforcement of lockdowns has abruptly affected the livelihood of homestay owners, tourists guides, greeters and cultural performers in this region. For instance, tourism which accounts for about 8% of the GDP of Nepal, supporting more than a million jobs is brutally diminished (Koirala and Acharya, 2020; Sah et al., 2020). In addition, nature-based tourism which attracts more than 70% of the international tourists in Nepal is severely affected due to lockdown and partial restriction in travel (Sah et al., 2020; Ulak, 2020a, 2020b). With the excitement of the significant contribution of these sectors in improving livelihoods and conservation of forests and wildlife in the region, the government of Nepal has been promoting such businesses. Before the outbreak of COVID-19, many investors were attracted to the sector with an increased number of homestays openings due to the Visit Nepal 2020 campaign of the government (Pandey and Dhakal, 2019). As of 2019, nearly 320 registered homestays and many other unregistered homestays were under-functioning in the village areas of Nepal (Dahal et al., 2020). In the Terai Arc Landscape, WWF (2020) alone has supported a total of seventeen homestays. Because of COVID-19, all the businesses remained closed for a long time and the livelihood of homestay owners, greeters and cultural performers have been severely impacted.

The findings corroborate with the previous study that the ban on international travel due to the COVID-19 pandemic has disrupted the income generation from trophy-hunting and community-based enterprises (including lodges, campsites and craft shops), causing losses of income for conservancies, their inhabitants and Joint-Venture Partnerships in Namibia (Lendelvo et al., 2020a, 2020b). Experts reported that the mass withdrawal of domestic and international tourists leftover 414 rooms and 676 beds empty — impacting over 204 households. More than 400 other livelihoods connected to these homestay businesses — such as dairy, vegetable, and meat providers — have also seen their income dwindle (WWF, 2020). Impact on these businesses especially, homestays across the peripheries of Nepal's protected areas will have far-reaching negative consequences in sustainable management of forests and wildlife. The collective economic pressure on the people, whose livelihoods are heavily dependent on such businesses, may leave communities with no option but to rely on forests for energy sources (e.g. firewood and timber).

The financial stress on communities is already leading to rising pressure on Nepal's protected areas, particularly those that are tiger-bearing. Nepal's tourism industry also generates 95% of park revenue, 30–50% of which is channeled back into the development of local buffer zone communities (DNPWC, 2020). This loss of income will not only further jeopardize local economic growth but will also impact the overall management of protected areas, including national parks and conservation areas, especially as Nepal's Ministry of Forests and Environment may experience budget cuts in light of limited revenue collection. The government even may require large amounts of external financial assistance to operate the protected areas as before because of the significant reduction in the revenue (Lendelvo et al., 2020a, 2020b).

As the future of tourism is still highly uncertain even after the post-pandemic, it has brought us to a crossroads– giving us the perfect opportunity to select a new direction and move forward by adopting a more sustainable path (Ioannides and Gyimóthy, 2020). To make Nepal's tourism sector sustainable, the country should give priority to nature-based tourism by providing fiscal incentives for green recovery/investments by bringing on board to private sectors, including small-scale entrepreneurs. Since Nepal has a pristine and well-connected landscape and the world's iconic and endangered animals, investment in nature-based tourism generates millions of green jobs and ensures long-term social, economic and environmental co-benefits.

Likewise, other forest-based enterprises such as sawmills, resin collection and processing, and furniture businesses are also being impacted by COVID-19 in Nepal. This finding is consistent with the findings from studies in other developing countries. Recent news from Vietnam highlighted that the import and export supply chains of the timber processing companies are highly impacted by massive cuts in production. About 76% of Vietnamese processing companies reported a financial impact of US$130 million by March 2020 due to the COVID-19 (Vietnam News, 2020). Similarly, Indonesia has been facing the problem of forest exploitation and illegal logging due to the limited access to other resources and temporary suspension of forest development and empowerment activities (Golar et al., 2020). In Nepal's case, researchers have projected that timber production has been decreased by 80%

Table 5
Alternative livelihood strategies adopted by smallholders and local communities (N = 26).

Alternate livelihood strategies	Number of responses		
	First option	Second Option	Third option
Home garden/Agroforestry	10	3	3
Borrowing money	5	2	3
Liquidating livestock	4	4	1
Labour works in another's field and houses	2	4	1
Collection NTFPs	2	1	3
Asking support from Municipalities	2	1	1
Returned to their business	1		

compared to previous years (Basnyat et al., 2020), resulting in a loss of 9.6 million USD and 3.2 million man-days of employment in the Gandaki province of Nepal (Laudari et al., 2021) due to COVID-19 mobility restriction. If the (legal) supply of timber from Nepalese forests is continued to decline due to COVID-19, Nepal may either heavily rely on importing timber or people may illegally cut forests for meeting their needs. Both situations are detrimental to the forestry sector of Nepal where 45% of the land area is covered by forests and labour forces are considered one of the cheapest in the world.

4.2. COVID-19 impact on different forest management regimes

As we see the result, respondents mentioned private forests, religious forests and leasehold forests are the least impacted forest management regimes by COVID 19. The primary reasons provided by the respondents are the minimum level of interactions and public gatherings required in these regimes. Since these forests are either managed solely by an individual or a small group of people and also not on such a large scale compared to the government-managed and other community-managed modalities, their protection and utilization efforts were not much impacted. As noted, only one respondent mentioned the government-managed forests and suggested that it is highly impacted by the COVID-19 (Table 2). This does not mean that government-managed forest is less impacted than that of community forests, as results from Table 4 suggest that community forests are less impacted by COVID-19 responses compared to government-managed forests. It is worthwhile to mention here that we requested respondents to suggest the type of forest management regimes that have been hardest hit by COVID-19 and order them from highly impacted to the least impacted. Being a subjective question, respondents might have thought from their perspectives, because when the respondents were asked about both forest management regimes (government-managed and community-managed) simultaneously, they prioritized government-managed forest as highly impacted.

Even though there is a significant area of forests being managed as private farm forests following agroforestry practices, officially, there are only 3753 private individuals who have registered 2902 ha as their private forests (Aryal et al., 2020). On the other hand, community forests demand the active engagement of multiple stakeholders and their regular interactions for the conservation and utilization of those forests (Gentle et al., 2020; Laudari et al., 2020; Aryal et al., 2019). Preventive measures adopted by the government for COVID-19 have restricted movements and gathering of the users affecting patrolling of forests as well as making timely decisions in other aspects of forest management. Our findings of high impact on community managed forests and low impact on privately managed forests also support the logic of the theory of property rights (Ostrom, 1990). In hard times, people prioritize protection and management of private property and ignore the protection of common property, which results in weak governance of commonly managed resources.

An increase in illegal hunting of wildlife is also perceived as one of the key impacts of COVID-19 in the forestry sector of Nepal. The increase in poaching and threats to the wildlife during difficult socio-economic and political situations, including political conflicts or any pandemics such as COVID-19, is reported as a common phenomenon, particularly in developing countries. These situations, with no exception of COVID-19, have a massive impact on surveillance of civil society and ground monitoring of forest authorities resulting in poaching and illegal logging. For example, Conservation International has reported that lockdown measures during COVID-19 resulted in increased bushmeat harvest and wildlife trafficking in Africa, as the government lacks the money to support rangers' salaries and patrolling from the air (Conservation International, 2020).

In the case of Nepal, preliminary assessment by WWF-Nepal revealed that there has been a significant increase in illegal human entry into protected areas since the COVID-induced lockdown with the majority of those entries found focused on the hunting of wildlife for meat (WWF, 2020). Hence, respondent's ranking of the wild boar and different species of deer as highly impacted wild animals is substantiated by such reports in a sense that these species are hunted solely for the meat purpose. Wildlife hunting and poaching in the lowland region was also reported to be increased due to various reasons, such as, restriction on movement of even government-owned vehicles, mobility restriction to villages (shutdown of the village), tedious procedures for getting vehicle-pass during the lockdown period, obstruction in arrest, investigation, and register of loggers/hunters due to shortages of PCR test, and the reluctance of government staffs for travel and patrolling into COVID-19 infected areas/field sites due to the fear of its transmission.

As found in this study, COVID-19 will have a significant impact on the market price of the high valued products in the market such as timber. This is mainly due to the imbalanced supply and demand situation and the breakdown of the transportation system and the supply chain (Joshi, 2020). The price of fuelwood, fodder and NTFPs is perceived as either decreased or remained constant. One of the potential reasons behind that could be people consumes those resources for household purposes from their private lands because of the restricted travel and social movement. Also, NTFPs has to be harvested and sold out within a certain time due to their short-term nature of biological maturity as well as lack of proper storage facilities (Maraseni, 2008), products that were matured and harvested during COVID were either sold out in significantly lower price or were completely lost. Similarly, due to the restriction on transportation facilities, the supply chain of NTFPs might have been disrupted. Respondents have highlighted that there is a need for policy and programmatic attention of the federal and local governments to establish NTFP storage facilities to ensure minimum losses (Maraseni et al., 2006). Although food products such as bushmeat are quite common in different parts of the world, especially in Africa, respondents found it not applicable in Nepal's context.

Regarding the factors responsible for the perceived impacts in the forestry sector, limited ground monitoring and a higher level of dependency on forest products are the keys. Similar to our findings, Brancalion et al. (2020) believed that the pandemic has the potentials to be a new driver of tropical deforestation and illegal logging. Our study shows that limitations in-ground monitoring due to the impact of COVID-19 have increased illegal logging and poaching but not encroachment. Golar et al. (2020) suggested enhancing forest patrolling to minimize the threat of forest encroachment during pandemics, however, in our case, encroachment is not a problematic issue but illegal logging. One of the potential reasons might also be that forest encroachment needs social coalition and informal political support, which is very difficult to get in times of pandemics. Nevertheless, forest patrolling is suggested to be improved to reduce (small-scale) deforestation and illegal logging.

Smallholders and local communities who were primarily dependent on forest resources are adopting various livelihood strategies for responding to the impacts of COVID-19 in the forestry sector. Our findings revealed that home gardening and borrowing money were two key short-term strategies adopted by the smallholders in the lowland region of Nepal. Since, farming practice, forests and human subsistence are inextricably linked in Nepalese livelihoods (Gilmour, 1991; Acharya, 2006; Dhakal et al., 2012), those practices became helpful to fulfill their daily needs in these difficult times. Even though the agricultural sector is facing many challenges in Nepal invited by increased youth migration, land fragmentation and increased urbanization (Ojha et. al, 2017; Cedamon et. al, 2018), small-scale agroforestry practices are not much affected and are being a key backbone to fulfill subsistence livelihoods. Policy and programmatic support in such small-scale practices at an individual level could help to sustain the rural livelihoods, particularly in the situation where and when other sources will be impacted by various factors including the pandemics such as COVID-19.

Similarly, local savings and credit cooperatives and mother's groups have been important sources of financial backup to the rural and semi-

urban population. Although these institutions are sometimes blamed for their high-interest rates and multiple requirements to be eligible for credits, these institutions have been an alternative for the local people to manage their financial needs particularly in the situation of urgency created by multiple shocks and pandemics such as earthquakes and COVID-19 (Tompkins, 2018). Regarding the livelihood alternatives, we support a notion mention by Golar et al. (2020) that access to rural living must be improved to minimize illegal logging and deforestation during pandemics.

4.3. Immediate and potential future impacts of COVID-19 in forestry activities

As mentioned in Table 4, at least 70% of the respondents either "strongly or mildly agree" that: (1) illegal logging is growing; (2) poaching is growing; (3) community forests are less impacted compared to government forests; and (4) migration to rural areas is accelerated due to COVID-19. The first three activities are caused by less ground monitoring and civil society surveillance activities. Among the others, reverse migration caused by COVID-19 could have serious implications in Nepal, as about 8 million Nepalese people are working overseas and contributing about 28% of Nepal's GDP (Bhattarai et al., 2020). It is speculated that many governments may prioritize health and financial returns, as a post-crisis response, which would further accelerate deforestation and forest degradation rates (FAO, 2020a). However, 69% of our respondents believe that reverse migration may enhance rural innovation and productivity, as returnees may use their acquired knowledge and skills to develop new opportunities. The finding of our study is in line with a result of a previous study that the return of (male) migrants and youth has reduced women's farming responsibilities and created opportunities for household togetherness at a time of great uncertainty (Nichols et al., 2020). Reverse migration, however, doesn't always bring a positive impact and its impact doesn't remain the same for a longer period. For example, a recent study shows that COVID-19 and the reverse migration has put increasing pressure on forest resources by promoting illegal charcoal production, conversion of forests to agriculture and other unplanned activities where livelihood opportunities are lost (FAO, 2020). Similarly, reverse migration is likely to hit the national economy because of labour shortage in industry, textile and construction work (Mukhra et al., 2020).

Many other countries are considering reverse migration (UN, 2020) as an opportunity to develop the forestry sector. For example, India recently announced funding of US$ 800 to generate employment through afforestation and forest restoration activities in urban, semi-urban and rural areas (UN, 2020). The Jharkhand State of India has created a new afforestation-based income-generation program for migrant workers. In Pakistan, unemployed people have been given jobs to plant trees as part of their 10 Billion Tree Tsunami program (UN, 2020). If Nepal can implement a similar program, part of the reverse migration-related problems can be addressed. To secure funds for this program, among the others, EverGreening Global Alliance (2020) could be instrumental as this alliance aims to capture and restore 20 billion tons of CO_2 annually from the atmosphere to the land by the year 2050 by restoring 500 million hectares of agricultural lands and 575 million hectares of degraded forest lands.

Although the long-term impacts of COVID-19 are highly uncertain, we recommend some forward-looking responses that will help address the cross-cutting impacts of the COVID pandemic: (1) improved environmental oversight and forest patrolling (Brancalion et al., 2020), (2) stimulus packages of clean energy to reduce pressure on forest resources (Aryal et al., 2022; Gillingham et al., 2020), (3) economic incentives and enabling policies to build the resilience of supply chain of timber market (FAO, 2020), and (4) improved access to local people through alternative income generation packages (Golar et al., 2020) to counter the impacts of COVID-19 in the forestry sector for future. As forest-dependent communities are the hardest hit by the COVID-19 crisis, the national and subnational governments need to reaffirm their commitments to the sustainable management of all forests and trees outside of forests, as charted clearly in the UN Strategic Plan for Forests 2030 with its Global Forest Goals and in the 2030 Agenda with its Sustainable Development Goals (Sen, 2020) for creating new green job under various post-COVID-19 recovery stimulus programs (Marchetti and Palahí, 2020) and building the resilience of forest-dependent indigenous and local communities (Sen, 2020).

5. Conclusions

This study has assessed the impact of COVID-19 on the forestry sector of Nepal, capturing the real ground experiences of key forestry officials from national to local levels. Findings suggest that the private and leasehold forest regimes are less impacted by COVID-19, compared to the community- and government-managed forest regimes, mainly due to their strong property rights and provision of integrating cash crops and small livestock. Among different activities within the forestry sector, nature-based tourism, processing companies and furniture industries are hardest hit by COVID-19, mainly due to interruption of supply chain. Due to reverse migration, and less ground monitoring and civil society surveillance activities, illegal logging and poaching have upsurged. The rampant killing of wild boar, deer, birds and some other wildlife for local consumption is increasing. These activities, if continued, could jeopardize Nepal's effort in conserving flagship species, including the tiger (*Panthera tigris*) and rhino (*Rhinoceros unicorns*) and its habitat. In order to minimize these activities during this and future pandemics, investment should be made to fulfill the subsistence livelihood and reduce (in) direct pressure on forests.

Due to strict lockdown from different levels of governments and surveillance of local communities, forests encroachment for squatters and government/public infrastructure activities have been halted, but it is doubtful that this will be maintained in the long term. Improvement in forest law enforcement and governance system can help to combat illegal activities in the forests.

Agroforestry (home garden), borrowing money from different sources and livestock liquidation remained key short-term livelihood management strategies of rural communities. Being smallholders, they have been practicing subsistence farming systems, and therefore, these options are gradually vanishing. Therefore, developing diversified livelihood strategies through making investments in (1) nature-based tourism, (2) reforestation and afforestation programs, (3) clean energy, (4) supply chain of forest products, and (5) entrepreneurship development could help to withstand risks and enhance the resilience of forest-dependent and local communities during and after the COVID-19 pandemic. Moreover, making an association of smallholder farmers and linking them with their value chain actors and building partnerships between them could be instrumental to re-store broken value chains.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Annex 1. Questionnaire survey

1. Which forests-related sectors have been hardest hit by COVID-19, and why? Please order with most impacted first, and so on. Examples include processing companies, ecotourism, homestay etc.

Forests-related sectors	Reasons

2. Which forest management regimes have been the least impacted, and why? Please order with least impacted first, and so on. For example, community forests, private forests, government forests etc.

Forest management regimes	Reasons

3. COVID-19 has impacted local communities and smallholders as forestry operations are ceased. What alternative livelihood strategies have been adopted to meet their urgent needs. For example, liquidating livestock, borrowing money, collecting NTFPs, growing daily needs at home gardens etc?

Alternate livelihood strategies	Reasons

4. What are promising strategies for dealing with the COVID-19 crisis in the forestry sector? Which organizations are instrumental in these strategies? Please explain with examples.
5. Please suggest the impact of the COVID-19 response on illegal poaching of various wildlife. Which animals are the most impacted?
6. Please suggest the impact of the COVID-19 response on illegal harvesting of various forest products. Which products are most impacted?
7. Impact of COVID-19 on the market prices of different forest products. Please suggest whether products decreased, remained constant or increased in price.

a.	Timber:	(i) decreased;	(ii) constant;	(iii) increased
b.	Fuelwood	(i) decreased;	(ii) constant;	(iii) increased
c.	Fodder	(i) decreased;	(ii) constant;	(iii) increased
d.	NTFPs	(i) decreased;	(ii) constant;	(iii) increased
e.	Bushmeat	(i) decreased;	(ii) constant;	(iii) increased

8. Please indicate how strongly you agree or disagree with each of the following statements about the impact of COVID-19

Statements	Strongly disagree	Disagree mildly	Neither agree nor disagree	Agree mildly	Strongly agree
Illegal logging is growing					
Forest encroachment is growing					
Poaching is growing					
Due to reduced civil society surveillance, the government think that this is an appropriate time for accelerating development activities on forest land					
When COVID-19 is over, government may prioritize employment & financial returns, which could result in increased rates of deforestation and forest degradation					
Community forests are less impacted by COVID-19 responses compared to government forests					
Tree planting time is delayed or suspended					
COVID-19 is accelerating migration to rural areas. This will put stress on forests resources.					
In the long run, reverse migration may enhance rural innovation and productivity					

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