Understanding Local Perceptions of NTFP Availability in the Himalayan Landscape of Nepal

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Abstract

Non-timber forest products (NTFPs) are integral to the livelihoods and sociocultural practices of forest-dependent communities in Khare village, Dolakha district, located in Nepal's Gaurishankar Conservation Area. However, their availability is increasingly threatened by climate change and human-induced pressures. This study, conducted in 2023, applied a convergent parallel mixed-methods approach to assess both the status of NTFP availability and local perceptions of climate-related changes. A total of 95 randomly selected households were surveyed using a pre-tested semi-structured questionnaire (Cronbach's alpha = 0.82), supplemented by key informant interviews, focus group discussions and field observations. Results show that 95.8 per cent of respondents observed noticeable changes in NTFP occurrence. While fodder (100%) and fuelwood (99%) were most commonly used, medicinal plants (42%) and honey (21%) had lower usage, largely due to ecological degradation and overharvesting. Significant altitudinal variation was observed ($p < 0.05$ for most categories), with decreased availability reported below 1,600 m and increases above. Key stressors identified included overexploitation (75%), climate change (52%), forest fires (36%), invasive species (*Ageratina adenophora*) and pest outbreaks (*Gazalina chrysolopha*). Respondents emphasised reduced grazing and growing conservation awareness as contributors to localised recovery. The study calls for stronger regulatory mechanisms, sustainable harvesting guidelines and community-led restoration efforts to safeguard NTFPs and strengthen rural resilience in Himalayan landscapes.

Keywords: NTFP, climate change, community perceptions, local ecological knowledge, Likert scale, altitudinal gradient

INTRODUCTION

Non-timber forest products (NTFPs) are products other than timber derived from forests (Ahenkan and Boon 2011). Recently, NTFPs have gained recognition as significant forest resources, especially for rural communities. These products have long been a vital part of livelihoods (Chandrashekharan 1998). Common NTFPs include medicinal and aromatic plants, wild vegetables, wooden utensils, edible fruits, bamboo, fodder, and fuelwood (Shackleton and Shackleton 2004). Among these, medicinal and aromatic plants (MAPs) are the largest and most important component, contributing more to the rural economy and healthcare than other NTFP sub-sectors (Ghimire *et al.* 2008). NTFPs are especially crucial for mountain communities, where 12 per cent of the world's population resides and where about 10 per cent rely on NTFPs and mountain resources for their livelihoods (ICIMOD 2008). In Nepal, NTFP-based activities can account for up to 90 per cent of rural household income (Bista and Webb 2006). Approximately one-third of rural Nepali people collect and trade forest products, which generated US$7.66 million in 2010 and benefited 78,828 participants (Chitale *et al.* 2018).

Climate change refers to long-term shifts in weather patterns over decades to millions of years (Forner and Robledo 2006; Parmesan and Yohe 2003). Globally, increase in temperature, atmospheric carbon dioxide and variations in rainfall, along with the frequency and severity of extreme weather events, have been observed (FAO 2008). These changes have significant impacts on forest ecosystems worldwide, including species (plants and animals) extinctions, prolonged or shifted growing seasons and increased forest fires. Human-induced climate change has intensified since the latter half of the 20th century (Cook *et al.* 2013; Reusswig 2013). Extreme weather and climatic conditions affect forestry and agriculture, leading to reduction in productivity and food shortages. The impacts on species populations and ecosystems alter the availability and supply of ecosystem services: provisioning, regulating, supporting and cultural (Malhi *et al.* 2020). Changes in optimal temperature ranges threaten the survival of multiple species, accelerating the loss of NTFPs by gradually changing forest structures (Leal *et al.* 2021).

In Nepal, forests cover about 46.08 per cent of the total land area (FRTC 2024), contributing NPR 0.92 billion to the national GDP in fiscal year 2072/73 (NPC 2016). Nepal's rich biodiversity makes NTFPs a vital part of its economy, providing for people's needs without causing deforestation. Despite significant potential, NTFPs are often undervalued within the forestry legal frameworks in many developing countries (Wynberg and Laird 2007). Most national forest policies categorise NTFPs as minor products, prioritising timber over other forest resources (Gautam and Devoe 2006). Local communities and forest dwellers often rely heavily on timber for income; however, the contribution of NTFPs is frequently overlooked. Policy efforts have emphasised timber value, and, recently, some countries have initiated plans for NTFP management and utilisation, yet many still focus primarily on timber. While development efforts have concentrated on timber promotion, the ecological and livelihood benefits of NTFPs are often neglected despite their potentially greater conservation and socioeconomic importance. The inhabitants of the Himalayan region possess extensive traditional knowledge of the sustainable management and use of natural resources (Chauhan *et al.* 2021). Nevertheless, understanding local perceptions of NTFP availability and management within the Himalayan region remains limited (Azhar *et al.* 2021). Gaining insights into these perceptions is vital for developing effective conservation and sustainable resource management strategies (Masoodi and Sundriyal 2020). Investigating local viewpoints is essential for creating strategies that promote the sustainable use of these resources (Baral and Katzensteiner 2009).

This study focuses on the Gaurishankar Conservation Area (GCA), specifically Khare village in Dolakha district, Nepal, renowned for its biodiversity and abundance of NTFPs. Despite their key role in supporting livelihoods and ecosystem services, the effects of climate change on NTFP availability and community perceptions in this area are poorly documented. The research aims to assess the current state of NTFPs in Khare, examine how climate change and other factors impact these resources, and understand local perceptions of rainfall and temperature changes. By integrating local knowledge with altitude- and village-specific conservation strategies, this study aims to inform forest management and restoration efforts. The results will help shape evidence-based policies to sustain NTFPs and improve the livelihoods of forest-dependent communities in the GCA.

METHODOLOGY

Study sites

The study was conducted in Khare (27°49'N, 86°18'E), located in the Gaurishankar Rural Municipality in Dolakha district, Bagmati province, northeastern Nepal, as shown in Figure 1. This region falls under the Gaurishankar Conservation Area (GCA 2022) and spans a tropical to subalpine elevation gradient, ranging from 1,010 metres above sea level (masl) to 5,522 masl. The area comprises diverse forest types, including subtropical forests (1,000–2,000 m), temperate forests (2,000–3,000 m) and subalpine forests (3,000–4,000 m) (DNPWC 2022). Covering an area of 104.43 square kilometres, the region is home to a population of 1,718 individuals belonging to various caste and ethnic groups, such as Chhetri, Brahmin, Dalit, Tamang, Sherpa, Newar, Gurung, Magar, Thami, Surel, and Jirel (GoN and NSO 2021). Agriculture is

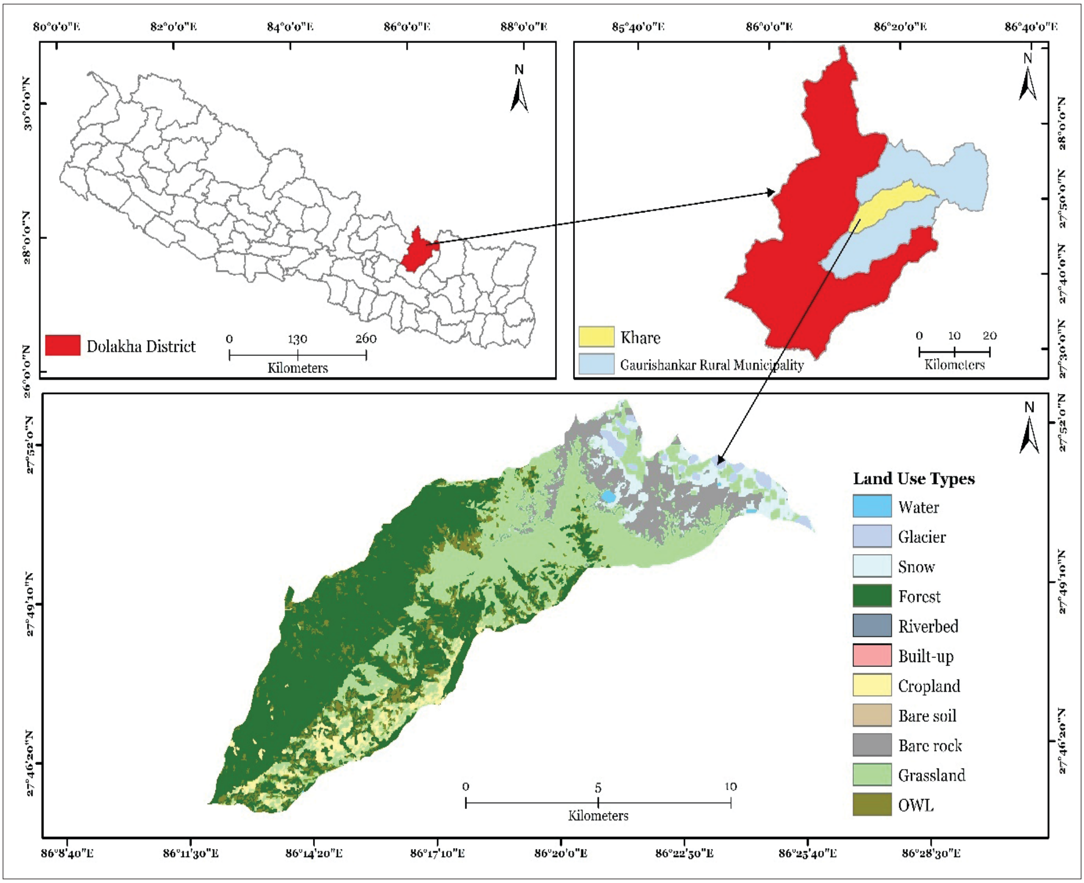

Figure 1: Study area map

the predominant livelihood, with more than 90 per cent of residents engaged in NTFP harvesting for either subsistence or income generation. Dependence on NTFPs is particularly pronounced among households with limited alternative income sources (Maharjan and Dangal 2020). Key NTFPs collected in the area are *Swertia chiraita, Curculigo orchioides, Bergenia ciliata, Rheum australe, Ophiocordyceps sinensis, Rhododendron anthopogon, Eulaliopsis binata, Paris polyphylla,* and *Astilbe rivularis* (DNPWC 2022).

Sampling strategies and data collection

A random sampling method was employed to assess the local community's perceptions of the availability of NTFPs and the impact of climate change. A total of 95 respondents from the Khare area were selected randomly. To ensure the integrity of the sample, we avoided including multiple respondents from the same household and aimed to represent various types of residents within the community. The sample size was determined using the online Survey Monkey platform, based on the formula presented in Equation 1.

$$Sample\ size = \frac{\frac{z^2 \times \rho(1-\rho)}{e^2}}{1+\frac{[z^2\rho(1-\rho)]}{e^2 \times N}} \quad \text{equation 1}$$

Where z is the z score = 1.96 (for a confidence level of 0.95), e is the margin of error (calculated as 10%), N is the population size (the total population of Khare according to the 2021 census is 1718), and ρ is the population proportion (kept as 50%).

The survey focused on Khare villages, namely Tunitar, Suri Dobhan, Besi, Tallo Kaseri, Lamakali, Manedada, and Sothali. Data were collected during January–March 2023 by using household surveys and key informant interview (KII) questionnaires. KIIs were qualitative in-depth interviews with selected people. The participants were asked to provide all the information they perceived as identifying changes in climate and the impacts of such changes, particularly on NTFP availability. The questionnaires were semi-structured. A typical five-level Likert item (Table 1) was used (Poggie 1972) as an effective and systematic means of studying human attitudes and the factors that influence them.

Table 1: Likert scale value

Response category	Value	Range
Strongly disagree	1	1.00–1.80
Disagree	2	1.81–2.60
Neither/Nor Agree	3	2.61–3.40
Agree	4	3.41–4.20
Strongly agree	5	4.21–5.00

The questions were pre-tested through a pilot survey of selected households and were modified before the field survey. A systematic and evidence-based approach, as outlined by Yusoff (2019), was employed to ensure proper validation. The Item-level Content Validity Index (I-CVI), the Scale-level Content Validity Index based on the average method (S-CVI/Ave) and the Scale-level Content Validity Index based on the universal agreement method (S-CVI/UA) were calculated to be 0.869, 0.8452 and 0.8095 respectively. We consulted two experts for content validation. The calculated values of the Content Validity Index (CVI) exceeded the accepted CVI threshold of 0.8 recommended by Davis (1992).

For content reliability, we measured Cronbach's alpha, which assesses the internal consistency of a test or scale and is expressed as a number between 0 and 1 (Tavakol and Dennick 2011). Acceptable values of alpha range from 0.70 to 0.95 (Bland and Altman 1997; Nunnally 1975). In this study, Cronbach's alpha for the Likert scale was calculated to be 0.82, which falls within the accepted range. Therefore, the questionnaire scale has achieved a satisfactory level of content validity and reliability.

Data analysis

Both qualitative and quantitative methods were employed to analyse the data collected from KIIs and household surveys. The household survey data were visualised graphically and analysed quantitatively using R version 4.3.2 (R Core Team2023) and ArcMap 10.8. The qualitative data obtained from the KIIs were analysed using thematic coding analysis.

To examine the association between perceived trends in NTFP availability (increasing, decreasing, or no change) and the altitudinal gradient (categorised into two elevation bands: above 1,600 masl and below 1,600 masl), Fisher's exact test was applied. This non-parametric statistical test was selected due to the categorical nature of the variables and the relatively small sample sizes within elevation categories. Fisher's exact test is particularly suitable for contingency tables where the assumptions of the chi-square test may not be met (Kim 2017). The test was performed in R using fisher. Test () function to determine whether the distribution of perceived NTFP availability was statistically independent of the altitudinal gradient.

RESULT

Demographic overview

A total of 95 per cent of the targeted households responded to the survey. Of the respondents, 51.6 per cent were male and 48.4 per cent were female. The majority of participants (53.6%) were between 30 and 60 years of age, followed by those over 60 years (33.7%) and those below 30 years (12.6%). In terms of educational attainment, a significant portion of respondents (48.4%) had no formal education, 18.9 per cent had completed primary education, 24.2 per cent had attained secondary-level education, and 8.4 per cent had education beyond the secondary level. Occupation-wise, the majority of respondents (77.9%) were engaged in farming. Other occupational categories included the service sector (11.6%), trade (6.3%), daily wage labour (3.2%), and remittance-based livelihoods (1.1%). Regarding household income, more than half of the respondents (54.7%) reported an average monthly income of less than NPR 15,000, 28.4 per cent earned between NPR 15,000 and NPR 25,000, while 16.8 per cent reported a household income exceeding NPR 25,000.

Categorisation of NTFPs based on KIIs

The communities in the study area possess rich traditional ecological knowledge, particularly in the use of NTFPs. They identified nine major categories of NTFPs: fodder, fuelwood, medicinal plants, wild vegetables, agricultural tools, bamboo, wild fruits, weaving grass, and honey. While all were used to some extent, their level of utilisation varied considerably (Figure 2), reflecting differences in daily necessity, accessibility and cultural significance.

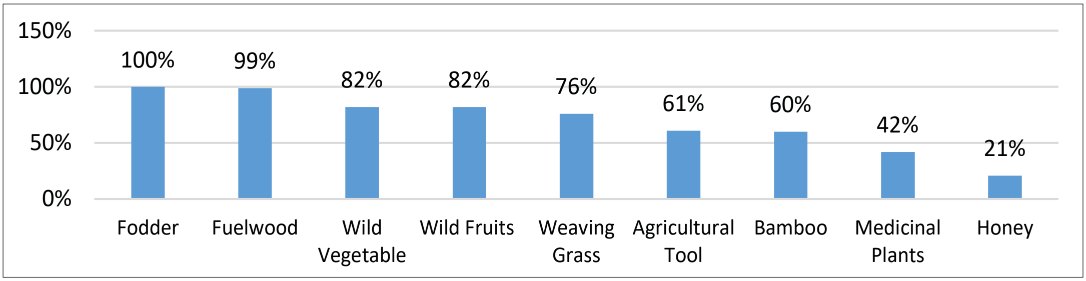

Figure 2: People's involvement in the collection of different NTFP categories

The survey confirmed the critical role of forest products, such as fodder and fuelwood, in daily subsistence, while highlighting varying degrees of reliance on wild edibles, materials and medicinal resources. Lower usage of items such as medicinal plants and honey may reflect limited access or waning traditional practices. Although key informants provided an extensive inventory, actual usage proved more nuanced and context-dependent, offering deeper insights into local perceptions and utilisation of forest ecosystem services.

Perceived trend of NTFP availability

Community perceptions of NTFP availability offer valuable insights into both social and ecological dimensions. The following sections present findings across four key areas: a) overall trends in availability, b) variations by altitude and c) perceived factors driving both increases and decreases.

Overall NTFP availability trends

The respondents perceived increased availability of fuelwood and weaving grass in the study area compared to agricultural tools, fodder, wild fruits, wild vegetables, honey, medicines, and bamboo (Figure 3). The mean score of fuelwood (3.29%), weaving grass (3.21%), agricultural tools (3%), fodder, wild fruits (2.94%), wild vegetables (2.92%), honey (2.83%), and medicines (2.71%) were within the neutral scoring range of Likert scale, ie 2.61–3.4, while that of bamboo (2.56%) lied within the decreased scoring range of Likert scale, i.e. 1.81–2.6. Hence, overall, among the major NTFPs, the availability of bamboo was perceived to have decreased in the study area.

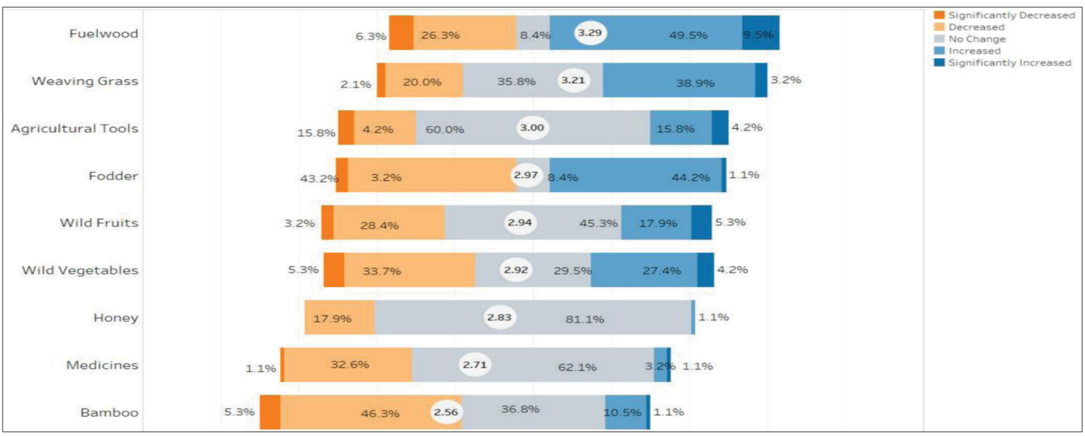

Figure 3: Overall changes in the NTFP availability (where 1: Significantly decreased, 2: Decreased, 3: No change, 4: Increased, 5: Significantly increased)

Change in NTFP availability with altitude

The availability of NTFPs has changed over the past few decades. Of the respondents, an overwhelming majority of 95.8 per cent agreed that the NTFP availability had changed. Furthermore, among them, 74 per cent reported overall increase in the NTFP availability below 1,600 masl, while 69 per cent reported overall increase in the NTFP availability above 1,600 masl. The fisher's test result showed that the availability of medicines, fuelwood, fodder, agricultural tools, weaving grass, bamboo, and wild vegetables significantly varied with altitude (Table 2). In higher altitudes, fuelwood, weaving grass, agricultural tools, fodder, wild vegetables, and wild fruits were reported to have increased, whereas bamboo, honey and medicines were reported to have decreased (Figure 4). Overall, NTFPs were perceived to be increasing with increase in altitude. However, the accessibility of medicinal plants was found to decrease along the altitude gradient.

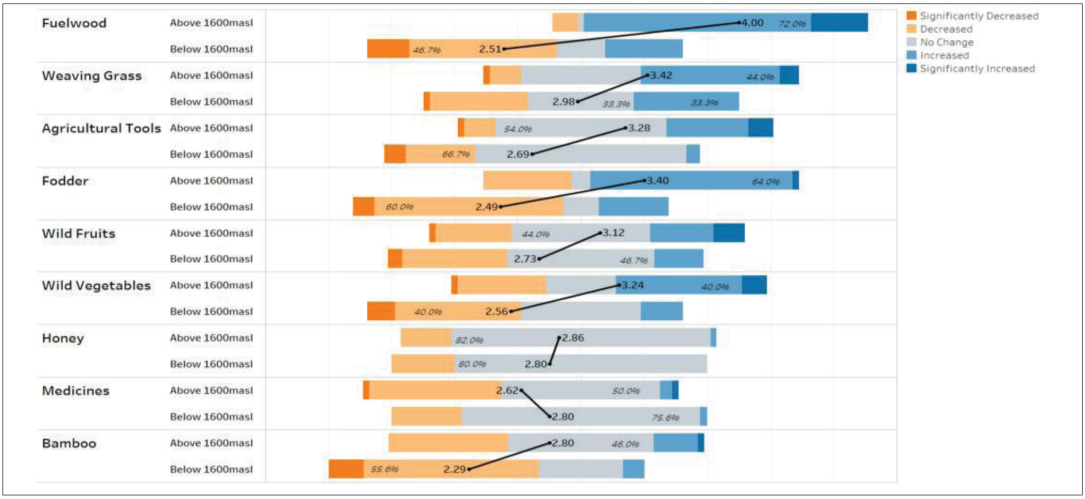

Figure 4: Perceived trends in the availability of major NTFPs above and below 1,600 masl

Table 2: NTFP availability trend against altitudinal gradient

NTFP Category against Altitude	Fisher's test
Medicines and altitude	0.04459 *
Fuelwood and altitude	1.78E-10 ***
Fodder and altitude	8.81E-05 ***
Agricultural tools and altitude	0.002555**
Weaving grass and altitude	0.04305 *
Bamboo and altitude	0.01126 *
Wild vegetables and altitude	0.003043 **
Wild fruits and altitude	0.1926
Honey and altitude	0.8893

Causes of increase in NTFP availability

The major perceived reasons for the increase in the availability of NTFPs above 1,600 masl were decreasing livestock and harvest (69%), decreasing population and family size (54%), increased awareness (40%) and reduced cultivation area (31%). Some respondents believed increment to be a result of forest conservation policy (25%). On the contrary, decreasing livestock and harvest (20%), along with increased awareness, reduced cultivation area and forest conservation policy were perceived as the major contributors to the increase below 1,600 masl (Figure 5).

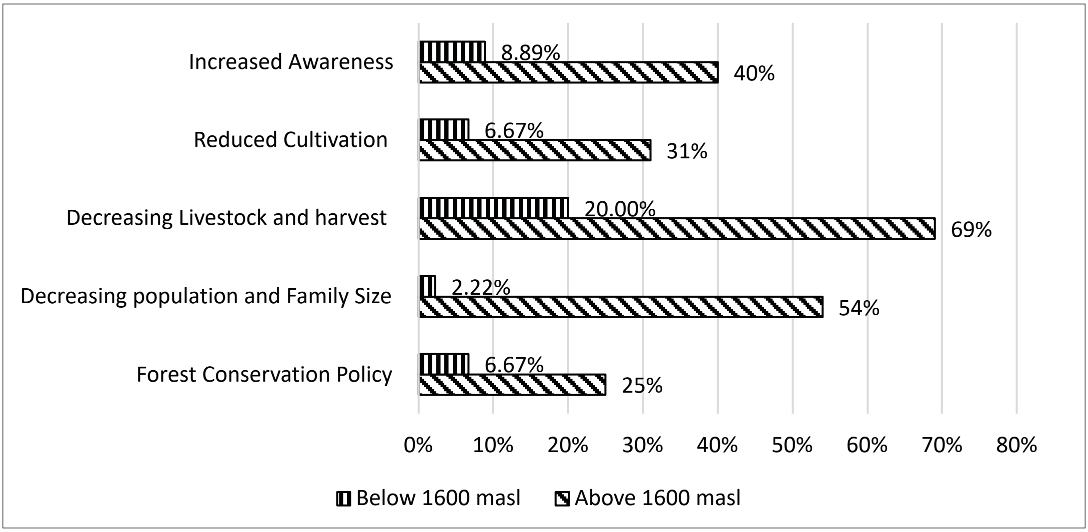

Figure 5: Comparison of perceived reasons for the increase in NTFP availability above and below 1,600 masl

Causes of decrease in NTFP availability

The major perceived reasons for the decrease in NTFP above 1,600 masl were overexploitation (75%), climate change (52%) and forest fires (36%). Some respondents attributed the decrease to earthquakes (11%) and divine wrath (16%). On the contrary, forest fires and overexploitation were perceived as the major contributors to the increase below 1,600 masl (Figure 6).

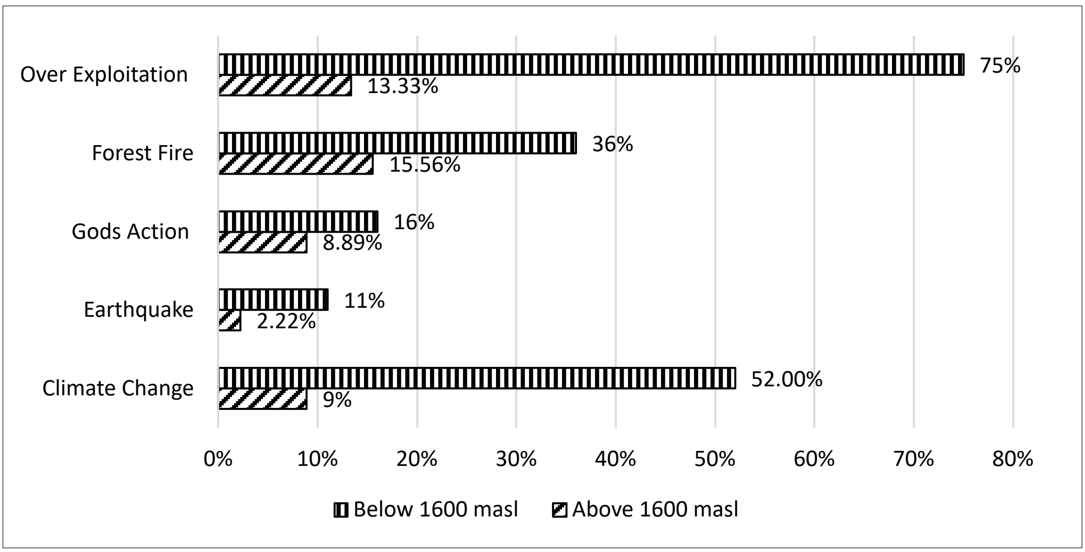

Figure 6: Comparison of perceived reasons for the decrease in NTFP availability above and below 1,600 masl

Impact of overexploitation of NTFPs

Respondents reported that fuelwood, followed by fodder and wild fruits, was the major NTFP that decreased because of overexploitation (Table 3), while weaving grass and bamboo were the least affected by overexploitation. The harvesting details of GCA for fiscal year BS 2077/078 showed that medicinal plants, like black *musli* (*Curculigo orchioides*), *pakhanbhed* (*Bergenia ciliate*), *sunpati* (*Rhododendron antopogon*) and wild honey, were harvested more than the permitted amounts.

Table 3: Ranking of NTFP availability due to overexploitation based on local perceptions

Particulars	Mean SD	Rank
Fuelwood	2.39 ± 1.07	I
Fodder	2.46 ± 0.84	II
Wild fruits	2.57 ± 0.63	III
Wild vegetables	2.64 ± 0.78	IV
Honey	2.64 ± 0.49	V
Agricultural tools	2.71 ± 0.854	VI
Medicines	2.86 ± 0.36	VII
Bamboo	2.86 ± 0.59	VIII
Weaving grass	2.96 ± 0.74	IX

Note: Particulars indicate the resources whose availability has decreased due to overexploitation

Impacts of climate change and extreme events

Respondents identified increases in the incidence of forest fires, pest and insect attacks, expansion of invasive plant species, strong wind events, changes in rainfall and temperature patterns, increased incidence of landslides and floods, and more frequent and severe winter droughts as the major drivers reducing the availability of NTFPs. Most participants perceived that forest fires have impacted the availability of most NTFPs (Figure 7). A high proportion of respondents agreed that the impact of forest fires on the availability of fruit, vegetables, fodder, fuelwood, bamboo, honey, and medicines had increased. Similarly, a majority of participants reported that an increase in landslide incidents had impacted the availability of most NTFPs, including fuelwood, fodder, bamboo, medicines, and fruit. The increased invasion and upward shift of alien species like *banmara* (*Ageratina adenophora*) was also reported. Increased insect and pest infestations were also the reasons behind the decrease in NTFPs. Similar research reported the moth caterpillar, locally called *Ghyosipiti* (*Gazalina chrysolopha* Kollar), as the major pest consuming leaves of trees, especially *Alnus nepalensis, Rhododendron arboreum* and other fodder plants around regions. Bamboo undergoing the flowering process was said to decline heavily. Reduced hailstone and snowfall incidents were also reported.

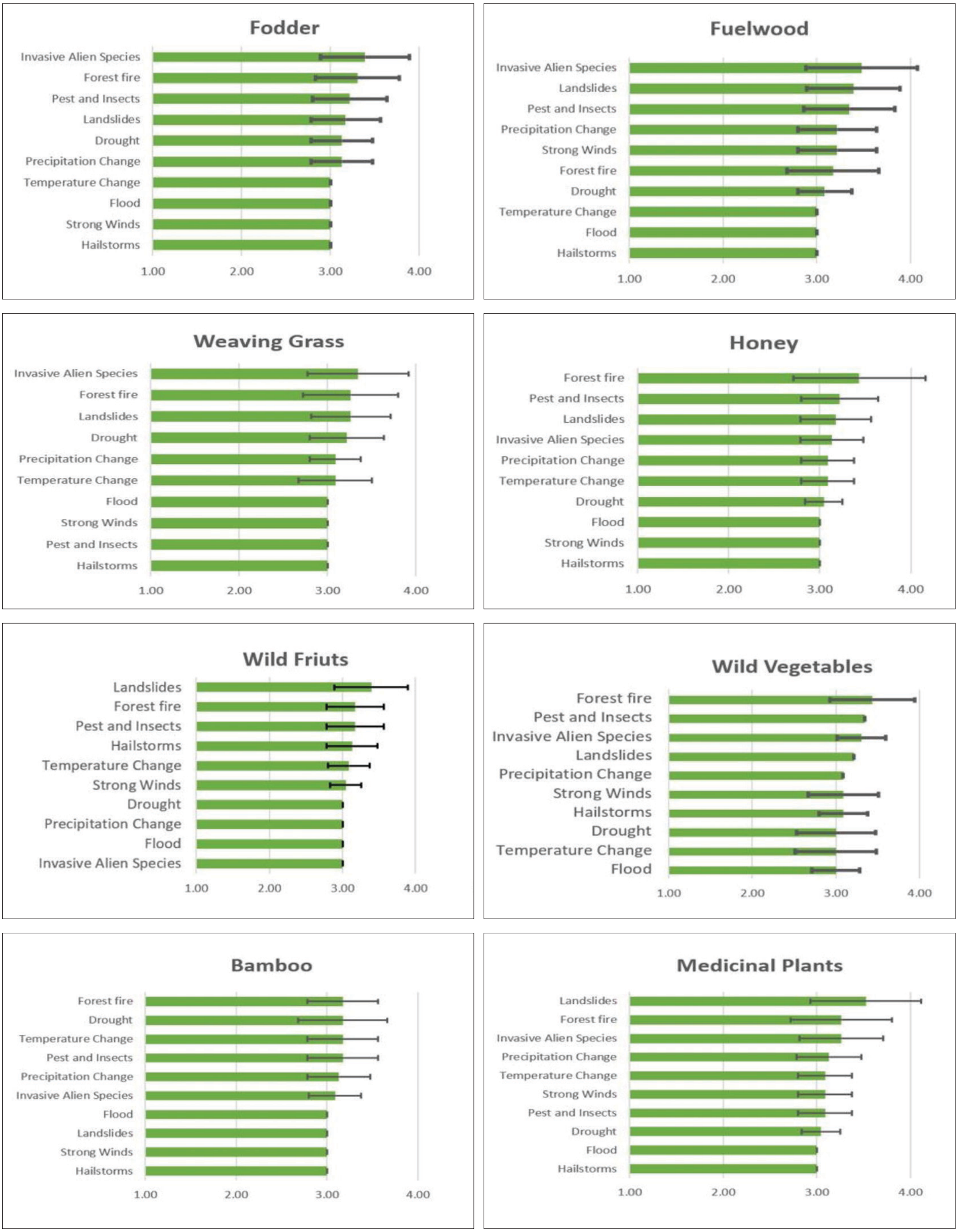

Figure 7: Perceived impacts of climate change on NTFP availability (where 1: No impact, 2: Low impact, 3: Moderate impact, 4: High impact, and 5: Very High impact; error bars represent ± 1 standard deviation)

DISCUSSION

Our findings demonstrate high subsistence dependence on NTFPs, with 100 per cent of households using forest-derived fodder and 99 per cent relying on fuelwood. This underscores a deeply-rooted livelihood–forest linkage, which is consistent with previous research across Nepal (Uprety *et al.* 2016; Sherpa 2025; Paneru 2024). For instance, Sherpa (2025) reported comparable fuelwood reliance in the Annapurna region, while Paneru (2024) highlighted similar dependence on fodder in the mid-hills. Together, these patterns reaffirm the continued centrality of NTFPs to rural economies.

In contrast, lower usage rates of medicinal plants (42%) and wild honey (21%) may signal a decline in traditional ecological knowledge and reduced availability, probably driven by overharvesting and climate-induced ecological changes (Kunwar *et al.* 2013). Notably, some respondents reported increased availability of weaving grasses and wild vegetables, especially at higher elevations. While this trend may initially appear counterintuitive, given the national biodiversity concerns, it can be linked to socio-demographic shifts, specifically declining livestock numbers, shrinking household sizes and abandoned farmlands. These findings are supported by our survey, which shows a 20 per cent drop in livestock and harvest. Such shifts mirror Nepal's broader agrarian transition, where rural outmigration and remittance-based economies are reshaping land use and labour allocation (Neupane and Poudel 2023). As traditional agricultural practices decline, forest dependence is being reconfigured in complex ways, with important implications for both livelihoods and forest management.

Furthermore, our data reveal a nuanced altitudinal pattern in NTFP availability within the GCA. Respondents perceived greater species richness at higher elevations and, at the same time, declining accessibility, particularly of medicinal plants, above 1,600 masl. These observations align with prior studies from the Himalayan region, where elevation and human accessibility jointly influence the NTFP distribution and harvestability as well as the intensity of ecological pressures (Kala 2005; Kunwar *et al.* 2013).

The apparent paradox of increased species diversity but decreased availability of medicinal plants can be explained by a combination of ecological and anthropogenic pressures. Chief among these is overexploitation, cited by 75 per cent of respondents as a primary driver of resource decline. This corroborates previous findings that attribute unsustainable extraction of high-value species, such as *Curculigo orchioides* (black musale), *Bergenia ciliata (pakhanbhed)* and *Rhododendron anthopogon (sunpati)*, to weak regulation, open-access systems and high market demand (Kunwar *et al.* 2013). These community concerns are validated by the GCA's official harvest records (FY BS 2077/078), which shows that the collection of key medicinal and aromatic plants exceeded sanctioned quotas. Such overharvesting highlights persistent gaps in enforcement, monitoring and compliance, especially in protected areas where conservation mandates are often misaligned with local livelihood needs (Shrestha and Bawa 2013; Kunwar *et al.* 2016).

The commercialisation of wild honey and alpine herbs has further intensified harvesting pressure, typically without corresponding investments in sustainable harvesting practices or habitat restoration (Subedi *et al.* 2013). In such contexts, ecological thresholds may be breached, endangering the long-term sustainability of these forest resources.

Climate change was another widely reported factor, cited by 52 per cent of respondents as adversely affecting NTFP availability. Community members reported observing changes in rainfall patterns, rising temperatures, winter droughts and increased incidence of extreme events such as landslides and strong winds. These perceptions are supported by scientific literature showing that climate change is altering the phenology, geographic distribution and productivity of alpine species across the Central Himalayas (Shrestha *et al.* 2012; Xu *et al.* 2009). The intersection of climatic and human-induced pressures places significant stress on both species and ecosystems, necessitating urgent adaptive responses.

An additional concern emerging from community observations is the proliferation of invasive alien plant species (IAPS) and rise in pest outbreaks. Invasive species such as *Ageratina adenophora* and *Lantana camara* are known to displace native flora, reducing NTFP availability and compromising ecosystem integrity (Merow *et al.* 2017; Shrestha *et al.* 2019). Communities attributed decline in certain NTFPs to the rapid spread of IAPS. Furthermore, the rise in pest outbreaks presents another layer of stress to native ecosystems, potentially weakening plant health and regeneration capacity. These dual threats highlight the urgent need for comprehensive monitoring and management strategies that address both biological invasions and forest health.

Together, these findings underscore the multifactorial nature of threats to NTFP sustainability in the region. Biophysical drivers such as climate extremes, pests and landslides interact with anthropogenic stressors, like overharvesting, fire and spread of invasive species, to create complex and dynamic pressures on forest ecosystems. Addressing these challenges requires integrated forest management approaches that balance conservation and livelihood objectives. Key strategies should include regulatory reforms, sustainable harvesting practices, community engagement and ecosystem restoration.

Lastly, the study reinforces the importance of local ecological knowledge (LEK) in conservation planning. Respondents' insights provided valuable early warning signals of ecological change, which can inform adaptive co-management and enhance resilience. When supported by participatory monitoring and validated through scientific research, LEK can serve as a cornerstone for inclusive and context-specific forest governance (Berkes 2009; Uprety *et al.* 2012).

CONCLUSION

This study showcases the enduring and evolving dependence of rural households on NTFPs, with common dependence on fuelwood and fodder, thereby highlighting the critical role of forest resources in sustaining subsistence livelihoods. However, observed decreases in medicinal plants and wild honey, along with increased invasive species and pest outbreaks, indicate emerging ecological and socioeconomic pressures. Variations in NTFP availability at different altitudes, driven by both environmental factors and access issues, further complicate sustainable resource management in mountainous protected areas, like the GCA.

Our findings emphasise the urgent need to shift NTFP management towards integrated and adaptable strategies. We recommend: (i) strengthening community-based monitoring systems that leverage local ecological knowledge; (ii) promoting sustainable harvesting practices and market regulation for high-demand species; (iii) expanding restoration efforts, focusing on degraded habitats and areas overtaken by invasive species; and (iv) improving climate-resilient forest management through localised adaptation planning. In particular, formal recognition and integration of local knowledge into policies and practices can improve responsiveness to ecological changes, as well as support effective and fair NTFP management. Without such comprehensive actions, the combined effects of overharvesting, land-use changes, climate change and invasive species could irreparably damage the ecological integrity and resource base that forest-dependent communities rely on. Sustainable NTFP management is, therefore, not only essential for conservation but also a socioeconomic necessity for mountain livelihoods.

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