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Dependency on national park resources of people living in a mountain protected area

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Keywords: firewood, Langtang National Park, local people, national park benefit, natural resource use, Nepal

Abstract

National Parks can provide diverse benefits to those living in and around them, supporting livelihoods and providing opportunities to harvest natural resources and to participate in nature-based tourism. To explore the direct benefits to local people, a questionnaire-based survey was conducted in four villages in Langtang National Park, Nepal. Firewood and fodder / grasses were the main resources harvested by local people. Household size and the total number of livestock units were the only significant predictors of resource use (firewood and fodder). These findings suggest that local people are dependent on national park resources. Strategies to reduce firewood dependency and hence pressure on the national park forests are recommended.

Profile

Protected area

Langtang National Park

Mountain range

Himalaya, Nepal

Figure 1 – Village inside Langtang National Park. © Kamal Thapa

Introduction

The world's commitment through the Aichi biodiversity target of the Convention on Biological Diversity led to an increase in the total extent of protected areas (PAs) (UNEP-WCMC et al. 2018). However, this is well below the target of 17% of the world's terrestrial surface (including inland waters) to be protected as PAs. While the primary objective of PAs is to conserve biodiversity, they also help support livelihoods through providing incomes and the opportunity to harvest natural resources to meet subsistence needs (Clements et al. 2014; Getzner & Shariful Islam 2013). From the ecosystem services point of view and the values placed on PAs, benefits to people often outweigh losses (Ninan & Kontoleon 2016; Sharma et al. 2015; Shrestha et al. 2006). However, the distribution of the benefits of PAs to the public (and the costs) has always been uneven and controversial (Brockington & Wilkie 2015). While benefits extend to the regional or national and international levels, economic losses are often more pronounced in and around the protected areas themselves.

PAs, including national parks, provide different types of natural resources used by local people, such as dead wood, firewood, thatch, timber, fodder or grasses, and medicinal plants (Baral & Heinen 2007; Chaudhary et al. 2016; Karanth & Nepal 2012; Ninan & Kontoleon 2016; Sharma et al. 2015; Spiteri & Nepal 2008b; Vedeld et al. 2012). Firewood, fodder / grasses, leaf litter and thatch tend to be the biggest resources that local people harvest from protected areas and forests (Asfaw et al. 2013; Baral & Heinen 2007; Baral et al. 2019; Heinen 1993; Mushi et al. 2020; Sharma et al. 2015; Vedeld et al. 2012). Firewood is often the ideal – and only – source of energy, particularly for poor people, living in the developing world. For example, in the Afromontane Forest of Ethiopia, 88.9% of households identified firewood from the forest as the most important forest product, followed by grass (Asfaw et al. 2013). In Sundarbans, Bangladesh, local people depended heavily on the mangroves for firewood in order to avoid having to spend money on firewood at the local market (Getzner & Shariful Islam 2013). However, the availability of these resources can fluctuate over time, and become depleted due to long-term changes in land cover (Chaudhary et al. 2016; Karanth et al. 2012).

If local people benefit from PAs, they are more likely to have a positive attitude towards PAs (Allendorf 2007). A positive attitude contributes to achieving conservation objectives (Kideghesho et al. 2007). However, even when the majority of local people

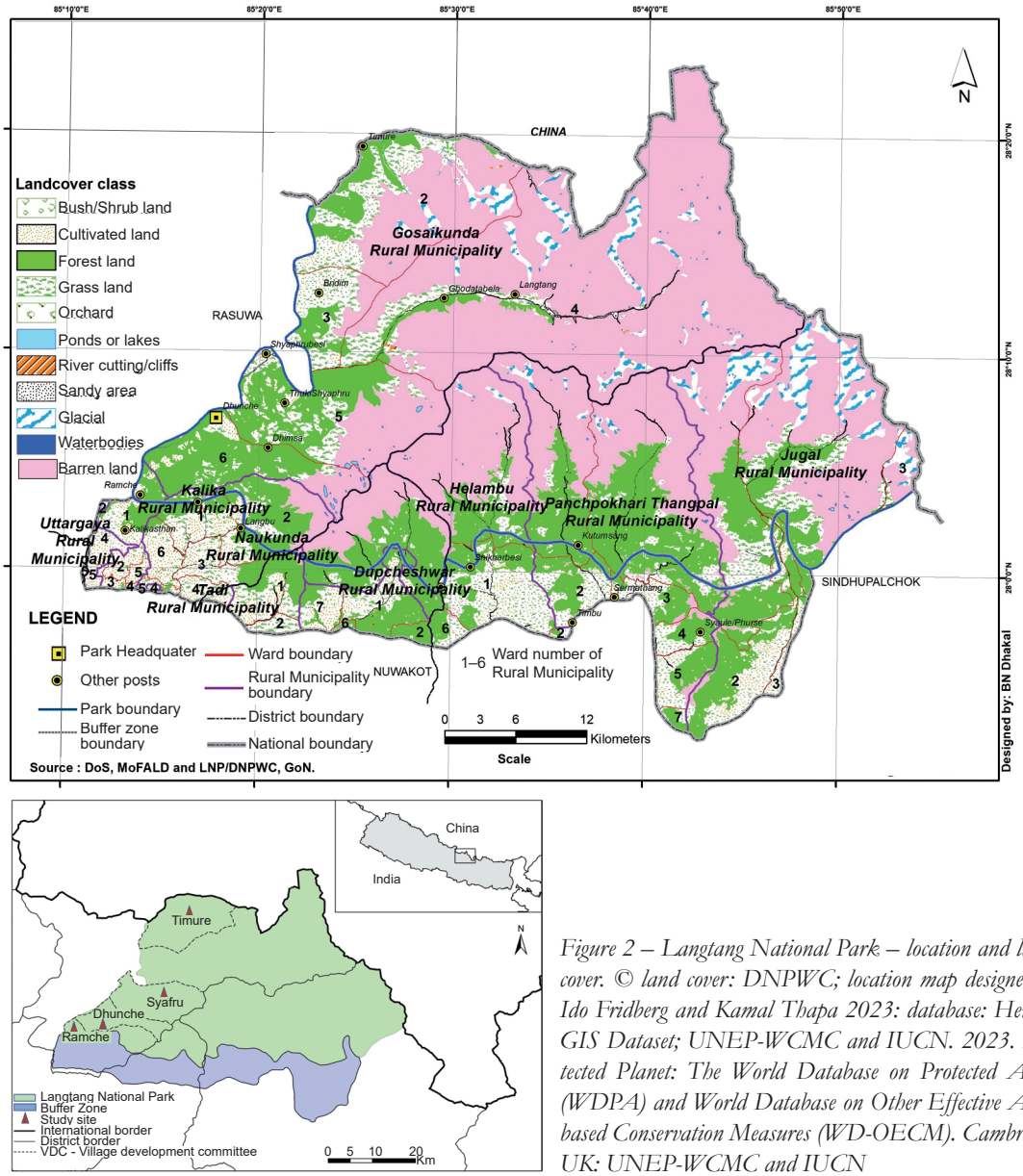

Figure 2 – Langtang National Park – location and land-cover. © land cover: DNPWC; location map designed by Ido Fridberg and Kamal Thapa 2023: database: Hermes GIS Dataset; UNEP-WCMC and IUCN. 2023. Protected Planet: The World Database on Protected Areas (WDPA) and World Database on Other Effective Area-based Conservation Measures (WD-OECM). Cambridge, UK: UNEP-WCMC and IUCN

understand the need for conservation, they still look for socio-economic opportunities arising from PAs, including national parks (Ezebilo & Mattsson 2010; Karanth & Nepal 2012).

Langtang National Park (LNP) is a Himalayan national park in Nepal. Unlike what happens in other national parks and reserves in the mid-hills and lowlands (Terai), local people are allowed to live within LNP's boundaries[1] and to carry out their traditional way of life. Earlier LNP-based studies focused on firewood consumption in the tourist destination by tourism-related businesses (e.g. hotels) and by the local population who did not run tourism-related businesses (Chapagain 2017). One study looked at firewood consumption by a yak cheese factory (Yonzon & Hunter 1991), but studies on the types and quantities of natural resources harvested by local people in areas off the trekking trail and / or tourist destinations are lacking.

In this context, the purpose of this research was (1) to investigate the resource-dependency of local people and its extent in LNP, and (2) to identify the main factors that determine the extent of their harvesting of resources.

Materials and method

Study site

Langtang National Park (27°57'36"N to 28°22'48"N, 85°12'36"E to 85°52'48"E) is a Himalayan protected area that covers 1,710 km^2 and shares an international border with Tibet (China). A buffer zone of 420 km^2 for conservation and development activities was added in 1998 (Figure 2). LNP is rich

[1] Communities inside the national park boundary in the Nepalese Himalayas are considered legal settlements, with the same regulations as in the buffer zone. However, lowland (Terai) protected areas are free from any human settlements as these were removed from the park in the past.

in biodiversity and is home to several protected and endangered wildlife species, of which the Snow Leopard (*Panthera uncia*) and Red Panda (*Ailurus fulgens*) are the flagship species (LNP 2019). Gosainkunda and other nearby lakes inside the national park are Ramsar sites. LNP is also an Important Bird Area (IBA) of Nepal (BCN, 2020). The park comprises different forest types and has more than one thousand species of flora. In the southern zone, vegetation is characterized by Sal *(Shorea robusta*) forest at lower elevations, and by Pine forest (*Pinus roxburghii*), Rhododendrons and Nepalese alder (*Alnus nepalensis*) at higher elevations (LNP 2020). The study site consisted of broad leaf forest mixed with pine.

In the past, economic activities were based largely on traditional agricultural practices combined with livestock rearing. Two cheese factories, in Kyanjin and Sing Gumpa, have been in operation since 1953 processing yak milk from local farmers (Yonzon & Hunter 1991). Along with arable farming and livestock herding, tourism provides local residents with major economic and livelihood activities. Tourism in LNP has experienced high growth rates in the last 10 to 20 years, with the LNP now drawing more than 17,000 international visitors annually (DNPWC 2020; LNP 2019). Visitors can experience both culture- and nature-based tourism in the national park and surrounding region. A recent (2019) National Park report shows that 77,207 people from 14,963 households were residing in LNP and the buffer zone. Our study site comprised a population of 7,255 living in 1,683 households (LNP 2019).

Data collection

A household-level survey, which is displayed at the end of this article, was conducted by the author in villages administered by four (former) Village Development Committees (VDCs), Ramche, Dhunche, Syafru and Timure in Rasuwa district, which are inside the national park boundary. The total numbers of households in these villages were 633 (Ramche), 392 (Dhunche), 553 (Syafru), and 105 (Timure) (LNP 2019). Dhunche is the district headquarters of Rasuwa and hosts the LNP office. Timure lies on the border with Tibet (China).

The survey was carried out along the Pasang Lhamu highway. The most distant household surveyed was 30 minutes' walk from the highway (one way). Most households surveyed were involved in agriculture or livestock rearing, and subsistence dependent on nature. For Rasuwa district, I aimed to survey at least 10% of households in that part of the buffer zone which in this instance lies within the national park boundary. However, given the distance of some households from the road and the partial inclusion of Ramche VDC inside the national park boundary, only 6% of households in Ramche were surveyed. Households were selected for survey based on convenience. Only one person per household aged over 18 was asked to participate. To ensure gender balance, I aimed to target male and female respondents alternately. However, achieving a ratio of exactly 50:50 was not possible. No household denied participation in the survey. The sample size (*N*) of the study was 184 (Table 1).

Table 1 – Socio-demographic profile of the respondents.

Village	Ramche	Dhunche	Syafru	Timure	Total
N	41	48	78	17	184
Variables	%				
Sex					
Male	58.5	62.5	36	53	49.5
Female	41.5	37.5	64	47	50.5
Age					
≤ 25	19.5	10.5	9	12	12
26–55	58.5	66.5	63	41	60.9
56+	22	23	28	47	27.2
Household Size					
≤ 4	39	29	19	17.5	26.1
5–14	61	69	81	82.5	73.4
15+	0	2	0		0.5
Educational level					
No Schooling	78	52	73	59	67.4
Primary (grades 1–8)	12	14.5	15.5	29	15.8
Secondary (grades 9–12)	7.5	31.5	11.5	6	15.2
Bachelor's degree and above	2.5	2	0	6	1.6

Data analysis

The local unit (*bhari*)[2] was used to estimate the quantity of resources harvested from the national park. One *bhari* of firewood can range between 25.2 and 65.5 kg (Baral et al. 2019; Chapagain 2017; Fox 1984; Karmacharya & Bhuju 2010; Nepal et al. 2011). However, the LNP office uses the *chatta* for firewood measurement, which is equivalent to 20 x 5 x 5 cubic feet and weighs about 10,470 kg (Subedi et al. 2014, 53).

I assumed that one *bhari* of firewood weighed 25.2 kg as a minimum conservative estimate for analysis purposes, as local people are allowed to collect dead wood and broken branches only, which are lighter in weight. Chapagain (2017) used 40 kg as equivalent to one *bhari* of firewood in Langtang village, LNP; therefore, 40 kg per *bhari* was used as a maximum conservative estimate. Fodder was also assigned the equivalent weight in kg per *bhari*, irrespective of the resource type. The number and types of domestic animals were converted into livestock units (LSU) for analysis. One LSU was calculated as 1 cow, or 0.66 buffalo, or 2 pigs, or 5 goats (or sheep) (Shahi et al. 2022)

Respondents' profiles were subjected to basic descriptive statistics; multiple regression was performed to show the effect of independent variables on firewood and fodder consumption. Assumptions were

[2] Bhari is a one back load usually one person can carry on his/her back by him/herself. Bhari is a common metric used for measuring (weight) goods, especially natural resources, in rural villages of Nepal.

checked for multiple regression. Data analysis used Statistical Package for Social Sciences (SPSS) (IBM SPSS Statistics 26).

Model specification

I hypothesized that the consumption (harvest) of natural resources (firewood, fodder) by a household is a function of various socio-economic factors, such as household (family) size, area of land owned, number of livestock (calculated as LSUs), and location of the village. Although in the regression models some authors (Asfaw et al. 2013; Baral et al. 2019; Mushi et al. 2020) included other individual parameters such as age, marital status, sex, literacy etc. these parameters were not applied in this model. I was more interested in the household-level parameters, because harvesting and use of natural resources such as firewood and fodder are household rather than individual activities. Household-level income was not included in the model as income is a sensitive subject for respondents, who may respond with irrelevant or misleading figures, or income may not represent the true economic status when there is no formal job / employment. Household distance from the road was not considered in the statistical model as the road's transect was used as the basis for the survey. Although the households surveyed were situated at varying distances from the road (maximum 30 minutes on foot one-way), all households were considered, from the local Nepalese perspective, to be near the road or within easy access of it.

I used multiple regression to model the relationships between the dependent variables (firewood and fodder consumption) and the independent variables (socio-economic predictors), as represented in the following equations:

$$\text{Firewood consumption} = x0 + x1_{\text{family size}} + x2_{\text{area of land owned}} + x3_{\text{LSU}} + x4_{\text{location of the village}} + \text{error} \ldots \quad \text{equation (1)}$$

$$\text{Fodder consumption} = x0 + x1_{\text{family size}} + x2_{\text{area of land owned}} + x3_{\text{LSU}} + x4_{\text{location of the village}} + \text{error} \ldots \quad \text{equation (2)}$$

Results

Socio-economic characteristics

All respondents were of Tamang ethnic origin, as is typical of the northern part of Rasuwa district. There were almost equal numbers of male ($n = 91$) and female ($n = 93$) respondents, with a mean age of about 45.5 years (age range 18 to 85 years). The average household size was 5.92 people (range 2 to 24 people). Most respondents were from Syafru VDC ($n = 78$), followed by Dhunche VDC ($n = 48$). Most respondents (67%) did not have any formal schooling, and only 1.6% had a Bachelor's degree or above (Table 1).

The average area of land owned by a household in the study area was 0.483 hectare (9.5 *ropani*)[3]. On average, local people owned 2 cattle, 0.5 buffaloes and 2.5 goats or sheep per household (Table 2). However, 112 households did not own any cattle, 146 did not own any buffaloes, and 147 did not own any goats or sheep.

Table 2 – Socio-economic characteristics of the respondents.

Variables	N	Min.	Max.	Mean	St. Dev.
Land area (ropani)	178	0	97	9.52	11.75
Cow/Ox	184	0	30	2	4.74
Buffalo	184	0	7	.49	1.14
Goat/Sheep	184	0	80	2.45	8.82
Total LSU	184	0	34	3.22	5.72
Location of villages in relation to LNP office*	184	1	2	1.74	.44

** coded as 1 (near), and 2 (far)*

Types of resource dependency and magnitude

Local people harvested two main natural resources from the national park forest: firewood and fodder. Harvest of leaflitter was negligible: only one respondent stated that they collected leaflitter from the national park forest in addition to firewood and fodder. Ninety-five households collected both firewood and fodder, 83 collected firewood only, and 6 did not collect any resources from the national park forest.

Local people were dependent on national park resources to meet their subsistence needs at household level. No-one sold firewood or fodder in the market. In total, about 97% of the respondents harvested firewood for domestic use, ranging from 252 kg to 9,198 kg per household per year (average 1,929 kg per household). Similarly, 53% of the respondents (97 households) harvested fodder / grass to feed livestock. The amount of fodder taken from the national park ranged from 504 kg to 18,396 kg per household per year (average harvest 4,509 kg). Ninety-four households harvested fodder and owned livestock, whereas only 3 households harvested fodder but did not own livestock. On the other hand, 15 households did not harvest fodder but did own livestock.

Factors influencing resource (firewood and fodder) dependency

Only 5.9% of the variance in firewood consumption (for both cooking and heating) was explained by the regression model (F (4, 173) = 2.722, $p < 0.05$). Household size was the only predictor ($p < 0.05$) of firewood consumption: the larger the household, the larger the harvest of firewood (Table 3).

For fodder consumption, 13.7% of the variation was explained by the regression model (F (4,173) = 6.842 $p < 0.001$). Household size ($p < 0.01$) and total number of LSUs ($p < 0.01$) were the two main predictors of fodder/grass consumption. The larger the household, the greater the harvest of fodder; and the more LSUs owned, the more fodder / grasses tended to be harvested. Households with greater holdings of land tended to harvest less fodder / grasses. The further the

[3] Ropani is the local land area measurement unit in Nepalese mountains. One hectare equals to 19.65 ropani.

villages were from the national park headquarters, the less harvesting and consumption of firewood and fodder occurred (Table 3).

Discussion

Local people in LNP harvested only two types of resources, firewood and fodder / grasses, for their subsistence needs. While firewood was harvested by almost all households surveyed, fodder was harvested by only about half of them. Where the harvest of resources from LNP is concerned, this study made findings similar to those of others (Måren & Sharma 2018; Spiteri & Nepal 2008a, b). In Annapurna Conservation Area and Chitwan National Park, local people identified timber, firewood, thatch grass and fodder as the most important extraction benefits, with firewood the main resource harvested (Spiteri & Nepal 2008a). However, these benefits were recognized more by villagers who were not involved in tourism than by those who were. Given the protected status of national parks and the limits put on resource extraction, resources harvested from the national parks may not meet the actual requirements of local people (Spiteri & Nepal 2008a). While this study found only one case of leaflitter being harvested from LNP forest, Måren and Sharma (2018) found no cases of fodder being harvested from the LNP and government forests. This discrepancy could be due to villagers considering fodder and leaflitter as one single resource.

The harvesting of firewood and fodder / grasses could be due to the fact that almost all the people residing in LNP are subsistence farmers, and livestock rearing and farming are their main livelihood activities. However, LNP office records showed that after paying a fee determined by the national park, local people also used various other resources, such as sand, gravel, timber for construction, firewood etc. (LNP 2019).

People living in LNP did not recognize natural resources other than firewood and fodder. The reasons for this could be: 1) the special permit required from the national park office to harvest resources; 2) natural resources are controlled (allocated, and restricted in quantity); 3) the fee charged for harvesting resources. For example, if, after a disaster, local people need timber for house construction, they must apply for a permit, pay a fee to the national park, and obtain permission from the national park office (with recommendation from the buffer-zone users' group or users' committee). Harvest permits are issued for limited quantities of sand, gravel and other resources. For firewood, however, no special permit is required, and it can be harvested twice a year (during one month in winter and one in summer) through a buffer-zone users' group / committee (Chapagain 2017). This author did, however, witness harvesting of firewood in other months.

Himalayan National Park regulations prohibit the collection of sand, stone and other resources from the national park. Similarly, cutting down live trees and bushes, and harvesting foliage or branches from them, are restricted in National Parks. However, harvesting wood / timber and forest products for house construction and / or repairs is sometimes allowed after payment of a fee (GoN 2019). In the fiscal year 2018 / 2019, the national park office distributed timber, firewood (212,017 kg) and *nigaloo* (Himalayan bamboo, 857 kg), and permitted the collection of sand, stone and gravel for a fee (LNP 2019). In the current study's area, there are only two buffer-zone community forests (in Syafru VDC) for forest resource use, protected and managed by the community (LNP 2019), whereas people from the other three VDCs rely on the national park forest. In the absence of a community forest, resources taken from the national park forest cannot be ruled illegal. However, as local people have also borne losses caused by national park wildlife, including damage to their crops or predation of their livestock (Kharel 1997; Regmi et al. 2013), opportunities to harvest resources could have been offered (albeit unofficially) as indirect compensation.

The national figures for Nepal have shown that the use of firewood for energy is increasing (GoN / NPC 2019). 68.6% of the country's energy consumption comes from traditional energy sources such as firewood, followed by commercial fuel sources (28.2%) and renewable sources (3.2%) (GoN / MoF 2021). Of the traditional energy sources, 87% of household energy comes from firewood, the main source of domestic energy for cooking and heating in Nepal's rural households (Baral et al. 2019). In Rasuwa district (the study area), improved stoves have been designed and promoted to reduce the consumption of firewood and increase energy efficiency (GoN / NPC 2019). However, they have not resulted in a reduction in the consumption of firewood (Nepal et al. 2011).

Table 3 – Multiple regression analysis of independent variables on firewood and fodder consumption.

	Firewood			**Fodder**		
Variables	Coefficient	Std error	p	Coefficient	Std error	p
Constant	72.415	21.777	0.001	110.973	63.253	0.081
Household (Family) Size	4.488	1.831	0.015**	15.185	5.318	0.005***
Land holdings	0.028	0.391	0.942	−1.797	1.136	0.116
Location	−14.163	10.295	0.171	−17.292	29.901	0.564
Total LSUs	0.596	0.827	0.472	7.804	2.402	0.001***

*Significance at ***1%, **5%*

In the high-altitude Langtang village in LNP, Chapagain (2017) found that the average consumption of firewood per household (non-hoteliers) was 6,500 kg to 7,175 kg per year (equating 6.6 kg per capita per day), which is higher than the current study found. There has been a growing trend in using firewood as the energy source in these high mountain villages (Chapagain 2017; Timmerman & Platje 1987 cited in Yonzon & Hunter 1991), where high consumption of firewood is inevitable because of the colder climate. Controlling local harvesting of national park resources such as firewood is often difficult. For example, in LNP, the yak cheese factories used more than 100% of their permitted quantity of firewood (Yonzon & Hunter 1991). Hence, there is a risk of over-harvesting national park forest resources, and thereby of reducing the overall growing stock of the forest and its biodiversity.

Requirements for firewood and fodder can also be met by planting trees on private farmland, as agroforestry. Trees on private farmland meet about 43% of the total firewood and fodder requirements of community forest users' groups in the Nepalese mid-hills. Most of the tree species grown on farmland are multipurpose fodder species (Oli et al. 2015). Encouraging farmers to plant trees on their own land may help reduce the demand for firewood and fodder from the national park in the long run, thus contributing to conservation. This study also found that households with more land are less dependent on the national park for fodder.

Baral et al. (2019) found that family size, per capita income, livestock units and literacy rate were the key predictors of firewood consumption. In another study, Mushi et al. (2020) found that distance from the forest and roads were the main predictors for the collection of non-timber forest products. Those people living close to the forest but far from the main road were the most frequent harvesters of fodder. People living far from the main road also collected more firewood, while households living some distance from the market but near the forest also consume more firewood (Asfaw et al. 2013; Oli et al. 2015). Higher levels of education could help reduce deforestation by opening up opportunities for better-paid work (Adhikari et al. 2004; Godoy & Contreas 2001, cited in Mushi et al. 2020). Easy access to markets and forests clearly leads to the accelerated extraction of forest resources. In the Langtang region, the density of cut tree stumps, a proof of human use, was higher in lower elevations and closer to settlements (Måren & Sharma 2018). In the present study, villagers near the national park headquarter were found to harvest more firewood, which could be explained, at least in part, by the ready availability of, and accessibility to, forest resources.

Conclusion

The livelihoods of the local people in LNP are typical of a hill-farming system in which livestock rearing, traditional agriculture and forest resources complement each other. Because local people are dependent on national park resources to support their livelihoods, strict conservation measures to prevent people harvesting resources could generate negative attitudes towards the national park. It is significant that local people who are able to extract resources are more likely to have positive attitudes towards protected areas and conservation (Allendorf 2007). However, allowing local people to harvest resources without controls can result in over-harvesting, and it is therefore important to find a win-win solution for the national park and local people.

Dependency on national park resources can be reduced by promoting alternative energy sources, and encouraging local people to plant multipurpose and fast-growing tree species on their own farmland. Strategies to ensure sufficient nutritious fodder throughout all seasons should be a major target for livestock production. Unproductive livestock can also be reduced through improved breeding techniques and more efficient use of animal feed while obtaining the same or increased outputs that suit the local environment (Khanal et al. 2022). While some level of dependency by local people on national park resources is inevitable, it is important to manage the national park for the conservation of biodiversity. By increasing people's understanding of the need for conservation and providing alternative resources to those of the national park, the balance between conserving biodiversity and meeting the needs of local communities will be easier to achieve.

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Survey questionnaire

Natural Resource Benefits from Langtang National Park in the Nepalese Himalayas

Household ID:

1. Demographic profile
Household size:
Age:
Ethnicity:
Education:
Village:
Occupation:
Sex:

2. Please mention the top three natural resource products that you often harvest from Langtang National Park.

3. For the Natural Resource product that you harvested given in (a) above, how much do you harvest per year, on average in bhari?

4. For the Natural Resource product that you harvested given in (b) above, how much do you harvest per year, on average in bhari?

5. For the Natural Resource product that you harvested given in (c) above, how much do you harvest per year, on average in bhari?

6. Do you own any livestock?
a) Yes
b) No

If yes, how many of the following do you own?
a) Cattle
b) Buffalo
c) Goats/Sheep

7. Do you own any land?
a) Yes
b) No

If yes, please state how much you own in ropani.