Ethnobotanical Documentation and Ecological Diversity of Non-Timber Forest Products in Annapurna Conservation Area, Nepal

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Research Article

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Abstract

Background: Development and modernization of the world is leading and thereby shrinkage of traditional practices and forest encroachment became horrible. Nepal is a biologically and traditionally diverse country where people still rely on forest resources for their daily needs. Current work explores the ethnobotanical knowledge of Non-Timber Forest Products (NTFP) and their ecology along the trekking route of Annapurna Conservation Area, Central Nepal.

Methods: Sixty sample plots were laid at each 200 m, using a systematic random sampling method where abundance was noted and later NTFP species composition was plotted. A semi-structured questionnaire was used for interviewing fifty-four local respondents including local healers (*Amchi)*and elder farmers.

Results: In total 228 NTFP species, belonging to 80 families and 167 genera were enumerated from ethnobotanical interviews and ecological data. Herbs were the dominant (95) life form among NTFP and Asteraceae (20 species) was the richest family in the area. Through an intensive ethnobotanical survey, only 59.21% (135 species) of total NTFP species were known to be in recent use at a local level. Leaf was the most frequently used plant parts and common NTFP species based on use value index were *Rhododendron arboreum*, *Daphniphyllum himalayense*, and *Arisaema utile*. The medicinal category comprised 83 species from 49 families and 69 genera with the highest informant consensus factor value for the treatment of jaundice (1), followed by fever (0.82), and gynaecological problems (0.78). Additionally, the highest fidelity level (1) shown the frequent use of *Rhododendron arboreum* for throat blockage relief. Ecological study revealed only 54.39% (124 species) of total NTFP, however, value of diversity indices; Shannon-Weaver index (4.22587) and Simpson index (0.98) were near to their optimum value with decreasing species richness along the altitudinal raise.

Conclusions: Although, diversity indices were high, some valuable plants mentioned in interview were not recorded from sampling sites, which might be an indication for waning of those species from the area. Difference on total NTFP and recently used species shows shifting of social status, occupation, daily practices, and effect of modern treatments. Economic development can be boosted with sustainable utilization, cultivation, and monitoring of potential high value NTFP at natural habitat in the area.

Introduction

Forest resources are major provisioning ecosystem services provided to livelihood from the very beginning of human civilization[1]. It provides non-consumptive services, ecosystem services, socio-cultural services, tourism, and recreational services[2]. Non-timber forest products (NTFP) are one of them, which encompass animal and plant products from forest, either used in raw or processed form, except for timber[3,4,5]. More than 1.6 billion rural people in the world, still depend on these forest resources to some extent of their livelihood and income generation[6–10]. These NTFP are economically important as it holds significant position in world trade[11,12]. It generates above 9s0% of total household

income in rural part of Nepal.[6] In addition, about 100 NTFP are commercially collected for trade, generating over $30 million annually[7,13].

In Nepal, 126 ethnic groups are living with their own traditions and socio-cultural norms that promote the uses and conservation of NTFP[14–16]. However, traditional ecological knowledge (TEK) was rarely recorded in written form, instead handed as folklore from one to another generation[15]. Traditional medicines are still practiced in different part of the world[17,18]. Moreover, above 1600 plant species are used for medicinal and aromatic purposes in Nepal[19], where standard traditional medicinal system includes *Ayurveda, Amchi, Siddha, Unani*, naturopathy, homeopathy and folk health care systems[20]. Annapurna Conservation Area (ACA) is an imperative part of Himalaya, rich in phytodiversity and traditional knowledge on NTFP[21]. Annapurna conservation area contributes about 426 useful species, including exotic and cultivated species[22]. Various NTFP species have been recorded from different parts of ACA[21,23–26]. Shakya *et al.*,[21] recorded 154 NTFP species from Modi Khola Valley and Upper Mustang. Similarly, Pandey[23] found 93 medicinal plants used in traditional Tibetan therapy by *Amchi* in Upper Mustang. Later, Chhetri and Gupta[24] reported 101 species of NTFP from the same place. Further, 16 plant species from Manang[25] and 40 species from Mustang[26] district were described for fuel wood and fencing purposes. Adhikari and Fischer[27] reported increasing use trend of some valuable plants and animals in Ghandruk village during past 20 years from their study.

In other hand, plantation and NTFP promotion has increased the greenery of the area by 25% and have supported more than 25,000 households[28]. Local communities are beneficiary of surrounding NTFP and active authority for biodiversity conservation within ACA[29]. Additionally, beautiful traditional norms for collection and use practices among ethnic community could be another aspect for conservation of NTFP; which have unknown status along the trekking route where socio-cultural and living standard were changing. Thus, present work drew the pattern of NTFP species diversity, ecological distribution, and traditional ethnobotanical knowledge along the trekking route of ACA. It could be a reference work for the further programs and scientific works.

Materials and methods

Study area

Annapurna Conservation Area was established in 1992 on the Himalayan range of Central Nepal. ACA has an area of 7629 square km with altitudinal range from 1000 m to 8000 m above sea level[22]. Study area includes three villages of ACA, famous for trekking, with unique geography, beautiful mountains, climate, biodiversity, water resources, and cultural diversity with 22 types of forests. Randomly selected three villages along the walking route were Dhampus (Machhapuchre Rural Municipality; Ward 7), Ghandruk (Annapurna Rural Municipality; Ward 10 & 11) and Ghorepani (Annapurna Rural Municipality; Ward 6), first two lying on Kaski district and later Myagdi district (Fig. 1). Dhampus is located on 28.31^0

N, 83.85^0 E; Ghandruk on 28.377^0 N, 83.807^0 E and Ghorepani on 28.398^0 N, 83.699^0 E in geographic system. The altitudinal range of the study area lies between 1700 m asl (Dhampus) to 3200 m asl (Poonhill). The major ethnic groups were *Gurung* and *Dalit* communities.

Figure 1: **Map of study area**

Sampling

Using systematic random sampling method, common walking trail was taken for reference line and sampling plots were laid on either side of the trail at the distance of 200 m. In total 60- square plots of size 10 m x 10 m for trees, a sub-plot of size 5 m x 5 m for shrubs and three sub-plots of size 1m x 1m for herbs were laid. Within plots, respective numbers and coverage of each individual species were recorded. Later, density, frequency, abundance, and importance value index (IVI) were calculated using average value in case of multiple subplots within the plot and calculation method was given by Yadav *et al*[30]. Diversity indices were calculated using formula given by Simpson[31], Shannon and Weaver[32] and Peet[33] in MS Excel 2010.

Herbarium preparation

Field exploration of plants was carried out with the help of local farmers and herders in the area. Photographs of available species were taken and specimens were systematically collected as required following the collection ethics. Herbarium was prepared following Bridson and Forman[34] and managed in the folders. The prepared herbarium specimens were later identified with the help of experts, comparison with KATH herbaria, digital herbaria, and respective literatures[35–51]. Further unreported species from sampling sites were identified with the help of local people on walks around the cultivation fields and high hills.

Interview

Semi-structured questionnaire prepared based on objectives was used for interviewing fifty-four local respondent including traditional healer, and elder farmers separately through informal talks. Photographs and live specimens were displayed to avoid possible misidentification and misunderstanding of plant and their use. **Use Value (UV)** for NTFP having high number of events were calculated using formula given by Philips and Gentry[52]. For medicinal species, **Informant consensus factor (ICF)** was calculated using formula by Heinrich *et al*.,[53] revised by Canales *et al*.,[54] and **Fidelity level (FL)** calculated for species having equal or more than 5 events under medicinal category (ailment) following the derivation of Friedman *et al*.,[55].

Results

Diversity and richness of NTFP

Along the study area, in total 228 plant species were recorded as NTFP species. Species belonging to 167 genera and 80 families were enlisted with taxonomic and ethnobotanical detail (**See Additional file 1**). The highest number of species found under division angiosperms followed by gymnosperms and pteridophytes (Table 1). Among flowering plant families, Asteraceae had highest no. of species followed by Rosaceae, Rubiaceae, Solanaceae, and so on. Whereas, the largest family in terms of generic diversity was Asteraceae followed by Rosaceae, Lamiaceae, Orchidaceae, Fabaceae and so on. Similarly, largest genera in terms of species were *Rhododendron*, *Clematis*, *Solanum*, *Berberis*, *Galium*, and *Rubus*.

Table 1
NTFP species in different taxonomic groups

Taxa	Angiosperm	Gymnosperm	Pteridophytes	Total
No. of species	220	6	2	228
No. of genera	160	5	2	167
No. of families	75	3	2	80

Table 1: **NTFP species in different division**

Diversity based on life form

NTFP species were reported in different life forms as herbs, shrubs, trees, and climbers (Fig. 2). Highest number of species recorded with herbaceous habit (95 species) followed by shrubs, trees, and climbers. Some of the common NTFP herbs were *Aconitum gammiei, Acorus calamus, Ageratum conyzoides, Arisaema tortuosum*, and *Begonia picta*. Similarly, shrubs were *Artemisia indica, Berberis aristata, Elaeagnus parvifolia, Girardinia diversifolia*, and *Osbeckia rostrata*; common trees were *Ficus neriifolia, Castanopsis indica, Juglans regia*, and *Lagerstroemia parviflora*; additionally, climber species were *Ceropegia pubescens, Clematis grewiiflora, C. montana, Lycopodium clavatum*, and *Dioscorea bulbifera*.

Figure 2: **Species richness of plants based upon their life form**

Uses of NTFP and parts used

Among total 228 species acknowledged by key informants; other informants provided information for only 135 species, recently in use. For those species, further detail interview helped to reach following findings.

For 135 species, nine different useful parts of the plants were recognized (Fig. 3). Among them, most of the NTFP made from leaves, followed by fruits, root, shoot and least from latex. Many plants reported with various useful parts than a single part.

Figure 3: **Number of species by parts used**

Use categories

Study revealed 258 NTFP uses of 135 species under six broad categories (Table 2). Largest numbers of species reported with medicinal use (83 species), followed by food and vegetables, fodder, religious, fuel and others. Similar pattern documented for number of events and respondent along use category. In total, 1398 events were reported with average 26 events per respondent. Different parts of same species were known for variety of uses, resulting more species with multiple uses and fewer species with single use.

Table 2
Use category and informants' data

S. No.	Use Category	Use Reported	Total no. of species	Total event	Informants mentioning category
1	Medicinal	All types of medicinal uses for human.	83	438	54
2	Food & Vegetable	All kinds of edible plants used as vegetables, fruits, salad, spices, pickle, fermenting yeast.	67	381	54
3	Fodder & veterinary	Used to feed domestic animals and birds, also for their medicinal property.	46	270	54
4	Religious & social	Used as incense, to make *toran, jagye* decoration, plants offered during worship, essential during religious functions in birth, *bartabanda*, marriage, funeral, & different types of other worship (*Puja).*	24	126	48
5	Fuel	Fire wood, fire initiator.	19	85	36
6	Others	Fencing, making brooms, dyes, Nepali paper, ornamental, stick, agricultural tools, etc	19	98	40

Table 2: **Use category and informants' data**

Traditional knowledge on Use value (UV)

Use value shows the diversity on use of the plant species. Based on interview, use value was recorded to be highest for *Rhododendron arboreum*, followed by *Daphniphyllum himalayense*, *Berberis nepaulensis*, *Arisaema utile*, and *Mentha spicata*. Similarly, least use value (1) reported for 87 species. Further detailed on use values of NTFP species shown in Additional file (**See additional file: 2**).

Informant Consensus Factor (ICF)

Informant Consensus Factor (ICF) informs about knowledge convey among the local people for medicinal plants (Table 3). Highest ICF value recorded for jaundice (1) followed by fever (0.82), gynaecological problem (0.78), throat problem (0.75) and hypertension (0.75) Least ICF value known for earache (0.0) and urine tract infection (0.14).

Table 3
Informant Consensus Factor (ICF) for different ailments

Ailments	N_{ur}	N_t	N_{ur}-N_t	N_{ur}-1	ICF	*Ref	**Ref
Jaundice	**3**	**1**	**2**	**2**	**1.00**	**0.91**	
Abdominal disorder	72	30	42	71	0.59	0.90	0.95
Skin disease	39	17	22	38	0.58	0.93	0.94
Diabetes	8	4	4	7	0.57		0.95
Gastritis	5	3	2	4	0.50	0.95	0.95
Urinary tract infection	8	7	1	7	0.14	0.92	0.93
Earache	**3**	**3**	**0**	**2**	**0.00**		**0.94**
Headache	26	11	15	25	0.60		0.93
Body ache	25	10	15	24	0.63		0.93
Cut and wound	49	19	30	48	0.63	0.86	0.94
Common cold	26	10	16	25	0.64	0.91	0.94
Burn	14	5	9	13	0.69	0.90	0.94
Impotence	11	4	7	10	0.70		
Hypertension	9	3	6	8	0.75		0.97
Throat problem	17	5	12	16	0.75		0.94
Gynaecological problem	10	3	7	9	0.78	0.97	0.93
Fever	74	14	60	73	0.82	0.90	0.95

[**Notes**: N_{ur} = No. of use reported for treatment of ailment; N_t = No. of taxa recorded for the treatment of a particular ailment; ICF = Informant Consensus Factor; Supporting references *Ref: Kunwar et al.,[56]; **Ref: Singh et al.,[57]]

Table 3: **Informant Consensus Factor (ICF) for different ailment**

[**Notes on** Table 3: N_{ur} = No. of use reported for treatment of ailment; N_t = No. of taxa recorded for the treatment of a particular ailment; ICF = Informant Consensus Factor; Supporting references *Ref: Kunwar et al.,[56]; **Ref: Singh et al.,[57]]

Fidelity level (FL %)

Fidelity level provided the range of species used for the treatment of different ailments (Table 4). Fidelity level shown high use of *Rhododendron arboreum* to treat throat problem; *Anisodus luridus, Dioscorea*

bulbifera and *Lycopodium clavatum* to treat cut and wound; *Elsholtzia flava* for skin disease, *Ficus neriifolia* in burns, *Melastoma malabathricum* for cough and cold and *R. campanulatum* for fever and other species with low FL value having wide range of use for different ailment.

Table 4
Total events for ailment and species with fidelity level

Name of medicinal species	Ailments									TUR	FL (%)
	SD	BA	Hp	CC	TP	I	F	B	CW		
Rhododendron arboreum					**10**					**10**	100.0
Anisodus luridus									**6**	**6**	100.0
Dioscorea bulbifera									**7**	**7**	100.0
Elsholtzia flava	**7**									**7**	100.0
Ficus neriifolia								**5**		**5**	100.0
Lecanthus peduncularis		**5**								**5**	100.0
Lycopodium clavatum									**5**	**5**	100.0
Melastoma malabathricum				**5**						**5**	100.0
Rhododendron campanulatum							**8**			**8**	100.0
Picrorhiza scrophulariiflora							**13**			**16**	81.3
Dryopteris cochleate						**7**				**9**	77.8
Rubus ellipticus							**8**			**11**	72.7
Urtica dioica			**5**							**7**	71.4
Lindera neesiana				**5**						**8**	62.5
Parnassia nubicola							**9**			**15**	60.0
Paris polyphylla							**13**			**22**	59.1
Swertia nervosa							**8**			**15**	53.3
Bergenia ciliata		**6**								**12**	50.0

[**Note**: SD = Skin Disease, BA = Body Ache, Hp = Hypertension, CC = Common cold, TP = Throat Problem, I = Impotence, F = Fever, B = Burn, CW = Cut & Wound; **TUR = Total use reported; FL = Fidelity Level]

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NTFP Diversity

Total 124 species (54.39%) of total documentation was recorded from field. NTFP species diversity in the study area was calculated in terms of two diversity indices; Simpson index and Shannon-Weaver index (Table 5). Values of Simpson diversity index (0.98) and Shannon-Weaver diversity index (4.22587) were near to their optimum value 1 and 5 respectively with high value of evenness.

Table 5
Diversity indices

S. No.	Indices	Value
1	Simpson Index (1-D)	0.98
2	Shannon-Weaver Index (H)	4.22587
3	Evenness (E)	1.83527

Table 5: **Diversity indices**

Density, Frequency, Abundance, and Importance Value Index

Density, Frequency, Abundance, and IVI of the NTFP species were calculated and presented based on their habit (**See Additional file 3**).

Among the tree species number of individuals ranged from two to 360 individual per hectare. The highest density was obtained for *Daphniphyllum himalayanse*, which was most frequent and abundant as well, resulting to highest importance value among trees. *D. himalayanse* was followed by *Rhododendron arboreum*, *Lyonia ovalifolia*, and so on. The lowest density was known for *Juniperus indica*, *Tamarindus indica* and *Toxicodendron wallichii*. These species were least frequent, least abundant and had least IVI as well. Similarly, among the shrubs, density ranged from 0.01 to 0.87 per m^2. It was highest for *Daphne bholua* followed by *Maesa chisia*, *Sarcococca hookeriana*. However, *Maesa chisia* was the most frequent species followed by *Daphne bholua*, and *Drepanostachyum intermedium*. Subsequently, *Daphne bholua* was the most abundant species. Ultimately, IVI was highest for *Maesa chisia* followed by *Daphne bholua*, *Drepanostachyum intermedium*, *Sarcococca hookeriana*, and least for *Elsholtzia flava*, *Colebrookea oppositifolia, Thespesia lampas, Thysanolaema latifolia* and *Urena lobata*. Moreover, from study area 63 NTFP herb species were recorded with highest density of *Selaginella willdenowii*, followed by *Eleutherococcus cissifolius*, *Dryopteris cochleata*, and *Cyperus rotundus*. *E. cissifolius* reported as most frequent species followed by *Argentina lineate*, *Anaphalis busua*, and *C.*

rotundus. However, *S. willdenowii* was most abundant among other herbs. IVI was highest for *S. willdenowii* followed by *E. cissifolius*, *C. rotundus*, and least for *Primula glomerata*, and *Reinwardtia indica*.

NTFP species richness along altitudinal gradient

From the entire ecological data complete species richness of NTFP along the altitudinal gradient was drawn and presented through regression line graph (Fig. 4). NTFP species richness shown declined pattern with increasing altitude in the area.

Figure 4: Regression analysis of species richness (NTFP) with altitude

Discussions

High NTFP diversity is the crucial finding for the present study in Annapurna Conservation Area. Plants are particularly documented under pteridophytes, gymnosperm and angiosperm category. At the same time, it is more interesting to document eleven threatened species from the area. Diverse life form, structure, high species richness, and their composition appreciate the existence of various microclimatic conditions, geography, soil elements and other environmental factors. Traditional knowledge among diverse ethnic communities also supports the availability of these species through different perceptions as their cultures, traditions, livelihoods, and beliefs. These findings have several similarities with previous reports from different part of Annapurna Conservation Area[21,24,58,59]. Many studies have been carried out around ACA on firewood, medicinal and edible plants separately[23,25,26,60,61].

Herbs have highest species richness among NTFP. It has revealed maximum number of herbs utility than other life forms[57]. Its emphases the importance of herbaceous life form/ ground vegetation for livelihood. It shows consistency with previous findings from Kanchenjunga landscape, Eastern Nepal,[62] and NTFP of Nepal Himalaya database[63]. Another striking result shows maximum utilization of leaf parts in NTFP plants[57]. Physiological theories support this outcome, as they are photosynthetic site for plants where physiological & metabolic activities take place. Finding concurs with previous one, as reported by Bhattarai *et al.*,[61] and Uprety *et al.*,[62] for medicinal plants that point towards richness of bioactive chemical compounds in leaves and roots. Fruit was another highly used part, which might due to harvesting of wild plants for food and vegetables and additionally wild edible fruits drew more interest for their exclusive taste[60].

People acknowledged highest number of medicinal plants along with higher use events from total respondents. People are highly concerned about their health and traditional believe towards local medicinal practices. In another aspect, there is lack of well-equipped health centres and managed transportation facility to reach city areas for modern treatment. In addition, the reason could be increasing concern of world towards traditional medicine and their economic proficiency. Bhattarai *et al.*,[61] and Uprety *et al.*,[62] obtained similar findings in their studies. In contrast, people were collecting fuel

wood from few plants, as it needs hard woody species and gives more durable fire. Accordingly, another reason could be availability of fossil fuel from local market.

Among the medicinal plants, highest ICF value was recorded for jaundice treatment. From the visual observation of data, single taxa reported for its treatment and only a few people reported this use which resulted on its highest ICF score. There seems the need of some changes/ revision in present formula to address such doubts over their accuracy. Further, higher ICF values calculated for fever, gynecological problem, and throat problems imply use of many species for their treatment as highly appreciated by local users as well. As mentioned in table, Kunwar *et al*.,[56] and Singh *et al*.,[57] reported different results from Baitadi, Darchula and Terai region of Western Nepal respectively. Concurring information also sign towards common symptoms and ailments in the area due to similar climatic condition and cultural proximity. In another side, least ICF value for urinary tract infection entails variety of species reported for its treatment and each supported by fewer people as low events reported. Most people disagree on each other's knowledge due to poor verbal communication and insecurity to their knowledge. It refers to the high knowledge on medicinal properties and varying knowledge scattered among the people.

Study area is rich in NTFP diversity though populations of the valuable species are exceptional. From the result, species used for fodder, fuel wood and religious functions were found to be dominant, whereas species used, as medicines were rare. Among the trees, few species are highly dominant in wide range of study area like *Daphniphyllum himalayanse* recorded from 1700masl to 2600masl in remarkable number. While other trees were higher in number but less frequently occurred such as *Rhododendron arboreum, Lyonia ovalifolia, Alnus nepalensis*, *Eurya acuminata* etc. Number and frequency both high for trees might due to abundant availability of fodder trees planted near to the village around the boundaries of crop field. In addition, number of individuals for a species varied based on its habit, size and habitat suitability. Shrubs were more frequent but less in number forming scattered distribution whereas herbs were less frequent but high in number showing clumped distribution. Variation in population and distribution could be influenced by tree canopy that alters light reached to the ground level. Most trees and shrubs were used for fodder and fuel wood; and herbs for medicinal purpose.

Some valuable species were less frequent with very low density, implies threat to them. Increasing threat to those species might be consequence of over harvesting (due to its high economic value), habitat sensitivity, habitat loss or fragmentation, multiple use purposes, and illegal trades. Most important and major species of NTFP were *Adina cordifolia, Taxus wallichiana, Arisaema utile, Acorus calamus, Maharanga emodi and Swertia chirayita* reported occasionally in least number. Some of the valuable and most priority plants of the region were *Dactylorhiza hatagirea*, *Picrorhiza scrophulariiflora*, *Paris polyphylla*, *Cordyceps sinensis*, *Meconopsis spp*., which were not reported in this study. Outcome concurs with Shakya et al.,[21] as few species were fewer and some even not reported for long. Which might due to over-harvesting as Olsen[64] mentioned, about 50–100 percent of households in mountain range of central Nepal were involved in collection and sale of medicinal species. Nevertheless, the utilization of natural resources in the study area found to be very low. Only few poor people depend on forest for medicine and food. Consequently, threat on plants and indigenous knowledge were ever

increasing. Species richness of NTFP decreases along the higher elevation in Himalayas due to effects of different climatic and geographical features[65]. Previous studies reported hump-shaped correlation between altitude and species richness of medicinal and vascular plants[66,67].

To address declination in diversity ACA has band to collect NTFP from core forest rather use the part of the forest handed over to local *Aama Samuha* for resource utilization, management, and conservation. Promoting plantation of fodder plants (*Nimaro*) in the edges of crop fields and nearby bare lands was another effective step for forest resource conservation. ACAP is carrying out different programs such as natural resource conservation program (NRC), which conducts activities such as nursery management, plantation, community mobilization, Conservation Education and Extension Program (CEEP) as tool in practice to spread the conservation awareness message to every part of the ACA and its beyond. Although NTFP are not widely used in ACA, their status is declining unintentionally because of its haphazard utilization for fire, fodder, constructions, and open animal grazing. Previously similar declined pattern of useful plant species had been reported from Sagarmatha National Park[68] and Shey-Phoksundo national park[69].

Conclusions

The largest conservation area of Nepal, with beautiful geography and high mountains, was rich for diversity of non-timber forest products. NTFP species from the study area were in different life forms and with variety of uses. Area is highly rich for traditional knowledge however; present generation shows knowledge sharing gap. Knowledge on medicinal plants is prevalent with high informant consensus factor, and fidelity level. High use preference with concurring knowledge reported for the treatment of common symptoms. Frequent use reported on decoration, religious, medicine, food, fodder, and fencing purposes. Recurrently occurring species were fewer and species occurring in specific habit were forming dense patches. Despite huge diversity, their population and distribution are sparse, urbanization has affected the life style of people and consequently declination of traditional knowledge was prevailing due to poor communication and modernization.

Abbreviations

ACA	Annapurna Conservation Area (ACA)
asl	Above sea level
B	Burn
BA	Body Ache
CC	Common cold
CEEP	Conservation Education and Extension Program
CW	Cut & Wound
DNPWC	Department of National Parks and Wildlife Conservation
F	Fever
FL	Fidelity level
Hp	Hypertension
I	Impotence
ICF	Informant consensus factor
ICF	Informant Consensus Factor
IVI	Importance value index
m	Meter
NRC	Natural resource conservation program
Nt	No. of taxa recorded for the treatment of a particular ailment
NTFP	Non-Timber Forest Products
Nur	No. of use reported for treatment of ailment
SD	Skin Disease
TEK	Traditional ecological knowledge
TP	Throat problems
TUR	Total use report
UV	Use Value

Declarations

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Ethical approval

Ethical guidelines for plant sampling and collection from the Department of National Parks and Wildlife Conservation (DNPWC) have been followed with written permission from DNPWC, Babarmahal, Kathmandu Nepal. Further informant's consent was taken prior to the interview for recording and publication of information on useful plant species and their products with verbal permission.

Declaration for publication

Here is no any personal data or information included. It is not applicable.

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Availability of data and materials

Field data are not available due to respondents' privacy concerns and other ecological as well processed data of interviews are available in additional files.

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.

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Figures

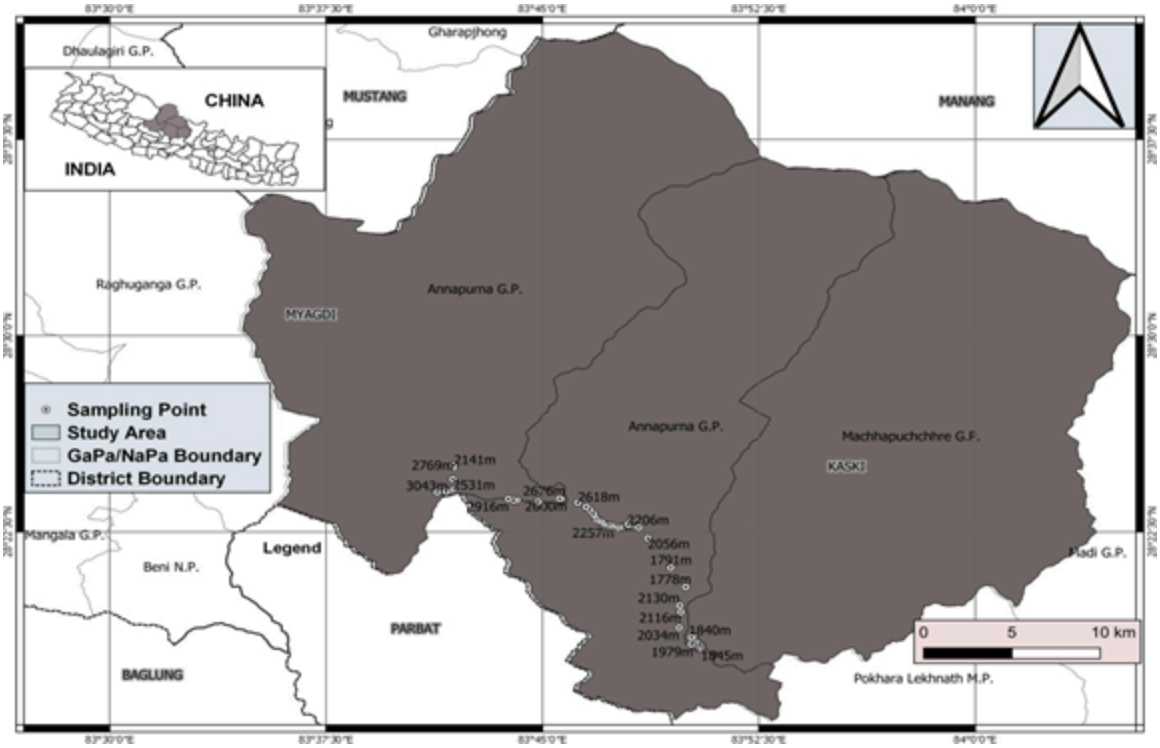

Figure 1

Map of the study area

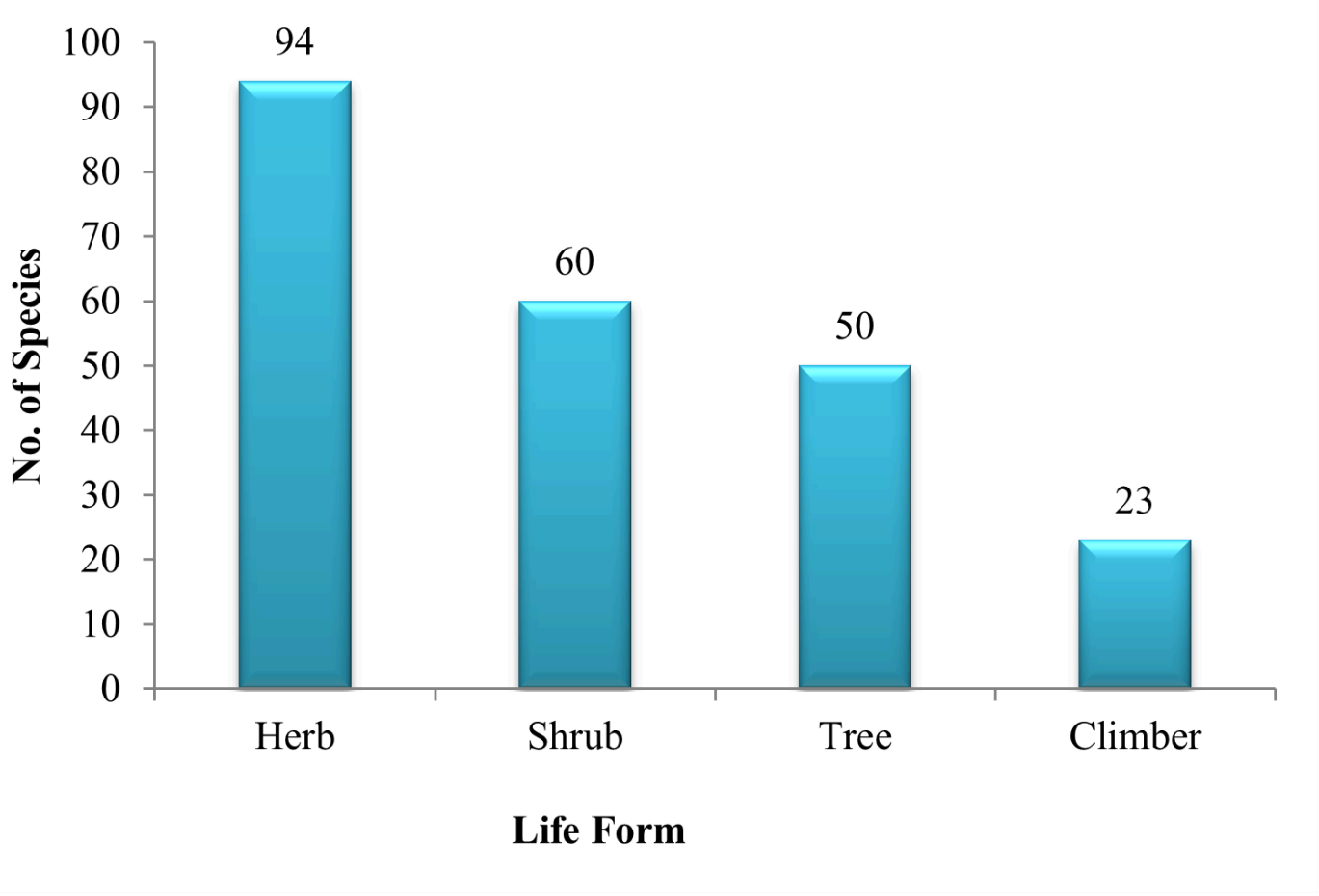

Figure 2

Species richness of plants based upon their life form

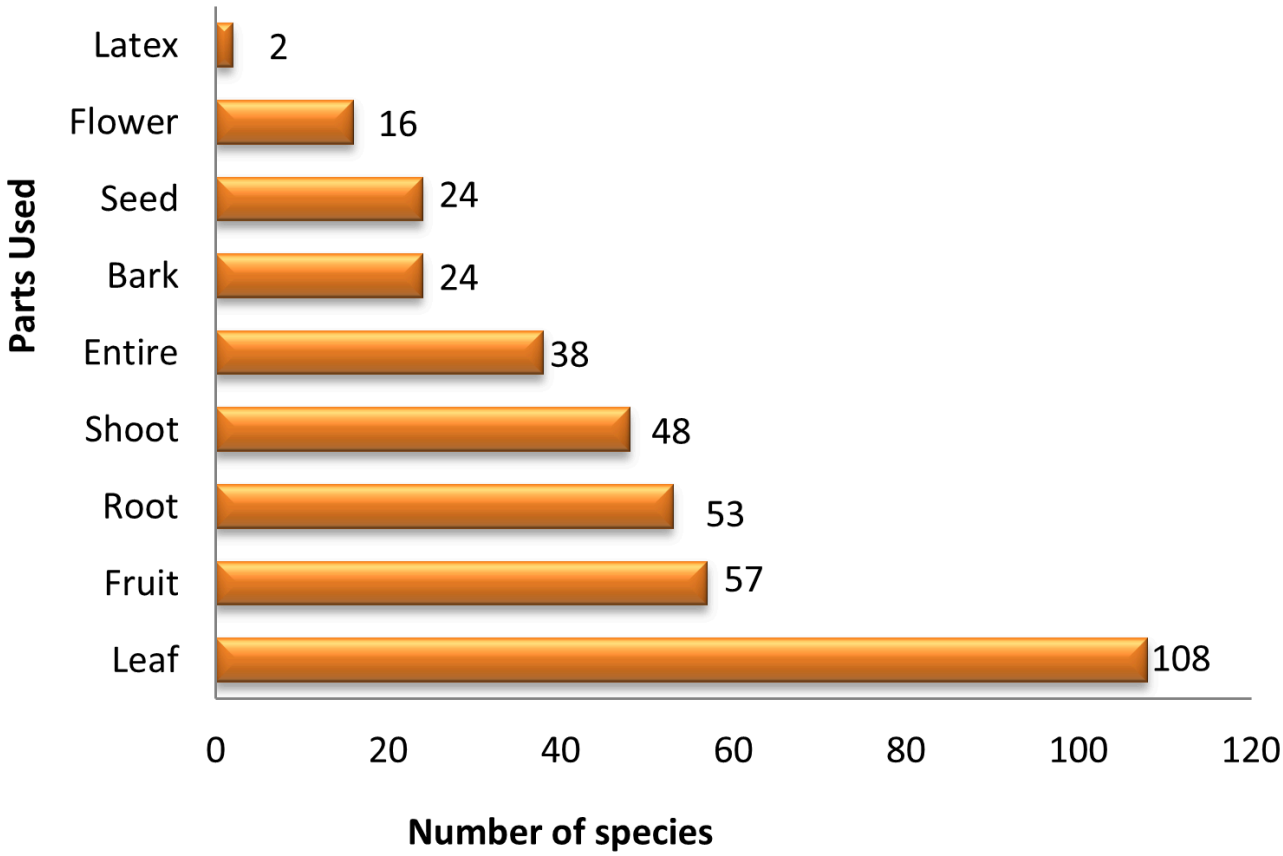

Figure 3

Number of species by parts used

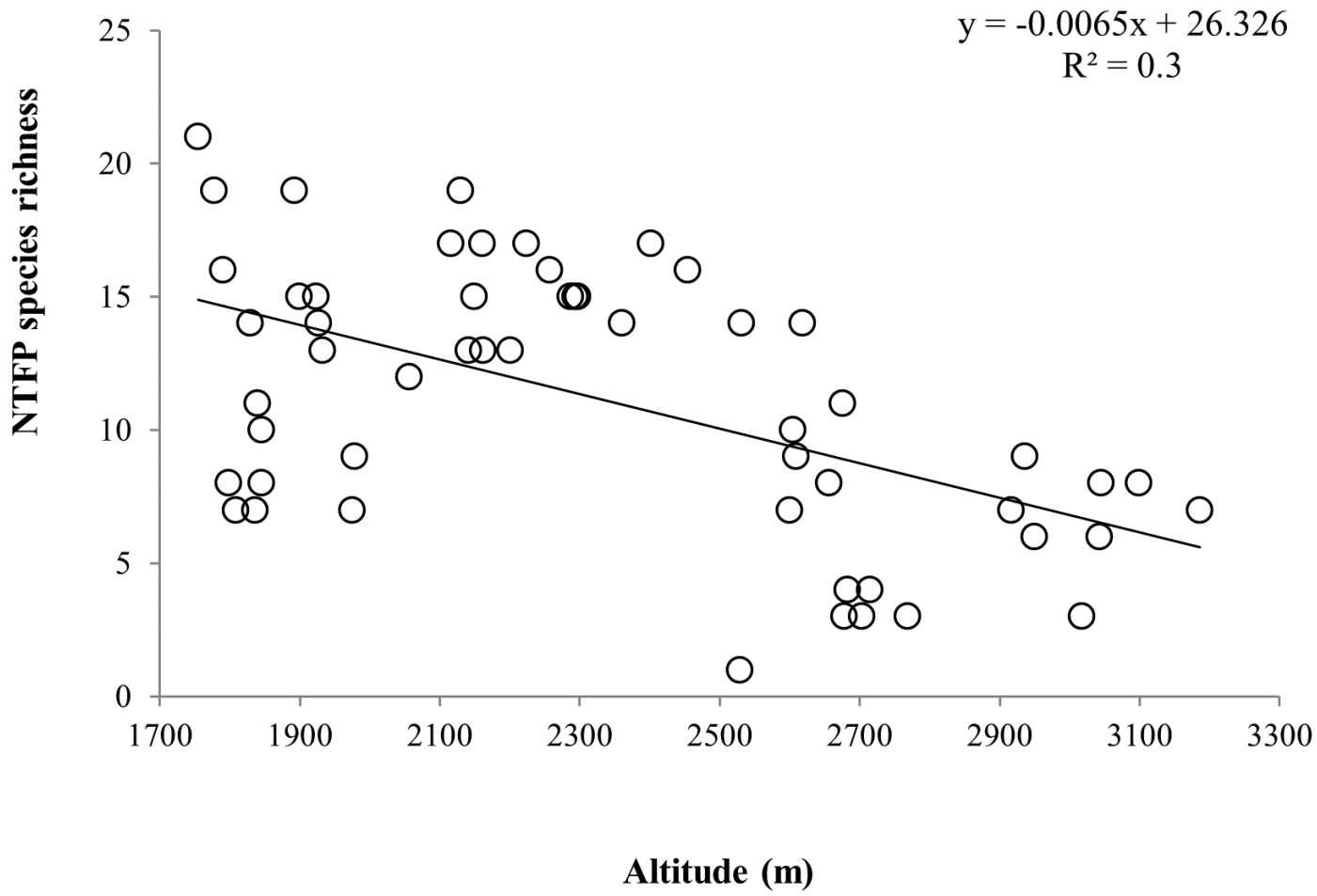

Figure 4

Regression analysis of species richness (NTFP) with altitude

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