2. Ban Lasun (*Allium wallichii*)

The largest patch of the pocket area of Ban Lasun was found inside the Dhorpatan Hunting Reserve in Baglung District **(Figure 2)**. Most of the patches of pocket areas were recorded in Gorkha, Manang and Myagdi Districts.

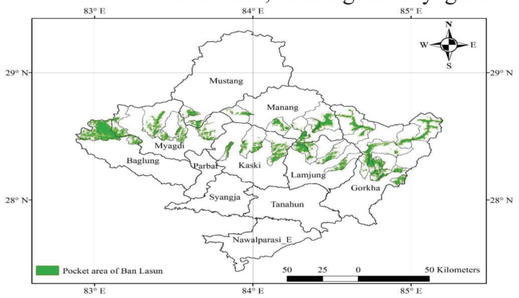

Figure 2: Spatial distribution of pocket area of Ban Lasun

3. Jatamansi (*Nardostachys jatamansi*)

The largest patch of the pocket area of Jatamansi was found at Dhorpatan Hunting Reserve in the Baglung District **(Figure 3)**. Most of the patches of the pocket areas were recorded in Gorkha, Manang and Mustang Districts.

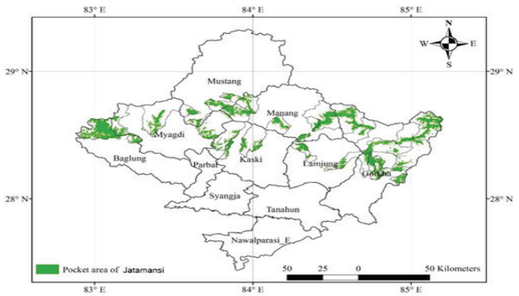

Figure 3: Spatial distribution of pocket area of Jatamansi

4. Panchaule (*Dactylorhiza hatagirea*)

The largest patch of the pocket area of Panchaule was found inside the Dhorpatan Hunting Reserve in Baglung District. Most of the patches of pocket areas were located in Gorkha, Manang, Mustang and Myagdi Districts **(Figure 4)**.

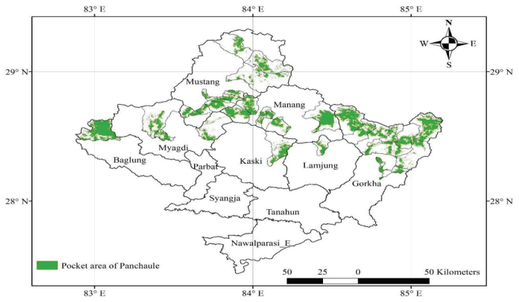

Figure 4: Spatial distribution of pocket area of Panchaule

5. Yarshagumba *(Ophiocordyceps sinensis)*

This study identified a total of 386 km2 area as the pocket area of Yarshagumba in 13 wards of 12 rural municipalities of four districts of Gandaki Province. The largest patch of the pocket area of this species was in ward no 1 of Chum Nubri Rural Municipality in Gorkha District. Most of the patches of pocket areas were found in Gorkha, Manang and Mustang District **(Figure 5)**.

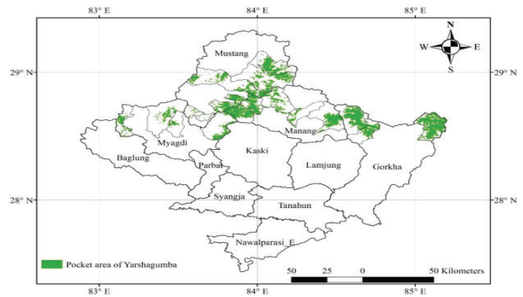

Figure 5: Spatial distribution of pocket area of Yarshagumba

Conclusions

Important medicinal plants are present in the High Mountain region of the Gandaki Province. The region can be considered as suitable habitat of the medicinal plants and also serves as pocket areas.Out of 15 species (Ban Lasun, Bish, Chiraito, Jatamansi, Kurilo, Kutki, Lauthsalla, Nirmansi, Panchaule, Satuwa, Setakchini, Siltimur, Tejpat, Timur, and Yarshagumba), the pocket areas of the majority of the species were identified around these regions. Out of eleven districts, Baglung, Myagdi, Gorkha, Mustang and Manang are acting as the pocket areas for most of the economically important medicinal plants.

Recommendations

The identification and mapping of economically important medicinal plants of Gandaki Province have pointed out some recommendations for conservation, cultivation, promotion, value addition, and sustainable use of medicinal plants in Gandaki Province.

- The Provincial Government needs to focus on conservation, cultivation, and promotion of medicinal plants in the identified pocket areas. Significant consideration should be given to the pocket areas as it shades a large volume of medicinal plants allowing traders/collectors to collect such medicinal plants from specific locations ensuring easy transportation.
- Identified pocket areas should be protected for conservation of the medicinal plants. If pocket area is conserved, medicinal plants will be conserved and local people get benefited from the medicinal plants.
- Medicinal plants can also grow outside the pocket area. Therefore, stakeholders should plan to develop these areas as pocket areas of the medicinal plants.
- Researches on identification of cultivation sites for important medicinal plants needs to be done.

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Identification and Mapping the Pocket Areas of Medicinal Plants in Gandaki Province

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Introduction

Medicinal plants

The demand for medicinal plants and their derivatives is growing globally at the rate of 7-15% due to its therapeutic and medical importance. They have been used in ethno-medicine for a long time. In Nepal, the maximum richness of medicinal plants was found at an elevation of 1,100 m (Acharya, Chaudhary, and Vetaas 1970).

Medicinal plants have been used domestically as traditional medicine since long time. Use of *Cordyceps sinensis* as an aphrodisiac, *Berberis asiatica* for eye problems, *Bergenia ciliata* for disintegration of calculi, *Sapindus mukorossi* for dandruff, and *Zanthoxylum armatum* for toothache were the most frequently used plants of Nepal (Kunwar et al. 2013). Due to the unique geographic position with altitudinal and climatic variation, the Gandaki Province is overwhelmed with richness of the medicinal plants. Thirty-three species are recognized as major medicinal plants and fifty four species are traded annually in the Province (MoITFE 2018).

Pocket area of medicinal plants

Hard and fast definitions and criteria of the pocket area have not been known yet. In general, area, where medicinal plants are growing in larger sizes is considered as a "Pocket area". The Pocket area of medicinal plants varies according to the species. This study considers pocket area as the area having more than 10 km^2 of suitable habitat for medicinal plants along with their recumbent presence. In addition, areas promoted in patch by Division Forest Offices as a pocket but with an area smaller than 10 km^2 area were also considered as a pocket area after comprehensive consultation with DFO officials.

Rationale of the study

The rising global acceptance of the utility of plant-derived drugs has driven local communities to the commercial cultivation of medicinal and aromatic crops. And, its economic contribution to the country is significant. NTFP's contribute about 15% of Nepal's GDP (Edward,1996). However, accurate estimation has not been updated. But, many of the literature reveal that contribution of the medicinal plants sector has not been significantly decreased.

Medicinal plants are listed as an economic sector of five year periodic plans of Gandaki Province (PPPC, 2020). The data of the last ten years show the trade of 54 species of medicinal plants in the Province. Satuwa (*Paris pariphylla*), Kakoli(*Fritilaria spinosa*), and Kalo Musali (*Curculigo orchioides*) were major medicinal traded plants among them(MoITFE 2018).

Basically, Himalayan region people's livelihood is directly dependent on medicinal plants. Insight of these circumstances and increasing demand for medicinal plants and their derivatives, medicinal plants sector have faced many conservation threats which needs to be tackled with adequate strategic effort. Of the many conservation threats, over-exploitation is the major one. For instance, medicinal plant habitats such as primary forests have become increasingly over-exploited and indigenous species have become limited (Kunwar et al. 2016).

Conservation strategies based on the geographic patterns of medicinal plant species richness and priority areas for conservation could improve the effectiveness of policy and management of medicinal flora in this area. Baseline information is crucial for planning and strategic implementation of conservation program which has not been explored in Gandaki provices. Therefore, this study is intended to fulfill this gap by identifing and mapping the pocket area of medicinal plants in the Gandaki Province.

Objectives of the study

The general objective of this study was to identify and map the pocket areas of medicinal plants inGandaki Province. The specific objectives of the study were as follows:

- To identify the potential pocket areas of these medicinal plants in the study area.
- To analyze the current distribution and coverage of these medicinal plants in the study area.
- To map the pocket areas of these medicinal plants

Materials and methods

The study was conducted in Gandaki Province which lies in the central part of Nepal and covers 11 districts. Similarly, there are 85 local administrative bodies including 1 metropolitan city, 26 municipalities and 58 rural municipalities (MoITFE 2018).This Province consists of five distinct geographical regions including Himalaya, High Mountains, Middle Mountains, Siwaliks and Terai.

In this study, two types of data were collected for modeling: one for the geographical location of Medicinal Plants species, which was used to describe the distribution of the species, and the other for climate data of the distribution areas, which described the climatic conditions of the habitats. The field survey was carried out to assess Medicinal plants including occurrence point while other occurrence points of medicinal plants were also compiled from the secondary sources. Moreover, the information about the pocket area was collected from all Division Forests Offices. Locations (municipality / rural municipality and ward number) of pocket areas of NTFP were identified and mapped based on these information.

A systematic sampling method was adopted to find sample points for ground data collection. In this sampling, the vegetated area (forests, shrub lands and grasslands) were identified using the land cover map. A grid of 10 km X 10 km was prepared throughout the Province and grids with vegetation cover were identified through visual interpretation and expert consultation. A transect of 100 m length and 10 m width was employed for data collection in the identified grids.

Besides this, 14 enviromental variables i.e. 5 Enhanced vegetation index (EVI) related (annual mean EVI, standard deviation of EVI, maximum EVI, minimum EVI, forest cover) variables, 5 anthropogenic (distance to settlement,distancetomotorroad,distancetopath,distancetobuilding,landuse/land cover) variables and 4 topographical (slope, aspect, elevation and distance to water) variables were collected for this study.

This study identified and mapped the pocket areas of medicinal plants whose presence were recorded in adequate amount. Species, for mapping the pocket area, were chosen based on their value, traditional use, trade amount, the possibility of farming and domestication as well as ease of cultivation. Based on these criteria, pocket areas of 15 species were identified. The Maximum Entropy (MaxEnt) model was used to predict the distribution of the species by using the species occurrence points and environmental variables (Phillips, 2006). The model used 10replicates and 1000 background points for predictions for the modeling (Barbet-Massin et al. 2012).

Pocket area of medicinal plant species

The livelihoods of people of Mountain areas of this province are dependent on medicinal plants. A total of 54 species of medicinal plants were in trade for the last ten years. Among them, Tejpat (*Cinnamomum tamala*) was a highly traded medicinal plant by volume. Following table shows the pocket areas of some economically important medicinal plants of the Provinces on the district basis. The largest suitable area (1057 km^2) was found for Kutki (*Neopicrorhiza scrophulariiflora*) while the smallest for Siltimur (*Lindera neesiana*).

Table 1 reveals that four Himali districts: (Myagdi, Mustang, Manang and Gorkha) and one middle mountain district (Baglung) have maximum pocket areas more than 300 km^2. The largest area was found in Gorkha district (1520 km^2). Moreover, Jatamasi (*Nardostachys jatamansi*), Kutki (*Neopicrorhiza scrophulariiflora*), Banlasun (*Allium wallichii*) and Pacnchaule (*Dactylorhiza hatagirea*) have maximum coverage areas with respect to species coverage.

Table 1, Districtwise pocket areas of 15 medicinal plants

District / MAP'S	Myagdi	Parbat	Mustang	Manang	Nawalpur	Gorkha	Tanahun	Baglung	Syangja	Lamjung	Kaski	Total area in km^2
TEJPAT	0	0	0	0	15	12	43	0	8	0	12	90
CHIRAITO	22	0	38	0	0	26	0	0	0	0	0	86
BISH	44	0	20	33	0	66	0	54	0	0	0	217
JATAMASI	61	0	53	141	0	281	0	83	0	32	46	697
SATUWA	22	1	0	47	0	47	0	28	0	12	11	168
KURILO	59	0	13	34	0	64	0	31	0	72	94	367
KUTAKI	60	0	607	142	0	98	0	65	0	37	48	1057
TIMUR	22	1	76	48	0	86	13	12	2	38	13	311
BAN LASUN	98	0	28	110	0	219	0	145	0	70	68	738
NIRMANSI	0	0	0	0	0	73	0	29	0	0	11	113
SETAKCHINI	27	0	0	0	0	44	0	16	0	11	38	136
YARSHAGUMBA	28	0	111	102	0	144	0	0	0	0	0	385
PANCHAULE	12	0	0	37	0	277	0	80	0	11	25	442
LAUTHSALLA	67	6	0	21	0	83	0	23	0	14	24	238
SILTIMUR	0	0	5	0	0	0	0	0	0	0	0	5
DISTRICT TOTAL	522	8	951	715	15	1520	56	566	10	297	390	

Pocket area of some economically important medicinal plants in Gandaki Province

1. Kutki (*Neopicrorhiza scrophulariiflora*)

The largest patch of the pocket area of kutki was found in ward no. 5 of Lo-Ghekar Damodar Kunda Rural Municipality of Mustang District. Most of the patches of the pocket areas were located in Manang and Mustang Districts **(Figure 1)**.

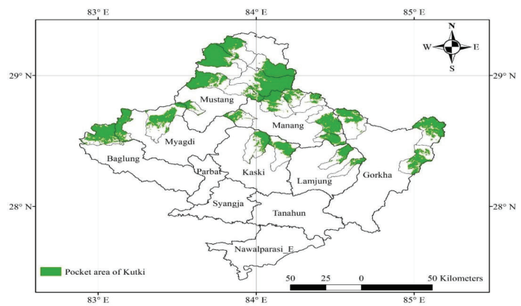

Figure 1: Spatial distribution of pocket area of Kutki