

# Diversity of Flowering Plants in Nubri Valley, Manaslu Conservation Area, Central Nepal

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## Abstract

Central Nepal has long history in the field of botanical investigation in contrast with different parts of the nation. Nevertheless, the present study area (Manaslu Conservation Area) is still under-explored. The present floristic study was carried out with the aim of fulfilling this gap by giving particular attention on flowering plants and their documentation. Two field visits were directed in May-June 2012 and September-October 2012 in two unique seasons with a specific end goal to gather plant samples of both seasons. On the contrary, herbarium specimens were prepared and later identified at Tribhuvan University Central Herbarium (TUCH) and National Herbarium and Plant Laboratory (KATH). The present study uncovers the presence of 276 species of flowering plants belonging to 78 families and 200 genera of which 63 families belong to dicotyledons and 15 families belong to monocotyledons. Among these, 17 species (6.15%) of climbers, 178 species (64.49%) of herbs, 58 species (21.01%) of shrubs and 23 species (8.33%) of trees are found. Economically important flowering plants comprise about 156 species where 75 species are used as medicine, 29 species as fuel wood, 23 species as fodder, 29 species are edible, 6 species are for religious purpose, 5 specifically for construction purpose, 10 for ornamental and 13 species reported to have miscellaneous uses. MCA accounts to 9 flowering plant species for research and development and agro-technology development and 12 species are listed under IUCN and CAMP threatened categories. MCA and its affinity are likewise house to 10 endemic flowering plants. As from the study it can be inferred that Manaslu Conservation Area (MCA) is a treasure hub of flowering plants that not only represent its economic importance rather it is also a house to threaten and endemic flowering plants. Thus, proper management plans must be implemented for the conservation of resources in MCA.

## Keywords

Flowering Plants, Documentation, Economic Important Plants, Threatened,

## 1. Introduction

Several Nepalese and foreign explorers have enumerated the flora of Nepal. The important publications related to the Flora of Nepal are “*Prodromus Florae Nepalensis*” (Don 1825) *Tentamen Florae Nepalensis* (Wallich 1824-26) and *Plantae Asiaticae Rabriores* (Wallich 1830). These publications covered the plants collected by Buchanan-Hamilton (1802-03) and N. Wallich (1820-21) [1] [2]. Then His Majesty’s Government of Nepal (now Government of Nepal) also initiated countrywide collection of herbarium collections for the Department of Medicinal Plants (now Department of Plant Resources). A number of local floras have been published in this regard. The University of Tokyo in collaboration with the Nepal Government has produced significant contributions like *The Himalayan Plants* Vol. I (1988), Vol. II (1991), besides their earlier contributions such as *Flora of Eastern Himalaya* (1966), second report (1971) and the third report (1975) [1].

Another remarkable contribution has been made by [3] who enumerated 5833 species of flowering plants belonging to 213 families and 1496 genera. In the following years after 1993, exploration was conducted by different botanists in Ganesh Himal area, Langtang valley, Manaslu area, Gosainkunda, Kali Gandaki valley, Jomson Yak Kharka, Dhorpatan, Upper Mustang area, Damodar Kunda, Parsa and some other areas. H. Takayama, K Arar, H Hatta, S Takatsuki and M. N. Subedi collected 20,000 specimens in the year 1994 [1]. M. Mikage, N. Angiki, N. Kondo, K. Yonekura and R. Lacoul conducted another important exploration in Kali Gandaki in 1995 where they collected 15,000 specimens. In the year 1996, 1999, 2000 and 2001 Japanese team conducted various expeditions with some Nepali members in Dhorpatan, Jomsom, Yakkharka, Mustang area, Langtang valley, upper Mustang area, Jatapokari and Gosainkunda area. Large numbers of specimens were collected during these years. The specimens have been stored in Tokyo University Herbarium [1].

The systematic study on flora of Nepal has been carried on since the establishment of Department of Plant Resources (DPR), Nepal and National Herbarium and Plant Laboratories (KATH), established on 1960. In 1967, DPR published a booklet “*Key to the Dicot genera of Nepal, Part I*” which represents the Polypetalae group and is the first publication of the series of the keys to the identification of Nepalese plants. In the following year (1968), the department published second part of this booklet comprising of Gamopetalae and Monochlamydeae in 1981 “*Key to the Pteridophytes, Gymnosperms and Monocotyledonous genera of Nepal*” was published, which actually fulfilled the need of genera key for Nepalese vascular plants. Since 1967, flora of different areas has been published in the form of Bulletins. *Flora of Rajnikunj (Gokarna Forest)*, Bull. No. 1 reported 2 species of Gymnosperms, 34 species of monocots and 194 species of dicots. *Flora of Phulchoki and Godawari* (1969) Bull. No. 2 reported 525

species of angiosperms and 2 species of gymnosperms. *Flora of Nagarjun* (1973) Bull. No. 4 enumerated 350 species of angiosperms and 3 species of gymnosperms. *Supplement to the Flora of Phulchoki and Godawari* (1974) Bull No. 5, reported 44 species within 27 families. *Flora of Langtang and Crosssection Vegetation Survey* (1976), Bull. No. 6 reported 76 species of Pteridophytes, 10 species of gymnosperms, 125 species of monocots and 700 species of dicots. *Flora of Kathmandu Valley* (1968), Bull. No. 11 comprises 1312 vascular species, of which 169 are pteridophytes, 7 are gymnosperms and 1136 are angiosperms [4].

Since 1996, DPR has published flora of Nepal in the form of fascicles and is the serial task for the compilation of flora of Nepal. Magnoliaceae Vol. 2, Part 17 (1996); Myrsinaceae, Vol. 5, Part 7 (1996); Theaceae, Vol. 4, Part 39 (1996); Apocynaceae, Vol. 5, Part 18 (1997), Annonaceae Vol. 2, Part 20 (1997); Cornaceae, Vol. 5, Part 4, (1997a); Fagaceae Vol. 1, Part 20 (1997) and Thymelaeaceae, Vol. 4, Part 54 (1997a) have been published [1].

*Endemic flowering plants of Nepal Part I* [5] comprises 98 species belonging to 18 families, of which 4 species were endemic from Gorkha district. *Endemic flowering plants of Nepal Part II* [6] reported 100 species listed under 15 families, Gorkha district only accounts for 3 endemic species. Further, *Endemic flowering plants of Nepal Part III* [7] enumerated 84 species placed in 10 families, 2 species are endemic to the district.

*Catalogue of Nepalese flowering Plants-I* [8] includes 31 species of gymnosperms and monocots under 17 genera and 10 families, of which 13 species are reported from Gorkha district. *Catalogue of Nepalese flowering Plants-II* [9] account to 1433 species of dicots under 510 genera and 98 families, 19 species are reported from Gorkha district. *Catalogue of Nepalese flowering Plants-III* [10] consists of 1513 species of dicots under 530 genera and 62 families, of which, 28 species are reported from Gorkha district. Recently, most remarkable contribution has been made by [11]. They enumerated 6076 taxa of flowering plants. The most latest and remarkable publication is *Flora of Nepal Vol. 3* [12], which enumerates 21 families, with 123 genera, 600 species, 19 subspecies, 31 varieties and 4 forma. Documentation, thus, helps in the enumeration, updating nomenclature change of the species and adding specimens in the herbaria.

Limited research works have been conducted in the Manaslu Conservation Area (MCA) to explore the floristic diversity and studies related to natural resources. The area was first explored by the Japanese team while exploring Central Nepal. [13] reported 437 species of vascular plants from Gorkha district among which 7 species are gymnosperms, 53 species are monocotyledons and 377 species are dicotyledons. Stainton in 1963 collected plants from Upper Budhi Gandaki Valley during June and July, 1962. Amatya and Manandhar collected 350 specimens of flowering plants from Gorkha district during July, August, 1977 [1]. Shakya, Adhikari and Subedi collected 1000 specimens of flowering plants from Gorkha district during May, June 1983 [1]. [14] collected plants from Manaslu region (Arughat-Larke pass) during July-August, 1994. [15] reported distribution of orchidaceous flora in lower Gorkha Area of Manaslu re-

gion. [16] reported 161 species of flowering plants from Manaslu Conservation Area. [17] reported the presence of 54 species of herbaceous plants from Sama-gaun VDC of MCA.

In this paper, the results were prepared aim of examining the status of flowering plants from Manaslu Conservation Area and attempt to document flowering plants available in the area of study. The list of plants in the conservation area not only determine the status of flowering plants, but also helps to outline further conservation measures to protect the diversity of the area.

## 2. Materials and Methods

### 2.1. Study Area

Manaslu Conservation Area (MCA) lies in the north of Gorkha District in Western Development Region with latitude  $28^{\circ}20'$  -  $28^{\circ}45'N$  and longitude  $84^{\circ}30'$  -  $85^{\circ}12'E$ , covering an area of 1663 sq. km ranging from 1400 m (Jagat) to 8163 m [18] [19] [20] [21]. Complex topography of MCA is represented by mountainous landscapes that arise from 1400m elevation to the summit of Mt. Manaslu (8163 m), the world's eighth highest mountain [18] [19] [20] (Figure 1).

On 28<sup>th</sup> December, 1998, Manaslu Conservation Area was declared third and youngest Conservation area in Nepal after Annapurna Conservation Area (1985) and Kanchenjunga Conservation Area (1997). Since than the MCA is managed by National Trust for Nature Conservation (NTNC) [18] [19] [20] [21]. MCA consists of seven village development committees (VDCs) which include: Sama-gaun, Lho, Prok, Bihi, and Sirdibas (Nubri Valley) and Chumchet and Chhekampar (Tsum Valley) [18]. Current study was conducted in the five VDCs of MCA (Figure 1).

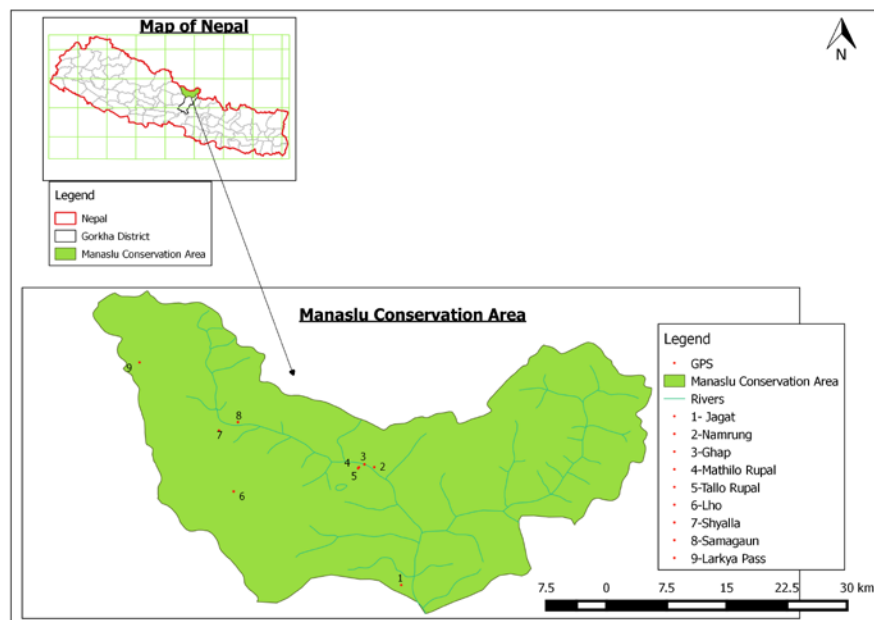


Figure 1. Map of study area showing Manaslu Conservation Area. (Source Arc GIS 9.0).

## 2.2. Climate

Climate, the long term weather of an area, is the outcome of various factors like water condition, temperature, rainfall, evaporation, sunlight, wind and so on [22]. Of them, temperature and rainfall are the most crucial factor determining the whole set of climate. The maximum temperature is 34°C and minimum been 13°C. The rainfall ranges from 530 mm (October to November) to 1680 mm (June to September), December – May is usually dry [17].

## 2.3. Vegetation of MCA

MCA consists of both Eastern Himalayan humid vegetation and the western Himalayan drier vegetation. Eastern Himalayan vegetation such as Rhododendrons, evergreen oaks and laurels dominate the area while western Himalayan vegetation is characterized by Chir pine (*Pinus wallichiana*), spruce (*Picea smithiana*) and hemlock (*Tsuga dumosa*). MCA is represented by five different climatic zones-subtropical (1000 - 2000 m), temperate (2000 - 3000 m), subalpine (3000 - 4000 m), alpine (4000 - 5000 m) to nival zone (above 5000 m) [23] [24] and 19 different forest types [21] and is recognized as a 'biodiversity hotspot' [19]. Each vegetation zone are characterized by the presence of specific dominant species. Major dominant plants species includes *Abies spectabilis*, *Pinus roxburghii*, *P. wallichiana*, *Juniperus indica*, *J. recurva*, *Ephedra Gerardiana*, *Rhododendron arboretum* etc.

## 2.4. Floral Diversity

The area includes 545 species of plants, 495 species been an angiosperms (410 species are dicotyledons and 85 species are monocotyledons), 13 species are gymnosperms and 37 species are pteridophytes [21]. MCA is mainly dominated by the east himalayan species like *Larix himalaica*, *Schima wallichii* and *Castanopsis indica* whereas *Picea smithiana* is the western himalayan species. The flora of this region is quite interesting as few flowering plants endemic to the country are found. Large numbers of medicinal plants are also found in MCA, which is very important and highly valuable like *Aconitum* spp., *Nardostachys grandiflora* (Jattamansi), *Dactylorhiza hatagirea* (Panchaunle), *Valeriana jatamansi* (Sugandawal), *Ophiocordyceps sinensis* (Yartsagunbu), etc. [19].

## 2.5. Methodology

Current study focuses on the collection of herbarium samples from field visit and preparing the list of flowering plants reported form MCA through secondary information. The methodology of the study was incorporated in order to answer following question of the research work:

- a. How many species of flowering plants are present in MCA?
- b. What are the threatened plants present in MCA that are prioritized for conservation?
- c. Which flowering plants are economically important?
- d. Which flowering plants of medicinally important that are prioritized for re-

search and development?

In order to answer all the question, our methodology comprises of following methods were used.

### 2.5.1. Collection and Preservation of Plant Samples

The floristic study of Nubri Valley of Manaslu Conservation Area is conducted under Institutional Research grant supported by University Grant Commission (2011-2013). Localities of collections with altitude are given in Appendix 1. Collection of plant species was done in two different seasons of the year viz. one in the pre-monsoon and another in the post-monsoon season. First field trip was between 26th May, 2012 and 15th June, 2012. Second field trip was completed on 12<sup>th</sup> October, 2012 which started on 28<sup>th</sup> September, 2012. Collection of angiosperms was done from different sites of MCA ranging from 2200 m to 4200 m altitude. The collected specimens were tagged, pressed and dried naturally. Two specimens for each species were collected as far as possible. Field notes such as location, habit, habitat, collection date, colour of flower, phenology, etc. along with their uses, local names and other information were recorded in the field notebook. Insecticides were used to preserve herbarium specimens. The specimens were later mounted on the herbarium sheets of 11" × 17.5" and were labeled accordingly from the field notebook. The specimens are deposited at Tribhuvan University Central Herbarium (TUCH).

### 2.5.2. Identification of Collected Samples

The collected specimens were identified by using authentic literatures such as [4] [12] [13] [25] [26] [27] [28] and tallying with the authentic specimens housed at the National Herbarium and Plant Laboratories, Godawari, Nepal (KATH), Tribhuvan University Central Herbarium (TUCH) at Central Department of Botany, Tribhuvan University, Kirtipur and also verifying with the experts. [27] [28] [29] and [11] along with online internet site like <http://www.efloras.org/> and <http://www.theplantlist.org/> were followed for nomenclature and author citation of the plants.

## 3. Results

### 3.1. Taxonomic Diversity

The floristic study of the Manaslu area has been made to enumerate and document the trees, shrubs, herbs and climbers following the Engler and Prantl system of classification (1887-1915), from the Nubri Valley (Jagat to Larke pass). The study reveals the presence of 276 species of flowering plants from Manaslu Conservation Area comprising of 78 families and 200 genera (**Appendix 1**). The total enumerated plant species (276 species) from the research comprises 82.60% of dicotyledons and 17.38% of monocotyledons, of which 37 genera and 48 species listed under 15 families belong to monocotyledons and 163 genera and 228 species representing 63 families belong to dicotyledons. Among these, 17 species (6.15%) of climbers, 178 species (64.49%) of herbs, 58 species (21.01%) of shrubs

and 23 species (8.33%) of trees are found (**Appendix 1**).

Among the recorded dicotyledons, the largest families are Asteraceae (22 genera and 30 species), followed by Rosaceae (7 genera and 13 species) and Fabaceae (9 genera and 10 species). Similarly, in monocotyledons, Orchidaceae (10 genera and 12 species) is the largest family, followed by Asparagaceae (5 genera and 7 species) Liliaceae (3 genera and 5 species). *Rhododendron* and *Senecio* are the largest genera with six and five species respectively, followed by *Androsace*, *Hypericum*, *Geranium*, *Viburnum*, *Pedicularis* and *Zanthoxylum* with four species each (**Appendix 1**).

### 3.2. Plants of Economic Importance

According to our study, 156 plants were reported to be potential economic importance from MCA and adjoining areas (**Appendix 2**). The economic importance of the plant is based on field information and secondary literature. The information from local people and literatures [30]-[36], were used to prepare the list of plants of importance. Among them, 75 species are used as medicine to cure various ailments, 29 species as fuel wood, 23 species as fodder, 29 species are edible, 6 species are for religious purpose, 5 species for construction purpose, 10 for ornamental and 13 species are of miscellaneous uses (**Appendix 2**).

### 3.3. Medicinal Plants Prioritized for Research and Development and Agro-Technology Development

[37] has prioritized 30 medicinal plants for research and development and agro-technology development. MCA accounts to 9 plant species for research and development and agro-technology development. These species includes—*Aconitum spicatum*, *Asparagus racemosus*, *Bergenia ciliata*, *Dioscorea deltoidea*, *Juglans regia*, *Podophyllum hexandrum*, *Rubia manjith*, *Swertia chirayita* and *Zanthoxylum armatum* listed under medicinal plants prioritized for research and development. *Asparagus racemosus*, *Swertia chirayita* and *Zanthoxylum armatum* were the medicinal plants prioritized for agro-technology development (**Table 1**)

### 3.4. Threatened Medicinal and Aromatic Plants Reported from MCA

Threatened species are any species (including animals, plants, fungi etc.) which are vulnerable to endangerment in the near future [38]. According to IUCN and Convention Assessment Management Plan (CAMP) workshop in 2001 category, 60 plant species were prioritized for conservation with categorizing species in different red list categories in Nepal [37] [38]. Twelve species of flowering plants are found to be threatened in their natural habitat from the present study area, which covers 20% of the total threatened species in Nepal (**Table 2**). According to our study, 3 species viz. *Aconitum spicatum*, *Bergenia ciliata* and *Dioscorea deltoidea* as threatened and 2 species viz. *Podophyllum hexandrum* and *Swertia chirayita* are listed as vulnerable under IUCN Red List whereas, CAMP listed 7

**Table 1.** Flowering plants of MCA, prioritized for research development and agro-technology development.

Medicinal plants prioritized for research and development		
S.N.	NAME OF SPECIES	FAMILY
1	<i>Aconitum spicatum</i> (Bruhl) Stapf	Ranunculaceae
2	<i>Asparagus racemosus</i> Willd.	Asparagaceae
3	<i>Bergenia ciliata</i> (Haw.) Sternb.	Saxifragaceae
4	<i>Dioscorea deltoidea</i> Wall. ex Griseb.	Dioscoreaceae
5	<i>Juglans regia</i> L.	Juglandaceae
6	<i>Podophyllum hexandrum</i> Royle	Berberidaceae
7	<i>Rubia manjith</i> Roxb. ex Fleming	Rubiaceae
8	<i>Swertia chirayita</i> (Roxb. ex Fleming) H. Karst.	Gentianaceae
9	<i>Zanthoxylum armatum</i> DC.	Rutaceae
Medicinal plants prioritized for agro-technology development		
1	<i>Asparagus racemosus</i> Willd.	Asparagaceae
2	<i>Swertia chirayita</i> (Roxb. ex Fleming) H. Karst.	Gentianaceae
3	<i>Zanthoxylum armatum</i> DC.	Rutaceae

**Table 2.** List of threatened medicinal and aromatic plants of Manaslu Conservation Area.

SN	Plant Species	Family	Local Name	Threat Category	
				CAMP	IUCN
1	<i>Aconitum spicatum</i> (Bruhl) Stapf	Ranunculaceae	Vikh	V	T
2	<i>Asparagus racemosus</i> Willd.	Asparagaceae	Kurilo	V	----
3	<i>Bergenia ciliata</i> (Haw.) Sternb.	Saxifragaceae	Pakhan bhed	----	T
4	<i>Dioscorea deltoidea</i> Wall ex Kunth	Dioscoreaceae	Bhyakur	EN	T
5	<i>Fritillaria cirrhosa</i> D. Don	Liliaceae	Kakoli	V	----
6	<i>Lilium nepalense</i> D. Don	Liliaceae	Khiraula	DD	----
7	<i>Meconopsis dhwojii</i> G. Taylor ex. Hay	Papaveraceae		NT	----
8	<i>Panax pseudo-ginseng</i> Wall.	Araliaceae	Magan	V	----
9	<i>Podophyllum hexandraum</i> Royle	Berberidaceae	Laghu Patra	V	V
10	<i>Rubia manjith</i> Roxb. ex Fleming	Rubiaceae	Manjitho	V	----
11	<i>Swertia angustifolia</i> Buch.-Ham ex D. Don	Gentianaceae	Chiraito	EN	----
12	<i>Swertia chirayita</i> (Roxb. ex Fleming) H. Karst.	Gentianaceae	Chiraito	V	V

Acronyms: EN = Endangered, T = Threatened, V = Vulnerable, DD = Data deficient and NT = Nearly threatened.

species as vulnerable (*Aconitum spicatum*, *Asparagus racemosus*, *Fritillaria cirrhosa*, *Panax pseudo-ginseng*, *Podophyllum hexandrum*, *Rubia manjith* and *Swertia chirayita*, *Dioscorea deltoidea* and *Swertia angustifolia* are listed as en-



dangered, *Meconopsis dhwojii* as near threatened and *Lilium nepalense* as data deficit.

### 3.5. Protected Plants of MCA

Government of Nepal under its Forest act (1993) listed 12 different species of flowering plants under legal protection which are—1) Banned for collection, transportation and trade; 2) Banned for export outside the country without processing; 3) Banned for felling, transportation and export, and, 4) Banned for export without identification and certification [37]. Of these 12 species, 1 species (*Juglans regia*) was the protected plant species present in MCA during the time of study. The bark of *Juglans regia* is band for collection, transport and trade whereas whole plant is banned for felling, transport and export.

### 3.6. Flowering Plants Endemic to Nepal Present in MCA and Adjoining Area

Endemism is the ecological state of a species being unique to a defined geographic location, such as an island, nation, country or their defined zone, or habitat type [5] [6] [7] [39]. Organisms that are indigenous to a place are not endemic to it if they are also found elsewhere [7] [39]. [39] reported 324 species of flowering plants representing 134 genera and 45 families in Nepal. Analysis of endemic flowering plants in Manaslu Conservation Area and vicinity of Gorkha district, ten species have been found under endemic category revealed from the secondary sources (references listed in Table 3) which includes about 3.086% of the total endemic species of Nepal [39] (Table 3).

### 3.7. Number of Angiosperms Reported from MCA

Although the research is mainly based on the field survey, but various literatures

**Table 3.** List of endemic flowering plants from MCA and adjoining area.

SN	Family	Latin name	Altitude (m)	Localities
1	Asteraceae	<i>Leontopodium makianum</i> Kitam.	4000	Thaple Himal, <i>Nakao</i> s. n. (Holotype, KYO)
2	Asteraceae	<i>Saussurea dhwojii</i> Kitam.	4500	Pongsing, <i>Dhwoj</i> 126 (Holotype BM)
3	Cyperaceae	<i>Carex rufulistolon</i> T. Koyama	3100	Pisang- Tatpani, <i>Nakao</i> s.n. (Holotype, KYO)
4	Euphorbiaceae	<i>Croton nepalensis</i> T. Kuros	970	Tatopani to Dovan, <i>M. Suzuki et al.</i> 9455100 (Holotype, TI)
5	Fabaceae	<i>Astragalus nakaoi</i> Kitam.	3800	Manaslu, <i>S. Nakao</i> s. n. (Holotype, KYO)
6	Fabaceae	<i>Hedysarum manaslense</i> (Kitam.) H. Ohashi	3800	Manaslu, <i>S. Nakao</i> s. n. (Holotype of <i>Astragalus manaslensis</i> , KYO)
7	Papaveraceae	<i>Meconopsis regia</i> G. Taylor	3900	Barpak, <i>Dhwoj</i> 18 (Holotype BM)
8	Papaveraceae	<i>Meconopsis manasluensis</i> P.A. Egan *	ca. 4000	Manaslu Himal, east of Samdo, <i>Ikeda et al.</i> 20815156 (Holotype E)
9	Rosaceae	<i>Prunus himalaica</i> Kitam.	3900	Chum Gumba, <i>S. Nakao</i> s.n. (Holotype, KYO)
10	Scrophulariaceae	<i>Pedicularis breviscaposa</i> T. Yamaz	3100	Pisang-Tatpani, <i>S. Nakao</i> s.n. (Holotype, KYO)

Source: [39] and \*[40]. Acronym:-BM-British Museum of Natural History, KYO-Kyoto University, TI-University of Tokyo, E-Royal Botanic Garden Edinburgh.

[13] [16] [17] [19] [36] [41] [42] [43] were cited to prepare the list of flowering plants that were reported from Manaslu Conservation Area. Total number of angiosperms that were reported from MCA from cited literatures reveal the presence of 981 species representing 107 families and 495 genera. Information from above cited articles were compiled to prepare the list (**Appendix 3**).

#### 4. Discussion

[11] and [27] [28] [29] enumerated the plants found in Nepal in which Asteraceae represents the largest family which is followed by Gramineae, Orchidaceae, Fabaceae, Rosaceae, Cyperaceae, Scrophulariaceae, Labiatae, Ranunculaceae, Umbelliferae. Most of the top ten families of present study lie within top ten largest families of Nepal according to [11].

Most of the species of *Senecio* of Nepal Himalaya are confirmed to the Eastern and Central region rather than the Western region [44]. This statement is found to be true after completion of this research work. A total of six species of this genera were recorded, inspite of the limited study area, which is the largest genera of collected species. [16] reported 118 species of herbs, 26 species of shrubs and 17 species of trees from the Manaslu Conservation Area. Similarly, [21] revealed 336 species of herbs, 111 species of shrubs and 74 species of trees from the MCA.

From present study, 178 species of herbs, 17 species of climbers, 58 species of shrubs and 23 species of trees are reported. So, the study area is dominated by herbaceous plants, and the number of trees found is very few in comparison to the NTNC floral list which gives a list of 74 species of trees. The less number of trees might be due to the limited exploration of the study area. The reason for enormous occurrence of herbaceous plants in the study area is because of the open environment, which usually supports the growth of the plants in comparison to the forested areas [45].

The database of medicinal and aromatic plants of Nepal include 1,624 species of wild, domesticated and naturalized plants [46]. Being in same physiographic conditions, the study from Parbat district reveals 28 plant species under 22 families and 27 genera of medicinal values [47]. [48] estimated approximately 100 species of plants being exported from Nepal. [49] reported 48 species of medicinal and aromatic plants traded from Gorkha district to elsewhere. Due to very little information about medicinal and aromatic plants from Gorkha district, for the study of trade [50]. Popular medicinal plants for domestic use and trade include *Nardostachys grandiflora*, *Swertia chirayita*, *Bergenia ciliata*, *Rheum australe* etc. Similarly, [36] documented 127 important species for fuel wood and fodder and 19 species of plants of medicinal values from MCA. Popular medicinal plants for domestic use and trade include *Rosa sericea*, *Rhododendron anthopogon*, *Zanthoxylum armatum* etc. From the present research, popular medicinal plants for the domestic use and trade include *Fritillaria cirrhosa*, *Astilbe rivularis*, *Hydrocotyle himalaica*, *Tagetes patula*, *Cuscuta reflexa* etc. (**Appendix 2**).

In the present study, a total of 156 species has been reported to be of economic values. This result covers 10.16% in context of Nepal and reveals maximum number of economically important plants in comparison to previous studies. Among six traded species from Gorkha district as reported by [50], three species namely *Nardostachys grandiflora*, *Swertia chirayita*, *Neopicrorhiza scrophulariiflora* are the highly traded flowering plant species. Among these three also, *Nardostachys grandiflora* and *Swertia chirayita* have less price value whereas roots of *Neopicrorhiza scrophulariiflora* has significantly high value due to the high demand in India [50].

Twelve species of flowering plants are found to be threatened in their natural habitat from the present study area, which covers 20% of the total threatened species in Nepal [37]. It might be due to their over-exploitation and unsustainable use for domestic and commercial purpose [50]. Tubers of *Dioscorea deltoidea* is threatened because of its high nutritive value [51] [52]. Other species are exploited due to its medicinal value [53].

According to [37], about 60 different species prioritized under research and agro- technology development. This research covers about 20% of the total prioritized species which include *Aconitum spicatum*, *Asparagus racemosus*, *Bergeria ciliata*, *Dioscorea deltoidea* etc. These plants can be focused for carrying out different types of research activities without destroying their natural habitat. Moreover, some of these species are also under threat categories for instance *Podophyllum hexandrum*, *Rubia manjith*, *Swertia chirayita* etc. So, while carrying out research activities related to these species, priority must be given to their existence in their living world. Otherwise with the development, there shall be problem of disappearance of the threat species.

## 5. Conclusions

It can be concluded that Manaslu Conservation Area is a homeland of different and diverse plant species with medicinal and economic values, providing a suitable environment, climatic and favourable rainfall for germination and growth of flowering plants. Moreover, it provides a decent settlement for the rare, threatened and endangered species. Being a youngest conservation area, Manaslu Conservation Area is the emerging phase of botanical exploration. Most of the botanical work has been directed in the Nubri Valley and another valley of MCA i.e. Tsum (Chum) Valley is under-explored. The present study is also done only in Nubri Valley; So, Tsum Valley must be extensively explored for the enumeration of medicinal, threatened and rare plants, the traditional knowledge and distribution of the plants within the altitudinal variations.

The present study additionally highlighted the status of floral exploration in Nubri Valley of Manaslu Conservation Area of Central Nepal requiring comparative investigations and floristic contemplates in these areas. It is thought that this study would be beneficial to future floristic studies in the present study area as well as other adjoining areas. As a solitary exertion can't give a good result, local people must cooperate and work friendly with NTNC group for the protec-

tion and conservation of natural resources of Manaslu Conservation Area.

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## Appendix

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