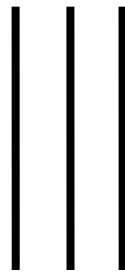




Booster Grant

Mid-term Report to Rufford Small Grant Foundation Application ID. 12663-B

**Study on the Bryofloral Diversity, Their Current Status
and Conservation Issues in Central and South-eastern
Region of Sindhupalchok District, Central Nepal**



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Summary

First and Second RSGs were implemented at the northern parts of Sindhupalchok district of central Nepal which were successful to bring a long list of diverse bryophyte species of highland areas. These two studies covered the elevation of 1400 to 4000 m where different habitat types were noted and many new records of this plant were also made that updated the country's overall list. Tourism prospect in northern parts this district was also considered in these studies.

The current study is to give continuity to the previous works and is emphasized mostly to unexplored areas of the south, east and central parts of this district. This midterm study came up with many interesting findings which revealed out a list of 76 species of bryophytes categorized into 26 families. All the three classes of Bryophytes were represented in this study with new records of two species viz. *Frullania teneriffae* (Frullaniaceae) and *Calypogeia suecica* (Calypogeiaceae). Of the recorded species, the class Anthocerotae represented 2 species, Hepaticae 35 and Musci 39 species. Varying habitat types of tropical and subtropical bioclimatic zones at 720 to 1500 m were explored in this midterm study.

Vegetation. observed in and around the habitats of bryophyte were documented well which included 24 herbs, 30 shrubs, 29 tree species, 5 climber species, 2 gymnosperm species and 18 fern species. Investigation of the faunal species which are associated to the bryophyte habitats is also an important aspect in this work. This revealed out a list of 34 invertebrate species and majority of them were the insects with 21 species. This study is still underway and detail account on this will be incorporated into the final report due by February, 2015.

Many local peoples at different village communities were made aware under Door to Door Awareness Program. This work will continue till December, the end of field program. Community based awareness program has been scheduled to run in different village communities during the period of November- December



Acknowledgement

Without generous support of this prestigious Rufford Grant this work was not possible to launch extensively in different areas of the Sindhupalchok District of central Nepal. Many parts of this district still remain to explore out and has been targeted to complete by the end of this study program. So, I and my team members express our sincere gratitude to the Rufford Small Grant Foundation for this generous support in the form of Booster Grant. I am equally thankful to my honorable Referees Prof. Dr. Krishna Kumar Shrestha of the Central Department of Botany, Tribhuvan University (Nepal), Dr. Bhuvan Keshar Sharma, Senior Resource Specialist at the Forest Resource Assessment Project, Kathmandu, Prof. Dr. David Long, reputed Bryologist of UK and Prof. Dr. Bhaiya Khanal of the Natural History Museum, Nepal for their kind recommendations and suggestions to this work. Our driver, Mr. Surendra Parajuli who made his excellent driving during this field trip is acknowledged well.

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Photographs

Acronyms and Abbreviations

BPP	Biodiversity Profile Project
C	Common
CITES	Convention on International Trades of Endangered Species of Flora and Fauna
DNPWC	Department of National Park and Wildlife Conservation
DoF	Department of Forest
E	East
FC	Fairly Common
GPS	Geographical Position System
GoN (HMGN)	Government of Nepal
IEE	Initial Environment Examination
IUCN	International Union of Conservation of Nation
MC	Most Common
MFSC	Ministry of Forest and Soil Conservation
N	North
NBS	Nepal Biodiversity Strategy
NHM	Natural History Museum
NRDB	Nepal Red Data Book
R	Rare

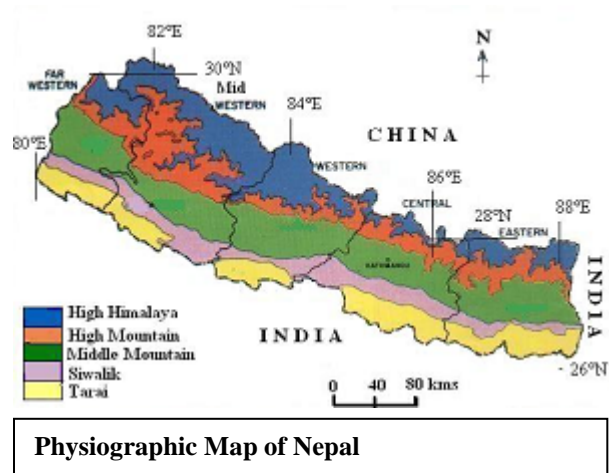
RRRSDP	Rural Reconstruction and Rehabilitation Sector Development Programme
RSG	Rufford Small Grants
SPTDMC	Sindhupalchok Panch Pokhari Tourism Development and Management Committee
UK	United Kingdom
VDC	Village District Committee
S.No.	Serial Number
%	percent
*	New records
cf.	close to
Eds.	Editors
<i>et al.</i>	and all
m	meter
spp.	Species (plural)
Sq. Km.	Square Kilometer
Sq. mi	Square mile
viz.	namely

1. Background

Nepal is situated on the southern slopes of central Himalayas and occupies a total area 147,181 km². The country is located between the latitudes of 26° 22' to 30° 27' N and longitudes of 80 ° 40' to 88 ° 12' E. The average east-west length of the country is 885 km and the south-north width varies from 145 km to 241 km. Hills and high mountains cover about 86% of the total land mass and the remaining 14% are the flatlands of Tarai, which are less than 100 m in elevation. Altitude varies from 62 m above in east Tarai to the Mount Everest at 8,848 m, the highest point in the world. Nepal's location in the central portion of the Himalayas places it in the transitional zone between the eastern and western Himalayas. It includes the Palaearctic and the Indo-Australian biogeographical regions and the major floristic provinces of Asia (the Sino-Japanese, Indian, western and central Asiatic, Southeast Asiatic, and African Indian desert) creating a unique and rich terrestrial biodiversity (Nepal Biodiversity Strategy 2002).

1.1. Central Midland

The midlands lie north to the Mahabharat and occupy the central region of the country. The average altitude is 2,000 m with elevations ranging from 600-3500 m. Being a fertile land this part has high productivity for agricultural yields. This part has interesting agricultural patterns practiced on terraces on the steep hillsides. A high degree of deforestation is an ongoing phenomenon in this part.

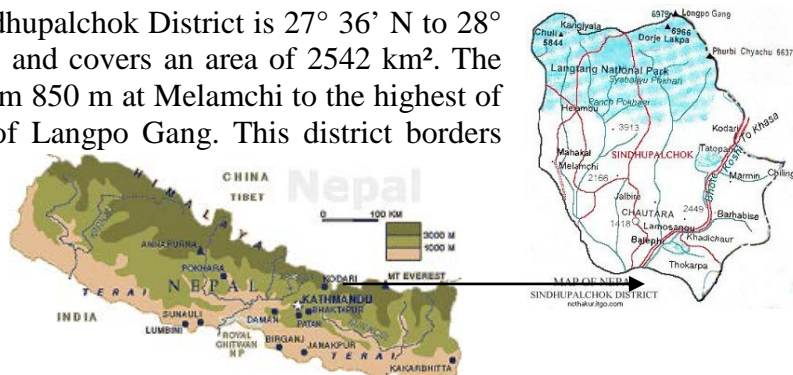


1.2. Physiography

The mid-hill generally has complicated physiographic pattern with considerable variation in altitudes across south to north approaches. This has led to the formation of deep river valleys below the elevation of 1000 m. The climatic features and distribution of vegetation display remarkable change over a very short distance showing an interesting ecological diversity across the south to the north range. In general, the area rises towards the north, to the main Himalayan ranges, and a huge area of these slopes show innumerable terraces for agriculture.

2. Sindhupalchok

The geographical position of Sindhupalchok District is 27° 36' N to 28° 13' N and 85° 27' E to 85° 85'E, and covers an area of 2542 km². The elevation in this district ranges from 850 m at Melamchi to the highest of 7083 m, the snow capped peak of Langpo Gang. This district borders Rasuwa district to the west and Kavrepalanchok District to the south which is indirectly connected to the Kathmandu



district through Sankhu of Bhaktapur district (Department of Information 1971)

The major destinations in this district especially from tourism prospects are Helambu, Panchpokhari, Tatopani, Bhairavkunda, Gangjala Pass, Palchok Bhagawati, Patal Cave, Tripurasundari Temple, Bank of Sunkoshi and Indrawati Rivers. Bhairav Kunda and Panch Pokhari are the popular trekking destinations which famed both for the religious and cultural significances. Tatopani (Hot Water Spring) nearby Nepal China boarder is a popular pilgrimage place. The major business area and towns of this district are Chautara, Barhabise, and Melamchi Bazaar.

The southern part of this district is densely populated than the northern part. The lower part is fertile where popular crop like potato is well grown.

2.1. Ethnic Tribes

This district has mixed ethnic culture though Tamang tribes are in majority in the south-central to the mid hills of this district. The other groups in this district are the Brahmins, Chhetris, Newars, Danuwars, Magars and Gurungs who came down to this district in the late eighteen to early nineteenth centuries (Graner, 1997; Pokharel, 2010). The Yolmos of the highland migrated from Tibet over more than 250 years ago.

The major ethnic tribe of this district is Tamang with an average population of 38.54 %. They are said to be the first settlers in this district. Brahmins and Chhetris live mostly in the western part of Sindhupalchok; yet they predominantly inhabit the lower bank of Indrawati and Melamchi Rivers. In the northern regions, they only account for less than 10% of the population (Graner, 1997:132). Sherpas are the next tribe who are scattered mostly in the highland areas of this district.

2.2. Tourism Prospects in Sindhupalchok District

The northern part of this district which includes Helambu and Melamchi Ghyang are well known destinations both for internal and external tourism. However, the central and eastern Sindhupalchok has not yet been fully developed as one of the pioneer tourism destination of Nepal. Now the start of the Bungee Jumping at Bhote Koshi area and white water rafting at Sunkoshi River have attracted external and mostly domestic tourists where they also can find good physical facilities and resorts for accommodations. This is a most popular route for the Chinese tourists who enter here from the eastern border at Kodari. Tatopani (hot water) which is a well known geyser has been believed to carry high religious valley if someone takes shower in this water. Thousands of religious peoples visit this place for holy bath every year. Business tourism is also well flourished in this part. Many native peoples from different parts of the country visit Chinese border to buy different goods and items for their daily uses.

Due to scenic beauty, incredible landscape, diverse cultural and natural diversity, Panch Pokhari can be expected to attract many tourists of different interests. For tourism promotion, this destination still needs sound management of physical facilities like good camping areas,

restaurants and trained guides. Other interesting spots like Bhairab Kund, a popular high altitude lake is also located in this region at 4270 m. The next beautiful lake called Suraj Kund lies at the junction of Sindhupalchok, Nuwakot and Rasuwa districts. Some well known waterfalls of this district are Bhairav Kunda Fall of 198 m, Lidhi falls of 107 m, Gumchhyal a west Balefi falls of 117 m etc (Department of Information 1971).

Sindhupalchok Panch Pokhari Tourism Development and Management Committee (SPTDMC) a nonprofit Organization is supporting local peoples who are engaged to promote tourism in this place. This organization is located in Chautara, the head quarter of the district.

This organization assists in different sectors such as health, education, eco-tourism, social mobilization and social empowerment. Next to natural tourism this district also has many cultural and historical sites which can attract many tourists annually if managed and publicized well. Because of all these attractive touristic spots, it can proudly be said that tourism has high potentiality in this district. Some parts of the districts that fall within Helambu region are very popular for tourism activities. The Langtang - Helambu area is ranked as the third tourist's destination in Nepal. Some of the well known and highly possible tourism sites within the district are Helambu area, Tatopani, Ama Yangri, Bhote Koshi, Panch Pokhari, Duganagadi, etc.

2.3. Business and Industries

Since it is very near to the Chinese border, the business basically has been influenced with Chinese market. Most of the people in Barhabise Bazaar are involved in business mainly of the Chinese products including clothing, bedding, food items, electronic devices, etc. This is also the popular route to import the Chinese goods to other parts of Nepal including the capital city. Nepalese products are also exported to China through this route. Considering the expanding trade with China, Nepal Government with support of the Chinese Government is establishing a dry port near the Tatopani village and is almost to the final stage for completion.

2.4. Agriculture

Majority of peoples of this district rely on agriculture. Being a hilly district, the northern part is non fertile with lesser yield. The central and southern parts at lower elevation represent good fertile land for farming of rice, maize, wheat, mustard and other vegetable crops including horticultural products. The local peoples are mostly attracted to cultivate cash crops and vegetables like Cardamom, Potatao, Cauli flower, Ginger, etc.

The total area occupied by this district is about 2, 52, 800 hectares of land, of which 1300 hectares are fit for agriculture while remaining 2, 39, 000 hactares are non usable and waste land. Potato is the main cash crop in higher parts and has gained wide market up to Kathmandu city. Other common vegetables include soybeans, beans and tomatoes which are grown mainly in

rainy season. Cereal crops like wheat and maize grow up to the elevation of 1600 m. They also harvest wild edible mushrooms for their food but use their own system to differentiate a poisonous mushroom from a non poisonous one. Among fruits, apple and berries grow well in higher parts especially above the Bhotang and Helambu areas. These apples get wide market in Kathmandu and adjoining cities.

Dairy production is another source of income for local farmers. Over 80 percent of total population is dependent on agricultural activities for their livelihood. Chauri (cow) farming is common in higher part of this district. The crosses of yak (*Bos grunniens*) and local hill cow (*Bos indicus*) and vice versa are called Chauri (Joshi 1982). Chauri farming is a main source of households' income in the upper slope areas of Sindhupalchok. The Chauris are reared under migratory systems, grazing around the Bhairabkund lake areas during summer and feeding oak forest leaves during winter (Pande 2004).

The availability of pastures and fodder is becoming scarce. The Chauris are transferred to the alpine pastures (3000-4500 m) for two months of July and August and rest of the year they are placed at the lower altitude (2500-3000 m). The oak forest has been seriously lopped out and threatened to its existence. Due to the shortage of pastures, the productivity of the Chauris has been decreased significantly and the Chauri farming business is no more beneficial in present context (Pande 2004).

2.5. Major Festivals

Janai Purnima: This festival is observed in the mid of August annually and devotees from various parts of the country visit the legendary Panch Pokhari lake to take their holy bath which is said to carry high religious value. More than five thousand peoples are estimated to visit this place annually.

Dasahara: This festival is observed in March/ April. During this time, many devotees visit to Panch Pokhari Lake to worship God Shiva and to take holy bath there. They also pay visit to a locality at Chitre where a small fountain of sour water (water with high rate of basic elements) is located. They believe, this water may cure their contaminated diseases if they drink it once in their life.

Buddha Purnima: Thousands of Buddhist devotees visit Monasteries at Tarki Ghyang, Ghyangkiul and Melamchi Ghyang in Buddha Purnima and other festivals related to Buddhism.

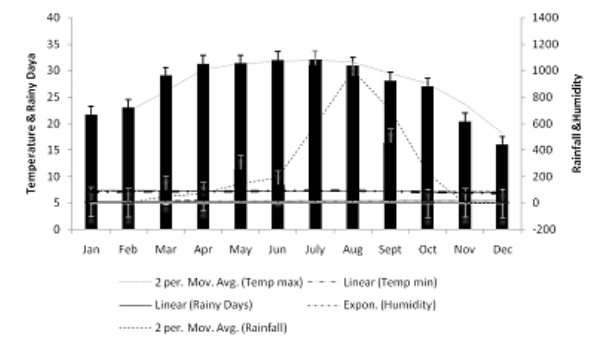
2.6. Economy

The economy of this district is mainly related to employment of the local peoples in various sectors which has increased in recent years. Many peoples are engaged in business activities especially in Kathmandu and other potential towns of the country. Seasonal migration to Kathmandu and different parts of India to earn money is also a common phenomenon which has contributed significantly to develop their socio economy. Many peoples of this district are also

employed in Gulf countries, Malaysia and other Asian countries. The remittance that comes from their earnings is also contributing to the nation's economy.

Some local people are engaged in cottage industries like weaving bamboo products and making furniture. This district has many items to export to other cities of Nepal. This includes, milk, vegetables, fruits and bamboo products etc.

3. Climate



Generally, the rainy season starts from June till September. South-west monsoonal wind that emerges from the Bay of Bengal is the carrier of major rain during June to August. The winter rain is due to the Mediterranean wind that brings rain from the west. The meteorological record shows the total average annual rainfall is 1,615 mm. The average minimum temperature of this district is 5°C and average maximum temperature is 25°C (District Profile of

Sindhupalchowk, 2014). This district has complex physiographic feature like the warm and dry tropical belt to the alpine region where harsh and cold weather prevails.

3.1. Bio-climatic Zones

The mid-hill has interesting pattern of ecosystem diversity and shelters rich biodiversity. This is due to the variation in terrain types followed with changing bioclimatic zones. Nearly 32% of Nepal's forest occurs in the mid-hills.

Mountains are the meeting places for the Palaearctic and the Oriental faunal and floral components. There are 38 major ecosystems in the Mountains and relatively show less diversity of flora and fauna than the Mid-hills and lowlands because of harsh environmental conditions, they are nevertheless characterized by a large number of endemic species (Nepal Biodiversity Strategy 2002).

Dobremez (1996) has described an altitudinal distribution of flora of central Nepal. He has mentioned the representation of the eleven ecological zones from the lower tropical level (below 500 m) to the highest level (above 5000 m).

The BPP (1995) has shown the distribution of flowering plants which indicates its high diversity in the mid-hills. This has been stated that 283 species of bryophytes and 97 species of pteridophytes are recorded from Central Nepal (BPP 1995).

The tropical zone which covers about 6.0 % of area lies below 1000 m of elevation. This is a warmer belt but remarkably fertile for agriculture. *Shorea robusta* forest has predominance in this zone.

The altitude at 1000 to 2000 m is the subtropical zone. Major fertile area of the mid mountains falls under this zone. The lower part of this zone is warm and humid while the upper part has mild climatic feature. About 37.2 % of land of the district is covered with this bio-climatic zone.

The forest of *Schima-Castanopsis* is an important forest in the Mahabharat Hills between 1000 and 2000 m. *Schima wallichii* is distributed over major areas of central Nepal which lies east to the Kali Gandaki Valley. This occurs in association with *Castanopsis indica* at the lower elevation (1000-2000 m) and with *Castanopsis tribuloides* at higher elevations (1500-2000 m); at times both species can be found in the same forest as their altitudinal distribution is not sharply differentiated (DoF 2002).

3.1.1. Tropical Zone

Tropical zone encompasses major areas of Tarai, Siwaliks, Duns and southern Mahabharat ranges. This zone is located below 1000 m where humid and deciduous forests are widely spread. The major trees of this zone are *Shorea robusta*, *Adina cordifolia*, *Terminalia tomentosa*, *Dalbergia sisoo*, *Acacia catechu*, etc. Popular bryoflora recorded in this region are *Bryum nitens*, *Bryum coronatum*, *Entodontopsis* spp., *Fissidens* spp., *Hyophila involuta*, *Trachyphyllum influxum*, *Hypnum pleumaforme*, *Thuidium tamariscellum*, etc.

According to BPP (1995), the biological diversity present in the Tarai and Siwalik are significant both for globally threatened wildlife and endangered floral elements. Considering valuable biodiversity of Tarai and Siwalik, Nepal Government has established seven protected areas in Tarai region. These include Koshi Tappu Wildlife Reserve (East), Parsa Wildlife Reserve (Central) Chitwan National Park (Central), Bardia National Park (Midwest), Banke National Park, Krishnasar Conservation area (Midwest), and Suklaphanta Wildlife Reserve (Far-west).

3.1.1.1. Tarai plain

This region extends roughly to 800 km at east-west direction bordering India. The total area covered by the Tarai is just 17 % of the entire country. This is a fertile region with high population density. The forest cover is very rich and dense, mostly confined to the western parts. The altitude of the Tarai ranges from 62-300 m from the mean sea level.

3.1.1.2. Churia Hills (Siwalik)

Siwalik or Churia extends between 700 to 1500 m along the mid axis of the country. This newly formed mountain has warm valleys of the Bhitri Madesh (Inner Tarai). These hills are crisscrossed by several north-south directed rivers enclosing many wide and flat lands and valleys. Siwalik is very popular for rich fossilized remnants of the pre-existing flora

and fauna. The well known 8-12 Km strip of *Char Koshe Jhadi* (Four miles long forest) is the characteristic feature of this region.

3.1.2. Subtropical Zone

Subtropical belt is extended between the elevations of 1000 to 2000 m at the southern strip of the country. *Schima-Castanopsis* forest is fairly common in the east and central parts while *Pinus roxburghii* is popular in the west. Major floral components of this zone are *Schima wallichii*, *Castanopsis indica*, *Rhus succedanea*, *Maesa chisia*, etc. The bryoflora of this region are *Marchantia polymorpha*, *Asterella walliachiana*, *Cyathodium tuberosum*, *Targionia hypophylla*, *Bryum argenteum*, *Rhodobryum giganteum*, *Babulla javanica*, *Bartramidula bartramiodes*, *Funaria hygrometrica*, *Haplocladium angustifolium*, etc.

The temperate zone at the elevation of 2000 - 3000 m starts north to the subtropical zone. Being a mountainous region, this zone has cold climatic type. About 24.5 % of the land of this district is covered with this zone. Mixed forest of *Alnus nepalensis* and *Rhododendron arboreum* are quite prevalent in this zone.

3.1.3. Temperate Zone

This zone lying between 2000 -3000 m is under the influence of cold climatic condition. The temperate region has interesting moist and deciduous forest with *Aesculus indica* (Chestnut) and *Acer caesium* as the main components. Other trees found here are *Abies spectabilis*, *Quercus dilatata*, *Betula* species, etc. Representations of the coniferous forest include *Cedrus deodara*, *Pinus wallichiana*, *Cupressus torulosa*, *Picea smithiana*, etc. Among bryophytes, *Brachythecium formosanum*, *Bryum argenteum*, *Polytrichum commune*, *Pogonatum microstomum*, *Campylopus* species, *Sphagnum cuspidatum*, *Sphagnum nepalensis*, *Mnium confertidens*, *Thuidium cambifolium*, etc. are popular in this region.

3.1.4. Sub Alpine Zone

The subalpine zone at the elevation of 3000 m to 4000 m features cold climatic condition where diversity of vegetation declines following altitudinal rise. This zone occupies about 15.1 % of the land area of this district. Occupied with high mountains, this zone also includes many significant lakes like the Panch Pokhari, Bhairav Kunda and other small lakes. Forests of different *Rhododendron* sps, *Pinus roxburghii*, *Betula utilis*, and *Juniperus* species are found in this zone.

3.1.5. Alpine Zone

The elevation of 4000 m to 5000 m represents alpine zone prevailed with cold and harsh weather condition. This zone covers an area of about 7.8 % to the northern part. This zone features sophisticated terrains where stunted growth of vegetation can be found. Different *Rhododendron* species in bushy forms, *Juniperus* species etc are the significant vegetations in this part.

The green and lustrous meadows represent varied flora like *Primula* spp., *Potentilla* spp., *Gentiana* spp., *Saxifraga* spp., *Saussurea* spp. etc. Bryoflora of this region are *Bryum pallescens*, *Campylopus handelii*, *Plagiochila retusa*, *Polytrichum alpinum*, *Racomitrium crispulum*, *Sphenolobopsis minutus*, *Plagiochila retusa*, *Polytrichum alpinum*, *Racomitrium crispulum*, *Sphenolobopsis minutus*, etc.

3.1.6. Nival Zone

About 9.1. % of the northern land of this district is occupied with the nival zone which lies above the elevation of 5000 m. This zone always features harsh and extremely cold climate. This part still has some grass, lichens and bryoflora species.

The bryophytes recorded in this zone are *Bryum argenteum* (5,100 m), *Marsupella commutata* (5200 m), *Grimmia longirostris* (5350 m), *Pohlia microstoma* (6250 m), *Aongstoemia julacea* (6,532 m), etc.

4. Biodiversity

This study is still underway at the central and eastern parts of the Sindhupalchok District. Besides predominance of *Shorea robusta* this zone also has the representations of *Adina cordifolia*, *Aegle marmelos*, *Albizia* spp., *Anthocephalus chinensis*, *Anogeissus latifolia*, *Butea frondosa*, *Dillenia pentagyna*, *Dillenia indica*, etc.

Among the prominent fauna of this part are the Common Leopard (*Panthera pardus*), Barking Deer (*Muntiacus muntjak*), Wild Cat (*Felis chaus*), Jackal (*Canis aurieus*), Procupine (*Hystrix indica*), Rhesus Monkey (*Macaca mulatta*) etc. Common birds found here are Dove (*Streptopella senegalensis*), Common Kingfisher (*Alcedo atthis*), Black kite (*Milvus migrans*), etc.

4.1. Route for Illegal Trade of Wildlife

Kathmandu to Kodari is a transitory route for the illegal trade of wildlife and their organs which they smuggle to the Tibet. Most of the caught items are the skins and bones of the Common Leopard (*Panthera pardus*), scales of Pangolins (*Manis crassicaudata* and *Manis pentadactyla*) and mammalian skins and their parts. Sometimes a huge number of the dead and dried Sea Horses (*Hippocampus* sp.) brought from India is smuggled through this route to the Tibet. Likewise Red Sandle Wood which has a high demand in Tibet is also carried illegally through this district. Most of these items are caught enroute at different check posts before they can reach to their destination. Nepal so far has included 28 species of mammals in CITES I, 83 in CITES II and 1 under CITES III Appendices. Likewise 9 species flora are in CITES II and 5 under CITES III. Three species of butterflies also are included in CITES II. There are many other reptile and Amphibians which are placed under different appendices of CITES (DNPWC 2003).

5. Conservation Area

Gaurishankar Conservation Area is a protected area network which was established in January of 2010. This covers an entire area of 2,179 km² (841 sq mi) of the Ramechhap, Dolakha and Sindhupalchok districts. Some eastern parts of the Sindhupalchok like Ghorthali, Maming, Listikot, Tatopani, Fulkipatti and Gumba are now included into this area.



This Conservation Area is rich for bio-diversity components. A total of 16 varieties of vegetation have been identified in the area, including forests of *Pinus roxburghii*, *Schima-Castanopsis*, *Alnus*, *Pinus wallichiana*, *Pinus patula*, *Rhododendron*, *Quercus lanata*, and temperate mountain oak forest.

6. Distribution of Bryophytes

Three main taxonomic groups of bryophytes have been recognized, these are now known as Anthocerotopsida (Hornworts), Marchantiophyta (Liverworts) and Bryophyta (Mosses). The hornworts consist of a dorsoventrally flattened thallus often in the form of rosette with long horn like sporophyte. They are widely distributed in the temperate and tropical regions throughout the world. The liverworts have both thalloid as well as leafy growth forms and are distributed in the tropical to alpine zones. The mosses are advanced on account of the greater structural diversity (especially that of the sporophytic generation) than other bryophytes.

Bryophytes show diverse distribution patterns than the vascular plants, perhaps of their greater dispersal capacity through minute spores. Many cosmopolitan species are found over all the continents. The high humidity and predominating rain are the important factors to create suitable environment for the luxuriant growth of bryophytes. The decrease in precipitation is directly associated to the decrease in the growth and distribution. Some bryophytes can tolerate high temperature, extreme desiccation and some can survive prolonged freezing under wet or dry conditions.

6.1. Nepalese Context

6.1.1. Tropical Region

Rich diversity of bryophytes can be found in the tropical region. Most of the species occurring here are the origin of the Indo-Australian eco-regions. The popular species of bryophytes of

tropical habitats are *Asterella wallichiana*, *Plagiochasma pterospermum*, *Cyathodium tuberosum*, *Marchantia polymorpha*, *Frullania muscicola*, *Jungermannia truncata*, etc. Among mosses, *Bryum coronatum*, *Trematodon longicolis*, *Octoblepharum albidum*, *Philonotis thwaitesii*, *Hyophila involuta*, *Fissidens sylvaticus*, *F. zippeliannus*, *Phycomitrium eurystomum*, *Hypnum pleumaformae*, *Entodontopsis tavayense*, etc are widely distributed species in the tropical region. These species are found below 1000 m of elevations. *Anthoceros punctatus* is a hornwort (Anthocerotae) which is less diversified in Nepal and is distributed within the altitudinal limits of 200-1000 m only.

6.1.2. Subtropical region

The subtropical region which covers the altitudinal range of 1000 - 2000 m also represents good diversity of the bryoflora. This region accommodates popular species like *Asterella wallichiana*, *Asterella multiflora*, *Targionia hypophylla*, *Plagiochasma pterospermum*, *Marchantia emarginata*, *Dumortiera hirsuta*, *Bryum argenteum*, *Anomobryum julaceum*, *Pholia flexuosa*, *Rhodobryum giganteum*, *Fissidens taxifolius*, *Fissidens plagiochiloides*, *Brachythecium*, *Barbule constricta*, *Funaria hygrometrica*, *Hypnum pleumaforme*, *Thuidium cambifolium*, *Pogonatum microstomum*, *Polytrichum commune*, etc.

Anthoceros punctatus, *Marchantis emarginata*, *Riccia himalensis*, *Frullania delatata*, *Jungermannia* spp., *Mylia taylorii*, *Hypnum pleumaformae*, *Pogonatum microstomum*, *Fissidens* spp. and *Thuidium* spp. are common mostly in the Barhabise to Tatopani range of this study route.

7. Outcome of Previous RSG Supports

7.1. First Rufford Small Grants, March 31, 2009 (Our Ref: 10.09.07)

Panch Pokhari and adjoining areas at the northern higher elevation (4000 m) of Sindhupalchok District was extensively studied for the existing biodiversity in the year 2008. This work made a complete documentation of the existing components of the biodiversity in Panch Pokhari and adjoining areas. Threat factors were also identified which later was recommended to the conservation authorities of the Langtang National Park. The local community was also made aware of the prevailing threats on biodiversity of their areas. Their commitment was also made to protect the biodiversity and associated habitats found in their areas.

The documentation and status assessment of various biodiversity components like insects, amphibians, reptiles, birds, mammals, lower and higher groups of plants (Lichens, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms) were all documented in detail. New records of five species of Bryophytes were also made in this study.

This work was very successful to implement the Conservation Awareness Programme in Botang Village (a nearby village of Panch Pokhari). Participating peoples of this community made very positive response with commitment to support to conservation campaign. Significant ideas were shared with the villagers regarding promoting tourism in this place. Various underlying problems to promote tourism in this place were identified. Concerning agency in Kathmandu called the

Nepal Tourism Board was approached and recommendation was made to develop an affective infrastructure for tourism development in this place.

7.2. Second Rufford Small Grant, July 16, 2012 (Application ID: 10111-2)

This study “An Approach to Determine the Diversity and Conservation Status of Bryophytes in Northern Sindhupalchok District of Nepal” was confined within the elevation of 1300 m to 3020 m where bryophytes of different status categories were recorded. The species diversity of bryophyte was found changing with the effect of altitudinal gradients representing least diversity at 3000 meter whereas the middle zone accommodated rich diversity.

The highest diversity of this plant was recorded at the northwest part within the elevation of 1300- 1850 m where 60 species were documented. About 18 species were identified at 1800-2200 m and 47 species at 2200 to 3000 m.

This study brought a list of 141 species of bryophytes with 11 new records to the country. The faunal association to the bryophyte habitats was also documented. Door to door awareness programme was launched at different village wards in order to bring local peoples’ participation in conservation efforts. Information was collected from the local inhabitants at different village communities regarding uses of bryophytes in their society. *Sphagnum junghuhnianum* was recorded very rare in this study which so far has been reported from a single locality of the eastern Nepal. In country’s context, *Cephaloziella massalongi* (Cephaloziellaceae) was made as a new record which is an endangered and rare species occurring at 2000 m of elevation.

One of the aspects of this study was also to find out the traditional uses of bryophytes in village community or society. This was a poorly known aspect in this part and provided very few information. Peoples at every station were interviewed besides letting them know about the uses of bryophytes for their benefits and income generation.

8. Significance of this Study

This district was least known for bryoflora and existing biodiversity till the first RSG study was initiated in 2008-2009. The second RSG extensively explored the bryophytes of the western Sindhupalchok district which was not done before. Both of these studies summing up with current study has been expected to come up with extensive diversity data of bryophytes and interesting and beneficial information related to this plant. This also has considered a study on the faunal components which are in association to the habitats of bryophyte and in fact this is a new topic for study in country’s context. Traditional use of bryophytes is an unfamiliar topic among the village communities of Sindhupalchok though is quite popular in Indian villages. If used sustainably, this plant may help to raise their socio economy and can be beneficial to them. Peoples residing in the remote areas are still unknown about the conservation aspects and associated laws. So this study is very significant as it emphasizes specifically on bryophyte

diversity, conservation issues, uses and its relationship to faunal components. This study carries high value and provides a baseline data for the future researchers as well. The outcome of this work has also been planned to publish in the forms of book and research papers.

Once species diversity is documented, the future monitoring can be made easy to determine the degree of habitat alteration. If any impact is found in future, the village communities, local leaders and government organizations will be reported to add effectiveness in their conservation policies.

9. Objectives

The study of bryophytes during the First and Second RSGs were conducted in the northern and northwestern parts of the Sindhupalchok district so this is a continuing study to the south and central parts of the same district.

- This work makes an extensive documentation of bryophyte diversity in the central, eastern and southern parts of Sindhupalchok District of central Nepal within the elevation range of 700 to 1400 m.
- Status of every recorded species will be determined on local and native levels.
- Prevailing threats will be assessed minutely that may help to develop effective conservation policy for bryophytes.
- Awareness program which is one of the important aspects of this work will be launched at different communities to familiarize local peoples on significant value of this plant.
- This work also investigates the faunal species which are associated to the habitats of bryophyte species.
- Diversity record and prevailing threats resulted from this study will be used to design locally sound measures for conservation and update country's list of bryophytes.

10. Methodology

Best effort was carried out to identify all the observed species of bryophytes in the field. This was done with the help of magnifying hand lens and consulting books of Gangulee (1969-1980), Eddy (1988, 1990 and 1996), Kashyap (1972) and Smith (1996). Unidentified species in the field were collected and placed in paper packets and brought to the laboratory in Kathmandu to confirm their identification. Quick Identification in the field was done using hand lens of magnifying power 5X-20X. Latitude/Longitude reading was taken in the field using GPS meter. The higher plants, shrubs and herbs found in and around the habitats of bryophyte were also identified while unidentified species of such plants were brought to Kathmandu based Natural History Museum for identification. Polunin and Stainton (1987) and Stainton (1988) were also consulted for identification of higher plant species. The association of fauna to bryophyte habitats was also studied in this phase. Unidentified invertebrate species were brought to the Natural History Museum where identification work is still underway. These invertebrate specimens are preserved in small bottle containing Ethyl alcohol.

Observed bird species was identified using binocular and the field guide book by Fleming (1976). Field identification of butterflies and moths were done with the help of books by Khanal and Smith (1997) and Haruta (1995).

One of the aspects of this study is also to find out the traditional uses of bryophytes in village society. Interviews were taken with local peoples of the visited sites to determine how they take bryophytes in their society. They were also provided basic knowledge on the uses of bryophytes under sustainable way. Community based Awareness program has been planned to implement at different sites in November and December of 2014. Door to door awareness program which is also a part of this study will be continued till the end period of this study. For this work, questionnaires have been developed and 10 % of the households in every visited village are selected to provide them knowledge on uses and conservation value of bryophytes and other wild components in nature.

10.1. Status Categorization

The status of different species of bryophytes is based on the percentage of occurrence of a species on local scale. Those species which are recorded in less than 10 percent of the entire species present in a particular area has been placed under Rare Status. The presence of species under the level of 30 % of the entire recorded species in a particular area has been categorized under Uncommon or Moderately Common Status. The Common Status includes the level of 70% record of a species in a particular area. Above 70 % record of a species in a particular area has been designated under Most Common Status.

11. Results

A detail list of the recorded species of Bryophytes is given in the Appendix I. Likewise the list of Pteridophytes (ferns) noted in and around the habitats of bryophytes is provided in Appendix II. The Higher plant species recorded at various habitat areas is given in Appendix III. The list of faunal components recorded in bryophyte habitats is given in Appendix IV.

This study covered all the potential habitats of bryophytes in ten different villages at the eastern and southern parts of this district which included Barhabise, Maneswara, Ghumthang, Listikot, Tatopani, Ramche, Kadambas, Mangkha, Jalbire, and Golche. Extensive study was carried out in six Village Development Committees like Barhabise, Listikot, Tatopani, Ramche, Jalbire, and Golche.

11.1. Study Areas in Southern and Eastern Parts of Sindhupalchok District

11.1.1. First Phase study

Date	From	To	Locality Major
May 9, 2014	Kathmandu	Kadambas VDC -Sukute	Sukute, 920; Simle, 900 m; Kodari, 850 m.
May 10, 2014	Kadambas-Sukute	Barhabise	Mangkha- Khadichour, 850 m; Mangkha-Lamosangu, 860 m;

			Mangkha-Jure, 780 m
May 11, 2014	Barhabise	Golche VDC - Baikunthe	Baikunthe, 1350 m; Tarke, 1300 m
May 12, 2014	Golche VDC - Baikunthe	Golche VDC - Baikunthe	Kubeshwor 1300 m; Kause, 1300 m; Kopicha, 1250 m
May 13, 2014	Golche VDC Baikunthe	Barhabise	On the way observation
May 14, 2014	Barhabise	Maneshwara Barhabise	Maneswara, 1360 m; Harre, 1200m; Ghumang, 1200 m.
May 15, 2014	Barhabise	Kathmandu	---

11.1.2. Second Phase Study

Date	From	To	Locality Major
June 5, 2014	Kathmandu	Mangkha VDC- Khadichour	Khadichour, 850 m; Lamosangu, 860 m.
June 6, 2014	Mangkha VDC- Khadichour	Barhabise	Khorsanibari 850 m, Thulo palate, 1150 m.
June 6, 2014	Barhabise	Ghumthang VDC - Danda Gaun	Danda Gaun 1520 m; Kolbari, 1520 m.
June 7, 2014	Ghumthang VDC- Danda gaun	Listikot VDC - Panglang	Pansang and periphery areas, 1350-1400 m
June 8, 2014	Listikot - Panglang	Tatopani VDC - Tatopani Kunda	Chaku, 1250 m; Tatopani Kunda 1650 m
June 9, 2014	Tatopani VDC	Tatopani VDC	Bhote koshi Dam site, 1600 m; Larcha, 1500 m.
June 10, 2014	Tatopani	Barhabise	Duguna Gadhi; Chhoti Bhansar; Larcha pool; Bhairab Khola, Andheri Khola 1350-1600 m.
June 11, 2014	Barhabise	Kathmandu	Kopheshwar temple, 840 m; Sunkoshi River bank, 850 m.

11.1.3. Third Phase Study

Date	From	To	Locality Major
July 19, 2014	Kathmandu	Barhabise	On the way collection
July 20, 2014	Barhabise	Barhabise	Khorsanibari, 950 m; Dharpa, 1400 m; Kyayung, 1620 m; Sunkoshi forest, 980 m.
July 21, 2014	Barhabise	Kadambas VDC -Sukute	Jure, 780 m; Mangkha- Pahadi Gaun 900 m.
July 22, 2014	Kadambas VDC - Sukute	Jalbire VDC- Jalbire	Simle, 860 m; Balafi, 850 m; Ban Sanghu, 930 m; Chimling base, 920 m; Way to Jalbire, (850- 1600 m)
July 23, 2014	Jalbire VDC- Jalbire	Jalbire VDC- Jalbire	Jalbire, 850 m; Kartike, 1160 m; Khamare, 1230 m;
July 24, 2014	Jalbire VDC- Jalbire	Baramchi VDC	Ramche, 1240 m; Sisneri, 1120 m;

July 25, 2014	Baramchi VDC	Jalbire VDC - Jalbire	Paire, 1250 m; Chanaute, 1260 m.
July 26, 2014	Jalbire	Barhabise	On the way observation
July 27, 2014	Barhabise	Ramche - Ramche	Ramche, 1320 m; Chepe Gaun, 1240 m; Ratmate, 1200 m.
July 28, 2014	Ramche Barhabise	- Kathmandu	- ---

11.1.4. Tatopani: Tatopani village stands at its geographical position of 27° 98' N and 85° 93' E and is situated to the eastern part of Barhabise very close to the Chinese border at Kodari. This Village has the population of 3102 with 613 households. Majority of the peoples of this part are from Sherpa and Tamang tribes.

Eleven species of bryophytes were recorded in and around the Tatopani area. These include *Marchantia emarginata*, *Bryum capillare*, *Pohlia flexuosa*, *Campylopus ericoides*, *Fissidens nobilis*, *Fissidens taxifolius*, *Funaria hygrometrica*, *Hypnum pleumaforme* and *Hydrogonium arcuatum*, all of common in status. *Frullania teneriffae* of the family Frullaniaceae was a new record to the country which was collected in the Kund Garden of Tatopani at 1250 m of elevation.

11.1.5. Barhabise: Barhabise, a commercial town of Sindhupalchok district is located at 27.78°N and 85.89°E. It consists of nine village wards. In 1991 Census, this town has a population of 6132 and 1161 houses. Since it is very close to the Chinese border, the business has been influenced here with the Chinese market. Most of the peoples in Barhabise Bazaar are involved in business mainly of Chinese products.

Total of 32 species of bryophytes were recorded in Barhabise. Of the recorded species, 23 species were found common while the rare species observed here were *Marchantia tosana* cf., *Calypogeia arguta*, *Jungermannia filamentosa*, *Jungermannia macrocarpa*, *Pohlia camptotrachela*, *Octoblepharum albidum*, *Hyophila rosea* and *Fissidens robinsonii*.

Interesting record of *Nostoc* colonies (Blue green algae) was found in association with the thalli of *Marchantia polymorpha* and *Asterella wallichiana*. The ongoing damage of pristine nature is at alarming rate not only in the Sindhupalchok district but the country as a whole. *Riccia himalayensis* and *Jungermannia atrovirens*, *Jungermannia pumila* and *Jungermannia truncata* were observed common in Barhabise and vicinity areas. Similarly, *Asterella wallichiana* was recorded as a moderately common species in this area.

Sunkoshi village is situated on the bank of Sunkoshi River. The 10 Megawatt hydropower station is located here. This is located about 2 km behind to Barhabise Bazaar. Of the recorded bryophytes in Barhabise, 19 species were recorded in the Sunkoshi area. The status of *Calypogeia arguta*, *Jungermannia atrovirens*, *Jungermannia macrocarpa*, *Pohlia camptotrachela* and *Thuidium meyenianum* were found rare. These were confined only to the Sunkoshi forest of Barhabise VDC.

11.1.6. Jalbire: Jalbire village is located at its geographical position of 27° 83'N and 85°78' E. The census of 1991 has indicated the individual population of this village as

2026 with 414 households. Now this village is an important station for a strenuous trek to Bhairav Kunda, a high altitude lake located to the north. This lake besides a well known trekking destination is equally significant for Hindu followers. Now this village has been developed into a small town.

Thirteen species of bryophytes were recorded in Jalbire and adjoining areas. *Fissidens javanicus*, *Calypogeia suecica* and *Riccardia multiflora* were the rare records. *Calypogeia suecica* is a new addition to country's list. Fairly common species recorded here were *Asterella khasiana*, *Jungermannia pumila* and *Hydrogonium arcuatum*.

11.1.7. Listikot: Listikot village stands at 27°92'N and 85.°87' E in the eastern part of this District. The population census of 1991 has shown its population of 3664 and 714 households. This village is surrounded by Kavrepalanchok, Ramechhap, Rasuwa ditrics and China to the north; most of the peoples are engaged in agriculture and some other businesses. Majority of the population are Sherpas who are of Buddhist religion.

Total of 14 species of bryophytes were recorded at the Listikot area. Of the recorded species *Anthoceros punctatus*, *Marchantia emarginata*, *Marchantia palacea*, *Riccia himalayensis*, *Pogonatum microstomum* and *Fissidens sylvaticus* were noted common while *Lescurea incurvata* was a rare species.

11.1.8. Golche: Golche village is situated at 28°02' N 85°78' E in the southeastern part of Sindhupalchok district. The population census of 1991 has indicated the population of 3814 peoples in this village. This place has varying altitudinal levels from 1040 m to 3680 m. The forested part of this village represented good diversity of bryophytes representing 16 species of different status categories. Of the recorded species, *Ptilium crista-cristensis* and *Herpetineuron toccoe* were found fairly common in this area while *Marchantia polymorpha*, *Plagiochasma appendiculatum*, *Funaria hygrometrica*, *Fissidens sylvaticus*, *Thuidium cambifolium*, *Pogonatum microstomus*, etc. were just the common species.

11.1.9. Ramche stands at 27°78' N and 85°87' E. In 1991 census, this village has shown the population of 2893 with 566 households.

Records of 12 species of this plant were made from the Ramche and nearby forest habitats. *Pellia calycina*, *Jungermannia exertifolia* and *Lophocolea minor* were only the rare records in this part. *Philonotis turneriana* though not recorded in other villages was noted common in Ramche. Other common species found here are *Bryum argenteum* and *Fissidens taxifolium*.

11.2. Faunal Association to Bryophyte Habitats

Bryoflora habitats provide shelters to diverse group of faunal components. Various species of invertebrates and vertebrates were found sheltered in the moist habitats of different bryophyte species. This plant grows intact to the soil so diverse species of micro-organism are contaminated to bryophyte species. Small faunal species found in such habitats are more diverse

in warm and humid tropical and subtropical parts than the cooler upper temperate and above zones.

Comparing the first and second RSGs, the current study in the tropical and subtropical zones can be expected to reveal out more faunal species which are found in association to the habitats of different bryophyte species.

In this study, 3 species of Beetles (Coleoptera), 4 species spiders and mites (Arachnida), 6 species of flies (Diptera), 2 species of homopterons, 1 species of hemipteron, 2 species of Annelids, 1 species of Shell (Mollusca), 1 species of Mole Cricket (Gryllotalpidae), 1 species of Damselfly (Odonata), 1 species of Nematode (Nematohelminthes), 1 species of reptile, 3 species of Rodents (Rodentia), 4 species of moths and butterflies (Lepidoptera), 2 species of Hymenopterans (Hymenoptera), 1 species of Earwig (Dermaptera) and 1 species of Millipede (Myriapoda) were recorded in the habitats of bryophyte at varying elevation levels. A detail list of this study is provided in Appendix IV.

12. Discussion

Seventy six species of bryophytes were recorded till the end of this midterm program. This also includes two new records like *Calypogeia suecica* of Calypogeiaceae and *Frullania teneriffae* of Frullaniaceae. Recorded members of the class Anthocerotae included two species and two genera. Likewise, the class Hepaticae represented 35 species and Musci 39 species. This study brought a list of species with different status categories. This included five species with most common status, 27 species common and 26 species of fairly common status. Records of 18 rare species were made in this study. *Philonotis laevis* was not recorded above 950 m of elevation. An interesting species collected at Ban Sanghu of the Mangkha Village was *Macromitrium nepanense* of the family Orthotrichaceae. This recorded was made at 1400 m of elevation and showed an unclear status in this part. Some of the rare species found here were *Riccardia multifida*, *Pellia calycina*, *Calypogeia arguta*, *Riccia fluctans*, *Riccio-cappous natans*, *Hyophila rosea*, etc. *Riccia himalayensis* with sporophytic form was recorded as most common in all the areas. *Rhodobryum giganteum* though a common species in Sindhupalchok district was recorded only at the Listikot forest. Likewise *Cyathodium tuberosum* of Targioniaceae was not noted in this phase.

This phase covered two main seasons of spring and summer (including raining period). During spring season the bryofloral species was dormant and dry lacking sporophytic generation. When the monsoonal rain started at the beginning of July most of the species were seen in good growth representing sporophytic generation as water is an essential factor for fertilization in this plant. This study made in the start of May, June and July (Tables 11.1.1 to 11.1.3) was conducted in different habitats like the forested areas, river banks, roadsides, deforested zones, human settlements etc. The damp areas of the forest represented good patches of this plant and diversity was also found rich with sporophytic growths.

The invertebrate fauna associated to bryophyte habitats were also studied. The faunal species noted in these habitats were different species of beetles, spiders, earthworms, hemipteron bugs, etc. The identification of some collected specimens of the insects is still underway. This midterm

study also investigated 18 species of ferns, 24 species of herbs, 30 shrub species, 5 climbers, 29 tree species and 2 Gymnosperms which were seen in and around the habitats of the bryophyte. The identification of some of these plants is still under way. The detail account on all these aspects will be incorporated into the final report.

The interesting specimens of Hepaticae like *Asterella wallichiana* and *Marchantia polymorpha* were noted sheltered with *Nostoc* colonies (Blue-green algae) on their dorsal surface of the thalli. This study is the continuing part of the first and second RSGs and is focused specifically on unexplored areas of the southern, central and eastern parts of the Sindhupalchok district. Being the floor area, mostly tropical and subtropical species are more prevalent in this region. At the end of this work, it has been expected to reveal out an interesting distribution pattern of bryoflora at differing bioclimatic zones from the lower to the higher elevations including tropical (720-1000 m) to subtropical (2000 m, second RSG, 2012) to temperate to alpine (2000-4000 m, first RSG, 2009) zones.

The second phase of this work which starts from the end of August to December includes the diversity documentation of bryophytes of autumn and winter seasons. This duration also works for awareness program, identification of collected specimens of bryophytes, higher plants and associated faunal components as well. The door to door awareness program will be emphasized most in this period. National Herbarium Section at the Lalitpur district and Natural History Museum (NHM) in Kathmandu will also be consulted to confirm identification of the unidentified floral and faunal specimens brought from the field.

12.1. People's Concept on Bryophytes

The knowledge on this plant is least understood among the village peoples of Sindhupalchok district. The villagers are still unfamiliar with this plant though they see it widely distributed in their areas. Their knowledge on species diversity and how this plant can be used for their benefits is an unknown subject to them. This has been experienced that the school students do have some knowledge on the life history of this plant which they have studied in their course books.

This midterm study was found quite helpful to disseminate the knowledge on bryophytes, its uses and how it helps to check the landslides and erosion. The villagers were found more enthusiasts to know all about this plant and its uses for their benefits. This part of work still remains to cover extensively during the final phase of study. The village peoples of the visited areas of this district will be made acquainted with this plant group and its conservation significances.

13. Threats, Issues and Challenges

Bryophytes are under high risk due to enormous loss of their habitats at several potential areas of this district. Deforestation, urbanization, hydropower stations, road networking and human pressure are the main threats to the habitat of this plant. This is a least prioritized plant group for conservation concern in Nepal. The knowledge on this plant and its conservation status is very limited or not fully understood among the circles of conservation authorities, community peoples

and policy makers. Publication on this work and discussion with these peoples has been expected to enhance their knowledge on this plant and related conservation issues. This will be done in the post-project period.

The main threats observed in this study are the road networking and increasing deforestation leading to habitat loss. Physical constructions like the hotels, resorts and hydropower stations are also causing impact to some extent. These indeed are essential requirements for the development, employment opportunities and tourism promotion but need to understand equally to the significances of conservation. This is an understood fact that the development and conservation should go side by side without disturbing each other.

It has been assessed that the potential habitats of bryophyte especially at Barhabise, Tatopani, Sunkoshi, Jalbire, Listikot, Golche and Ramche areas were found most impacted due to ongoing deforestations. Study and collections were made in ten villages which were visited in different periods during the months of May, June and July. Listikot, the southern part of Barhabise and peripheral parts of Jalbire village still display good forest habitats accommodating diverse species of this plant. Least diversity of this plant was represented at Maneshwara and Ghumthang areas. The outcome of this study has been expected to play a significant role to develop a baseline data and can be a good reference to formulate an effective conservation policy on based on community level. This study can also help to update the IUCN Red list on Nepalese context (NRDB 1995).

As mentioned before, this is a least studied plant group in Nepal. This is mainly due to lack of sufficient number of bryologists in the country. Complicated physiography and least or no knowledge on bryophytes among the peoples have been considered as basic problems for its conservation. Urbanization and physical constructions ignoring this plant's potential habitats also made many significant species disappeared from this country for the last 10 years. This can be exemplified with a very rare species of moss called *Sauteria spongiosa* which no more exists in the Chandragiri Mountain of Kathmandu district. This was first reported from this place in 1984. The road network linking Kathmandu to Makwanpur district made a massive destruction to the habitat of this plant during this 10 years period. Unfortunately, no record of this species has been made from rest of the country so far.

14. Community Awareness

The ongoing damage of pristine nature is at alarming rate not only in the Sindhupalchok district but the country as a whole. The main cause for such damage is population explosion, unmanaged urbanization and industrialization. Expanding road ways in the villages and towns and exploitation of forest resources under irreparable ways are the basic causes of environmental degradation in this country. Public residing specially in villages and remote areas are still unaware of the values of forest, its resources and environment benefits. This has been experienced that the regular and effective launch of the



awareness program considering remote villages and mountains is a “must” that may arouse not only public consciousness but also helps to restrict further damage to the environment and its precious resources. The awareness program needs to be implemented effectively and understandably with impressive presentations of posters, photographs, audio-visuals etc. Next part of this work is the Door to Door awareness. This has been expected to develop conservation confident among the village peoples who are least literate or absolutely illiterate and cannot communicate their views in mass or gatherings.

This work has considered this kind of awareness program as its significant activity. This program will be launched in November to December of 2014 in different potential areas where people’s dependency on forest resources is high and deforestation is under increasing state. Community peoples of the respective villages will be invited for their significant participation in this program. Besides lecturing and demonstration, their reaction and comments will also be taken into account. Relevant questionnaires have also been developed to go for door to door awareness. Conservation knowledge on simplified version will be provided to them. They will also be asked to provide their valuable inputs on conservation, uses and other related information on bryophytes found in their areas.

15. Recent Landslide



River which blocked this River with big rocks and clays. Due to this, the water level increased to 130 m above the normal level. An operation to open this blockage in this river is continuing vigorously by the Nepal army.

A massive area of the bryophyte habitats was also damaged and flooded away in various parts of this district during this rainy season.

Recently on August 3, 2014, Sindhupalchok district faced a serious natural calamity which claimed the life of about 50 peoples due to a huge landslide that occurred suddenly at the village called Jure near the Sunkoshi about 3 km before the Barhabise bazaar. A large part of the mountain was slided down at the Sunkoshi



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Appendix I

Bryophytes Diversity

Classes/Families	Latin names	Specimens Examined	Status
ANTHOCEROTAE			
Anthocerotaceae	<i>Anthoceros punctatus</i>	Ghumthang- Kolbari, 1520 m, 27°50' N, 85°51'E, 06.06.2014, Pradhan RSG571; Listikot- Chaku, 1240 m, 27°53' N, 85°55'E, 08.06.2014, Pradhan RSG624; Barhabise-Khorsanibari, 950 m, 27°47' 11"N, 85°55'E, 20.07.14, Pradhan RSG711.	C
	<i>Phaeoceros laevis</i>	Kadambas-Sukute, 920 m, 27 42'N, 85 45'E, 09.05.2014, Pradhan RSG598; Barhabise-Khorsanibari, 950 m, 27°47' 11"N, 85°55'E, 20.07.2014, Pradhan RSG712.	C
HEPATICAE			
Aneuraceae	<i>Riccardia multifida</i>	Baramchi-Jalbire, 1030 m, 27°49' N, 85°47'E, 25.07.2014, Pradhan RSG693a.	R
Pelliaceae	<i>Pellia calycina</i>	Ramche-Ratmate, 1200 m, 27°47' N, 85°53'E, 27.07.2014, Pradhan RSG 713.	R
Aytoniaceae	<i>Asterella khasiana</i>	Jalbire-Kartike, 1160 m, 27°49' N, 85°47'E, 23.07.2014, Pradhan RSG715.	FC
	<i>Asterella multiflora</i>	Ghumthang- Kolbari, 1520 m, 27°50' N, 85°51'E, 06.06.2014, Pradhan RSG570; Ramche-Ratmate, 1200 m, 27°47' N, 85°53'E, 27.07.2014, Pradhan RSG716.	FC
	<i>Asterella wallichiana</i>	Barhabise-Khorsanibari, 950 m, 27°48' N, 85°55'E, 06.06.2014, Pradhan RSG615; Ramche-Ratmate 1200 m, 27°47' N, 85°53'E, 27.07.2014, Pradhan RSG714.	C
	<i>Plagiochasma appendiculatum</i>	Mangkha-Khadichour, 850 m, 27°45' N, 85°40'E, 05.05.2014, Pradhan RSG561; Golche-Tarke, 1300 m, 27°53' N, 85°46'E, 11.05.2014, Pradhan RSG 566; Barhabise- Kopheshwar; 900 m, 27°42'11" N, 85°53'5"E, 11.06.2014, Pradhan, RSG734.	MC
	<i>Plagiochasma pterospermum</i>	Mangkha-Jure, 780 m, 27°45'56" N, 85°52'39E, 10.05.2014, Pradhan RSG 565; Ghumthang- Kolbari, 1520 m, 27°50' N, 85°51'E, 06.06.2014, Pradhan RSG568; Barhabise- Kopheshwar; 900 m, 27°42'11" N, 85°53'5"E, 11.06.2014, Pradhan, RSG733; Jalbire-Paire, 1250 m, 27°49' N, 85°47'E, 25.07.2014, Pradhan, RSG740.	MC
	<i>Reboulia hemispherica</i>	Ghumthang- Kolbari, 1520 m, 27°50' N, 85°51'E, 06.06.2014, Pradhan RSG569.	R
Calypogeiaceae	<i>Calypogeia arguta</i>	Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG682.	R
	* <i>Calypogeia suecica</i> (H.	Jalbire- Ban Sangu, 920 m, 27°46' N, 85°52'E, 22.07.2014, Pradhan RSG703.	R
Conocephalaceae	<i>Conocephalum conicum</i>	Jalbire-Paire, 1250 m, 27°49' N, 85°47'E, 25.07.2014, Pradhan, RSG737.	FC
Frullaniaceae	<i>Frullania ericiodes</i>	Kadambas-Sukute, 920 m, 27°42'11" N, 85°45'5"E, 09.05.2014, Pradhan RSG586; Mangkha -Jure, 780 m; 27°46'08" N, 85°51'6"E, 21.07.2014, Pradhan RSG736	C
Frullaniaceae	<i>Frullania dilatata</i>	Maneswara-Ghumang, 1200 m, 27°48' N, 85°53'5"E, 20.07.2014, Pradhan RSG712.	C

		14.05.2014, Pradhan <i>et al.</i> RSG595; Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG708.	
	<i>Frullania muscicola</i>	Jalbire-Chanaute, 1260 m, 25.07.2014, Pradhan RSG 729; Jalbire-Andheri Khola, 900 m, 10.06.2015, Pradhan RSG679.	FC
	* <i>Frullania teneriffae</i>	Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG648.	R
Geocalyceae	<i>Heteroscyphus argutus</i>	Kadambas-Kodari, 850 m, 27°43' N, 85°46'E, 09.05.2014, Pradhan 581	FC
	<i>Heteroscyphus planus</i>	Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG690a; Jalbire-Simle, 860 m, 27°45'N, 85°46'E, 22.07.2014, Pradhan RSG 687.	FC
	<i>Lophocolea minor</i>	Ramche-Chepe Gaun, 1250 m, 27°46' N, 85°53'E, 27.07.2014, Pradhan RSG728.	R
Jungermanniaceae	<i>Jungermannia atrovirens</i>	Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG681a.	FC
	<i>Jungermannia exertifolia</i>	Ramche-Chepe Gaun, 1250 m, 27°46' N, 85°53'E, 27.07.2014, Pradhan RSG732.	R
	<i>Jungermannia filamentosa</i>	Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG676a.	R
	<i>Jungermannia hyaline</i>	Kadambas-Jure, 780 m, 27°45'56" N, 85°52'39"E, 21.07.2014, Pradhan RSG699a.	R
	<i>Jungermannia macrocarpa</i>	Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG684.	R
	<i>Jungermannia pumila</i>	Jalbire, 820 m, 23.07.2014, Pradhan <i>et al.</i> RSG718; Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG693a.	FC
	<i>Jungermannia truncata</i>	Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG701; Jalbire, 820 m, 23.07.2014, Pradhan <i>et al.</i> RSG717.	C
	<i>Mylia taylorii</i>	Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, RSG687b; ; Kadambas-Jure, 780 m, 27°45' 56"N, 85°52'39"E, 21.07.2014, Pradhan RSG699b; Mangkha- Pahadi Gaun, 900 m, 27°46' N, 85°51'E, 21.07.2014, RSG683.	C
Marchantiaceae	<i>Marchantia emarginata</i>	Golche-Baikunthe, 1350 m, 11.05.2014, Pradhan RSG576; Maneswara- Harre, 1200 m, 14.05.2014, Pradhan RSG584; Ghumthang- Danda Gaun, 1520 m, 27°50' N, 85°51'E, 06.06.2014, Pradhan RSG572; Barhabise-Khorsanibari, 950 m, 27°47' 11"N, 85°55' E , 06.06.2014, Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG544; Pradhan RSG612.; Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG620.	MC
	<i>Marchantia paleacea</i>	Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG543; Barhabise-Khorsanibari, 950 m, 27°47' 11"N, 85°55'E, 06.06.2014, Pradhan RSG613.	C
	<i>Marchantia tosana cf.</i>	Barhabise-Thulopalati, 1150 m, 27°48' N, 85°54'E, 06.06.2014, Pradhan RSG619.	R
	<i>Marchantia polymorpha</i>	Golche-Kubeshwar, 1300, 27°52' N, 85°45'E, 12.05.2014, Pradhan RSG591; Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG	C

		542; Barhabise-Khorsanibari, 950 m, 27°47' 11"N, 85°55'E , 06.06.2014, Pradhan RSG614.	
Ricciaceae	<i>Riccia fluctans</i>	Kadambas-Sukute, 900 m, 27°42' N, 85°45'E, 21.07.2014, Pradhan RSG741.	R
	<i>Riccio-carpous natans</i>	Rasmche-Ramche, 1320 m, 27°47' 11"N, 85°53'E 27.07.2014, Pradhan RSG 712;	R
	<i>Riccia himalayensis</i>	Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG 540; Barhabise-Khorsanibari, 950 m, 27°47'31"N, 85°53'53"E, 20.07.2014, Pradhan RSG656; Kadambas-Jure, 780 m, 27°45'56" N, 85°52'39"E, 21.07.2014, Pradhan RSG668; Ramche-Ratmate, 1200 m, 27°53' N, 85°43'E, 27.07.2014, Pradhan RSG738.	MC
Targioniaceae	<i>Targionia hypophylla</i>	Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG541; Ramche-Ratmate, 1200 m, 27°53' N, 85°43'E, 27.07.2014, Pradhan RSG739.	FC
Wiesnerellaceae	<i>Dumortiera hirsute</i>	Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG727.	FC
MUSCI			
Bartramiaceae	<i>Philonotis mollis</i>	Barhabise-Kopheshwar, 840 m, 11.06.2014, Pradhan RSG633; Barhabise- Sunkoshi, 850 m, 27°52'11" N, 85°45'5"E, 20.07.2014 Pradhan RSG725.	C
	<i>Philonotis thwaitzii</i>	Barhabise- Sunkoshi, 950 m, 27°52'11" N, 85°45'5"E, 20.07.2014 Pradhan 725; Jalbire--Paire, 1220 m, 27°49' N, 85°47'E, 25.07.2014, Pradhan RSG691.	C
	<i>Philonotis turneriana</i>	Ramche, 1320 m, 27°53' N, 85°47'E, 27.07.2014, Pradhan RSG726.	C
Brachytheciaceae	<i>Brachythecium rutabulum</i>	Barhabise-Dharpa, 1400 m, 27°55' N, 85°49'E, 20.07.2014, Pradhan RSG670.	C
Bryaceae	<i>Anomobryum julaceum</i>	Mangkha- Khadichour, 850 m, 27°45'N, 85°40'E, 05.06.2014, Pradhan <i>et al.</i> 623.	C
	<i>Bryum argenteum</i>	Dhumthang- Danda Gaun, 1520 m, 06.06.2014, Pradhan RSG644; Barhabise-Khorsanibari, 950 m, 27°47'31"N, 85°53'53"E,20.07.2014, Pradhan RSG723; Ramche, 1320 m, 27°47' 11"N, 85°53'E , 27.07.2014, Pradhan RSG724.	C
	<i>Bryum capillare</i>	Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG629.	C
	<i>Bryum coronatum</i>	Mangkha- Lamosangu, 860 m, 27°45' N, 85°51'E 06.2014, Pradhan RSG634.	FC
	<i>Pohlia camptotrachela</i>	Barhabise- Sunkhshi forest, 950 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG675.	R
	<i>Pohlia flexuosa</i>	Jalbire-Paire, 1250 m, 27°49' N, 85°49'E, 25.07.2014, Pradhan RSG730; Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG632.	FC
	<i>Rhodobryum giganteum</i>	Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG 645.	FC
Dicranaceae	<i>Campylopus ericoides</i>	Golche- Baikunthe, 1350 m, 27°54' N, 85°46'E, 11.05.2014, Pradhan RSG550; Jalbire- Balephi, 850 m, 27°43' 58"N, 85°45'50"E, 22.07.2014, Pradhan RSG702; Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG531;	C
	<i>Trematodon longicolle</i>	Barhabise- Khorsanibari, 950 m, 27°47'31"N85°53'53"E, 20.07.2014, Pradhan RSG661.	FC

Fissidentaceae	<i>Fissidens crenulatus</i>	Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG546; Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG690b.	FC
	<i>Fissidens javanicus</i>	Jalbire, 850 m, 27°49' N, 85°47'E, 23.07.2014, Pradhan RSG 695.	FC
	<i>Fissidens nobilis</i>	Golche- Baikunthe, 1350 m, 27°54' N, 85°46'E, 11.05.2014, Pradhan RSG549; Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG614, Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG618.	FC
	<i>Fissidens robinsonii</i>	Barhabise-Khorsanibari, 950 m, 27°48'N, 85°55'E, 20.07.2014, Pradhan RSG 672; Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG681c.	C
	<i>Fissidens sylvaticus</i>	Golche- Kopicha, 1250 m, 27°52'N, 85°45'E, 12.05.2014, Pradhan RSG589; Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG 545; Ramche, 1250 m, 27°47' 11"N, 85°53'E, 27.07.2014, Pradhan RSG722.	C
	<i>Fissidens taxifolius</i>	Golche- Baikunthe, 1350 m, 27°54' N, 85°46'E, 11.05.2014, Pradhan RSG548; Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG676b; Baranchi-Ramche, 1320 m, 27°47' 11"N, 85°55'E 24.07.2014, Pradhan RSG719; Ramche, 1250 m, 27°47' 11"N, 85°55'E, 27.07.2014, Pradhan RSG720; Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG530.	MC
Funariaceae	<i>Funaria hygrometrica</i>	Golche-Tarke, 1300 m, 11.05.2014, Pradhan RSG 580; Ramche, 1250 m, 27°47' 11"N, 85°55'E, 27.07.2014, Pradhan RSG721; Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG631;	C
	<i>Physcomitrium eurytomum</i>	Kadambas-Simle, 900 m, 27°45'N, 85°46'E, 09.05.2014, Pradhan RSG577.	FC
Hypnaceae	<i>Hypnum pleumaforme</i>	Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG631; Ramche, 1250 m, 27°47' 11"N, 85°55'E, 27.07.2014, Pradhan RSG722.; Golche-Tarke, 1300 m, 11.05.2014, Pradhan RSG 533.	C
	<i>Ptilium crista-cristensis</i>	Golche-Kubeshwar, 1300 m, 27°52'N, 85°45'E, 12.05.2014, Pradhan <i>et al.</i> RSG599; Maneswara, 1360 m, 27°49'N, 85°52'E, 13.05.2014, Pradhan <i>et al</i> RSG600.	FC
	<i>Taxiphyllum taxirameum</i>	Mangkha- Jure, 780 m, 27°45'56" N, 85°52'39"E, 10.05.2014, Pradhan <i>et al.</i> RSG583; Golche- Baikunthe, 1350 m, 27°54' N, 85°46'E, 11.05.2014, Pradhan RSG547; Barhabise- Kopheshwar temple, 950 m, 27°42'11" N, 85°53'53"E, 06.06.2014, Pradhan RSG650; Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG 538; Jalbire- Simle, 860 m, 27°49'N, 85°55'E, 22.07.2014, RSG690c.	C
Leskeaceae	<i>Lescuraea incurvata</i>	Listikot- Chaku, 1240 m, 27°53' N, 85°55'E, 08.06.2014, Pradhan RSG626.	R
Leucobryaceae	<i>Octoblepharum albidum</i>	Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG 537; Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E,	FC

		20.07.2014, Pradhan RSG678.	
Orthotrichaceae	<i>Macromitrium nepanense</i>	Mangkha-Ban Sanghu, 930 m, 27°46' N, 85°52'E, 23.07.2014, Pradhan RSG704.	R
Polytrichaceae	<i>Pogonatum microstomum</i>	Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG539; Listikot- Chaku, 1240 m, 27°53' N, 85°55'E, 08.06.2014, Pradhan RSG625; Golche- Baikunthe, 1350 m, 27°54' N, 85°46'E, 11.05.2014, Pradhan RSG588.	C
	<i>Polytrichum commune</i>	Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan <i>et al.</i> RSG 636.; Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG526.	C
Pottiaceae	<i>Anoetangium thomsonii</i>	Barhabise-Thulopalati, 1150 m, 27°54' N, 85°48'E, 06.06.2014, Pradhan RSG617; Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG527.	FC
	<i>Hydrogonium arcuatum</i>	Jalbire-Balephi, 850 m, 27°43' 58"N, 85°46'50"E, 22.07.2014, Pradhan RSG666; Tatopani-Tatopani Kund, 1650 m, 27°53' N, 85°55'E, 06.06.2014, Pradhan RSG528.	FC
	<i>Hyophila involute</i>	Barhabise- Kopheshwar, 890 m, 27°47' N, 85°53'E, 11.06.2014, Pradhan RSG635; Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG681b.	C
	<i>Hyophila rosea</i>	Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG709.	R
	<i>Semibarbula orientalis</i>	Mangkha-Khadichour, 850 m, 27°40' N, 85°45'E, 05.06.2014, Pradhan RSG621	FC
	<i>Weissia edentula</i>	Kadambas-Simle, 900 m, 27°45'N, 85°46'E, 09.05.2014, Pradhan RSG597.	FC
Thuidaceae	<i>Abitina abitinella</i>	Barhabise- Kopheshwar, 890 m, 27°47' N, 85°53'E, 11.06.2014, Pradhan RSG632.	FC
	<i>Herpetineuron toccocae</i>	Golche-Tarke, 1300 m, 11.05.2014, Pradhan RSG 534; Listikot- Pasang, 1400 m, 27°53' N, 85°53'E, 07.06.2014, Pradhan RSG654.	FC
	<i>Thuidium cambifolium</i>	Golche-Tarke, 1300 m, 11.05.2014, Pradhan RSG 535; Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG690c; Barhabise-Dharpa, 1400 m, 27°49' N, 85°55'E, 20.07.2014, Pradhan RSG677.	C
	<i>Thuidium meyenianum</i>	Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG693b.	R
	<i>Thuidium tamariscellum</i>	Golche-Tarke, 1300 m, 11.05.2014, Pradhan RSG 536; Barhabise-Sunkoshi forest, 980 m, 27°52'11" N, 85°45'5"E, 20.07.2014, Pradhan RSG693c.	C

Appendix II

Fern Diversity associated with Bryophytes

Serial No.	Latin names	Families	localities	Altitude	Status
1.	<i>Adiantum capillus- beneris</i> L.	Pteridaceae	Golche-Tarke; Golche-Baikunthe; Barhabise- Sunkoshi; Jalbire- Kartike	950-1300	C
2.	<i>Azolla imbricata</i> (Roxb.) Nakal.	Salviniaceae	Golche- Kubheshwar; Tatopani-Bhote Koshi dam site	1300 1500	R
3	<i>Botrychium lanuginosus</i> Wall. Ex Hook. & Grev.	Botrychiaceae	Jalbire- Paire	1250	R
4	<i>Cheilanthes anceps</i> Blanf.	Pteridaceae	Barhabise -Sunkoshi forest; Kadambas-Simle; Tatopani-Tatopani Kund Garden; jalbire – Paire.	950-1220	C
5	<i>Cheilanthes bicolor</i> (Roxb. In Griff.) Griff. ex Frax.-Jenk.	Pteridaceae	Kadambas –Simle; Golche-Baikunthe	900-1350	FC
6	<i>Diplazium esculentum</i> (Retz.) Sw.	Aspidiaceae	Barhabise- Sunkoshi forest; Kadambas-Kodari; Listikot-Chaku; Ramche- Ratmate; Ramche- Purana Gaun	850-1300	MC
7.	<i>Diplazium javanicum</i> (Bl.) Makino	Aspidiaceae	Ramche-Ramche; Listikot-Chaku; Tatopani- Tatopani Kund Garden	1200-1300	C
8	<i>Diplazium maximum</i> (D.Don) C. Chr.	Aspidiaceae	Barhabise-Dharpa	1420	R
9.	<i>Dryopteris pulcherrima</i>	Dryopteridaceae	Listikot- Chaku Bazar- Tatopani; Barhabise- Sunkoshi forest	950- 1500	FC
10.	<i>Equisetum diffusum</i> D. Don	Equisetaceae	Barhabise -Sunkoshi forest; Golche-Kause; jalbire- Simle	860-1300	C
11	<i>Equisetum ramosissimum</i> Desf.	Equisetaceae	Mangkha- Jure; Mangkha-Khadichour; Golche-Baikunthe; Listikot-Chaku	780-1300	C
12	<i>Gleichenia gigantea</i> Wall. ex Hook. et bauer.	Gleicheniaceae	Barhabise -Sunkoshi forest; Ghumthang- Danda Gaun; ramche –Chepe Gaun	960-1500	C
13	<i>Lycopodium japonicum</i> Thunb.ex A. Myrray <i>L. clavatum</i>	Lycopodiaceae	Listikot- Pasang; Barhabise-Dharpa	1400	FC
14.	<i>Lygodium flexuosum</i> L.	Schizaeaceae	Barhabise - Sunkoshi forest;	950	R
15.	<i>Nephrolepis cordifolia</i> (L.) Presl.	Dryopteridaceae	Barhabise- Khosanibari- Barhabise - Sunkoshi, Tatopani-Bhote koshi; Mangkha –Jure; Listikot-Chaku; Ghumthang-Danda Gaun; Jalbire-Paire.	780-1500	MC
16.	<i>Onychium siliculosum</i> (Desv.) C. Chr.	Pteridaceae	Mangkha-Jure; Barhabise-Sunkoshi forest;Kadambas-Sukute; Kadambas- Simle; Listikot-Chaku; Golche-Baikunthe	780-1550	MC

17.	<i>Pteris vitatta</i> Linn.	Pteridaceae	Barhabise- Khosanibari; Barhabise-Sunkoshi; Listikot- Chaku;	950-1300	C
18.	<i>Selaginella pinnata</i> (D.Don) Spring.	Selaginellaceae	Barhabise- Khosanibari; Barhabise-Sunkoshi forest	950-1000	FC

Appendix III

Floral Diversity

S.No.	Latin names	Families	Localities	Altitude m.	Local Status
HERB					
1	<i>Altermanthera philoxeroides</i>	Amaranthaceae	Sunkoshi- Bahrabise	800	C
2	<i>Amaranthus spinosus</i> L.	Amaranthaceae	Listikot-Chaku; Golche on the way	1240-1350	C
3	<i>Amaranthus viridis</i> L.	Amaranthaceae			C
4	<i>Argemone maxicana</i> L.	Papaveraceae	Mangkha- Pahadi Gaun; Kadambas- Simle	850-900	R
5	<i>Arisaema tortuosum</i> (Wall.) Scott.	Araceae	Sunkoshi- Bahrabise	850	R
6	<i>Begonia picta</i>	Begoniaceae	Tatopani- Kund Garden	1560	R
7	<i>Begonia picta</i> Smith.	Compositae	Listikot-Panglang	1650	FC
8	<i>Chenopodium botrys</i>	Chenopodiaceae	Tatopani- Chaku Bazar-	1500	FC
9	<i>Commelina benghalensis</i> L.	Caryophyllaceae	Sunkoshi forest; KhadiChour	810	C
10	<i>Cuphia</i> sp.		Barhabise -Sunkoshi forest-	950	FC
11.	<i>Cyperus iria</i> L.	Cyperaceae	Sunkoshi forest - Barhabise		C
12	<i>Cyperus rotundus</i> L.	Cyperaceae	Barhabise-Sunkoshi	950	C
13	<i>Eclipta prostrata</i> (L.) L.	Compositae	Barhabise -Sunkoshi forest-	950	C
14	<i>Euphorbia hirta</i> L.	Euphorbiaceae	Mangkha-Jure	780	C
15	<i>Euphorbia milii</i> Desmoul	Euphorbiaceae	Mangkha-Jure; Mangha-Khadichour	780-850	C
16.	<i>Fagopyrum esculentum</i> Moench	Polygoniaceae	Listikot-Chaku	1240	FC
17	<i>Galinsoga parviflora</i> Cav.	Compositae	Mangkha- Pahadi Gaun; Kadambas- Simle	850-1350	MC
18	<i>Hydrilla verticillata</i> (L.f.) Royle	Hydrocharitaceae	Tatopani- dam site	1450	R
19	<i>Inula cappa</i> DC.	Compositae	Barhabise-Sunkoshi	950	C
20	<i>Mimosa pudica</i> L.	Leguminosae	Tatopani - larcha	1520	R
21	<i>Mintha arvensis</i> L.	Labiatae	Barhabise - Khorsanibari	900	C
22	<i>Mintha spicata</i> L.	Labiatae	Barhabise- Khorsanibari	900	C
23	<i>Oxalis corniculata</i> L.	Oxalidaceae	Tatopani-Bhotekoshi	1350	C
24	<i>Oxalis latifolia</i> Humb.	Oxalidaceae	Golche on the way	1350	FC
SHRUBS					
1	<i>Achyranthes aspera</i> L.	Amaranthaceae	Barhabise-Sunkoshi	950	C
2	<i>Achyranthes dentata</i> Blume	Amaranthaceae	Khadichour		FC
3	<i>Agave cantula</i> Roxb.	Agavaceae	Barhabise	800	R
4	<i>Agave cantula</i> Roxb.	Agavaceae	Jure		
5	<i>Asparagus officinal</i> B.L.	Liliaceae	Phulphing VDC		R
6	<i>Asparagus racemosus</i> Wild.	Liliaceae	Bandau Check post		
7	<i>Berberis aristata</i> DC	Berberidaceae	Balephi; Barhabise	800-900	C
8	<i>Bidens pilosa</i> L.	Compositae			
9	<i>Callicarpa macrophylla</i> Vahl.	Verbenaceae			
10	<i>Cannabis sativa</i> L.	Cannabaceae	Barhabise-Sunkoshi; Mangkha-Khadichour	850-950	C

11	<i>Cassia fistula</i> L.	Leguminosae	Mangkha-Lamosangu	860	C
12	<i>Cassia floribunda</i> Cav.	Leguminosae			
13	<i>Clerodendron viscosum</i>		Golche- on the way	1450	R
14	<i>Colebrookea oppositifolia</i>	Lamiaceae			
15	<i>Crotolaria alata</i> Buch.- Ham. ex D. Don	Leguminosae	Barhabise-Sunkoshi; Listikot-Chaku	950-1250	FC
16	<i>Daphne bholua</i> Buch.- Ham. ex D. Don	Thymelaeaceae	Barhabise-Sunkoshi;	950	FC
17	<i>Datura stramonium</i> L.	Solaniaceae	Jalbire-Balephi	850	FC
18	<i>Durenta repens</i> L.	Verbenaceae	Barhabise- Khorsanibari	900	R
19	<i>Eupatorium adenophorum</i> Spreng.	Compositae	Phulping Danda; Pothe		C
20	<i>Euphorbia royleana</i> Boiss	Euphorbiaceae	Ramche-Ratmate	1200	R
21	<i>Ficus semicordata</i> Buch.- Ham. ex Sm.	Moraceae	Mangkha-Lamosangu	860	C
22	<i>Jasmine officinale</i> L.	Oleaceae	Barhabise- Khorsanibari	900	FC
23	<i>Justicia adhatoda</i> L.	Acanthaceae	Barhabise- Sunkoshi forest	950	R
24	<i>Lantana camara</i> L.	Verbenaceae	Barhabise-Sunkoshi forest' Jalbire in the way	950-1300	MC
25	<i>Maesa chisia</i> Buch.-Ham. ex D. Don	Myrsinaceae	Barhabise- Dharpa	1400	FC
26	<i>Mirabilis jalapa</i> L.	Nectaginaceae	Barhabise- Sunkoshi forest; Mangkha-Jure;Maneswara- Harre	780-1200	C
27	<i>Osbeckia stellata</i> Buch.-Ham ex D. Don	Melastomaceae	Kadambas-Simle; Barhabise-Kupheshwor; Jalbire-Balephi	860-950	FC
28	<i>Phragmites karka</i> (Retz.) Trin. Ex Steudel	Gramineae	Kadambas-Sukute	920	FC
29	<i>Rubus ellipticus</i> Smith	Rubiaceae	Tatopani- Larcha	1500	FC
30	<i>Xanthium strumarium</i> L.	Compositae	Barhabise-Kupheshwor;	860	FC

CLIMBERS

1	<i>Abrus precatorius</i> L.	Leguminosae	Kadambas- Simle	860	R
2	<i>Cuscuta reflexa</i> Roxb.	Convolvulaceae	Barhabise Sunkoshi forest	950	C
3	<i>Dioscorea sagittata</i> Royle	Dioscoreaceae	Barhabise Sunkoshi forest	950	FC
4	<i>Ipomia purpurea</i> (L.) Roth.	Convolvulaceae	Barhabise Sunkoshi forest	950	R
5	<i>Smilax ovalifolia</i> Roxb. ex D. Don	Smilacaceae	Barhabise Sunkoshi forest; Golche-Kause	950-1300	R

TREES

1	<i>Adina cordifolia</i> (Wild. ex Roxb.) Benth.- Hook.f. ex Brandis	Rubiaceae	Dolalghat- way to Bandau; Kadambas-Simle	900-950	FC
2	<i>Aesandra butyracea</i> (Roxb.) Baehni	Sapotaceae	Mangkha-Chipling Base; Barhabise-Kopheshwar	920-1000	FC
3	<i>Agave cantula</i> Roxb.	Agavaceae	Kadambas-Bandau	900	C
4	<i>Albizia julibrissin</i> Durazz.	Leguminosae	Mangkha-Lamosangu	860	C
5	<i>Alnus nepalensis</i> D. Don	Betulaceae	Sunkoshi; Tatopani	800-900	C
6	<i>Azadirachta indica</i> A.Juss	Meliaceae	Barhabise-Khorsanibari	900	
7	<i>Bombax cieba</i> L.	Bobacaceae	Dolalghat	800	MC
8	<i>Callistemon citrinus</i> (Curtis) Skeels	Myrtaceae	Mangkha-Lamosangu; Mangkha Khadichour; Ramche-Purana	840-1320	FC

			Gaun		
9	<i>Cinnamomum camphora</i> (L.) J. Presl.	Iauraceae	Kadambas -Andheri Check post, Bhaise	860-1000	C
10	<i>Castanopsis indica</i> (Roxb.) Miq.	Fagaceae	Barhabise -Sunkoshi forest; Listikot-Pangsang	950-1380	MC
11	<i>Castanopsis latifolia</i> (Kura.) Hickel & A. Carnus	Fagaceae	Barhabise -Sunkoshi forest; Listikot-Pangsang	850-1400	C
12	<i>Celtis australis</i> L.	Ulmaceae	Barhabise- Kupheshwar	900	FC
13	<i>Dalbergia sisso</i> Roxb.	Leguminosae	Kadambas-Sukute; Jalbire-Balephi; Mangkha-Khadichour; Golche-Baikunthe	850-1380	C
14	<i>Ficus benghalensis</i> L.	Moraceae	Kadambas-Bandau; Golche-Baikunthe; Tatopani Kund	850-1560	C
15	<i>Ficus religiosa</i> L.	Moraceae	Barhabise-Kopheshwar; Kadambas-Bhaise; Tatopani-Tatopani Kund Garden;	800-1550	C
16	<i>Grevillea robusta</i> A. Cunn. Ex R. Br.	Proteaceae	Dolalghat- on the way to Barhabise	800-950	R
17	<i>Lagerstroemia indica</i> L.	Lythraceae	Kadambas -Bandau; Kadambas - Simle Kadambas - Bhaise	800-900	FC
18	<i>Mangifera indica</i> L.	Anacardaceae	Kadambas -Bandau; Kadambas-Bhaise; Mangkha-Lamosangu	800-900	MC
19	<i>Melia azederach</i> L.	Meliaceae	Mangkha-Sukute Barhabise-Khosanibari	800-950	C
20	<i>Morus nigra</i> L.	Moraceae	Jalbire-Balephi	850	FC
21	<i>Mussaenda macrophylla</i> Wall.	Rubiaceae	Barhabise-Sunkoshi forest; Listikot-Panglang	950-1380	FC
22	<i>Myrica esculenta</i> Buch.-Ham. ex D. Don	Myricaceae	Kadambas-Bandau; Golche-Baikunthe; Tatopani Kund	850-1560	C
23	<i>Myrica esculenta</i> Buch.- Ham. ex D. Don	Myricaceae	Barhabise-Thulo Palati; Golche-Kopicha	1200-1300	FC
24	<i>Nerium oleander</i> Blanco.	Apocynaceae	Kadambas-Bandau; Mangkha-Ban Sanghu	900-1000	
25	<i>Ricinus communis</i> L.	Euphorbiaceae	Kadambas-Bandau;	800	
26	<i>Sapium insigne</i> (Royle.) Benth. ex Hook. f.	Euphorbiaceae	Jalbire- Andheri Check Post; Kadambas -Bandau; Kadambas - Simle Kadambas - Bhaise	800-950	MC
27	<i>Schima wallichii</i> (DC.) Korth.	Theaceae	Dolalghat- way to Kadambas	900	C
28	<i>Shorea robusta</i> Gaertn.	Dipterocarpaceae	Dolalghat; ; Sukute; Phulphing Danda;		MC
29	<i>Symbucus canadensis</i> L.	Sambucaceae	Jalbire- Balephi; Barhabise-Bazaar	850-950	FC
GYMNOSPERMAE					
1	<i>Juniperus</i> sp.	Cupressaceae	Tatopani- Kunda	1560	FC
2	<i>Pinus roxburghii</i> Sarg.	Pinaceae	Kadambas-Bandau; Mangkha-Khadichour; Jalbire-Paire	850-1220	C

Appendix IV

Association of Fauna to Moss Forest Habitats

Order	Family	Fauna
Coleoptera	Carabidae	Carabus sps
Coleoptera	Scarabidae	Onthophagus sps
Coleoptera	Chrysomelidae	Acropteryx sp
Diptera	Sepsidae	Dicranosepsis bicolor
Diptera	Chironomidae	Chironomid larvae
Diptera	Bibionidae	Bibio sps
Diptera	Caliphoridae	Calliphorid sps
Diptera	Tachinidae	Tachinid sps
Diptera	Culicidae	Anopheles sps
Diptera	Tipulidae	Tipula sps.
Homoptera	Aphidae	Capitophorus sps.
Homoptera	Cicadidae	Cicada
Hemiptera	Lygidae	Lygaeus sps.
Gryllotalpidae	Gryllotalpidae	Gryllotalpa major
Odonata	Coenogrinidae	Still to identify
Lepidoptera	Arctiidae	Spilosoma casignatum
Lepidoptera	Acraeidae	Acraea issoria
Lepidoptera	Satyridae	Melanitis leda
Lepidoptera	Noctuidae	Noctuid sps.
Hymenoptera	Formicidae	Formicid ants
Hymenoptera	Ichneumoniidae	Megarhyssa sps
Demaptera	Forficulidae	Forficula sps.
Myriapoda	Diplopodae	Millipede
Arachnida	Araneidae	Araneus sps
Arachnida	Salticidae	Saltis sps.
Arachnida	Salticidae	Heteropoda sps.
Arachnida	Formicidae	Epicriopsis sps
Phylum	Class/order	Fauna
Annelida	Clitellata	Pheritima posthuma
Annelida	Hirudinea (subclass)	Hirudo medicinalis
Mollusca	Gastropoda	Helix pomatia
Nematohelminthes	Nematoda (order)	<i>Eudorylaimus</i> sp
Chordata	Reptilia (family Gekkonidae)	Gecko gecko
Chordata	Rodentia (order)	Ratus ratus