Sustainable harvesting plan of Loth Salla (*Taxus contorta*) and Bikh (*Aconitum spicatum*) Api-Nampa Conservation Area (ANCA) (2018 AD to 2022 AD)

Submitted to

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Executive Summary

The flora of the Nepal Himalaya contains 10,167 plant species, of which over 7,000 are flowering plants and over 1,600 species are medicinal and aromatic herbs. The herbs, representing about 25% of the total country's vascular flora, are used under different traditional systems including the *Ayurveda*, Homeopathic, Home herbal (folklore) and *Amchi* (traditional Tibetan medicine) medicinal systems (Bhattarai, 1997). Thirty percent medicinal plant species of the country occur in the western part of the country (Manandhar, 1998) and about 50% of the plants used as ethno-medicine in Nepal Himalaya (Kunwar et al. 2008) have been documented. ANCA aims to conserve pristine nature of the conservation area while addressing the needs of Local people. In point of view of revenue collection, an important activity of the office, approved sustainable harvest plan for the prioritized NTFPs is a must and also is needed by the collectors and local traders as it is one of the main sources for subsistence need for their daily life activities. The major livelihood of local people depends on agriculture, **collection of medicinal and aromatic plants** as well as artisan productions. The region is origin place of valuable NTFPs and Medicinal and Aromatic Plants (MAPs), extracted and traded in local, national and international market every year. To date 75 MAPs / NTFPs have been identified from the area (ANCA management plan 2015-19). The main objective of establishing ANCA was to conserve the unique biodiversity and cultural heritage of the area and socio-economic improvement of the local residing inside ANCA. Because of the dependency of local collectors and local traders who relies on NTFPs and MAPs, it is the very important to have the approved harvest plan for the most used key species in trade. Hence, it is believed that after approval of this draft harvest plan, it will assure the improvement and development of socio-economic conditions of the collectors and local traders. After consultation with local NTFPs traders, collectors and other relevant key stakeholders, Bishjara (*Aconitum* spicatum) and Lothsalla (*Taxus contarta*) were prioritized for the inventory and drafting harvest plan for both of the species.

Potential area of Bishjara (*Aconitum* spicatum) and Lothsalla (*Taxus contarta*) in all identified strata (VDCs wise) of ANCA was delineated based on the altitudinal range and land use map using ArcGIS 10.3. The total potential area of Bishjara (*Aconitum* spicatum) and Lothsalla (*Taxus contarta*) in ANCA was estimated 19484.92 ha and 7969.89 ha respectively. Stratified systematic sampling method was used for laying out sample plots to collect field data. Three VDCs level strata (Khandeswori, Byas and Ghusa) and four VDC level strata (Khandeswori, Ghusa, Byas and

Sitaula). Altogether, 20 (twenty) and 40 (forty) sample plots were systematically distributed in all of the potential strata (3 strata for Bishjara and 4 strata for the Lothsalla). The issues and challenges of the selected NTFPs includes over harvesting, illegal harvesting, poor trail conditions, unmanaged camping, waste management at camping sites, lack of health services and natural problems like untimely snowfall and also the market management for the selected species is of great challenge. The main objective of the study is to quantify the allowable harvestable amount of the two selected MAPs/NTFPs viz., Bishjara (*Aconitum spicatum*) and Lothsalla (*Taxus contarta*).

Based on the current inventory carried out, **density, frequency** and **abundance** of the **Bishjara** and **Lothsalla** in each stratum were estimated. The overall density of Bishjara in ANCA was to estimated 93.33 individuals/ha while frequency and abundance was estimated **31.67%** and **444.44 individual/ha** respectively. Similarly, **overall density** of **Lothsalla** in ANCA was **9.96 individuals/ha** with **frequency** and **abundance** estimated as **46.47%** and **31.67 individuals/ha** respectively.

The **total yield** estimated for **Bishjara (*Aconitum spicatum*)** and **Lothsalla (*Taxus contarta*)** was **35037.15 kg** and **91133 kg** with annual allowable harvestable amount **(AAH)** of **22,891 kg** and **33563 kg** for **Bishjara (*Aconitum spicatum*)** and **Lothsalla (*Taxus contarta*)** respectively.

There is a strong need of baseline information (database management) for periodic monitoring and evaluation of socio economic improvement of the local collectors and local traders of MAPs as the region is a hub for NTFPs / MAPs. Besides, periodic conservation education, campaigns among public for sustainable harvesting is must. Similarly environmental impacts of unscientific collections, awareness programs on importance of the MAPs and NTFPs with sustainable harvesting plan, management and utilization of the resources (MAPs and NTFPs) at local level need to be conducted in the area.

Baseline database management for all key traded species should be maintained for drafting action plans for each of the selected species on the basis of the baseline data to compare progress periodically and also for any management intervention needed. Government in this regard of NTFPs development programs, should play a proactive initiative role for market promotion (e.g. via cooperative, buyback, etc.), storage and packaging facility of collected / harvested MAPs and NTFPs should be developed and promoted for facilitating marketing of the graded MAPs qualitatively and there is also a strong need for nominal entry fee / permissive fee for NTFPs / MAPs collections for each individual local collectors and traders which not only generates revenues

but also helps keep and monitor the harvesting record annually and recommends further improvement if any needed. Community ownership and mobilization should be promoted for effective management of collection sites.

Acronyms and Abbreviation

NTFPs : Non Timber Forest Products

NPWC: National Park and Wildlife Conservation

DoF: Department of Forests

ANCA: Api Nampa Conservation Area

ANSAB: Asia Network for Sustainable Agriculture and Bio-resources

KSL: Kailash Sacred landscape

KSLCDI: Kailash Sacred Landscape Conservation and Development Initiative

ICIMOD: International Center for Integrated Mountain Development

RECAST: Research Center for Applied Science and Technology

IUCN: International Union for Nature Conservation

PRA: Participatory Rural Appraisal

RRA: Rapid Rural Appraisal

CAMC: Conservation Area Management Council

MAPs : Medicinal and Aromatic Plants

VDCs : Village Development Committee

GoN: Government of Nepal

GPS: Global Positioning System

GIS: Geographic Information System

AAH: Annual Allowable Harvest

B.S.: Bikram Sambat

Sq.km.: Square kilometer

Mt.: Mountain

°C: Degree Celsius

CF: Community Forest

CFUGs: Community Forest Users Groups

Kg : Kilograms

In: Inch

Ha: Hectare

DHM: District Hydro Metrology

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Chapter 1: Introduction

Background

It has been estimated that the Himalayan region harbors about 12,000 species of medicinal and aromatic plants, supporting the livelihood of about 600 million people living in the area (Pie Shengji 2001). The flora of the Nepal Himalaya contains 10,167 plant species, of which over 7,000 are flowering plants and over 1,600 species are medicinal and aromatic herbs. The herbs, representing about 25% of the total country's vascular flora, are used under different traditional systems including the *Ayurveda*, Homeopathic, Home herbal (folklore) and *Amchi* (traditional Tibetan medicine) medicinal systems (Bhattarai, 1997). Thirty percent medicinal plant species of the country occur in the western part of the country (Manandhar, 1998) and about 50% of the plants used as ethno-medicine in Nepal Himalaya (Kunwar et al. 2008) have been documented. The management of medicinal and aromatic plants and knowledge of utilization of the resources therefore is of great importance and it can be promoted by considering and documenting the diversity of the medicinal plant resources and their indigenous knowledge of utilization (Kunwar et al. 2006). Valued MAPs collection and trade has been one of the major activities sustaining the livelihood annually in the Himalayas of Nepal extending from the east to the far-west of the country Himalayan region with higher in the western Himalayan compared to the eastern.

Some MAPs like Yarsagumba, Ban lasun, Satuwa, etc have so much value in terms of economy which has pushed the collectors, local traders to act accordingly and the activity of collections and trades has become an integral part of their livelihoods fulfilling almost more than any other activities can fulfill or may say the best option and alternative for the Himalayan region resident for their yearly income either may be subsistence or substantial.

ANCA aims to conserve pristine nature of the conservation area while addressing the needs of Local people. ANCA seeks to involve local people in overall management as participatory conservation model which is must for effective implementation of the plan. Limited numbers of tourists visit conservation area due to remoteness.

The major livelihood of local people depends on agriculture, **collection of medicinal and aromatic plants** as well as artisan productions.

Diversity in physiographic and climatic conditions in the area offers a possibility of the existence of variety of vegetation. Out of 35 forest types identified by Stainton (1972), this region represents sixteen forest types (ANCA management plan 2015-19). The major species in the region constitute

Chir pine (Pinus roxburghii), *Alnus spp., Pinus patula,* Blue pine (*Pinus wallichiana*), *Rhododendron spp*., *Cedrus deodara*, *Quercus lanata*, *Q. semicarpifolia*, *Abies spp., Birch spp*., *Juniperous spp*. and moist alpine scrubs.

The region is an origin place of valuable NTFPs and Medicinal and Aromatic Plants (MAPs), extracted and traded in local, national and international market every year. To date 75 MAPs / NTFPs have been identified from the area (ANCA management plan 2015-19). Among them, the main NTFPs traded from this region are Yarshagumba (*Ophiocordyceps sinensis*), Banlasun (*Allium wallichii*), Satuwa (*Paris* polyphylla), Chiraito (*Swertia ciliata*), Majhito (*Rubia cordifolia*), Allo (*Girardinia diversifolia*), Jatamansi (*Nardostachys grandiflora*), Panchaunle (*Dactylorhiza hatagiera*), Ritha *(Mukurossa spendis),* Dhupi *(Juniperus spps*.), Rock honeybee and several others. Due to the high demand in market for some specific NTFPs, collection of those target NTFPs and local trade need permission of from the ANCA office prior of collection if the collection sites lies inside ANCA. In point of view of revenue collection, an important activities of the office, approved sustainable harvest plan for the prioritized NTFPs is a must and also is needed by the collectors and local traders as it is one of the main source for subsistence need for their daily life activities and can be substantial too according to the price fetched by the collectors. Till date most of the traded NTFPs harvest plan has been prepared but due to yearly demand for different NTFPs / MAPs species, new species of NTFPs already identified, needs to be inventoried for allowable harvest plan for that particular species. Hence the current inventory and study was focused for two major species (Bishjara_*Aconitum spicatum* and Lothsalla_*Taxus contarta*) as per consultation with local collectors, local traders, ANCA management council and the district level NTFPs / MAPs development organization of Darchula.

Rationale

Api Nampa Conservation Area (ANCA), was established in 2010 by Government of Nepal based on National Parks and Wildlife Conservation Act, 1973 (2029 BS) clause 3 as an newly protected areas, hence is in the phase of initial development and lacks adequate database management for effective specific management interventions which needs a bit of time to wholly understand the immense opportunities and potentials for socio economic development of the residents of ANCA and participatory biodiversity conservation across the Kailash Sacred Landscape. This conservation area is named after the two famous peaks Api and Nampa. ANCA covers an area of 1,903 km2 (735 sq mi) extending in former 21 Village Development Committees of Darchula district. It is surrounded by the Mahakali River in west, international boundary of Tibet in North and is adjacent to Bajhang (eastern part) and Baitadi (southern part) districts in east. ANCA's elevation ranges from 518 to 7,132 m (1,699 to 23,399 ft) at Mt. Api.

The main objective of establishing ANCA was to conserve the unique biodiversity and cultural heritage of the area and socio-economic improvement of the local residing inside ANCA.

The major livelihood of local people depends on agriculture, collection of medicinal and aromatic plants as well as artisan productions.

The region is origin place of high valued NTFPs and Medicinal and Aromatic Plants (MAPs), extracted and traded in local, national and international market every year. To date 75 MAPs/NTFPs have been identified in the area (ANCA). Among them, the major NTFPs traded from the regions are Yarshagumba (*Ophiocordyceps sinensis*), Banlasun (*Allium wallichii*), Satuwa (*Paris* polyphylla), Chiraito (*Swertia ciliata*), Majhito (*Rubia cordifolia*), Allo (*Girardinia diversifolia*), Jatamansi (*Nardostachys grandiflora*), Ritha *(Mukurossa spendis)*, Dhupi *(Juniperus spps*.), Rock honeybee and several others.

Majority of the population residing inside ANCA depends on NTFPs collections and trade according to the market demand which is mediated by the local trades who perceives from the foreign traders outside district or Kathmandu based traders. According to questionnaire with local collectors and local traders, the prices gain from the NTFPs sales is uncertain and fluctuate according to the demand by the end users of the products. Although more than 75 NTFPs/MAPs have been identified inside ANCA, only less than half of the identified MAPs are in trade due to selected market demands.

ANCA has much potential for socio-economic supports for the local residing inside ANCA from NTFPs and MAPs sustainable collection and trade. As one of the major activities of the ANCA is revenue collection from different source, the majority of the revenue collection (more than 90%) is

due from NTFPs / MAPs trades royalty and collection permit. To date more than 30 MAPs species harvest plan has been prepared and approved for collection and trade, still there are some new emerging opportunities and demands for specific MAPs too which have not been properly addressed and documented and surely lacks harvest plans. In this context, Kailash Sacred Landscapes Conservation and Development Initiatives, a program initiated since 2013 seeks socio-economic development of the people residing in KSL while at same time conserving the biodiversity across the sacred landscape, KSL. It has been supporting ANCA / Darchula districts along with other parts of the KSL regions in Nepal (Baitadi and Bajhang districts), India and China (the KSL area) since its initiation of the first phase (2013-2017) with programs which directly and indirectly support local residents and conservation of the KSL area simultaneously. In this regard, KSLCDI 2017 program has certain discrete programs for supporting ANCA for its objectives achievement with various listed programs with a program directed to support for ANCA management plan implementation. Among the approved programs of KSLCDI 2017, one of the supporting programs was preparation of harvest plan for two MAPs.

With consultation with local traders and collectors, ANCA management council, review of the MAPs/NTFPs harvest plan approved till date and ANCA management plan 2015-19, two species were prioritized for inventory to prepare sustainable harvest plan that are not included in the ANCA MAPs Harvest plan of 2016 but do have market potentials which in turns can benefits both local collectors and local traders. Bishjara (*Aconitum spicatum*) and Taxus leaves (*Taxus contarta*) were selected for the study, inventory and harvest plan draft preparation for approval which indeed is very necessary for it is not listed in the approved (MAPs harvest plans to date).

ANCA is thankful to the KSLCDI programs launched by ICIMOD and RECAST for including this program in their approved program of 2017 and also seeks more support in this regard of NTFPs promotion, sustainable collection and trade which directly benefit and uplift the socio economy of the ANCA residents and also for revenue generation for the nation and directly benefit to local communities in turns with the provision of 30-50% of the revenues generated by ANCA to be provided for social development as an incentive for participatory conservation needs.

Chapter 2. Objectives

The main objective of this study is the assessment of annual harvestable amount of *Taxus contorta* and *Aconitum spicatum* from ANCA area.

The specific objectives of the study are :

- To assess potential areas of *Taxus contorta* and *Aconitum spicatum* in ANCA.
- To prepare spatial distribution maps of *Taxus contorta* and *Aconitum spicatum.*
- To recommend proper harvesting techniques for sustainable resource management of *Taxus contorta* and *Aconitum spicatum.*

Chapter 3: Scenario Analysis (*Taxus contorta* and *Aconitum spicatum*)

Nepal's rich biodiversity has tremendous potential for economic development of the country. To materialize the national policy of development through the optimum and sustainable utilization of natural resources, the Government of Nepal has prioritized 33 plant species for further research and agro-technology development.

Taxus contarta

Being one of the species included in the threatened plant list and having high medicinal value in traditional as well as modern health care systems, Yew (*Taxus spp.*), has extensive distribution in Nepal, offers unlimited prospects of economic development and social prosperity. This plant is globally renowned for natural source of **Taxol** which is a chemotherapy drug to treat cancer having generic name as **Paclitaxel**, which is extracted mainly from the leaves of the yew trees. Taxol is widely used in the treatment of breast, ovarian, lung, bladder, prostate and melanoma, esophageal as well as other types of solid tumor cancers.

Yews are slow growing evergreen dioecious trees, with trunk sizes reaching more than 5m and a height of up to 30m in Nepal. Several different local names exist for the species in Nepal. viz., Luit, Lhuit, Jembersingh, Saangasingh, Tongasingh, Dhenge, Lauthsalla, Kaande lotti, Talispatra, jhyambarsingh.

Traditionally yew is highly valued for making household tools, religious artifacts and construction of suspension bridge and buildings. In the last two decades, the pressure on the natural population of Yew along the Himalaya has increased severely due to commercial exploitation. This plant is not only in the pressure of indiscriminate felling for taxol but is also suffering from intensified human activities like habitat destruction and global climate change impacts.

Although Forest Act, 2049 of Nepal have recognized this species as a threatened plant and given higher priority for its protection, few gaps about number of species in Nepal, their distribution range and nomenclature have not been identified properly which has caused discrepancies in the existing conservation efforts and its trade. Based on extensive field visits and review of literature and herbarium records, an actual distribution range of Taxus species in Nepal has been thoroughly assessed.

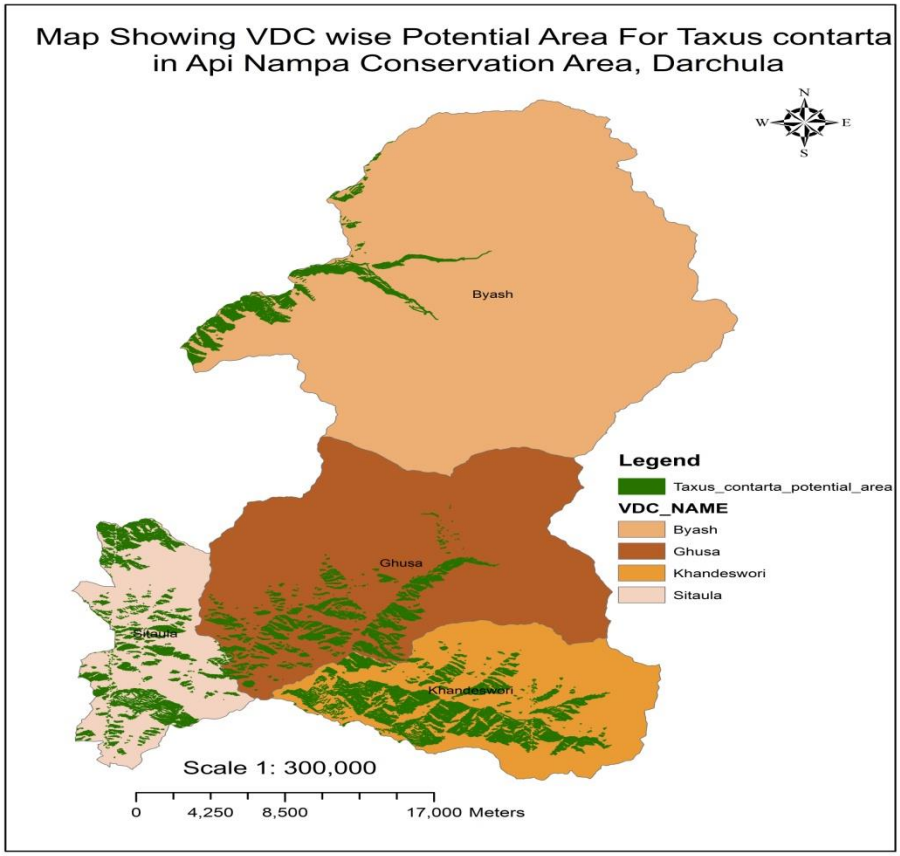


Figure 1: Spatial distribution map of Taxus contarta

Morphologically, ecologically and genetically distinct three species were found distributed into three different eco-climatic zones of Nepal. ***Taxus contorta,*** a West Himalayan temperate species is spreading from Darchula District of West Nepal to the northern belt of Gorkha District in Central Nepal. ***Taxus mairei*** is found scattered in relatively low lying areas of Kavrepalanchok, Makwanpur and Sindhuli Districts of Central Nepal, while ***Taxus wallichiana***, being an east Himalayan species covers the temperate regions of east to central Nepal extending from Taplejung to the south east part of Baglung District to the west (Bhatt G.D., Poudel R.C., Pandey T.R. and Basnet R. (2017).

Taxus contarta is particularly found in four Village Development Committees (VDCs) of Darchula district viz., Khandeswori, Ghusa, Byas and Sitaula (Uprety, Y., Poudel, RC., Chaudhary, RP., Oli, BN., Bhatta, LD., and Baral, SP. 2016).

Aconitum spicatum (Bruhl) Stapf.

Thirty species of Aconitum has been identified in Nepal. *Aconitum spicatum* has been the most collected and traded species among the other identified Aconitum species. Local names varies with regions and languages used in that particular region as Bish, Bishjara, Nilo bish, aunle bish, chendu(Sherpa), Glantu(gurung), Bish(tamang). The species has been found to be 1-2 meter in height and is a perennial shrub. The leaves are long enough having 3-5 sections. The stems possess light greenish white colored flowers congregation. The roots when dried, appears like horn in shape n blackish in color (Upreti et.al. 2016).

Geographically, the species is found from east to west Nepal at an elevation range of 1800 m to 4200 m in moist and humid forest, scrubland and in open rangelands. The species is spread over Himalayan regions and also in south of China (Autonomous region of Tibet). In darchula, the species is found in khandeswari VDC, Ghusa VDC and Byas VDC (Upreti et.al. 2016).

The species root is highly toxic but used in different medicinal treatment after proper processing. The chemical 'aconite' is used in processing for ayurvedic treatment and also used with higher importance in modern treatment too. It has been seen very useful for treating fever, dysentery, muscular pain relief, cough, swells and as painkiller, intestinal and heart related problems. It is also used as insecticides, rat poisoning and also beem used to be applied at the tip of spears for hunting in the Himalayas long date back (Upreti et.al. 2016).

Traditional and modern use

The species flowers in July to September and seed ripens during the period from August to October. The proper collection time for Bishjara roots is from September to October after seed had fallen when leaves color changes to yellowish. For sustainable harvesting, root collection should be done only when the mother plant is mature enough for seeds ripening and spreads over the ground. Collectors should apply the rotational collection methods and collect only the mature roots from 60-70% mature plants selected.

In Nepal, ***Aconitum spicatum*** is collected only from natural conditions and commercial farming has not been started yet. It has been found to flourish in areas with high nitrogen availability and damp soil. It avoids water logging areas. It can be cultivated from seeds and from old mature root also (Upreti et.al. 2016).

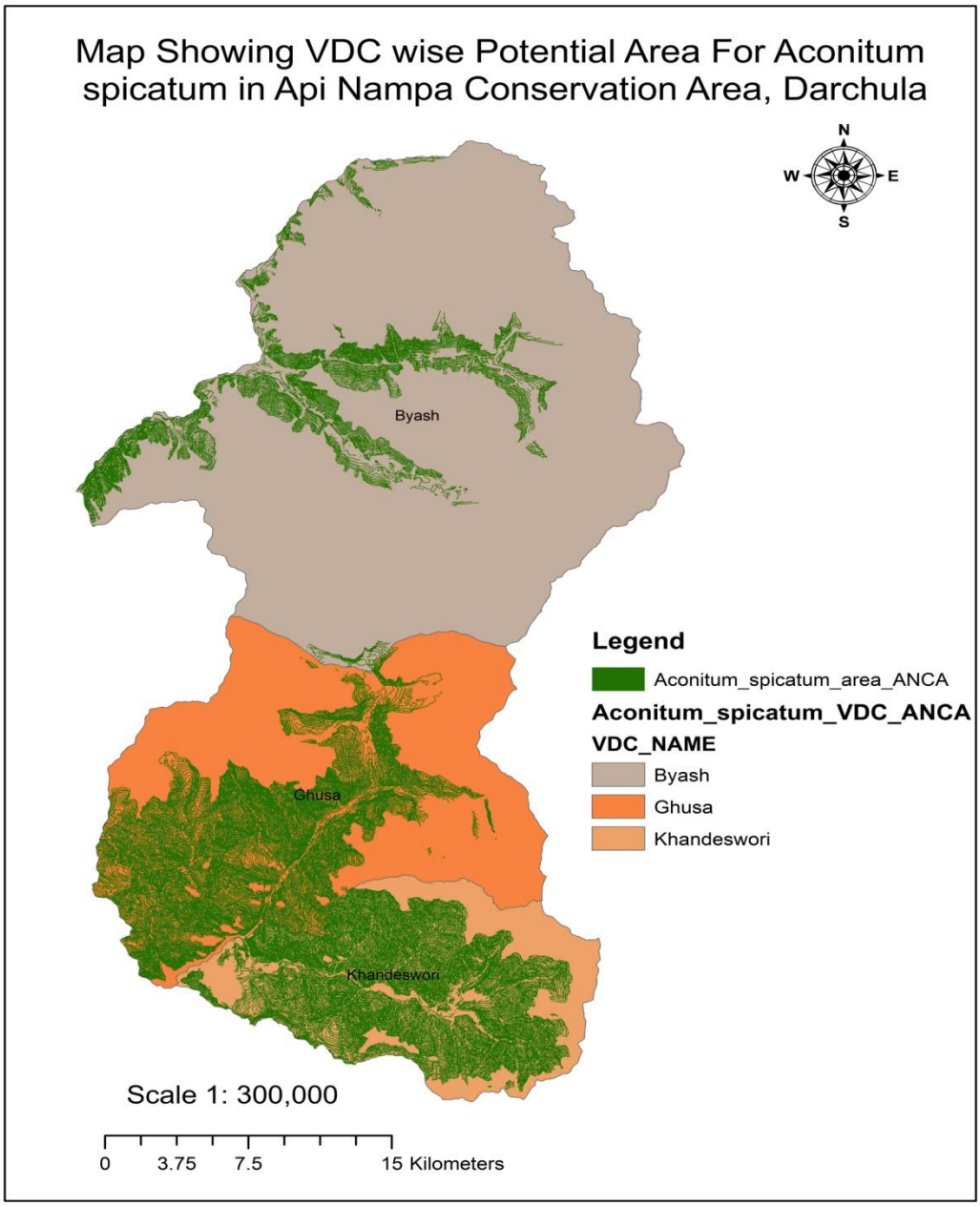


Figure 2: Spatial distribution of Aconitum spicatum

Care has to be taken during root collection so as to minimize soil excavation and only the mature rhizoids should be chosen and immature roots be left as it is and buried with soil properly.

Collected roots have to be cleaned properly for soil removal and had to be dried in mild sunlight or shades and graded for trade in which almost of all the roots are exported to India. Due to improper and lack of sustainable harvesting systems from natural forest, the species has been listed in threatened list by IUCN (Upreti et.al. 2016). The current study of *Aconitum spicatum* has identified three potential VDCs inside ANCA namely Khandeshwari, Byas and Ghusa.

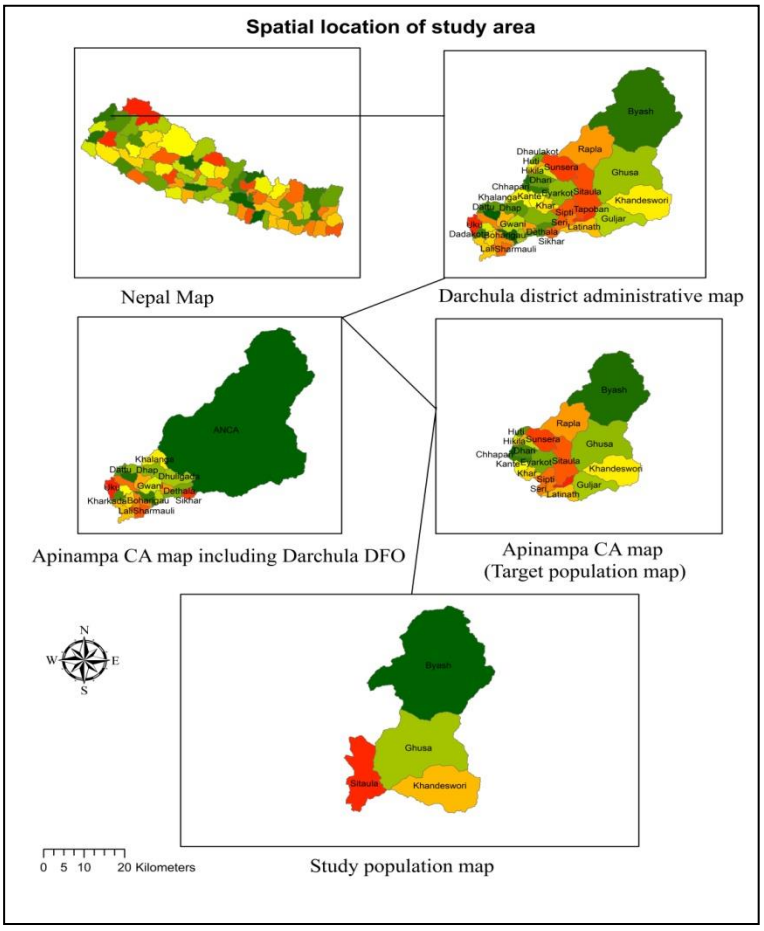
Table 1*: Scientific classification of Taxus contorta and Aconitum spicatum*

Scientific classification (Taxus contarta)		**Scientific classification (Aconitum spicatum)**	
Kingdom:	Plantae	Kingdom:	Plantae
Division:	Tracheophyta	Division:	Tracheophyta
Class:	Pinopsida	Class:	Magnoliopsida
Order:	Pinales	Order:	Ranunculales
Family:	Taxaceae	Family:	Ranunculaceae
Genus:	*Taxus*	Genus:	*Aconitum*
Species:	***Taxus contorta* Griff.**	Species:	***Aconitum spicatum* (Brühl) Stapf**

Chapter 4: Methodological Approach

Study area description

The study was conducted in Api Nampa Canservation Area (ANCA) which lies in Darchula district in far-west Nepal. ANCA is the most recent CA that covers the northern part of Darchula district, bordering with two big land massive countries viz., China in North and India in West. This is also an important part of trans-boundary Kailash Scared Landscape (KSL). ANCA was established in 2010 with an area of 1903 sq.km., was named after Api (7,132 m) and Nampa (6,757 m) peaks situated in the region. Spatially ANCA extends from 80°22' to 81°09'longitude and from 29°30 to 30°15' latitude. Northern border extends up to autonomous region of Tibet while its Southern border extends up to Lasku and Naugad khola. The eastern border extends up to Bajhang district and its western border extends up to one of the major river system; Mahakali river which separates it from India.



ANCA is spread over wide range of altitudinal variation from 539m to 7,132m elevation, gifted with mountains higher than 6000m, such as Api (7,132 m), Nampa (6,757 m) and Byas (6,670 m). Soils in the middle mountains are moderately acidic, medium to light-textured coarse grained sand and gravel (ANCA 2008). The region possesses fragile geology as a result of crash between Indian subcontinent plate and Tibetan plate. Schist, Gneiss, Limestone and Sediments are prevalent in the area making it highly sensitive and prone to landslide, erosion and flooding during rainy season.

Figure 3: Spatial location of ANCA and Study sites

Climate

The climate of the greater Kailash landscape is primarily governed by the monsoon in the southern part (Greater and Lesser Himalayan Zones), by the rain shadow zone (cold desert conditions) over the crest of the Himalayas (Trans-Himalayan zone), and continental and Central Asian climatic conditions drive climate in Tibetan Plateau (Zomer and Oli, 2011). Due to variations in altitude and topography, the climate of the region varies widely from subtropical to temperate, alpine, and cold high altitude desert types.

In the Southern Himalayas, The average temperature is around 18°C with minimum temperatures of 7°C, and average rainfall in excess of 2,100 mm. Temperature and rainfall patterns of the southern Himalayan ranges are tropical to subtropical up to 2,000 masl; and temperate up to above 3,000 masl (Ibid). In these locations an increase in minimum temperatures has been recorded since the 1970s (Zomer and Oli, 2011).

ANCA has diverse climatic conditions due to variation in altitude and topography. South-eastern valleys of ANCA have sub-tropical climate while temperate and alpine climatic conditions are dominant in the middle mountains and high Himalayas. Subtropical climate is found in southern part of former VDCs (Latinath, Tapoban, Sipti, Khar and Kante) whereas temperate to alpine climate occur in the former VDCs (Byas, Rapla, Ghusa and Khandeswori) which are situated at higher altitude (ANCA Mgt. plan, 2010-2014).

Average annual maximum and minimum temperature of the region is recorded 13.69 °C and 7.78 °C respectively with the lowest monthly average minimum temperature recorded in December, January and February and highest monthly average maximum temperature recorded in May, June and July.

The average annual precipitation was recorded to be 209.4 mm with highest rainfall in the months of July and August and the least from November to April.

Land use classification of ANCA

Out of total area of ANCA, forest area covers highest area (30.08%) followed by barren land (28.78%), grassland (23.98%). Lowest area is covered by ponds/lake (0.02%) and water bodies (0.22%). The river cuttings/cliffs covers 0.48%, whereas sandy areas, glacier, cultivated land, shrub land occupies 2.13%, 3.28%, 4.91% and 6.12% respectively. The land use map and details of area covered by different land use is presented in the **Error! Reference source not found.** and **Error! Reference source not found.Error! Reference source not found..**

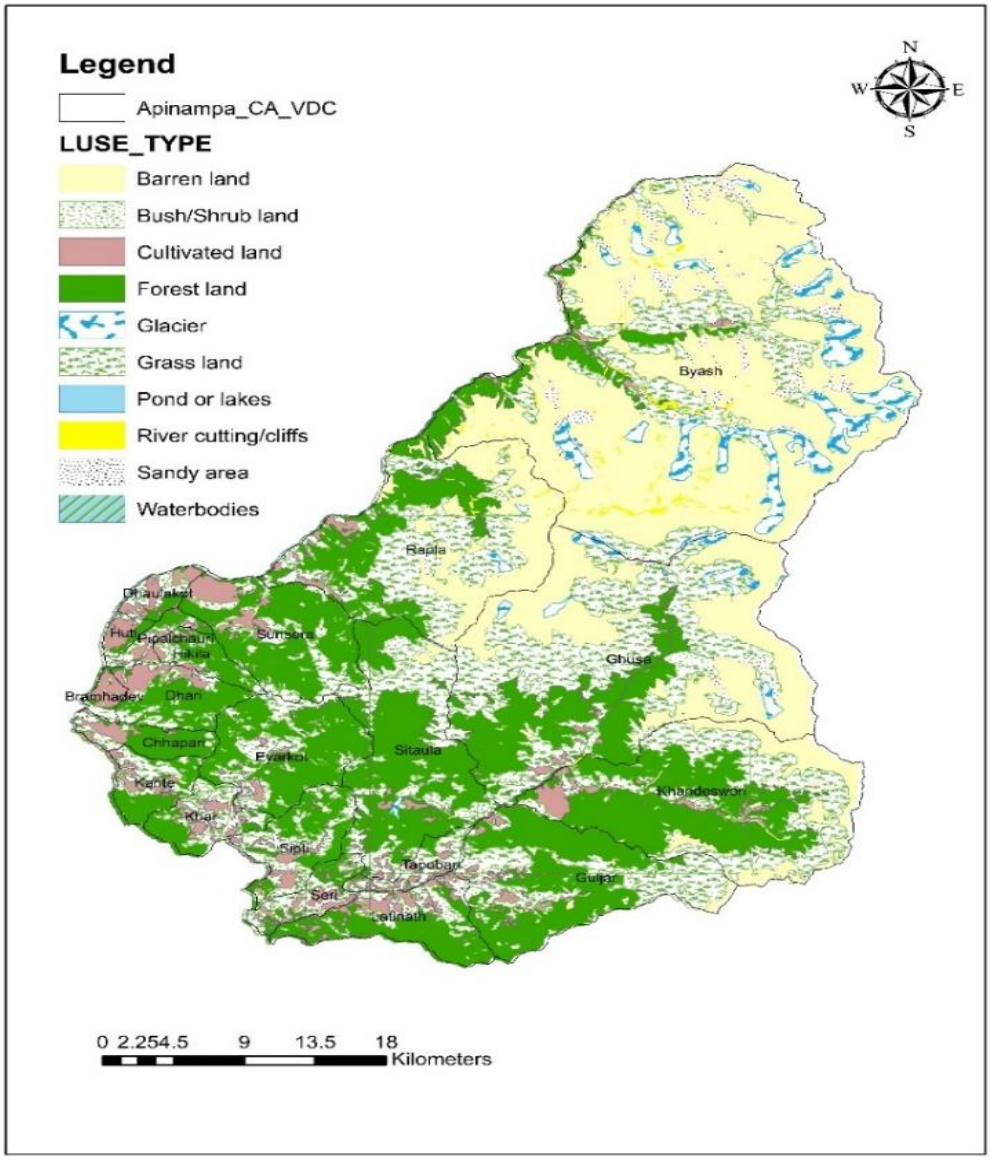


Figure iv: Land use map of ANCA (Source: DNPWC 2017)

Table 2: Land use of ANCA showing area (km^2) of different land use

Lanuse_Type	Area_Sq_km	Area_ha	% of ANCA
Barren_land	547	54735	28.78
Grassland	456	45597	23.98
Bush_shrubland	116	11639	6.12
Cultivated land	93	9343	4.91
Forest land	573	57200	30.08
Glacier	62	6243	3.28
Ponds_lakes	0	31	0.02
River cuttings/cliffs	9	915	0.48
Sandy area	40	4043	2.13
Water bodies	4	412	0.22
Total	**1903**	**190159**	**100**

Approach and Methodology

The VDCs identified as potential habitat were taken as study strata for respective NTFP species. Thus, study area stratified into four strata based on VDC boundary namely; Khandeshwari, Byas, Sitaula and Ghusa, were randomly selected for *Taxus contorta* (Lothsalla) (Uprety, y, et.al). In case of *Aconitum spicatum* (Bishjara) study area stratified into three strata based on VDCs boundary namely; Khandeshwari, Byas and Ghusa were randomly selected (Uprety, y, et.al).. Effective areas for both species in each VDCs were delineated using ArcGIS 10.3 and circular fixed area sample plots of 25m^2 and 500 m^2 were randomly laid out in each strata for *Aconitum spicatum* (Bishjara) and *Taxus contorta* (Lothsalla) respectively. The distances between two adjacent plots were adjusted to at least 100 meter and the sampling intensity was taken 0.5% and 0.1% for Lothsalla and Bishjara respectively. Altogether 20 and 40 random plots were distributed in three and four strata for Bishjara and Lothsalla respectively. The detail of plot design is presented in **Error! Reference source not found.** and Table 4.

The study was based on participatory approach where village level consultations were undertaken adopting participatory tools including community mapping or participatory resource mapping, Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA). Different forms of formal and informal group discussion and key informant survey were undertaken to better understand the past and existing condition of the natural resources in the study area. The toolkit "NTFPs Inventory Guidelines 2069" developed by Forest Department and 'participatory inventory of non-timber forest products" developed by ANSAB were extensively followed during the study. The inventory and harvesting plan were prepared through the information provided by the Conservation Area Management Council (CAMC) members, ANCA officials, forest technicians, local leaders and relevant actors and stakeholders. The detailed approach of this study is outlined below.

Delineation of Potential Area of NTFPs

In order to delineate potential area of both NTFPs, digital layer of contour map, aspect map and land use map were analyzed through ArcGis 10.3 software. First altitudinal range of 2400m-3400m for *Taxus contorta* (NTFPs inventory guideline, 2069) was taken as stated above in scenario analysis chapter and then altitudinal range was extracted from contour map through "select by attribute" tool of the software. This extracted layer was then intersected through "geoprocessing tool" with land use map containing layers of forest land layer and aspect map as Northern aspect was found to be preferred by Lothsalla. Then the extracted layer was converted to raster data and again the raster data

was converted to polygon feature and finally the potential area of Lothsalla was found out considering its altitudinal range, aspect preference and existence of the species on forest land layer of land use map. Similarly, potential area of bishjara was delineated taking altitudinal range of 3300m-4300m (NTFPs inventory guideline, 2069) with aspect preference of north and existence of species on bush/shrub land layer of land use map (Uprety,Y, et.al.,2016). The potential area was then validated by overlaying the coordinates of sample plots containing individual species whether they fall in the area or not.

Number of sample plots was determined based on area of the polygons, budget and time availability for field work. Circular sample plots of $25m^2$ and $500m^2$ were randomly laid out within the polygons (Figure ii) and centroid's coordinates of each sample plot were calculated through ArcGIS 10.2 for navigation by global positioning system (GPS). The distances between two adjacent plots were adjusted to at least 100 meter and the sampling intensity was taken 0.5% and 0.1% for Lothsalla and Bishjara respectively.

Organization of VDC level Workshops and Conduction of social survey

A half /half day workshop was organized at Byash, Ghusa, Khandeshori and Sitaula VDCs of Darchula district to get information on the availability of NTFPs in the study area, secondary information were collected from ANCA officials, local community people, NTFPs collectors, CFUG executive members, local traders, local leaders, teachers and NTFPs processors. Social survey was conducted to assess current collection practices, recent trends of NTFPs market, NTFPs availability in the forest, accessibility, market price, conservation status and number of people involved in harvesting as per the questionnaire. The participants were also asked to delineate the area of the forest showing abundance of each NTFPs / MAPs for field work purpose by participatory resource mapping.

Sampling of measurement plots

Number of sample plots in each VDC

Sampling design defines how the observation units are selected and numbers of sample plots are calculated. The sampling method and the design used in an inventory depend on the distribution of the species, the budget and the objectives of the inventory.

Sampling design, plot design and data collection for this study was based on Participatory Inventory of Forest Resource (ANSAB, 2010) and NTFPs Resource Inventory Guideline, 2069 (DoF, 2069).

Table 3: Effective area of strata and number of plots in the study strata for Taxus contorta

Strata	**Effective area(Ha)**	**No. of plots**	**Plot area (m^2)**	**Remarks**
Khandeswori	2948.80	15	500	Circular plot
Byas	1334.76	7	500	Circular plot
Sitaula	1884.27	9	500	Circular plot
Ghusa	1802.06	9	500	Circular plot
Total	**7969.89**	**40**		

Table 4: Effective area and number of plots in the strata for Aconitum spicatum(Bishjara)

Strata	**Effective area (Ha)**	**No. of plots**	**Plot area (m^2)**	**Remarks**
Khandeswori	10094.8	10	25	Circular plot
Byas	5056.46	6	25	Circular plot
Ghusa	4333.66	4	25	Circular plot
Total	**19484.92**	**20**		

Orientation to inventory team and field crew members inventory

One day orientation training on "Resource mapping, interpretation of topographic maps and NTFP inventory technique" was conducted to the forest technicians and the local resource person including Game scouts of ANCA. The main objective of the orientation was to ensure that they would perform the inventory task consistently and uniformly.

Size and shape of sample plots

The nested co-centric-circular plot was applied for the inventory because of its easiness to establish plots in sloping terrains and also reduce the edge effect problem that normally occurs in rectangular plots. As illustrated in figure v, sub plots with 1.2 m radius were established for Bishjara and sub-plots with 5.64 m radius were used for Lothsalla. Slope correction in each permanent plot was done whenever required.

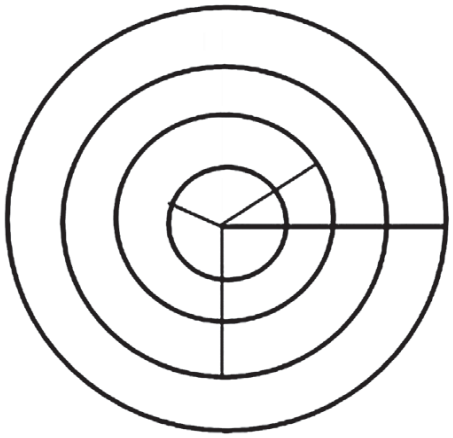


Figure v: Nested Co-Centric Circular Plots

Equipment and materials

Field inventory equipment include GPS, D-tape, linear tape, tailoring tape, compass, survey master, etc. Field equipment were prepared, checked and calibrated before hand and the field inventory team ensured that instrument was functioning. A complete checklist of instruments was prepared so that no materials get left behind and this checklist was also useful during the fieldwork and team movement from one location to another.

Field work

The NTFPs inventory was conducted based on NTFP resource inventory guideline, 2012 produced by Department of Forest (DoF). However, some adjustments were made in the prescribed method used in the guideline considering coverage and topography of the study area because guideline was developed focusing methods that can be applied in Community Forests areas while the present study focused on ANCA as a study area. The sample plots of size 25 m^2 and 500m^2 were used while carrying out fieldwork.

All together 20 sample plots in three strata were laid in the field for inventory purpose for Bishjara and 40 sample plots were allocated for Lothsalla in four strata. After navigating to the center of sample plots using GPS, respective 4.0 m^2 and 100 m^2 sized plots were laid out in the field.

In each sample plot, detailed plot variables information, such as plot number, altitude, slope, aspect, local name of NTFP species, number of individual species, and fresh weight of individuals, were recorded in inventory sheet. If slope of plot was recorded more than 10%, slope correction was

applied. For field inventory, the field crew consisted of forest technician, game scout and local social mobilizer.

Radius correction for fixed area circular plot:

$SR = \frac{R}{\sqrt{Cos\theta}}$

Where,

SR=Radius in slope terrain, R=Radius in horizontal plain and Θ=Angle or slope in degree

Social survey

Different forms of formal and informal group discussion and key informant survey were undertaken to better understand the past and existing condition of the target natural resources in the study area

Post field work

Data compilation

The enumeration sheets were collected, reviewed and coded as per required. These data were compiled into Microsoft Excel for further analysis. The following parameters were analyzed which are essential for preparation of harvesting plan.

Frequency

Frequency is the number of sampling units in which the particular species occur, thus it expresses the dispersion of the species in a community. It refers to the degree of dispersion in terms of percentage occurrence. The following formulae were used to calculate the target species frequency.

$$Frequency = \frac{Number\ of\ sample\ plots\ in\ which\ species\ occurred}{Total\ number\ of\ sample\ plots\ taken} * 100$$

Density

Density expresses the numerical strength of the presence of species in a community. It is the number of individuals per unit area and is expressed as number per hectare. The following formulae were used to calculate species density.

$$Density = \frac{Total\ number\ of\ any\ species}{Total\ number\ of\ sample\ plot * area\ of\ sample\ plot} * 10000$$

Chapter 5: Yield Calculation

Yield calculation is quantification of the amount of a particular product that can be obtained from certain area. An estimation of the yield of a particular product requires the enumeration of certain characteristics of the individuals making up the parent population. The study used destructive method for Bishjara while Lothsalla inventory is non-destructive as only sample leaves (Needles) from different parts (topmost tip, middle branches and lowest branches leaves of trees are extracted for the fresh weight calculation of samples from each sample plots. Hence, yield per hectare and total yield were calculated using following formula:

$$Yield\ (gm\ per\ ha) = Density * Average\ weight\ of\ an\ individual$$

$$Yield\ (kg\ per\ ha) = \frac{Total\ yield\ (gm\ per\ ha)}{1000}$$

$$Total\ yield\ from\ area\ (ha) = Total\ yield\ \ per\ ha(kg) * total\ area\ (in\ ha)$$

Conversion Factor

The conversion factor is ratio of dry weight to green weight. The conversion factor is used to estimate per hectare dry weight and total yield of the area. The green weight of each individual collected in the field are calculated, recorded in the field while dry weight of Bishjara roots and Lothsalla was taken from *Sigdel et al. 2017*. The dry weight factor estimated by *Sigdel et al, 2017* ranges from 0.2 to 0.5.

$$Conversion\ factor = \frac{Dry\ Weight}{Green\ weight}$$

Correction factor

Since the fresh roots of Bishjara were taken in field without cleaning, therefore it also included the weight of soil attached to it. If we don't reduce the weight of the soil from fresh weight of roots, yields will be overestimated. Therefore, it is necessary to apply correction factor to fresh weight. Since there is no standard correction factor for soil weight, it was assumed 10% of total fresh weight. Hence, correction factor of 0.9 was used to adjust fresh weight of Bishjara from inventory. In case of Lothsalla, there is no need for correction factor as mentioned for Bishjara as its leaves (Needles) is the only useable parts as known to this date and due to its (leaves/needles) situation is aerial, soil contamination doesn't occur and hence doesn't need for soil factor corrections.

Chapter 6: Results

This chapter presents the results derived from the resource inventory, social survey and the document analysis. The results were analyzed and discussed in relation to the study objectives.

Frequency, Density and Abundance

Error! Reference source not found.5 and 6 presents estimated frequency, density and abundance of Bishjara and Lothsalla in studied VDCs (Strata) and overall ANCA. The frequency of Bishjara ranged from 20% (Khandeswori) to 50% (Byas) and overall frequency is estimated to be 31.67%. Density per hectare ranged from 80 per hectare (Khandeswari) to 200 per hectare (Ghusa/Byas) while overall density of Bishjara in ANCA is estimated 93.33 individuals per hectare. The abundance in overall ANCA is estimated to be 444.44 per hectare with lowest found in Ghusa and Khandeswori (400 per ha) and highest in Byas (533 per ha).

Table 5: ***Bishjara (Aconitum spicatum) frequency, density and abundance in three strata***

Strata	Frequency (%)	Density (individual/ha)	Abundance (per ha)	Remarks
Ghusa	25	200	400	
Byas	50	200	533.33	
Khandeswori	20	80	400	
Overall ANCA	**31.67**	**93.33**	**444.44**	

The frequency of Lothsalla ranged from 33.3% (Sitaula) to 57% (Byas) and overall frequency is estimated to be 46.47%. Density per hectare ranged from 6.67 individuals (Sitaula) to 11.43 individuals (Byas) while overall density of Lothsalla in ANCA is estimated 9.96 individuals per hectare. The abundance in overall ANCA is estimated to be 24.33 per hectare with lowest found in Byas (20 individuals per ha) and highest in Khandeswori (26.67 individuals per ha).

Table 6: Lothsalla (*Taxus contarta*) frequency, density and abundance in all four strata

Strata	Frequency (%)	Density (individual per ha)	Abundance (per ha)	Remarks
Ghusa	55.55	11.11	24	
Byas	57	11.43	20	
Khandeswori	40	10.67	26.67	
Sitaula	33.3	6.67	26.66	
Overall ANCA	**46.47**	**9.96**	**24.33**	

Chapter 7: Total Yield and Allowable Harvest

Growing stock or the total yield of the studied and inventoried two major NTFPs / MAPs; Lothsalla (*Taxus contarta*) and Bishjara (*Aconitum spicatum*) resulted the yields in form of number of plants avail in the study area and is in hectare basis. But the result in terms of number is incomplete for harvesting allowable limit determination primarily because of only specific parts/portions of these NTFPs and MAPs are of only use and hence it needs the calculated numbers be transformed in terms of the usable parts measurement units such as kilograms/grams. Therefore these mentioned MAPs/NTFPs should be yielded in terms of kilograms as per requirement such as the roots of Bishjara is only of use from the whole plant parts and the Lothsalla leaves are the only usable parts which is also traded in terms of kilograms. Hence, references must to be taken into consideration to convert the entire plant volume to usable roots and leaves quantification of the yield in terms of kilograms.

During the field survey, green/fresh weight of roots and leaves of Bishjara and Lothsalla respectively were weighed. In terms of Lothsalla, fresh leaves were weighed and noted from entire sample plots chosen while for roots of Bishjara, it was properly cleaned for removal of any soil attached to the roots due to contact with soil as it lies beneath the soil surface. Also correction factor for soil was taken into consideration for the calculation of the weight of the roots. The soil correction factor was taken as 0.9 which when multiplied by the weight give the more reliable weight of the roots weighed during the field survey and inventory. In case of Lothsalla, no soil factor correction was needed. During the field inventory of the two mentioned NTFPs and MAPs, the collected sampled of roots of Bishjara (*Aconitum spicatum*) and leaves from various parts viz., leaves from lowest branch, middle branch and top most branch/tip of Lothsalla (*Taxus contarta*) were weighed from all of the use plots where they occur and the weight of both NTFPs were averaged separately from all of the sample units allocated in the field accordingly, recorded in MS excel for database and analyzed

The standard conversion factor for fresh weight to dry weight of the Bishjara and Lothsalla was taken to be 0.2 and 0.5 respectively (taken from *Sigdel et al. 2017*) from which when multiplied with the weight of green roots and fresh leaves of Bishjara and Lothsalla recorded during the field survey gave comparatively reliable yield in terms of kilograms. The average fresh weight of the roots of "*Aconitum spicatum"* per plants was found around **90 gm** per plants after applying soil correction factors and averaging all the plants from the selected plots while the average weight of the leaves

from selected branches of Lothsalla as mentioned above and taken from all the sample plots selected was quantitatively **2.3 kg** on an average from all the sampled trees.

Table 7*: Result of potential area, total yield (KG) with fresh and dry weight of Aconitum spicatum*

Name of VDC	***Potential Area of Aconitum spicatum (Ha)***	***Total yield (Kg / fresh weight) per Hectare***	***Total Yield (Kg / Dry weight) per Hectare***	***Total Yield in kilograms***	***Allowable harvestable amount in KG (65%)***
Ghusa	5056.46	18	3.6	18203.25	**11832.11**
Khandeswori	10094.8	7.2	1.4	1412.72	**918.27**
Byash	4333.66	18	3.6	15601.17	**10140.76**
Total/Averages	**19484.92**	**14.4**	**2.86**	**35037.15**	**22891.15**

Table 8*: Result of potential area, total yield (KG) with fresh and dry weight of Taxus contarta*

Name of VDC	***Potential Area of Taxus contarta (Ha)***	***Total yield (Kg/fresh weight) per Hectare***	***Total Yield (kg /dry weight) per Hectare***	***Total Yield in kilograms***	***Allowable harvestable amount in KG (20%)***
Ghusa	1802.66	25.55	12.77	23020	**4604**
Khandeswori	2948.8	24.5	12.25	36122.8	**7224.56**
Byash	1334.76	26.29	13.14	17538.7	**3507.74**
Sitaula	1884.27	15.34	7.67	14452.35	**18226.77**
Total/Averages	**7969.89**	**20.1**	**11.46**	**91133.85**	**33563**

Annual Allowable Harvest (KG) plan for Bishjara and Lothsalla

It is estimated that average number of Bishjara and Lothsalla collectors have much reduced from few years back in lack of harvest plan for the target species inside the Conservation Area. A species is considered as overharvested when the harvest rate of any given natural populations of that species exceeds its natural replacement rate (Peres, 2010). Therefore, to ensure the sustainable harvest of the Bishjara (*Aconitum spicatum*) roots, it is recommended that allowable harvest should be restricted to 60%-65% of the total yield (ANSAB, 2010) and in case of leaves of Lothsalla (*Taxus contarta*), 20% harvestable amount is taken for sustainable harvest plan preparation. The harvestable amounts (KG) for both of the species *Aconitum spicatum* (Bishjara) and *Taxus contarta* (Lothsalla) are presented in annex-1.

Issues and challenges of MAPs/NTFPs harvesting

During socio economic data collection, NTFPs and MAPs harvesting is hardship work and is problematic and had lots of issues prevalent and also the challenges due to harsh physiographic and climatic condition. The problems during harvesting period includes illegal collection, over harvesting, poor trail condition and networks for collectors to reach collection sites. Lack of health posts / services, unmanaged wastes in camping sites and security are other issues needed to be addressed.

The issues/problems during collection of MAPs / NTFPs faced by harvesters are listed below:

- Illegal collection of the target species
- Over harvesting and premature harvesting
- Improper market price at local level
- Fire on grassland in dry season
- Poor trail conditions
- Unmanaged Camping
- Lack of waste management in camping site
- Untimely snowfall
- Lack of health post/services

The challenges related to collection and trade of NTFPs and MAPs are:

- Market management
- Grassland management
- Waste management in camping sites
- Revenue generation from each of the onsite collectors
- Monitoring of MAPs/NTFPs collection/harvesting due to insufficient human resource and harsh terrain.

Chapter 8: Recommendation

Based on the inventory results, field observation and socio-economic data analysis, below are some points to be followed as recommendations:

- There is a need of baseline information for periodic monitoring and evaluation of socio economic improvement of the local collectors and local traders.
- Conservation education and campaigns among public need to be carried out to ensure that interested MAPs and NTFPs are harvested after sufficient seed dispersal; environmental impacts of unscientific collections, awareness programs on importance of the MAPs and NTFPs with sustainable harvesting, management and utilization of MAPs and NTFPs at local level need to be conducted in the area.
- Detailed scientific research should be conducted to monitor ecological factors and regeneration pattern in ANCA area and all of above baseline database management for all key traded species should be maintained for drafting action plans for each of the species having baseline data.
- Strong monitoring of MAPs harvesting is strongly required at local level to ensure sustainable harvesting.
- Government should play proactive initiative role for market promotion (e.g. via cooperative, buyback, etc.)
- Storage and packaging facility of collected/harvested MAPs and NTFPs should be developed and promoted to facilitate marketing of quality products.
- Nominal entry fee / permissive fee should be charged to local collectors and traders which not only generates revenue and contribute for socio economic development of the local community but also keep an account of collections, collectors and other relevant information annually and hence help monitor the collection activities and recommends also for any management intervention needs timely.
- Plantations should be established at lower forests to supplement growing stock depleted by the extraction of fuel wood during collection season.
- Over grazing should be checked for conservation of indicative/ associating flora.
- Community ownership and mobilization should be promoted for effective management of collection sites.

Annex 1: Annual Allowable Harvest of Bishjara(Aconitum spicatum) and Lothsalla(Taxus *contarta*)

Name of the VDC	**Potential area (ha)**		**Total Yield (Dry/Kg)**		**Allowable harvest (Dry/Kg)**	
	Bishjara	**Lothsalla**	**Bishjara**	**Lothsalla**	**Bishjara**	**Lothsalla**
Ghusa	**5056.46**	**1802.66**	**18203.25**	**23020**	***11832.11***	***11510***
Khandeswori	**10094.8**	**2948.8**	**1412.72**	**36122.8**	***918.27***	***18061.4***
Byas	**4333.66**	**1334.76**	**15601.17**	**17538.7**	***10140.76***	***8769.35***
Sitaula	**0**	**1884.27**	**0**	**14452.35**	***0***	***7226.17***
Total	***19484.92***	***7970.49***	***35217.14***	***1964791***	**22891.15**	**45566.9**

Chapter 9: References

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Photo plates

Aconitum spicatum in its natural habitat

Fresh roots of Aconitum spicatum

Weighing leaves of Taxus contarta

Data collection during field survey