A STUDY ON ETHNO-FLORA WITH SPECIAL REFERENCE TO TRADITIONAL HEALTH CARE SYSTEM (THCS) IN WESTERN LADAKH, JAMMU & KASHMIR

THESIS SUBMITTED TO THE
FOREST RESEARCH INSTITUTE UNIVERSITY (DEEMED)
DEHRADUN, UTTARAKHAND

For
THE AWARD OF THE DEGREE OF
DOCTOR OF PHILOSOPHY IN FORESTRY
(FOREST BOTANY)

By
KUNZES ANGMO

WILDLIFE INSTITUTE OF INDIA
DEHRADUN UTTARAKHAND
2013

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

DECLARATION

I hereby declare that the dissertation "**A Study on Ethno-flora with Special Reference to Traditional Health Care System (THCS) in Western Ladakh, Jammu & Kashmir**" is original research conducted by me under the supervision of Dr. B. S. Adhikari, Scientist E, Wildlife Institute of India and under the co-supervision of Dr. G. S. Rawat, Chief Scientist of ICIMOD, Nepal. The dissertation has been submitted to the Forest Research Institute (Deemed) University for the award of the degree of **Doctor of Philosophy in Forestry (Forest Botany)**, and has not formed the basis for the award of any other degree. It embodies my own work and observations, and in that respect the investigation appears to advance knowledge on the subject.

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CERTIFICATE

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Changing aspects of Traditional Healthcare System in Western Ladakh, India

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ABSTRACT

Ethnopharmacological relevance: The Sowa-rigpa system of traditional healing has been practiced from time immemorial in western Ladakh but its existence is in jeopardy today. Documentation of information on various aspects of this system such as treatment methods, materials used for medicine and socio-cultural aspects is needed to ensure the long-term survival of this system.

Materials and methods: Extensive field surveys were conducted from March 2009 to June 2011 in three different Valleys of the Kargil district. Interviews with traditional healers, village heads and local people were conducted using semi-structured questionnaires and participatory observations to assess the current status of traditional medicine system. Plant specimens were collected from the field for identification and herbarium preparation which were later deposited in herbaria for future reference.

Results: 160 plants were recorded to be used by traditional healers of Western Ladakh. Traditional healing system (THS) is taking care of 30% of public healthcare. Only 36 traditional healers are left in this region of which 67% was found along the Wakha-chu Valley, followed by the Lower Indus Valley (17%) and the SuruValley (16%). The transfer of knowledge to the next generation is very low (25%) in Kargil. Low income and continuously deteriorating social status of healers has contributed to the decline of this system.

Conclusions: Lack of interest in young generation in adopting this system may pose a threat to the survival of Sowa-rigpa. Integration of this system with the modern healthcare system and more government support may prove effective to enhance its deteriorating conditions.

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1. Introduction

The dependence on nature for sustenance and survival over time has guided humans to discover remedies for common ailments from natural sources. These discoveries resulted in the accumulation of traditional knowledge and to the development of traditional health-care system which is recognised as a complementary medical practice today. Given the importance of traditional medicine, several national and international organizations (e.g. WHO) all over the world have advocated for its preservation and development. Even today more than 80% of the human population in developing countries are dependent on traditional systems of healthcare (WHO, 2008). In India traditional medicine is the only available source of healthcare for 65% of the population (WHO, 2002). It is not only affordable but is also firmly embedded in their belief systems. Since, allopathic drugs do not provide remedy for several diseases and are not affordable by a large segment of society, indigenous system of medicine can be considered as an alternative.

In western Ladakh, 60% of the population is dependent on traditional medicine (Kala, 2005). The traditional medicine system of western Ladakh is called "*Sowa-rigpa*". The healers of this system are known as *Amchis*. The word *Sowa-rigpa* is a combination of two Tibetan words, i.e., *Sowa* meaning 'to nourish' and *Rigpa* meaning 'science'. Although, the system originated in India, it is popularly practiced throughout Tibet, Bhutan, Mongolia, China and Nepal (Gurmet, 2004). In India, this system is practiced in Sikkim, Arunachal Pradesh, Darjeeling, Lahaul and Spiti and Ladakh (Namgyal and Phuntsog, 1990). *Sowa-rigpa* system of medicine was given official recognition recently (25 August, 2011), through the Indian Medicine Central Council Amendment Bill 2010.

Amchi are given high status and respect as they are the life savers. *Amchi* use a standard book entitled "secret instruction" that has treatise on eight fold essence of the immortality. They follow ancient theoretical texts in Tibetan script on medico pharmacopeia. Earlier, *Amchis* offered free services and in return, members of every household in the village helped them in various ways such as assistance in agricultural works. Gradually, *Amchis* began to sell their knowledge (teachings) and medicines. The Sowa-rigpa system of healthcare mainly uses parts of plants even though animal and minerals are also used. With the increase in availability of modern medicines, use of this traditional healing system is continuously decreasing. Government may have to take necessary steps to ensure for the survival of this system in the future.

The documentation of the use of medicinal plants to cure several diseases has led to the discovery of many important drugs of

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allopathic medicine (Fabricant and Farnsworth, 2001; Anon, 1994; Cox and Balick, 1994). Ethno-flora of Ladakh has been studied by various authors (Abrol and Chopra, 1962; Stewart, 1984; Namgyal and Phuntsog, 1990; Navchoo and Buth, 1992; Singh et al., 1996; Singh and Chaurasia 2000; Kala, 2005, 2002, 2000; Gurmet, 2004; Ballabh and Chaurasia, 2007; Kumar et al., 2011) but very few (Uniyal,1981; Gohil and Qadri, 1992; Ballabh et al., 2008; Gurmet et al., 2000; Ballabh and Chaurasia, 2011) of them have focused on ethno-medicine with special reference to Kargil. Dependence on medicinal plants for curing diseases is very high in Kargil due to its remoteness and lack of modern healthcare facilities. Knowledge on THS in these areas is rapidly declining due to modernization and acculturation. Inadequate documentation of THS may reduce opportunities to discover new drugs. Keeping this in view, the present study was initiated with two main objectives: (i) to document the prevalent diseases and use of various plant parts in *Amchi* system of medicine and (ii) to study the factors affecting the THS.

2. Methodology

In order to document the utilization of medicinal plants, extensive field surveys were carried out during March 2009 to 2011 June in three different Valleys (Suru, Wakha-chu and Lower Indus) of Kargil district (Fig. 1).

The field surveys were conducted during different seasons. After reconnaissance survey, 56 villages in the study area were selected for intensive study. During field surveys a considerable amount of time was spent with the local people of different age groups to understand several details about their dependency on *Amchis*. Village heads were contacted to know the number of *Amchis* in the village. Semi-structured questionnaires, interviews and participatory appraisals were used to elucidate information from the resource persons (*Amchis*) using standard methods (Martin, 1995). Information on local names of plants, and plant parts used for curing, were recorded. Field visits to the high alpine areas were organized with the *Amchis* so as to ascertain the correct identity of plants and also to obtain first-hand information on their distribution and availability. These plants were collected for identification and Herbarium preparation following standard methods (Jain and Rao, 1976). The voucher specimens are housed in the herbarium of Wildlife Institute of India, Dehradun for future reference.

Extensive literature survey was carried out for the compilation of various traditional practices, beliefs and raw materials used for curing different ailments by *Amchis* of the Kargil. In order to assess the traditional knowledge among various age groups, the *Amchis* were categorized into four age classes, i.e. 20–30 years (new generation), 31–50 years (adult), 51–70 years (middle aged) and above 70 years (veterans). *Amchis* were interviewed on different parameters such as education, income and the source of medicine. Quantitative methods were used to analyze the influence of demographic parameters on the distribution of their knowledge. The use value of plants was calculated to know the relative importance of species (Phillips et al., 1994).

3. Results and discussion

Amchis were once the backbone of the social system of Ladakh but their number has reduced considerably and even these remaining healers are finding it difficult to keep pace with modernisation.

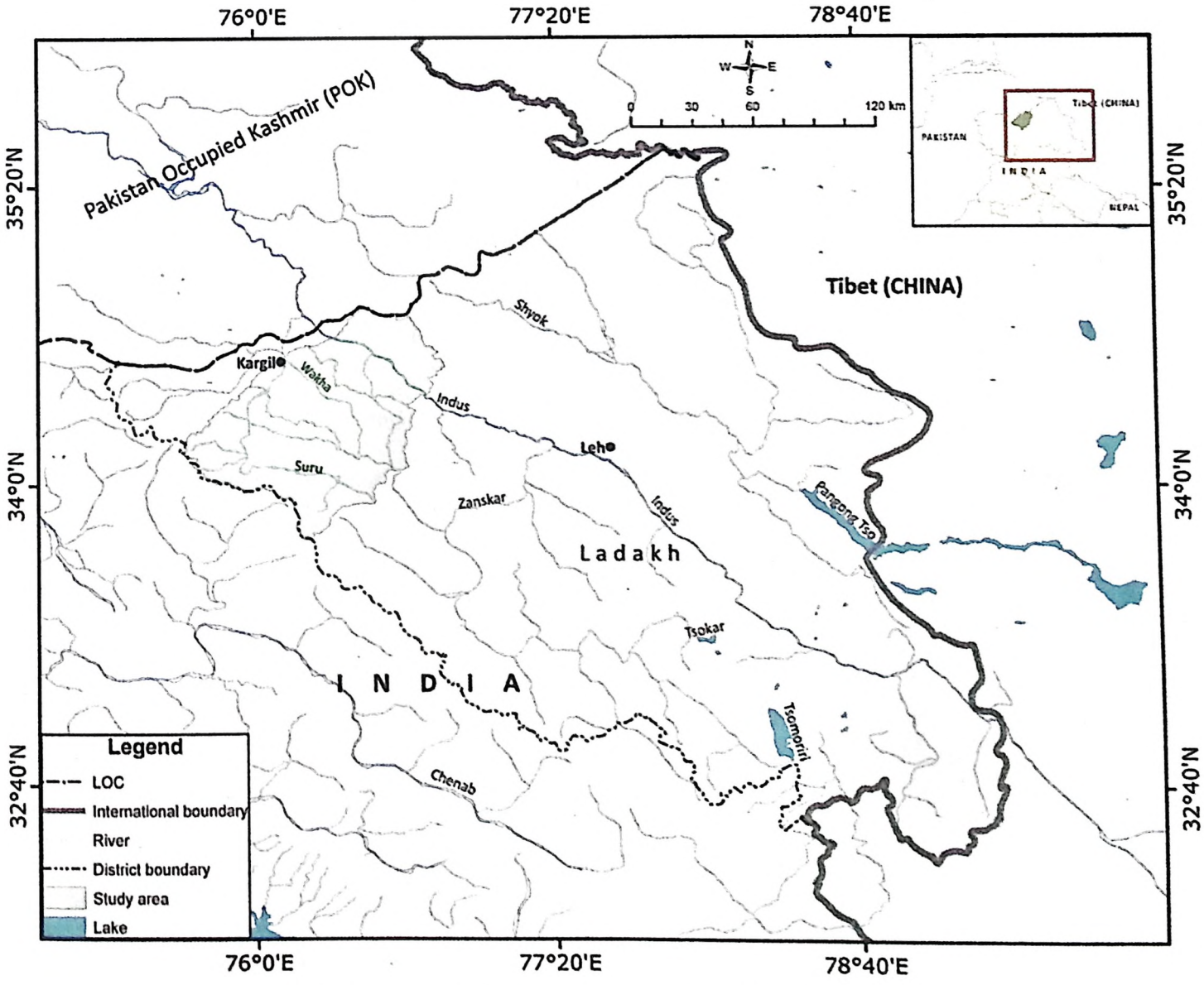

Fig. 1. Location map of Suru, Wakha-chu and Lower Indus Valley (Kargil).

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At present, there are 36 *Amchis* in western Ladakh looking after 30% of public healthcare. They are treating a wide range of ailments including some chronic diseases such as diabetes, jaundice and asthma. The highest concentration of *Amchis* (67%) was found along the Wakha-chu Valley, followed by Lower Indus Valley (17%) and Suru Valley (16%). *Amchis* use different methods and practices such as moxibustion, vein puncturing and hot water bath to cure the diseases. The results of the study are discussed below in detail.

3.1. Disease prevalence

Amchis are treating 54 types of diseases. The most prevalent diseases in Kargil region are presented in Fig. 2.

According to the *Amchis*, a severe drop in winter temperatures and poor living conditions causes Upper respiratory infection (common cold) which is the most prevalent disease (12%). Acid peptic disease is the second most prevalent disease (10%) caused by dietary factors and high altitude. Headache (10%) and acute gastro-intestinal disease (9%) are other common ailments in the study area. *Nurbo-dun-thang*, prepared from seven herbs, is used for the treatment of majority of the diseases. The *Agar-sumchusona*, prepared from thirty five herbs, is used in the treatment of backache, fever and rheumatism. *Tsandan-gyat-pa*, prepared from eight herbs, is used to treat cold, fever, tuberculosis and eye infection. *Manu-ji-thang* is used for the treatment of headache and cold. Proper diet and medicine is recommended by the *Amchis* for a healthy life.

3.2. Practices and treatment techniques

3.2.1. Moxibustion and puncturing of veins

This method is used for the treatment of paralysis, inflammation of joints, arthritis, headache, mental illness, fracture and acid peptic disease. The moxibustion is carried out on different parts of the body such as head, temples, above forehead, knee and spinal cord. The flower of *Tawa (Leotopodium spp.)* is collected, dried and made into cottony ball (smaller than a pea) which is then put into a golden needle and is burned onto the body area which is ailing. Sometimes heated metal needles of iron, gold or silver are directly placed on certain parts of the body. The method of application depends on the type of disease for example, for a mentally retarded person moxibustion is done at the 6th and 7th vertebral column, while in case of headache it is applied at the centre of the head. To cure some diseases, *Amchis* allow blood to ooze out for a certain period of time by puncturing veins with a needle, a practice similar to acupuncture. The day and time of day plays a major role in practicing moxibustion and these are decided depending on the age of the person according to the Tibetan lunar calendar.

3.2.2. Medicinal hydrotherapy

This is a moderate method with different forms of treatment which can be broadly classified as bathing in medicinal water, and medicinal tie bathing. These methods require simple spring water, medicinally prepared water or steam depending on the nature of ailment. The ingredients of medicinal water, '*bdud-rtsi-Inga-lums*' (five *Amritas*), contains *Juniper* spp. *(Shuk-pa)*, *Waldheimia* spp. *(Ba-lu)*, *Myricaria* spp. *(Um-bu)* *Artemesia* spp. *(mKhampa karpo)*, and *Ephedra* spp. *(Tsepat)*. These ingredients are ground crushed and boiled in a big pot of water. When the water is lukewarm, a small quantity of *chang* (alcoholic beverage made of barley) is added to it. The boiled medicines are mixed with boiled grains, and yeast powder is added to the mixture. The patient is asked to sit in the tub of this medicinal water for some time. This treatment is used for people suffering from paralysis, rheumatoid arthritis, acid peptic disease or movement disorders. In medicinal tie bathing, which is a relatively simpler method, a medicine is put into a bag made of thin cloth and tied to the affected part of the patient's body.

About one half of the *Amchis* of Ladakh use medicinal baths in their practice. The method is time consuming and requires patience. Patients are also advised to visit hot springs with or without accompanying *Amchis*. Similar to moxibustion, medicinal bathing is also done only on special days and hours (*Skarma-Tangrung*). It is believed that at these times the medicinal property of water increases many fold. Spring and autumn are the best times of the year and the duration of the bath increases with consecutive treatment days. The important hot springs in Ladakh are located at Chumathang, Panamik, Chilling, Kanji, Markha, Serchan and Puga.

3.3. Plant parts used

Amchis believe that all the plants on earth have medicinal properties and possess some inherent efficacy. There are 315 plants used by the *Amchis* for medicine preparation, which include plants outside Ladakh also. Out of 315 medicinal plants 160 (Appendix Table A1) are being used by them in Kargil. It was found that taxonomy is uncertain in the THS. *Amchis* use different names for the same plant species and in some cases one name for different plant species. For example tuber of *Aconitum* species is called *Zinba*, while its flower is called *Boga* and the leaves are *Dursi*. In old transcriptions, Tibetan plant names have been described with their medical function, but not always accompanied by a precise illustration. Different parts of plants used for medicine includes flowers, fruits, roots, tubers, bark, stems and leaves (Fig. 3).

Collection of the plants depends on the availability and accessibility. While some plants are easily available in nearby

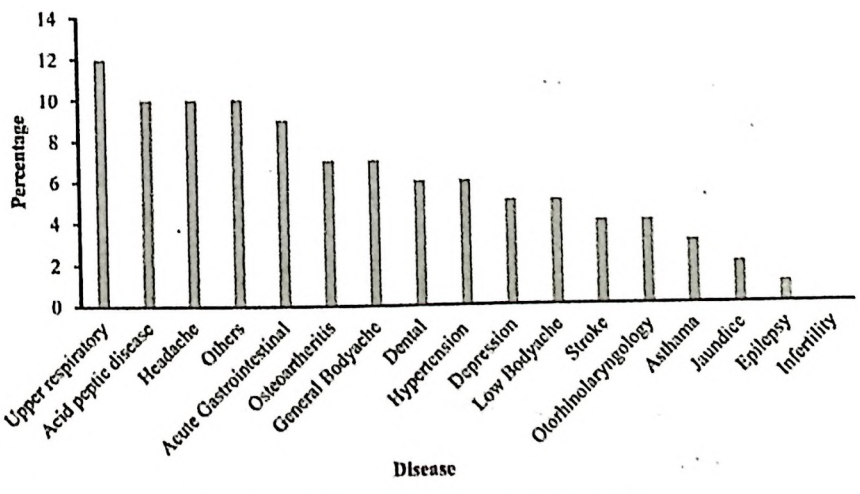

Fig. 2. Disease prevalence in Kargil (Ladakh).

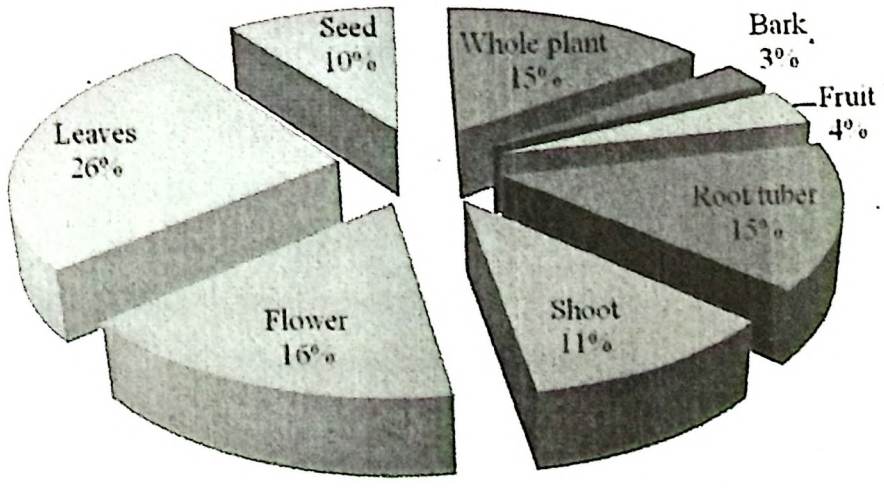

Fig. 3. Plant parts used by the *Amchis* in Kargil, Ladakh.

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areas, many of them are collected from the high passes and pasturelands, as they believe that the higher the elevation the better the quality of the species. If some species are not available in the proximity, they may get it through exchange with *Amchis* of other areas. 79% of the *Amchis* in Kargil exchange medicinal plants with *Amchis* from the Leh district and Zanskar range and sometimes from Dhramshala and Dehradun. Every year 'Ladakh Amchi Sabha' organises a tour for group collection in different parts in Ladakh. Around 36% of the *Amchis* go for the collection at distant places. The areas for medicinal plant collection are Khardong-la, Tanglang-la, Chang-la, Suru, Sangra, Sapi and Zanskar. The plants commonly used by *Amchis* are given in the Table 1.

3.4. Use of minerals

Except a few unidentified minerals, five were documented which are currently being used by *Amchis*. These are calcite, gold, silver, pearl and rock salt (*Shilajit*). *Shilajit*, locally called as *Dak-Joon*, is the most frequently used mineral. In Kargil, *Shilajit* is found in *Manta, chopodok lungba and Dha-lungba* areas in the Lower Indus Valley. Of all the *Amchis* interviewed 56% use minerals and stones in their medicines while the rest are unaware of this form of treatment. *Shilajit* is used as purgative, anti-allergic, anti-diabetic, anti-inflammatory, aphrodisiac and for strengthening immune system and nervous system. From the medicinal point of view, the chief active substances in *Shilajit* are benzoic acid and benzoates (Chopra et al., 1958). Gold is used for long life, antidote for dog bite and as tonic. The procedure of making these medicines is cumbersome and also not economical. Pearl is also used to treat some diseases.

Table 1
List of plants with high use value.

Plant name	Use report	Use value	Plant name	Use report	Use value
Aconitum heterophyllum	36	1.00	*Pedicularis longiflora*	29	0.81
Aconitum violaceum	36	1.00	*Clematis orientalis*	28	0.78
Primula macrophylla	36	1.00	*Rhodiola fastigiata*	28	0.78
Codonopsis ovata	36	1.00	*Nepeta longibracteata*	28	0.78
Dactylorhiza hatagirea	36	1.00	*Geranium pratense*	26	0.72
Swertia thomsoni	35	0.97	*Arenaria griffithii*	24	0.67
Oxyria digyna	35	0.97	*Gentiana tubiflora*	23	0.64
Aster flaccidus	35	0.97	*Gentianella moorcroftiana*	23	0.64
Carum Carvi	35	0.97	*Epilobium latifolium*	23	0.64
Urtica hyperborea	35	0.97	*Aconogonum tortuosum*	22	0.61
Corydalis sp	34	0.94	*Rosa webbiana*	22	0.61
Clematis tibetana	34	0.94	*Inula racemosa*	21	0.58
Arnebia euchroma	34	0.94	*Juniperus* sp.	20	0.56
Saussurea obvallata	34	0.94	*Pedicularis bicornuta*	19	0.53
Lagotis kunawurensis	33	0.92	*Allium carolinianum*	19	0.53
Rheum webbianum	33	0.92	*Allium przewalskianum*	19	0.53
Rheum australe	32	0.89	*Bistorta vivipara*	19	0.53
Swertia petiolata	31	0.86	*Delphinium cashmerianum*	19	0.53
Cremanthodium arnicoides	30	0.83	*Ephedra gerardiana*	19	0.53
Rheum speciforme	29	0.81	*Hippophae tibetiana*	19	0.53

3.5. Use of animal parts

Animal parts are also used by *Amchis* for the treatment of various ailments. Around 75% of *Amchis* use animal parts in their preparations. Organs of 28 animal species, used in therapy, were recorded during present survey. They have a reticent methodology in the preparation of their medicines which are meant to be kept secret because it is believed that medicine loses its effect and sanctity once its ingredients are revealed to the user. Animals body parts used in the preparation of Amchi medicine includes blue sheep, wolf, Tibetan antelope, black bear, donkey, fox, rhinoceros, ibex, tiger, wild yak, goat, sheep, pig, marmot, snow leopard, Tibetan woolly hare, otter, musk deer, chukar partridge, eagle, vulture, peacock, tortoise, snake, fish and crab (Appendix Table B1). Earlier people used to hunt wild animals for medicines but now use of animal parts by *Amchis* has reduced drastically.

3.6. Medicinal formulations

Plants are the major source of medicines in the *Amchi* system, besides animal products, minerals, rocks and salts. The medicine is generally an amalgamation of 3 to 100 ingredients. The end-product is either in the form of powder (*chema*), tablet (*rilbo*), paste (*dehgu*), ointment (*chukma*) or decoction (*thang*). All except the ointment are taken orally. Most practitioners formulate and dispense their own prescriptions. There are more than one thousand herbal formulations and recipes in *Amchi* system (Dorji and Morrisco, 1989). 89% of *Amchis* make their own medicine and 11% use medicines manufactured by professional Tibetan drug manufacturers. Some formulations are difficult to make due to unavailability of the constituents such as *Rinchen wangyor* (requires more than hundred ingredients) and *Motik-dun-chu* (seventy ingredients). Hence, many *Amchis* are not aware of these recipes.

3.7. Status of Knowledge across age, gender and education

The *Amchi* system is dependent completely on the knowledge and practice passed down from their predecessors. An assessment of knowledge among the practitioners reveals that the duration of study, formal or informal, positively affects the level of knowledge, while the years of professional experience does not necessarily increase the knowledge.

3.7.1. Education levels of traditional healers

Amchis acquire their education in two ways viz., informal, traditionally passed down from ancestors on a lineage basis and from formal schooling, known as Bachelor of Traditional Medicine System (BTMS).

Fig. 4 shows that 44% of the healers did not have formal school education; 11% were drop outs from primary school (under grade 5) and 39% had done their secondary school (grades 9–10). Only 6%

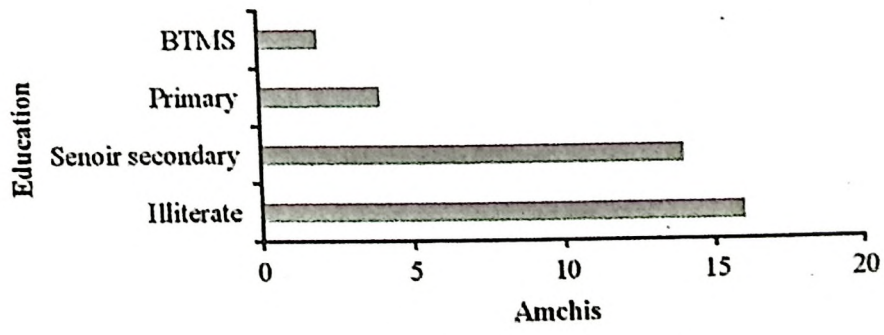

Fig. 4. Literacy status of *Amchis* in Kargil, Ladakh.

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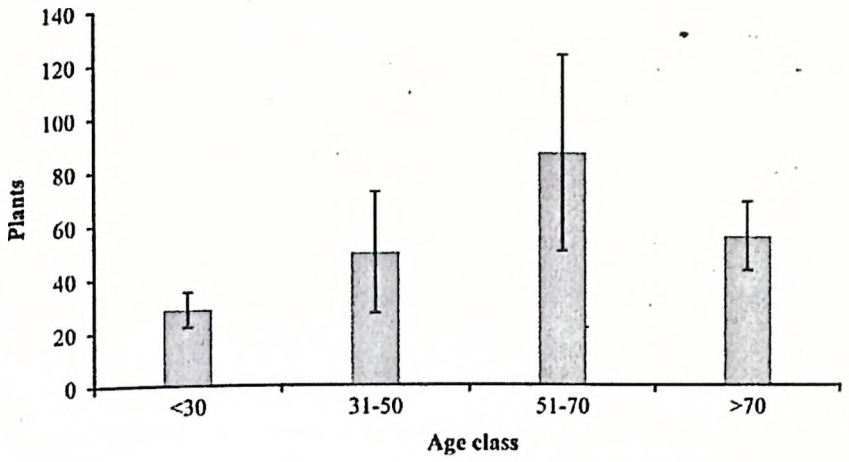

Fig. 5. Traditional knowledge of *Amchis*.

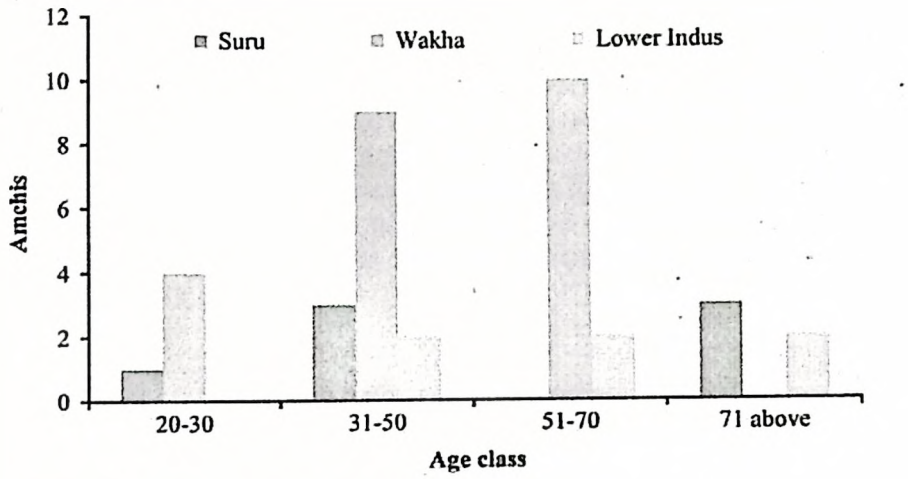

Fig. 6. Age–class distribution of *Amchis* across three Valleys.

studied in the school of Tibetan Medicine System at the Ladakh School of Traditional Medicine in Leh. *Amchis* require knowledge of the *Bhoti* language in order to understand the written prescriptions and Mantras in the standard book. It takes 3–16 years of informal study to learn this system of medicine from older *Amchis*. They are finally examined for pulse diagnosis, urine diagnosis and other important oral tests from four "Tantras" in front of their own teacher, elder *Amchis* and villagers.

3.7.2. Level of knowledge

The level of knowledge among *Amchis* was assessed from the number of plant species they know which was positively correlated with the number of years of informal education ($R^2=0.04$). There were very few *Amchis* with BTMS degree. The correlation between the years of experience and knowledge of number of plants indicates that experience does not increase the level of knowledge ($R^2=0.006$).

The level of knowledge of each *Amchi* was quantified based on the percentage of the number of recorded plants that he knew. Fig. 5 indicates that there is variation of knowledge among different age groups. Greater knowledge among older *Amchis* may be interpreted as evidence of poor knowledge transfer to younger generations. Not only does the knowledge of plants and preparations vary among *Amchis*, their expertise in different diseases also varies. Only 19% of *Amchis* have expertise in a variety of ailments such as fracture, bruises, cold/cough, asthma, acidity and pulmonary disorders.

3.8. Factors influencing the change in traditional healthcare system

3.8.1. Demographic pattern

Demographic data shows that the majority of *Amchis* (39%) are between 31–50 years of age. This is followed by: 51–70 years (33%), 20–30 years (14%) and above 70 years (14%). Since, traditional healers are mostly in middle age group ($\chi^2=98.0$, df=6, $P<0.00$), age and experience might be a factor in qualifying for being traditional healers. Fig. 6 shows that the young generation are not willing to adopt this profession in the three Valleys.

Among 36 respondents interviewed, 86% were male and 14% were female (Fig. 7). Interviews with *Amchis* revealed that the traditional health care system is dominated by males since its inception and that females are seldom a part of this system. Traditional knowledge in the family or community is passed from father to first born son, while the knowledge of females is primarily based on their personal observations. This could be the reason of less knowledge of female *Amchis* as compared to their male counterparts.

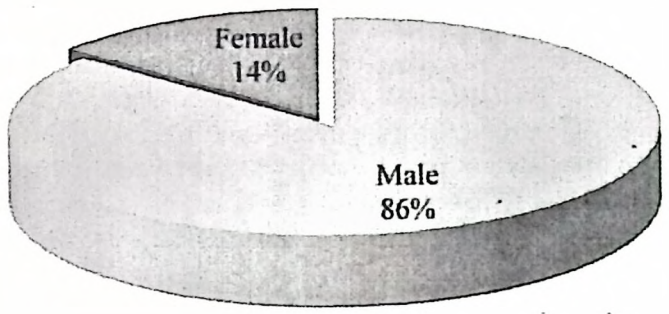

Fig. 7. Gender rátio of *Amchis*.

3.8.2. Modernization and generation gaps

The main factor responsible for the decrease number of *Amchis* is the introduction of modern medicine in these areas. 60% *Amchis* revealed that young generation preferred higher studies or other professions over their family tradition because of the less income. Around 86% of them are in favor of passing their knowledge to the new generations and in keeping this tradition alive. However, 65% of them want their offspring to be in other professions, mostly in the government jobs.

64% of the *Amchis* adopted the tradition from their ancestors while 36% obtained the knowledge from outside their families. This implies that they prefer their own son to be the successor *Amchi*. In the Suru and Wakha-chu Valleys only 25% *Amchis* had students studying *Sowa-rigpa* and only these *Amchis* are passing on their traditional knowledge to keep this tradition alive. However, in the Lower Indus Valley the tradition seems to be dying as no *Amchi* is transferring the knowledge to the next generation. It can be concluded from the above mentioned facts that the *Sowa-rigpa* system of medicine is dwindling due to the lack of interest among the young generation to accept it as a profession.

3.8.3. Religion

In the three Valleys 94% *Amchis* are Buddhist which could be due to the fact that *Sowa-rigpa* system originated from Tibet and all its scripture are available only in the Bhoti script. Although, the area is mostly inhabited by the Muslim community, only 6% of *Amchis* are Muslim. Most of the Muslims in the Valley are converted Buddhists. The recent discovery of several statues which belong to a thousand year old civilization from Sangra village (Suru Valley), and holding property papers in the *Bhoti* script, is evidence of the dominance of a Buddhist culture in the past. Decrease in Buddhist population in western Ladakh could be one of the reasons for degradation of this system.

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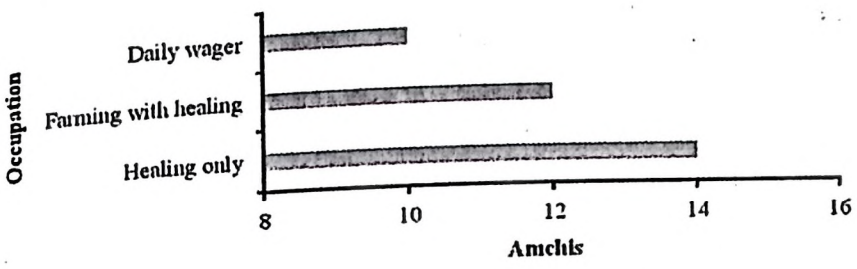

Fig. 8. *Amchis* involvement in other occupation.

3.8.4. Socio-economic conditions

The economic condition of several *Amchis* is not good. Most of them (67%) have a monthly income of INR 500–700, while only 5% *Amchis* are earning more than INR 5000 per month. *Amchis* registered with the government of India (47%) are getting an allowance of INR 5100 per annum for keeping the tradition alive. This allowance includes INR 1500 to buy raw material for their medicines and INR 500 per month for individual work.

Low income and high expenses compelled *Amchis* to choose other occupations such as transport drivers, porters, running a shop, teaching school, and other part-time work (Fig. 8) along with the healing job. Most of them are not happy with their profession and a trend to leave this tradition has been observed over the study period.

3.8.5. Treatment techniques and delinquents

The lack of sufficient knowledge among healers for certain treatment techniques such as moxibustion and puncturing of veins, which is not feasible among women *Amchis*, is one of the reasons for the decreasing popularity of this system. In the Kargil 78% of the *Amchis* practise moxibustion as a part of their treatment. The remaining 22% do not practice it because of the discomfort of the technique and lack of expertise.

Safety and quality are other aspects which greatly affects the popularity of these methods compared to modern medications. Scientific proof regarding the safety and quality of traditional medicinal products and practices is not available. Even though effectiveness of some treatment techniques (e.g. acupuncture, some herbal medicines) are already established further study is needed to standardize the practices. The safety, effectiveness and quality of herbal medicines depend heavily on the methods of preparation. As many of the *Amchis* prepare their medicine in unhygienic conditions, especially during processing (e.g. drying and grinding), these procedures and medicines need to be standardized properly.

Identification of different constituents from plants as well as animal body parts requires adequate knowledge. The musk pod, at present is illegally traded in several regions yet fake-specimens are widespread among traders. Synthetic semi-precious stones and minerals are also widely traded all over the Himalaya replacing the original medicinal stones. Young *Amchis* do not have proper knowledge about medicinal plants because manufactured medicines are easily available. It is very difficult to choose a plant and its parts. For example, tuber of *Aconitum* spp. is very difficult to choose as the one year old tuber can be poisonous.

3.8.6. Modern medicine vs. traditional medicine

Amchis believe that the arrival of modern medicine has supressed the traditional medicine system and many people are moving towards modern medicines. They believe that their medicines take longer time to heal and that the patient has to observe many precautions while taking their medicines. Unlike traditional medicines modern medicines provide easy and quick relief and are easily available. Despite the fact that modern medicines are increasingly being used by modern society, there is now growing concern to protect and improve the quality of traditional medicines. Diversity, flexibility, accessibility, broad continuing acceptance in developing countries and increasing popularity in developed countries, relatively low cost, low levels of technological input, fewer side effects and growing economic importance are some of the positive features of traditional medicine (WHO, 2002).

4. Conclusion

This study reveals that a part of society in western Ladakh still depends on traditional healthcare system for the treatment of diseases such as cold, cough, fever, headache, rheumatism and skin diseases. However, the THS is now facing serious threat due to decrease in the number of *Amchis* involved in this profession, especially in the Lower Indus Valley where the transfer of their knowledge to younger generations is lowest. The *Amchis* have low income and their social status too has deteriorated. Demographic data indicate that traditional healers were mostly in the 31–50 years age group, and very few descendants are willing to inherit this profession. Poor educational background is a major factor that directly affects the learning process of this system that later affects the quality of treatment delivered to the patient. The major reason of poor education is the lack of schools in nearby areas. Though government of India aims at "right to education" scheme which has the provision that every village should have one primary school, it is not yet achieved.

An effective way to conserve the system is to integrate *Sowa-rigpa* with the modern healthcare system. This has been emphasized in the recent World Health Organization "Beijing Declaration" which advocates that the "communication between conventional and traditional medicine providers should be strengthened and appropriate training programs be established for health professionals, medical students and relevant researchers" (World Health Organization, 2008, p. 1), which will add new dimensions to the nation's system of healthcare and also facilitates empowerment of patients by providing them with a choice of healthcare systems and different options for treatments. Government support for traditional healers and traditional medicines needs to be increased.

Acknowledgements

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Appendix A

See Table A1.

Appendix B

See Table B1.

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Table A1
List of plants parts used in Sowa-rigpa system of medicine.

Botanical name	Family	Medicinal properties	Local name	Parts used
Acantholimon lycopodioides (Girard) Boiss	Plumbaginaceae	Cardiac disorders	Longzey	L/F
Achillea millefolium L	Asteraceae	Urinary problem, toothache and gum problem inflammation, astringent, diaphoretic, treatment for cold	Chuang	L/F.
Aconitum heterophyllum Wall. ex Royle	Ranunculaceae	Toothache, fever, stomach complaint, gastric problem, headache and antiperiodic	Boga-karpo	T
Aconitum violaceum Jacquem. ex Stapf	Ranunculaceae	Cold, cough, asthma, fever and gastric problems	Boga-karpo	R/T
Aconogonum tortuosum (D. Don) H. Hara	Polygonaceae	Blood purifier	Nyalo	L
Allium carolinianum DC	Amaryllidaceae	Constipation, feminine problems and joint pains	Skotse	B/L
Allium cepa L	Amaryllidaceae	Appetizer and vomiting	Tsong	R/L
Allium przewalskianum Regel	Amaryllidaceae	Stomachache and dysentery	Kangmar	L
Allium sativum L	Amaryllidaceae	Digestion and appetizer	Skokpa	L
Anaphalis triplinervis (Sims) Sims ex C.B.Clarke	Asteraceae	Wounds and chronic diseases and genital problems	Spra-rgo	S/L/F/ Fr
Anaphalis busua (Buch.-Ham.) DC.	Asteraceae	Cold & cough	Shishing	L
Androsace aizoon Duby	Primulaceae	Fever, cough and indigestion	Zatikmukpo	S/W
Androsace rotundifolia Hardw	Primulaceae	Tonic	Zigsolo marpo	W
Anemone rivularis Buch.-Ham. ex DC.	Ranunculaceae	Cold & cough, fever, wounds and cuts	Zukpa	W
Arabidopsis himalaica (Edgew.) O.E.Schulz	Brassicaceae	Indigestion and appetizer	Sbiu-lapug	W
Arctium lappa Kalm	Asteraceae	Astringent, blisters, burns and ulcers	Jisung	W
Arenaria griffithii Boiss	Caryophyllaceae	Mensuration disorder and bile disorder	Oma-strwa	L/Sh
Arnebia euchroma (Royle) I.M.Johnst	Boraginaceae	Hair tonic, Cough, backache, cold & cough, lung & pulmonary problems and blood vomit	Demok	R
Arnebia guttata Bunge	Boraginaceae	Hair tonic and blood purifier	Deemok	R
Artemisia absinthium L	Asteraceae	Rheumatism, malaria, anti-worm	Burtse-kar	W
Artemisia brevifolia Wall. ex DC	Asteraceae	Gastrointestinal disorder, anthelmintic, aphrodisiac, antiseptic, laxative and blood purifier	Khampa	L/F
Artemisia maritima L. ex Hook.f.	Asteraceae	Skin diseases and intestinal parasites	Burtse	L/S
Artemisia moorcroftiana Wall. ex DC.	Asteraceae	Cure malaria fever	Burtse	W
Aster flaccidus Bunge	Asteraceae	Eye treatment, liver disease and fever	Lukmik	F/S
Astragalus zanskarensis Bunge	Fabaceae	Intestinal worms	Chisigma	R
Berberis brandisiana Ahrendt	Berberidaceae	Eye problems and tonic	Skerpa	R/B
Bergenia stracheyi (Hook.f. & Thomson) Engl	Saxifragaceae	Stone problems, cuts & wounds, urinary problems and stomach-ache	Gatikpa	L/R/F
Betula utilis D.Don	Betulaceae	Jaundice, burns, leprosy and bronchitis	Towa	B/R
Biebersteinia odora Stephan ex Fisch	Geraniaceae	Cuts & wounds, peptic ulcer diarrhea and kidney problem	Drakspos	W
Bistorta vivipara (L.) Gray	Polygonaceae	Abdominal pain and backache	Langna	F/S
Bunium persicum (Boiss.) B.Fedtsch	Apiaceae	Abdominal pain, cold, cough, fever, loss of appetite, back pain and liver problems	Zera nakpo	S
Bupleurum longicaule Wall. ex DC	Apiaceae	Stomach-ache, tonic, antidote and gastric problem	Sah-kukchak	Fl
Capparis spinosa L	Capparidaceae	Paralysis and gout, tonic and toothache	Capra	L/R/Sh
Capsella bursa-pastoris (L.) Medik	Brassicaceae	Anti-vomit	Medikus	L
Caragana versicolor Benth	Fabaceae	Food poisoning, fever and throat infection	Trama	S
Carum carvi L	Apiaceae	Cold, nose-pain, carminative, stimulant, stomach-ache and tonic	Kosnyot	R
Cerastium cerastoides (L.) Britton	Caryophyllaceae	Headache, renal colic and body-ache	Spang-yan-karpo	L/Sh
Chenopodium botrys L	Chenopodiaceae	Anthelmintic, laxative and stomach complaints	Snue	F/L
Chenopodium glaucum L	Chenopodiaceae	Purgative	Sanek	L
Chrysanthemum tibeticum C.B.Clarke	Asteraceae	Antiseptic paste	Phematso	Sh
Cicer microphyllum Benth	Fabaceae	Jaundice and sore throat	Sari	L
Cirsium arvense (L.) Scop	Asteraceae	Anti-vomit and headache	Biangtser	L
Clematis orientalis L	Ranunculaceae	Digestion	Emong	Sh
Clematis tibetana Kuntze	Ranunculaceae	Indigestion and scabies	Emong nakpo	R/S/L
Colchicum luteum Baker	Liliaceae	Colchicine and gout	Tukpa	Rh
Codonopsis ovata Benth	Campanulaceae	Chest conjunction, lung and liver problems, ulcer and blood disorder	Lurdud-dorjey	Sh/L
Corydalis megacalyx Ludlow & Stearn	Fumariaceae	Pus dry	Stongzil	W
Corydalis govaniana Wall	Fumariaceae	Antipyretic, febrifuge, diuretic, gastric problem and muscular pain	Stongzil	R/L
Corydalis meifolia Wall	Fumariaceae	Fever	Tongrusilva	W
Cousinia thomsonii C.B.Clarke	Asteraceae	Body pain, sprain and arthritis	Biangtser nakpo	L/R/F
Cremanthodium arnicoides (DC. ex Royle) R.D.Good	Asteraceae	Peptic ulcer, dysentery, fever and liver disorder	Nimma-gorgos	F/Sh/S
Crepis flexuosa (Ledeb.) Benth. ex C.B.Clarke	Asteraceae	Fever, backache, abdominal disorder and urinary problems	Gulthak	W
Cynoglossum wallichii G.Don	Boraginaceae	Anti-vomit, wounds, swelling and cough	Nima-jarma	L/Sh/ Fl/F
Dactylorhiza hatagirea (D.Don) Soó	Orchidaceae	Health tonic and aphrodisiac	Wangbolakpa	T/L
Datura stramonium L	Solanaceae	Ear problems, impotence, intestinal worms and respiratory problems	Datura	L/S
Delphinium cashmerianum Royle	Ranunculaceae	Insecticide, swelling and wounds	Chagotpa	Sh/F/S
Delphinium viscosum Hook.f. & Thomson	Ranunculaceae	Cold & cough and fever	Chargos	R/S/F/ Sh
Descurainia sophia (L.) Webb ex Prantl	Brassicaceae	Chicken pox	Khampa	S
Dianthus anatolicus Boiss	Caryophyllaceae	Stomach complaints, cough & cold	Thangthorn	L
Dracocephalum heterophyllum Benth	Lamiaceae	Peptic ulcer, Hypertension, Cold	Zinzer, Zypsi	Sh/L/F

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Table A1 (*continued*)

Botanical name	Family	Medicinal properties	Local name	Parts used
Echinops cornigerus DC	Asteraceae	Food poisoning and tonic	Ekzima	R/S/F/ Sh
Ephedra gerardiana Wall. ex Stapf	Ephedraceae	Asthma, rheumatism and Heart stimulant	Tsepath	Sh/Fr
Epilobium angustifolium L	Onagraceae	Abdominal pain, intestine and renal complaints	Utpalwampo	F/S
Epilobium latifolium L	Onagraceae	Acidity	Utpalwampo	F
Equisetum arvense L	Equisetaceae	Diuretic, kidney problems and acidity	Kihnn	W
Erodium tibetanum Edgew. & Hook.f	Geraniaceae	Wounds & burns and hair tonic	Zemma	S/F
Euphrasia himalayica Wettst	Scrophulariaceae	Eye problems and cardiac ailments	Skianglo	L
Ferula jaeschkeana Vatke	Apiaceae	Chest pain	Thunak	R/S
Galium pauciflorum Willd. ex K.Schum	Rubiaceae	Throat infection	Rangche	L
Gentiana nubigena Edgew	Gentianaceae	Cough & cold, throat disorder and bronchitis	Spangyanmentok	L
Gentiana tubiflora (G.Don) Griseb	Gentianaceae	Cough, stomach disorder, joint pain and loss of appetite	Spangyan snonpo	W
Gentianella moorcroftiana (Wall. ex Griseb.) Airy Shaw	Gentianaceae	Fever, giddiness, cough & cold and nausea	Chumbutik	W
Geranium pratense L	Geraniaceae	Analgesic, influenza, pneumonia and swelling	Katur	W
Heracleum pinnatum C.B.Clarke	Apiaceae	Leprosy, chicken pox and small pox	Spisho	S
Hippophae rhamnoides L	Elaeaganaceae	Anti-ageing, anti-cold, memory restoration and energy boosting	Tsestallullu	F/L/S
Hippophae tibetana Schltdl	Elaeaganaceae	Revitalizing, and rejuvenations	Chitaka	F/L/S
Hyoscyamus niger L	Solanaceae	Sedative, toothache, headache, asthma and cough	Gya-Lhathang	L/S
Hyoscyamus pusillus L	Solanaceae	Antiseptic, expectorant and diuretic	Sastalulu	L
Hypecoum leptocarpum Hook. f. & Thomson	Papaveraceae	Stomach disorder and acidity	Parpata	R
Inula racemosa Hook.f	Asteraceae	Rheumatism, gastro-intestinal complaints, Acidity	Manu	R/L
Inula rhizocephala Schrenk	Asteraceae	Chest pains and common cold, constipation, intestinal infections and ulcers	Turzit	W
Juglans regia L	Juglandaceae	Constipation and Toothache	Starga	F/B
Juniperus communis L	Cupressaceae	Kidney disorder	Shukpa	B/Fr
Juniperus recurva Buch.-Ham. ex D.Don	Cupressaceae	Diarrhea, indigestion and cough, kidney disorder, paralysis and skin diseases	Lha-shook	B/T
Jurinea ceratocarpa (Dcne.)	Asteraceae	Headache, backache, lung tuberculosis, asthma and bronchitis	Turzith	R
Lactuca lessertiana Wall. ex C.B.Clarke	Asteraceae	Rheumatism	Tharnue	L/Sh
Lactuca tatarica (L.) C.A.Mey	Asteraceae	Headache, fever, internal wounds	Bshakha	L
Lagotis kunawurensis Rupr	Scrophulariaceae	Fever, blood purification and bile disorder	Honglen	R
Lancea tibetica Hook. f. & Thomson	Scrophulariaceae	Heart diseases, cough, and chest congestion	Raksa	R/L
Leontopodium alpinum Colm. ex Cass	Asteraceae	Septic wounds	Tzima	W
Leontopodium himalayanum DC	Asteraceae	Septic wounds and headache	Tawa	L
Lepidium latifolium L	Brassicaceae	Rheumatism	Seoji	S/L
Lloydia serotina (L.) Rchb	Liliaceae	Eye disorders and fever	Tsa-wa	F
Malva verticillata L	Malvaceae	Treatment of piles	Chiroti	R/S
Meconopsis aculeata Royle	Papaveraceae	Headache, against ulcers, disorders of lungs, liver and inflammation, pharyngitis, stomachache	AchaK-srmum	L/Sh/R
Melica persica Kunth	Poaceae	Eye disorders, rheumatism, gout and joint pain	Awa	W
Mentha longifolia (L.) L	Lamiaceae	Dysentery, vomiting and diarrhea	Phololing	L/Sh
Myricaria elegans Royle	Tamaricaeae	Blood purifier	Umbu	L
Nepeta floccosa Benth	Lamiaceae	Fever, cough and cold	Shamagok	L
Nepeta glutinosa Benth	Lamiaceae	Diarrhea, dysentery and stomach-ache	Jatukpa	F/L
Nepeta longibracteata Benth	Lamiaceae	Stomach complaints, acidity, liver and kidney	Piangku	L/F
Oxyria digyna (L.) Hill	Polygonaceae	Digestion appetizer and gastritis	Chumtswa	L/Sh
Papaver nudicaule L	Papaveraceae	Analgesic and cold	Tshersngon-serpo	L
Paraquilegia microphylla (Royle) J.R. Drumm. & Hutch	Ranunculaceae	Gynecological diseases, uterine tumors, and blood disorder	Yumo deujin	S/L/F
Pedicularis bicornuta Klotzsch	Scrophulariaceae	Burns, Rheumatism, gout, general inflammation and acidity	Peyasang	L/F
Pedicularis longiflora Rudolph	Scrophulariaceae	Vertigo, dry tongue, diuretic, liver, gall bladder problems, excessive seminal discharge and edema	Luguruk serpo	L/St
Pedicularis oederi Vahl	Scrophulariaceae	Headache, backache, body-ache, food poisoning and sedative	Luguruk serpo	W
Peganum harmala L	Zygophyllaceae	Stomach complaints, eye disorders, measles, asthma, and menstrual disorder	Sepan	S
Perovskia abrotanoides Kar	Lamiaceae	Burning sensation	Iskilling	L/Fl
Phlomis rotata Benth. ex Hook.f	Lamiaceae	Bone fracture and healing bone marrow and joint swelling	Tapaq	W
Physochlaina praealta (Decne.) Miers	Solanaceae	Ulcer and toothache	Langtang	L/F/S
Plantago depressa Willd	Plantaginaceae	Diarrhea and gastric disorder	Humbuksuk	L
Plantago himalaica Pilg	Plantaginaceae	Diarrhea	Tharum	S
Plantago major L	Plantaginaceae	Dysentery, gastric problems, gum problem and toothache	Tharum	S
Podophyllum hexandrum Royle	Podophyllaceae	Skin diseases, blood dysentery and constipation	Tandik	F/Fr
Potentilla anserina L	Rosaceae	Diarrhea, kidney stone and stomach complaints	Toma	L
Potentilla argyrophylla Wall. ex Lehm	Rosaceae	Chest and Throat pain	Skyaldaypo	R
Potentilla multifida L	Rosaceae	Insomnia	Thak-toma	S
Prangos pabularia Lindl	Apiaceae	Carminative, stimulant and diuretic	Prangos	Fr
Primula denticulata Sm	Primulaceae	Cold, headache and gastric problems	Tarla-iching	Sh
Primula macrophylla D. Don	Primulaceae	Cough &cold and joint pain	Khi-chey	W
Primula rosea Royle	Primulaceae	Muscular pain	Troma	R
Psychrogeton andryaloides (DC.) Novopokr. ex Krascha	Asteraceae	Wounds	Lukchung	W
Ranunculus brotherusii Freyn	Ranunculaceae	Indigestion	Chu-rugpa	L/Fr/ S
Rheum australe D. Don	Polygonaceae	Internal injuries, bone fracture, indigestion and general weakness	Chun-tswa	R
Rheum spiciforme Royle	Polygonaceae	Rheumatism and veterinary	Lacchu	R

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Table A1 (*continued*)

Botanical name	Family	Medicinal properties	Local name	Parts used
Rheum webbianum Royle	Polygonaceae	Appetizer, purgative, astringent and wounds	Lacchu	R
Rhodiola fastigiata (Hook. f. & Thomson) S.H. Fu	Crassulaceae	Congestion in chest and cough	Rholo mukpo	W
Rhodiola himalensis (D. Don) S.H. Fu	Crassulaceae	Headache	Rholo	L/Sh
Rhodiola imbricata Edgew	Crassulaceae	Tonic	Rrholo karpo	R
Rosa webbiana Wall. ex Royle	Rosaceae	Bleeding, jaundice and liver problems	Sai marpo	Fr/F
Rumex patientia L	Polygonaceae	Fever, skin disorder, rheumatism and backache	Shoma	L/Sh
Sagina saginoides (L.) H.Karst	Caryophyllaceae	Food poisoning, diarrhea, cold and fever	Gangachon	W
Salix alba L	Salicaceae	Knee, hip pain and fever	Malchang	B
Salix denticulata Andersson	Salicaceae	Joint pain and menstrual disorder	Langma	L/S
Saussurea obvallata (DC.) Edgew.	Asteraceae	Kidney problems	Yuling	W
Saussurea bracteata Decne	Asteraceae	Wounds & cut, boil, headache, fever, cough and veterinary	Spangsi-tawo	R/F
Saussurea gnaphalodes (Royle) Sch.Bip	Asteraceae	Retardness and depression		L/F/R
Saussurea schultzii Hook.f	Asteraceae	Headache cough, fever and throat ache	Jarbag	L/S
Saxifraga flagellaris Willd	Saxifragaceae	Increasing of life span	Sumchutik	W
Sedum ewersii Ledeb	Crassulaceae	External injury and toothache	Dachungpa	W
Senecio chrysanthemoides DC	Asteraceae	Dysentery problems	Rgu-dus	W
Silene moorcroftiana Wall. ex Benth	Caryophyllaceae	Ear and nose problems(ENT) and anemia	Sugpadagbyed	L
Sisymbrium orientale L	Brassicaceae	Appetizer and carminative	Staga	S
Stachys tibetica Vatke	Lamiaceae	Insecticide, mites and lice control	Churukpa	Sh
Swertia petiolata Royle ex D.Don	Gentianaceae	Headache and body-ache	Zatik	W
Swertia thomsonii C.B.Clarke	Gentianaceae	Stomach disorder	Tikya	W
Tanacetum gracile Hook.f. & Thomson	Asteraceae	Anti-worm	Kham-chu	L/F
Taraxacum officinale Webb	Asteraceae	Mouth blisters, liver problems and digestive system, alcoholism and intestinal worms	Kurmang	F
Thlaspi arvense L	Brassicaceae	Digestion and gastritis	Brega	W
Thalictrum minus L	Ranunculaceae	Gout and rheumatism	Chak-ackoo	Sh/L
Thermopsis inflata Cambess	Fabaceae	Swelling	Dugsrad	W
Thymus linearis Benth	Lamiaceae	Stomachache, gastrointestinal problems and used in pregnancy	Tumburu	W
Tragopogon gracilis D.Don	Asteraceae	Laxative	Tharnoo	F
Trigonella emodi Benth	Fabaceae	Fever, anemia and peptic ulcer	Shamilik	L/S
Urtica hyperborea Jacq. ex Wedd	Utricaceae	Cold & cough, stomach ache and rheumatism	Zahchot	W
Verbascum thapsus L	Scrophulariaceae	Used as diuretic, blood disorder, sores, infections, bleeding wounds and cuts	Ngo-serjee	L/S/Fr
Viola kunawurensis Royle	Violaceae	Heart diseases	Rholo	F
Waldheimia glabra (Decne.) Regel	Asteraceae	Headache and fever	Thumba	W
Waldheimia tomentosa (Decne.) Regel	Asteraceae	Joint pain and headache	Lukmik sepo	W

Abbreviations: B=Bulb, F=Flower, Fr=Fruit, L=Leaves, S=Stem, Sh=Shoot, W=Whole plant.

Table B1
Animal parts used in Sowa-rigpa system of medicine.

Animal organ	Animal name (local name)	Use
Horns/Antlers	Rhinoceros (Seru)	Liver disorder
	Reindeer (Shawa)	Drying of pus
	Wild yak (Dong)	Indigestion
	Spotted deer (Ridaks)	Drying of pus
	Gazelle (Goa)	Diarrhea
	Tibetan antelope (Tsǫd)	Child birth
	Urial (Shapo)	Drying of pus
	Wild sheep (Napo)	Antibiotic
Bone	Human skull	Drying of pus
	Human scapular	Chronic fever
	Domestic sheep (Luk)	Intestinal pain
	Tiger (Stak)	Arthritis and fracture
	Domestic pig (Phak)	Intestinal pain
	Monkey (Manu)	Child birth
	Ungulate bones(Ridaks)	Drying of lymph and pus
Flesh	Human (Me-sha)	Poison, plague and epilepsy
	Snake small (Chaks-sbrul) skin	Eye problems
	Vulture (Khowa)	Digestion and goiter
	Peacock (Map-ja)	Poisoning and throat infection
	Otter liver	Liver related disease and reproductive disorder
	Marmot (Phai) liver	Bone fracture and stomach pain
	Domestic goat (Rama)	Liver, lung, kidney eye and lung disorders
	Wolf (Chanku) tongue, stomach	Tongue cures inflammation and stomach cures digestion problems
	Pig tongue	Cure growth of nodules in the bones
	Dog (Khi) tongue	Ulcer
	Ass tongue	Diarrhea
	Fox (Watse) lung	Lung ulcer
	Bat	Anti-vomit
	Sparrow (Chipa)	Kidney problems

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Table B1 (*continued*)

	Lizards (Galchik)	Promotes semen production
	White-breasted dipper	Poisoning
	Pigeon (Phorgon)	Semen production
	Chukar (Rakpa)	Impotence cure
	Tortoise (Sbalpa)	Diphtheria and tongue swelling
	Fish (Nya)	Acidity
	Crab	Kidney disease and urinary infection
	Goat liver	Liver and bile disorder
	Elephant (Langpoche) liver	Antipyretics
	Reindeer (Shawa)	Anti-worm
Blood	Pig	Acidity and blood vomiting
	Wild yak (Dong)	Anemia and heart disease
	Goat (Rathak)	Small-pox, arthritis, bruises and anemia
	Donkey (Boo)	Wounds and joint pain
	Pig	Wounds and skin diseases
Fat	Reindeer (Shawa)	Skin diseases, lice control and anti-vomit
	Sheep	Vertigo and ear problems
Brain	Rabbit (Rivong)	Diarrhea and dysentery
	Dog	Cure retardants
Heart	Rabbit	Cure retardants
	Bear (Denmo)	Dysentery and wounds
Bile	Elephant (liver- part)	Fever
	Cow urine	Infection and antipyretics
Urine/stool	Horse droppings	Infection and anti-vomit
	Rabbit droppings	Skin diseases
	Pigeon	Inflammation, ointment wound
	Shell (puskyok)	Weakness and edema
Other	Musk deer (Lhasi)	Anti-vomit and liver disorder
	Pearl (motik)	Paralysis and nerve pain

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Abbreviation

MHCP	Modern Healthcare Practitioner
PHC	Primary Health Centre
BTMS	Bachelor of Tibetan Medicine
ISA	Indicator Species Analysis
CPS	Conservation Priority Score
WHO	World Health Organization
NGOs	Nongovernment Organizations
CBD	Convention on Biological Diversity
IUCN	International Union for Conservation of Nature
WCED	World Commission on Environment and Development
TK	Traditional Knowledge
TKS	Traditional Knowledge System
MDS	Multidimensional Scaling
RFC	Relative Frequency of Citation
RI	Relative Importance Index
CVI	Cultural Value Index
CI	Cultural Importance Index
ANOVA	Analysis of Variance
SPSS	Statistical Package for the Social Sciences
PAST	Paleontological Statistics
NU	Number of Use
UR	Use Report
FC	Frequency Citation
AGDEM	Aster Global Digital Elevation Model
GPS	Global Positioning System
GIS	Geographical system
WII	Wildlife Institute of India
ISA	Indicator Species Analysis
OIV	Observed Indicator Value
CPS	Conservation Priority Score
MAPs	Medicinal and Aromatic Plants
MPs	Medicinal Plants
THCS	Traditional health Care System
THCP	Traditional health Care Practitioner
ICIMOD	International Centre for Integrated Mountain Development

Executive Summary

A study on ethno-flora with special reference to traditional health care systems (THCS) was conducted in Western Ladakh, Jammu & Kashmir (Indian Trans-Himalaya) during 2009-2013. The major objectives of the study were: i) to study and compare the traditional health-care system across major ethnic groups (Boto, Balti and Dards) in Suru, Wakha-chu and Lower Indus valleys, ii) to document the Traditional Knowledge System (TKS) across various ethnic groups, and iii) to assess the conservation status of ethno-medicinal plants in the study area. To meet the objectives of the study a detailed field investigation was undertaken in all the valleys. The field work involved questionnaire survey and group discussions in the three valleys to document traditional healthcare system (THCS), perception of people and allopathic doctors regarding THCS (objective 1); Interviews of local healers and different sections of the society to assess the status of traditional knowledge (objective 2); and Rapid survey of wild medicinal plants across various land forms, habitat and vegetation types so as to ascertain the distribution of ethno-flora across various landforms, and ethnoecology and conservation prioritization of Ethno-flora (objective 3).

The study area is located above 2700m altitude and is characterized by unique geographical and socio-cultural attributes. Traditional medicine is one of the tangible heritage of the local people in Ladakh, which has been an indispensable source of both preventive and curative medicine. At present, THCS of Ladakh provide its services to more than 30% of population. Three different traditional health-care systems (THCS), *Sowa-rigpa*, S*hamanism* and *Akhonism* were studied in detail with a view to conserve the valuable knowledge and the plant resources upon which these system depends. The traditional knowledge of the people regarding plant resources and their use pattern in different use categories was documented to understand the interaction between people and natural resources, and the factors that influence this dynamic process.

The study design includes selection of representative and adequate number of samples from different target groups (180 individuals in each valley with equal

number of male and female; each gender group comprises equal number of people from three age groups; *Amchis, Akhons, Shamans* and allopathic doctors) and vegetation parameters (65 hectare plots in Suru, 51 in Wakha and 39 in Lower Indus; distributed across 9 landform units with minimum two plots in plateau habitat and 21 in stable landform; distributed across three months, i.e., June-mid- September); collection of data through standard protocols (vegetation sampling after Muller-Dumbois and Ellenberg (1974); questionnaire survey using snowball sampling and personal interview), analysis of data (socio-economic status of traditional healers, status and use pattern of ethno-flora) using both qualitative and quantitative methods (free listing, ranking, ANOVA, chi-square test and multiple regression) and prioritization of plants based on their population status and harvesting pressure. Data from different valley was collected in different year and hence they lack any temporal trend. Finally, the distribution maps of prioritized plant species were generated to select areas for conservation activities.

As a part of the first objective, an assessment of social status of traditional healers and dependency of local people on THCS was done through semi-structured questionnaire and personal interviews. The perception of the allopathic doctors on integration, collaboration and legalization of THCS was also determined. At present 36 *Amchi* healers (*Sowa-rigpa*), 21 *Shamans* and 53 *Akhons* are practicing in Western Ladakh. They treat more than 17 diseases including some chronic respiratory diseases and arthritis. Their treatment techniques include Oral medicine (more than 300 formulations), Moxibustion (treatment through hot needle touch), Puncturing of veins (treatment through allowing blood to ooze out) and Medicinal hydrotherapy (treatment through hot water). The socio-economic status of *Amchi* healers is critical and young generation is not willing to adopt this system due to the lack of financial support and due to modernization and acculturation. People's perception on the effectiveness of this system was overwhelming and majority of them are in favor to legalize the *Amchi* system. According to the perception of doctors, providing training to *Amchi* healers on the nutrition and hygiene and allocating resources for more effective drug selection through clinical trials has potency to improve this system immensely. People visit *Akhons* and *shamans* less frequently as compared to *Amchis*.

The practice of *Shamanism* has increased in recent years due to increase in non-native visitors and the proportion of young people involved in this system is highest (52%). Most of the people were uncertain regarding the legalization of these two systems due to lack of scientific approach to treat the patients.

Traditional knowledge (TK) was assessed through questionnaire survey and personal interviews with 540 local respondents from three different valleys (Suru, Wakha-chu and Lower Indus). A total of 246 species were recorded, which belong to eight different use categories, *i.e.* food, fodder, fuel wood, religious, medicinal, dye, ornamental and others (roofing, flooring, hallucination etc.). The preference of species was determined based on free listing and ranking. Ethno-botanical indices, *i.e* Relative frequency citation (RFC), Relative importance (RI), Cultural value (CV) and Cultural importance (CI) indices were used to calculate their total importance and finally 30 plants were categorized as species of high conservation priority. *Arnebia euchroma, Juniperus communis* and *Artemisia* spp. with total frequency of citation 442, 463 and 470, respectively are plants of highest cultural importance. There is no difference in the knowledge of male and female in western Ladakh., however indigenous communities of Lower Indus valley (*Brokpa*, an ethnic group) has more knowledge than that of other two valleys. The socio-economic factors (age, ethnicity, distance to town, religion and education) were strongly related to the knowledge of informants (R^2=0.68, dF=5, F=232.79 and P<0.01).

Population parameters of plants were derived using standard methods of vegetation analysis (Rawat and Adhikari 2005). Stratified random sampling and extensive field surveys were conducted covering different altitudinal zones (2700-5500m) in nine landforms units (field margins, alpine meadows, marsh meadows, stable slopes, bouldery slopes, cliff and rocks, moraine, scree and plateau). Analysis of data from 155 hectare plots consisting of 3875 quadrats (1x1m) resulted in 301 species belonging to 159 genera and 51 families. Indicator species analysis (ISA) discriminated eighty-one ecologically interpretable vegetation groups (24 in Lower Indus; 25 in Wakha-chu and 32 in Suru valleys). *Geranium* sp.-*Aconogonum tortuosum* vegetation group in stable slope and *Taraxacum officinale-Euphrasia himalayica* in marsh meadow have highest richness. Shanon's diversity index (H)

varied from 1.44 to 4.13. The diversity was highest in stable slope of Wakha-chu (H'= 4.13) followed by stable slope in Suru (H'= 4.09) and bouldery slope in Lower Indus valley (H'= 3.29). Richness of species varied from 17 to 123 in different landform units of which lowest was recorded in plateau and maximum in stable slope. Evenness (E) varied from 0.42 to 0.92, indicated that the species distribution was uneven in alpine meadow in Wakha-chu valley and evenly distributed in moraine landform in Wakha-Chu valley. In Lower Indus valley, highest density was recorded for *Allium prezewalskianum* (10.29/ m^2) across four different habitat, i.e., alpine meadow, plateau, stable slope and bouldery slopes. Lowest density was recorded for *Saussurea bracteata* (0.5/ m^2) which occurred only in bouldery slope. In Wakha-chu highest density was recorded for *Codonopsis ovata* (8.92/ m^2) which occurred along field margins and in the alpine meadows. *Papaver nudicaule* has the lowest density (0.15/ m^2) and occurred only on stable slope. In Suru valley *Dactylorhiza* spp. (D=5.15/ m^2) has the highest density which occurred in two landform units, i.e., field margin and marsh meadows, whereas lowest density was recorded for *Clematis tibetana* (D= 0.08/ m^2) from rock and cliff type of landform units.

The conservation status of ethno-flora was assessed based on four parameters, *i.e.* density, harvesting risk, frequency of collection and use diversity. The conservation score was calculated only for plants with high cultural importance. These plants were kept in three broad categories, *viz*, Category I: species were very rare and hence needs strict protection, Category II: species had low density and should be avoided for harvesting, and Category III: species had high density and has potential for harvesting. Each of the categories highlights a species-specific management plan for conservation and sustainable harvest. The habitat suitability maps of 16 plants species from category I were prepared in geographical information system (GIS) domain to select the suitable areas for conservation purpose.

The present study concludes that THCS of Western Ladakh is not only a viable source of healthcare services for the people, but also has potency to become best alternative of allopathic system, if such initiatives are taken by the government. Traditional knowledge of people is rich and they use native species for most of their purposes. However, high cultural importance and low reported density of several

plants indicate high harvesting pressure and hence there is an immediate need to develop sustainable resource management plan to conserve these species. Local community can be involved in the conservation and monitoring of species to reduce the cost of management practices. Adaptive monitoring and management that allow the development of harvesting practices through 'learning by doing' can be used to manage plant resource in a sustainable way.

"There is much to use of nature's way. It is with you always, available to you always. Take time to hear and see that which is close at hand. There are forces in you untried. They are yours to be used as you find them"

John and Lyn St Clair-Thomas

Personal notes

During recent years, I spent much time observing the people and culture of my native Ladakh. Although I was a part of it, I rarely had the opportunity to spend much time in my land and with my people due to my higher studies in Dehradun. The same applies to most of the young generation of Ladakh, which has led to acculturation. They are more inclined towards the western culture and are not aware of their culture and traditional practices, which is so rich and unique. My work is an attempt to reduce this gap and to know the culture and practices deeply rooted in the older generation.

Ladakh is known to be a mysterious land by many writers and scholars. Despite being a part of its culture, it was difficult for me to understand the reason behind several cultural practices and this curiosity encouraged me for the present research work. The most fascinating aspect for me was my family tradition, which says that we are healers '*Lhas*' (*Shamans*). This tradition had been passed on from generation to generation in the family with a motive to serve people through providing treatment. I gained a fascination for the wonders of treatment techniques that my ancestors and elders have been using, being not only *Shaman*ist but also herbal healers. This reverence and inquisition induced me to pursue scientific research more seriously. Herbal healers came into limelight after the inclusion of "Sowa-Rigpa" under sections 2,3,8,9 and 17 of the Indian Medicine Central Council Act, 1970 thereby recognizing this system legally on 2009 10th September.

The research was designed to understand the various components of healthcare in Western Ladakh. The present work was conducted in three different valleys with different ethno-ecology, ethno-botany, and traditional healthcare systems. The origin of the people in each valley is different. Their dependence on plants is very high and herbs are an integral part in most Ladakhi society where it is used as medicine, food, fodder, fuel wood, ornaments and artifacts. My work on ethnoflora of Ladakh is an attempt to answer several questions regarding the species-specific use pattern and their distribution that would be useful from a resource management point of view.

CHAPTER 1

Introduction

1.1 Origin, History and Future Scope of Ethnobotany

Dependence of human beings on plant resources can be considered as early as the origin of humans itself but the recognition of resources with individual identity (plant taxonomy) happened much later. The Sumerian ideograms, dating back to 4000 B.C. can be considered the oldest civilization of the world that depicts plant uses. Other historical evidence of plant uses are the Ebers Papyrus, written in Egypt (1500 B.C.), Erh-ya, the oldest Chinese book on nature studies (3000 B.C.) and the sacred Vedas of India (1500-1000 B.C.). The discipline dealing with the study of plant utilization by aboriginals is termed as ethnobotany. The term ethnobotany has its origin in 1895 by John Harshberger (Cotton 1996). However first holistic definition of ethnobotany was given by Robbins et al. (1916) who defined it as a "Study and evaluation of the knowledge of all phases of plant life amongst primitive societies and effect of the vegetal environment upon the life". Ethnobotany is a multidisciplinary subject which incorporates the culture or practice of ancient knowledge that deals with the interaction between peoples and plants (Turner 1995). Other definitions of ethnobotany includes-

- "Ethnobotany is the study of the interactions between 'primitive' humans and plants." (Jones 1941)
- "Ethnobotany may be defined as the study of plants relationships, which exists between people of a primitive society and their plant environment." (Schultes 1962).
- "The study of the direct relationships between humans and plants" (Ford 1978). He added it as a unit of an ecological study specialization in the interaction of man and the plant world.
- "The study of the relationships between people and plants, especially the utilization of plants by people" (Given and Harris 1994).
- "All studies (concerning plants) which describe local people's interaction with the natural environment" (Martin 1995).

Ethnobotany as a discipline includes collaboration with other disciplines such as ecology, chemistry, anthropology, economics, and linguistics (Prance 1991). The founding father of this discipline is Richard Evans Schultes. Since its origin, this discipline has evolved from merely documentation of plant uses to the various other aspects, such as biosynthesis for drug development and biodiversity conservation (Turner 2000). Leopold Glueck, a German physician working in Sarajevo at the end of 19th Century, is considered the first individual to study the plant from ethnobotanical perspective. His published work on traditional medical uses of plants by rural people in Bosnia (1896) is considered the first modern ethnobotanical work (Wikipedia 2012). In India, ancient literature, relevant to ethnobotany can be found in the Vedic scriptures such as Charak and Shusrutu and Charak samhita. The glimpses of Indian ethnobotany (Jain 1981) and the Bibliography of Ethnobotany (Jain 1964) form the first books of ethnobotany in India. Organized study of ethnobotany is of recent origin in India with about 300 papers published on various aspects of ethnobotany (Kumar 2011).

Being multidisciplinary in nature, there are numerous approaches and applications of ethno-botanical studies (Alexiades 1996). Among several sub-disciplines of ethnobotany, ethnopharmacology has evolved as the most widely studied due to its vast economic potentials. A large number of modern drugs have been isolated from natural sources, many based on their use in traditional medicine (Table 1.1).

Table 1.1 Active constituents of medicinal plants used worldwide

Drug	Medicinal Use	Plant source
Aspirin	Reduces pain and inflammation	*Filipendula ulmaria*
Codeine	Eases, suppresses coughing	*Papaver somniferum*
Ipecac	Induces vomiting	*Psychotria ipecacuanha*
Pilocarpine	Reduces pressure in the eye	*Pilocarpus jaborandi*
Pseudoephedrine	Reduces nasal congestion	*Ephedra sinica*
Quinine	Combats malaria	*Cinchona pubescens*
Reserpine	Lowers blood pressure	*Rauvolfia serpentina*
Scopolamine	Eases motion sickness	*Datura stramonium*
Theophylline	Opens bronchial passages	*Camellia sinensis*
Vinblastine	Combats Hodgkin's disease	*Catharanthus roseus*

These plant based traditional medical systems continue to play an essential role in healthcare, with about 80% of the world's inhabitants relying mainly on traditional

medicines for their primary healthcare (WHO). Globally there were 119 compounds from 90 plants which were used as single entity medical agents (Farnsworth et al. 1985). About 77% of these were obtained as a result of examining the plants, based on ethnomedical knowledge (Cordell 2000).

In India, Mitra and Jain (1991) summarized the information on medicinal plant uses from English literature published in the 19th century in the form of catalogues, dispensaries, pharmacopoeias and illustrations of plants with notes on medicinal uses, which culminated in Watt's (1889-1896) six-volume Dictionary of Economic Products (Cotton 1996). Out of more than 15,000 plant species so far reported from India, about 2,000 are known to have medicinal properties and many of them are used as traditional medicines in the rural and remotest parts of the country (Arora 1985).

Apart from medicine, people uses plants for food, shelter, dyes, cosmetics, clothing and various other purposes. The knowledge, gathered over centuries from their surrounding environment, has been passed through generation to generation with or without written documents. Without proper documentation, the information or knowledge may not be available for long time. The extinction of knowledge is as important as biological extinction (Cox 1999). More than 50 percent of the world's languages have disappeared in the last century and 90 percent of the remaining languages will either die or become moribund in this century (Krauss 1992). The loss of language and traditional knowledge due to acculturation and plant habitat destruction is a major concern, particularly among smaller and more vulnerable tribes and indigenous groups. This is a major problem that should concern the whole world and ethnobotanists in particular. The advocacy for conservation of ethno-flora will continue and strengthen in future, as indigenous peoples, governments, educators, nongovernment organizations (NGOs) and corporations will struggle to address impending environmental degradation and accelerating loss of cultural knowledge and language (Turner 2000). Protection of intellectual property (traditional knowledge) is borne within the context of international imperatives to respect and support the rights and knowledge of indigenous peoples worldwide (CBD).

Ethnobotanists have a major role to play at both the community level, in the documentation and protection of botanical and ecological knowledge, and at broader regional, national and international levels in policy development for the recognition and protection of such knowledge (Turner 2000).

Assistance in developing school and college curricula, science and cultural camp activities, museum exhibits, locally relevant plant guides, ethnobotanical gardens and eco-cultural centres can be a practical and effective way for an ethnobotanist to support local communities (Turner 2000). In addition, ethnobotanists can help in developing programs for communicating ethnobotanical knowledge and practices in ecotourism ventures, in undertaking collaborative research on sustainable harvesting of Non-Timber Forest Products, or in helping to link indigenous and local communities with ethical partners for developing and marketing local products (Turner 2000). Bioprospects that focus on the development of new drugs for huge markets is probably the most promising research area requiring the help of ethnobotanists. Contemporary ethnotbotanical studies can be a way of catalyzing awareness of the value of biological diversity and support for its conservation among a broad range of people (Balick 1996). The deep relationship between plants and people, in both traditional and acculturated societies can be elucidated through ethnobotanical studies and used to increase biological literacy among the non-scientific community (Balick 1996).

1.2 Orientation of chapters

Folk treatments are part of healthcare practices in Ladakh but the traditional knowledge regarding ethnobotany is now eroding due to modernization, development and introduction of modern healthcare. The present research work entitled **'A study on ethno-flora, with special reference to traditional healthcare system in Western Ladakh, Jammu and Kashmir'** was carried out to conserve the traditional knowledge, ethno-ecological knowledge and biodiversity which will not only help in understanding the changing scenario of the healthcare practices but also provide the necessary information on the available natural medicinal plant resources of the study area.

In chapter II, the study area (Western Ladakh) is discussed in detail regarding the physiography, drainage, soils, glaciers, lakes, important passes, trails and location, climate, biological attributes (flora and fauna), culture profile (ethnic groups and demography), traditional land use practices and socio-economy of Ladakh. It concludes with a brief section on the history of their traditional practice of healing.

Chapter III discusses the healthcare systems in the three different valleys in Western Ladakh (Suru, Wakha-chu and Lower Indus valleys). The perspectives, experiences and personal accounts of *Amchis*, *Shamans* and *Akhons* (THCS) were assessed.

Chapter IV highlights whether modern health-care practitioners appreciated and understood the traditional healing systems. Furthermore, drawing on a blend of qualitative and quantitative research design, the study was intended to establish the extent to which traditional medicine equipped health practitioners with knowledge of traditional healing techniques and whether practitioners would reconcile traditional and conventional medicine.

Chapter V deals with ethno-ecology, which includes ethnobotany, ethnopharmacology and traditional knowledge of the people across the three valleys.

Chapter VI deals with the floristic diversity of Western Ladakh. It also details the distribution of ethno-flora across landforms and communities.

Chapter VII aims at categorizing key species according to their conservation score, based on data analysis (cultural importance) from Chapter V., which was further grouped on conservation priority, based on a paper by Dzerofos and Witkowski (2001). Mapping of harvesting and conservation areas in each valley using participatory resource mapping and distribution of these plants using geographical information systems (GIS) incorporated with species distributions.

The study provides the results of a community-based inventory of useful plants carried out between 2009 and 2013 in three different valleys of Western Ladakh. Recorded ethnobotanical data from thirty-six local healers belonging to three communities (Purigkey, Brokpas and Balti) and fellow villagers are presented.

1.3 Ethno-flora and Ladakh

Ladakh, located in the Indian Trans-Himalaya, represents a unique region well known for its natural, biological, aesthetic and socio-cultural values. The region is spread over approximately 96701 km^2 and inhabited by different ethnic groups including Boto, Balti and Dard. It is surrounded by the Greater Himalaya in the south, the Tibetan Plateau in the east, the Karakoram ranges in the north and dry arid areas of northern Pakistan in the west. The region has had a special historical significance as it provided linkages with a number of Central Asian regions including Tibet, Yarkand, Kashmir, Lahaul and Spiti and traversed by a large number of traders, explorers, and

missionaries. The topography, climate and vegetation of the region are significantly different from the rest of the Himalaya in being much colder, drier and devoid of forests (Bhatnagar et al. 2002). In spite of the overall low numbers of species of plants and animals, the region is home of highly specialized assemblage of flora and fauna and a unique traditional knowledge of healthcare systems, which evolved over several centuries of physical and cultural isolation (Das 1966).

A perusal of literature on the flora and fauna of Ladakh reveals that this region has not been fully explored in terms of ethno-flora, traditional healthcare systems and distribution of many high value species (Dickoré and Miehe 2002, Humbert-Droz and Dawa 2004, Pfister 2004). Table 1.2 lists the major ethnobotanical studies in Western Ladakh.

1.4 Issues and Gaps

With the increase in urbanization and development (infrastructure, roads, electricity, etc.), Ladakh is undergoing rapid transformation in terms of its socio-economics. Population of humans as well as livestock has increased abruptly since 2001 (232459 to 290492 persons). While the ethnic communities need to be brought in the mainstream of development, there is a fear that these fragile ecosystems may degrade further and the age-old traditional knowledge may erode which has so far helped in sustainable use of natural resources (Jina 1981, Humbert and Dawa 2004). With the increasing human population and excessive exploitation of natural vegetation, several areas have degraded significantly. One of the major and most commonly cited reasons for such degradation is erosion of traditional knowledge and lack of conservation awareness among local communities.

Linkages between plant resources and ethnoecological knowledge have not been adequately researched and documented. Hence, there is a need to conduct a detailed investigation on various components of indigenous knowledge on ethno-flora from cultural, religion, lingual, historical and scientific perspectives.

The region supports a large number of pastoralist communities who use the area for livestock grazing and fuel wood collection during summer season. Concern has been expressed that the unsustainable grazing and extraction of fuel wood from the wild would change the plant communities, its habitat and may even cause local extinction of important medicinal plants.

Table 1.2 Major research studies on Ethno-flora in Ladakh

Study Tittle/ Research	Researcher	Year
Travels in the Himalayan Provinces of Hindustan and the Punjab; in Ladak and Kashmir; in Peshawar, Kabul, Kunduz and Bokhara from 1819 to London	W. Moorcroft, G. Trebeck, H.H Wilson	1841
The flora of Ladakh and Western Tibet	R.R.Stewart	1916-1917
Phytosociological and floristical explorations	H. Hartmann	1968–1997
Flora of Ladakh; An ecological and taxonomic appraisal	P. Kachroo, B.L. Sapru and U. Dhar	1977
Medicinal plants of Kashmir and Ladakh (Temperate and cold Himalaya)	M.K. Kaul	1977
Medicinal systems of Ladakh, India	Navchoo I.A.and G.M Buth	1989
Ethnobotany of Kargil-Medicinal Plants used by Balti, Dard, Bokpa Races	P.N. Gohil and M.A. Quardi	1992
Patterns of plant species distribution in the Trans-Himalayan region of Ladakh, India.	C.P. Kala and V.B. Mathur	2002
Vegetation characteristics and patterns of livestock grazing in Changthang plateau, eastern Ladakh	G.S. Rawat and B.S. Adhikari	2002
Ethnobotany of Boto tribe of Ladakh Himalaya	B. Ballabh	2002
Life-forms and clonality of vascular plants along an altitudinal gradient in E Ladakh (NW-Himalayas)	L. Klimeš	2003
A contribution to the vascular plant flora of Lower Ladakh (Jammu and Kashmir, India)	L. Klimeš and W.B. Dickore	2005
Millennia of grazing history in eastern Ladakh, India, reflected in rangeland vegetation	G.S. Rawat and B.S. Adhikari	2005a
Floristics and distribution of plant communities across moisture and topographic gradients in Tso-Kar basin, Changthang plateau, Eastern Ladakh	G.S. Rawat and B.S. Adhikari	2005b
Traditional medicinal plants of cold desert Ladakh used in treatment of cold, cough and fever	Ballabh, Basant and O.P. Chaurasia	2007
Social change, religion and medicine among Brokpas of Ladakh, Ethnomedicine	V Bhasin	2008
Clonal growth forms in eastern Ladakh, Western Himalayas: classification and habitat preferences	Klimešová J., J.Doležal, M.Dvorský, F. de Bello and L.Klimeš	2011

The threat is not only to the plants but also to the traditional healthcare system, which is eroding at an alarming rate. Loss of the traditional or indigenous knowledge is an inevitable result of these changes. Detailed studies of these parameters are deficient in Ladakh.

A number of studies have been undertaken in and around Ladakh over the last decade covering anthropology, ecology, ethnobotany, ethnopharmacology, geology, etc. In spite of 100 years of research work, there are still major research gaps in Ladakh. A broad area where information is still lacking includes a proper database of medicinal plants, ethno- flora, ethnoecological knowledge and many more.

Ethno-flora of the study area has been explored by other researchers as well but there is no long-term study on the ethno-flora, its use and status in the wild. This study focuses on the plants used by the local healers in the study area with respect to traditional healthcare systems and also reveals the traditional knowledge, ethnoecology and the geographical distribution of some important plants in the study area. Many studies have been done in the Suru valley but these studies discuss only medicinal plants while traditional knowledge and ethnoecology has not been addressed. The present study covers the research gaps related to the ethnoecolgy, traditional knowledge and ethno botanic study across the three valleys of Ladakh.

1.5 Objectives and Questions

The overall objectives and underlying research questions are as follows:

a. To study and compare the Traditional Health Care System (THCS) across major ethnic groups in Suru, Wakha-chu and lower Indus valleys.

- Traditional health-care Systems across major ethnic groups
- People's Perception towards traditional health-care systems

b. Traditional Knowledge System (TKS) across various linguistic groups.

- What is the status of traditional knowledge in the study area?
- What are the plants used for by the local people?

c. To assess the conservation status of ethnomedicinal plants in the study area.

- Distribution of ethno-flora across various landforms, communities
- Ethnoecology and conservation prioritization of Ethno-flora.

1.6 Challenges and Limitations

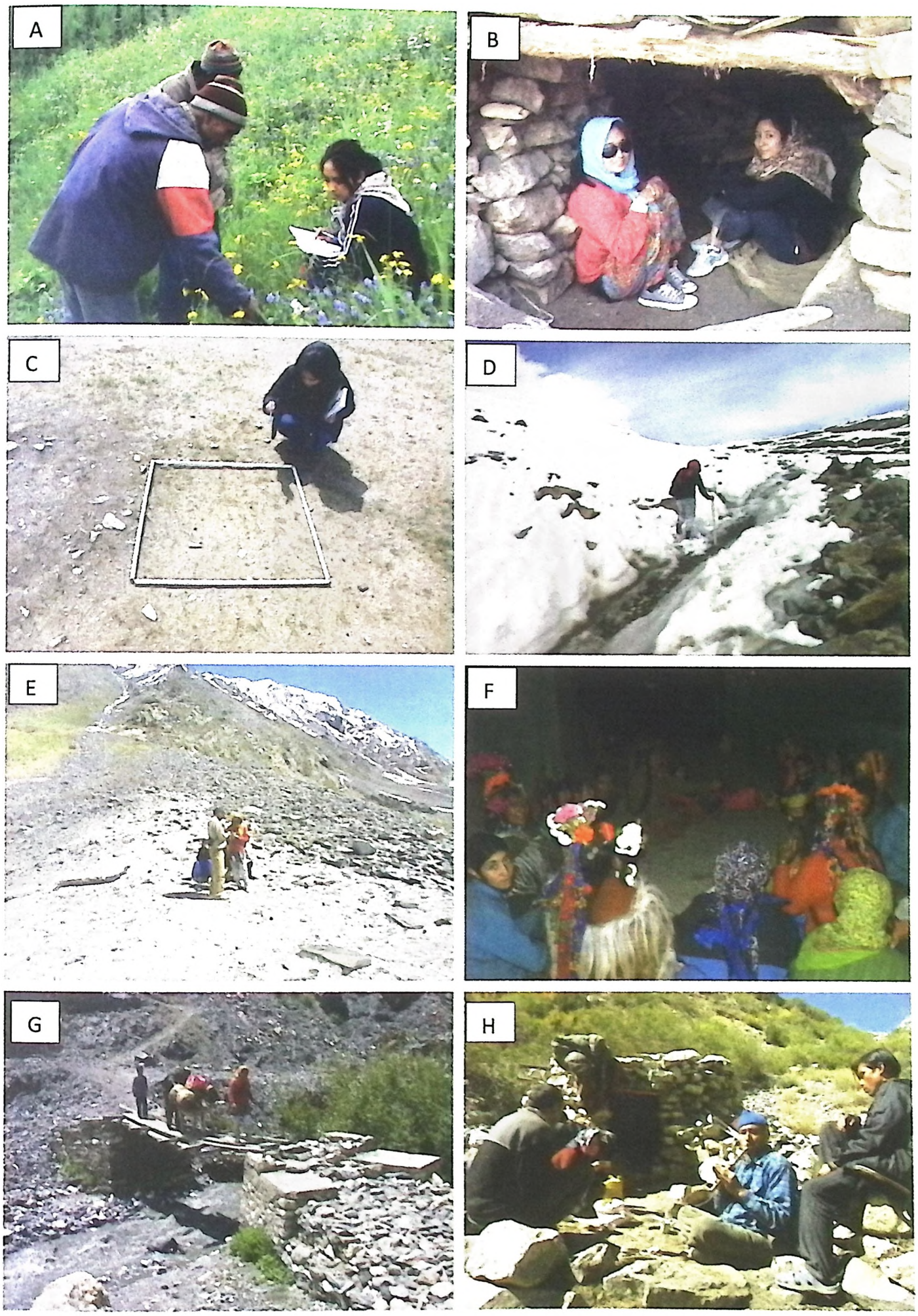
The challenges to this study include a large study area in the Trans-Himalaya, with steep mountains undergoing a rapid change due to landslides and floods. The vegetation study was carried out on different landforms along the gradient.

Climate: The vegetation was best observed in July and August. The limited time span and unpredictable rainfall leads to landslides and floods, which block the roads and bridges.

Geography: The large geographical area of this study, with highly rugged terrain, is difficult to access and I covered these areas mostly on foot and often alone.

Finances: During vegetation sampling, tents and porters @ 300 INR were hired with one healer @ 300-350 INR per day; camping and cooking costs were high.

Lack of support from locals: Getting information from local residents is sometimes difficult due to the issue of knowledge sharing which was considered intellectual property. In the wildlife sanctuary (Kanji), people are in conflict with the wildlife department, so they did not allow sampling in the valley. But after convincing them that we are locals from the same nearby area, they opened up to our questioning.



A. Interaction with *Amchis* **B.** Stay in coral during field work **C.** Plant sampling using quadrat **D.** Sampling at the highest point 5500m **E.** Field work with Supervisor **F.** Group discussion with Locals **G.** Tracking in the field **H.** Stay with *Amchis*

Plate I: Field and Methodology

CHAPTER 2

Study Area: Western Ladakh

2.1 INTRODUCTION

Himalaya is the youngest of world's all mountain chains and contains highest mountain peaks in the world (Sherpa et al. 2004). Himalayan and the trans-Himalayan areas covers 12% of the country's 3.3 million km^2 geographical area in six Indian states which includes Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, part of West Bengal and Arunachal Pradesh (Tambe 2007). Unlike other parts of Himalaya, Indian Trans-Himalayan has a characteristic of cold arid environment, low productivity and sparse vegetation cover. The physiography of the area is highly rugged with stiff glaciers. The Himalayan region is known for its rich wealth of ethno-flora which is being utilized by the local inhabitants since ages but are getting recognition world over only recently.

The Ladakh region of Jammu and Kashmir is characterized by its rich culture, Buddhist monasteries, part of old silk route, trans-Himalayan panorama, unique wild life, lofty mountain chains, with broad open intermountain valleys dotted with saline water lakes and hot springs (GSI). Ladakh is sometimes referred as "Little Tibet" due to its cultural similarity, as Buddhist population dominates in the area. Ladakh consists of two districts, *viz.*, Kargil and Leh. It is flanked by the Kunlun mountain range in the north and the Greater Himalaya to the south, inhabited by people of Indo-Aryan and Tibetan descendents. The word 'Ladakh' came from the local word '*Ladwags*' which implies the land of high passes and is very aptly coined because of the altitude where it lies (2900m to 5900m asl.). It is one of the highest inhabited areas in the world. The region is sparsely populated and most of the settlements are typically around the banks of major rivers and streams. Ladakh is spread over 96701km^2 of which Leh consists of 45110 km^2 and hence Leh is the second largest district in the country. The region borders with Pakistan occupied Kashmir and Chinese occupied Aksai Chin in the North-West and North respectively, while in the East it shares boundary with Tibet (China) and Lahul and Spiti (Himachal Pradesh) in the South. It hosts three mighty parallel mountainous ranges of the Himalayas, the Zangskar, the Ladakh and the Karakoram ranges. Major population lives on the banks

of Shayok, Indus, Suru, Wakha-chu and Zangskar rivers which flows through these mountain ranges (Figure 2.1). The district Leh consists of six blocks viz Nubra, Panamik, Khalsi (Khaltse), Saspol, Leh, Chuchot, Kharu, Durbuk, and Nyoma (LAHDC 2011) while Kargil has nine blocks Kargil, Dras, Kargil, Shargole, Shaker-Chiktan, Gund-Mangalpur, Trespone, Sankoo, Taisuroo, Zanskar and Lungnuk (LAHDC 2011). Leh district has 112 inhabited villages and one uninhabited village (LAHDC 2011) and Kargil district has 129 villages.

The present study was carried out in Suru, Wakha-chu and Lower Indus valley which are located in the north Western part of Ladakh (Figure 1.1). These valleys are situated between 2700-5300m above mean sea level and are more fertile than other regions of Ladakh.

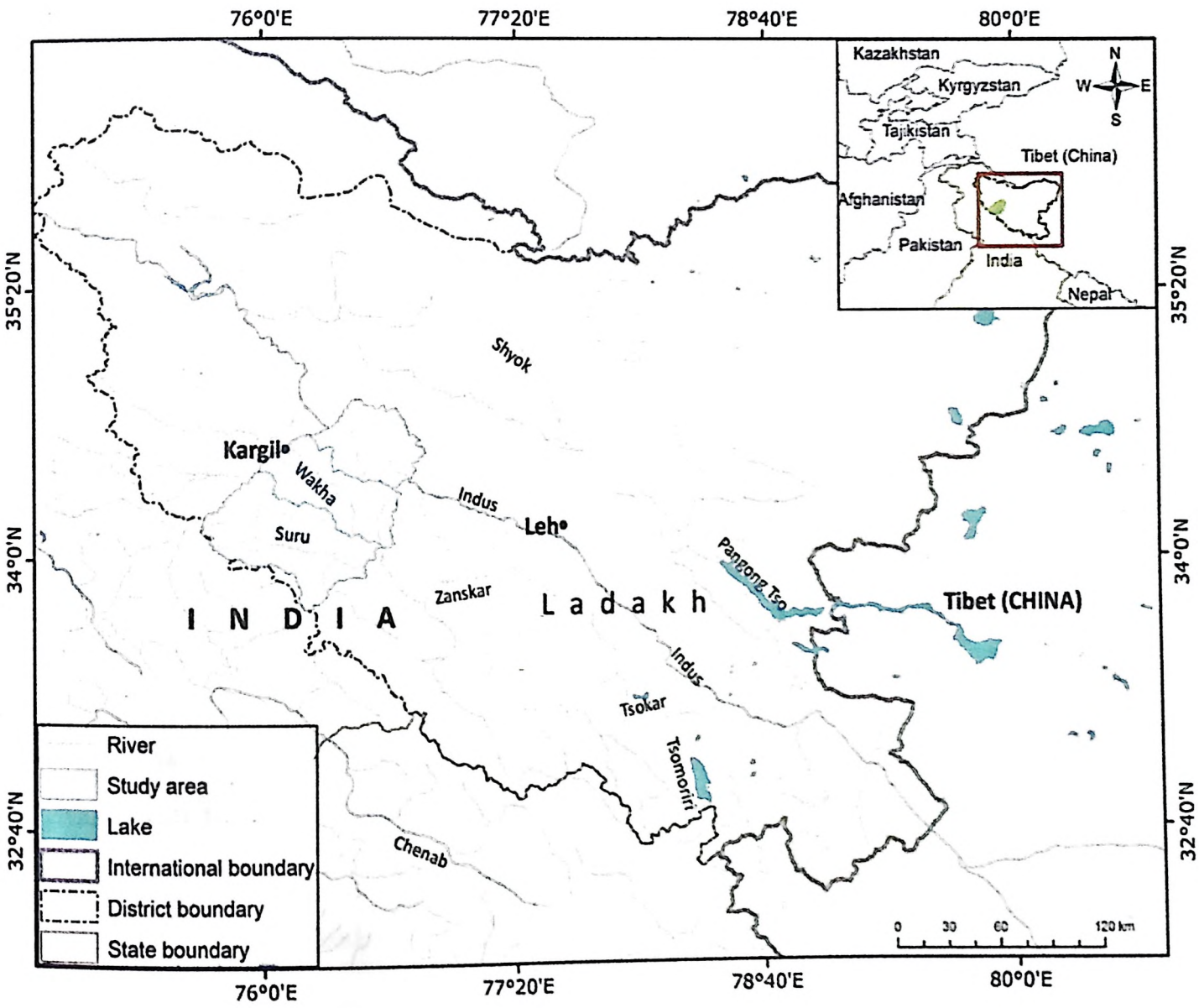


Figure 2.1 Location map of Suru, Wakha-chu and Lower Indus valley

Suru watershed is spread over more than 3013.59km^2 and has three major settlements (Panikar, Sankoo and Tai-Suru). Wakha-chu watershed has only one major settlement i.e. Kargil and is spread over 1935.02 km^2 while Lower Indus watershed has no major settlement and is spread over 1581.23 km^2.

2.2 METHODS

The study area for the present study is not confined by any administrative boundary and hence a watershed based approach was adopted to delineate the study area. Watershed was derived from ArcGIS tool box using default neighbourhood window (10,000) and later small stream watershed were merged to get major river watersheds. The 30m resolution Aster global digital elevation model (AGDEM) used for watershed extraction was downloaded from USGS website (http://gdex.cr.usgs.gov/gdex). Physiographic features such as glaciers, rivers, lakes and mountain peaks were digitized from the survey of India (1:25,000 scale), topographic maps using Arc view 3.2 software. Slope and Aspect maps were derived from AGDEM in the ERDAS IMAGINE software. The soil map, road and trekking routes were acquired from Wildlife Institute of India. Rainfall data was acquired from the Metrological Department of Leh. The population of the villagers is as per the 2001 census of India (Statistical Department). The major ethnic groups in these villages were determined during the village meetings.

2.3 Physical Features

2.3.1 Physiography and Geological set-up

In the northern arc of the Trans-Himalayan mountain complex, two differently formed orographic areas have been distinguished by geologists. The upper Indus valley marks the suture zone where the Indian plate is being thrust under Asia (Robyr et al. 2002). This chisel-like penetration into Asia started about forty million years ago and is still processing at a speed of approximately 5 cm per year (Van Andel 1983). It has given rise to the Himalayas themselves and, on the Ladakh scale, to the complex system of the mountain ranges as well as active faults and enclosed basin where the region's main river and lakes are located. It is more of the system of basins bounded by mountains and connected with the gorge parts of the river valleys.

Ladakh, the highest mountain range of the India ranges between 2600 m to 5900 m with 32°15′ to 36° N latitude and 75°15′ to 80°15′E longitude. It spans over the Hindukush and Karakoram mountain ranges and the upper Indus river valley. The Zansker range marks the end of Trans Himalaya in the west, and together with the Ladakh Mountains makes up a transitional zone between the Trans-Himalaya and east Karakoram (apart of the Tectonic mountain system of southern Tibet). North of the

Karakoram lies the Kunlun range. Thus, between Leh and eastern central Asia there is a triple barrier the Ladakh range, Karakoram Range and Kunlun.

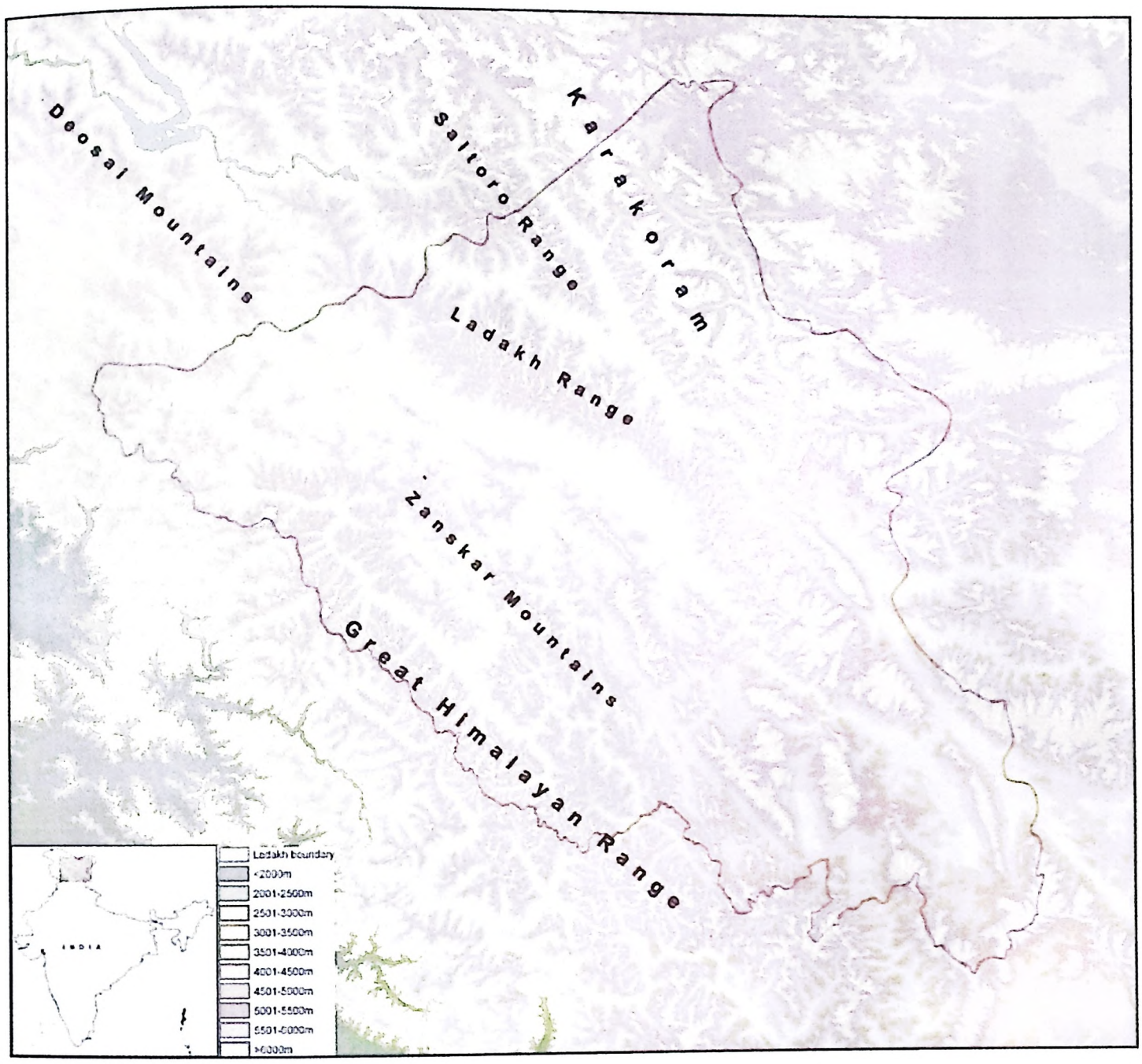


Figure 2.2 Mountain ranges of Indian Trans Himalaya

The Ladakh region exposes earth's mantle rock, Ophiolite, in the form of twin zone, called the Indus Ophiolite and the Shyok Ophiolite Belt, separated by the lofty high ranges of Ladakh Granitoid Complex running for almost 500 km (GSI). The Indus Zone is a complex belt consisting of several tectonic units: The Northern Zanskar Unit, Lamayuru Unit, Dras Unit, Indus Flysch and Indus Molasse (Fuchs 1980, Figure 2.3). The Northern Zanskar Unit contains multi-coloured lime-stones, marls and slates which are several hundred meters thick. The Lamayuru Unit is composed of thick series of dark argillites, siltstones, locally interbedded with dark limestones or sandstone layers. The Dras Unit consists of Ophiolitic melanges with klippes of various limestones with radiolarites, serpentinites etc. Indus Flysch consists of flyschoid shales and sandstones, tuffs, volcanic breccias, and basic effusiva. Indus

Molasse consists of thick-bedded conglomerates, pebbly sandstones and silty shales, frequently bright coloured red, green and beige.

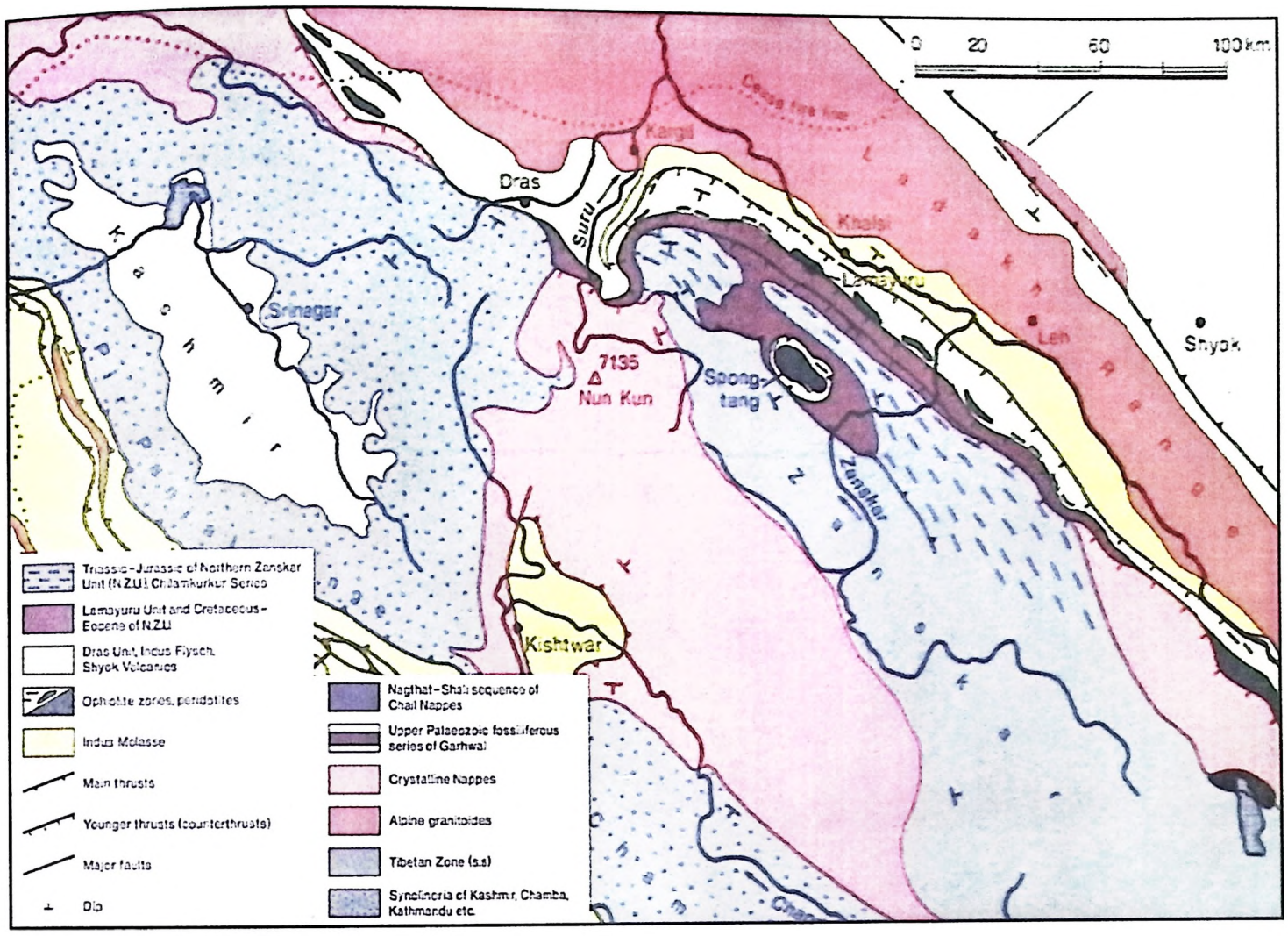


Figure 2.3 Geological map of Jammu and Kashmir (Fuchs 1980)

2.3.2 Elevation, Aspect and Slope

Elevation of Western Ladakh varies from 2600 to more than 6000m above sea level (Figure 2.4). Areas above 4500m are more in Suru valley which remains under snow for longer duration and hence are less vegetated. Areas below 3500 are more in Lower Indus valley which is also most fertile among all the three valleys. Wakha-chu valley has maximum representation between 3500-4500m and has maximum vegetated alpine areas. Elevation zone increases towards south-east in both Suru and Wakha-chu valley due to presence of Great Himalayan range and Zanskar range respectively. Presence of Ladakh range causes a sharp increase in elevation in Lower Indus valley towards north. The distribution of various aspect and slope categories derived from AGDEM data is shown in the Figure 2.6 and 2.8. The orientation of Suru valley is north-south in northern part and east-west in southern part. Major aspect class in this valley belongs to east and north-west (Figure 2.7).

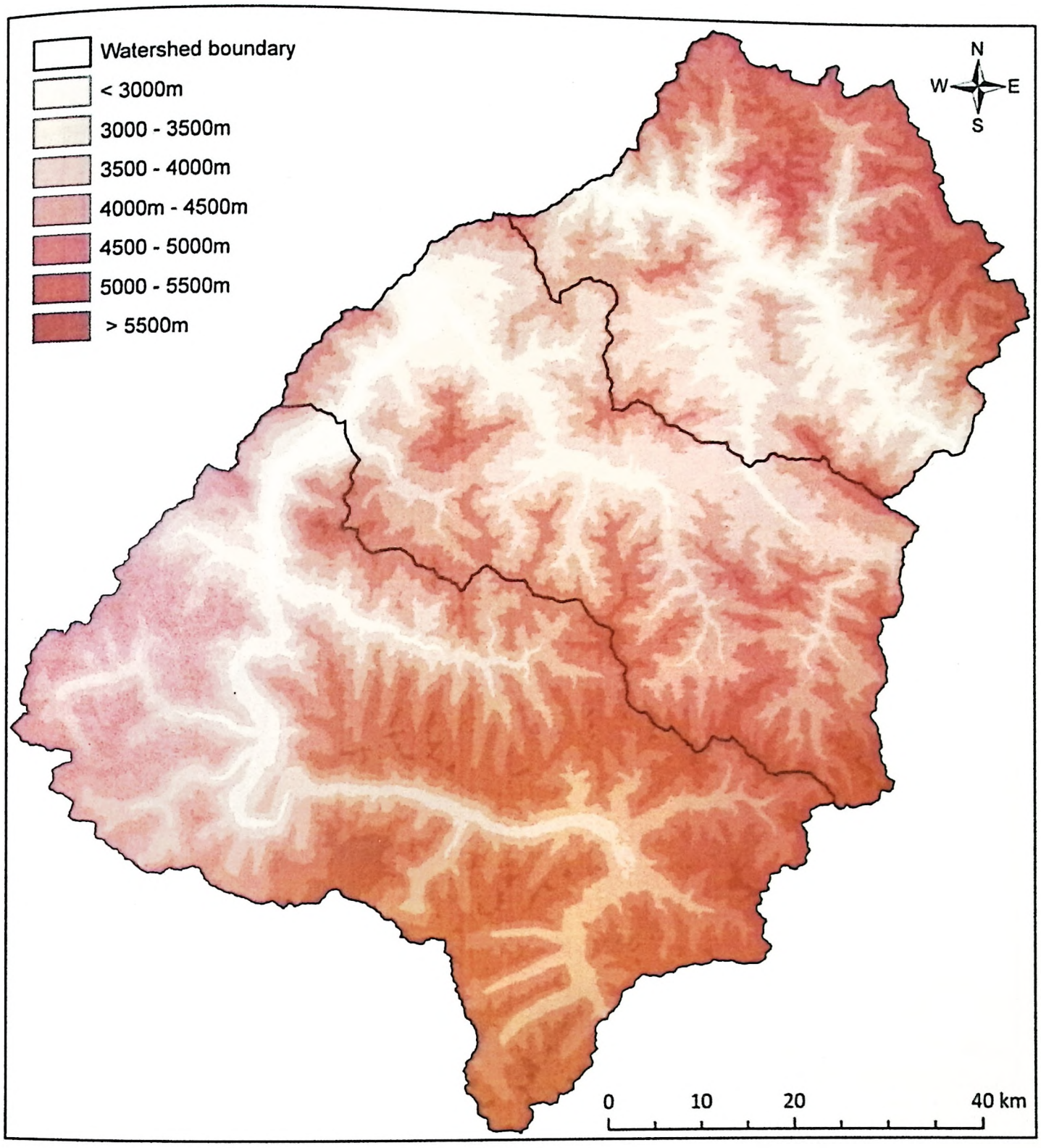


Figure 2.4 Elevation zone map of Western Ladakh

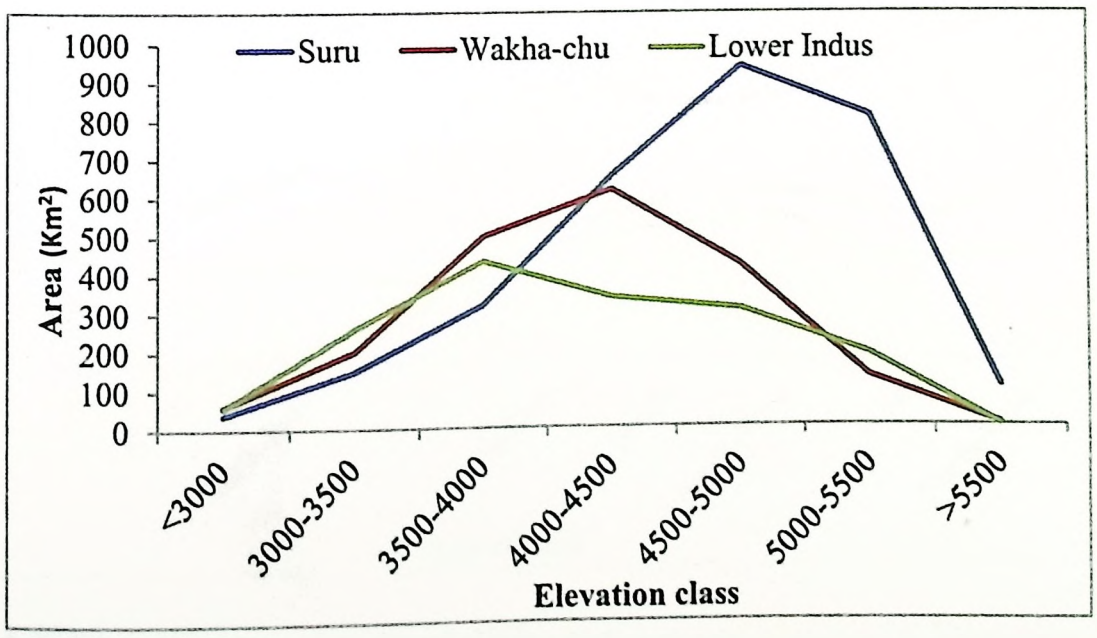


Figure 2.5 Distribution trends of different elevation zones in Western Ladakh

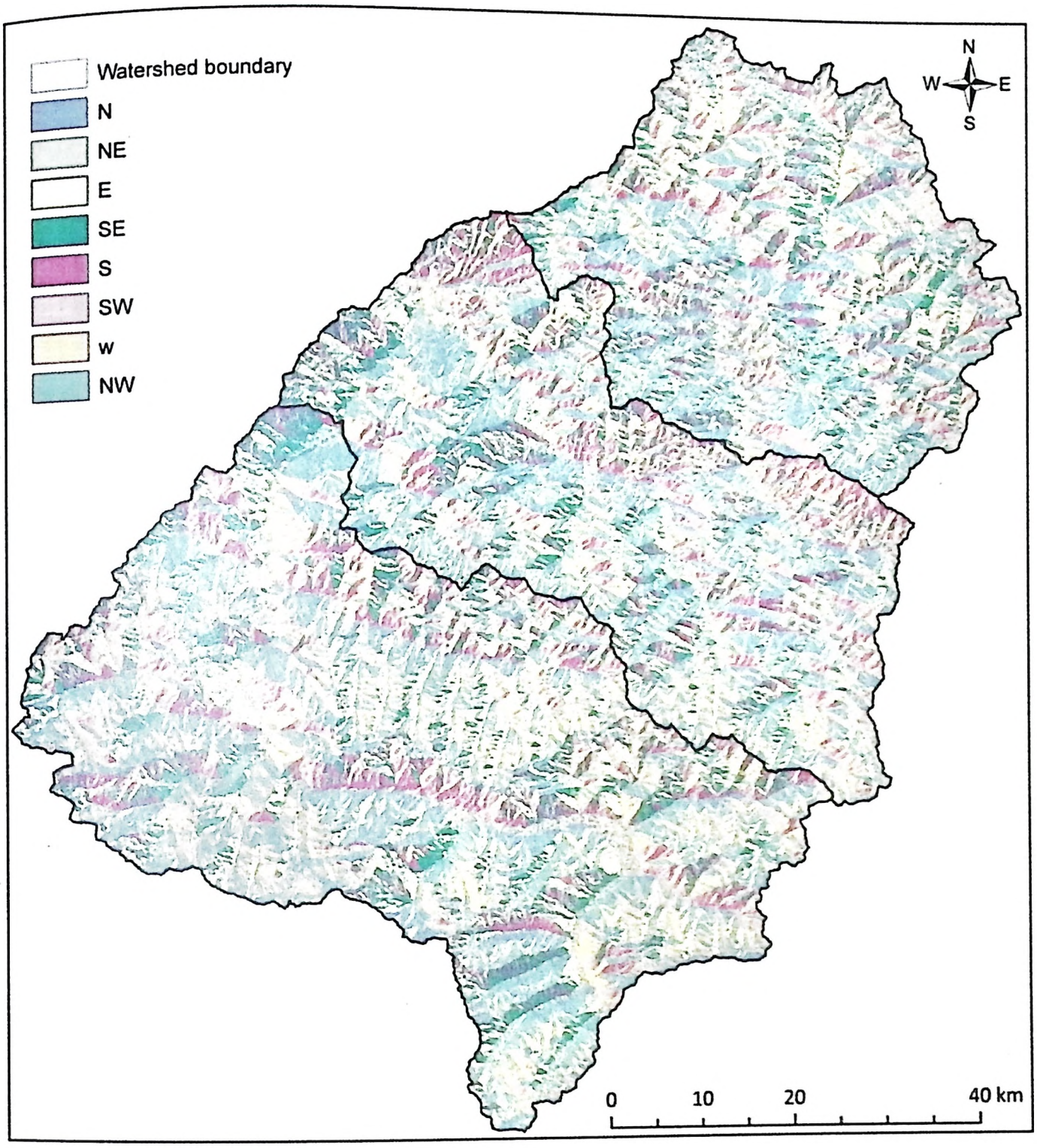


Figure 2.6 Aspect class map of Western Ladakh

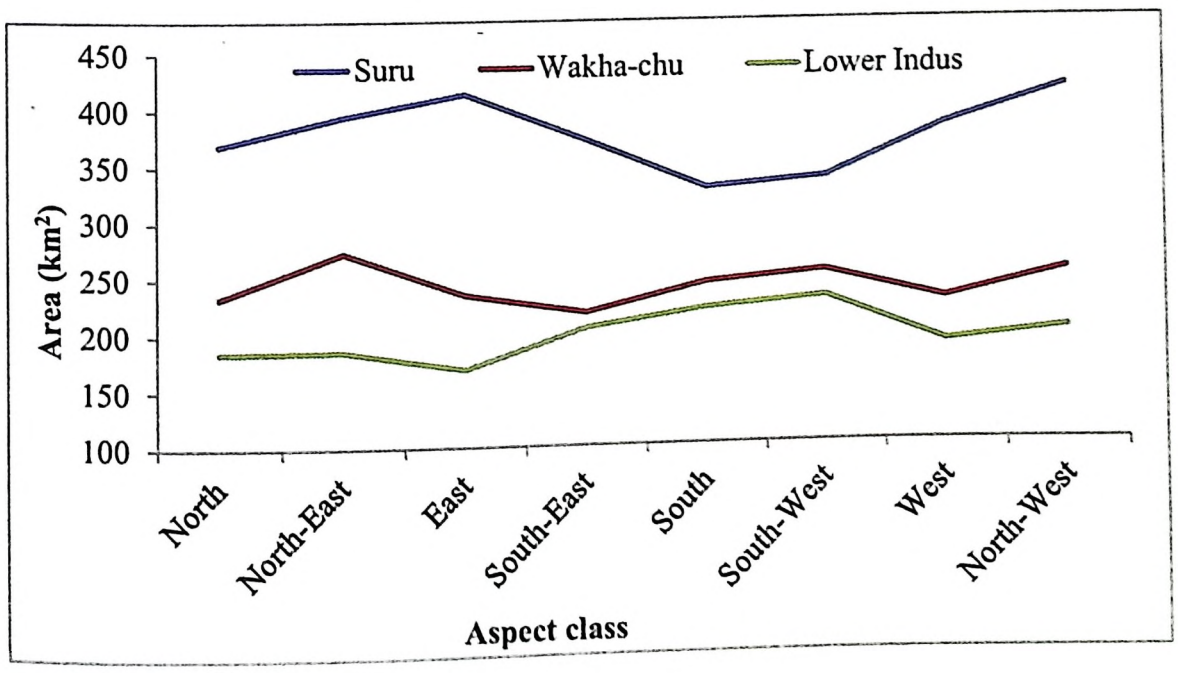


Figure 2.7 Distribution trends of different Aspect classes in Western Ladakh

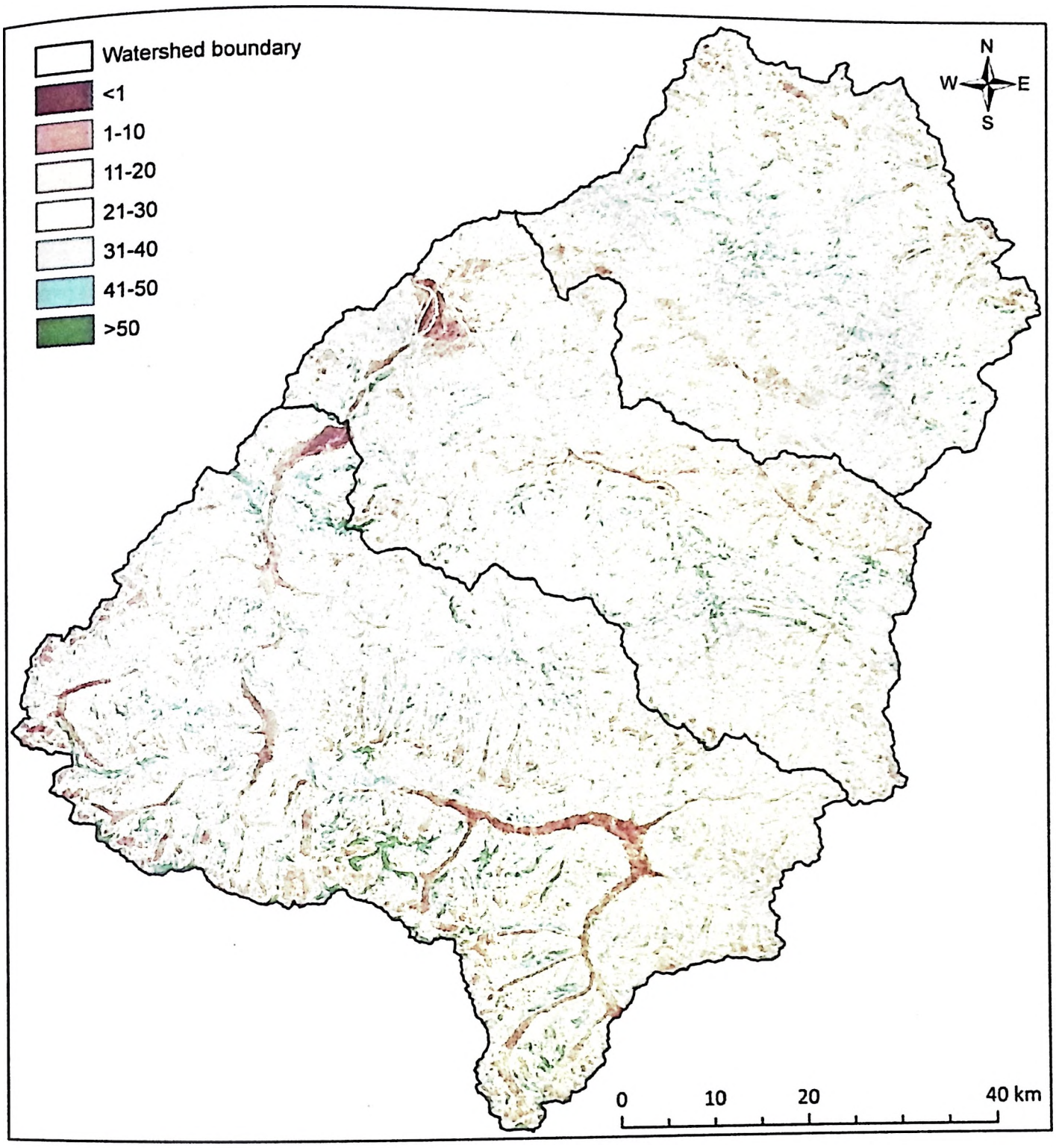


Figure 2.8 Slope class map of Western Ladakh

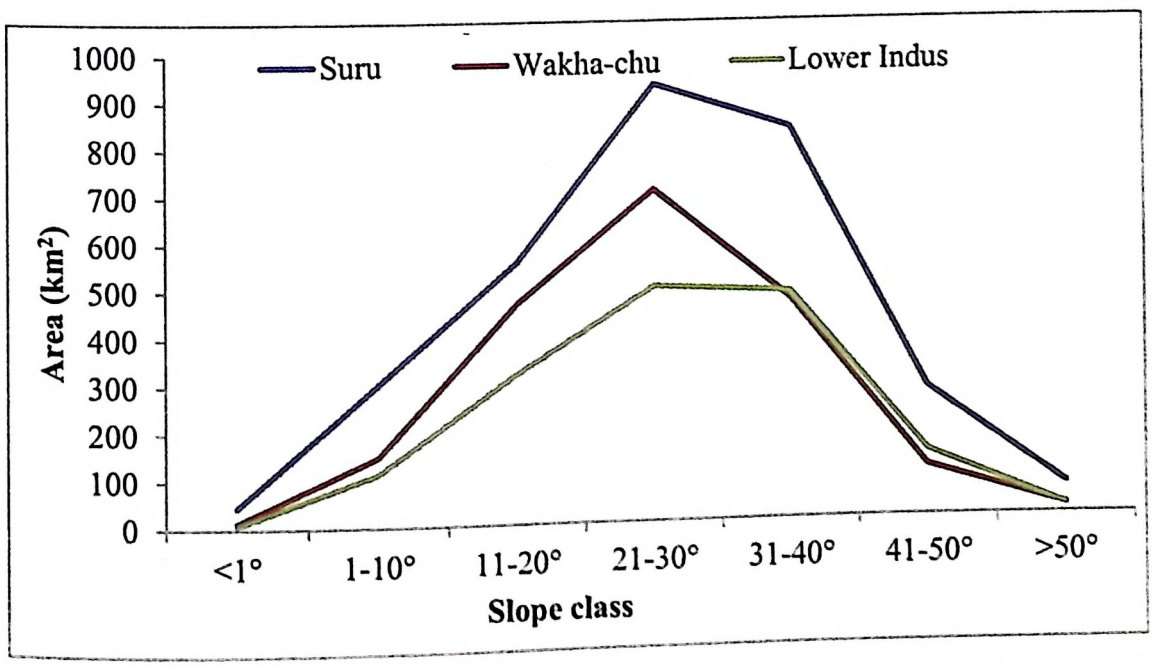


Figure 2.9 Distribution trends of different slope classes in Western Ladakh

Wakha-chu and Lower Indus valleys are oriented in east-west direction and all the aspect classes in these two valleys are distributed almost equally (Figure 2.7). Distribution of slope class in all the three valleys (Figure 2.8) has similar trend with most of the area falling between 10-40° dominated by 20-30° class (Figure 2.9).

2.3.3 Drainage and Watersheds

Western Ladakh landscape forms the head water of four main rivers systems Suru, Dras, Wakha-chu and Indus. The Indus river is locally known as the Sênggê Sangspo which means "Lion river." It is a major river which flows through China, India and Pakistan. River Indus originates in high plains of Tibet Autonomous Region, near the vicinity of Lake Mansarovar in the Great Himalayas. It runs a course through the Ladakh district of Jammu and Kashmir province of India and then enters Pakistan through Chulichan-Gilgit-Baltistan areas after which it flows in a southerly direction along the entire length of Pakistan and finally merges into the Arabian Sea near the port city of Karachi in Sindh. Major rivers of Western Ladakh are shown in Figure 2.10. The Indus river is the backbone of Ladakh as all major settlements are situated around its banks and major population are depend on it. River Dras originates from Machoi glacier in the North West part towards Zojila. It moves into the course from south to north across the Dras block to Karbu and merges with Suru and Wakha-chu near Kargil valley. Wakha-chu river Originates from the Kanji la flows across the Wakha chu valley crossing Wakha-Mulbek-Lotsum-Darket-Paskum villages and finally meets Suru and Dras river in Kargil. The Suru River originates from Penzila glacier and flows through the valley. Many tributaries join its way including three mighty rivers, Chillong chu, Nakpo chu and Phulungma chu. These watersheds though located adjacent to one another show a significant variation in physiography, climate, and culture. Most of the villages in the study area lies in Suru valley, followed by Wakha-chu and river Indus.

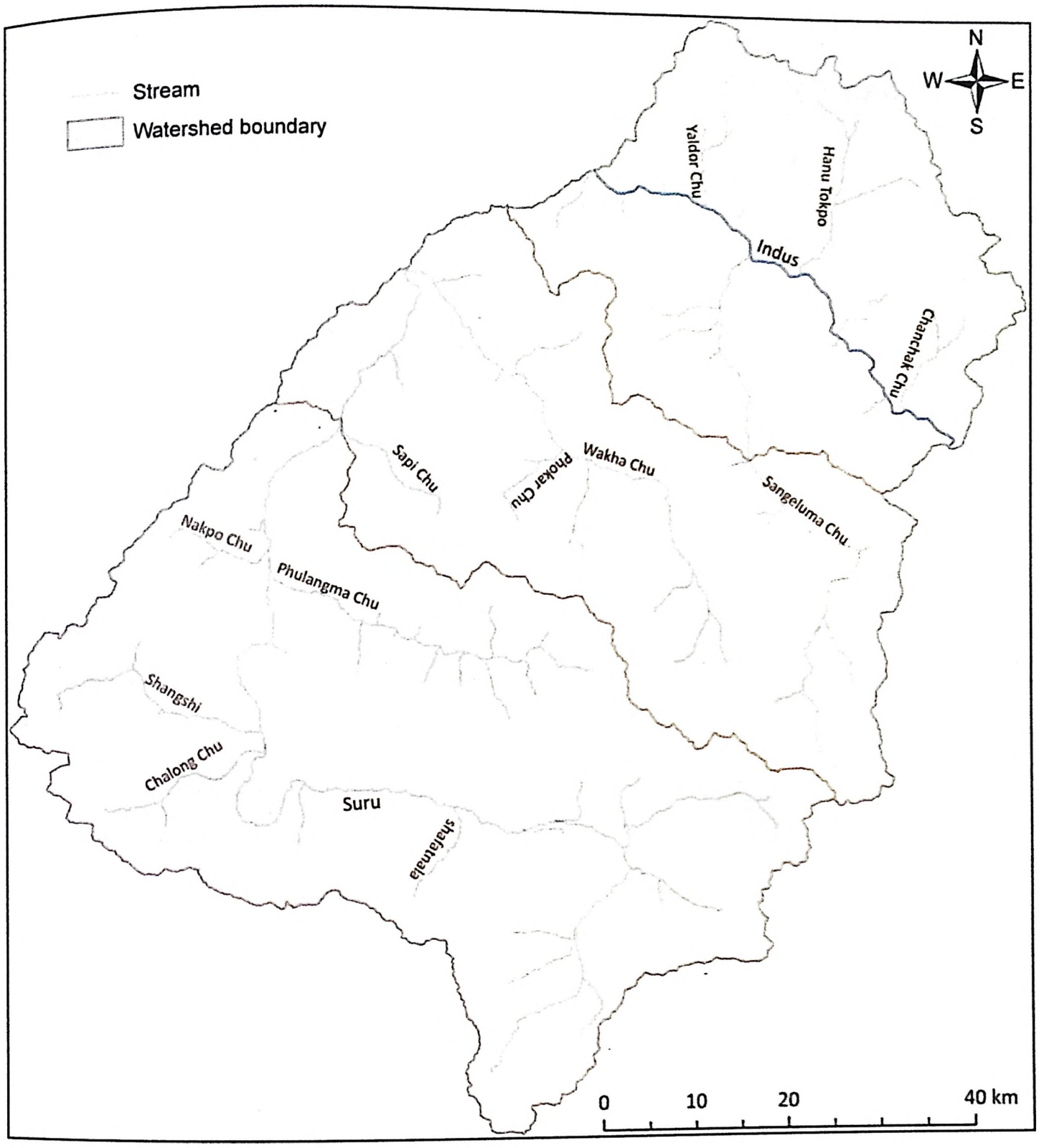


Figure 2.10 Drainage system of Western Ladakh

2.3.4 Glaciers and Glacial Lakes

There is no concrete information on total number of glaciers in Ladakh. However, according to (ICIMOD, 2004), Indus river basin (in both India and Pakistan) has 1098 glaciers and 574 glacial lakes covering an area of 688 km^2 and 26.06 km^2 respectively (Ives et al. 2010). The Siachen glacier is the largest in Ladakh spanning over 72 km^2. In both Ladakh and Zanskar ranges, numerous cirque glaciers ranging from 0.5 to 2 km^2 and their snouts are located on the north-west to north-east-facing slopes, generally above 5100 m (Burbank 1985). Small glaciers and permanent ice fields of less than 0.5 km^2 are infrequent on southern exposures above 5500 m (Burbank 1985). Figure 2.11 shows major glaciers of Western Ladakh.

Durung Drung is the largest glacier in Western Ladakh which spans over 23.10 km with an average width of 2.75km and total area of 72.83 km^2. Another major glaciers of Western Ladakh are Pharkachik glacier (>13km^2), Kangriz glacier, and Safat glacier.

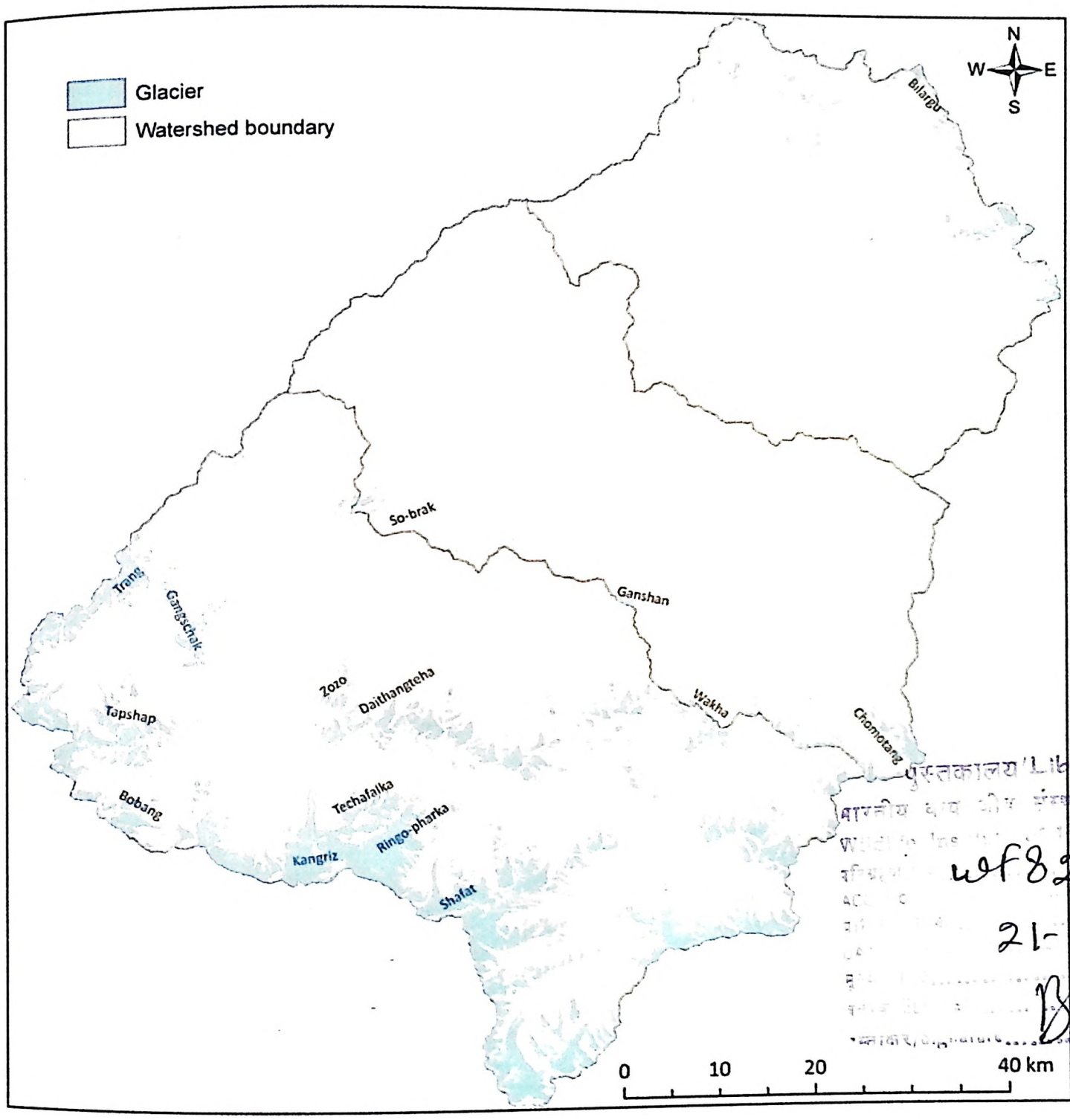


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Figure 2.11 Major glaciers of Western Ladakh

2.3.5 Mountain Peaks and Passes

Ladakh lies among some of the most magnificent mountain ranges of the world, where the mountain system proliferates into an astonishing complex of ranges and sub-ranges. The highest is the Nun, which is 7135m and Kun 7070m is the highest peak in Kargil. Figure 2.12 Map shows the location and elevation of the major peaks of Western Ladakh. The Ladakh range has no major peaks; its height ranges between 5000m upto 6000m. The Pangong range which runs parallel to the Ladakh range

about 100 km northwest from Chushul has comparatively higher peaks. Its highest range is 6,700m and the northern slopes are heavily glaciated. The massifs to the north and east of the Nubra-Siachen line include the Apsarasas group (highest point 7245m), the Rimo group (highest point 7385m) and the Teram Kangri group (highest point 7464m) together with Mamostong Kangri (7526m) and Singhi Kangri (7751m).

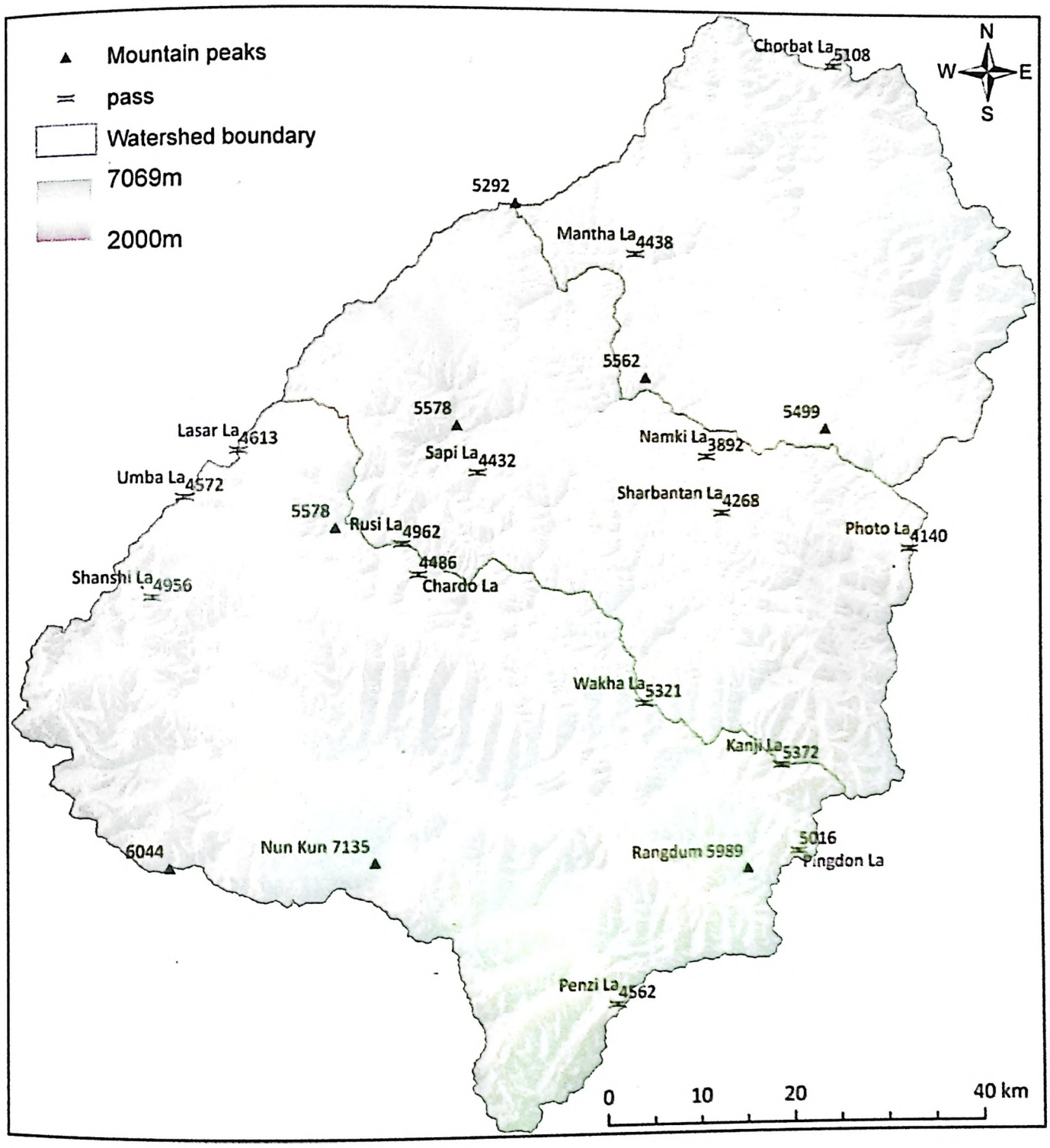


Figure 2.12 Major mountain peaks and passes of Western Ladakh

Ladakh has several passes above 5000m asl. including Kardungh la (5615 m), Tanglang la (5.390m), Chang la (5.360 m), Wari la (5300m) and Namshang la (5050 m). The main connecting route to ladakh from Srinagar crosses Zoji la (3450m), Namika la (3700m) and Fatu la (4100m). The route from Manali (Himachal Pradesh) crosses three major passes, Baralacha la (4892 m), Lungalacha or Lachulung la (5059 m) and Taglang la (5325 m).

2.3.6 Soils

A major part of the geographical area is under glaciers and ice sheets or perpetual snow cover and there is hardly any soil formation. Loamy skeletal soils on high relief glaciated land and cliffs (slope> 50%) with severe erosion and moderate stoniness have a dominant cover of 53%. While coarse loamy soils, which are moderately shallow, excessively drained on steep slopes (slopes>30%) cover about 11% of the total area of the Ladakh. Figure 2.13 shows the distribution of the major soil classes and their extent while Table 1 shows their properties.

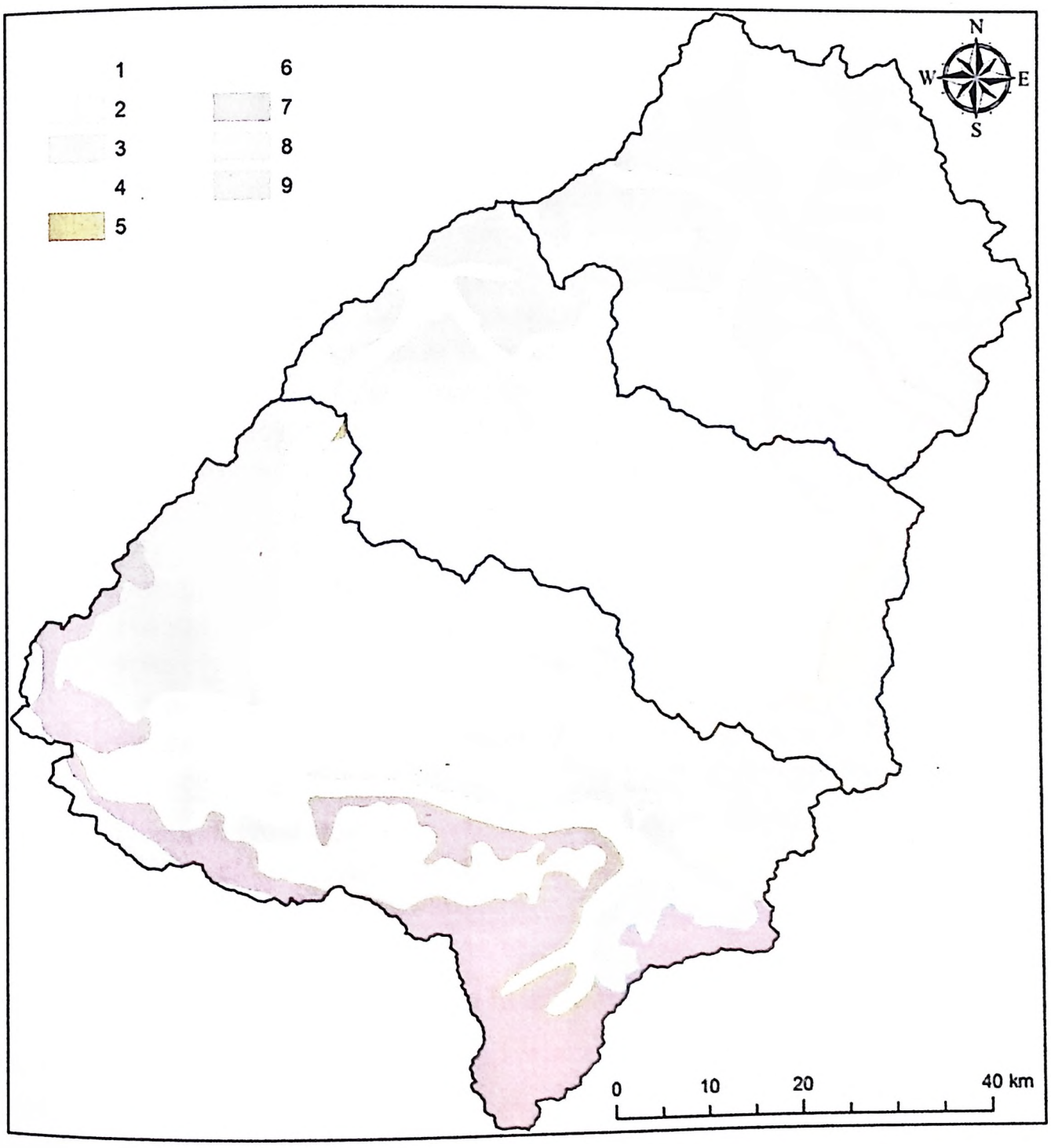


Figure 2.13 Distribution of different soil classes in Western Ladakh

The soil is sandy developed from the debris of weathering rocks. Soil texture is coarse and has good soil aeration, but cannot moisture and nutrients. The mechanical

analysis of soil of different places of Ladakh region has been depicted in the Table 2.2.

Table 2.1 Properties of soil types of Western Ladakh (Rana et al. 2000)

Type	Property
1	Dominantly glaciers and rock outcrops associated with shallow, excessively drained, sandy skeletal soils on very steep slopes with sandy surface, severe erosion and strong surface stoniness
2	Dominantly rock outcrops; associated with: Shallow, excessively drained, sandy skeletal, coarse loamy-skeletal soils on very steep slopes with sandy surface, severe erosion and moderate surface stoniness
3	Rock outcrops; associated with: Shallow, excessively drained, loamy coarse loamy-skeletal soils on steep slopes with loamy surface, severe erosion and moderate surface stoniness
4	Deep, excessively drained, coarse loamy-skeletal soils on gentle slopes with sandy surface, moderate erosion and slight stoniness; associated with: Deep, well drained, coarse-loamy. coarse loamy-skeletal soils with loamy surface, moderate erosion and slight surface stoniness
5	Deep, excessively drained, sandy-skeletal coarse loamy-skeletal soils on gentle slopes with sandy surface, slight erosion and moderate stoniness; associated with: Deep, well drained, coarse-loamy, coarse loamy-skeletal soils with loamy surface and slight erosion
6	Dominantly rock outcrops; associated with: Shallow, loamy, coarse loamy-skeletal soils on steep to very steep slopes with loamy surface, strong stoniness and severe erosion.
7	Dominantly glaciers and rock outcrops; associated with: Shallow, excessively drained, sandy-skeletal soils on very steep slopes with severely eroded sandy surface and moderate surface stoniness
8	Dominantly rocky landscape; associated with: Very Shallow, excessively drained fragmental soils on very steep slopes with loamy surface, very severe erosion and strong surface stoniness
9	Deep, excessively drained, coarse-loamy, coarse loamy-skeletal soils on gentle slopes with loamy surface, moderate to severe erosion and moderate surface stoniness.

Table 2.2 Proportion of constituents in different texture class

Place	Coarse sand (%)	Fine sand (%)	Silt %	Clay %	Textural class
Dras	0.88	19.82	53.9	25	Silty clayey
Kargil	6.44	61.1	3.3	20.5	Loamy clay
Leh	4.17	24.83	2.5	8.5	Loamy sand
Suru	1	58.55	28.5	12	Loamy
Zansker	3.77	54.82	15	25.5	Sandy loamy

Source Department of Agriculture J&K state

2.4 Transport Trails and Settlements

Ladakh was once the connection point between Central Asia and South Asia when the Silk route was in use. The Silk route connecting Amritsar and Yarkand through eleven passes was frequently undertaken by traders till the third quarter of the 19th century (Rizvi Janet 2001).

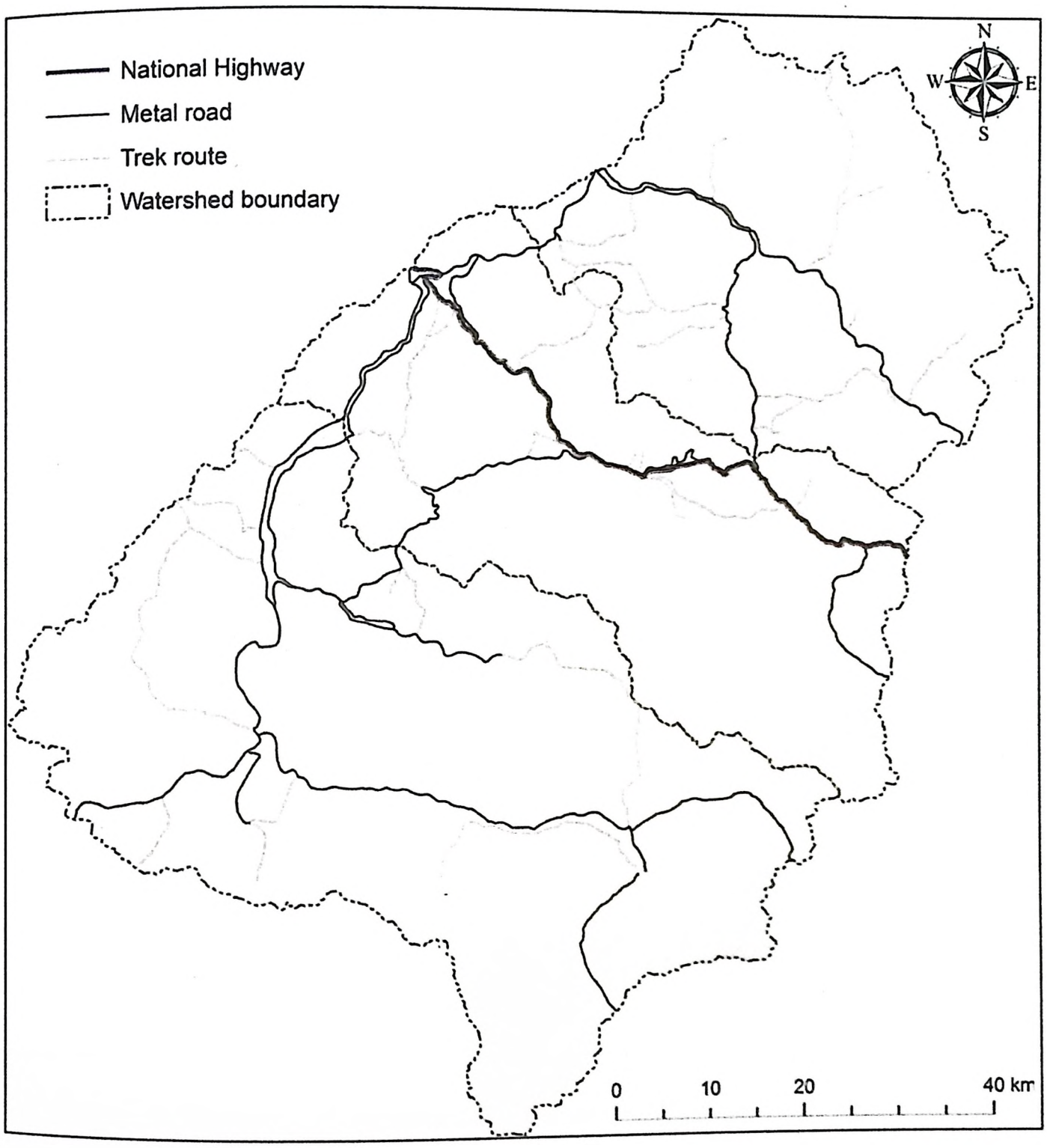


Figure 2.14 Road network and trekking routes of Western Ladakh

Another important route was the Leh-Kalimpong Lhasa through and Gartok, either Tanglang la or the Chang la. But now these traditional routes are closed. At present, the only two land routes to Ladakh are from Srinagar and Manali. These routes are closed during winters for 3-4 months. By the end of March 2004, a total road length of 1177 km has been constructed and maintained by PWD and BRO border road

organization (Figure 2.14). Even now, the old trails crossing through difficult passes are the only medium of inter valley connection. Trek routes passing through Rusila which connects Sapi village (Wakha-chu valley) to Pangbar village (Suru valley) and Wakha la and Kanji la which connects Kanji and Rangdum are famous trek routes for tourists.

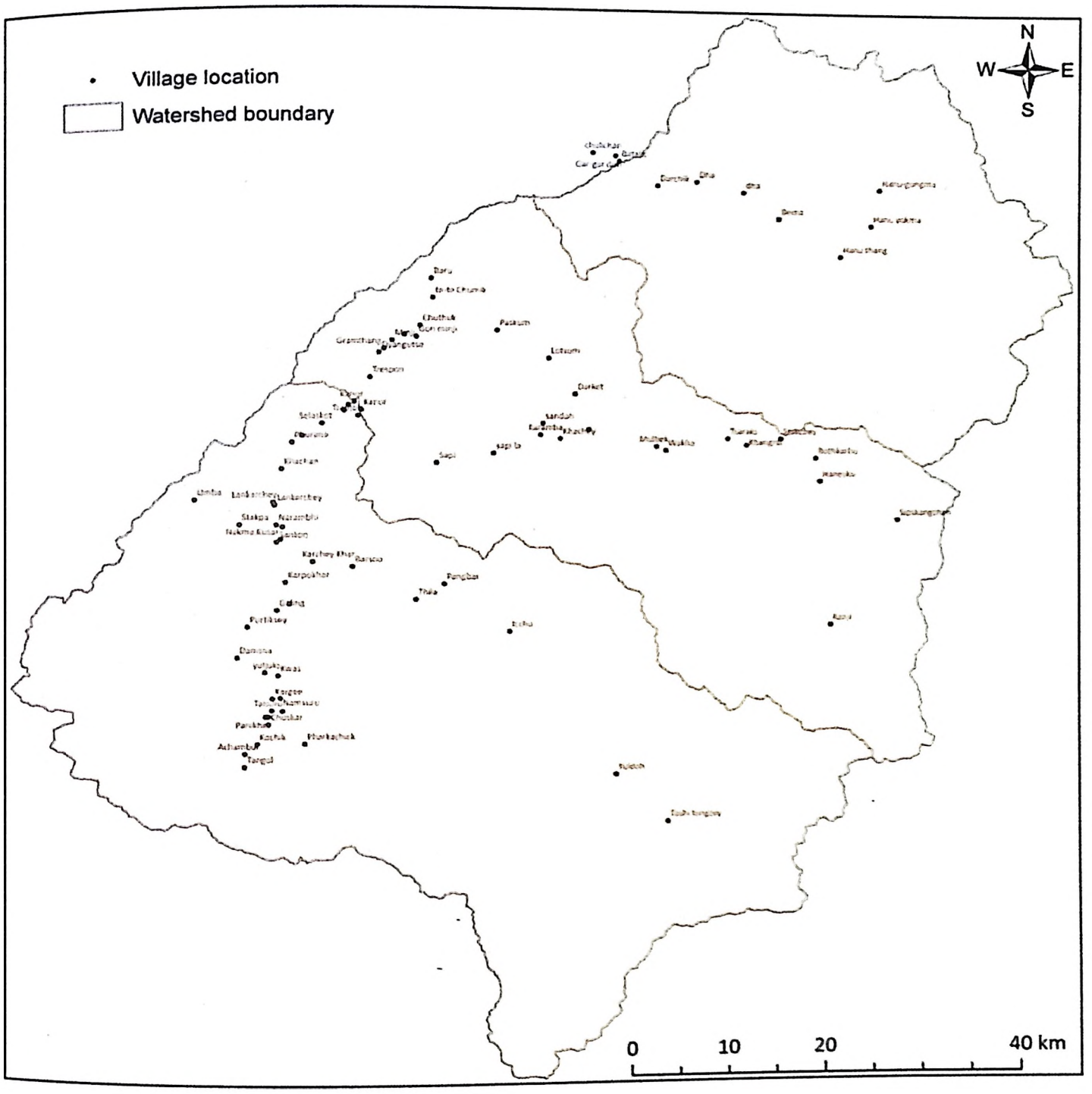


Figure 2.15 Human settlements in Western Ladakh

Most of the Western Ladakh comes under Kargil district. Kargil has 2 Tehsils, 9 Blocks, 65 Panchayats and 129 villages. Most of the villages are situated along Suru River (Figure 2.15).

2.5 Climate

The region experiences an extreme climatic condition, temperature ranging from +30 to -35°C. It falls in the rain shadow area as the high ranges of Greater Himalaya

blocks the monsoon arriving from the Indian sub-continent. Most of the part of north-Western Himalaya, receive heavy snowfalls during the winter with moisture supplied from the mid-latitude westerlies and the Mongolian high pressure system. Ladakh gets an annual rainfall of only 140 mm. Western Ladakh receives about 239 mm of rainfall while central and eastern Ladakh receives only 100 mm annually. Recent flooding in the region has been attributed to abnormal rain patterns and retreating glaciers, both of which might be linked to global warming. The regions on the north flank of the Himalayas, Dras, Suru valley and Zangskar, experience heavy snowfall and remain cut off from the rest of the region for several months in the year, as the whole region remains cut off by road from the rest of the country. Summers are short, though they are long enough to grow crops.

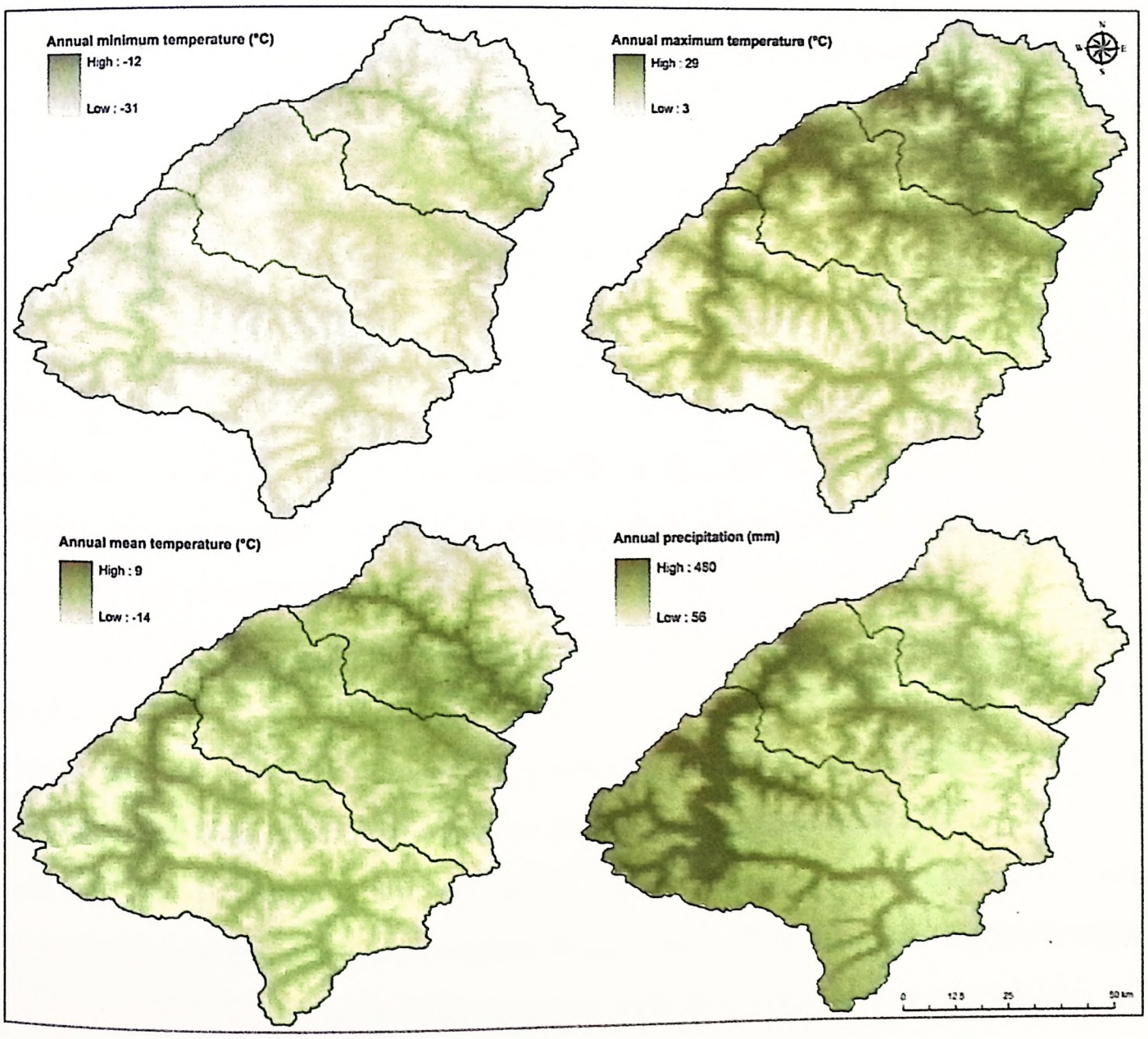


Figure 2.16 Annual variations in climate of Western Ladakh (Worldclim)

2.6 Natural Ecosystems and Protected areas

Ladakh is often described as a high elevation desert-steppe or even colder as a cold desert. Typically of such ecosystem, the flora and fauna of Ladakh are characterized

by their low density and abundance, as well as high level of adaptation to high altitude and aridity. It is often called as the Trans-Himalayan ecosystem (Namgail et al. 2006). Ladakh's complex hydrological system of rivers, lakes and enclosed basin has allowed the development of important wetlands. These ecosystems function as oases of productivity in an otherwise arid environment, hosting varied plant communities, including most of the bushes and trees growing naturally in the region, as well as a diverse wildlife including an abundant migratory bird fauna. There are three protected areas (PA) in the region. Hemis National Park was designated as PA in 1981. Changthang High Altitude Wetland Reserve has been recognized as Ramsar Convention on wetland conservation. Although, Karakoram Wildlife Sanctuary in the north eastern Shayok-Nubra region have not yet delineated, Wildlife Institute of India (WII) had done a potential PA mapping for the whole region. In Western Ladakh, Kanji Wildlife Sanctuary in Wakha-chu and Brako Wildlife Sanctuary in Lower Indus valley are under proposed sanctuaries in the study area.

2.7 Biological Attributes

2.7.1 Flora

The forest types of Kargil and Dras are temperate and alpine forest. Floral diversity in Ladakh region is relatively poor compare to areas of similar altitude in the main Himalayas, Ladakh's flora has considerable biological interest, depicting with its diversity of origin and endemic species, a high adaptability to extreme climatic conditions and biotic pressure (Chundawat and Rawat 1994). Six hundred and eleven species of flowering plants have been recorded from Ladakh (Kachroo et al. 1977), though recent estimates suggest that number may be higher (Dickoré and Miehe 2002) estimate at 500-1000 the number of species. Another recently survey by (Klimes 2003) recorded 404 species of vascular plants. Ladakh harbours a large number of plants of special conservation, economic and ethno-botanical significance. These include wild fodder species and relatives of cultivated plants like wild legumes, caper, wild gooseberry, wild barley, wild onion as well as a great variety of aromatic and medicinal plants adapted to cold and arid conditions such as *Artemisia* sp., *Delphinium* sp. (Chaurasia and Gurmet 2003). Most of these floral plants have traditional medicinal value.

2.7.2 Fauna

Owing to its geographical location across the main Himalayan chain and despite low biological productivity, Ladakh hosts a surprisingly diverse herbivore fauna. Herbivores range from mouse hares (*Ochotona* spp.), hares (*Lepus oistolus*), marmots (*Marmota caudata*), great Tibetan sheep, nyan (*Ovis ammon hodgsoni*), Tibetan wild ass (*Equus kiang*) and wild yak (*Bos grunniens).* Mammal predators include weasel *(Mustela altaica),* wild dog *(Cuon alpinus*), Tibetan wolf (*Canis lupus chanco*), lynx (*Lynx isabellina*), Himalayan brown bear (*Ursus arctos isabellinus*) and snow Leopard, (*Uncia uncia).*

The only information available from the Zanskar and Suru valley is about the status of brown bear–human conflicts (Sathyakumar 2003) and wildlife conservation status and planning of a protected area network in Ladakh (Chundawat and Qureshi 1999). These studies suggest the presence of snow leopard, Tibetan wolf (*Canis lupus changku*), Himalayan brown bear (*Ursus arctos isabellinus*), Asiatic ibex (*Capra ibex*), Ladakh urial (*Ovis vignei vignei*), musk deer (*Moschus* spp.), pikas, and hares etc.

According to Pfister (2004), Ladakh bird fauna consist of about 310 species. Families with highest species are Muscicapidae (thrushes, fly catcher, red start and chat: 32 species), the Sylviidae (whitethroats and warblers), the Fringillidae (finches and bunting: 24 species), the Accipitridae (hawks: 23 species), the Scolopacidae (sandpiper, snipes and curlews: 23 sp), the Passeridae (sparrows, wagtails, pipits and accentors: 22 species) and the Anatidae (ducks and geese: 15 species). A very handful of reptile and amphibians exists in Ladakh, three species of amphibia of Bufonidaeor Toad family and 11 species of reptiles have managed to adapt to the high altitude ecosystem. Reptiles reported from Ladakh belong to 3 families of lizards (Agamidae, Geckonidae and Scincidae) and one snake family (Colubridae). Very little is known about the species distribution about the fishes in Ladakh, five species were known, of which 4 belongs to the loach family (Homalopterdae) and one is a Cyprinoid (Carp family), commonly found in the high altitude streams and rivers (Humbert-Droz 2001). Eventually, among the invertebrates, a total of 113 species belonging to 28 families and 7 orders were listed in the region. Some of the mammal sightings during the study are given in the Table 2.3.

Table 2.3 Large mammals of Western Ladakh along with their global and legal conservation status.

Common Name	Scientific name	Local name	Global threat status (IUCN)					WPA-1972
			Critical	Endangered	Vulnerable	Near threatened	Least concerned	Schedule
Herbivores								
*Himalayan marmot	*Marmota himalayana*	*Phai*					LC	II part II
*Asiatic Ibex	*Capra ibex*	*Skin*					LC	I
Musk deer	*Moschus moschiferus*							I part I
*Ladakh Urial	*Ovis orientalis vignei*	*Shapo*			V			I part I
Carnivore								
*Snow leopard	*Panthera uncia*	*Schen*		E				I part I
**Himalayan brown bear	*Ursus arctos*	*Denmo*					LC	I part I
*Lynx	*Lynx lynx*	*Eeh*					LC	I part I
*Red fox	*Vulpes vulpes*	*Watzey*					LC	
*Tibetan Wolf	*Canis lupus chanku*	*Shangku*					LC	I part I
*Stoat	*Mustela altaica*	*Lakimo*				NT		

*sighting**indirect sighting

2.8 Culture Profile

2.8.1 Sacred Landscape

Western Ladakh is also the abode of a number of Buddhist monasteries and mosques. The Lower Indus valley is having an influence of Buddhist culture. There are six monasteries and four mosques in lower Indus valley compare to Wakha-chu and Suru valley having six and one monasteries and 11 mosques and 14 mosques respectively. This shows a strong influence of Islam in Western Ladakh. As it is believed that the area was under the influence of Buddhism which converted afterwards to Islam. The remnants of statue of Buddhist craft was found recently (2010) in Sangra, Suru valley (Figure 2.17) during the reconstruction of an old house. One of the famous and old monastery is the cave monastery that attracts pilgrims from all over the world due to

typical constructional wonder. The monastery is known as Phokar-phu. Another monastery of Kargil of almost similar feature is Shargol monastery. The monastery gives the appearance of a hanging abode from the centre of the mountain on which it is located, it is known as Shargole monastery. The people believed that near every mountain, hill-top, prominent rock, mountain pass, crevasse, valley, tree, Lake and stream seems to be the abode of some supernatural things. The Kartse Khar (palace) is an ancient village in Suru valley known for its 7m tall rock carved statue of Maitriya Buddha which is an evidence of the presence of Buddhist community in the Suru valley in the past. The other magnificent rock carved statue of 9m tall of Matriya Buddha at Mulbek. The Mulbekh monastery is bedecked with frescoes and statues. The presence of monasteries and Mosques shows that the people living in this area are religious.



Figure 2.17 Remnants of Buddha statue

2.8.2 Political and strategically importance

Ladakh was given the autonomous status in 1995. Politically, Leh district is governed by the Ladakh Autonomous Hill Development Council, Leh having a strength of 30

Councilors (26 elected and 04 nominated), which is being headed by the Chairman or Chief Executive Councilor, who is assisted by four Executive Councilors since 1995 working within the framework of the constitution of India/ Jammu and Kashmir. Kargil district was also granted autonomous recently. Under the guidance and supervision of the Ladakh Autonomous Hill Development Council, Leh and Kargil, the districts have made tremendous development within the available resources and provision provided by the central and state Governments resulting into overall economic growth of the district (LAHDC 2004). Strategically and politically Ladakh forms an important region for India, since it is bordered with Pakistan and China. After the inclusion within Indian state in 1947, and due to its strategic location, several battles were fought between India and neighboring countries. Right after partition of India and Pakistan in 1947, Ladakh was also divided into Baltistan in Pakistan and Ladakh in India. In 1962, a part of Ladakh was annexed by China so called as Aksai China. In 1972 another war was fought between India and Pakistan. Recently in 1999, another war was fought on Kashmir dispute.

2.8.3 Population

Ladakh has total population of 290492 persons. Out of which Leh district has population of 147,104 with decadal growth rate of 25.48% while Kargil district has 143388 with growth rate of 20.18%. Literacy rate in Leh district is 80.48% as compare to Kargil district 74.49% (Population census 2011). Population is mostly in rural areas and comparing to Leh's urban population of 42.96 percent, Kargil has only 8.89 percent lives in urban regions.

2.9 Economy

The economy of Ladakh rests on three pillars: the Indian Army, tourism, and civilian government in the form of jobs and extensive subsidies. People of Ladakh rely mainly on subsistence agriculture. Agriculture cultivation in the Ladakh region is mostly confined to the river valleys, like Indus valley, Nubra-Shyok valley, Shingo- Suru valley (or Dras-Suru-Wakha valley) and Zangskar valley (Figure 2.3). People in this area earn their livelihood through subsistence agriculture and pastoralism, since majority of the population dwells in the rural sector. The region has inherent constraints like prolonged winter, scanty rainfall, rugged mountain terrain and limited availability of agricultural land. Still agriculture and pastoralism are the main

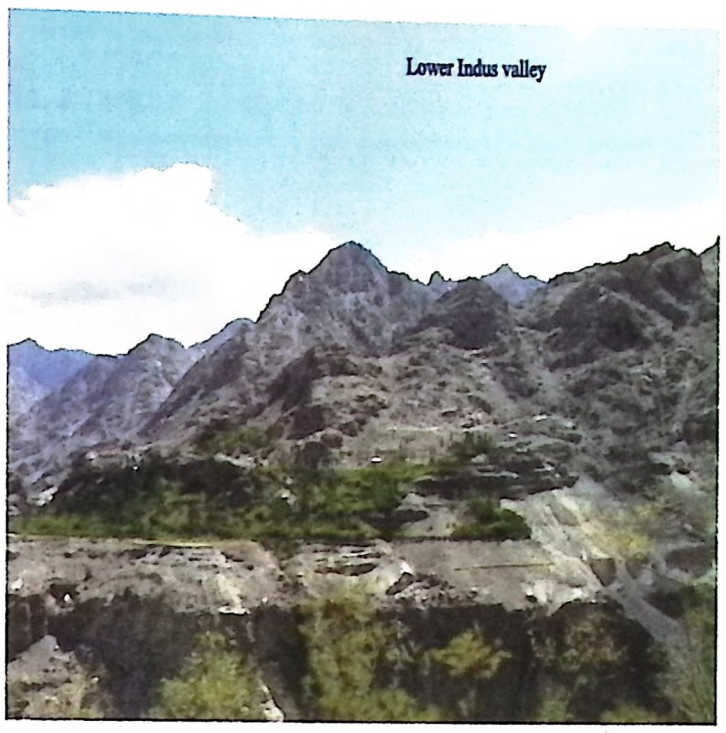
livelihood in the region yet this traditional sector has been adversely affected by the service sector especially tourism and government services. There are vast stretches of land available for irrigation facilities, but due to unavailability of water resources and scanty rainfall, these lands cannot be brought under cultivation. Furthermore, reclamation of these desert areas becomes economically unfeasible. Main crops, which are cultivated in the region, are wheat, barley, pulses and potatoes. Summers are warm and longer in Suru as compared to other valleys of Ladakh. It includes Kargil, Sankoo, Panikhar, Batalic, Sodh, Paskum and Shakar-Chiktan areas etc. The cultivated area lies between 2600-3050m and most of the area is doubled cropped (two or more crops on the same land in same season). Kargil is famous for quality production of apricot (*Prunus armeniaca*). Kargil district covers a geographical area of 14036 sq Km, of which 19437 Hect is total cultivable area, 10600 Hect is irrigated and 10666 Hect. is net sown area (LAHDCK 2011), horticulture is gaining much attention in the recent years. The main productions are apricot and apple; however, in Western Ladakh fruits such as almond and grape are also grown. The fruit production are either marketed in Leh town or supplied to the armed forces stationed in the region.

In recent years, production of seabuckthorn (*Hippophae rhamnoides*) has shown an appreciable increase in consumption outside the region of present study (Dawa and Humbert Droz 2004). Pastoralism and livestock rearing is one of the most important activities in the economic growth of the region, because much of the habitants live in the rural sector. The region shows deficient in animal by-products such as milk, meat and eggs. Due to no availability of fodder, presently the requirement is being met partly from the department of Animal Husbandry department, Kargil. Presently fodder is being purchased from the private sector, which involves a huge amount (LAHDCK 2010). According to the department of Animal Husbandry, Kargil, the region is having a cattle heads (cows/bulls/calves) 46206, yak/demo and hybirds (dzo/Zomo) 21154, Equines (horse/ponies/mules/donkey) 4929, sheep 169794 and goat 92268. Other than the subsistence agricultural practices, other main sectors of Ladakh economy are trade and commerce, employing 2.5% in Leh district, construction 1.8% and manufacturing and processing 1.5%, transport 1% and house hold industry 0.8%. Employment by the government, armed forces and tourist industry are other major sources of livelihood.

2.10 Health Care System

Tibetan medicine has been the traditional health system of Ladakh for over a thousand years. This school of traditional healing contains elements of Ayurveda and Chinese medicine, combined with the philosophy and cosmology of Tibetan Buddhism. For centuries, the only medical system which was accessible to the people has been the *Amchi* who are traditional doctors following the Tibetan medical tradition. *Amchi* medicine is still an important component of public health to this day, especially in remote areas.











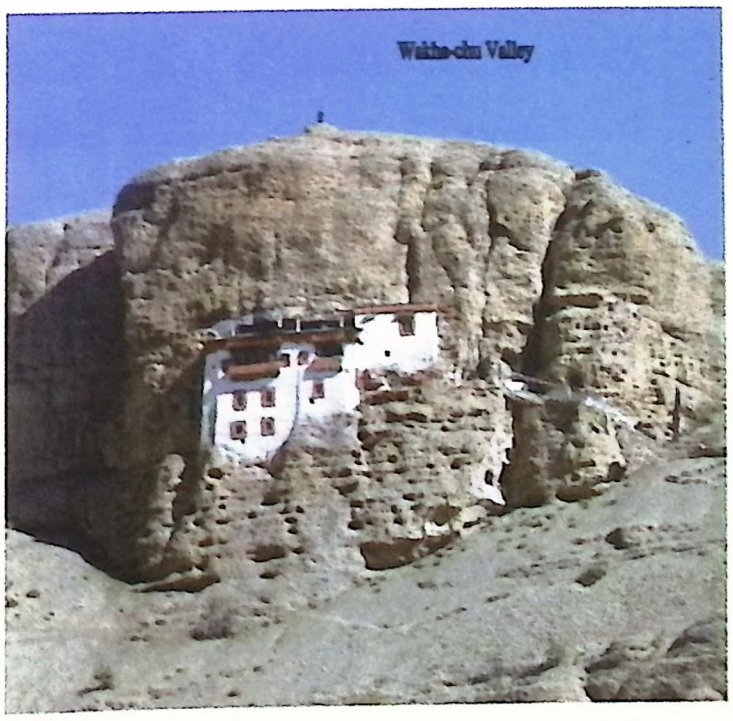


Plate II: Study Area: Western Ladakh three valleys

CHAPTER 3

Traditional Health-Care Systems across Major Ethnic Groups

3.1. INTRODUCTION

With increasing demand of health-care services throughout the world, the World Health Organization (WHO) has recognized traditional medicine (TM) as one of the best alternative forms of modern medicine. In recent years, initiatives taken by local governments have caused a continuous increase in the demand for traditional health-care services, which has an immense potential for further growth. These services include all the possible treatment techniques used by the local aboriginal, which constitutes that Traditional Health-care Systems (THCS). THCS comprise a body of knowledge that explains the etiology and diagnostic procedure, pathogenesis, prognosis, treatment and prevention of ailments. This also includes human psychology. The most important concept in THCS is to believe in the equilibrium and harmony of the spiritual and natural world. Modern health-care lacks this equilibrium, since it concentrates mainly on bodily problems. Today 80 % of the human population in developing countries is dependent on traditional systems of health-care (Farnsworth et al. 1985). The estimated use of complementary, alternative, and TM in Africa (80%), Japan (72%), Australia (49%), China (30-50%), and Vietnam (30%) is fairly large and may grow further with increasing populations (WHO 2002).

According to WHO, TM is the only available source of health-care in 65% of the population in India. It is not only an affordable source of health-care in many countries but is also firmly embedded in their belief systems and can be considered culturally compatible. Indian THCSs comprise Ayurveda, Unani, Siddha, Yoga, naturopathy and several other locally well-known practices including Sowa-rigpa, which is practiced in Ladakh region of Jammu and Kashmir. India has a long history of TM that is well established and integrated within the overall medical structure of the country (Lodha and Bagga 2000, Hyodo et al. 2003). Although THCS is prevalent in India, there is still insufficient information regarding the safety and efficacy of TM and lack of policy to support this system has undermined its potential.

Despite the rapid growth and technological advances in modern medicine, interest in TM has dramatically increased at the end of the last century. The increasing demand for its use has led to the considerable interest among policy makers, health

administrators and medical doctors on the possibilities of bringing traditional and modern medicine together. TM however has not yet been officially recognized by most countries. On the other hand, several countries in East-Asia such as China (Hesketh and Zhu 1997), Taiwan (Chi et al. 1996), Vietnam (Ladinsky et al. 1987) and South Korea (Cho 2000), TM has already been integrated into western or allopathic medicine. Integration of THCS into modern medical systems requires an extensive documentation, through clinical research, on the safety and effectiveness of TM. The practice of TM is mainly based on conventional use of natural products and personal experience. Current information on the quantity and quality as well as the safety and efficacy of TM are far from sufficient to meet the criteria needed to support its use worldwide. Consequently, education, training and research in this area have not been accorded due attention and support. One of the reasons for the lack of research data is due to insufficient health-care policies.

The present study deals with the different healing practices in contemporary Ladakh and the transformations that have occurred and are ongoing in THCS among the people of Ladakh. Concept of disease and sickness, the different methods of treatment, the official health policies over the years among the locals are taken into account. The study focuses on how and why traditional knowledge still persists among the locals of Western Ladakh. It also focuses on other aspects of the health-care system in Western Ladakh. The present study aims to contribute to the subject of medical anthropology by looking at the combination of use of popular and home-based remedies, herbal, religious healing, spiritual practices and biomedical treatment among the communities of Western Ladakh.

The Government of India stresses the importance of health-care services, in order to give every Indian access to effective and affordable health-care services. The National Rural Health Mission (NRHM) focuses on the holistic approach of health-care system that includes traditional healing as well as self-medication. The participation and involvement of traditional practitioners and local communities are in line with the principle of primary health-care (PHC). However, these approaches have been inadequately understood and developed. There are numerous views and opinions on the traditional health-care systems that have been considered, but none of them has addressed the need to operationalize the involvement of traditional healing into the modern health-care delivery system. India is a multicultural society whose health-care

delivery is mostly westernized, but consumers should have option to choose traditional or modern health-care system equally. The Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) is a part of the Ministry of Health and Family Welfare of the Government of India. It puts emphasis on the need to incorporate and utilize optimally all of the country's human and material resources.

3.2. OBJECTIVES

The overall objective of this study was to assess the use of health-care systems and to evaluate the preference of the local people to different health-care practices, including the available alternatives of different healing systems, and their status in western Ladakh. Specifically, the study aimed to evaluate:

1. the status of different traditional healing systems and their influence on human health
2. the effectiveness of treatments given under different healing systems by traditional healers

3.2.1. Research Questions

The main questions of this research were

1. the extent to which traditional healing systems can be incorporated into the modern health-care system
2. which traditional health-care systems prevail
3. the prevalent diseases
4. the status of traditional healers
5. the plant most widely used by the THCS in Western Ladakh.

3.3. METHODS

After a reconnaissance survey, preliminary data were obtained from various district offices and through a questionnaire, survey of village heads (*Nambardars*). Systematically, the first step involved collecting data on demography, professional training and recognition as professionals. The second step was to focus on treatment techniques and the traditional pharmacopoeia. Thirdly, the perception of people regarding effectiveness and ease of treatments and lastly the social status of traditional

healers were investigated. Data were collected from different health-care practitioners through a semi-structured questionnaire.

According to Lobiondo-Woad and Harber (1998), both the research objectives and the conceptual framework influence any research design and hence a research process involves not only gathering and analyzing data but also paying attention to the validity and reliability of the research findings. Research design for this study is discussed below in detail.

3.4.1 Target groups and health-care systems

Targeted consumers and traditional healers belong to three major ethnic groups i.e., Brokpa, Balti and Purig. There are no precise data regarding the total number of traditional healers practicing in study area. Uncertainty in numbers is due to several reasons. Some of the traditional healers operate covertly and in some areas, after the death of old healers in the family their descendants do not practice despite their name being on the list of healers. On the other hand, some healers are actively involved in the healing profession but are not registered. Traditional healing systems in Ladakh belong to three major groups as discussed below.

***Traditional medicine practioners (Amchis)*:** An *Amchis* are the traditional healers who use extracts of plants or animals as medicine to treat a wide range of diseases. Their treatment techniques have many similarities to Ayurveda and Tibetan healing systems yet they have their own unique methods of treatment. In this system, plants are the main source of medicine although sometimes they use minerals and other natural products.

***Shamanic healers*:** Traditional *Shamanic* healers are called *Lhaba* (male) or *Lha-mo* (female) in Ladakh. The word *Lha* literally means a "divine person". They perform *Shaman*ic curing, analyze the cause of special events, and interpret the messages. They use divination objects or explain the unknown by the special powers of prophecy. Their function is that of divination, but they often provide healing care. It is believed that *Shamans* embody spirits or deities during trance states. They are called upon to divine the future, cure bodily diseases and ward off harmful entities that haunt the land from the mountains.There are three types of *Shamans, Khim-lha* or *Nang-lha* for every household, *Ayeshes pa or Rhuh lha* for monastery and *Yul-Lha* for village. Each village has its own *Shamans* who protect villagers from evil spirits and demons.

Monastic *Shaman* serves the whole community while the village oracles practice individually orientated healing sessions. The prestige of monastic oracles is higher than that of the village oracles.

***Akhons* (Muslim faith healers):** *Akhons* are the Muslim faith healers who treat people using plant and animal parts and mineral substances not as medicine but a medium to divert people's minds with hymns based on social, cultural and religious background as well as prevailing knowledge, attitudes and beliefs regarding physical, mental and social well-being and causation of the disease. *Akhons* actually indicate syncretism, an interpretation of orthodox Muslim society in a way to reconcile with traditional culture.

3.4.2 Sampling Procedures and Intensity

This research study was multidisciplinary in nature and hence, the tools and techniques adopted were drawn both from the physical and from social sciences. In order to document the traditional health-care systems in three valleys, extensive field surveys were carried out from 2009 to 2012 in western Ladakh. The surveys were spread across three seasons in order to get maximum information provided by the local informants of different age groups.

Snowball sampling (Coleman 1958, Goodman 1961, Spreen 1992) method was used for the target samples i.e. *Amchis*, *Akhons* and *Shamans*. Members of these populations have not all been previously identified and are more difficult to locate or contact than known populations. This method employs the presumed social networks that exist between members of a target population. It can provide comprehensive (though not generalizable) characterizations of unknown populations. In this method, the data collected were from the members of the target population he or she can locate, and then enquire those individuals to provide information needed to locate other members of that population whom they know.

After a reconnaissance survey, 81 villages were selected for further study. At first, village heads were interviewed to determine the number of THCS in the village after which semi-structured interviews and participatory appraisals of different practitioners in all three valleys were organized. Data on the number of health-care practitioners, their family profile, social and economic status and information on the prevalent diseases were collected. Information on local plant and part names used for

curing were also recorded. Altogether 36 *Amchis*, 21 *Shamans*, 53 *Akhons* and 30 Allopathic doctors were interviewed. The last phase involved the interview of 540 local people.

Field visits to the high alpine areas were organized with the *Amchis* in order to ascertain the correct identity of plants and also to obtain first-hand information on their distribution and availability. These plants were collected for identification and herbarium preparation following standard methods (Jain and Rao 1976). The voucher specimens are housed in the herbarium of the Wildlife Institute of India, Dehradun for future reference.

An extensive literature survey was carried out for the compilation of various traditional practices, beliefs and raw materials used for curing different ailments by traditional healers. In order to assess the traditional knowledge among various age groups, traditional healers were categorized into four age classes, i.e. 20-30 years (new generation), 31-50 years (adult), 51-70 years (middle aged) and above 70 years (veterans). Traditional healers were interviewed on different parameters such as education, income and the source of medicine.

3.4.3 Data Collection Tools

Data were collected with the help of questionnaire surveys and informal interviews to get maximum information from the people. Interviews were recorded with the help of a digital video camera for future reference. Both qualitative and quantitative data were recorded. (a list of questions is included in the Appendix 1)

Semi-structured questionnaire

A semi-structured interview is a qualitative method of inquiry that combines a pre-determined set of questions (questions that prompt discussion) with the opportunity for the interviewer to explore particular themes or responses further. A semi-structured interview does not limit respondents to a set of pre-determined answers (unlike a structured questionnaire). A semi-structured interview will involve closed questions (i.e. yes-no answers), although they may also contain some open-ended questions ("Tell me about .....") and some arise naturally during the interview ("Can you elaborate what you said right now ...?"). The aim is to understand the respondent's point of view rather than make generalizations about behavior.

Review of documents

Relevant documents regarding the visit of consumers to healers/doctors were reviewed to know the disease prevalence. Data were also collected from the secondary sources like hospitals and Public health centers in the area. There were inadequate records of people visiting the health centers so, three years records were collected from all the public health centers.

3.4.4 Validity and reliability

Impingement of personal bias was excluded as much as possible. The process of data collection was done in either winter, beginning of spring or late autumn when people have enough time to participate in the interviews. During the summer, they were busy making their livelihood. The questions were translated into Ladakhi for those participants who could not understand English.

3.4.5 Data analysis

Quantitative analysis

Parameters such as age, gender, education level, years of experience, socio-economic standards were quantified and compared across different classes. These parameters were compared to the level of knowledge among traditional healers. Prevalence of disease was determined on documented information regarding number of patients visited during the last three years from different health centers. Disease prevalence was also obtained from the *Akhons* and the *Shamans*.

The use value (UV) was calculated to demonstrate the relative importance of the species known locally by the *Amchis*, using Gazzaneo et al. (2005). Use value is calculated using the citation of species by the *Amchis*.

$$UV = \sum U/n$$

Where U is the number of citations per species, and 'n' is the number of informants.

Qualitative analysis

The research questions were categorized into different parameters such as knowledge, awareness, collaboration, acceptance and legalization.

3.5 RESULTS AND DISCUSSION

3.5.1 Demography

There are 110 Traditional health-care practitioners in western Ladakh of which 53 are *Akhons*, 36 *Amchis* and 21 *Shamans*. According to Burke-Mason (1997), 150 *lha-mos* and *lha-pas* were known to exist in Ladakh already in 1996.

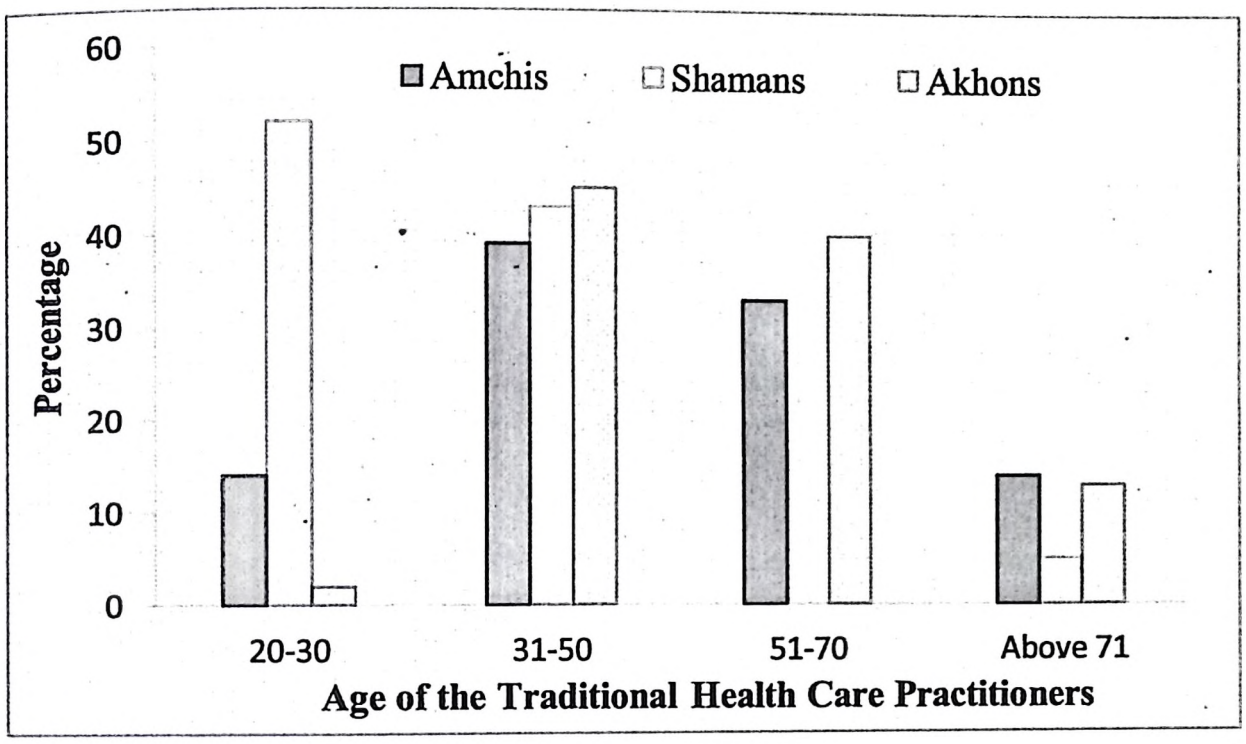


Figure.3.1 Age distribution of *Amchis*, *Shamans* and *Akhons*

The highest concentration of *Amchis* (67%) was found along the Wakha-chu valley, followed by the Lower Indus valley (17%) and the Suru valley (16%). The majority of *Amchis* (39%) were between 31-50 years of age followed by 51-70 years (33%), 20-30 years (14%) and above 70 years (14%). Figure 3.1 shows that in the three valleys surveyed younger generations are not willing to adopt their traditional profession.

There are 21 *Shamans* in the three valleys; 14 in Suru, 4 in the lower Indus and 3 in the Wakha-chu valley. The majority of *Shamans* (52%) were between 20-30 years of age followed by 31-50 years (33%), 50-70 years (10%) and above 70 years (5%). The study reveals that in recent years there was a sudden increase in *Shamans* in Western Ladakh. The reason for this increase, given by the *Shamans*, was due to the influx of tourism and acculturation.

Other than these two practitioners, there are 53 *Akhons* of which thirty-seven are in the Suru valley followed by twelve in Wakha-chu and four in the Lower Indus valleys. Most of these *Akhons* (nearly 45%) are between 31-50 years old, 40% are 51-

70 years of age and more than 30% are over 70 years old. Only 2% of the *Akhons* are between 15-30 years of age. The *Amchis*, *Akhons* are also mostly of middle age.

Among the *Amchi* respondents interviewed, 86% were male and 14% were female. Interviews with *Amchis* revealed that males dominated the traditional health-care system since its inception and that females were seldom a part of this system (Figure 3. 2).

In the case of *Shamans*, 81% were female and 19% male. It is not a matter of choice to become a *Shaman* they have to follow their family legacy hence there is no rule regarding the gender of a *Shaman*ist.

Unlike *Amchis* and *Shamans*, *Akhons* were only male dominated, as females have never been a part of this tradition.

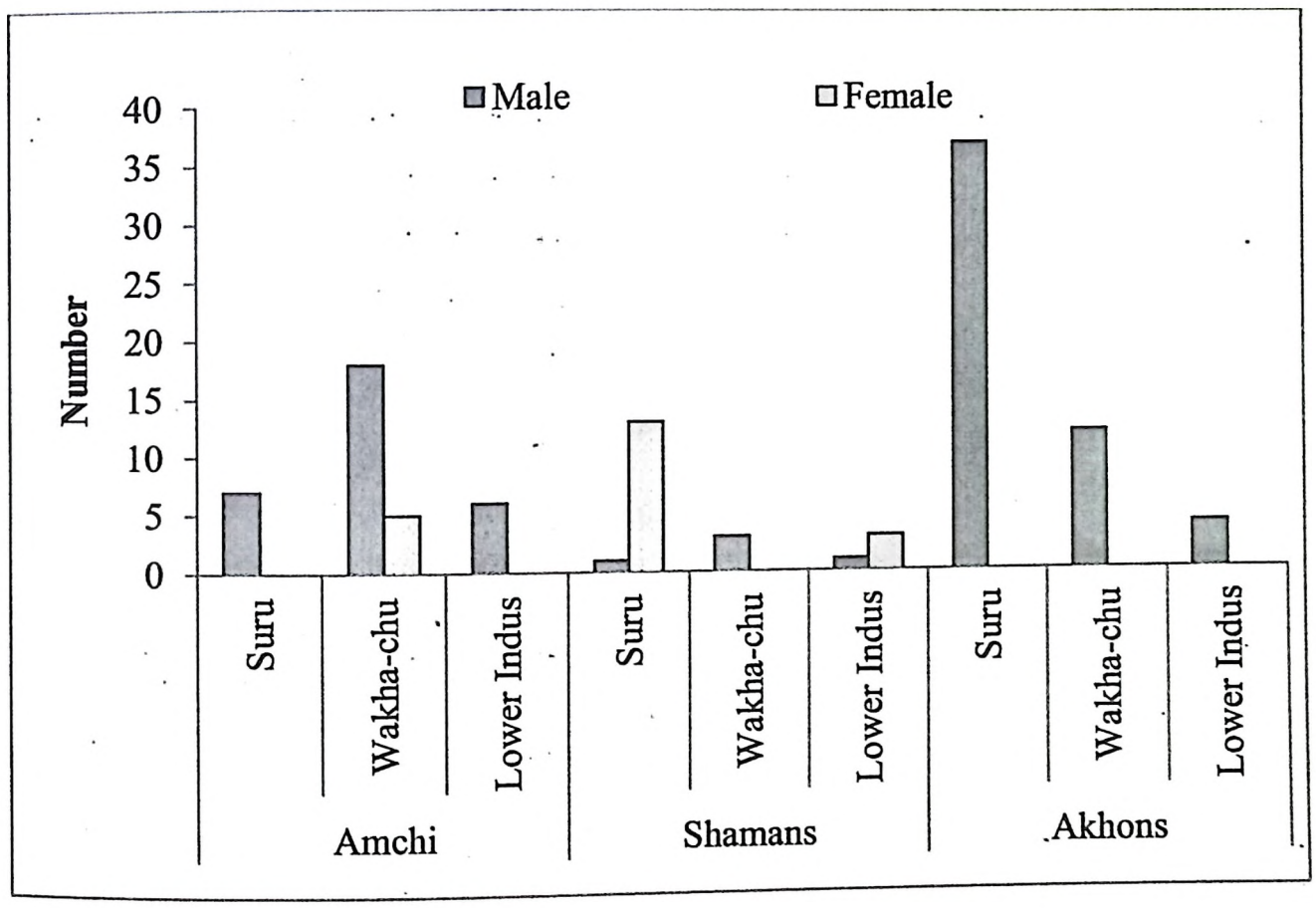


Figure 3.2 Gender of *Amchis*, *Shamans* and *Akhons*

3.5.2 Educational level

Amchis acquire their education in two ways viz., informal, traditionally passed down from ancestors on a lineage basis and from formal schooling, known as Bachelor of Traditional Medicine System. Figure 3.3 shows that 44% of *Amchis* were not educated; 39% have passed secondary school (grades 10 or above) and 11% finished only primary education (under grade 5). Only 6% had studied under the school of Tibetan Medicine System at the Ladakh School of Tibetan Medicine, Leh. The

Bachelor in Tibetan Medicine System (BTMS) is a 5-year course. Although most of the *Amchis* have no formal schooling, the healing practice requires knowledge of the Bhoti language in order to understand the written prescriptions and mantras. It takes 3-16 years of informal study to learn this system of medicine from older *Amchis*. Disciples are then examined on pulse diagnosis, urine diagnosis and other important oral tests from four "Tantras" in front of their own teacher, elder *Amchis* and villagers.

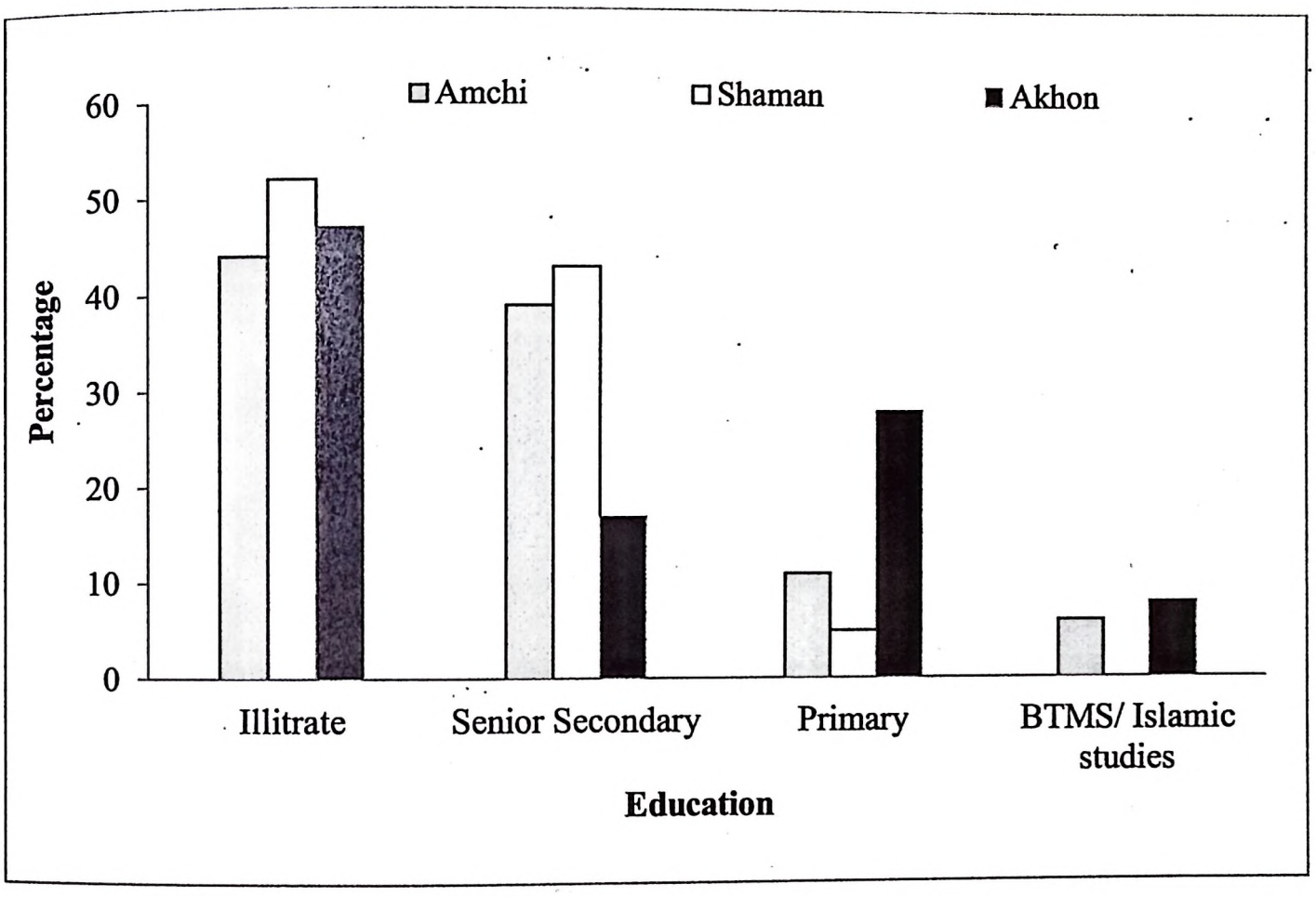


Figure 3.3 Literacy status of *Amchis, Shamans* and *Akhons*

Practice of *Shamanism* does not require any formal or informal education as it is totally based on physical and spiritual training given by monks. People in Ladakh believe that becoming a *Lha* is not one's own choice but rather they are chosen by oracle or the diety themselves or, in other words, it requires some kind of spiritual attainment to be a *Shaman*. Figure 3.3, shows that 52% of the healers were illiterate, and 43% are in their Senior Secondary. Some are still attending school. Only 5% had dropped their studies after primary grade. Unlike *Amchis*, *Shamans* are comparatively younger.

To become an *Akhons* also does not require a formal education but does require a knowledge of the Arabic and Urdu languages. Out of a total 53 *Akhnons*, 47% were illiterate, 17% dropped out during primary school (under 5th) and 28% reached, but

did not finish, matriculation. Only 8% had completed their formal education under Islamic studies in Kargil or abroad, mostly in Iraq.

3.5.3 Experience

The experience of the *Amchis*, *Shamans* and *Akhons* were classed into six groups example in *Amchis* 22% have 1-10 years' experience, 22% has 11-20 years, 25% has 21-30 years, 14% has 31-40 years, 14% has 41-50 years and 3% has above 50 years. The experience helps us to understand their proportional distribution, which reveals that very few *Amchis* above 40 years of experience are left.

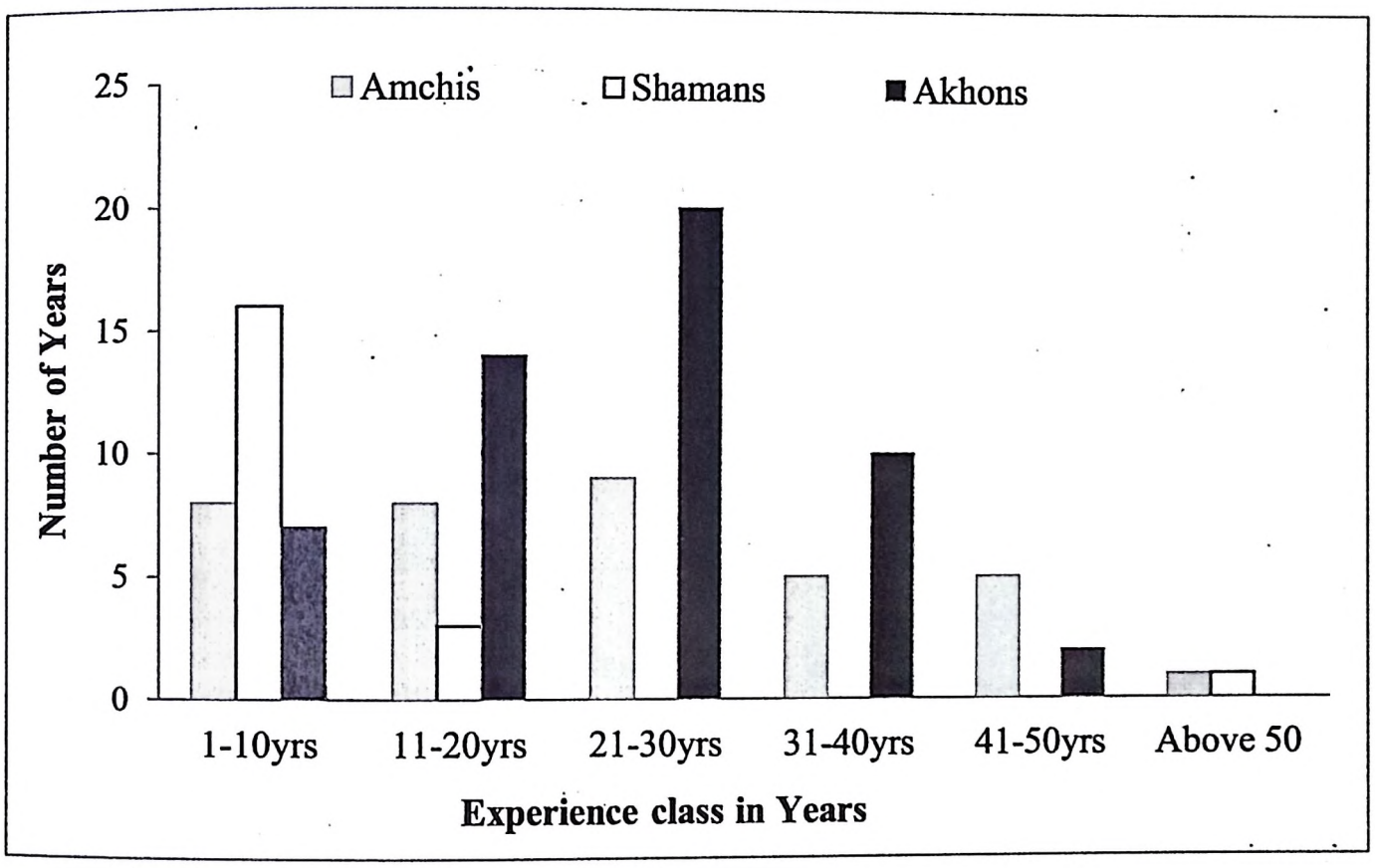


Figure 3.4 Experience of practitioners

All *Akhons* use plants not for its medical properties but as a part of their treatment techniques. It was difficult to quantify the knowledge of *Akhons*, as their treatment technique was totally based on knowledge of Quaran, the holy book of Muslims. Saffron and Viola species was considered as important ingredients of the system. According to the graph most of the *Akhons* i.e. 38% has 21-30 years of experience, followed by 26% having 11-20 years of experience, 19% has 31-40 years, 13% has 1-10 years of experience and only 4% has 40-50 years.

In *Shamans* most of the *Shamans* (80%) has 1-10 years' experience, followed by 15% having 11-20 years experience and only 5% under above 50 years' experience. Knowledge of *Shamans* was based on their experiences. They do not possess the knowledge of plant as *Amchis* as they are not involved in medicine preparation.

3.5.4 Transfer of Knowledge

Over 75% of all *Amchis* adopted the tradition from their ancestors while the remaining obtained this knowledge from outside their families (Figure 3.5). Traditional knowledge in the family or community was passed from father to first-born son while the knowledge of females was based on their personal observations. Lack of interest in young people to adapt this system as profession clearly indicates that the Sowa-rigpa system of medicine is dwindling.

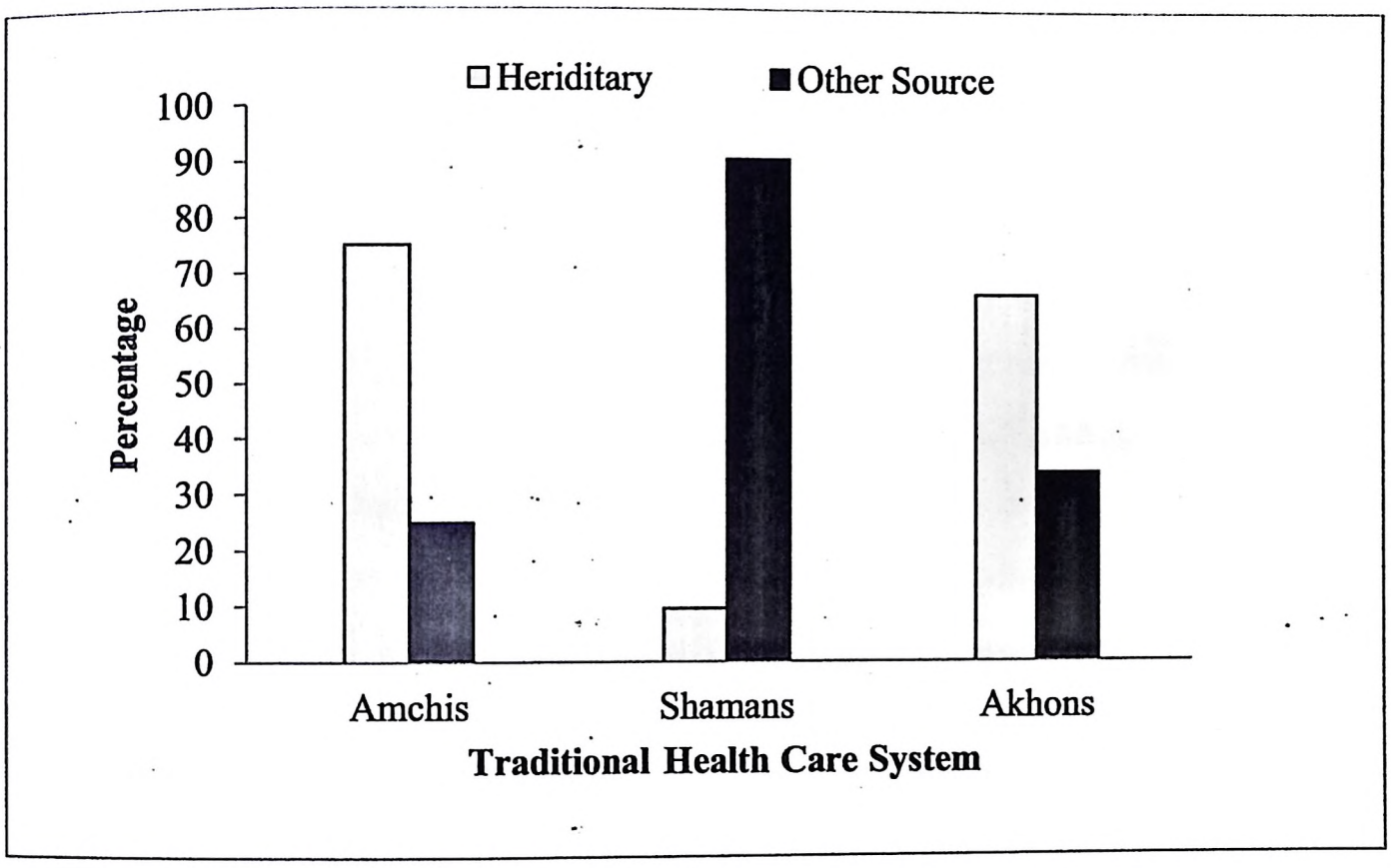


Figure 3.5 Transfer of knowledge from hereditary or other sources amongst *Amchis*, *Shamans* and *Akhons*.

Shamans, on the other hand, do not transfer knowledge from generation to generation. However, family tradition requires that offspring to pursue this knowledge. There are only two families (10%) who are following the *Shaman* tradition, but others have no history of *Shamans* in their families.

Shamans mainly undergo informal training under one of the renowned *Shamans* or *Rinpoches* (head Abbot of the monastery). Usually a *Rinpoche* is employed to approve the possession of evil spirits, which can be sometimes mistaken by the divine powers. Therefore to separate them from demons who are taking possession of the *Shamans* body (*lus-gyar*), teachings and initiations (*Lha-pog*) are given in consecutive stages by an elderly *Shaman* (teacher) selected by the individual *Lha* or *Lhamo*. In their opinion there is little to be done against an inherited ownership by *Lhas* if it is already in their lineage. In certain cases, "*tum*" a special religious ritual was

performed to stop the possession of people who have received the *Shamanic* vocation.

The practice of *Shamanism* starts with *Shamanic* vocation, which was known by the person through a mental distress, an acute life crisis, and general emotional stress, which continues for months. In some cases, *lhas* are allowed to continue being possessed by divine power for the benefit of all living beings.

In the *Akhons* system, knowledge is transmitted from generation to generation. Although they have both formal and informal education most (66%) *Akhons* transmit knowledge over generations. This knowledge transfer tradition is very similar to the *Amchis* tradition.

3.5.5 Religion

In the three valleys examined in this study, most (94%) of the *Amchis* is Buddhist. The reason for this may be that the Sowa-rigpa system originated from Tibet and all their scriptures are available only in the Bhoti script. Although the Muslim community mainly inhabits these areas, only 6% of healers are Muslim. Most of the Muslims in the valley are converted Buddhists. The recent discovery of several statues, which belong to a thousand year old civilization from Sangra village (Suru valley) and holding property papers in the Bhoti script, is evidence of the dominance of a Buddhist culture in the past.

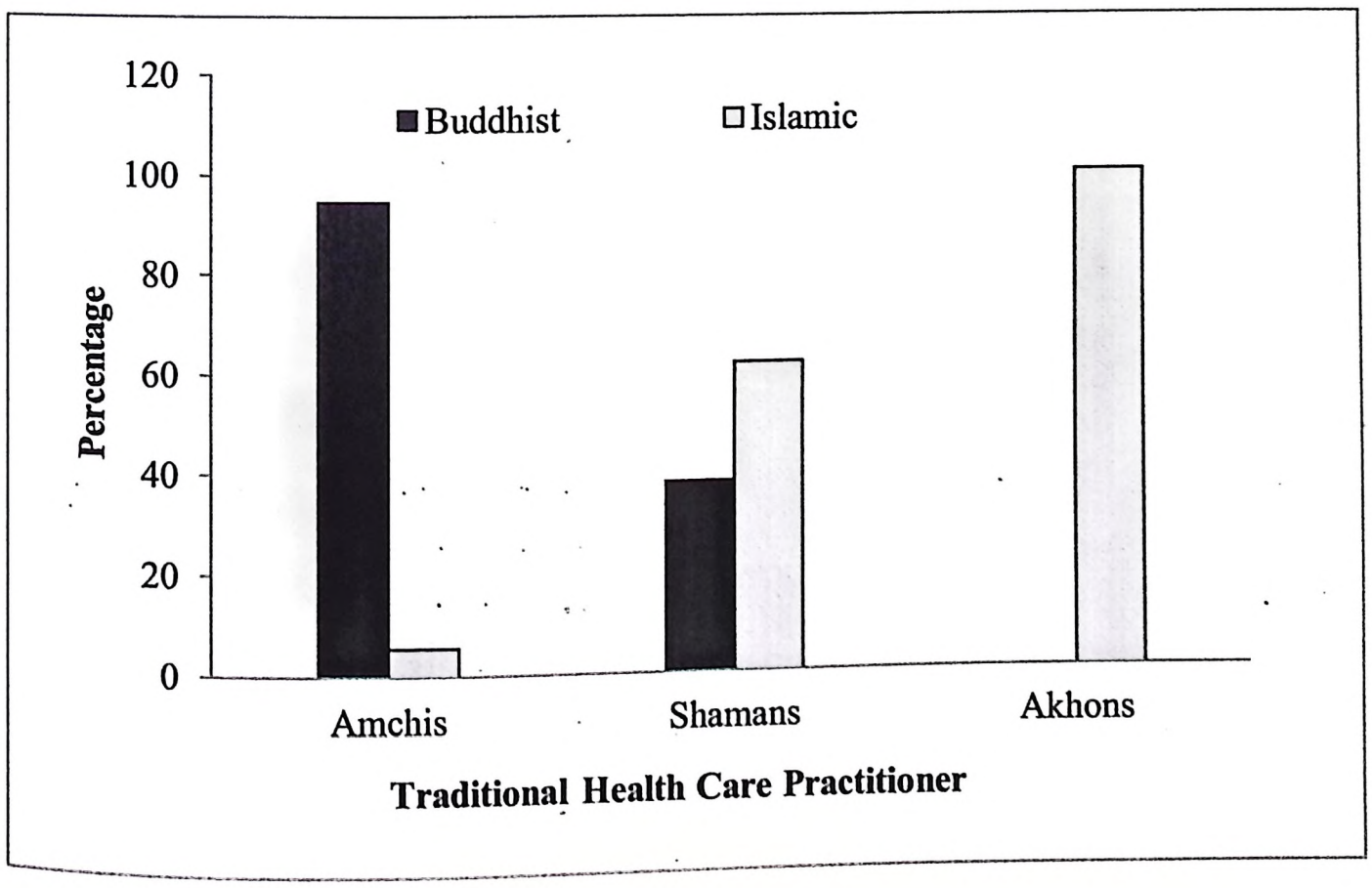


Figure 3.6 Religion of THCPs

The practice of *Shamanism* in Ladakh was based on the Buddhist philosophy and is mainly practice by Buddhists. However, a few Muslims also practice *Shamanism* despite their insufficient knowledge of the Bhoti language and difference in faith. All *Akhons* belong to the Muslim community since are subjected to Muslim community only (Figure 3.6).

3.5.6 Socio-economic standards

The socio-economic conditions of *Amchis* are not good. Most of them (67%) have a monthly income of INR 500-700, while only 5% *Amchis* are earning more than INR 5000 per month. Some *Amchis* get an allowance of INR 5100 per annum from the government of India for keeping the tradition alive. This allowance includes INR 1500 to buy raw material for their medicines and INR 500 per month for individual work. Only those *Amchis* who are registered with the government (47%) get this allowance.

Due to low income and high expenses, healers are inclined towards other occupations such as transport drivers, porters, shopkeepers, schoolteachers, and other part-time work (Figure 3.7). Low income and high inflation makes it difficult for the *Amchis* to survive. Most of them are not happy with their profession and a trend to leaving this tradition has already started during the last few years.

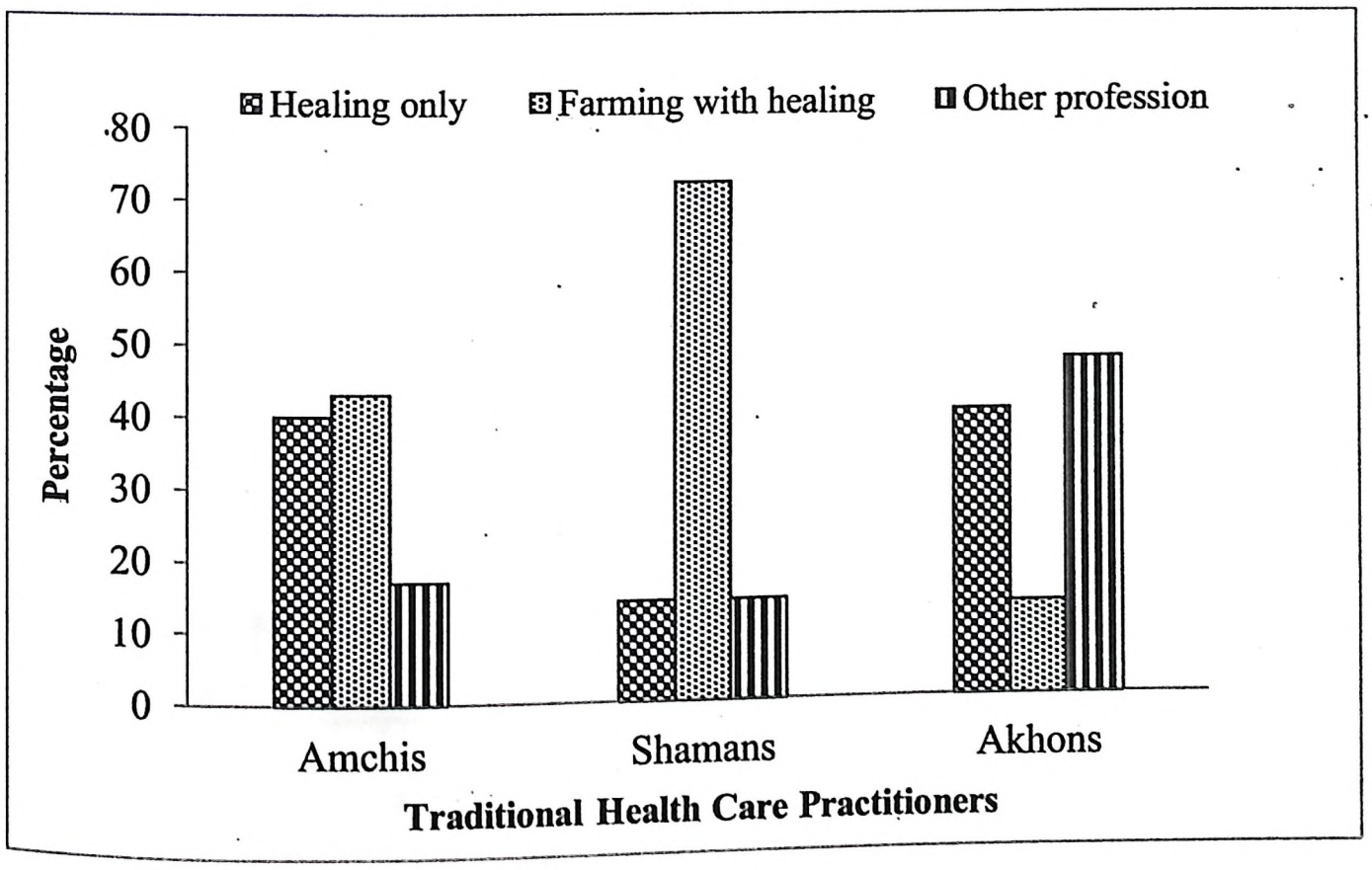


Figure 3.7 Traditional Health Care Practitioners involvement in other occupations

Akhons are respectable and well known among the locals. Their income is insufficient to provide even basic needs of living and hence they also have to be involved in other professions. Most of them (47%) are involved in other professions such as shop-keepers, porters, teachers, etc. 13% are involved in both farming and the healing practice while 40% are only involved in the healing practice. Their monthly income ranges between INR 500-3500. Figure 3.8 shows that most of them earn between 500-1000 INR. Due to low income and high expenses, *Akhons* are more inclined towards other occupations such as porters, shop keeping and teaching. In recent years, most of the *Akhons* families have stopped practicing their healing tradition.

Most of the *Shamans* are females so they are mostly involved in farming and healing practice. *Shamans* are not willing to continue the Shamanistic life as people in the village do not respect them and consider them as lunatics. But the practice cannot be stopped by will, as the possession of spirit is a cyclic process that happens without any will to be possessed.

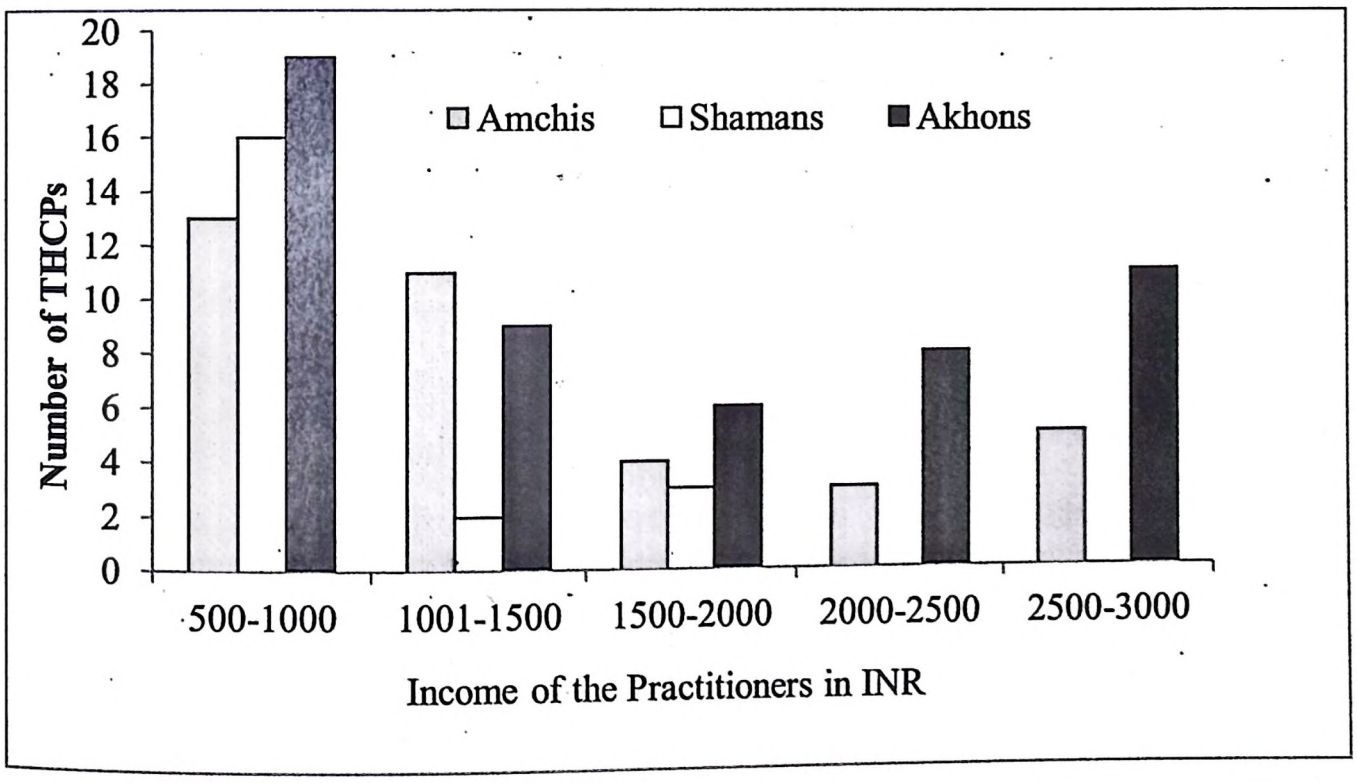


Figure 3.8 Monthly income of THCPs

3.5.7 Practices and treatment techniques

Amchi*: *The herbal healer

Moxibustion and puncturing of veins: This method is used for the treatment of paralysis, inflammation of joints, arthritis, headache, mental illness, fracture and acid peptic disease. The moxibustion is carried out on different parts of the body such as head, temples above the forehead, knee and spinal cord. The flower of *Tawa*

(*Leotopodium* spp.) and *Artemisia* sp. is collected dried and made into cottony ball (smaller than a pea) which is then put into a golden needle and is burned onto the ailing body area. Sometimes heated metal needles of iron, gold or silver are directly placed on certain parts of the body. The method of application depends on the type of disease: for example, for mentally retarded persons moxibustion is done at the 6th and 7th vertebral column, while for headaches it is applied at the centre of the head. To cure some diseases, *Amchis* allow blood to ooze out for a certain period of time by puncturing veins with a needle, a practice similar to acupuncture. The day and time of day play a major role in practicing moxibustion and these are decided on the age of the person according to the Tibetan lunar calendar. Usually it is on 16th day of the month.

Medicinal hydrotherapy: This is a moderate method with different forms of treatment which can be broadly classified as bathing in medicinal water, and medicinal tie bathing. These methods require simple spring water, medicinally prepared water or steam depending on the nature of ailment. The ingredients of medicinal water, '*bdud-rtsi-Inga-lums'* (five *Amritas*), contains *Juniper* spp. *(Shuk-pa)*, *Waldhemia* spp. (*Ba-lu), Myricaria* spp. *(Um-bu) Artemesia* spp. *(mKhampa karpo),* and *Ephedra* spp. *(Tsepat)*. These ingredients are ground crushed and boiled in a big pot of water. When the water is lukewarm, add a small quantity of *chang* (alcoholic beverage made of barley). The decoction of barley is mixed with boiled grains, and finally yeast powder is added to the mixture. The patient is asked to sit in the tub of this medicinal water for some time. This treatment is used for people suffering from paralysis, rheumatoid arthritis, acid peptic disease or movement disorders. In medicinal tie bathing, which is a relatively simple method, a medicine is put into a bag made of thin cloth and tied to the affected part of patient's body.

About one half of the *Amchis* of Ladakh use herbal baths in their practice. The method is time consuming and requires patience. Patients are also advised to visit hot springs with or without accompanying *Amchis*. Similar to moxibustion, medicinal bathing is also done only on special days and hours (S*karma-Tuszang*). It is believed that at these times the medicinal property of water increases many fold. Spring and autumn are the best times of the year and the duration of the bath increases with consecutive treatment days. The important hot springs in Ladakh are located at Chumathang, Panamik, Chilling, Kanji, Markha, Serchan and Puga.

3.5.8 Constituents

i) *Plant parts*

Amchis believe that all the plants on earth have medicinal properties and possess some inherent efficacy. There are 315 plants used by *Amchis* for medicine preparation, which include plants outside Ladakh also. Out of 315 medicinal plants 160 (Appendix IIA) are used in Kargil. It was found that taxonomy is uncertain in the THCS. *Amchis* use different names for the same plant species and in some cases one name for different plant species. For example tuber of *Aconitum* species is called *Zinba*, while its flower is called *Boga* and the leaves are *Dursi*. In old transcriptions, Tibetan plant names have been described with their medical function, but not always accompanied by a precise illustration. Different parts of plants used for medicine includes flowers, fruits, roots, tubers, bark, stems and leaves (Figure. 9).

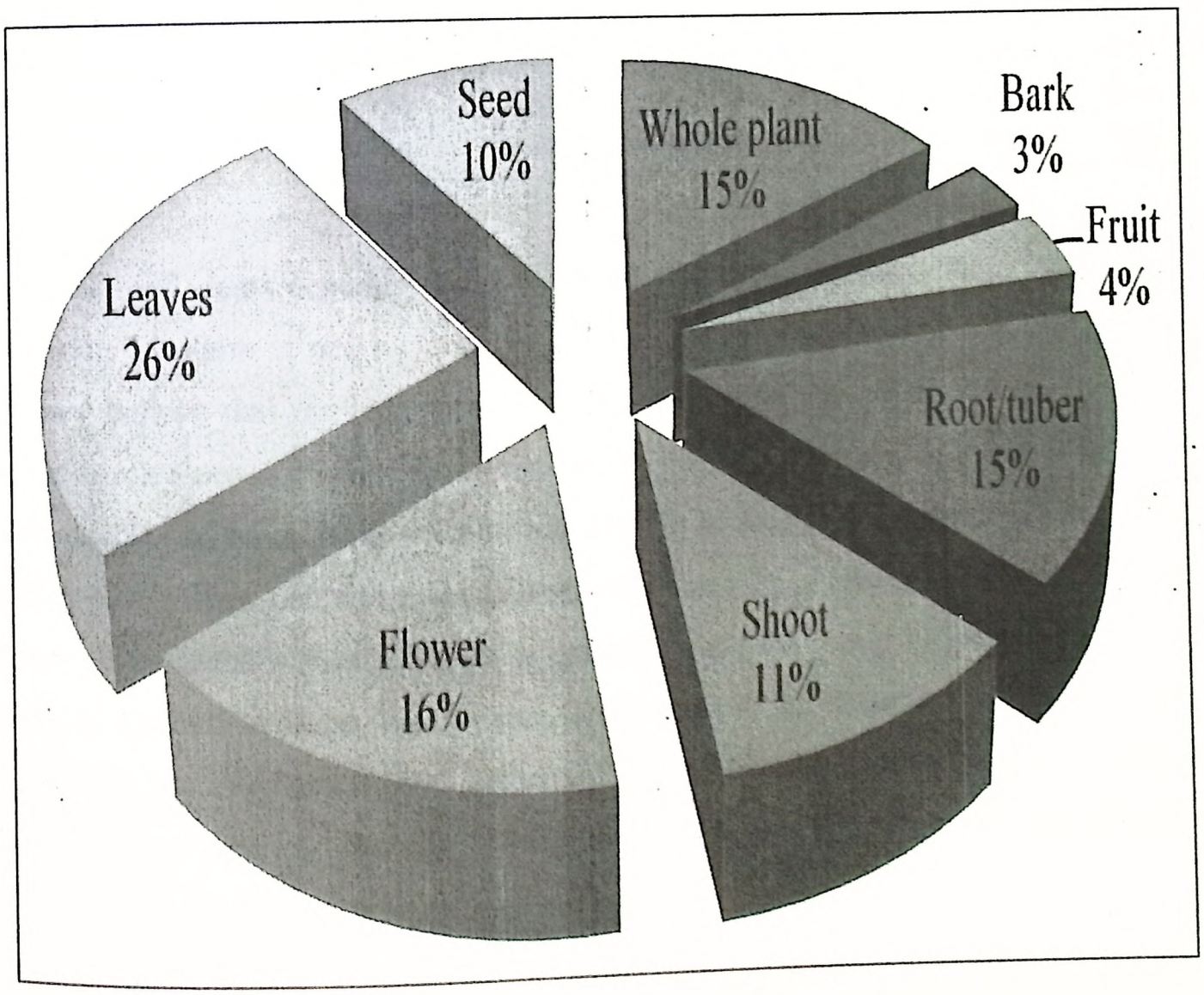


Figure 3.9 Plant parts used by *Amchis* in Kargil, Ladakh

Table 3.1 List of plants with high use value

Plant Name	Use report	Use value	Plant Name	Use report	Use value
Aconitum heterophyllum	36	1.00	*Pedicularis longiflora*	29	0.81
Aconitum violaceum	36	1.00	*Clematis orientalis*	28	0.78
Primula macrophylla	36	1.00	*Rhodiola fastigiata*	28	0.78
Codonopsis ovata	36	1.00	*Nepeta longibracteata*	28	0.78
Dactylorhiza spp.	36	1.00	*Geranium pratense*	26	0.72
Swertia thomsonii	35	0.97	*Arenaria griffithii*	24	0.67
Oxyria digyna	35	0.97	*Gentiana tubiflora*	23	0.64
Aster flaccidus	35	0.97	*Gentianella moorcroftiana*	23	0.64
Carum carvi	35	0.97	*Epilobium latifolium*	23	0.64
Urtica hyperborea	35	0.97	*Aconogonum tortuosum*	22	0.61
Corydalis sp.	34	0.94	*Rosa webbiana*	22	0.61
Clematis tibetana	34	0.94	*Inula racemosa*	21	0.58
Arnebia euchroma	34	0.94	*Juniperus* sp.	20	0.56
Saussurea obvallata	34	0.94	*Pedicularis bicornuta*	19	0.53
Lagotis kunawurensis	33	0.92	*Allium carolinianum*	19	0.53
Rheum webbianum	33	0.92	*Allium przewalskianum*	19	0.53
Rheum australe	32	0.89	*Bistorta vivipara*	19	0.53
Swertia petiolata	31	0.86	*Delphinium cashmerianum*	19	0.53
Cremanthodium arnicoides	30	0.83	*Ephedra gerardiana*	19	0.53
Rheum speciforme	29	0.81	*Hippophae tibetana*	19	0.53

Collection of plants depends on the availability and accessibility. While some plants are easily available in nearby areas, many are collected from high passes and pastures, as they believe that the higher the elevation the better the quality of the species. If some species are not available in the proximity, they may get it through exchange with *Amchis* of other areas. 79% of the *Amchis* in Kargil exchange medicinal plants with *Amchis* from Leh and Zanskar and sometimes from Dhramshala and Dehradun. Every year 'Ladakh Amchi Sabha' organises a tour for group collection in different parts in Ladakh. Around 36% of the *Amchis* go for the collection at distant places. The areas for medicinal plant collection are Khardong-la, Tanglang-la, Chang-la, Suru, Sangra, Sapi and Zanskar. The plants commonly used by *Amchis* are shown in Table 1.

ii) Use of minerals

Except for a few unidentified minerals, five were documented and are currently used by *Amchis*. These are calcite, gold, silver, pearl and rock salt (*Shilajit*). *Shilajit*, locally called as *Dak-Joon*, is the most frequently used mineral. In Kargil, *Shilajit* is

found in *Manta, Chopodok lungba and Dha-lungba* areas in the Lower Indus Valley. Of all the *Amchis* interviewed 56% use minerals and stones in their medicines while the rest are unaware of this form of treatment. *Shilajit* is used as purgative, anti-allergic, anti-diabetic, anti-inflammatory, aphrodisiac and for strengthening the immune and nervous systems. From the medicinal point of view, the chief active substances in *Shilajit* are benzoic acid and benzoates (Chopra et al. 1958). Gold is use for long life, an antidote for dog bites and as a tonic. The procedure for making these medicines is cumbersome (requires more than 100 ingredients) and also not economical (use of gold, silver etc). *Shamans* and *Akhons* are not involved in making medicines so they do not use minerals.

iii) Use of animal parts

Animal parts are also used by *Amchis* for the treatment of various ailments. Around 75% of *Amchis* use animal parts in their preparations. Organs of 28 animal species, used in therapy, were recorded during the present survey. They have a reticent methodology in the preparation of their medicines which are meant to be kept secret because it is believed that medicine looses its effect and sanctity once its ingredients are revealed to the user. Animal species whose parts are used in the preparation of *Amchi* medicine include blue sheep, wolf, Tibetan antelope, brown bear, donkey, fox, rhinoceros, ibex, tiger, wild yak, goat, sheep, pig, marmot, snow leopard, Tibetan woolly hare, otter, musk deer, chukar partridge, eagle, vulture, peacock, tortoise, snake, fish and crab (Appendix IIB). Earlier people used to hunt wild animals for medicines but more recently, the use of animal parts by *Amchis* has reduced drastically.

3.5.9 Medicinal formulations

a) *Amchis*

Besides animal parts, minerals, rocks and salts, plants are the major source of medicines in the *Amchi* system. The medicine is generally an amalgamation of 3 to 100 ingredients. The end-product is either in the form of powder (*chema*), tablet (*rilbo*), paste (*ldehgu or snum-mar*), ointment (*chukma*) or decoction (*thang*). The most commonly used medicine is *Nurbo-dun-thang*, (prepared from seven herbs) was used for the treatment of a majority of these diseases. The *Agar-sumchusona* (prepared from thirty-five herbs) was used in the treatment of backache, fever and

rheumatism. Another important medicine, *Tsandan-gyat-pa* (prepared from eight herbs) was used to treat cold, fever, tuberculosis and eye infections and *Manu-ji-thang* for the treatment of headache and cold. All except the ointments are taken orally. Most practitioners formulate and dispense their own prescriptions. There are more than one thousand herbal formulations and recipes in the *Amchi* system (Dorji and Morrisco 1989). 89% of *Amchis* make their own medicine and 11% use medicines manufactured by professional Tibetan drug manufacturers. Some formulations are difficult to make due to unavailability of the constituents such as *Rinchen wangyor* (which requires more than hundred ingredients) and *Motik-dun-chu* (seventy ingredients). Hence, many *Amchis* are not aware of these recipes.

b) *Akhons*

The majority of *Akhons* use plants in the form of smoke or coloring agents to treat patients. They have no scientific techniques and this method is completely spiritual healing. They use paper strips inscribed with religious mantras to treat patients. The inscription is different for different diseases. The patients are prescribed with these strips as medicine and these strips are dipped into the water and are supposed to drink that. One example is for toothache, in which the strip is prescribed for three days, three times a day (breakfast, lunch and dinner). Sometimes it also involves amulets (*Tabis)* as a part of their treatment if required. The plant parts used by *Akhons* are seeds, flower and fruits. The plants are mainly collected from the wild. Most of them who are following this system collect these plants for their *Akhons*. On an average *Akhons* collects only 1-2 kg of plants every year. The plant species used by the Akhons are *Viola* sp., *Juniperus* sp. etc,

c) *Shamans*

The main constituents of the *Shaman*istic healing consist of barley, rice, Juniper and *Waldhemia* spp. that are used during the *Shaman*istic rituals but are not used as a medicine. Ladakhi *Shamans* (*Lha*) start preparing for the *Shaman*istic ritual after washing their hands and face and arranging offerings for the altar. While praying the *Shaman* enters the room, wearing the *Shaman* dress consisting of a five-sided crown and silk attire. During the process, some *Shamans* conceal their face with a cloth. They carry a *damaru* (little hand drum) in one hand and a dorjay (*Vajaraya* in Sanskrit) in another with a *tilu* (bell) which they keep ringing between reciting the

mantras. They then set up a slow rhythm with the drum; begin to chant the mantras, while rocking back and forth. As the speed and the sound of the chanting are increased, a hypnotic and unearthly atmosphere was created. The *Shaman* sucks the illness from the patient's body and spits the black fluid into a bowl. Ladakhi *Shamans* treat all types of patients whether suffering from headache or many other diseases. After the treatment, the *Shaman* bows to the altar and then suddenly slumps to the floor in silence. The ceremony is then over. The *Shaman* then returns to normal life where he does not remember his state of trance. *Shamans* also use plants but not as a medicine but as smoke or fumes which helps the patients to get rid of their unknown disease. There are 15 plants used by *Shamans* during the *Shamanic* healing (some of these plants come from outside Ladakh).

3.5.10 Disease prevalence

THCS treat 17 different disorders or diseases Table 10 shows the most common ones are acid peptic disease is the major disorder in Western Ladakh (Figure 3.10). According to *Amchis,* a poor diet and high altitude causes this. The next most prevalent disease is the upper respiratory infection (common cold) which is due to severe drop in winter temperatures and poor living conditions depression, headache, dental and acute gastrointestinal disease are other common ailments. 67% of the *Amchis* also treat animal diseases, which include injury, diarrhea, constipation, milking, and lactation problems.

Shamans provide treatments for all kinds of physical and psychological disorders. They believe that doctors cannot diagnose some diseases. It is believed that in such diseases patients accumulate "poison" (tug) in their body due to greed and jealousy and only a *Shaman* can heal them. Other than the purpose of treatment, people also seek advice if a dreadful disease strikes them. *Shamans* and *Akhons* also treat animals in the same way as they treat humans. *Akhons* mainly treat diseases such as epilepsy, depression and psychological disorders.

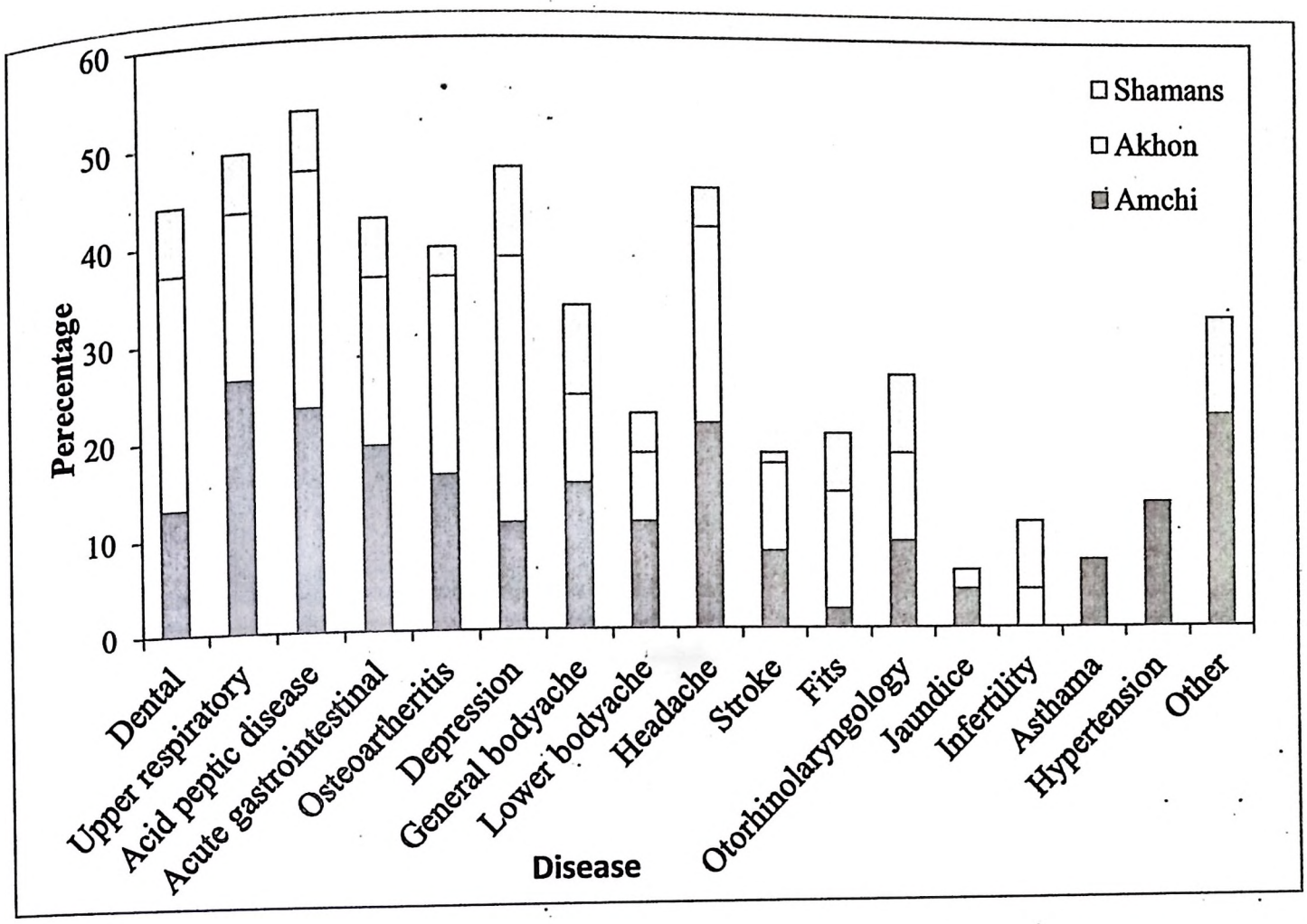


Figure 3.10: Disease prevalence in the Western Ladakh

3.5.11 Level of knowledge

The level of knowledge among *Amchis* was assessed from the number of plant species they know which was positively correlated with the number of years of informal education (R^2=0.04). There were very few *Amchis* with BTMS degree. The correlation between the years of experience and knowledge of number of plants indicates that experience does not increase the level of knowledge (R^2=0.006).

The level of knowledge of each *Amchi* was quantified based on the percentage of the number of recorded plants that he knew. Figure 3.11 indicates that there is variation of knowledge among different age groups. Greater knowledge among older *Amchis* may be interpreted as evidence of poor knowledge transfer to younger generations. Not only does the knowledge of plants and preparations vary among *Amchis*, their expertise in different diseases also varies. Only 19% of *Amchis* have expertise in a variety of ailments such as fracture, bruises, cold/cough, asthma, acidity and pulmonary disorders.

Incase of *Shamans* and Akhons the knowledge of plants was not sufficient.

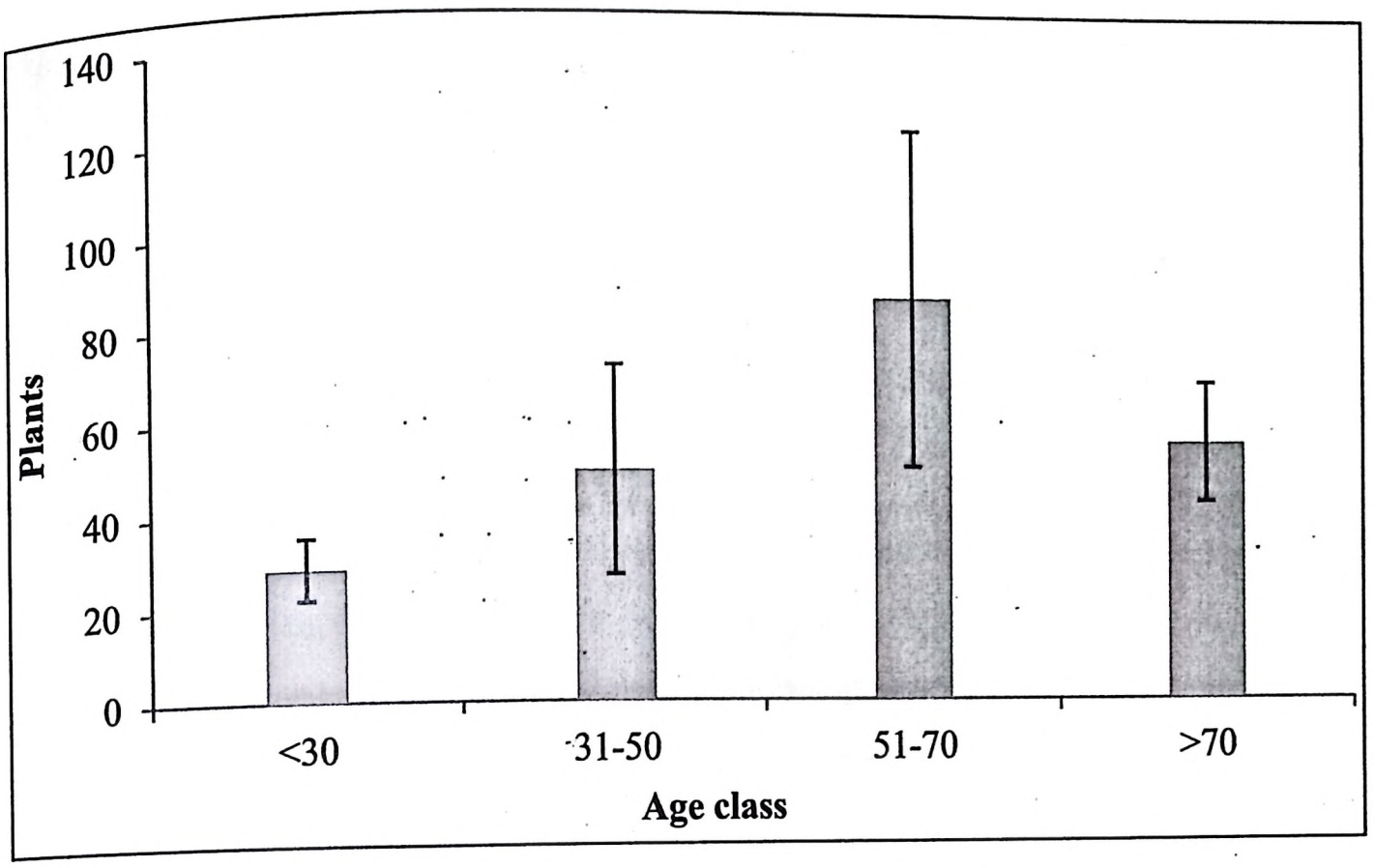


Figure 3.11 Traditional knowledge of *Amchis*

3.5.12 Effectiveness and Acceptance

Amchis accept that people often seek treatment. The number of patients treated each day by *Amchis* varies depending on the disease but usually it is up to 10 patients. Around 52% of all *Amchis* stated that their treatment and methods are not anymore demanding and popular among the local community. The remaining 48% reported that these methods are not accepted for various reasons such as changing eating habits when taking *Amchi* medicine, very limited food options, restricted use of edible oil and the bitterness of the medicines. The healing period is usually longer compared to modern medicine. 69% of all the *Amchis* agreed that the tradition is dwindling due to low income, lack of interest by younger generations, lack of government support, easy availability of modern medicine and decreasing availability of important medicinal plants.

More than half (54%) of the *Akhons* believed that they were accepted by the community and other health practitioners. They revealed that some practitioners from other health-care system consulted them for infertility and depression. Some doctors even refer patients to consult *Akhons*. More than a quarter (37%) reported that they are not accepted because people associate them with black magic and consider them as liar. Less than 13% were not sure whether they are accepted or not.

Akhons are less popular than *Amchis* but patients with certain diseases such as epilepsy, infertility and depression visit them frequently. When they were asked whether anybody was totally cured by their treatment, most of them agreed (60%) but others denied the complete cure and 7% accepted that they were cured only partially. Unlike *Amchis*, they do not use any animal parts for treatment. 73% of the *Akhons* confirmed that the practice is fading away, whereas the remaining 27% believe that the system is still popular.

Shamans are aware of the fact that they are widely accepted by the locals in Western Ladakh. Most of the *Shamans* in the Suru valley are Muslims but they provide their services to all people irrespective of their religion. It was notice that in a session 10-15 people comes to *Shamans* for treatment. *Shamans* claimed that their treatment is becoming very popular and that the number of patients has increased considerably because of their healing abilities. They believe that their method not only provides a complete cure for several disorders such as kidney stones, that are difficult to cure with modern medicines, but also has proved to be effective for patients at critical stages of a disease. During the last decades, a remarkable proliferation of village oracles has taken place in Western Ladakh after Kuhn (1988) and Day (1989) observed the same in whole Ladakh.

3.5.13 Legalization, training and certification

All *Amchis* agreed to be registered and they strongly believed that the system should be legalized and accepted as legal health-care system. This will not only open job opportunities for them but also help them to regain their respect and improve their economic status. Eighty percent of the *Amchis* reported that their services could be improved by providing training in certain disciplines such as plant taxonomy, health and hygiene. But even after their recognition, no such effort has been made by the government agencies.

A majority of *Akhons* (87%) need to be registered, mainly to be known to other communities. *Akhons* believe that they should be treated as health-care professionals because they are rendering health-care services to their patients. More than 64% do not believe in certification since they believe they already have necessary qualification from respective institutions. Less than 13% of them did not want to be registered because they are not practicing for any gain.

Shamans are not in favour of legalization, training and certification, as they believe that they have learned whatever is required and that they have gone through a very stressful vocation. Moreover, they do not consider it as a way of making a livelihood, as they believe that they are the chosen ones to serve the people without getting any remuneration. They have to help people for the sake of humanity.

3.6 CONCLUSIONS

This study reveals that in Western Ladakh people still depend on the traditional health-care system for the treatment of diseases such as cold, cough, fever, headache, rheumatism and skin diseases. However, one of the main practitioners, the *Amchis* now face a serious threat due to a decrease in their numbers, especially in the Lower Indus valley where the transfer of their knowledge to younger generations is very low. *Amchis* have low incomes and their social status has deteriorated. The demographic data indicates that traditional healers are mainly in the 31-50 years age group, and very few descendants are willing to inherit this profession. Poor education is a major factor that directly affects the learning process of this system that later affects the quality of treatment delivered to the patient. The major reason of poor education is the lack of schools in nearby areas. Although the government of India aims at a "right to education" scheme, which has the provision that every village should have one primary school, this has not yet been achieved.

The situation for the *Shamans* is totally different as they are proliferating in Western Ladakh. Most of the *Shamans* belong to younger generations. The reason for the increase in their numbers (as told by the elder *Shamans*) is that acculturation and modernization have changed their lifestyle, which has given rise to selfishness and a decrease in compassion. The *Akhon* population is also on the rise but there is little chance of their recognition, as they do not have any well-defined treatment techniques. They are more or less similar to *Shamans*. Of all the THCS the *Amchi* system seems to be the most scientific and therefore the most logical one to be integrated into the modern medicine system.

An effective way to conserve the system is to integrate *Sowa-rigpa* with the modern health-care system. This has been emphasized in the recent World Health Organization "Beijing Declaration" which advocates that the "communication between conventional and traditional medicine providers should be strengthened and

appropriate training programs be established for health professionals, medical students and relevant researchers" (WHO 2008). This will add new dimensions to the nation's system of health-care and also facilitates empowerment of patients by providing them with a choice of health-care systems and different options for treatments. Government support for traditional healers and traditional medicines needs to be increased.

CHAPTER 4

People's perception towards Traditional Health-Care Systems

4.1. INTRODUCTION

The increasing popularity of herbal preparations during the last few decades, especially in developed countries (Tindle et al. 2005), has raised the concern regarding the quality of such health-care services among modern health-care practitioners (MHCP) who are most often uncertain about the safety and effectiveness of traditional medicines (Hyodo et al. 2003). The major reason behind wide use of traditional medicine (TM) for self-care is the misconception that TM is safe. Most of the people are not aware of the potential side effects, and precautions needed before and during the use of TM. Increasing number of unknown and incurable diseases such as cancer has led to THCPs (Traditional health-care practitioners) seeing more patients/clients who are continually disappointed with modern medicine. However, several cases of misuse of herbal preparations have also been reported by MHCP. In such a condition, the attitudes and knowledge of physicians would affect the doctor-patient relationship and affect the overall quality of health-care delivery.

Negative perception of doctors towards traditional healers compels patients to hide facts regarding the traditional medicine they take. This may cause poor diagnosis and delay in healing. Such perception of doctors can be considered in direct contrast to the principles of the Patient's Rights, which states that health consumers are entitled to exercise the right to choose the type of health-care service they prefer. A drawback of absence of integrated service is that patients' consultation with doctors is delayed often at an advanced stage of their illness. These and other complications, which could be avoided, forced the different sectors to negotiate for allowing the patients to practice their beliefs openly for the sake of anticipatory guidance and action. In order to attain health for all by the year 2020 (NRHM), traditional medicine/healing should become an integral part of the health-care delivery system in India, which would help the Ministry of Health to attain its objectives.

Participants at the World Health Organization Congress on Traditional Medicine in Beijing have made six major recommendations, i.e., preservation and promotion of TM, formulation of national policies on THCS, integrating TM into national health systems, adopting strategy for innovation and intellectual property, accreditation of

traditional medicine practitioners and strengthening communication between conventional and traditional medicine practitioners (Beijing Declaration 2008). The last declaration envisages the need to increase mutual understanding between modern health-care practitioners and traditional healers through appropriate training programs for health professionals, medical students and relevant researchers. A combination of traditional and modern methods has great potential to develop and enhance the quality of the public health-care system. At a conference on medicinal plants of Trans-Himalaya, traditional healers who attended a two-week voluntary course on urinary infections along with some other basics of modern health-care practices commented, "*there is a lot we traditional healers can learn from doctors and they can also learn from us*". They also said, "*there are some illnesses that are cured better by traditional healers while others can only be treated by doctors*". These two statements necessitate an appreciation of traditional medical concepts. In an integrative system, the government recognizes TM and provisions are developed and regulated similar to the modern health-care system. This means that TM is included in the relevant country's national drug policy; providers and products are registered and regulated; THCS therapies are available at hospitals and clinics; treatment with TM is reimbursed under health insurance; relevant research is undertaken; and education in TM is available (WHO 2005). If these inter-sectional and cost effective collaborations were not adopted, a holistic approach of health-care services would be difficult to implement.

The present study aims to report on the attitudes and practices of allopathic doctors regarding integrations of complementary and alternative medicine in the contemporary health-care delivery system, with special emphasis on herbal medicine. It also investigates the level of acceptance and knowledge regarding herbal medicine by doctors as well as health consumers.

4.2. Objective

The overall objective of this study was to establish the extent to which traditional medicine equipped health providers with the knowledge of traditional healing methods and its related diagnostic techniques. Specifically the study aimed to evaluate:

1. the extent of use of traditional healing systems by local people
2. the perception of MHCPs on THCS in Western Ladakh

3. peoples' perception on the choice of health-care systems
4. to what extent allopathic doctors appreciate and understand THCS
5. how a collaboration between MHCS and THCS can be realized

4.3. METHODS

4.3.1 Sampling

A total of 30 modern health practitioners (working under Kargil district hospital, in primary health centers and in private clinics) were interviewed using structured self-administered questionnaires. Health consumers were selected for interviews based on stratified random sampling. Equal numbers of respondents i.e. 180 individuals in each valley were interviewed after stratifying them into three age groups: age class I, 18-30 years; age class II, 31-50 years; and age class II, veterans above 50 years of age.

4.3.2 Data collection

Information was collected using a semi-structured questionnaire. The questionnaire was prepared intuitively after several discussions with experienced MHCP working in the district hospital. The objective of the research was first described to the respondents prior to starting the questionnaire. The questionnaires fall into three categories. The first part deals with the attitude of MHCP towards the acceptance of TM. The second part asks the opinion of MHCP regarding the integration of traditional and modern medicine. The third part inquires the opinion of people on acceptance and integration of both health-care systems.

The questionnaires were interviewer-administered and contained details regarding awareness, collaboration, and acceptance, duration of employment at the hospital, years of practicing medicine and level of qualification. Acceptance was assessed using questions that evaluated beliefs, feelings and actions regarding THCP (Appendix IB)

4.3.3 Analysis

For analyzing the preference of different healing systems, the interviews were analyzed with a hypothesis, which assumes that all the people give equal importance to all four health-care systems in all three valleys. Chi-square goodness of fit test was used to see whether there is any significant difference in expected and observed

consultancy with an assumption that expected consultancy is equal for all the health-care systems. To see the preference of health-care systems in three age classes (Age class I, Age class II and Age class III), similar chi square tests were performed for all three valleys.

4.4. RESULTS AND DISCUSSION

4.4.1 Perception of MHCP

Awareness

Most of the MHCPs are aware of the THCS and also regarded THCS as important health-care facility. But out of 30 MHCPs interviewed 20 (67%) accepted that they are not aware of the effectiveness of TM and never knew any case where somebody was completely cured by traditional healers. Only 5 (16%) of the MHCP confirmed that they know of patients who were cured completely after visiting traditional healers but that too is mainly in the case of *Amchis* system of medicine. 73% confirmed that THCS is dwindling while 17% admitted that this system is still thriving and 10% were not sure. 54% of MHCP accepted that a patient requested the need of a traditional healer and demanded discharge for the same reason. The remaining 47% participants had never experienced this situation.

Acceptance

Most physicians (87%) agreed that herbal medicines were beneficial to health. Fourteen physicians (47%) reported that they had used THCS in the past and were also able to identify the herbs and herbal products in the treatment of common diseases such as stomachache, toothache and cold. However, only 9 physicians (30%) had ever advised their patients to consult an *Amchi* or an *Akhon* because their treatments were simply placebo effects.

Twenty-four (80%) indicated that they accepted herbal medicines as a viable health-care option, as they were aware of traditional medicinal practices, such as Ayuvedic medicine, and clinical trials that supported safety and efficacy of herbal remedies. For physicians (20%) the primary reason for rejection was due to insufficient scientific information available from clinical trials to support the safety and efficacy of medicinal herbs.

43 % of physician believed that *Akhons* are needed to treat some diseases, and only 27 % reported that *Shamans* too are needed to treat certain diseases such as psychosomatic disorders, mental illness and infertility. Most of them (70%) believed that *Amchis* are always required for several common diseases. 33% agreed to the fact that patients could be visited by traditional healers, while 57% disagreed and the remaining 10% were not certain whether they could accept visitations or not. About 47% were in favour of referral of patients to and from traditional healers. It was therefore concluded that collaboration would be the key to provide better health-care services for all in the future.

Table 4.1 Perception of MHCPs towards THCS

Questions	Yes		No		Uncertain	
	Total No.	%	Total No.	%	Total No.	%
Is THCS an important health-care facility in the society?	24	80	6	20	0	0
Do you believe that some diseases need traditional healers?	24	80	6	20	0	0
Because you are one of the multi-disciplinary team, can you accept a traditional healer in this team?	18	60	12	40	0	0
Do you want traditional healers to be legalized?	15	50	10	33	5	17
Did any patient ever ask for discharge to consult a THP?	16	54	13	43	1	3
Will you suggest referrals to and from THCPs?	14	47	16	53	0	0
Do you know of any person who was completely cured by a traditional healer?	5	16	20	67	5	17
Have you ever used herbs?	14	47	16	53	0	0
Do you ask patients whether they opted for TM?	23	77	7	23	0	0
Can you work in collaboration with THCPs?	18	60	12	40	0	0
Is THCS fading away?	22	73	5	17	3	10

A majority of MHCPs were not in favour of traditional healers for the following reasons:

1. Most of the THCPs claim that they can cure all diseases while in reality patients go to MHCPs after not being cured by THCPs.

2. Hygienic conditions at their clinics and homes are very poor.

3. Lack of proper standard protocol of diagnosis and treatments.

4. Unscientific approach and insufficient information regarding the constituents and expiration dates of traditional medicine.

5. There are some undefined medicines in THCS, which may affect the kidneys and other vital organs. I have seen people going into acute renal failure after being treated by THCPs.

6. They cannot diagnose the diseases properly which may also lead to patients' death.

Legalization and Collaboration

50% of MHCP wanted traditional healers to be legalized, 33% totally rejected this idea while the remaining 17% respondents were not sure. This profile clearly indicates the need for legalization of traditional healers. But they mainly agreed to the legalization of the *Amchi* system but not for *Akhons* and *Shamans*.

In response to a question asked on the integration of THCS into the national health-care policy, most of the MHCPs were in favour. 60% preferred integrated health-care systems while the remaining 40% were not in favor. Most of the respondents (77%) ask their patients regarding treatments taken by traditional healers in the past in addition to other medical history (Table 4.1).

In response to the question on possible areas of focus for improving the THCS and integration of the two systems, most of them 78% indicated scientific research on traditional medicine. 35% suggested training of the healers and 41% accepted that government assistance is needed to improve the services provided by traditional healers. MHCPs also advocated that there should be more focus on dosage determination and quality preparations.

General comments

The following were comments given by the MHCPs:

1. Patients cannot be denied the right of choosing any health system; hence, THCS should be included in national health policy.

2. The practice must be standardized, certified, regulated and have proper codes of practice.

3. They should also have a code of conduct and discipline.

4. They should improve hygienic conditions.

5. Their inclusion should be such that all harmful practices on human lives are controlled.

4.4.2 Perception of Health Consumers

Demography

Stratified random sampling method was used and from each valley 90 male and 90 female of respondents (Total respondents n=180 per villages) were selected and was further grouped into three different age classes: class I: 20-30 years; class II: 31-50 years, class III: above 51 years.

Education

Figure 4.1 indicates educational levels of the health-care consumers who participated in the study. Out of 540 respondents, 375 are illiterate, 125 had senior secondary, and 29 have only primary studies. 70% of the consumers are illiterate, which indicates that they saw a need for the traditional health-care system.

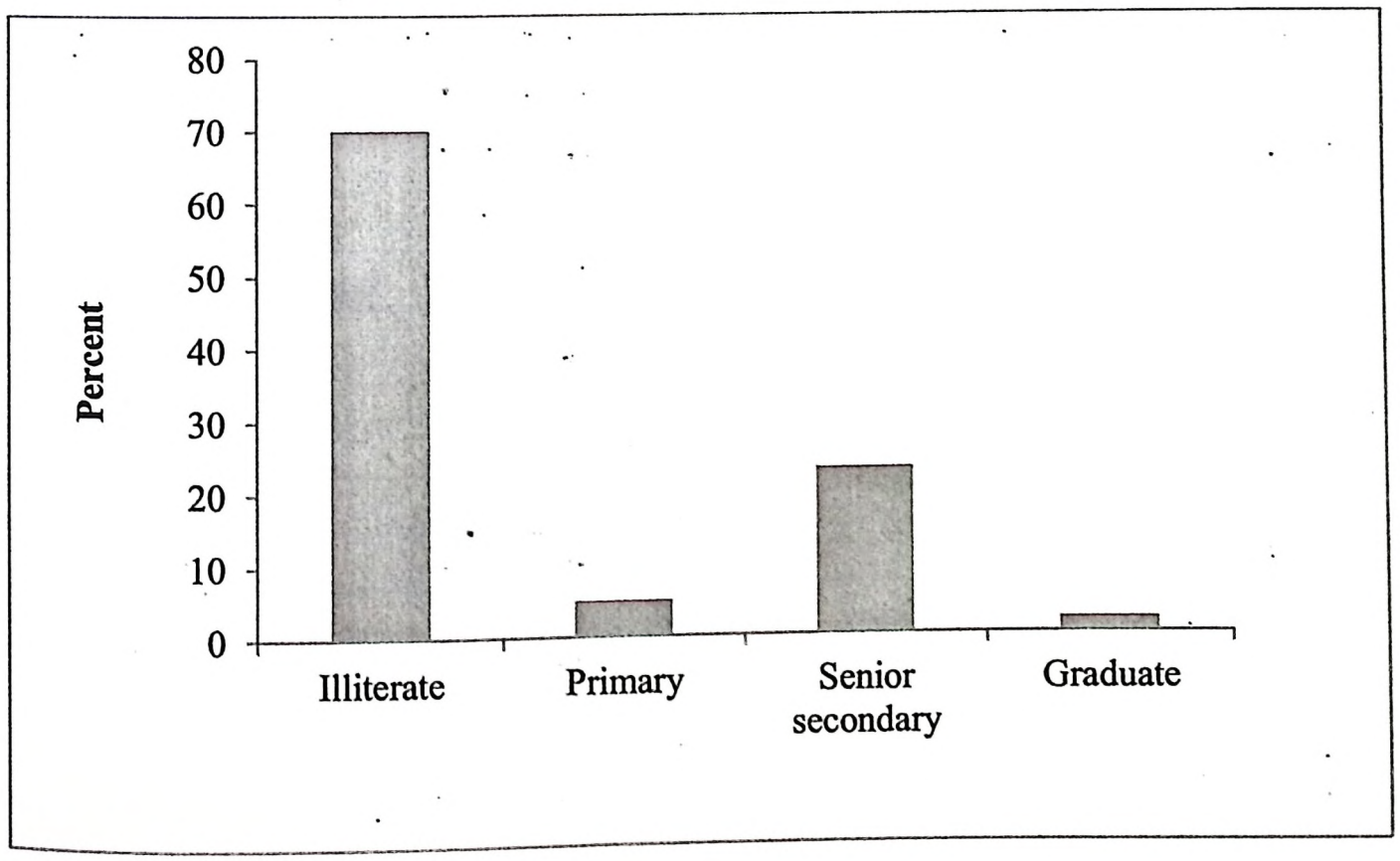


Figure 4.1 Education level of health-care consumers

Awareness

Most patients had visited practitioners of both health-care systems depending on the type of disease they had. Most of the patients (451 or 84%) had visited the THCPs for different reasons (Table 4.2). Some of them were cured; some were partially cured while for others the system was ineffective Table 4.3.

Table 4.2 Perception of health-care consumers

Questions	Yes		No		Uncertain	
	Total No.	%	Total No.	%	Total No.	%
Do you know about the other health-care systems?	520	96	20	4	0	0
Have you ever visited a THCP for treatment?	451	84	89	16	0	0
Do you think you need THCPs in the future?	491	91	114	21	0	0
What do you think about the collaboration between THCPs and MHCPs?	350	65	121	22	69	13
Do you think THCS should be legalized?	365	67	128	24	47	9

Table 4.3 Number of people cured, partially cured or found the treatment in effective

Diseases	Cured	Partially cured	Ineffective
Dental	32	12	11
Cold	23	2	9
Acid peptic disease	23	8	22
Acute gastrointestinal	80	17	15
Rheumatism	92	16	19
Depression	1	0	9
General body ache	71	11	21
Headache	151	7	23
Stoke	17	0	3
Infertility	0	0	21
Hypertension	34	31	12
Skin diseases	78	13	9
Evil eye	47	17	14

Acceptance

One hundred ninety (35%) respondents were uncertain regarding their preference of traditional healers to medical doctors whereas the remaining three hundred fifty (65%) preferred MHCP to THCP. The local people did not feel any need for traditional healers while hospitalized.

In all three valleys, there are significant differences between the expected and observed consultancies to different health-care systems (Valley I: X^2- 352.8, df-4 and $p< 0.05$; Valley II: X^2- 141.72, df- 4 and $p< 0.05$; Valley III: X^2- 163.11, df- 4 and $p< 0.05$; Table 4.4). That is, the hypothesis that people give equal importance to all the health-care systems in unlikely to be true. The result shows that people in all three valleys give more importance to the MHCS than THCS. The number of *Amchis* was found to be more or less the same as the expected number, except in Valley III, where observed consultation of *Amchis* was almost twice as much as the expected value.

Table 4.4. Preference of health-care systems in different age-class of consumers

Valley	Age class	Chi-square	df	Significance Level
Suru	18-30	49.9	4	$P< 0.01$
	31-50	54.0	4	$P< 0.01$
	>50	40.5	4	$P< 0.01$
Wakha-chu	18-30	40.5	4	$P< 0.01$
	31-50	67.5	4	$P< 0.01$
	>50	62.5	4	$P< 0.01$
Lower Indus	18-30	106.2	4	$P< 0.01$
	31-50	149.1	4	$P< 0.01$
	>50	128.0	4	$P< 0.01$

Legalization and Collaboration

More than half (67%) of the health-care consumers believed that traditional healers should be legalized while, 24% were totally in disagreement with the idea and 9% were not sure (Table 4.2).

Most of the respondents (65%) agreed that traditional health-care practitioners should be included in the modern health-care system. However, 22% totally disagreed and 13% were skeptical about this idea (Table 4.2).

4.4.3. Perceptions of Allopathic doctors towards THCS

Although it is clear that the majority of health-care professionals have little to do with traditional healers, they do consider that traditional practices should not be ignored. Allopathic doctors are fully aware of the fact that traditional healing is rated high in most of the individuals' value systems. The following are the perceptions of MHCP about traditional healers:

1. *Akhons* and *Shamans* are rather "primitive" and unscientific whereas *Amchis* are more serious in the use of medicinal plants for the treatment of diseases.
2. Their works needs to be research and scrutinised by scientists in order to exclude herbal poisoning following incorrect measurements and dosing. Damage to vital organs such as kidneys and incorrect information about the causes of the disease.
3. They claim to cure all types of diseases and disorders. However, in several cases patients visit hospitals after not getting cured by THCPs. In one instance, an *Amchi* unsuccessfully treated hepatitis and ultimately the patient contracted encephalopathy.
4. *Amchis* do not know what doses to prescribe to people of specific ages, such as infants, children and adults.
5. They are not hygienic - their instrument should be sterilized.
6. Traditional healers should refer their patients to hospitals more often.
7. THP's should have certified courses from institutions recognized by the government.
8. THCS should be trained and recognized by NRHM norms.
9. THP should be aware of human anatomy and physiology.

It is therefore clear that there is a need to bridge the rift between THCPs and modern practices, so that health-care consumers could be saved from becoming victims of malpractice. The findings of this study have revealed that THCS is full of superstitious beliefs and harmful practices. Therefore, there is a need to train and educate them in modern medicine.

Moreover, the knowledge of THCS was conveyed from one generation to the next. This information conveyance leads to distortion or total demise of the knowledge and necessitates urgent documentation and digitalization. The study further showed the presence of mutual respect and recognition among practitioners of both systems and the majority agreed to collaborate with one another. Collaboration would provide the patient with a choice of modern vs. traditional health-care. It would further help to improve general health-care knowledge, enhancement of the quality and number of traditional practitioners and dissemination of knowledge on health-care. Most importantly, it would bring the best possible health-care for the local people particularly to the underserved rural population at a relatively reasonable cost.

On the issue of collaboration MHCPs were of the view that THCPs can add to the total number of the human resources by way of being incorporated into primary health-care services e.g., in preventive, primitive, curative and rehabilitative services. In preventive and primitive health, they can help by teaching their clients of the importance of immunization, family planning, cancer, infant feeding, childhood diseases, communicable diseases, sexual transmitted diseases and many others in many more ways than modern allopathic medicine.

They accepted the fact that sometimes patients need psychological treatment rather than medical treatment and that THCS treatment may be a placebo effect, which may be beneficial to the patients.

4.4.4. Perceptions of health consumers

Most health-care consumers were in favor of both health-care systems. They could clearly indicate the following perceptions about traditional healers:

1 THCPs must improve their personal and environmental hygiene, including their utensils such as drinking mugs, bottles as well as other containers used for storing medication and also used during the treatment.

2 They need to be monitored by the government to stop illegal practices if any and exploitation of consumers in terms of cost of treatments. They need promotion, education and training and standard protocols of treatment methods.

3 They treat patients even in circumstances when there is no guarantee of being paid. They relate well with the natural etiology of the disease, that is its root culturally linked cause.

4 They are readily available and acceptable because they are part of the society, and stay with their patients and practice within the normal acceptable norms and values of the society. In most instances, the patient does not need an interpreter, as in most cases the language would be known by the client or a family member.

5 Availability of doctors in the remote areas is a major problem while THCP's are always present in these areas.

Comparing the different health-care systems it is clear that in Western Ladakh modern medicine has a larger influence than the *Amchi* system, followed by the *Akhon* and the *Shaman*ist systems. In all three valleys, none of the three age classes gives equal importance to the five health-care systems (Table 4.5). The modern health-care system was preferred in all age classes and in all three valleys. In all age classes of the Suru valley, *Amchis* were given almost equal importance to doctors and these were consulted almost to the extent. The other three health-care systems were consulted much less than the expected number. In the Wakha-chu, both *Amchis* and *Akhon* were consulted as expected by all three-age classes. All age classes in this valley avoided *Shaman*ist and self-health care systems. In the Lower Indus Valley, *Amchis* and doctors were given almost equal importance by all age classes.

The results show that observed consultation of *Amchis* is much higher than the expected value. *Akhon* consultation was avoided in all age classes except in age class I they were consulted more or less as expected. Ranking of different health-care systems according to the observed consultation by members of different age classes of the three valleys is shown in Table 4.5.

Peoples' response to the questions regarding collaborations between different health-care systems was mostly positive. They clearly stated that THCPs are good in the treatment of some specific diseases such as loss of Psychic and infertility, which do not have specific treatment techniques in MHS. Most of the THPs promote breast-feeding more than MHCPs and some appear to be good in treating mental illnesses, fear of unknown stress and depression.

Table 4.5 Ranking of different THCS in the study area

Age class	Health-care system	Ranking (%)		
		Valley I (Suru)	Valley II (Wakha-chu)	Valley III (lower Indus)
I	Doctor	100	100	100
	Amchi	75	75	75
	Akhon	50	50	50
	Shaman	0	25	25
	Self	25	0	0
II	Doctor	100	100	100
	Amchi	75	50	75
	Akhon	0	75	0
	Shaman	50	25	50
	Self	25	0	25
III	Doctor	100	100	100
	Amchi	75	75	75
	Akhon	50	50	25
	Shaman	0	0	50
	Self	25	25	0

4.4.5 Approaches to strengthen THCS

THCPs

THCPs in Ladakh are facing a great change in response to development in other parts of the social and economic system. The change has been brought about by economic modernization, which affects the way in which THCPs operate. It is necessary for traditional healers to form a strong organization to prevent exploitation and to share information and problems. The educational status of traditional healers is not sufficient to understand issues affecting their practice and they also lack skills such as basic taxonomy, sustainable management, and clinical management. In addition, they should practice with social and ethical values to get more trust from the people in their community. Workshops and seminars should be established at regular intervals for traditional healers and health-care professionals to exchange information and experiences.

MHCPs

Educating modern health-care personnel about traditional health-care is necessary as they express a strong prejudice against traditional practitioners and resist their integration into national health-care policy. This attitude is motivated by fear of competition and also by genuine mistrust of traditional methods of treatment. One way to stimulate the interest of modern practitioners in the potential value of traditional health-care is through modifications to their training. For example, in countries like China and Vietnam, traditional health is well accepted to the extent that their medical school curriculum incorporates traditional health-care compulsorily. This constitutes a systematized body of knowledge about traditional health-care to health professionals unlike in India.

MHCPs should follow a policy of neutrality, allowing patients to go to the traditional healer while encouraging them to continue with the particular treatment that they prescribed. Professionals such as nurses, doctors, psychiatrists need to learn more about the cultural background of their patients. Student nurses should be exposed to the community and psychiatric nursing science practice.

Government

One of the obligations of the government is that of ensuring that people are in the process of being cared for, are free from any physical, social, spiritual and psychological harm by any means whatsoever. This obligation does not create scope for the government to simply ignore THCS that is leaving them unrecognized, unregulated, but free to respond to demands for their services by their consumers. It becomes important for the government to make strategies of supervising and training traditional healers, or regulate traditional health-care practices. Furthermore, it acts as a helping hand for traditional health work force development and service expansion. Ignoring traditional medicine frustrates the exchange of information between modern health-care and traditional practitioners (DeJong 1991).

A policy should be formulated to make collaboration a reality at the central, provincial and district levels. However, after the formulation of policy strict guidelines on licensing, certification of traditional healers, strategies on how referral systems will work must be communicated to participants. Codes of conduct and

regulations regarding THCPs as well as a legal control body should be put in place with new reforms.

It was witnessed that the relationships among practitioners of different systems and between practitioner and patients is very poor. The MHCPs sometimes get annoyed by the persistence of some patients to utilize the services of the traditional, regarded THCS as unhealthy and never recommended patients to consult traditional healers. But in several cases when modern medicine failed to cure a particular illness, patients frequently visited traditional healers. It is clearly indicated that patients do seek services from traditional healers when modern medicine fails to cure the disease. Two main reasons responsible for irrational use of TM are lack of appropriate training for practitioners and lack of policy regarding legalized and illegal practitioners, which make it difficult for health-care consumers to identify qualified providers.

The study shows that MHCP in the public health-care sector in Ladakh generally accepted traditional medicine especially herbal remedies as a viable option; however, their insufficient knowledge on the uses and potential risks associated with TM is a great hindrance in the collaboration. MHCP with the knowledge of THCS would be able to get more information from patients on the case history of disease, which would improve the quality of health-care delivery, as more meaningful and important issues such as adverse effects and herb-drug interactions would be facilitated. Since MHCPs see the need to transfer patients to and from traditional healers it can be concluded that they need to collaborate.

The study shows that health-care consumers' prefer the modern system over the age old practice. The reason was mostly due to easy availability and faster relief of their disorders.

4.5 Recommendation

Inclusion of THCS into a national health policy should be considered seriously because the more gaps that are created between disciplines, the more dissatisfaction would arise in health-care consumers. Although some efforts have been made in the past in this direction, more resources and efforts need to be committed.

Awareness programme

The modern health-care practitioners should be made aware of anthropology and how culture affects the lives of the people in decision-making and freedom of choice. Traditional healers should be educated about:

1. Personal and environmental hygiene,
2. Use of appropriate equipment and methods of sterilizing utensils,
3. Balanced diet and other nutritional aspect for children weaning and
4. Referrals of cases, which they cannot handle to the clinic or hospital.

Further Research

The study finds that women and children comprise a major part of consumers who frequently visit THCS practitioners and hence a detailed study of the use of TM in maternal and child health-care would be necessary. Another study could be of participant observation on the daily execution of the traditional healer's skills during their disease intervention processes. It seems that much must still be unveiled before the two disciplines can start off on the same footing. It is also necessary to facilitate more resources for clinical trials of medicinal plants, which will not only help in the discovery of new medicines but can also make the treatment techniques easier and more effective.

CHAPTER 5

Traditional knowledge system (TKS) across various ethnic groups

5.1. INTRODUCTION

Ethnic communities around the globe have developed several ways to adapt to the surrounding environment by utilizing the resources available in nature. Their traditional knowledge (TK) embodies a wealth of wisdom gained through experience over millennia. In recent years, worldwide destruction of the environment has raised concern that modern scientific knowledge alone may not be enough to provide a sustainable model of development and hence we must look back to traditional knowledge for available alternatives. This concern has to some extent, modified attitudes towards traditional peoples and their knowledge. The importance of traditional knowledge for the protection of biodiversity and the achievement of sustainable development is already recognized internationally through various organizations and conventions such as World Conservation Strategy (IUCN 1980), Brundtland Commission's "Our Common Future" (WCED 1987), Convention on Biological Diversity (CBD 1992) and the subsequent Global Strategy for Plant Conservation and Economic Development (Twang and Kapoor 2004). Initiatives taken by above mentioned institutions and organizations have resulted in the extensive documentation of traditional knowledge on plant use diversity throughout the world. The need to document TK is also driven by the fact that younger generations are no longer interested in practices adopted by their ancestors, and is becoming increasingly disconnected from rural life. Ethno-botanical survey and documentation of valuable plant species in the wild, helps in the identification, conservation and development of strategies for sustainability.

The importance of TK of plant use diversity for the effective management and conservation of biodiversity has been studied widely (Boom 1987, Prance et al. 1987), but the factors that govern the local knowledge and use of these resources are not yet fully understood (Campos and Ehringhaus 2003, Lawrence et al. 2005). The present study attempts to fill this gap by providing detailed information on the use pattern of locally available plant resources from different demographic, socio-economic and cultural perspectives. These aspects can be used to derive information on factors responsible for the uneven distribution of knowledge and key areas for further

research. The relationship of TK with cultural aspect is based on the assumption that a society with people from diverse cultures is likely to have diverse practices regarding their resource endowment. Likewise, a great mosaic of divergent landscape that shows traditional knowledge can also be differentiated along ethnic lines (Turner and Hiernaux 2002). In Eastern Ladakh, *Changpas*, the nomadic herders, dominate the society where agriculture is almost absent while in Western and Central Ladakh people are mostly agro-pastoralist farmers. Since ethnic group or tradition influences environment/ecological knowledge, pastoralists will tend to know more forage plant species than agriculturists do. Demography is another important aspect, which influences the divergence in TK within each household. Differences between men and women's' knowledge are often related to divergences in their daily activities, and to their divergent domains of responsibility (Styger et al. 1999, Byg and Balslev 2004, Hanazaki et al. 2000, Luoga et al. 2000). Women often know medicinal and food plants, while men typically know more about construction and commercially valuable species. Another important aspect affecting TK is the dependency of people on locally available resources. Indigenous knowledge of plant species is often strong for species that are in common use by the local community. In more remote areas, people generally rely more on local resources and with increasing dependency on external resources through access to roads, markets and other modern goods and services, knowledge may decline considerably. However, this tendency can be reversed when other factors such as environment, socio-cultural identity, and settlement history come into play (Coomes 1996, Coomes and Barham 1997).

The main objectives of this study are to describe ethnobotanical knowledge of plants from informants of three different valleys of Western Ladakh and to examine the effects of demography, remoteness, occupation, education and economic status on the knowledge of people belonging to different ethnic (linguistic) communities. The study addresses the variation in the use of plants by various communities in the study area depending on the socio-economic and ecological factors. Such relationships are of practical importance for the sustainable management and conservation of resources, because they point to the groups in society that mostly depend on natural resources and it also points to mechanisms that drive resource exploitation.

5.2. METHODS

5.2.1 *Ethnic Groups*

Balti: Three valleys under investigation are dominated by different ethnic groups. The Balti community dominates the Suru valley, which is the second largest community in Ladakh (about 21% of the total population) after Ladakhi. The Balti community is mostly concentrated along the banks of the Suru river. Their livelihood is dependent primarily on agriculture but many people also own small herds of cattle, sheep and goats.

Purkey: The wakha-chu valley is inhibited mostly by the Purkey community and accounts for about 10% of the Ladakhi community. In contrast to the Suru Valley, these people are dependent on extensive livestock rearing, complemented by subsistence production of barley and wheat.

Brokpas: The Lower Indus valley is occupied by the Brokpas community who are known as the highlanders and have settled near the banks of the Lower Indus river. Some anthropologists believe that they are the descendants of Alexander, while some believe that they came from Gilgit, much before Alexander. They are mostly dependent on livestock rearing (*Dzo, langtoh*).

5.2.2 Sampling design

A stratified random sampling approach was adopted for data collection. The study area was stratified into three different valleys and in each valley, 180 people were selected for interview and questionnaire survey. Throughout the valley some villages are continuously connected to each other. So the villages were clustered into six sample groups with a sample size of 180 people. They were again divided into equal number of male and female, and each gender group comprises an equal number of people from different age groups, age class I, 18-30 years; age class II, 31-50 years; and age class II, veterans above 50 years of age. Different valleys represent different ethnic groups.

5.2.3 Data collection

Quantitative and qualitative methods were combined to collect information in order to improve the accuracy and quality of the information collected. Well-established

methods from cognitive and economic anthropology were combined in this study. To ensure accuracy, qualitative data collection methods were used. Ethnographic information helped to inform the design of formal surveys and to interpret results.

Participant observation: Approximately 40 months of research gave us opportunities to participate in the regular activities of the communities. Especially at weddings, village festivals or working activities such as drinking cha, chatting, going to the field, drying apricots and oil extraction. Participant observation allowed me to see different uses and preparations of plants. Qualitative ethnographic information has widely been used to explain the results derived from quantitative methods.

Questionnaire survey: Both structured and unstructured questionnaires were used in this study. A structured questionnaire was used to get information on the uses of plants in various categories while an unstructured questionnaire was used for social and cultural information such as dependency on a particular work for livelihood and cultural practices (ethnoecology).

***Open-ended interviews*:** Interviews were conducted with respondents during each spring and autumn and occasionally during the summer months. Questions on free listing of plants, perception on traditional food, traditional attire, consumption of fuel wood etc were asked. These interviews allowed us to identify the most appropriate questions and to gain a more complete ethnographic understanding that helped to interpret the results of the surveys. Interviews were made in Ladakhi or in local language and using local names of plants.

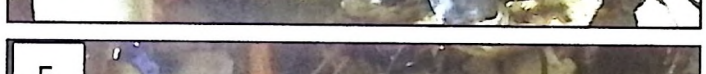
***Semi-structured interviews*:** These interviews were conducted to see the effect of age on the knowledge about plant uses. Each respondent was asked about the diversity of use of each plant including the management of wild populations, if any. Socio-economic data were collected through this method included income survey from different sources such as salaries, sale, barter of goods and remittances. Parameters of socio-demographic data included name, age, and members in the family, mother tongue, ethnicity, education, occupation and religion (Boster 1986, Caniago and Siebert 1998).

















A. Identification of plants by a Veteran **B.** Interview in Wakha-chu valley **C.** Interview in Suru valley **D** Interview with Brokpa Women **E.** Taking out apricot oil **F.** Interview with old women **G** Interview in Lower Indus valley **H.** Participant observation

Plate III Questionnaire Survey

***Voucher specimens collection*:** Voucher specimens (deposited in the Wildlife Institute of India) were collected with the help of local people to identify the plants correctly. Plant specimen collection also helped to overcome ambiguity regarding similar names for two or more plants and different names for the same plant. Local names as well as uses for each collected species were recorded on the spot.

5.2.4 Analysis

Free listing and ranking

Free listing was done to generate a comprehensive list of plants and their uses (Weller 1998), which was used to rank plant in each use category. Every person was asked to give the name of plants for eight different use category mentioned in Table 5.1. The final list was then used to calculate the rank as well as the frequency of citation of a particular plant in these categories. Number of plants given by a respondent in each category was used as score to evaluate and compare the level of traditional knowledge among and across different groups. Data collected though questionnaire and interview were organized into categories based on their uses. The free listing data were arranged across respondents and species cited matrix. The matrix with binary value i.e., 0 and 1, was used as input for multidimensional scaling.

Table 5.1 Eight use-categories used to evaluate the knowledge of people

Use category	Description
Food	Dietary products, consumed directly or after processing, including oil extraction and indirect uses. All edible plants whether cooked or raw
Fodder	Plants used for livestock and cattle
Fuel-wood	Wood/plants which are used as fuel/firewood for cooking and warming
Medicinal	Materials used alone or as ingredients (extracts, oils) in medicinal
Religious	Materials used in ceremonial or religious activities (perfumes, decoration) and others related to cultural activities
Wild Ornamental	Use in decoration or beautification
Dye	Coloring agent
Others	Raw materials for the manufacture of tools used in hunting, basket-making and utensils used in the home and/or agricultural implements, construction of permanent or temporary houses

Multidimensional scaling

The ordination plot prepared for different use categories through multidimensional scaling was used to represent similarities/dissimilarities in uses among plants. Multidimensional scaling (MDS) uses ranked similarity to generate two or three-dimensional plots. Rank values are plotted in a multidimensional space such that the distance between points represents their relative similarity/dissimilarity i.e., the closer the points, the greater their similarity (Kruskal and Wish 1976).

Ethnobotanical Indices

All the ethnobotanical indices were founded on the basic structure of the ethnobotanical information: "informant *i* mentions the use of the species *s* in the use-category *u*." The events resulting from the combination of these three variables were defined as a use-report (UR; Kufer et al. 2005). In a particular survey that yields NS species (S_1, S_2,..., S_{NS}), with a total number of use-categories NC (u_1, u_2,..., u_{NC}) and N informants (i_1, i_2,..., i_N), UR_{ui} can reach the value of 1 when a combination exists or 0 when this combination is not mentioned. These ethnobotanical data can be grouped in different manners fixing one or two of the variables. For studying the cultural importance of plants, one of the most commonly used tools is the total number of use-reports (UR) for each species, i.e., fixing the variables. This can be mathematically expressed as:

$$UR_s = \sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui}$$

First, we sum the UR of all the informants (from i_1 to i_N) within each use-category for that species (s); i.e., the number of informants who mention each use-category for the species. Second, we sum all the UR of each use-category (from u_1 to u_{NC}). We have compared the importance of each species using the following four indices: relative frequency of citation (RFC), relative importance index (RI), cultural value index (CV), and cultural importance index (CI).

Relative Frequency of Citation (RFC)

This index was given by Tardío and Pardo-de-Santayana (2008), this does not consider the variable *u* (use-category), is obtained by dividing the number of informants who mention the use of the species, also known as frequency of citation

(FC), by the number of informants participating in the survey (N). Using the same terminology, the numerator can be seen as the summation of the UR of all the informants interviewed for the species without considering the use-category.

$$RFC_s = \frac{FC_s}{N} = \frac{\sum_{i=i_1}^{i_N} UR_i}{N}$$

Relative Importance Index (RI)

Created by Pardo-de-Santayana (2003a), this index takes into account only the use-categories using the following formula:

$$RI_s = \frac{RFC_{s(max)} + RNU_{s(max)}}{2}$$

Where $RFCs_{(max)}$ is the relative frequency of citation over the maximum, i.e., it is obtained by dividing FCs by the maximum value in all the species of the survey $RFCs_{(max)} = FCs_{(max)} / FC$ and $RNUs_{(max)}$ is the relative number of use-categories over the maximum, obtained by dividing the number of uses of the species.

Cultural Value Index (CV)

This index, developed by Reyes-García et al. (2006), is calculated using the following formula:

$$CV_s = \left[\frac{NU_s}{NC}\right] \times \left[\frac{FC_s}{N}\right] \times \left[\frac{\sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui}}{N}\right]$$

Where the first factor is the relationship between the number of different uses reported for the species ("ethnospecies" in the original work) and the total number of use-categories considered in the study (NU_s divided by NC). The second factor is the relative frequency of citation of the species (previously defined). Finally, the third factor is the sum of all the UR for the species (defined at the beginning of this section), i.e., the sum of number of participants who mentioned each use of the species, divided by N. These three factors are then multiplied together.

The theoretical maximum value would be reached when all the factors reached their maximum; in the unlikely case that all the informants would mention the use of the species (FC_s=N) in all the use-categories considered in the survey (NU_s=NC), the first two factors would be equal to 1 and, as will be explained in the following index, the

third factor would be the total number of different use categories (NC). Therefore, this index varies as well from 0 to NC.

Cultural Importance Index (CI)

The cultural importance index (CI) is defined by the following formula.

$$CI_s = \sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui} \Big/ N$$

This index, the third factor of the previously defined CV index, also can be seen as the sum of the proportion of informants that mention each species use. This additive index takes into account not only the spread of the use (number of informants) for each species, but also its versatility, i.e., the diversity of its uses. The theoretical maximum value of the index is the total number of different use-categories (NC), reached in the unlikely case that all the informants would mention the use of the species in all the use categories considered in the survey, i.e., eight in our study. In the case of species with only one use, this index would be equal to RFC.

These measures of use and knowledge of plants were statistically evaluated by means of Spearman and Kendall's non-parametric analysis (Zar 1996) to detect possible correlations. Step-wise multiple regressions were used to relate all measures of knowledge provided by the informants with the socio-economic variables. In all analyses, these measures were used as dependent variables while the socio-economic variables were used as independent or explanatory variables (Table 5.2).

Table 5.2 Socio-economic and other variables

Variable		
Name	**Data type**	**Measurement type**
Village	Nominal	(3 groups): 1=Suru; 2=Wacha-chun; 3=Lower Indus valley
Distance	Nominal variable	(6 levels): In relation to proximity to Kargil
Ethnicity	Nominal variable	(2 levels): 1=Purikey; 2=Balti and 3=Brokpas
Gender	Nominal variable	(2 levels): 1=Male; 2=female
Age	Continuous	Number of years
Religion	Nominal variable	1=Buddhist; 2=Muslim
Education	Nominal variable	(literate or illiterate)
Member of family	Continuous variable	Number

Statistical analysis and test of hypothesis

To test the parametric test requires compliance of the data with normal distribution, we have tested normality of the data with Kolmogorov-Smirnov Test. Since the data of same factor levels were not normally distributed we used a square root transformed knowledge score which was normally distributed and TK as a response in one way Anova analysis to test for significance difference in knowledge level between the valleys, gender, education, religion.

Quantitative analysis of the relationship between several interviewee categories (gender, age, ethic group, religion and education) and plant knowledge of different categories (food, fodder, fuel-wood, medicinal, religion, ornamental, dye and other use) was performed using analysis of variance (ANOVA), linear regression, and t-tests. These analyses were performed in different software (SPSS, UCINET, PAST) for Windows. Hypotheses tested through above mentioned methods are as follows:

H_0 1 There is no significant difference between knowledge of people across different age groups (15-30, 31-50, above 51).

H_0 2 There is no significant difference between the knowledge of people across gender.

H_0 3 There is no significant difference between the knowledge of people (number of plants) across different valleys.

5.3. RESULTS AND DISCUSSION

5.3.1 Traditional botanical knowledge across all use categories

A total of 246 plant species belonging to 53 families were reported to be known by the respondents. Asteraceae (35) was the most dominant family, followed by Leguminosae (16), Ranunculaceae (14), Poaceae (11), Rosaceae (11), Gentianaceae (10), Polygonaceae (10), Amaranthaceae (9), Apiaceae (9) and Boraginaceae (9). From all the uses recorded in this study, maximum number of species were reported in the medicinal (23%), followed by fodder category (22%), ornamental (15%), food (15%), fuelwood (10%), religious (5%) and dye (4%). The category "other" (6%) included species used for making agricultural implements, sports appliances, artifacts etc. Figure 5.1 shows the comparison of use category of plants across three valleys in Western Ladakh.

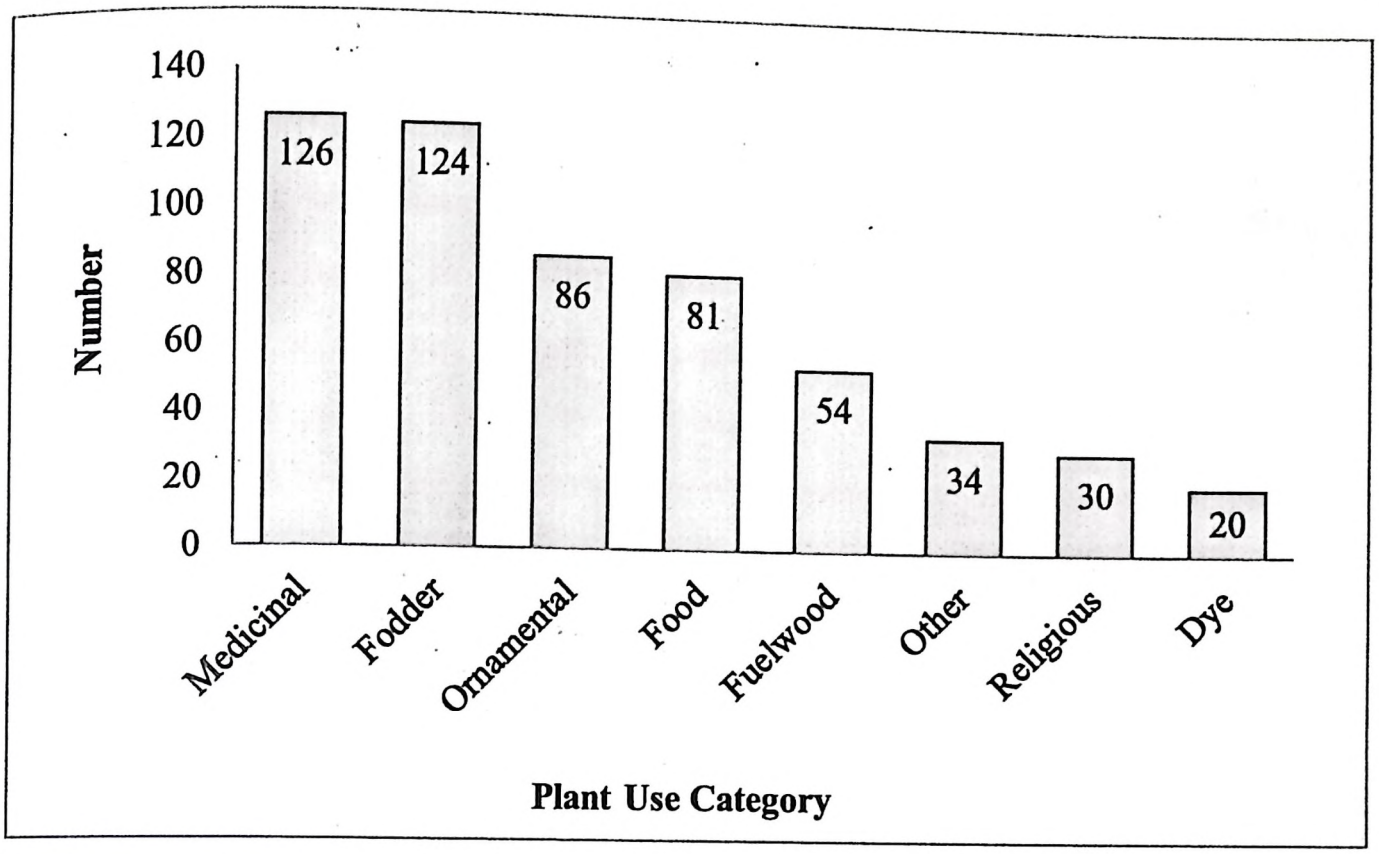


Figure 5.1 Number of plants used in different categories

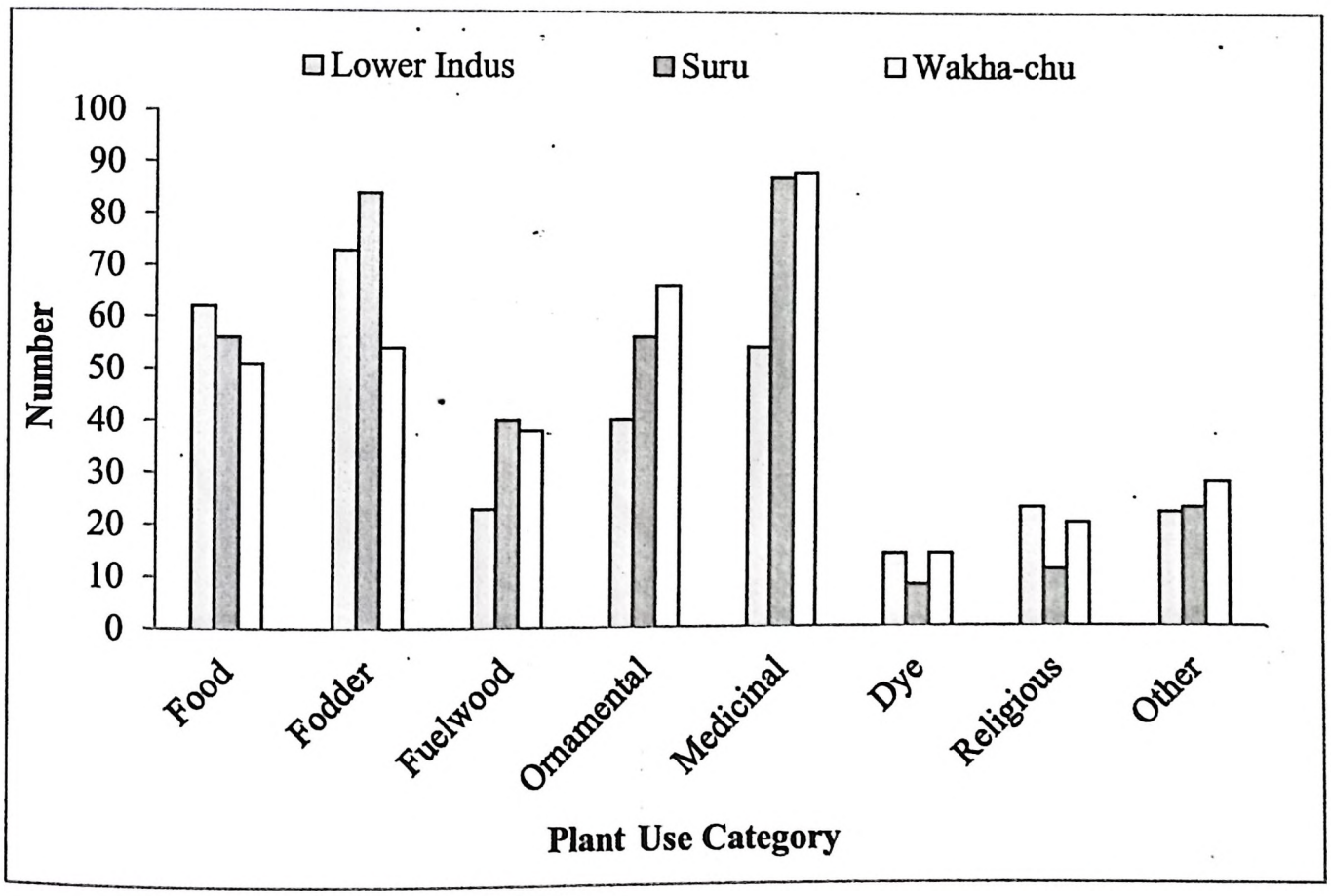


Figure 5.2 Number of wild plant species used for different purposes across the valleys

The highest number of plants was cited by the locals in Suru (192 plants i.e. 37%) followed by Wakha-chu (168 plants i.e. 33%) and Lower Indus valley (152 plants i.e. 30%) of the total plants in the study area. Figure 5.2 shows the plants reported in

different categories across different valleys. Appendix III shows the number of plants with average ranking and frequency citation of different use categories.

The comparative information given by the Balti (Suru), Purig (Wakha-chu) and Brokpas (Lower Indus) in Western Ladakh shows that there is variation in the knowledge of people living in three different valleys. Food and fodder are the most prominent use categories known by the people of the Lower Indus, while medicinal and fodder plants dominate the knowledge of people of the Suru valley. People in the Wakha-chu valley have more knowledge of medicinal and ornamental plants than the plants of other use categories.

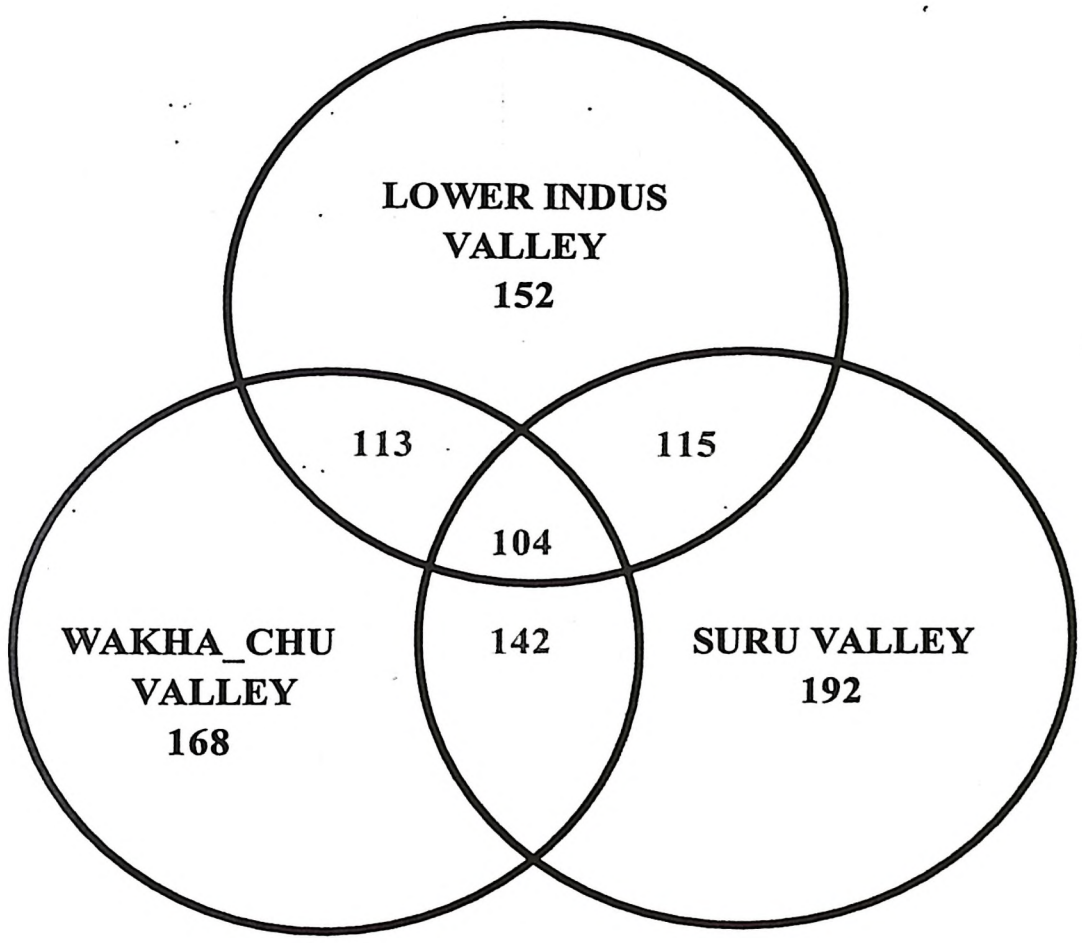


Figure 5.3 Venn diagram showing number of common and unique medicinal plants across three valleys.

Venn diagram (Figure. 5.3) shows that there are 104 species common across the three valleys, 113 plants common between the Lower Indus and Wakha-chu, 115 plants common between the Lower Indus and the Suru valley, 142 plants common between Wakha-chu and the Suru valley. A figure 5.4 MDS show the categories, which are similar to each other, are close and which is not related to each other is segregated.

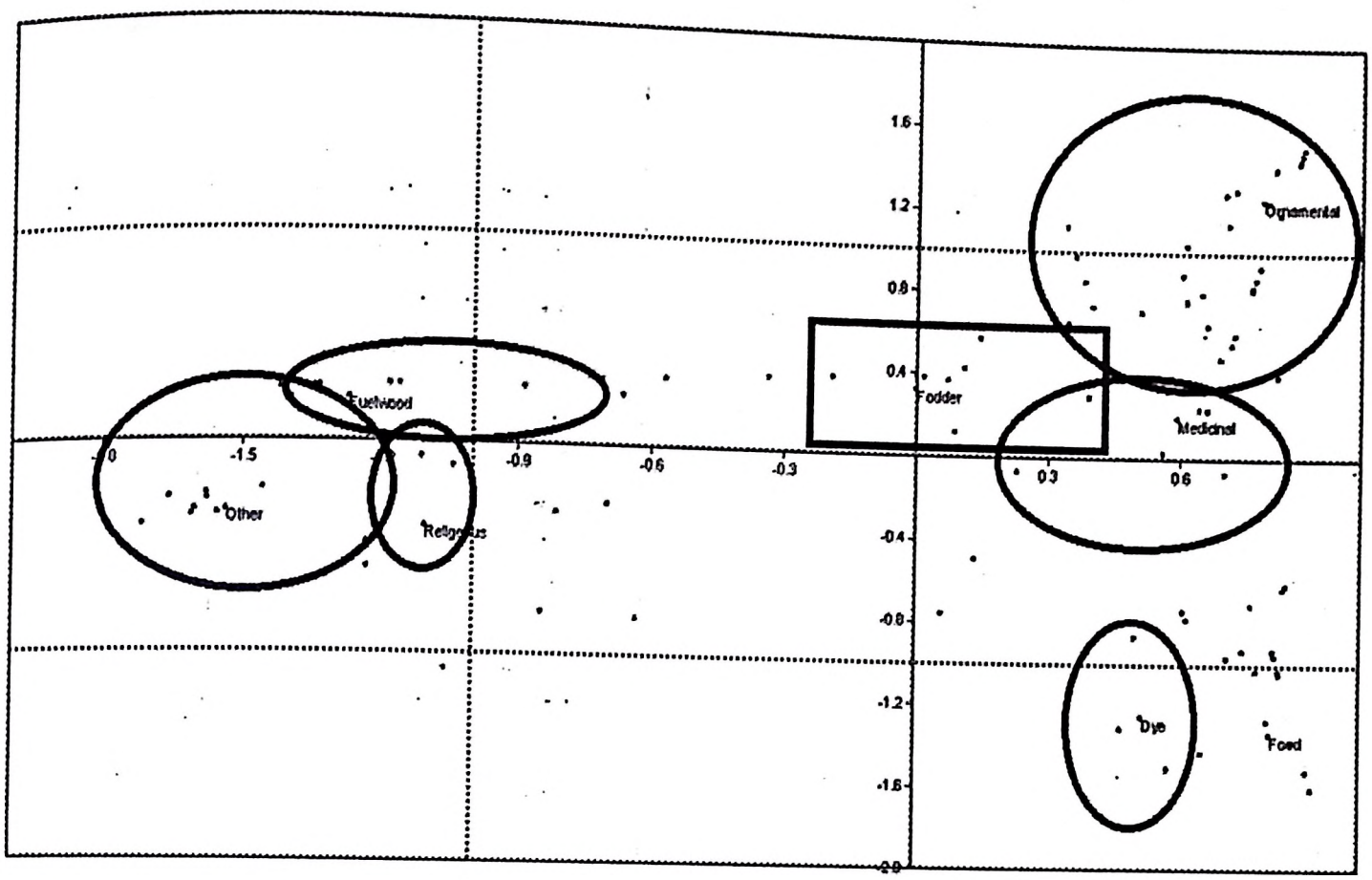


Figure 5.4 Similarities/Dissimilarities among different use categories of plants

5.3.2 Important plants in different use categories

Food

Wild edible plants are an important constituent of traditional diets in Western Ladakh. They also provide the majority of dietary requirement of proteins, sugars, vitamins, and minerals (Samant and Dhar 1997, Sundriyal and Sundriyal 2001). There are 84 plant species that are used as food in the study area. Among these top ten frequently cited species and high-ranking species plants are given in Table 5.3. These plants are consumed as vegetable, salad, beverages and fruit. The dependency on wild plants as a source of food is higher in the isolated community of the Lower Indus valley as compare to the other two valleys. Earlier, people used to store sun-dried food collected during summers to use during the winters. However, during recent years such practices have ceased due to increased accessibility in markets. Development has not affected the dependency of people on wild edible plants, which has rather increased.

The maximum dependency on wild plants, i.e., 63 edible species, have been reported from the isolated community of the Lower Indus, 58 species from the Suru and 51 species from the Wakha-chu valley. In the Lower Indus valley, the fruits of *Prunus domestica* (*Phating*) were the most popular food plants. These are eaten as meals,

fruit, used as face pack, oil extraction and also as beverages. The Lower Indus valley is famous for its traditional wine, which is popularly known as *grun-chang* (grape wine), which is prepared from grapes *Vitis* sp. grapes are only found in the Lower Indus valley. The other traditional beverage includes *chang* and *aarak*. These are prepared from barley and are popular among the Buddhist communities. *Chang* is prepared during religious and other occasions and is considered auspicious. *Rheum species* (*Lachu* and *khakol*) are eaten raw while *Allium* species are used as spice. They are also used to prepare a delicious traditional soup known as "*Thukpa*". *Urtica hyperborea (Zachot) Thymus linearis (Tumburu) and Capparis spinosa (Kapra)* are dried and used as vegetable in traditional delicacy. *Rosa webbiana* (*Pilli*) is ground with wheat flour to bake nutritious traditional bread (*pong pong*, *khambir*, *tuk-tuk*). Young shoots of *Hippophae rhamnoides, (tsetalulu) Potentilla* sp. (*Sonam chespa*) and *Rosa webbiana* (*Sai-mendok*) are used for making butter tea. More than half 71% (382) of the people interviewed in the three valleys use traditional food as their diet out of which 61% still consumes traditional food regularly (twice a day) and 32% consumes it once a day. Furthermore, the diet of the people has presumably undergone considerable changes, with the government providing food provisions such as sugar and rice at subsidized rates. Most of these changes have been accompanied by an increasing dependence on cash, integration with cash markets.

Tulipa stellata (*Kapi- chong*) species was recorded only from the Suru and in few parts of the Wakha-chu valley. Plants recorded from the interviews are mostly dependent on the availability of the species occurring in the area. In the Lower Indus valley, there is a difference in species ranking and citation. The top ten species ranked higher are not the frequently cited species. *Medicago sativa (Ole), Ephedra gerardiana (Tsepat), Arnebia euchroma (Demok)* and *Morus alba (Osey)* are the most cited species which are not listed among the ten most cited species. In the Suru valley, the ten highest priority plants based on average ranking are similar to the most cited species list, except *Mentha longifolia (Phololing)* and *Bergenia stracheyi (Shapur)*. This was also the case in the Wakha-chu valley, except for *Allium carolinianum (Skotse)* all the other species were similar enlisted as high priority species.

Table 5.3 Important food species based on average ranking and their frequency citation

Valley	Food	Average Rank	Food	Frequency Citation
Lower Indus	*Prunus domestica*	4.33	*Medicago sativa*	118
	Rheum moorcroftianum	3.86	*Ephedra gerardiana*	117
	Hippophae rhamnoides	3.71	*Prunus domestica*	116
	Thymus linearis	3.59	*Arnebia euchroma*	110
	Carum carvi	3.24	*Thymus linearis*	95
	Rumex angulatus	3.22	*Rhodiola imbricata*	95
	Allium przewalskianum	3.12	*Plantago major*	89
	Rhodiola imbricata	3.05	*Morus alba*	85
	Lactuca sativa	2.96	*Rheum moorcroftianum*	84
	Plantago major	2.54	*Rumex Angulatus*	82
Suru	*Rheum webbianum*	2.34	*Rheum australe*	130
	Rheum australe	2.25	*Rhodiola fastigiata*	126
	Lactuca lessertiana	1.79	*Rheum webbianum*	122
	Allium przewalskianum	1.6	*Corydalis govaniana*	93
	Rhodiola fastigiata	1.51	*Lactuca lessertiana*	86
	Corydalis govaniana	1.34	*Allium przewalskianum*	61
	Cicer microphyllum	1.31	*Cicer microphyllum*	47
	Tulipa stellata	1.23	*Mentha longifolia*	36
	Pedicularis punctata	0.79	*Tulipa stellata*	35
	Urtica hyperborea	0.77	*Bergenia stracheyi*	28
Wakha -chu	*Allium tortosum*	2.68	*Rheum australe*	146
	Rheum australe	2.65	*Rhodiola fastigiata*	145
	Rheum webbianum	2.61	*Rheum webbianum*	117
	Allium przewalskianum	2.13	*Allium przewalskianum*	110
	Capparis spinosa	1.79	*Allium tortosum*	107
	Cicer microphyllum	1.75	*Cicer microphyllum*	98
	Rhodiola fastigiata	1.48	*Capparis spinosa*	54
	Potentilla sp.	1.35	*Allium carolinianum*	37
	Rosa webbiana	1.16	*Rosa webbiana*	31
	Lactuca sativa	0.98	*Lactuca sativa*	29

Fodder

Farmers do not feed their livestock during summers because it is possible to rear them on free-range. Almost all respondents of Western Ladakh (95%) rear livestock and their livelihood is primarily dependent on agro-pastoral activity. The study revealed

that there are 5877 livestock in Western Ladakh including 1554 cattle, 133 yaks, 615 donkeys and 61 horses (interview). Cattle and other livestock are reared essentially for household purposes. The majority of people use livestock milk to make butter, which is used for making salt tea, a very popular stimulant. In the Lower Indus valley, cow milk was prohibited and so they use livestock milk substituting the cow milk.

There are 123 species used as fodder from Western Ladakh, 83 species reported from Suru, 74 species from the Lower Indus and 54 from the Wakha-chu valley.

Table 5.4 Important fodder species based on average ranking and their frequency citation

Valley	Fodder	Average Rank	Fodder	Frequency Citation
Lower Indus	*Cicer microphyllum*	2.256	*Cicer microphyllum*	107
	Stachys tibetica	2.167	*Medicago sativa*	106
	Artemisia spp.	2.017	*Aconogonum tortuosum*	103
	Geranium sibiricum	1.978	*Artemisia* spp	90
	Aconogonum tortuosum	1.733	*Geranium sibiricum*	84
	Oxyria digyna	1.217	*Stachys tibetica*	82
	Rumex nepalenisis	1.117	*Rumex nepalenisis*	44
	Convolvulus arvensis	1.106	*Oxyria digyna*	37
	Cotoneaster sp.	1.044	*Allium tortosum*	29
	Medicago sativa	0.917	*Rheum webbianum*	28
Suru	*Aconogonum tortuosum*	2.244	*Anaphalis* sp.	163
	Artemesia spp.	2.061	*Cicer microphyllum*	154
	Anaphalis sp.	1.733	*Aconogonum tortuosum*	109
	Artemisia brevifolia	1.650	*Artemisia brevifolia*	104
	Cicer microphyllum	1.506	*Artemesia* spp.	83
	Dactylorhiza sp.	0.983	*Rumex patientia*	35
	Rumex patientia	0.894	*Dactylorhiza* sp.	30
	Medicago lupulina	0.817	*Arnebia euchroma*	26
	Geranium pratense	0.778	*Geranium pratense*	25
	Chaerophyllum villosum	0.756	*Trifolium repens*	24
Wakha -chu	*Artemisia brevifolia*	1.944	*Artemesia* spp.	158
	Cicer microphyllum	1.844	*Cicer microphyllum*	136
	Aconogonum tortuosum	1.828	*Artemisia brevifolia*	109
	Cousinia thomsonii	1.783	*Aconogonum tortuosum*	96
	Artemisia spp.	1.617	*Cousinia thomsonii*	88
	Stachys tibetica	1.389	*Stachys tibetica*	68
	Trifolium repens	0.722	*Bromus* sp.	27
	Geranium spp.	0.572	*Trifolium repens*	25
	Bromus sp.	0.539	*Geranium* spp.	22
	Medicago sativa	0.528	*Rumex patientia*	22

Most of these species are collected from the wild. Only *Medicago* sp. and *Avena* sp. are cultivated. Some of the plant species are collected, dried and stored for winter. 68% of the people are still dependent on the wild for their fodder requirements.

In the Lower Indus valley, there is difference of two species between higher-ranking plants and most cited plants. *Allium tortosum* and *Rheum webbianum* are the most cited species but are not ranked high under the top priority species. In the Suru valley, the ten high priority plants based on average ranking are similar to the most cited species list, except *Arnebia euchroma* and *Trifolium repens.* In the Wakha-chu valley also, the ten high priority plants based on average ranking are similar to the most cited species list, except *Rumex patientia,* which is different from the most cited species list. Table 5.4 shows the list of some fodder species in Western Ladakh based on ranking and citation.

Fuel-wood

In Western Ladakh 89% (483 households) of the total households surveyed are dependent on fuel wood for their major household activities. Despite the fact that 97% of the surveyed households have LPG (liquid petroleum gas, used for cooking) connection, but they are nevertheless dependent on fuel-wood. Fuel wood is one of the important contrivances of all the ethnic groups in Ladakh. There are many species that could potentially be used as "fuel-wood". However, only a few of them, bearing unique characteristics, were sought after by the people. Of all the categories, fuel-wood is highly utilized throughout the year for heating rooms during the harsh winters, cooking, roasting of grains to obtain flour. *Juniperus communis* (*shukpa*), *Betula utilis* (*Stakpa*) and *Myricaria elegans* (*Umbu*) are the most preferred fuel-wood in the Lower Indus, Wakha-chu and Suru valleys, respectively. Other frequently used sources of fuel-wood are *Salix* sp., *Acantholimon lycopodioides* (*Longzey*), *Artemisia* sp. (*Burtse*) and *Rosa webbiana* (*Sai*). A total of 64 species are recorded as fuel-wood from Western Ladakh. The ethnic groups have reported 23 species in the Lower Indus, 38 species in Wakha-chu and 40 species in Suru valley. Fuel-wood was collected from the wild. The extraction of fuel wood varies from 50kg-100kg per family. Collection varies from valley to valley. There are certain rules made by the locals on collection of these resources from the wild but these are usually not followed.

In the Lower Indus valley, there is a difference of one species between higher-ranking plants and most citation species (Table 5.5). *Populus* sp. *(Yerpa)* was frequently cited but not listed under the top ranking species. In the Suru valley, the ten most priority plants based on average ranking are similar to the most cited species list. In the Wakha-chu also, the ten high priority plants based on average ranking are similar to the most cited species list, except for *Caragana versicolor(Tama, Brama).*

Table 5.5 Important fuel-wood species based on average ranking and their frequency citation

Valley	Fuel wood	Average Rank	Fuel wood	Frequency Citation
Lower Indus	*Juniperus communis*	1.980	*Juniperus communis*	171.
	Artemisia spp.	1.900	*Artemisia* spp.	86
	Ribes orientale	1.530	*Lonisera* spp.	78
	Hippophae tibetana	1.500	*Salix sclerophylla*	77
	Salix sclerophylla	1.470	*Hippophae tibetana*	64
	Lonisera spp.	1.470	*Myricaria elegans*	61
	Rosa ecae	1.170	*Ribes orientale*	60
	Salix tetrasperma	1.160	*Rosa ecae*	57
	Myricaria elegans	1.140	*Salix tetrasperma*	56
	Cotoneaster microphyllus	0.980	*Populus nigra*	46
Suru	*Betula utilis*	2.122	*Betula utilis*	129
	Artemisia spp.	1.800	*Artemisia* spp.	122
	Acantholimon lycopodioides	1.711	*Acantholimon lycopodioides*	106
	Cynoglosum planisiliqua	1.689	*Cynoglosum planisiliqua*	102
	Dianthus anatolicus	1.322	*Hippophae rhamnoides*	86
	Hippophae rhamnoides	1.244	*Dianthus anatolicus*	68
	Juniperus communis	1.222	*Juniperus communis*	60
	Anaphalis sp	1.144	*Anaphalis* sp.	55
	Ribes orientale	0.839	*Ribes* sp	35
	Ribes sp.	0.750	*Ribes orientale*	31
Wakha -chu	*Myricaria elegans*	1.822	*Myricaria elegans*	107
	Artemisia spp.	1.361	*Artemisia* spp.	102
	Acantholimon lycopodioides	1.356	*Acantholimon lycopodioides*	91
	Salix sclerophylla	1.278	*Arnebia euchroma*	78
	Arnebia euchroma	1.267	*Hippophae tibetana*	68
	Rosa webbiana	1.200	*Betula utilis*	66
	Hippophae tibetana	1.194	*Salix sclerophylla*	57
	Betula utilis	0.911	*Rosa webbiana*	50
	Ribes orientale	0.683	*Ribes orientale*	32
	Lonicera sp.	0.406	*Caragana versicolor*	30

Religious Plants

Like any other traditional society, people of Western Ladakh have a deep faith in spirituality which is reflected though their customs. This is why they have a high affinity towards religious plants, which are used in everyday lives. A total of 31 species of plants were recorded which are exclusively used for the same purpose. In the Lower Indus 23 species, 11 from Suru and 20 from Wakha-chu valley are recorded as religious plants. These plants are used in all the religious rituals from birth to death. The monks, *Shamans*, *Akhons* and locals use them during several religious occasions. Mostly religious plants are used either to please the deities and assure their support of human health and well-being or to drive out the malevolent spirits. The ritual plants are typically trees, shrubs or herbs. *Arnebia euchroma* (*Demok* or *Sbrimok*) has maximum citation in the Lower Indus and Wakha-chu valleys, while in the Suru valley *Viola kunawurensis* (*Gunapsha*) ranks first (Table 5.6).

In certain rituals, different voodoo (*storma*) dolls are made from the branches of *Salix* sp. or *Myricaria elegans*. These "voodoo like dolls" are used to drive ghosts away, to cure illnesses and during funerals. *Juniperus communis* (*Shukpa or Chilgi*) is the most important plant for religious purposes. Its needle scaly leaves are used as incense before each ritual. Additionally, the leaves provide an important contrivance for the *Shamans* (*Lha/Lhamos*) to remember his ritual texts. Other plants used for the same purpose are *Waldheimia glabra* (Palu) and *Rosa* sp. These are dried and mixed with Juniper sp and burned in an incense holder (*Phoks*). One of the mixtures, which are used regularly by every household, is the *Sangs,* prepared from *tsampa* (roasted barley grain) flour mixed with flowers of *Tagetes erecta, Rosa webbiana* or *Waldhemia* sp. This powder is stored in a container and put into the incense bowl (*Phoks-por*) every morning.

In the Lower Indus and Suru valleys, higher-ranking plants and most cited species are similar. However, there is difference in the hierarchical order. In the Wakha-chu valley, plants based on average ranking are slightly different from the most cited species list *Malus domestica (Ku-shu)* was replaced by *Salix alba (Selchang)* as the most cited species.

Table.5.6 Important religious plants with high average ranking and frequency of citation

Valley	Religious	Average Rank	Religious	Frequency Citation
Lower Indus	*Arnebia euchroma*	2.117	*Juniperus communis*	172
	Prunus armeniaca	2.039	*Arnebia euchroma*	123
	Malus domestica	1.950	*Malus domestica*	86
	Juniperus communis	1.800	*Prunus armeniaca*	82
	Juglans regia	1.650	*Juglans regia*	63
	Biebersteinia odora	1.411	*Waldheimia glabra*	51
	Bergenia stracheyi	1.083	*Artemisia sieversiana*	42
	Delphinium cashmerianum	1.022	*Biebersteinia odora*	35
	Artemisia sieversiana	0.817	*Bergenia stracheyi*	28
	Waldheimia glabra	0.756	*Delphinium cashmerianum*	21
Suru	*Viola kunawurensis*	0.494	*Viola kunawurensis*	71
	Juniperus communis	0.439	*Juniperus communis*	63
	Hippophae rhamnoides	0.239	*Arnebia euchroma*	20
	Arnebia euchroma	0.222	*Waldheimia tomentosa*	15
	Waldheimia tomentosa	0.200	*Hippophae rhamnoides*	14
	Artemisia sieversiana	0.194	*Artemisia sieversiana*	10
	Waldheimia glabra	0.128	*Myricaria elegans*	8
	Myricaria elegans	0.117	*Waldheimia glabra*	7
	Prunus armeniaca	0.100	*Prunus armeniaca*	5
	Betula utilis	0.028	*Betula utilis*	2
Wakha -chu	*Arnebia euchroma*	1.311	*Juniperus communis*	134
	Juniperus communis	1.311	*Arnebia euchroma*	112
	Waldheimia glabra	1.100	*Waldheimia glabra*	97
	Artemisia siversiana	0.494	*Artemisia siversiana*	35
	Hippophae rhamnoides	0.400	*Hippophae rhamnoides*	29
	Prunus armeniaca	0.211	*Viola kunawurensis*	17
	Viola kunawurensis	0.183	*Prunus armeniaca*	11
	Betula utilis	0.100	*Betula utilis*	6
	Malus domestica	0.083	*Salix alba*	5
	Waldheimia tomentosa	0.056	*Waldheimia tomentosa*	4

Medicinal Plants

This is the largest class with 120 plant species, most of which have multiple medicinal uses. A maximum number of medicinal plants was reported from the Wakha-chu valley (88 species) followed by the Suru (85 Species) and Lower Indus valleys (54 species). The diversity of species used as medicine was higher in the Wakha-chu and Suru valleys as compare to the Lower Indus valley. The utilization of the plants depends on their availability and accessibility. Summer and autumn are the best

seasons for collection. Most people collect during the rearing of animals in the higher altitude areas. They always collect some plants, which are required for curing ailments in day to day use. These medicinal plants are taken orally and topically in different forms such as powder, paste, ointment or decoction (liquid obtained from boiling of the medicinal plants in a solvent).

Table 5.7 Important medicinal plant species based on average ranking and frequency citation

Valley	Medicinal Plant	Average Rank	Medicinal Plant	Frequency Citation
Lower Indus	*Thymus linearis*	2.167	*Aconitum rotundifolium*	144
	Pedicularis longiflora	1.856	*Pedicularis longiflora*	89
	Hyoscyamus pusillus	1.756	*Thymus linearis*	85
	Mentha longifolia	1.506	*Hyoscyamus pusillus*	58
	Aconitum rotundifolium	1.467	*Corydalis govaniana*	51
	Carum carvi	1.372	*Mentha longifolia*	48
	Corydalis govaniana	1.222	*Aconitum violaceum,*	48
	Lagotis kunawurensis	1.106	*Carum carvi*	41
	Allium carolinianum	1.061	*Lagotis kunawurensis*	34
	Aconitum violaceum	0.844	*Rheum spiciforme*	32
Suru	*Thymus linearis*	1.978	*Aconitum violaceum*	82
	Aconitum violaceum	1.433	*Swertia thomsonii*	81
	Swertia thomsonii	1.322	*Thymus linearis*	80
	Trifolium repens	1.172	*Dactylorhiza* sp.	59
	Dactylorhiza sp.	1.144	*Clematis tibetana*	57
	Clematis tibetana	1.039	*Saussurea bracteata*	35
	Saussurea bracteata	0.861	*Arnebia euchroma*	32
	Aconitum heterophyllum	0.678	*Viola kunawurensis*	28
	Viola kunawurensis	0.611	*Trifolium repens*	27
	Hyoscyamus pusillus	0.611	*Hyoscyamus niger*	27
Wakha -chu	*Potentilla anserina*	1.689	*Aconitum heterophyllum*	69
	Bunium persicum	1.667	*Hyoscyamus pusillus*	68
	Latuca sativa	1.556	*Swertia thomsonii*	66
	Thermopsis inflata	1.439	*Potentilla anserina*	60
	Hyoscyamus pusillus	1.267	*Thermopsis inflata*	57
	Aconitum heterophyllum	1.239	*Bunium persicum*	49
	Chenopodium botrys	1.233	*Chenopodium botrys*	47
	Rheum webbiana	1.167	*Rheum webbiana*	45
	Swertia thomsonii	1.072	*Codonopsis ovata*	43
	Dactylorhiza sp.	1.039	*Dactylorhiza* sp.	40

Different types of preparations are used for different conditions and diseases. Example: *Aconitum* sp. was used for stomachache, the plant is used as a powder and also as a decoction. The medicines most commonly used were *Aconitum rotounifolium* (*Boga*) for stomachache and *Nepeta longibracteata* (*Piyangku*) for other gastrointestinal problems. They also use these medicinal plants for curing animal diseases. *Cicer microphyllum* (*Sari*) was used in mouth ulcer in cattle. The mites in livestock are removed with *Stachys tibetica* (*Yakzes*). The decoction was used as antimites.The study shows that *Inula racemosa* was the only medicinal plant, which is cultivated in fields. *Hyoscyamus pusillus* was another plant, which was seen frequently used by the people for toothache.

In the Lower Indus valley, there was difference of one species between high-ranking plants and most cited plants. *Rheum spiciforme* is among the ten most cited species but was not listed under the top ten ranking species (Table 5.7). In the Suru valley, the ten high priority plants, based on average ranking, are similar to the most cited species list, except for *Arnebia euchroma.* In the Wakha-chu valley, the ten high priority plants based on average ranking are similar to the most cited species list.

Dyes

People in Ladakh have traditionally been engaged in extraction, processing and preparation of dyes using barks, leaves, fruits and roots of plant. In Western Ladakh, 19 species of plants are recorded to be used as dyes (Table 5.8). These are especially used for dying wool, food and also hair. The most commonly used dye is *Arnebia euchroma,* which is multipurpose dye plant used in every rituals. Before synthetic clothes were introduced into the area, locals wore only traditional wool attires, which were dyed with *Arnebia euchroma* (*demok*). These attires were yarned from the wool of sheep. The leaves and flower of *Rumex* sp. and *Rosa species* also yield dyes, which give wool a blackish-red color. Fastness or longevity of dyes depends on the use of a mordant and personal experience, which can bring refinement to a particular dye or specific preparation.

In the Lower Indus, Suru and Wakha-chu valleys, there is no difference between higher-ranking plants and most cited plants list. This means that the species cited most frequently were also ranked high in all the valleys.

Table 5.8 Important dye plant species based on average ranking and their frequency citation

Valley	Dye	Average Rank	Dye	Frequency Citation
Lower Indus	*Arnebia euchroma*	1.094	*Arnebia euchroma*	132
	Rheum webbianum	1.011	*Rheum webbianum*	85
	Rheum spiciforme	0.817	*Juglans regia*	83
	Juglans regia	0.756	*Rheum spiciforme*	45
	Galium pauciflorum	0.556	*Galium pauciflorum*	35
	Urtica hyperborea	0.411	*Urtica hyperborea*	18
	Rosa webbiana	0.356	*Rosa webbiana*	15
	Oxyria digyna	0.189	*Oxyria digyna*	10
	Bergenia stracheyi	0.183	*Bergenia stracheyi*	10
	Primula denticulata	0.111	*Primula denticulata*	4
Suru	*Rheum webbianum*	1.000	*Rheum webbianum*	112
	Rheum spiciforme	0.472	*Arnebia euchroma*	59
	Arnebia euchroma	0.450	*Rheum spiciforme*	34
	Equisetum sp	0.261	*Equisetum* sp.	23
	Galium pauciflorum	0.189	*Galium pauciflorum*	16
	Oxyria digyna	0.183	*Oxyria digyna*	11
	Rosa webbiana	0.122	*Rosa webbiana*	7
	Artemisia sieversiana	0.067	*Artemisia sieversiana*	5
	Aconogonum tortuosum	0.039	*Aconogonum tortuosum*	3
Wakha -chu	*Oxyria digyna*	0.744	*Oxyria digyna*	84
	Rheum spiciforme	0.700	*Arnebia euchroma*	61
	Arnebia euchroma	0.572	*Rheum spiciforme*	58
	Arnebia guttata	0.528	*Arnebia guttata*	56
	Geranium pratense	0.311	*Rheum webbianum*	28
	Rheum webbianum	0.306	*Aconogonum tortuosum*	24
	Aconogonum tortuosum	0.306	*Geranium pratense*	23
	Rosa webbiana	0.261	*Rosa webbiana*	20
	Artemisia sieversiana	0.156	*Artemisia sieversiana*	11
	Galium pauciflorum	0.067	*Juglans regia*	8

Ornamental

People of Ladakh use various types of ornamental plants in their houses, monastries and during religious and cultural occasions. A total of 66 species of ornamental plants are used in the Wakha-chu, 41 in the Lower Indus and 56 in the Suru valley (Table 5.9). The Brokpas of the Lower Indus have more affinity towards ornamental plants than the Purkey and Balti of the other two valleys. They wear flowers (as headgear) on every occasion. Ornamental plants are also used for worshiping and to welcome

guests. The ornamental plants are also used to express love and care to their beloved ones. There is a folklore, which describes sending wild flowers (*Puroh)* from the high grazing land, where they take their cattle for rearing, to their families in the villages. This symbolizes the love and wellbeing of the person.

Table 5.9 Important ornamental plant species based on average ranking and frequency citation

Valley	Ornamental	Average Rank	Ornamental	Frequency Citation
Lower Indus	*Rosa webbiana*	2.578	*Biebersteinia odora*	137
	Anemone rivularis	2.561	*Delphinium cashmerianum*	125
	Aster flaccidus	2.406	*Geranium* spp.	96
	Primula macrophylla	2.211	*Anemone rivularis*	90
	Arenaria griffithii	2.106	*Arenaria griffithii*	74
	Aquilegia fragrans	1.828	*Aster flaccidus*	68
	Delphinium cashmerianum	1.739	*Rosa webbiana*	65
	Rosa ecae	1.700	*Primula macrophylla*	60
	Codonopsis ovata	1.622	*Codonopsis ovata*	54
	Biebersteinia odora	1.594	*Corydalis govaniana*	51
Suru	*Rosa webbiana*	1.889	*Rosa webbiana*	103
	Dactylorhiza spp.	1.650	*Gentianella moorcroftiana*	100
	Delphinium viscosum	1.650	*Papaver nudicaule*	84
	Gentianella moorcroftiana	1.589	*Dactylorhiza* spp.	78
	Biebersteinia odora	1.328	*Pedicularis oederi*	65
	Pedicularis oederi	1.300	*Inula obtusifolia*	59
	Papaver nudicaule	1.261	*Delphinium viscosum*	54
	Aconitum violaceum	1.233	*Biebersteinia odora*	44
	Inula obtusifolia	1.139	*Aconitum violaceum*	43
	Aquilegia fragrans	1.050	*Rosa ecae*	42
Wakha -chu	*Delphinium viscosum*	1.656	*Delphinium viscosum*	78
	Biebersteinia odora	1.294	*Saussurea bracteata*	73
	Aster flaccidus	1.244	*Biebersteinia odora*	66
	Pulsatilla wallichiana	1.067	*Rosa ecae*	58
	Saussurea bracteata	1.028	*Aster flaccidus*	50
	Rosa ecae	0.906	*Pulsatilla wallichiana*	49
	Arenaria griffithii	0.878	*Codonopsis ovata*	42
	Pedicularis punctata	0.806	*Arenaria griffithii*	38
	Codonopsis ovata	0.756	*Rosa webbiana*	36
	Pedicularis bicornuta	0.750	*Saxifraga* sp.	34

The species ranked higher are not the frequently cited species. *Rosa webbiana* and *Geranium* spp. are the most cited species but are not listed among the higher ranked species. In the Suru valley, the ten highest priority plants based on average ranking are similar to the most cited species list, except *Rosaceae.* In the Wakha-chu valley also the ten highest priority plants based on average ranking are similar to the most cited species list, except *Rosa webbiana* and *Saxifraga* sp. which are different under the most cited species list.

Others

This category consists of plants, which are used for making tools, cooking utensils, containers and construction. Out of 75 plants documented in this group, 21 species are used in the Lower Indus Valley, 29 and 25 species in the Wakha-chu and Suru valleys, respectively. These plants are used for making various household artifacts such as brooms, utensils, baskets, measuring devices for grains, containers for *chang*, wooden barrels for storing grains etc. Local people carve the hard inner wood of certain species into mortars for grinding. They also design barley containers (*zong)* made from the Salix wood. *Styipa* sp. (*sibskya*), a typical grass is split, thinned and then woven into local strainers (*chakma*), which are used during the preparation of *chang* (local beer) and other daily household activities. *Salix* and *Styipa* are also used for weaving baskets (*Chepo*) which are very popular in every household. *Chepo* (figure) was one of the assets, which was a part of women's attire in early times in Ladakh. The stem of the *Vitis* sp. *(grun*) is the most preferred fiber used for making ropes in the Lower Indus Valley.

Artemisia spp. *(burtse)* is used to make brooms. The wood of *Betula utilis* is the preferred material to make ploughs and agricultural implements. Though the use of wood for house construction is decreasing, wood flooring (*shen*) is still preferred throughout Ladakh. The flooring is made with *Juglans regia* (starga), *Prunus* sp. (*Phating*) and *Salix* sp. Sometimes even *Populus nigra* (*yerpa*) is also used for flooring. Traditional woodcarving is another very important utility of wood in Western Ladakh. The woods commonly used for this purpose are walnut and apricot. *Juniper* species are also used in making large containers (Picture) *zem*, which is used for making and storing local bear *chang*. *Ribes* sp. (*seth*) and *Rosa* sp. *(sai)* are used to make arrows which are used during the festivals devoted to Archery. *Corydalis* sp. *(Nya-tuk)* is used for poisoning fish.

The important species ranked higher are not the frequently cited species. *Lonicera* spp. and *Salix tetrasperma* are the most cited species but are not listed among the higher ranked species in the Lower Indus and Suru valleys. In the Wakha-chu valley average ranking plant list are similar to the most cited species list Table. 5.10.

Table 5.10 Important other plant species based on average ranking and their frequency citation

Valley	Other	Average Rank	Other	Frequency Citation
Lower Indus	*Populus* spp.	2.794	*Salix alba*	107
	Morus alba	2.256	*Populus* spp.	102
	Prunus armeniaca	2.233	*Myricaria elegans*	96
	Juglans regia	2.017	*Juglans regia*	87
	Salix alba	1.967	*Prunus armeniaca*	69
	Myricaria elegans	1.933	*Potentilla fruticosa*	65
	Stachys tibetica	1.167	*Morus alba*	62
	Hippophae rhamnoides	1.039	*Salix sclerophylla*	61
	Salix sclerophylla	1.028	*Lonicera* spp.	58
	Potentilla fruticosa	0.878	*Salix tetrasperma*	40
Suru	*Salix sclerophylla*	1.422	*Salix sclerophylla*	128
	Juniperus communis	1.311	*Juniperus communis*	80
	Populus nigra	1.028	*Populus nigra*	60
	Rosa webbiana	0.817	*Rosa webbiana.*	52
	Hippophae tibetana	0.806	*Myricaria elegans*	52
	Populus alba	0.789	*Hippophae tibetana*	51
	Myricaria elegans	0.722	*Populus alba*	44
	Salix alba	0.639	*Salix alba*	33
	Stachys tibetica	0.517	*Stachys tibetica*	33
	Salix tetrasperma	0.500	*Salix tetrasperma*	30
Wakha -chu	*Salix sclerophylla*	1.911	*Salix sclerophylla*	155
	Salix tetrasperma	1.861	*Salix tetrasperma*	93
	Hippophae rhamnoides	1.339	*Hippophae rhamnoides*	80
	Stachys tibetica	1.078	*Stachys tibetica*	71
	Populus alba	0.994	*Populus alba*	65
	Ephedra gerardiana	0.989	*Ephedra gerardiana*	60
	Myricaria elegans	0.811	*Rosa webbiana*	45
	Rosa webbiana	0.722	*Lonicera* spp.	41
	Lonicera spp.	0.667	*Ephedra intermedia*	36
	Ephedra intermedia	0.633	*Myricaria elegans*	30

5.3.3 Cultural Importance Indices

Table 5.11 shows the contribution of each use category to the total cultural importance index (CI) of the 30 most relevant and useful species in Western Ladakh. The folk species *Arnebia euchroma (Royle) I.M.Johnst.* (*"Demok"*) is the most culturally significant according to the CI index. It has a CI index value of 1.55 (FC=442) citations (836 use-reports).

Arnebia euchroma was mainly used for religious purposes and dyes, (CI_{RE} =0.47, CI_{DY}=0.47) or as firewood (CI_{FW}=0.11), fodder and medicine (CI_{FO}=0.15, CI_{MD}=0.15). The second species in the rank order was *Juniperus communis L.* (CI=1.42). Several informants cited its use in six out of the eight categories. The most important use category was religious (CI_{RE}=0.68), which was also observed during the interview. Every household uses Juniper for most of the rituals. The other uses includes fuel-wood (CI_{FW}=0.47), other categories (tool making, furniture, artifacts etc. (CI_{OT}=0.24), ornamental (CI_{OR}=0.02), and medicine (CI_{MD}=0.01).

Each index aims to assess the cultural significance of plant species and is suitable for statistical testing. For comparison, we used data concerning plants traditionally used in the study area. Our results show a positive and significant correlation between the number of uses (NU) and the frequency of citation (FC) of the species. It seems to be a general rule that the more versatile a plant, the more widespread its usefulness. In addition, NU is highly influenced by the number of use-categories in the study.

5.3.4 Comparision of Ethnobotanical Indices

Table 5.12 shows a comparison with the other three indices described earlier in the methodology section, indicating species ranking based on each index and the three basic values of the study, i.e., frequency of citation (FC), number of use-reports (UR) and number of uses (NU) for each species. As mentioned, except for FC, which only considers the spread of knowledge of useful plants (number of people that mention them), the other indices also take into account multiplicity of use (number of use-categories mentioned for a species).

There are considerable differences in species ranking yielded by the various indices set out in table. Although the first two species are the same in all of them, the order varies depending on the chosen index. The CI, RI and CV indices place *Arnebia euchroma* in first position because these two indices assign greater importance to the

multiplicity of uses and the species was mentioned in a higher number of use-categories (NU=8). *Artemisia* spp. logically should be considered the most important as they predominate in the landscape and are mentioned by a higher number of informants.

Table 5.11 Cultural Importance Index (CI) of the 30 most relevant species of Western Ladakh, with the CI component of each use-category

Plant	FD	FO	FW	OR	MD	DY	RE	OT	CI
Arnebia euchroma	0.22	0.05	0.15	0.02	0.15	0.47	0.47	0.03	1.548
Juniperus communis	0.00	0.00	0.47	0.02	0.01	0.00	0.68	0.24	1.422
Artemisia spp	0.00	0.61	0.58	0.00	0.01	0.00	0.00	0.06	1.269
Rheum webbianum	0.54	0.07	0.00	0.00	0.14	0.42	0.00	0.01	1.180
Rosa webbiana	0.16	0.06	0.11	0.38	0.05	0.08	0.04	0.24	1.113
Cicer microphyllum	0.28	0.74	0.00	0.00	0.03	0.00	0.00	0.00	1.044
Salix sclerophylla	0.00	0.02	0.25	0.00	0.01	0.00	0.01	0.64	0.928
Hippophae rhamnoides	0.16	0.00	0.40	0.00	0.02	0.00	0.08	0.22	0.880
Aconogonum tortuosum	0.08	0.57	0.01	0.00	0.00	0.05	0.01	0.00	0.715
Myricaria elegans	0.00	0.01	0.32	0.00	0.01	0.00	0.03	0.33	0.698
Rheum australe	0.51	0.00	0.00	0.00	0.06	0.08	0.00	0.00	0.654
Stachys tibetica	0.00	0.31	0.01	0.02	0.02	0.00	0.00	0.24	0.611
Corydalis govaniana	0.19	0.06	0.00	0.17	0.15	0.00	0.00	0.00	0.578
Thymus linearis	0.21	0.00	0.00	0.03	0.34	0.00	0.00	0.00	0.574
Prunus domestica	0.22	0.00	0.01	0.00	0.00	0.00	0.17	0.14	0.544
Dactylorhiza spp.	0.07	0.07	0.00	0.16	0.23	0.00	0.00	0.00	0.543
Biebersteinia odora	0.00	0.00	0.00	0.46	0.01	0.00	0.06	0.00	0.539
Acantholimon lycopodioides	0.00	0.06	0.43	0.00	0.00	0.00	0.00	0.03	0.528
Juglans regia	0.00	0.00	0.00	0.00	0.02	0.17	0.12	0.21	0.515
Rhodiola fastigiata	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.504
Codonopsis ovata	0.10	0.07	0.00	0.19	0.14	0.00	0.00	0.00	0.496
Populus alba	0.00	0.00	0.07	0.00	0.00	0.00	0.03	0.39	0.487
Lonicera spp.	0.03	0.00	0.21	0.00	0.00	0.00	0.00	0.24	0.476
Aconitum rotundifolium	0.00	0.00	0.00	0.09	0.36	0.01	0.01	0.00	0.465
Medicago sativa.	0.23	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.465.
Ephedra gerardiana	0.22	0.01	0.07	0.00	0.02	0.00	0.00	0.14	0.463
Rosa ecae	0.04	0.01	0.14	0.25	0.01	0.00	0.00	0.01	0.456
Salix tetrasperma	0.00	0.01	0.12	0.00	0.00	0.00	0.01	0.30	0.441
Artemisia brevifolia	0.00	0.39	0.03	0.00	0.00	0.00	0.00	0.00	0.435
Geranium spp.	0.00	0.20	0.00	0.22	0.02	0.00	0.00	0.00	0.435

(FD=food, FO= fodder, FW=fuel wood OR=ornamentals, MD=medicinal, DY=dye, RE=religious, OT=other)

Table 5.12 Evaluation of useful plants of Western Ladakh, using four quantitative indices. List of the first 30 species following the CI index and plant ranking, based on each index.

	Basic Value			Indices				Ranking			
Plant	**UR**	**FC**	**NU**	**RFC**	**RI**	**CV**	**CI**	**RFC**	**RI**	**CV**	**CI**
Arnebia euchroma	836	442	8	0.82	0.97	1.27	1.55	3	1	1	1
Juniperus communis	768	463	5	0.86	0.81	0.76	1.42	2	4	3	2
Artemisia spp.	685	470	5	0.87	0.81	0.69	1.27	1	3	4	3
Rheum webbianum	637	418	5	0.77	0.76	0.57	1.18	5	5	5	4
Rosa webbiana	601	385	8	0.71	0.91	0.79	1.11	7	2	2	5
Cicer microphyllum	564	433	3	0.80	0.65	0.31	1.04	4	11	9	6
Salix sclerophylla	501	401	5	0.74	0.74	0.43	0.93	6	6	6	7
Hippophae rhamnoides	475	342	6	0.63	0.74	0.42	0.88	9	7	7	8
Aconogonum tortuosum	386	338	6	0.63	0.73	0.34	0.71	10	8	8	9
Myricaria elegans	377	303	5	0.56	0.63	0.24	0.70	11	12	10	10
Rheum australe	353	343	3	0.64	0.55	0.16	0.65	8	16	12	11
Stachys tibetica	330	258	5	0.48	0.59	0.18	0.61	14	14	11	12
Corydalis govaniana	312	222	4	0.41	0.49	0.12	0.58	22	25	17	13
Thymus linearis	310	247	3	0.46	0.45	0.10	0.57	16	29	23	14
Prunus domestica	294	173	5	0.32	0.50	0.11	0.54	40	22	21	15
Dactylorhiza spp.	293	224	4	0.41	0.49	0.11	0.54	20	23	18	16
Biebersteinia odora	291	256	4	0.47	0.52	0.13	0.54	15	20	14	17
Acantholimon lycopodioides	285	261	4	0.48	0.53	0.13	0.53	13	18	15	18
Juglans regia	278	163	4	0.30	0.42	0.08	0.51	44	37	29	19
Rhodiola fastigiata	272	272	1	0.50	0.35	0.03	0.50	12	55	47	20
Codonopsis ovata	268	212	4	0.39	0.48	0.10	0.50	24	27	24	21
Populus alba	263	108	3	0.20	0.30	0.04	0.49	63	69	45	22
Lonicera spp.	257	208	3	0.39	0.41	0.07	0.48	25	38	32	23
Aconitum rotundifolium	251	207	5	0.38	0.53	0.11	0.46	26	17	19	24
Medicago sativa	251	181	4	0.34	0.44	0.08	0.46	33	31	28	25
Ephedra gerardiana	250	232	5	0.43	0.56	0.12	0.46	17	15	16	26
Rosa ecae	246	203	7	0.38	0.65	0.15	0.46	28	10	13	27
Salix tetrasperma	238	224	4	0.41	0.49	0.09	0.44	21	24	26	28
Artemisia brevifolia	235	219	4	0.41	0.48	0.09	0.44	23	26	27	29
Geranium spp.	235	167	4	0.31	0.43	0.07	0.44	43	36	33	30

(NU=Number of use, UR=Use report, FC=Frequency citation, RFC= Relative frequency citation, RI=Relative importance, CV= Cultural value, CI=Cultural importance)

Table 5.13 Spearman rank order correlations among all the variables: basic values and indices

	NU	UR	FC	RFC	RI	CV	CI
NU		0.78**	0.76**	0.76**	0.92**	0.84**	0.77**
UR			0.99**	0.99**	0.94**	0.93**	0.99**
FC				1.00**	0.94**	0.93**	0.99**
RFC					0.94**	0.93**	0.99**
RI						0.92**	0.94**
CV							0.93**
CI							

(NU=Number of use, UR=Use report, FC=Frequency citation, RFC=Relative frequency citation, RI=Relative importance, CV=Cultural value, CI=Cultural importance) ** Significant value P<0.05.

Table 5.13 shows the Spearman correlations among all the variables. All the correlations are significant at P<0.05 (n=247), some being stronger than others. The correlations range from 0.76 to 0.99 (highly correlated). An interesting point that appears to corroborate these data is that the frequency of citation (FC) is not completely independent of use diversity. The correlation index between the FC and NU is quite high (0-76) meaning that a versatile species is more likely to be mentioned by a higher number of informants.

5.3.5 Traditional knowledge across age, gender and ethnicity

Traditional knowledge is based on the scores (to measure the knowledge) One of the limitations in quantifying knowledge of people was to get the correct identity of plants based on their local names. However, to resolve the issue photographs and plant specimens were shown to the respondents. Unexpectedly, most of the plants had similar names in different valleys. Another limitation was deficient vocabulary of plants, which was encountered in all the three valleys. In a few cases more than one name was given for the same plant, while in other cases different plants had the same name. For example, several different names were given for the same species of *Medicago* sp. example *ole, buksuk, namtse.* Multiple names were also recorded for these plants. The number of plants in each use category given by a respondent varied depending on several factors, which were discussed below in detail.

H_0 1 There is no significant difference between knowledge of people across different age groups (15-30, 31-50, above 51).

Age

Analysis of variance between use categories and informant age groups indicated that the youngest informants group (15-30) had the lowest levels of knowledge (F=174.4, df=2 and P=0.00 or P<0.05), which can be attributed to a lack of interest in learning and practicing such knowledge. Difference in knowledge was found to be statistically significant for most of the use categories (P=0.021). Informants that identified most of the plants belonged to the 41-50 age groups. This suggests that knowledge of plant species are only concentrated among the veterans. No significant differences (P=0.10) were found in the use categories of dye and religion. Religious and dye plants are both contemporary uses. Both young and old unlike other uses use them. One possible explanation for this is that there are fewer plants used by the people in this category and their use is frequent across the valleys.

Table 5.14 Traditional Knowledge score (mean ± standard error) across different age-class in Western Ladakh

Variables	Age- class		
	15-30	31-50	50 above
Western Ladakh	75.25±2.02*	111.70±2.30*	144.34±3.34*
Valley			
Lower Indus	90.87±4.01*	141.68±3.94*	194.56±4.42*
Suru	65.67±3.13*	93.34±2.47*	121.81±3.62*
Wakha-chu	69.22±2.21*	100.07±1.84*	116.63±2.28*
Category			
Food	9.74±0.24*	14.11±0.33*	19.27±0.50*
Fodder	6.31±0.23*	9.18±0.21*	11.68±0.25*
Fuelwood	12.42±0.43*	18.13±0.57*	20.01±0.65*
Ornamental	7.80±0.28*	12.56±0.42*	16.18±0.61*
Medicine	5.23±0.29*	7.34±0.32*	12.13±0.44*
Dye	9.58±0.75*	16.46±0.70*	21.88±0.88*
Religious	10.84±0.74*	16.08±0.80*	21.54±0.89*
Other	13.2±0.57*	17.79±0.68*	21.61±0.73*

* Signifies the significance level p<0.05

Age related divergences in knowledge might either be an indication of a gradual accumulation of knowledge through time or the erosion of knowledge. Formal education, up to some extent, has changed the way of livelihood of local people and restricted their interaction with local biophysical and cultural environment. Another reason of less traditional knowledge among the youngsters is increasing opportunities

in different fields. Older people are more experienced and have had greater contact with plant resources through exchange of knowledge. Older people prepare home remedies for themselves and for younger people, which favors the retention of knowledge.

There was a significant difference in knowledge levels across all age classes in all three valleys. Lower Indus valley ($F=1.60$, $df=2$ and $P<0.05$), Suru valley ($F=81.14$, $df=2$ and $P<0.02$) and Wakha-chu valley ($F=127.8$, $df=2$ and $P<0.05$). However, knowledge varies between age classes for different categories in each valley: food ($F=149.61$, $df=2$ and $P<0.0001$), fodder ($F=129.95$, $df=2$ and $P<0.05$), fuel-wood ($F=48.89$, $df=2$ and $P<0.0001$), ornamental ($F=83.61$, $df=2$ and $P<0.0001$), medicine ($F=96.34$, $df=2$ and $P<0.0001$), dye ($F=61.44$, $df=2$ and $P<0.0001$), Religious ($F=42.78$, $df=2$ and $P<0.0001$), other ($F=38.94$, $df=2$ and $P<0.0001$). This difference in knowledge among different age classes in the Lower Indus valley is shown in Table 5.14.

H_0 2 There is no significant difference between the knowledge of people across gender

Gender

Gender related differences between men and women in ethno-botanical knowledge are often ascribed to the division of household responsibilities, labor and expertise, control and interests at the intra-household, inter-household and community levels. Result (Table 5.15) shows that across the valleys there is no difference in knowledge between men and women. Men have an average knowledge score (of useful plant species) of 109.18±2.7 (mean±standard error) whereas women have an average score of 111.68±2.8. No significant differences were found between the two groups (Tukey's test, $F=0.413$, $df=1$and $P=0.52$). The null hypothesis (H_o) was accepted. However, knowledge of plant species under different categories show those women knew of significantly more food plants than men. In contrast to a common perception that men possess greater knowledge of fodder and fuel-wood plants due to greater participation in activities related to natural resources, women too are equally involved in activities linked to the use of plant resources. It appeared that women possessed a level of knowledge, which was not restricted simply to that of plants that are directly related to their activities in the house and raising children.

Table 5.15: Traditional Knowledge score (mean ± standard error) across gender in Western Ladakh

Variable	Male	Female
Western Ladakh	109.18±2.68	111.68±2.79
Categories		
Food	13.44±0.37*	15.31±0.49*
Fodder	8.89±0.23	9.23±0.28
Fuelwood	16.49±0.49	17.22±0.62
Ornamental	11.85±0.40	12.51±0.54
Medicine	8.09±0.34	8.39±0.42
Dye	16.21±0.72	15.74±0.85
Religious	16.11±0.72	16.20±0.87
Other	18.10±0.59	17.02±0.69
Valley		
Lower Indus Valley	139.25±5.64	145.49±5.52
Suru Valley	94.11±3.42	93.11±3.60
Wakha-chu Valley	94.19±2.58	96.43±2.82

* Signifies the significance level $p<0.05$

H_0 3 There is no significant difference between the knowledge of people (number of plants) across different valleys.

Ethnicity

We rejected the null hypothesis (H_o) as we found evidence that the people of the Lower Indus valley were significantly more knowledgeable than those of the Suru and the Wakha-chu communities. This difference is due to the behavioral distinctions between the ethnic groups. They are closer to nature and their history shows that their religious beliefs and rituals were originally in essence demonolatry, ancestor worship and nature worship (Bhasin, 2008). The Lower Indus community is isolated from other parts of Ladakh since 1979 and they are more attached to nature and thus like to incorporate nature in their lives by simply what they wear as headgear, which is one of the important assets of their personality. Hence, they are closer to nature than the other two groups (F=90.7, df=2, P=0.0001) shown in which **Table 5.16.** But it is interesting to note that there is no significant difference between the knowledge of the people of the Suru and that of the Wakha-chu valley (F=0.29, df=1, P=0.587). They almost have similar knowledge of plants. The reason may be due to intercultural relationships between the valleys, which are relatively close to each other. Plants have great importance in all the valleys and locals are dependent on them for their daily

requirements. However, across all age categories in the three valleys there is a significant difference in knowledge of plants (Age class I: F=18.06, df= 2, P=0.0001); Age class II: F=81.98, df= 2, P=0.0001; Age class III: F=153.60, df= 2, P=0.0001).

Knowledge across the different use categories in three valleys is also significant. The knowledge across all categories in three valleys is shown in Table 5.18. The main categories were food (F=43.97, df= 2, P=0.0001), fodder (F=14.47, df=2, P=0.0001), fuel-wood (F=138.64, df=2, P=0.0001), ornamental (F=76.94, df=2, P=0.0001), medicine (F=27.70, df=2, P=0.0001), dye (F=3.24, df= 2, P= 0.040), religious (F=60.85, df= 2, P= 0.0001) and other (F=68.45, df= 2, P= 0.0001).

Table 5.16 Knowledge score (mean ± standard error) across different valleys in Western Ladakh

Category	Lower Indus	Suru	Wakha-chu
Food	17.64±0.59*	11.75±0.28*	13.74±0.41*
Fodder	9.14±0.36*	7.96±0.23*	10.08±0.21*
Fuel-wood	23.63±0.74*	13.75±0.32*	13.19±0.29*
Ornamental	16.61±0.67*	11.32±0.36*	8.61±0.26*
Medicine	10.62±0.53*	6.62±0.32*	7.48±0.30*
Dye	17.78±0.89*	15.0±1.00*	15.15±0.66
Religious	23.31±0.94*	12.17±0.87*	13±0.49*
Other	23.64±0.88	15.02±0.50	14.03±0.42

* Signifies the significance level $p<0.05$

5.3.6 Socio-economic and other factors of knowledge

To determine the influence of socio-economic and other factors on the knowledge of people different explanatory variables were selected. These variables are age, gender, religion, valley affiliation or ethnicity and socio-economic variables such as distance to town, education, tourism, occupation and income. Analysis was performed for total knowledge as well as for each use category separately. The result of the stepwise multiple regressions showed that the important factor that influenced the traditional knowledge in Western Ladakh was the age of the informant. This was true and statistically significant both when the entire data set was analyzed (Table 5.17) and when it was broken down between three valleys (Lower Indus, Suru and Wakha-chu) and also when it was broken down between use-categories (food, fodder, fuel-wood, ornamental, medicine, dye, religious and other).

Table 5.17 Different variables and impact of these variables in Western Ladakh

Variables	Unstandardized beta-coefficient (SE)	Standardized beta-coefficients	t	Sig.
(Constant)	9.51±4.89	-	1.94	0.05
Age	1.60±0.07	0.59	22.53	0.001
Ethnicity (Lower Indus Valley vs. others)	31.49±3.32	0.33	9.48	0.001
Religion (Buddhist vs. Muslim)	12.83±2.67	0.14	4.81	0.001
Distance from the town (kargil)	0.17±0.05	0.13	3.24	0.001
Education (illiterate vs. literate)	6.78±2.66	-0.07	-2.54	0.01

Other socio-economic variable that influence plant knowledge when the entire dataset was analyzed were valley affiliation, distance, religion and education (R^2=0.68, dF=5, F=232.79 and P<0.05) (Table 5.17).The prime importance of the informants' age reflects dwindling of knowledge in Western Ladakh and across different valleys, respectively. It may also indicate that age encompasses experience or, accumulation of knowledge through the course of a lifetime.

The second variable that influences knowledge is valley affiliation, which is ethnicity. It may also indicate that valley affiliation includes a number of aspects that functions in parallel, such as marginalization or isolation of the villages in the valley, the condition of the ecosystems available to villages, and the ethnic condition of the valley. The effect of the residence village on traditional knowledge showed that the choice of plant resources for certain purposes might be influenced by the cultural characteristics of the informants.

The third variable, that influenced the knowledge of people, was distance from the main town, Kargil. This observation was used to test the null hypotheses that modernization has caused loss of traditional knowledge on local level. People living in the remote areas or away from the main town have least access to goods and they totally depend on the natural resources available in their neighborhood. Significant but negative relationships were found between knowledge and increasing distance from interviewee's village to Kargil. It was observed that while other ethno botanical knowledge is being lost slowly, medicinal plant knowledge has been disappearing rapidly over an extensive period of acculturation. Nearly a decade later after the study of Kachroo et al. (1997), there is extremely limited ethno botanical knowledge present

in the province. The result supports the argument that medicinal plant knowledge is particularly vulnerable to modernization.

The fourth variable, which influences the knowledge in Western Ladakh, is religion. The practice of a religion which include rituals, sermons, commemoration or veneration of deity, gods or goddesses, sacrifices, festivals, feasts, trance, initiations, funerary, services, matrimonial services, meditation, prayer, music, art, dance, public service or other aspects of human culture. It was observed that a Buddhist respondent knows more plants compared to Muslims.

The fifth factor influencing knowledge was education, which was negatively correlated to the informant knowledge of plants. It was found that people who are illiterate, have more traditional knowledge compared to educated people. This is because mostly illiterate people are associated with agricultural practices, resources extraction and other traditional activities.

5.3.7 Comparison among use categories

Traditional knowledge of different use categories had different responses to the variables (Table different 3.19). In knowledge of food, age and distance shows a positive relationship while male respondents had a negative relationship (R^2 =0.54, F= 7.246, df=1, P=0.007). In case of fodder, age had a positive relationship while male respondents showed a negative relationship (R^2 =0.35, F=4.646, df=1, P=0.032). In fuelwood knowledge, age, distance to town, tourism had a positive relationship and male respondent had negative relationship (R^2 =0.50, F=4.638, df=1, P=0.032). In ornamental category, age, religion (Buddhist) have a positive relationship while tourism and male respondents had a negative relationship (R^2 =0.46, F=4.449 df=1, P=0.035). In the medicinal plant category, age and distance to town show a positive relationship (R^2 =0.35, F=16.619, df=1, P=0.00). In the case of dye, age, distance to town, tourism shows a positive while education shows a negative relationship (R^2 =0.27, F=7.180 df=1, P=0.008). In religious plant category, distance, age, religion (Buddhist), shows a positive and tourism shows a negative influence (R^2 =0.43, F=5.212, df=1, P=0.023). In the other category, age shows a positive and distance and occupation of people show a negative relationship (R^2 =0.59, F=0.353, df=1, P=0.040).

Table 5.18 The traditional knowledge score of different use-categories and variables influence them

Categories	R^2	Variables	Unstandardized beta- coefficient (±SEM)	T
Food	0.54	Age	0.24±0.01	20.903*
		Valley_LIV	2.00±0.67	2.983*
		Male	-2.32±0.38	-6.078*
		Suru_valley	-2.37±0.48	-4.893*
		Distance	0.02±0.00	2.692*
Fodder	0.35	Age	0.13±0.00	15.648*
		Wakha-chu	1.25±0.33	3.799*
		Suru-valley	-0.89±0.33	-2.706*
		Male	-0.57±0.27	-2.155*
Fuel wood	0.5	Valley-LIV	8.93±0.82	10.866*
		Age	0.19±0.01	12.414*
		Distance	0.03±0.01	2.516*
		Tourism	1.39±0.57	2.43*
		Male	-1.08±0.50	-2.154*
Ornamental	0.46	Age	0.19±0.01	14.401*
		Valley-LIV	2.66±0.69	3.841*
		Wakha-chu	-3.74±0.66	-5.646*
		Buddhist	2.94±0.58	5.01*
		Tourism	-1.29±0.58	-2.196*
		Male	-0.94±0.44	-2.109*
Medicine	0.35	Age	0.16±0.01	13.936*
		Distance	0.04±0.01	6.804*
		Suru-valley	-1.72±0.42	-4.077*
Dye	0.27	Age	0.27±0.02	9.539*
		Distance	0.09±0.01	6.891*
		Tourism	3.18±0.89	3.548*
		Education	-2.76±1.03	-2.68*
Religious	0.43	Distance	0.07±0.01	4.043*
		Age	0.27±0.02	11.725*
		Buddhist	5.89±1.04	5.683*
		Valley-LIV	3.22±1.26	2.546*
		Tourism	-2.29±0.97	-2.361*
		Member	-0.22±0.09	-2.283*
Other	0.35	Valley-LIV	10.16±1.01	9.97
		Age	0.21±0.02	10.693
		Distance	-0.05±0.01	-3.267*
		Wakha-chu	-1.81±0.85	-2.13*
		Occupation	1.56±0.76	2.05*

* Signifies the significance level $p<0.05$

5.4. CONCLUSIONS

People of Western Ladakh possess diverse traditional knowledge on ethno-flora. A total of 246 plant species were reported by respondents of the three valleys under different use categories, i.e., medicinal (126), fodder (124), wild ornamentals (86), food (81), fuel wood (54), dye (20), religious (30) and other (34). Some of these plants have not been reported earlier from the study area such as *Berberis brandisiana* Ahrendt and *Dactylorhiza kafiriana* Renz. The knowledge about useful plants is not homogenously distributed and the intracultural differences can be studied considering several subgroups. The CI index compares the plant knowledge among different cultures (Pardo-de-Santayana et al. 2007) opinions.The plant having highest Cutural importance value was *Arnebia euchroma* (Royle) I.M.Johnst. ("Demok"), followed by *Juniperus communis* and *Artemisia* spp. However, species like *Artemisia* sp. that was cited by more people but was ranked third in CI index.

There are clear differences in the total number of individual species used for various purposes in the three valleys. In the Lower Indus valley, the number of individual species used by the local people based on respondent interview was lowest as compared to the Suru and Wakha-chu valleys. However, the traditional knowledge on different use categories of these plants was highest in the Lower Indus valley. Many plants that were used earlier extensively many years ago, are now less frequently used due to increasing availability of other options e.g., cheaper readymade garments have replaced locally dyed woolen attires and hence reduced the number of plants used for dyes.

People living far from Kargil (small town) have the highest level of plant knowledge in the study area. Gender, which in other studies was shown to influence local knowledge about uses of plants, did not influence knowledge in the study area. It suggests equal participation of women in activities linked to the use of plants. Valley affiliation (ethnicity) affected local knowledge because the areas have different accessibility and availability to modern amenities. Religion, which was never reported as influencing knowledge, was reported as one of the factors. Similarly, the range of species that were used in the more isolated villages was also higher than the range of species used in the community closer to the town. Both factors suggest a lower dependency on the resources in the more accessible community.

Regardless of differences in knowledge, plants are important components in their daily activities. The observed variation reflects responses to differences in the socio-economic environment that surround the villages. Their subsistence strategy was characterized by the use of plants for a number of purposes. To preserve this pool of traditional knowledge it is important to make not only a detailed inventory of plants but also its extent of use and available resource base.

CHAPTER 6

Distribution of Ethno-flora across Landforms and Communities

6.1 INTRODUCTION

Ecological surveys focusing on the diversity, distribution, abundance and population structure of plants are prerequisite for further conservation planning and assessing the sustainability of harvesting the key or target species (Hall and Bawa 1993). Analysis of community structure and distribution pattern of plants also helps in understanding the ecology of species and natural associations under varying environmental conditions. Community structure of vegetation in an area can be used to derive information regarding locations, where species specific assemblages occurs such as patches containing high economic or use value. It is important from management point of view, especially when those landscapes are vulnerable to natural or anthropogenic changes. The population parameters such as density, diversity and distribution pattern could be a useful proxy indicator of overall conservation status of the species and response of communities to biotic and abiotic factors.

The alpine plant communities in the Western Ladakh differ considerably from rest of the high altitude regions of Greater Himalaya due to unique climatic conditions and physiography. Annual and perennial herbs followed by stunted shrubs and bushes dominate the flora. Earlier estimates of flora of Ladakh revealed that there may be about 750 species of vascular plants including 540 species of dicots, 65 monocots and two gymnosperms (Kachroo et al. 1977, Chaurasia et al. 2007). However, Klimeš and Dickore (2006) reported more than 1180 species of vascular plants in Ladakh. Cold arid environment of the region does not support lush vegetation and profuse growth of plants. Hence, plant populations are sparsely distributed in the form of small patches of sedge meadows, mixed herbaceous formations and riverine scrub along stream courses. Similar to other areas of Greater Himalaya, human dependence on biomass resources is very high in the Indian Trans-Himalaya, mostly in the form of livestock grazing, extraction of natural resources, tourism and developmental activities. Extreme environment, soil with poor fertility and rock dominated landscape of Western Ladakh supports less diversity of plants as compared to other parts of Himalayas. Such environment also supports more habitat specific plants with narrow distribution. The harsh environment of the area impose great constraints on plants,

which has to cope with aridity, extreme diurnal temperature fluctuations, strong winds and abrasion, solifluction at the higher altitudes and salinity at the lower altitudes, nutrient poor soils and a short growing season. Under such conditions, the productivity is generally very low and the vegetation is most often sparse. Nonetheless, large areas serve as grazing land for domestic livestock and wild sheep and goats, yaks, and other mammals and host unique flora, with most plants utilized by local people for medicinal purposes (Ballabh and Chaurasia 2007, Angmo et al. 2012). Owing to remoteness and the low population, the anthropogenic pressure remained limited and confined to traditional nomadic herders. However, in recent decades both human and livestock populations (mostly sheep, goats and yaks) have increased significantly and overgrazing posed a serious problem in many parts of the region (Bhatnagar et al. 2006).

Serveral studies have been conducted to study the flora of Ladakh (Chaurasia and Singh 1996, 1997, 1998, and 2001, Chaurasia et al. 1999, Chaurasia and Gurmet 2003, Klimes 2005, Ballabh and Chaurasia 2007). Work on vegetation community analysis of Ladakh has been done by several authors (Kala and Mathur 2002, Klimes and Dickore 2005, Rawat and Adhikari 2005). However, vegetation communities of Western Ladakh have not been focused in particular by any author. Study of Klimes and Dickore (2005) focuses on the Lower Indus valley covering only till Beema village and does not provide information on Suru and Wakha-chu valley. In particular, Northwest India is not sufficiently explored in terms of floristic diversity and new vascular plant species are still being described (Al-Shehbaz 2002, Klimes and Dickore 2005, Kirschner et al. 2006, Klimes and German 2008, Namgail, 2012). The main reasons for this can be the difficult accessibility and logistic problems along with political instability of the region (Klimesova et al. 2011). Detailed information on the abundance and distribution of local flora would provide information on potentials of resource harvest and developing strategy for conservation.

This study aims to describe the vegetation types in the Western Ladakh Trans-Himalayan zone of India, in terms of species composition and growth form distribution, and relating these patterns to the changes along environmental gradient.

6.2 METHODS

6.2.1 Sampling design and data collection

The vast extent of study area comprises several small watersheds, however for the convenience of data collection three major watershed derived from 30m resolution Aster Global Digital Elevation Model (AGDEM) expanding over 6523.88 km^2 (Suru 3011.94, Wakha 1933.54 and Lower Indus 1578.40) was selected for the study. The study was conducted during May 2009 to September 2012. Data was collected following standard methods (Curtis and Mc Intosh 1950, Greig-Smith 1957, Misra 1968, Mueller-Dombois and Ellenberge 1974, Dhar et al. 1997, Samant et al. 2002, Joshi and Samant 2004, Rawat and Adhikari 2005). Since a complete random approach for sampling was not possible due to ruggedness of the terrain, attempts were made to collect samples from all representative areas and both heavily and less disturbed sites. Sampling was done with following assumptions.

- abundance and richness of plant species changes along geographical and climatic gradients
- most of the plants are habitat specific (adapted to particular environmental conditions) and hence different landform contains different assemblages of species and
- plant species respond actively to disturbance factors and hence species richness and composition vary along disturbance gradient

Altogether 155 sites (each hectare plot, 100m X 100 m) were sampled in nine different landform units using stratified random sampling method in each of the three valleys following Rawat and Adhikari 2005. In each landform unit minimum two to maximum 21 sites were recorded in the area. The number of individuals of each plant species was counted in 25 randomly distributed quadrats 1x1 m^2. Each site represents a specific habitat and all the sites fall under 9 different habitats. These habitats and their specific features are given in Table 6.1.The vegetation cover (%) was estimated visually and the habitat parameters such as altitude, geographic coordinates (latitude and longitude) were tracked with Global Positioning System (Garmin GPS 12), slope and aspect were determined through an altimeter (Origo Accusense Multi-sensor) and level of disturbance was visually observed based on the presence and absence of pellets/dungs or also on the hoof mark of the cattle or the livestock.

The plant species were identified in the field using field guides (Kachroo et al. 1977, Polunin and Stainton 1984, Aswal and Mehrotra 1994) and voucher specimens of unidentified plants were collected and submitted after verification at the herbarium of Wildlife Institute of India.

Table 6.1 Description of different habitats identified for vegetation sampling

Habitat	Specific features
Field margins	Fields margins and Fallow lands
Alpine Meadows	Alpine grasslands
Marsh meadows	Understory near Streams, bogs dominated with Salix spp. and Hippophae spp.
Stable Slopes	Undulating land area above 3500 with good stability
Bouldery Slopes	Slopes with Large boulders or Talus
Rocks and Cliffs	Rough and barren ridges of cliff of the mountain
Moraine	Flat to angular stones of various dimensions including loose rocks
Scree	barren mountain slopes covered with small stones
Plateau	Plateau table lands

6.2.2 Data analysis

Data analysis

The plant communities were classified using cluster analysis and Indicator species analysis (ISA) using the method of McCune and Mefford (1999), PC-ORD, Multivariate Analysis of Ecological Data, Version 4.34 software. Indicator species analysis was conducted according to Dufrêne and Legendre (1997), McCune, and Mefford (1999). For each species i in each group j (i.e. a vegetation unit or biogeoclimatic zone), an indicator value was calculated by the formula: IVij = RAij × RFij × 100 (1) where IVij is the indicator value of species i in group j; RAij is the mean abundance (% cover) of species i in group j; and RFij is the relative frequency of occurrence of species i in the plots of group j. IVij ranges from 0 (no indication) to 100 (perfect indication). The highest indicator value (IV_{max}) for a given species across groups was treated as an indicator value of that species and the species name is used as a community name. Statistical significance of IV_{max} was evaluated by Monte Carlo test which was carried out with 1500 permutations). All species with P-value ≤ 0.05 in a Monte Carlo test were selected as indicator species, each for one of the groups in which it has the IVmax. The density (plants per square meter), diversity

(ShannonWiener Index, H') and richness (Menhinick's Index) following Magurran (1988) were calculated to describe the vegetation characteristics within each hectare plot.

Community Structure and Distribution Pattern of Species

The structural aspect of vegetation such as density, frequency, abundance and dominance of constituent species were determined following Misra (1968). Frequency, density and dominance following, Curtis and McIntosh (1950), Brown and Curtis (1952). Total number of individuals in all the quadrats

$$\text{Density} = \frac{\text{Total number of Individual in all quadrats}}{\text{Total number of Quadrats studied}}$$

$$\text{Frequency (\%)} = \frac{\text{Total number of quadrats in which species accured}}{\text{Total number of Quadrats studied}} X100$$

Diversity, Richness and Evenness

The diversity index makes the assumption that individuals are randomly sampled from an infinitely large population and also assumes that all the species from the community are included in the sample. The species diversity was computed using Shannon-Weaver Index (Shannon and Wiener 1949).

$$H' = \Sigma\,(ni/N) \times \ln\,(ni/N)$$

Where, H′ = Shannon's information index of species diversity

ni = Total number of individuals of one species

N = Total number of individuals of all the species in one stand

Richness was calculated by counting total number of species observed in each habitat.

Evenness (Equability) was calculated using the Pielou's (1966) equation. Evenness expresses how evenly the individuals in the community are distributed over the different species.

$$\text{Evenness (E)} = H'/ H' \text{ max.} = H' \log S \text{ or } H'/\ln S$$

Where, S = Number of species

H' = Diversity

Evenness ranges between 0 and 1. If the evenness value is higher, the variation in communities between the species would be less.



Rock and Cliff



Plateau



Alpine meadow



Moraine



Stable slope



Bouldery slope



Field margin



Moist Meadow



Scree

Plate IV Sampling across different landform units

6.3. RESULTS AND DISCUSSION

6.3.1 Floristic Structure

A total of 301 plant species were recorded at 155 sites consisting of 3875 quadrat in nine landform units (Table 6.2). In Suru 65 sites, Wakha-chu 51 sites and Lower Indus valley 39 sites were sampled. These plant species belongs to 159 genera and 51 families (Table 6.3). Eight large families, which represent 52.5% of all the species, are Asteraceae, Fabaceae, Ranunculaceae, Caryophyllaceae, Polygonaceae, Apiaceae, Orobanchaceae and Poaceae (Figure 6.2). Venn diagram shows the total number of plants available and overlap of the circles signifies the common plants of the valleys. Kumar et al (2011) followed a different sequence with the whole Ladakh vegetation described as Asteraceae, Brassicaceae, Fabaceae, Poaceae, Ranunculaceae and Lamiaceae as the dominant families. As many as 15 families were represented by only one species.

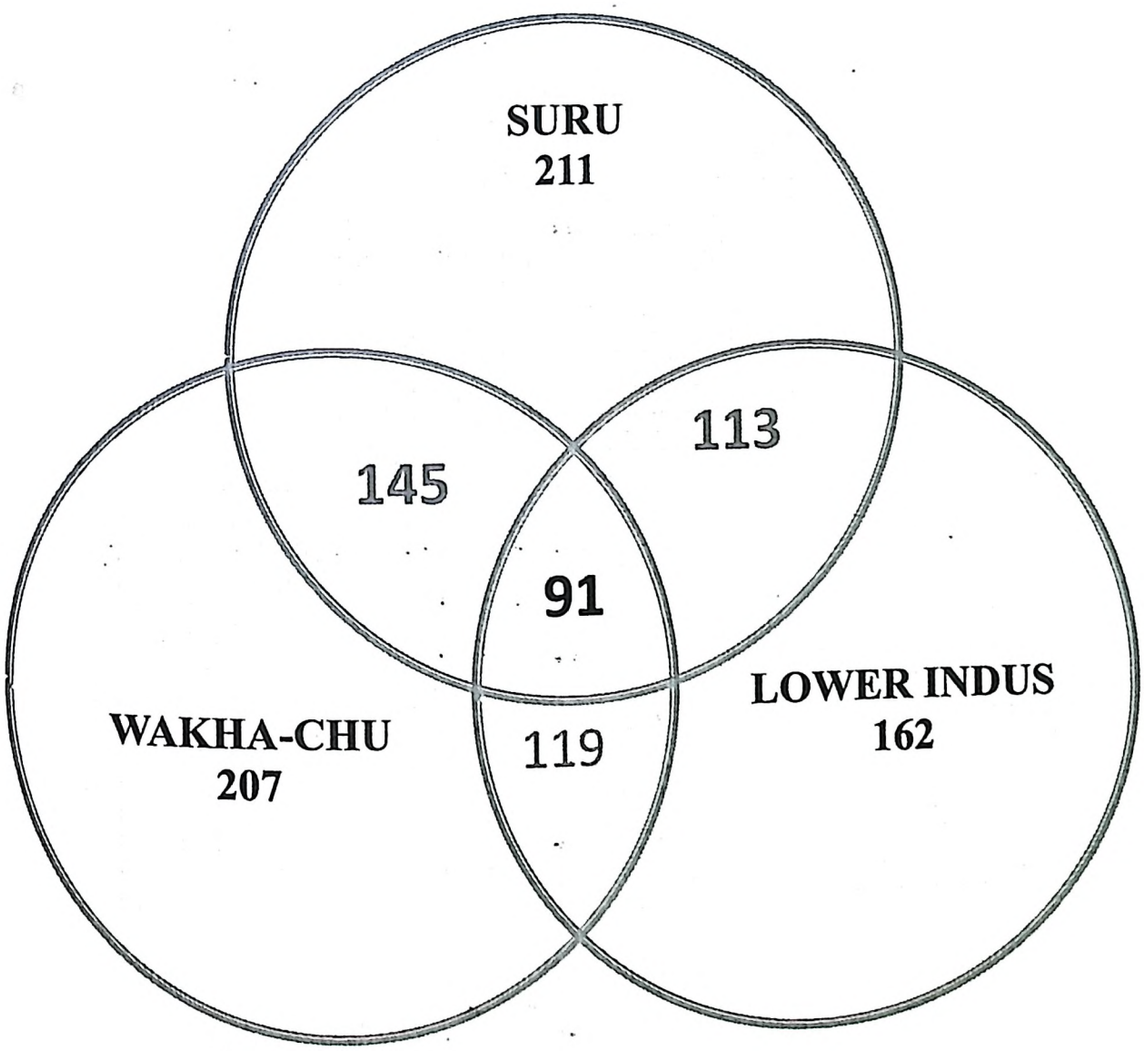


Figure 6.1 Venn diagram showing the common plants in the entire valley based on Vegetation sampling

Table 6.2 Vegetation plot data collected from the Lower Indus, Wakha-chu and Suru valley

Valley	Habitat	Plot ID numbers	Quadrats
Lower Indus	Field margins	2, 4,9,12,39 and15	150
	Alpine meadows	32,37	50
	Marsh meadows	6,7,16,30 and 40	125
	Stable slopes	21,33,34 and 35	100
	Bouldery slopes	22,23,26, 27, 28,29 and 36	175
	Cliffs and rocks	1, 3, 10, 14, 24 and 13	150
	Moraine	19,20	50
	Scree	5,11,17,18 and 25	125
	Plateau	31, 38	50
Wakha-chu	Field margins	10, 12, 16, 35, 47 and 6	150
	Alpine meadows	3 and 36	50
	Marsh meadows	13 and 34	50
	Stable slopes	5, 8, 14, 18, 19,20, 21, 22, 24, 26, 28, 29, 31, 32, 33, 37, 40, 43,44, 48 and 49	525
	Bouldery slopes	27, 41 and 42	75
	Cliffs and rocks	15 and 50	50
	Moraine	23, 25,38, 45 and 46	125
	Scree	1, 4, 7, 9, 11,17,30 and 39	200
	Plateau	2 and 51	50
Suru	Field margins	37,62,67,68,22,26,27,28 and 30	225
	Alpine meadows	17, 36, 38, 52 and 18	125
	Marsh meadows	59,60,61,2,13,23,25 and 29	200
	Stable slopes	12, 19, 20,31,34,35,39, 40, 43,46, 50,53, 54,55,57,58,64 and 14, 16	475
	Bouldery slopes	42,56, 65,10,11	125
	Cliffs and rocks	48, 63, 6,7, 21 and 24	150
	Moraine	33,44,45, 49 and 15	125
	Scree	32, 1, 4, 5 and 9	125
	Plateau	41, 66 and 8	75

Table 6.3 Angiosperm families of Western Ladakh and estimated number of species

Family	Number		Number	Family	Number
Asteraceae	58	*Papaveraceae*	6	*Grossulariaceae*	2
Fabaceae	22	*Rubiaceae*	5	*Violaceae*	2
Ranunculaceae	17	*Plantaginaceae*	5	*Biebersteiniaceae*	1
Polygonaceae	14	*Crassulaceae*	5	*Capparaceae*	1
Caryophyllaceae	14	*Saxifragaceae*	4	*Adiantaceae*	1
Apiaceae	11	*Caprifoliaceae*	4	*Chenopodiaceae*	1
Poaceae	11	*Onagraceae*	3	*Campanulaceae*	1
Orobanchaceae	11	*Salicaceae*	3	*Convolvulaceae*	1
Brassicaceae	9	*Plumbaginaceae*	2	*Equisetaceae.*	1
Rosaceae	9	*Orchidaceae*	2	*Balsaminaceae*	1
Alliaceae	9	*Ephedraceae*	2	*Iridaceae*	1
Primulaceae	8	*Euphorbiaceae*	2	*Phrymaceae*	1
Lamiaceae	8	*Geraniaceae*	2	*Celastraceae*	1
Gentianaceae	8	*Scrophulariaceae*	2	*Berberidaceae*	1
Boraginaceae	7	*Elaeagnaceae*	2	*Santalaceae*	1
Cyperaceae	7	*Solanaceae*	2	*Urticaceae*	1
Amaranthaceae	6	*Cupressaceae*	2	*Asparagaceae*	1

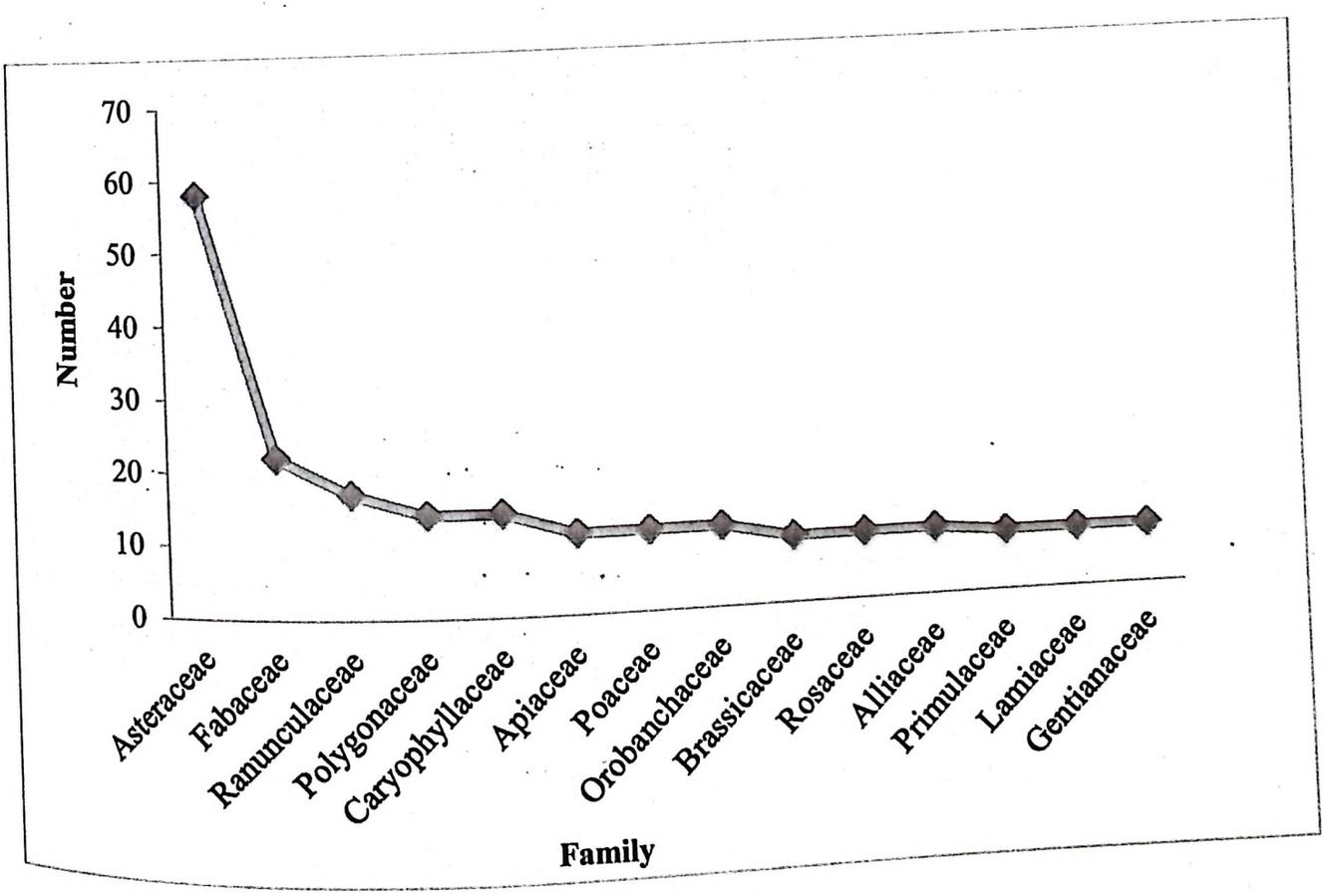


Figure 6.2 Dominant families of Western Ladakh

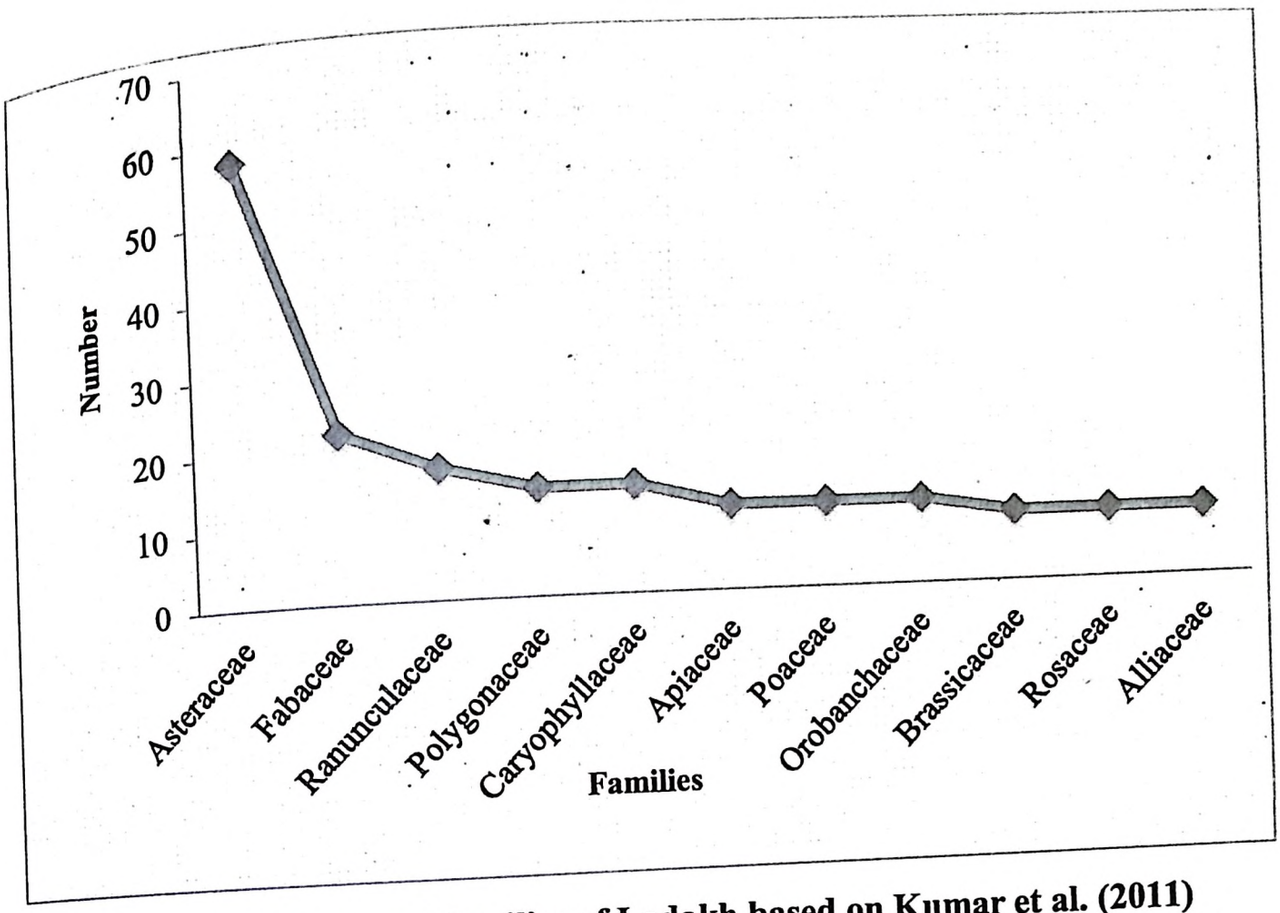


Figure 6.3 Dominant families of Ladakh based on Kumar et al. (2011)

In most of the studies, it was found that the families Asteraceae, Fabaceae, Poaceae, Brassicaceae, Cyperaceae and Ranunculaceae are the most dominating families in the Trans-Himalaya. The present study also suggests that the number of species in Asteraceae, Fabaceae, Ranunculaceae, Polygonaceae, and Caryophyllaceae are the most dominant families in Western Ladakh (Figure 6.2). In Nubra valley, almost a similar kind of trend was reported by Joshi et al. (2006) Poaceae, Asteraceae, Cyperaceae, Brassicaceae, Rosaceae, Fabaceae and Polygonaceae.

Suru valley has the maximum floristic diversity of the species followed by Wakha-chu and Lower Indus valley. Western Ladakh is different from the rest of Ladakh, because the snow line is much lower and there are many streams, and springs. This increased water supply is no doubt due to the presence of the Nun Kun peaks and glaciers (Steward 1916).

The taxonomic distribution of vegetation of Western Ladakh does not vary much from the study by Dvorsky et al., (2011) who reported 272 vascular 43 families from Eastern Ladakh, studied vegetation types of East Ladakh in the Trans-Himalaya, underlying environmental gradients. Hartmann (1983, 1999) whose study was based on geobotanical description of the area recorded about 280 vegetation records. However, number of species does vary depending on the size of geographical area studied for the purpose. There were large

differences in the number of plant species within different valleys. More species occurred close to the Ladakh range and Zanskar range.

6.3.2 Diversity Richness and Evenness

Diversity was calculated for all the landform units separately (Table 6.4). Shanon's diversity index (H) varied from 1.44 to 4.13 respectively. Diversity was highest in stable slope of Wakha-chu (H'=4.13) followed by stable slope in Suru (H'=4.09) and bouldery slope in Lower Indus valley (H'=3.29). The diversity values were lowest in case of alpine meadows in Wakha-chu (H'=1.98) and Lower Indus Valley (H'=1.44).

Richness of species varied from 17 to 123 in Western Ladakh. In Wakha-chu and Suru valley species richness was highest in stable slope (S=123 and S=121). Whereas in Lower Indus valley species richness was highest in bouldery slope (S=62). The richness is lowest in plateau in Lower Indus valley with 17 species and 18 species in Wakha-chu and 34 in Suru valley. Among various landform units plateau (17-41 species) while species richness was highest in stable slope (49-123 species). This could be due to species diversity relative to land area, the larger an area is, the more organisms it can support, which results in larger populations. Larger populations are characterized by fewer extinctions and more prevalent mutation events and are, consequently, more diverse.

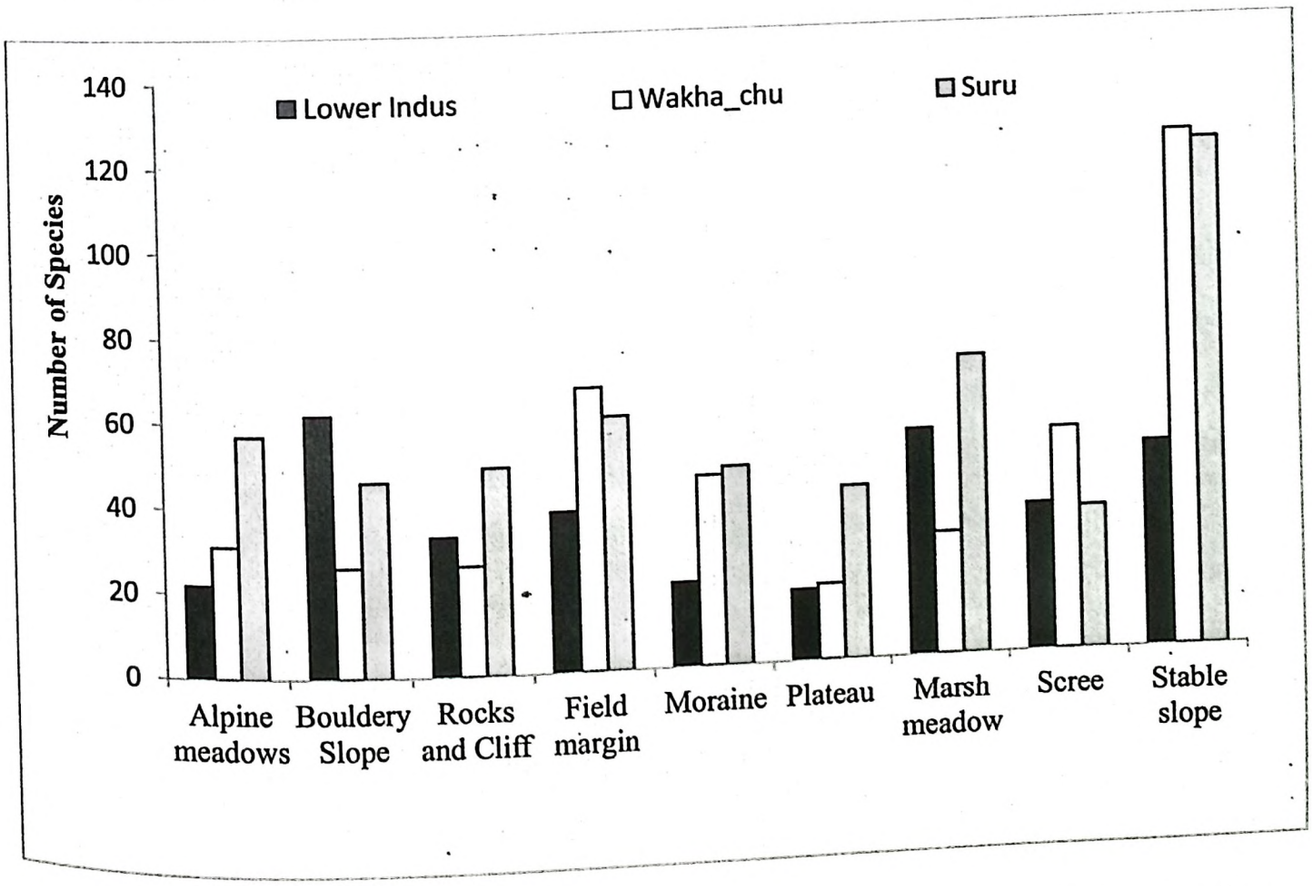


Figure 6.4 Cumulative species richness across landform units in different valley

When the data was pooled together for each valley, diversity in Waka-chu (H'=4.739) was significantly higher (t=-15.97, P=<0.0001) than Lower Indus valley (H'=4.18), while Suru (H'= 4.768) and Lower Indus Valley (H'=4.18) did not vary in the diversity (t=-1.125; P=>0.26), this may be possibly because they share the same mountain range i.e Ladakh range. As compared to the Lower Indus the plants diversity was significantly higher (t=-17.8: P=<0.0001) in Suru valley (H'= 4.768).

Considering the fact that the Shannon-Wiener Index can be difficult to compare between sites because its value changes not only due to changes in the relative abundance of different species, but also due to increase in species richness, a more appropriate way to compare diversity would be to control the number of species found within the communities which is measured through Evenness. Evenness ranges from near zero, when most species are rare or only a few are abundant, to 1, when all the species are equally distributed.

Evenness (E) varies from 0.42 to 0.92 within different landform units where single species dominance show lower values and vice-versa. In Lower Indus evenness (E) varied from 0.54 to 0.88, whereas in Wakha-chu from 0.42 to 0.92 and in Suru valley from 0.69 to 0.89 (Table 6.4). Stable habitats have highest species richness and evenness and hence these habitats are directly comparable between valleys while in case of alpine and marsh meadow, species richness and evenness vary greatly between valleys, and therefore its diversity may not be comparable. The evenness value of alpine and marsh meadows in valleys shows uneven distribution of species, while in bouldery slopes; moraines, scree and stable slopes were evenly distributed, mainly due to the microhabitats occupied by these landform units.

The diversity was highest in alpine meadows, bouldery slopes, rock and cliff, moraines, plateau, marsh meadow and stable slopes of Suru valley: Bouldery slope, field margins, Scree and stable slopes of Lower Indus valley and field margin, moraines scree and stable slopes of Wakha-chu valley. The diversity among landform units was highest in stable slope in all the valleys (3.23 in Lower Indus, 4.13 in Wakha-chu and 4.09 in Suru valley.

Table 6.4 Richness, evenness and diversity indices of three different valleys

Landforms	Valley	Richness	Evenness	Simpson D	Shannon H
Alpine meadows	Lower Indus	22	0.64	0.73	1.98
	Wakha-chu	31	**0.42**	0.50	**1.44**
	Suru	57	0.88	0.96	3.55
Bouldery slope	Lower Indus	62	0.80	0.92	3.29
	Wakha-chu	26	0.89	0.93	2.89
	Suru	46	**0.89**	0.96	3.40
Rocks and cliff	Lower Indus	33	0.69	0.83	2.41
	Wakha-chu	26	0.87	0.93	2.84
	Suru	49	0.80	0.92	3.10
Field margin	Lower Indus	38	0.83	0.93	3.00
	Wakha-chu	67	0.84	0.96	3.54
	Suru	60	**0.69**	0.87	2.85
Moraine	Lower Indus	20	0.81	0.87	2.43
	Wakha-chu	45	**0.92**	0.96	3.49
	Suru	47	0.85	0.94	3.26
Plateau	Lower Indus	**17**	0.79	0.84	2.24
	Wakha-chu	18	0.75	0.82	2.16
	Suru	41	0.84	0.94	3.13
Marsh meadow	Lower Indus	54	**0.54**	0.69	2.17
	Wakha-chu	29	0.68	0.82	2.29
	Suru	71	0.79	0.94	3.37
Scree	Lower Indus	35	**0.88**	0.94	3.12
	Wakha-chu	53	0.84	0.95	3.32
	Suru	34	0.72	0.85	2.56
Stable slope	Lower Indus	49	0.83	0.94	3.23
	Wakha-chu	**123**	0.86	0.97	**4.13**
	Suru	121	0.85	0.97	4.09

6.3.3 Density and frequency of some Ethno-flora

The density of plant species is a better measure of how these species might be utilizing the habitat and resource. Table 6.5, shows that in Lower Indus valley *Allium prezewalskianum* (10.29 individuals m^2) has the highest density across four different landforms units, mostly found in the Alpine meadow (5.5 individuals m^2), Plateau (2.26 individuals m^2), Stable slope (1.3 individuals m^2) and low density in bouldery slopes (0.89 individuals /m^2). The lowest density among the top priority species was *Saussurea bracteata* (0.5 individuals / m^2), recorded from bouldery slope and was restricted to that habitat. In Wakha-chu valley the highest density was recorded for *Codonopsis ovata* (8.92 individuals / m^2), which was recorded from field margins and also from Alpine meadows Table 6.6. *Papaver nudicaule* (0.15 individuals' m^2) has the lowest density, recorded from the Stable upper slope. In Suru valley *Dactylorhiza hatagirea* (5.15 individuals / m^2) has the highest density in two landform units, i.e., Field margins and Marsh meadows, whereas the lowest density was recorded for *Juniperus communis* (0.03 individuals m2) which was recorded from rock and cliff type of landform units Table 6.7.

Table 6.5. Density (individual plants per m^2), Standard Error (±) of plants at different Landform units in Wakha-valley

Scientific Name	Alpine meadow	Boulders	Rocks & cliffs	Field	Moraine	Plateau	Marsh meadow	Scree	Stable
Acantholimon lycopodioides	0.04±0.00	-	0.40±0.19	-	0.25±0.11	0.14±0	-	0.46±0.14	0.27±0.06
Aconitum rotundifolium	-	-	-	-	0.87±0.37	-	-	-	0.06±0.03
Aconitum violaceum	-	-	-	1.16±0.43	-	-	-	-	0.10±0.14
Aconogonum tortuosum	-	-	-	0.1±0.08	0.4±0.18	-	-	0.36±0.16	0.79±0.15
Allium prezewalskianum	-	-	-	-	0.56±0.42	3.28±1.20	-	1.32±1.47	0.48±0.98
Arnebia euchroma	-	-	0.58±0.12	-	-	-	-	0.43±0.19	0.23±0.08
Aster flaccidus	2.04±0.64	-	-	-	0.87±0.25	-	-	0.05±0.28	1.03±0.16
Carum carvi	-	-	-	0.23±0.15	-	-	0.42±0.28	-	-
Cicer microphyllum	-	-	-	0.06±0.01	-	-	-	0.17±0.10	0.15±0.05
Clematis tibetana	-	-	-	-	-	-	-	-	0.41±0.23
Codonopsis ovata	4.38±2.69	-	-	4.54±0.67	-	-	-	-	-
Corydalis govaniana	-	0.25±0.18	-	-	0.28±0.15	-	-	-	0.26±0.10
Dactylorhiza hatagirea	0.64±0.32	-	-	1.58±0.49	-	-	5.76±0.59	-	-
Delphinium brunonianum	-	1.70±0.21	-	-	0.87±0.27	-	-	-	0.09±0.07
Gentiana tianschanica.	-	-	-	-	0.17±0.05	-	-	-	0.51±0.14
Lagotis kunawurensis	-	-	-	-	2.52±0.37	-	-	-	0.76±0.17
Papaver nudicaule	-	-	-	-	-	-	-	-	0.15±0.09
Primula macrophylla	0.7±0.27	0.52±0.26	-	-	-	-	-	-	-
Rheum spiciforme	-	-	0.56±0.13	-	-	-	-	0.32±0.09	0.12±0.05
Rheum tibeticum	-	-	-	-	-	-	-	-	0.47±0.08
Rhodiola tibetica	0.76±0.21	1.3±0.16	-	-	0.93±0.18	-	-	-	0.28±0.08
Rosa webbiana	-	-	0.64±0.36	-	-	-	-	0.02±0.01	0.02±0.01
Saussurea bracteata	-	2.7±0.33	-	-	0.71±0.16	-	-	-	0.2±0.14
Swertia petiolata	-	-	-	0.08±0	0.41±0.32	-	-	-	0.08±0.02
Thymus linearis	-	-	-	-	-	0.58±0.37	-	-	0.02±0.004
Waldheimia glabra	-	-	-	-	0.41±0.05	-	-	-	-

Table 6.6 Density (individual plants per m^2), Standard Error (±) of plants at different Landform units in Suru valley

Scientific names	Alpine meadow	Boulders	Rocks and cliffs	Field	Moraine	Plateau	Marsh meadow	Scree	Stable
Acantholimon lycopodioides	-	-	0.16±0.06	-	-	-	-	-	0.0001±0.00
Aconitum heterophyllum	-	-	-	2.47±0.42	-	-	-	-	-
Aconitum rotundifolium	1.68±0.01	-	-	-	-	-	-	-	0.01±0.21
Aconitum violaceum	-	-	-	1.75±0.72	-	-	-	-	0.01±0.24
Aconogonum tortuosum	0.10±0.07	-	0.04±0.0	-	0.19±0.13	0.15±0.04	-	0.12±0.03	-
Allium prezewalskianum	-	-	-	-	-	0.4±0.27	-	-	-
Arnebia euchroma	-	-	0.2±0.12	-	0.18±0.07	-	0.85±0.37	-	0.002±0.0
Aster flaccidus	0.30±0.03	0.09±0.01	0.06±0.01	-	0.38±0.04	0.17±0.14	0.53±0.09	-	0.016±0.01
Carum carvi	-	-	-	1.47±0.24	-	-	1.28±0.54	-	-
Cicer microphyllum	-	0.13±0.10	0.04±0.0	-	0.14±0.06	-	0.17±0.01	-	0.002±0.00
Clematis tibetana	-	-	-	-	-	-	0.08±0.03	-	-
Codonopsis ovata	-	-	-	2.44±0.52	0.07±0.0	-	1.27±0.75	-	-
Corydalis govaniana	1±0.61	0.38±0.12	-	-	-	-	-	-	0.01±0.01
Dactylorhiza spp	-	-	-	1.67±0.71	-	-	3.47±0.86	-	-
Delphinium brunonianum	-	0.35±0.13	-	-	0.40±0.07	0.16±0.11	-	-	-
Inula rhizocephaloides	3.2±1.42	-	-	-	-	-	-	-	0.002±0.16
Oxyria digyna	-	-	-	-	0.61±0.32	-	0.09±0.19	-	0.0002±0.03
Parrya nudicaulis	-	0.22±0.13	-	-	-	0.45±0.25	0.05±0.07	-	0.005±0.37
Pedicularis roylei	-	-	-	-	-	-	0.11±0.08	-	0.003±0.18
Primula macrophylla	-	0.12±0.09	-	-	-	-	-	-	0.005±0.31
Rheum spiciforme	-	-	-	-	0.03±0.01	0.09±0.03	-	0.29±0.09	0.0001±0.00
Rheum webbianum	-	0.06±0.04	-	-	0.12±0.13	0.10±0.09	-	-	0.004±0.29
Rhodiola tibetica	-	0.72±0.28	-	-	-	1.10±0.35	-	0.14±0.12	0.010±0.0
Rosa webbiana	-	-	0.13±0.06	0.05±0.03	-	-	-	0.02±0.0	-
Saussurea bracteata	-	0.57±0.12	-	-	0.37±0.35	-	-	-	-
Swertia petiolata	0.52±0.25	-	-	0.91±0.48	-	-	-	-	0.010±0.54
Swertia thomsonii	-	-	-	0.05±0.05	-	-	0.36±0.03	-	0.005±0.31
Thymus linearis	0.15±0.02	-	0.24±0.01	-	0.04±0.02	-	-	-	0.015±0.0
Waldheimia stoliczka	-	0.88±0.46	-	-	-	-	-	0.18±0.21	0.002±0.14

Table 6.7 Density (individual plants per m^2), Standard Error (±) of plants at different Landform units in Lower Indus valley

Scientific name	Alpine Meadow	Boulders	Rocks and cliffs	Field	Moraine	Plateau	Marsh Meadow	Scree	Stable
Acantholimon lycopodioides	-	-	0.027±0.0	-	0.25±0.17	1.98±0.48	-	0.38±0.06	0.19±0.07
Aconitum rotundifolium	1.72±0.69	2.33±0.39	-	-	-	-	-	-	2.28±0.83
Aconogonum tortuosum	-	-	-	-	2.26±0.22	-	-	-	1.49±0.38
Allium prezewalskianum	5.5±1.52	0.89±0.73	-	-	-	2.6±0.72	-	-	1.3±0.83
Arnebia euchroma	-	-	0.06±0.02	-	-	-	-	0.15±0.13	-
Aster flaccidus	0.52±0.25	1.01±0.24	-	-	-	-	0.04±0.006	-	0.62±0.29
Cicer microphyllum	-	0.1±0.07	-	-	0.84±0.12	-	-	0.13±0.08	0.13±0.07
Clematis tibetana	-	-	-	-	-	-	0.28±0.36	-	-
Codonopsis ovata	-	0.29±0.35	-	0.8±0.05	-	-	-	-	-
Corydalis govaniana	-	0.4±0.19	-	-	-	-	-	-	-
Delphinium brunonianum	-	0.1±0.0	-	-	0.04±0	-	-	-	0.11±0.05
Gentiana tianschanica	-	0.79±0.39	-	-	-	-	-	-	-
Lagotis kunawurensis	1.4±0.30	0.18±0.15	-	-	-	-	-	-	2.01±0.56
Oxyria digyna	-	-	-	1.55±0.55	-	-	0.31±0.26	-	-
Papaver nudicaule	-	1.07±0.32	-	-	-	-	-	-	0.53±0.37
Pedicularis longiflora	-	-	-	-	-	-	1.69±0.71	-	-
Primula macrophylla	-	0.17±0.15	-	-	-	-	-	-	-
Rheum webbianum	-	0.26±0.10	0.12±0.11	-	-	-	-	-	0.57±0.27
Rhodiola tibetica	5.94±1.57	2.3±0.22	-	-	0.08±0.0	-	-	-	1.83±0.25
Rosa webbiana	-	-	0.04±0.0	-	0.82±0.18	-	-	0.07±0.06	-
Saussurea bracteata	-	0.05±0.02	-	-	-	-	-	-	-
Senecio dubitabilis	-	-	0.08±0.04	-	-	-	-	-	-
Thymus linearis	-	0.09±0.05	-	-	-	-	-	-	0.77±0.35
Waldheimia stoliczkae	-	0.77±0.45	-	-	-	-	-	-	2.5±1.02

Table 6.8 Community across different landform units in three different valleys

	Lower Indus Valley	Wakha-chu Valley	Suru Valley
Alpine meadow	*Carex* sp.-*Potentilla* sp.	*Carex-Kobresia* sp	*Geranium* sp-*Myosotis sylvatica*
	Sibbaldia cuneata-Lagotis kunawurensis	*Caragana versicolor-Codonopsis ovata*	*Oxygraphis* sp.-*Kobresia pygmaea*
		Bistorta affinis-Potentilla sp.	*Taraxacum officinale-Inula rhizocephala*
Bouldery slope	*Bistorta affinis-Aconitum rotundifolium*	*Artemisia* sp.-*Festuca kashmiriana*	*Corydalis* sp.-*Meconopsis aculeata*
	Elymus-Corydalis impatiens	*Potentilla argyrophylla-Elymus* sp.	*Artemisia-Nepeta glutinosa*
	Carex nivalis-Pseudomertensia moltkioides	*Primula macrophylla-Delphinium brunonianum*	*Rhodiola imbricate-Pedicularis pectinata*
			Draba setosa-Pedicularis ophiocephala
Rocks and Cliff	*Artemisia maritima-Scrophularia desertorum*	*Ribes orientale-Juniperus* sp.	*Festuca kashmiriana-Chrysanthemum tibeticum*
	Bergenia stracheyi-Rheum webbianum	*Androsace muscoidea-Ajania tibetica*	*Elymus* sp.-*Pseudomertensia moltkioides*
	Lysimachia sp.-*Nepeta* sp		*Polygonum paronychioides- Tulipa stellate*
Field margin	*Taraxacum officinale-Plantago tibetica*	*Convolvulus arvensis-Rumex nepalensis*	*Galium* sp.-*Festuca* sp.
	Impatiens racemosa-Rumex nepalensis	*Medicago sativa-Pedicularis punctata*	*Erigeron multicaulis-Podophyllum hexandrum*
	Medicago sativa-Rumex patientia	*Seseli mucronatum-Veronica biloba*	*Poa* sp.-*Plantago depressa*
	Lancea tibetica-Lactuca sativa	*Kobresia macrantha-Arenaria griffithii*	*Medicago sativa-Taraxacum officinale*
			Pedicularis bicornuta-Carex sp.
Moraine	*Juniperus* sp.-*Rosa webbiana*	*Acantholimon lycopodioides-Scutellaria heydei*	*Geranium* sp.-*Bistorta affinis*
	Cicer microphyllum-Festuca sp.	*Draba setosa-Carex nivalis*	*Festuca* sp.-*Arnebia euchroma*
		Lagotis kunawurensis-Potentilla argyrophylla	*Allium carolinianum-Aquilegia fragrans*
Plateau	*Bistorta affinis-Potentilla* sp.	*Ajania tibetica-Carex* sp.	*Filago* sp.-*Leontopodium* sp.
	Acantholimon lycopodioides-Polygonum paronychioides	*Artemisia maritima-Allium przewalskianum*	*Kobresia pygmaea-Saussurea atkinsonii*
			Androsace sp.-*Polygonum paronychioides*
Marsh meadows	*Impatiens racemosa-Trifolium repens*	*Euphrasia himalayica-Trifolium repens*	*Kobresia pygmaea-Gentianella moorcroftiana*
	Heracleum pinnatum-Lancea tibetica	*Parnassia palustris-Bistorta affinis*	*Crepis* sp.- *Oxytropis tatarica*
	Leontopodium spp.-*Carex* spp.		*Taraxacum officinale -Euphrasia himalayica*
Scree	*Scrophularia desertorum-Artemisia maritima*	*Artemisia maritima-Allium przewalskianum*	*Geranium* sp.-*Corydalis crassifolia*
	Nepeta floccose-Silene moorcroftiana	*Scrophularia desertorum - Orobanche* sp.	*Polygonum paronychioides-Ajania tibetica*
	Acantholimon lycopodioides-Krascheninikovia sp.	*Potentilla* sp.-*Caragana versicolor*	*Rheum moorcroftianum Psychrogeton andryaloides*
Stable	*Arenaria* sp.-*Festuca* sp.	*Geranium* sp.-*Aconogonum tortuosum*	*Carrex nivalis-Nepeta podostachys*
	Bistorta affinis- Potentilla argyrophylla	*Artemisia maritima-Chrysanthemum* sp.	*Anemone rupicola- Astragalus rhizanthus*
		Aster flaccidus-Rhodiola tibetica	*Rhodiola tibetica-Waldheimia tomentosa*
			Elymus-Bistorta affinis
			Kobresia pygmaea-Lloydia serotina

6.3.4 Community structure

ISA for nine habitat resulted in 81 plant communities of which 24, 25 and 32 communities were in the Lower Indus, in the Wakha-chu and Suru valley, respectively. The plant communities in all the habitat type within three valleys are given in the Appendix IV along with their indicator value and significance value (p). Each community was named after the highest indicator value species and their significance level. The synoptic Table of the diagnostic, constant and dominant species is given in Table 6.8. All the communities under each habitat are being discussed below in detail.

Alpine Meadow:

The Alpine meadows because of the cushioned form of vegetation dominated by *Carex* sp., *Poa* sp. and *Kobresia* sp. occurred mainly along a narrow or seasonal streams and species richness is low because of reoccurrence of the same species. The altitudinal optimum ranges between 3500-4900 m. The vegetation cover was 60 % to 80 % with sturdy *Kobresia* sp. This vegetation was dominated by clonal hemicryptophytes; and the annuals were absent or rare. The species composition of alpine meadows varied slightly across all the three valleys. The species like *Dactylorhiza* spp. is present in Suru and Wakha-chu while it is absent in Lower Indus valley. *Inula rhizocephala* was restricted to Suru valley only.

***Lower Indus Valley*:** A total of 22 species were recorded from 50 quadrats across two sites. Based on Indicator Species Analysis (ISA), these species were grouped into two main communities (Figure 6.5).

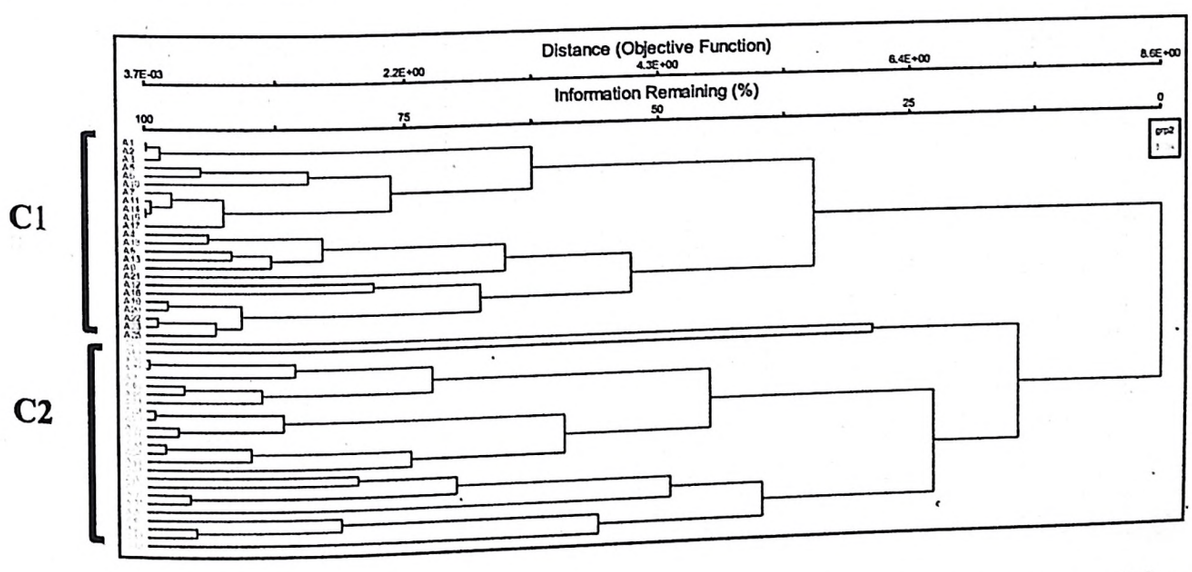


Figure 6.5 Dendrogram classification shows the grouping of two communities in Alpine meadow in Lower Indus valley

Community 1 *Carex* sp-*Potentilla* sp: There were nine species in the group and *Carex* sp have highest observed indicator value (OIV=85.4; P=0.001) followed by *Potentilla* sp (OIV=75.4; P=0.002). The other associated species of this community were *Rhodiola tibetica, Filago* sp, *Gentiana capitata, Leontopodium* sp, *Bistorta* sp etc.

Community 2 *Sibbaldia cuneata-Lagotis kunawurensis*: There were thirteen species in this group and *Sibbaldia cuneata* have highest indicator value (OIV=84; P= 0.001) followed by *Lagotis kunawurensis* (OIV=85.4; P= 0.001). Other important species of the community were *Aconitum rotundifolium, Allium przewalskianum, Aster flaccidus, Cortia depressa* etc.

Wakha-chu valley: In this valley, alpine meadows were grouped into three major communities (Figure 6.6). A total of 31 species were recorded from two sites.

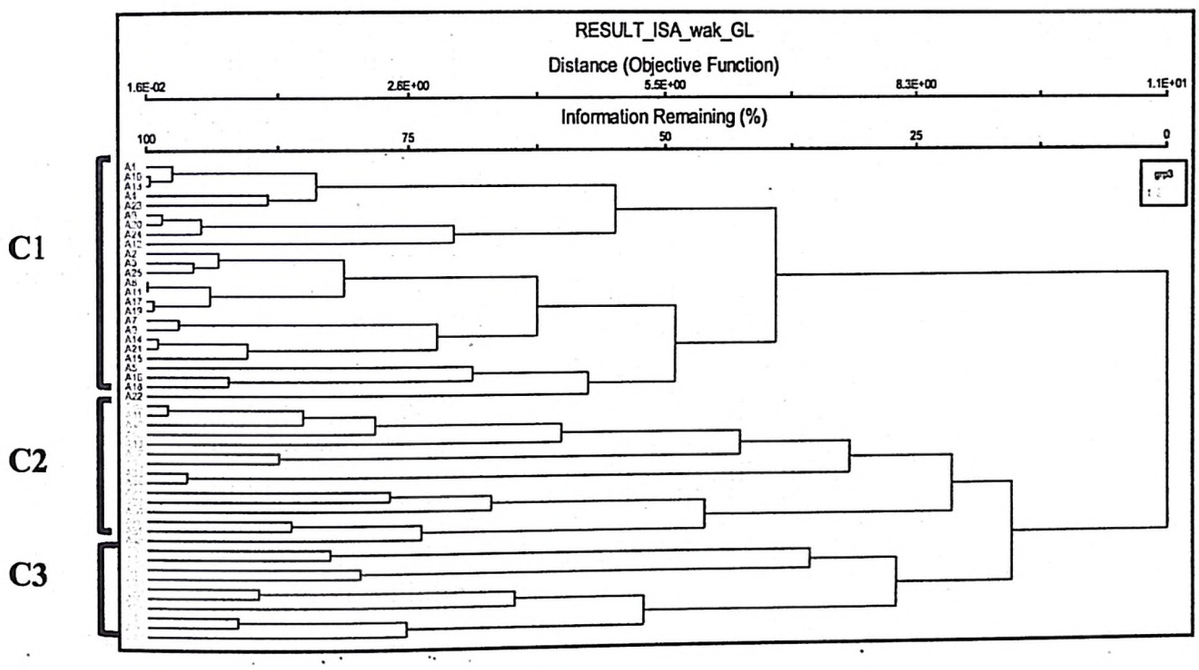


Figure 6.6 Dendrogram classification shows the grouping of three communities in Alpine meadow in Wakha-chu valley

Community 1 *Carex* sp-*Kobresia* sp: There were 12 species in the group with highest OIV of *Carex* sp. (OIV= 84; P=0.001) followed by *Kobresia* sp (OIV=75.1; P=0.001). The other important species of the community are *Leontopodium* sp, *Primula denticulata* and *Rhodiola tibetica.*

Community 2 *Caragana versicolor-Codonopsis ovata*: There were 10 species in the group and OIV of *Caragana versicolor* was highest (OIV=69.5; P=0.004) followed by *Codonopsis clematidea* (OIV=66; P=0.002). The other important species are *Myosotis* sp., *Geranium* sp. and *Corydalis* sp.

Community 3 *Bistorta affinis–Potentilla* sp: This community consist of 9 species and *Bistorta affinis* havehighest indicator value (OIV=67.2; P= 0.001) followed by *Potentilla* sp. (OIV=58.6; P=0.025). The other species were *Dactylorhiza hatagirea, Androsace muscoidea* and *Galium* sp.

***Suru valley*:** In this valley, 57 species were recorded in Alpine meadows across five sites in 125 quadrats and are grouped into three communities (Figure 6.7).

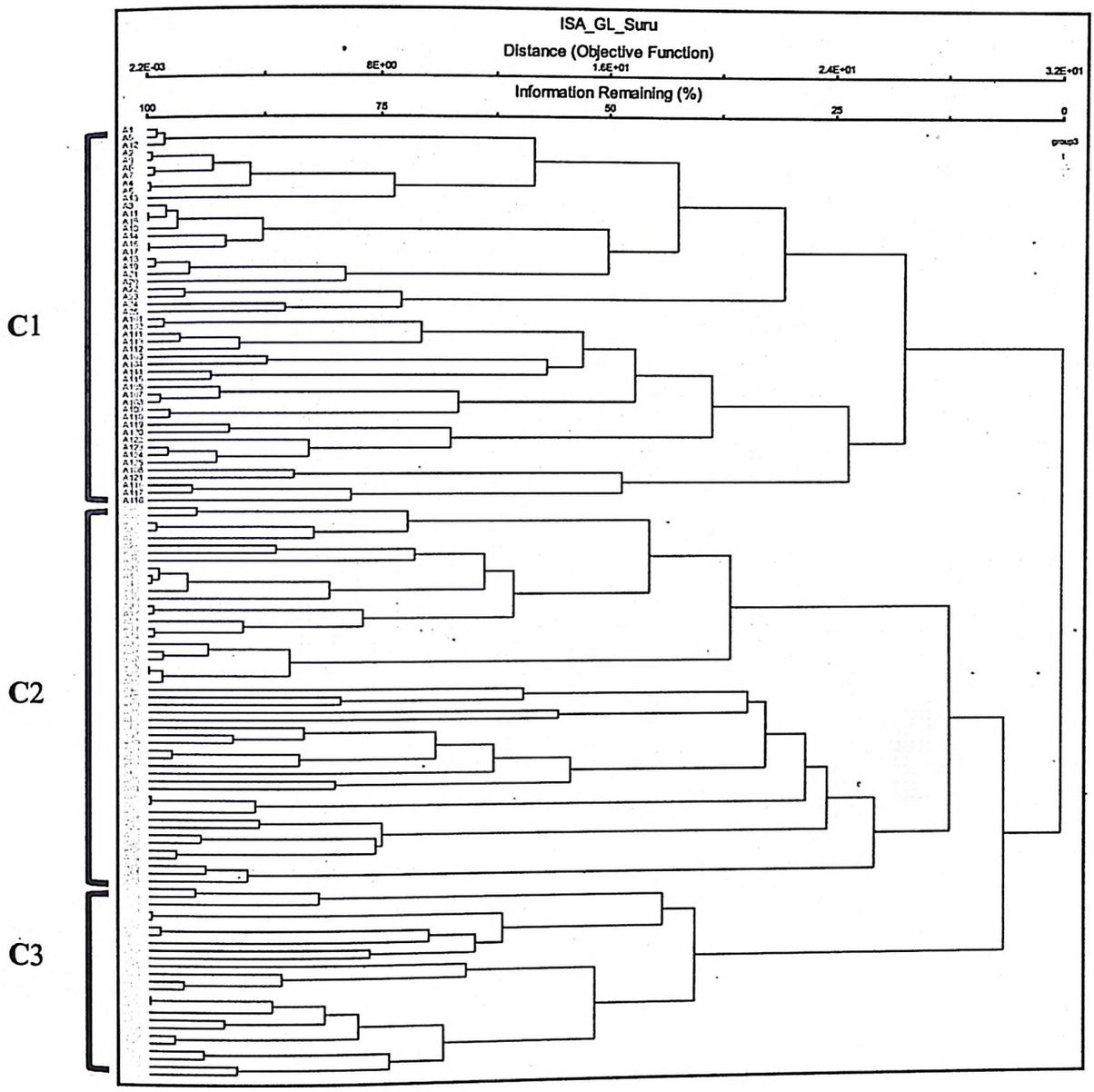


Figure 6.7 Dendrogram classification shows the grouping of three communities in Alpine meadow in Suru valley

Community 1 *Geranium-Myosotis sylvatica*: There were 20 species in the group and OIV of *Geranium* sp was highest (OIV=78: P=0.001) followed by *Myosotis sylvatica* (OIV=72; P=0.001). The other associated species includes *Anemone pulsatilla, Artemisia* sp, and *Papaver nudicaule* etc.

Community 2 *Oxygraphis* sp-*Kobresia pygmaea:* There are 17 species in the community and the species having highest indicator value was *Oxygraphis* sp

(OIV=76; P=0.001) followed by *Kobresia pygmaea* (OIV=69.3; P=0.001). The other species associated are *Veronica biloba, Aconitum rotundifolium, Bistorta affinis, Oxytropis* sp. etc.

Community 3 *Inula rhizocephala-Taraxacum officinale:* The community was represented by 20 species with highest OIV of *Inula rhizocephala* (OIV=60; P=0.001) followed by *Taraxacum officinale* (OIV=48.1; P=0.001). The other associated species were *Mentha longifolia, Swertia petiolata, Thymus linearis, Arenaria griffithii, Potentilla* sp. etc.

Bouldery Slope:

This landform unit is represented by moderate slopes covered with boulders or talus or broken rock at the base of mountain cliffs mainly at altitudes between 4000m-5000m. Vegetation cover was poorly developed and in most plots, it varied from 25% to 40%. The species, which was prominent in all the boulder slopes of the three valleys, were *Saussurea bracteata, Papaver nudicaule, Delphinium brunonianum, Biebersteinia odora* etc. However, some of the species were restricted to certain valleys. Example, *Meconopsis aculeata* was recorded only from Suru valley. *Tulipa stellata* was present in Wakha-chu and Suru while it was absent in Lower Indus valley.

Lower Indus Valley: A total of 62 species were recorded from seven sites within 175 quadrats and ISA resulted in the three major communities (Figure 6.8). The dendrogram classification shows the grouping of three communities in Bouldery slope in Lower Indus valley.

Community 1 *Bistorta affinis-Aconitum rotundifolium*: There are 39 species in this group. *Bistorta affinis* (OIV=60.2; P=0.001) had the highest OIV followed by *Aconitum rotundifolium* (OIV=47.1; P=0.001). The other associated species of the community are *Potentilla argyrophylla, Papaver nudicaule, Aster flaccidus, Codonopsis clematidea* etc.

Community 2 *Elymus* sp-*Corydalis impatiens*: This community consists of 11 species and the highest OIV of *Elymus* sp. was 56.7 (P=0.001) followed by *Corydalis impatiens* (OIV=51.2; P=0.001). The other associated species of the community include *Delphinium brunonianum, Rheum webbianum, Leontopodium* sp. etc.

Community 3 *Carex nivalis-Pseudomertensia moltkioides*: The community consists of 12 species and the highest OIV was calculated for *Carex nivalis* (OIV=34.2; P= 0.001), followed by *Pseudomertensia moltkioides* (OIV=31; P=0.001). The other associated species of the community include *Rhodiola imbricata, Waldheimia stoliczkae, Primula denticulata, Festuca* sp., *Saussurea bracteata, Artemisia* sp. etc.

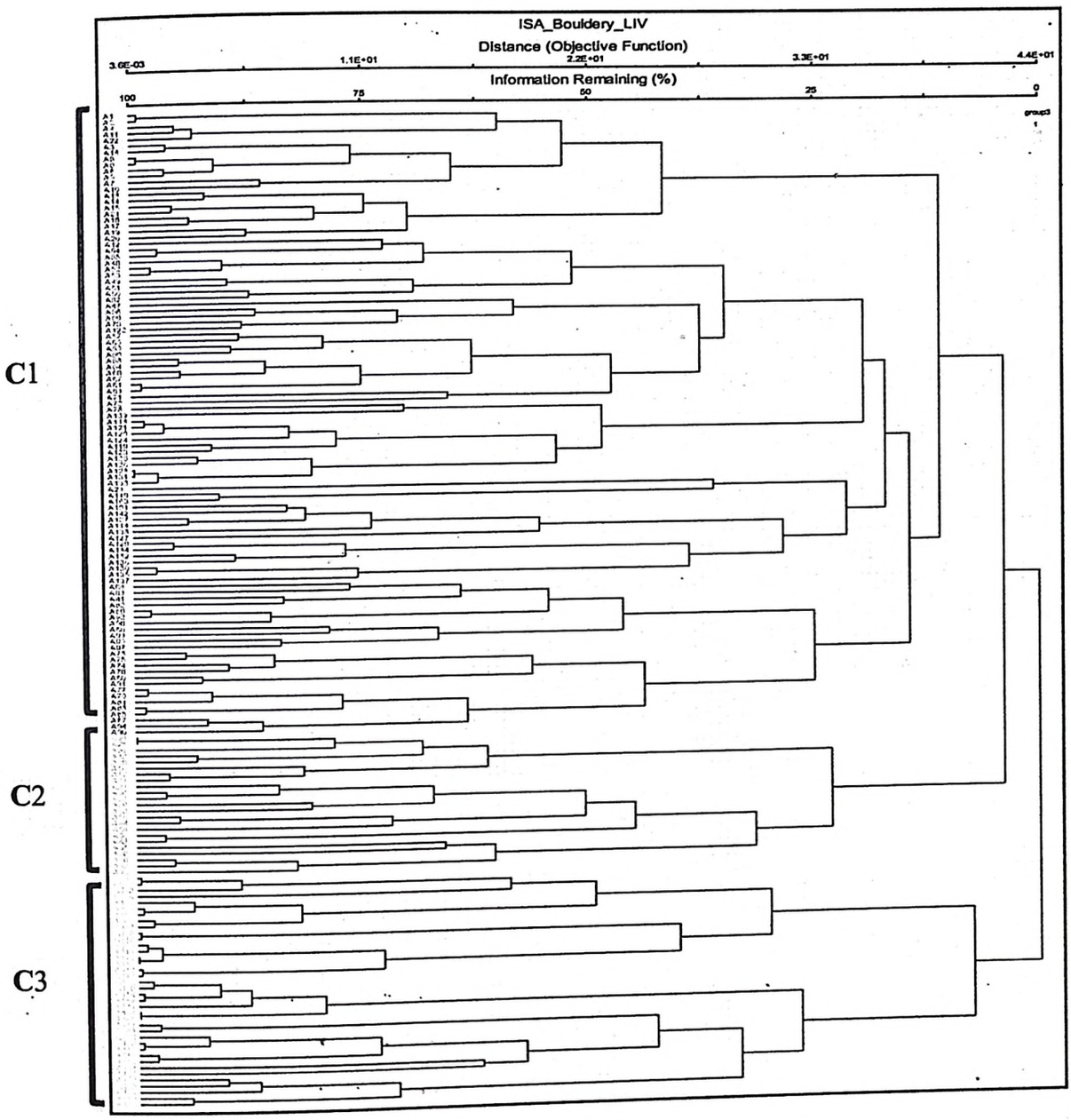


Figure 6.8 Dendrogram classification shows the grouping of three communities in Bouldery slope in Lower Indus valley.

Wakha-chu Valley: A total of 26 species were recorded across 75 quadrats across three sites. They are grouped into three communities Figure 6.9 Dendrogram classification shows the grouping of three communities in Bouldery slope in Wakha-chu valley.

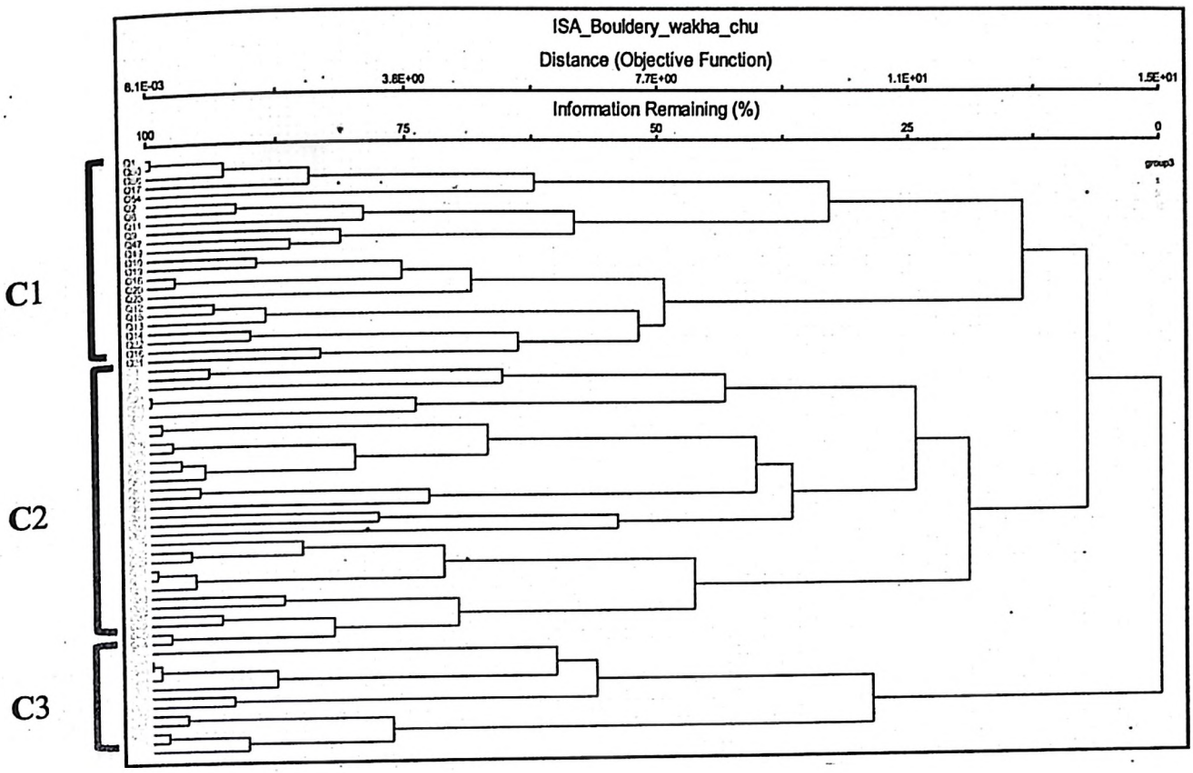


Figure 6.9 Dendrogram classification shows the grouping of three communities in Bouldery slope in Wakha-chu valley

Community 1 *Artemisia* sp.-*Festuca kashmiriana*: There are 3 species and *Artemisia* sp. (OIV=56.1; P=0.001) have highest indicator value followed by *Festuca kashmiriana* (OIV=38.1; P=0.012). The other species includes *Corydalis* sp.

Community 2 *Potentilla argyrophylla-Elymus* sp.: There are 15 species in the community and the highest observed indicator value was calculated for *Potentilla argyrophylla* (OIV=48.8; P=0.001) followed by *Elymus* sp. (OIV=38.7; P=0.003). The other species in this community are *Arenaria griffithii, Saussurea roylei, Anemone rupicola, Chrysanthemum pyrethroides, Rhodiola tibetica* etc.

Community 3 *Primula macrophylla-Delphinium brunonianum*: There are 8 species in the community having highest indicator value of *Corydalis* sp. (OIV=43.5; P=0.001), followed by *Delphinium brunonianum* (OIV=34.9; P= 0.05). The other species includes *Silene moorcroftiana, Primula denticulata, Corydalis* sp. etc.

Suru Valley: A total 46 species were recorded from 125 quadrats from five sites in Bouldery slope and are grouped into four communities (Figure 6.10)

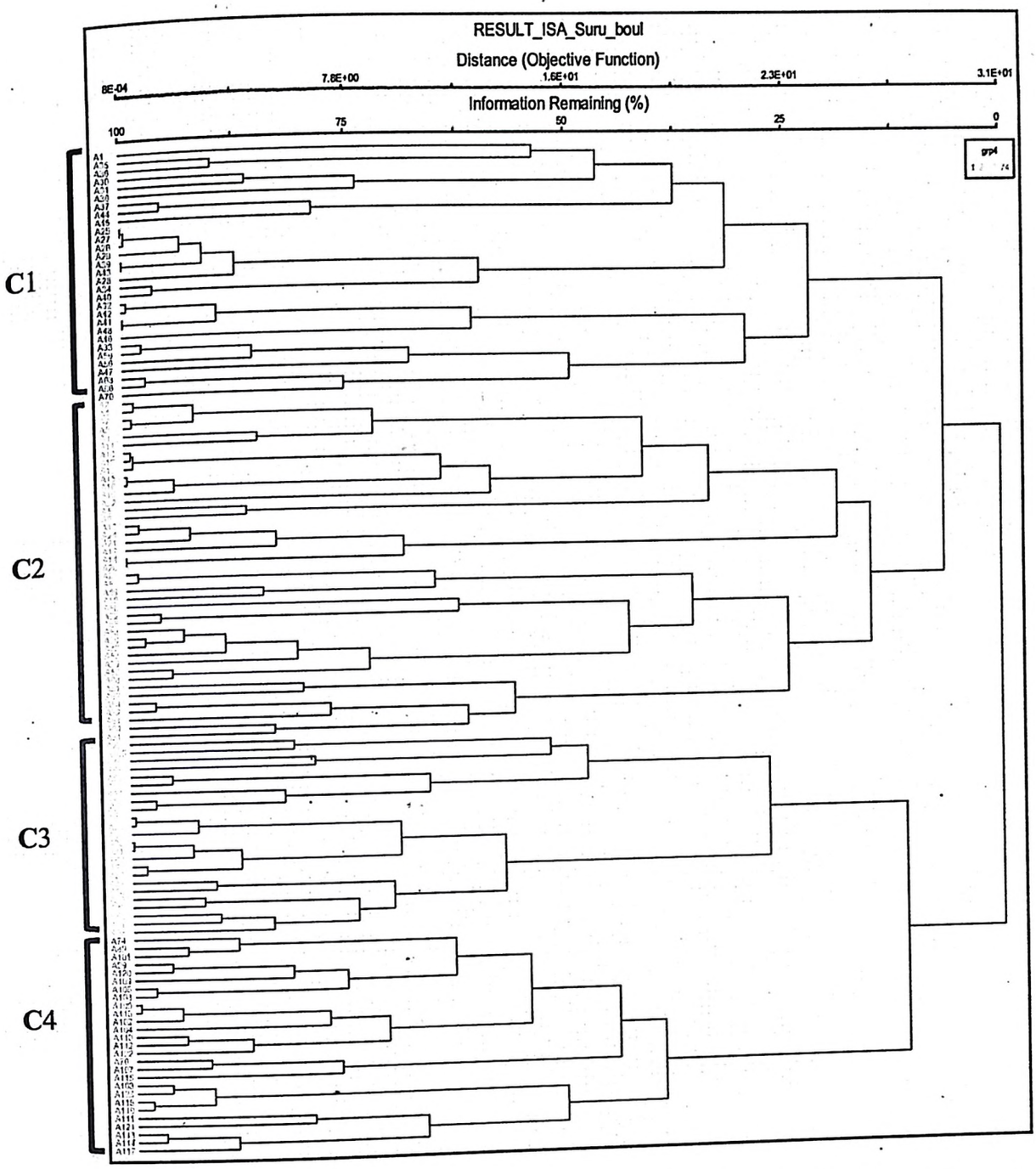


Figure 6.10 Dendrogram shows clustering of similar sites in Bouldery slope in Suru valley

Community 1 *Corydalis* sp-*Meconopsis aculeata*: There are only 13 species in the group. *Corydalis* sp. (OIV=53.3; P=0.001), have highest indicator value followed by *Meconopsis aculeata* (OIV=50; P=0.001). The other species includes *Delphinium brunonianum, Primula macrophylla, Saussurea bracteata* etc

Community 2 *Artemisia* sp-*Nepeta glutinosa*: There are 13 species in the group. *Artemisia* spp. (OIV=50.5; P=0.001), have highest indicator value followed by *Nepeta glutinosa* (OIV=35.7; P=0.001). The other species includes *Rheum webbianum, Rhodiola tibetica, Cicer microphyllum, Silene songarica, Waldheimia stoliczkae* etc.

Community 3 *Rhodiola imbricata-Pedicularis pectinata:* There are 9 species in the group and *Rhodiola imbricata* (OIV=71.7; P=0.001) have highest indicator value followed by *Pedicularis pectinata* (OIV=62.5; P=0.001). The other associated species includes *Tulipa stellata, Lonicera* sp., *Leontopodium* sp., *etc.*

Community 4 *Draba setosa-Pedicularis ophiocephala:* There are 11 species in the group and *Draba setosa* (OIV=63.3; P=0.001) having highest indicator value followed by *Pedicularis ophiocephala* (OIV=58.6; P=0.001). The other associated species includes *Nepeta podostachys, Polygonum paronychioides, Ephedra gerardiana,* etc.

Rock and cliff:

In these habitats due to of selective erosion, the surface of the exposed rock weathers into narrow holes and crannies in which soil gradually accumulates and some species (chasmophytes), starts establishing which may be defined as crevice plants independent of surface soil which grow in layers of debris overlying lips and ledges of rock. Some species growing in this habitat are *Rosa webbiana, Ephedra gerardiana* and *Artemisia* sp. Some species of this habitat includes *Haloxylon thomsoni* and *Capparis spinosa* are restricted to Lower Indus valley.

***Lower Indus Valley*:** A total 150 quadrats were sampled across six sites. A total 33 species were recorded and these species were divided into three communities (Figure 6.11).

Community 1 *Artemisia maritima-Scrophularia desertorum*: There are 8 species in the group. *Artemisia maritima* (OIV=57.3; P=0.001) have highest indicator value followed by *Scrophularia desertorum* (OIV=49.4; P=0.001). The other species in the group includes *Capparis spinosa, Senecio dubitabilis, Hyoscyamus pusillus,* etc.

Community 2 *Lysimachia-Nepeta*: There are 6 species in the community and highest indicator value was recorded for *Lysimachia* sp. (OIV=53.4; P=0.001) followed by *Nepeta* sp. (OIV=35.8; P=0.001). The other species in this group includes *Stachys tibetica, Rosa webbiana, Inula obtusifolia,* etc.

Community 3 *Bergenia stracheyi-Rheum webbianum*: There were 19 species in the group. *Bergenia stracheyi* and *Rheum webbianum* have highest indicator values (OIV=21.3; P=0.002) (OIV=21.1; P=0.001). The other associated species

includes *Ephedra gerardiana, Heracleum pinnatum, Rhamnus prostrata, Lactuca orientalis, Chrysanthemum tibeticum* etc

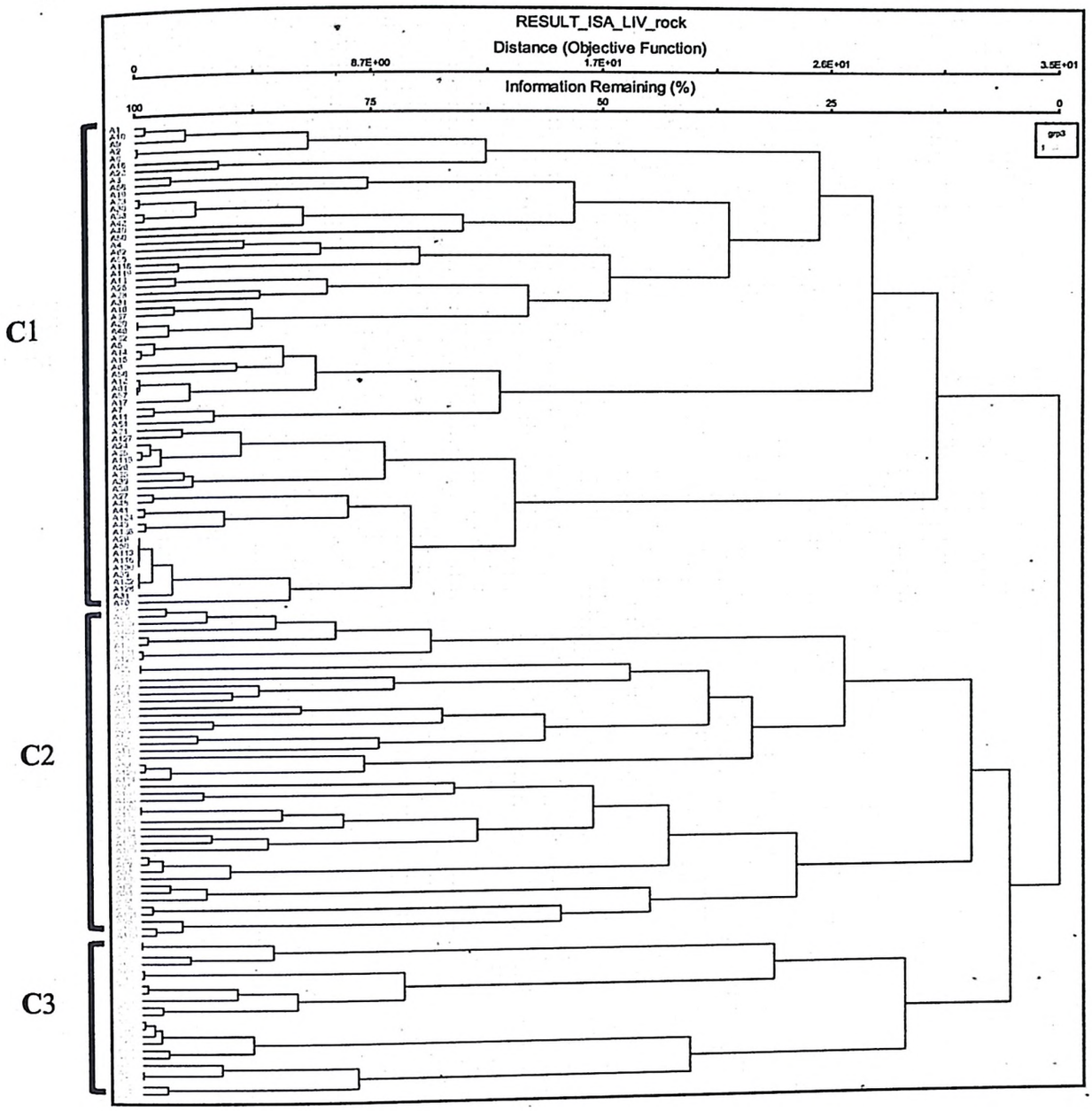


Figure 6.11 Dendrogram classification shows the grouping of three communities in Rock and cliff in Lower Indus valley

Wakha-chu Valley: Two sites were sampled across 50 quadrats. A total 26 species were recorded in the habitat (Figure 6.12). The dendrogram classification shows the grouping of two communities in Rock and cliff in Wakha-chu valley.

Community 1 *Ribes orientale-Juniperus* sp.: There were 11 species in the group. *Ribes orientale* (OIV=87; P=0.001) have highest indicator value followed by *Juniperus* sp. (OIV=65.2; P=0.001). The other associated species includes *Artemisia maritima, Lonicera caerulea, Bergenia stracheyi* etc.

Community 2 *Androsace muscoidea-Ajania tibetica*: There are 15 species in the community. *Androsace muscoidea* (OIV=68; P=0.001) have highest indicator

value followed by and *Ajania tibetica.* (OIV=48; P=0.001). The other associated species includes *Arenaria griffithii, Psychrogeton andryaloides, Ephedra gerardiana* etc.

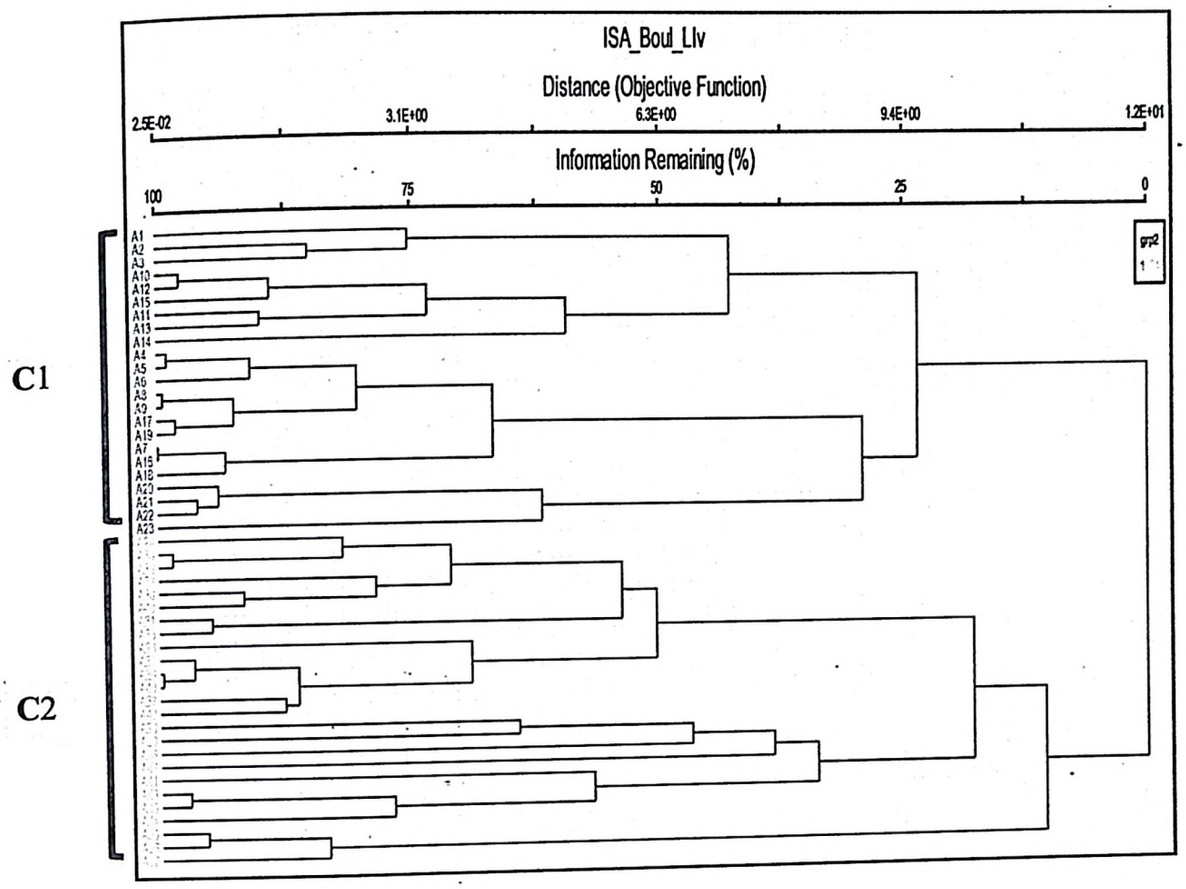


Figure 6.12 Dendrogram classification shows the grouping of two communities in Rock and cliff in Wakha-chu valley

Suru Valley: Six sites sampled across 150 quadrats and total 49 species recorded in the habitat and are grouped into three communities (Figure 6.13) Dendrogram showing clustering of similar sites into three communities in Rock and cliff in Suru valley.

Community 1 *Chrysanthemum tibeticum-Festuca kashmiriana:* There are 17 species in this group. *Chrysanthemum tibeticum* (OIV=39.3; P=0.001) have highest indicator value followed by and *Festuca kashmiriana* (OIV=29.5; P= 0.001). The other associated species includes *Euphorbia tibetica, Acantholimon lycopodioides, Cotoneaster integerrimus* etc.

Community 2 *Elymus* sp-*Pseudomertensia moltkioides*: There are 12 Species in the community. *Elymus* sp. *(*OIV=52.9; P=0.001) having highest indicator value followed by *Pseudomertensia moltkioides* (OIV=27.5.2; P=0.001). The other associated species includes *Dianthus chinensis, Juniperus* sp., *Arnebia euchroma* etc.

Community 3 *Polygonum paronychioides-Tulipa stellata*: There are 20 species in this group. *Polygonum paronychioides* (OIV=52.6; P=0.001) have highest indicator value followed by *Tulipa stellata* (OIV=49.4; P=0.001). The other associated species includes *Lindelofia anchusoides, Ephedra gerardiana, Oxytropis* sp., *Scrophularia decomposita,* etc.

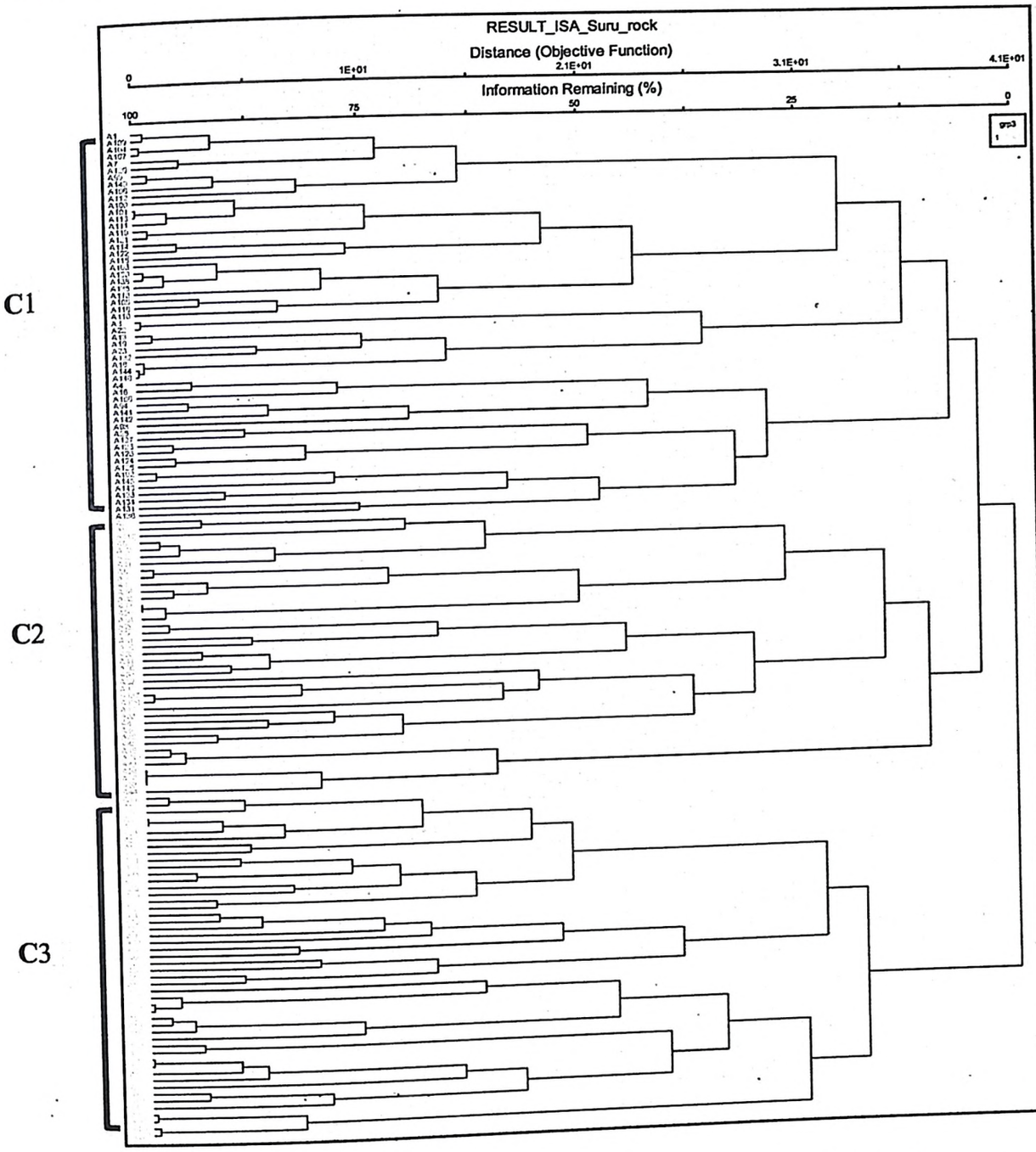


Figure 6.13 Dendrogram classification shows the grouping of three communities in Rock and cliff in Suru valley

Field margin:

The characteristic feature of field vegetation is the dominance of deep-rooted shrubs. The substrate was a mixture of sand and silt with a high proportion of gravel. The nutrient and salinity levels were generally low while water content was moderate to high. The altitudinal distribution varied from 2700 to 3700m

valley bottom in all the valleys. Vegetation cover was high in most plots, usually not exceeding 90% to 100%. The most common species in all three valleys was *Codonopsis clematidea, Aquilegia fragrans, Medicago sativa* etc. The species, which were, only restricted to Suru and Lower Indus valley are *Aconitum violaceum* and *Aconitum heterophyllum, Podophyllum hexandrum, Dactylorhiza hatagirea* and *Orobanche* sp.

Lower Indus valley: Six sites with 150 quadrats were sampled in field margins and total 38 species were recorded. The vegetation in the habitat was group into four major communities (Figure 6.14).

Community 1 *Taraxacum officinale-Plantago tibetica*: There were 13 species in the group and *Taraxacum officinale* (OIV=46.3; P=0.001) having highest indicator value followed by *Plantago tibetica* (OIV= 28.3; P=0.007). The other associated species includes *Physochlaina praealta, Aquilegia fragrans, Codonopsis ovata* etc

Community 2 *Impatiens racemosa-Rumex nepalensis*, There are 8 species in the group and *Impatiens racemosa* (OIV=36: P=0.001) have highest indicator value followed by *Rumex nepalensis* (OIV= 20.7; P=0.001). The other associated species includes *Cheilanthes grisea, Geranium* sp., *Stachys tibetica* etc.

Community 3 *Medicago sativa-Rumex patientia:* There were 6 species in the group and species with highest indicator value was *Medicago sativa* (OIV=42.7: P=0.001), followed by *Rumex patientia* (OIV=12.4: P=0.001). The other associated species includes *Trifolium repens, Iris* sp., *Chenopodium botrys, Hippophae rhamnoides* etc.

Community 4 *Lancea tibetica-Lactuca sativa:* There were 11 species in the group. *Lancea tibetica* (OIV=49.1: P=0.001) have highest indicator value followed by *Lactuca sativa* (OIV=49: P=0.001). The other associated species includes *Cirsium arvense, Mentha longifolia, Ranunculus hirtus, Pedicularis punctata,* etc.

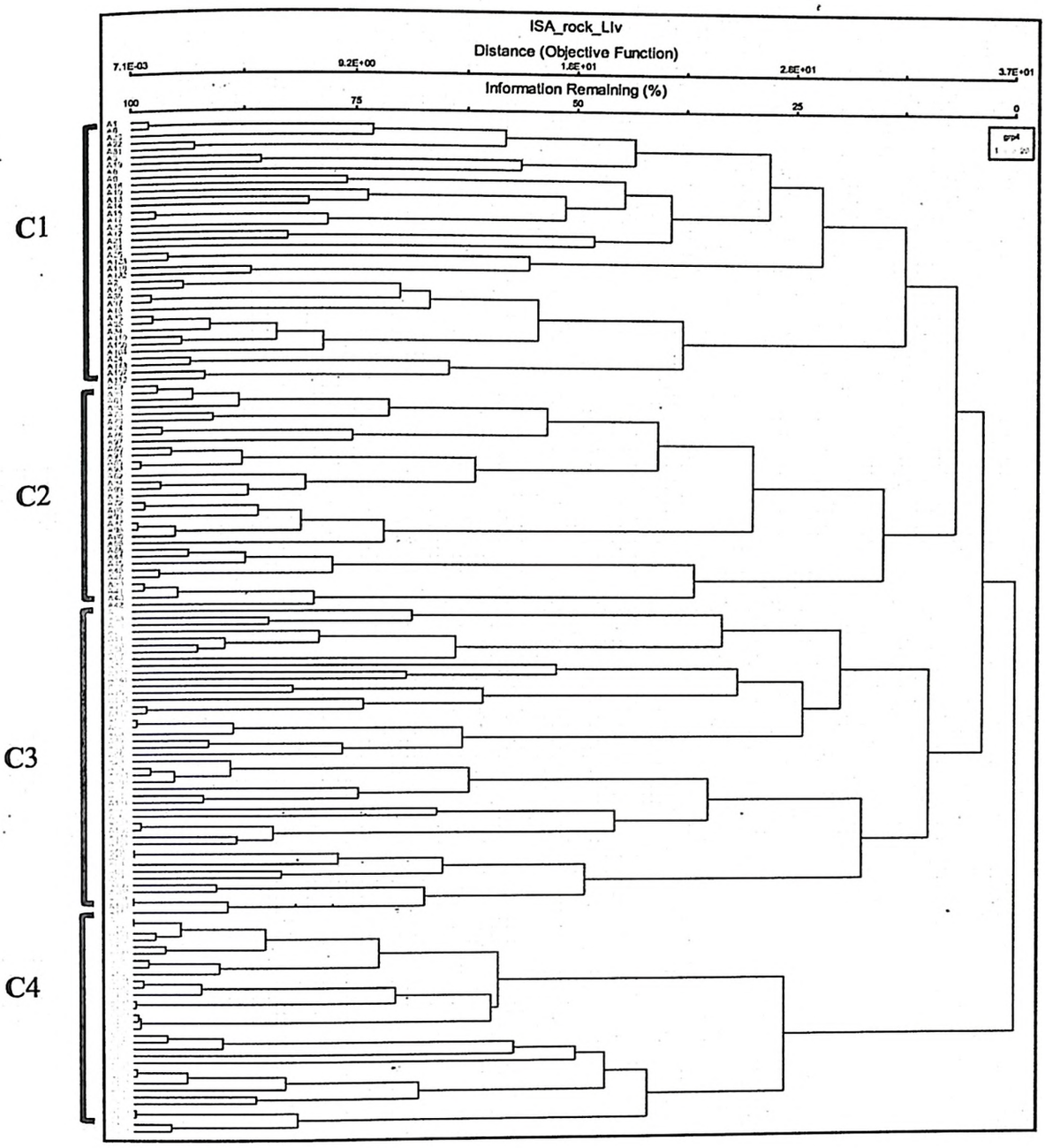


Figure 6.14 Dendrogram classification shows the grouping of four communities in field margins in Lower Indus valley

***Wakha–chu*:** Six sites with 150 quadrats were sampled in the field margins and total 67 species were recorded in the habitat (Figure 6.15). Dendrogram shows grouping of four communities.

Community 1 *Convolvulus arvensis-Rumex nepalensis*: There were 11 species in the group and *Convolvulus arvensis* (OIV=28.4: P=0.001) have highest indicator value followed by *Rumex nepalensis* (OIV=28.2: P=0.001). The other associated species includes *Carum carvi, Cirsium arvense* etc.

Community 2 *Medicago sativa-Pedicularis punctate*: There were 19 species in the community and *Medicago sativa* (OIV=46.2: P=0.001) have highest indicator value followed by *Pedicularis punctata* (OIV=39.1: P=0.001). The other

associated species includes *Mentha longifolia, Lancea tibetica, Heracleum pinnatum* etc.

Community 3 *Seseli mucronatum-Veronica biloba*: There were 18 species in the group and *Seseli mucronatum* (OIV=73.9; P=0.0021) have highest indicator value followed by *Veronica biloba* (OIV=46.2; P=0.001). The other associated species includes *Rumex tibeticus, Oxytropis hypoglottoides, Pedicularis bicornuta, Aconitum violaceum* etc.

Community 4 *Kobresia macrantha-Arenaria griffithii:* There were 19 species in the group and *Kobresia macrantha* (OIV=47.7: P=0.001) have highest indicator value followed by *Arenaria griffithii* (OIV=44.4: P=0.001). The other associated species includes *Dactylorhiza* spp., *Carex* sp., *Leontopodium* sp. etc.

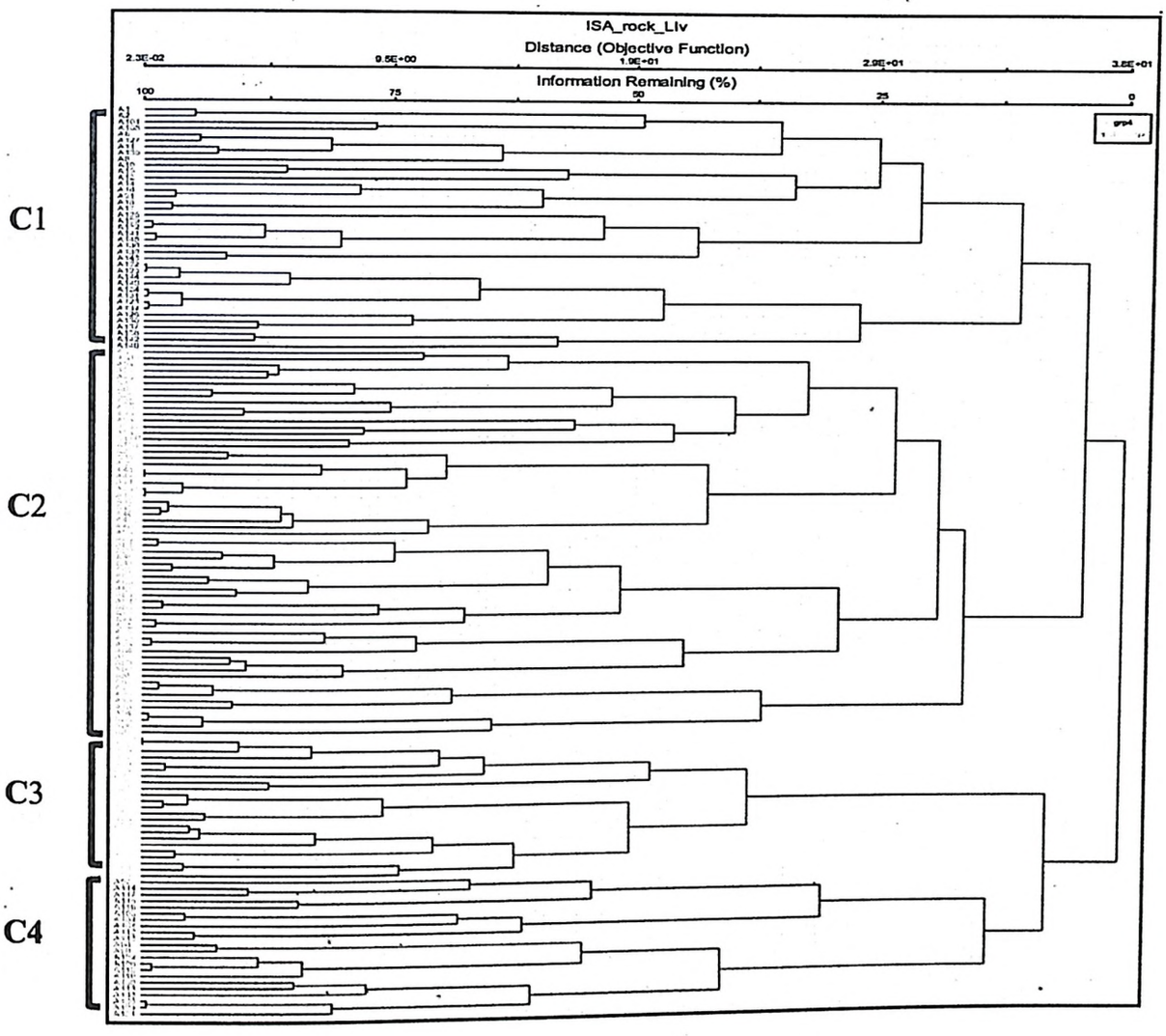


Figure 6.15 Dendrogram classification shows the grouping of four communities in field margins in Wakha-chu valley

Suru Valley: Nine sites with 225 quadrats were sampled across the field margins. A total 60 species were recorded in the habitat and grouping of five communities (Figure 6.16).

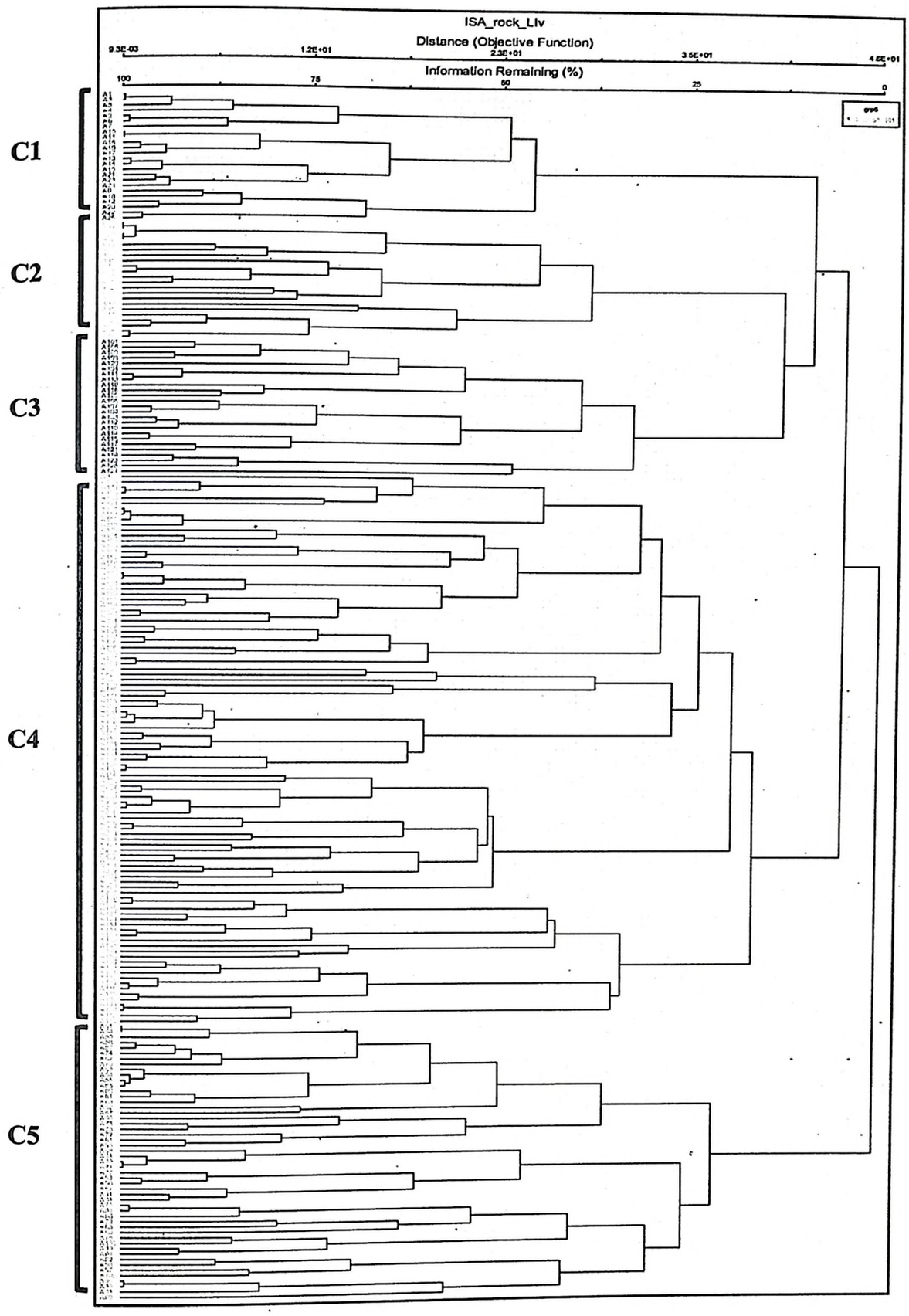


Figure 6.16 Dendrogram classification showing grouping of five communities in Field magins in Suru valley

Community 1 *Galium* sp.-*Festuca* sp*:* There were 11 species in the group and *Galium* sp (OIV=97: P=0.001) have highest indicator value followed by *Festuca* sp. (OIV=72.5: P=0.001). The other associated species includes *Senecio chrysanthemoides, Carum carvi, Lactuca lessertiana, Lotus corniculatus,* etc.

Community 2 *Erigeron multicaulis-Podophyllum hexandrum*: There were 16 species in the community. *Erigeron multicaulis* (OIV=60.2: P=0.001) have highest indicator value followed by *Podophyllum hexandrum* (OIV=54.4: P= 0.001). The other associated species includes are *Oxytropis hypoglottoides, Phragmites australis,* etc.

Community 3 *Poa* sp-*Plantago depressa*: There were 11 species in the group and *Poa* sp (OIV=78.4: P=0.001) have highest indicator value, followed by *Plantago depressa* (OIV=72.7: P=0.001). The other associated species includes are *Aconitum violaceum, Delphinium cashmerianum,* etc.

Community 4 *Medicago sativa-Taraxacum officinale:* There were 11 species species in the group and *Medicago sativa* (OIV=65.7: P=0.001*)* have highest indicator value followed by *Taraxacum officinale* (OIV=50.3: P=0.001). The other associated species includes *Euphrasia himalayica, Pedicularis punctata, Dactylorhiza hatagirea,* etc.

Community 5 *Pedicularis bicornuta-Carex* sp: There were 11 species species in the group and *Pedicularis bicornuta* (OIV=74.9: P=0.001) have highest indicator value followed by *Carex* sp. (OIV=60.2: P=0.001). The other associated species includes *Bistorta affinis, Veronica biloba, Swertia petiolata, Gentiana tubiflora* etc.

Moraine:

Landforms associated with these areas are consisted of weathered rocks with a high proportion of stones bigger than >20 cm in diameter. Soil moisture was moderate to high, particularly in deeper horizons. Vegetation cover was poorly developed and in most plots varied from 25 % to 30 %.

Lower Indus valley: A total of 50 quadrats were sampled across two sites and 20 species were recorded from the habitat. Figure 6.17 showing grouping of two communities in Moraine landform unit.

Community 1 *Juniperus* sp.-*Rosa webbiana*: There are 11 species in the group and *Juniperus* sp. (OIV=60.7.9: P=0.001) and *Rosa webbiana* (OIV=60.7.9: P=0.001) have highest indicator value followed by *Ribes orientale* (OIV=43.5: P=0.001). The other associated species includes are *Anaphalis* sp., *Acantholimon lycopodioides, Rhodiola imbricata,* etc.

Community 2 *Cicer microphyllum-Festuca* sp.: There were 9 species in the community. *Cicer microphyllum* (OIV=43.4: P=0.014) have highest indicator value followed by *Festuca* sp. (OIV=39.9: P=0.02). The other associated species includes are *Aconogonum tortuosum, Elymus* sp., *Rhodiola tibetica, Thalictrum minus* etc.

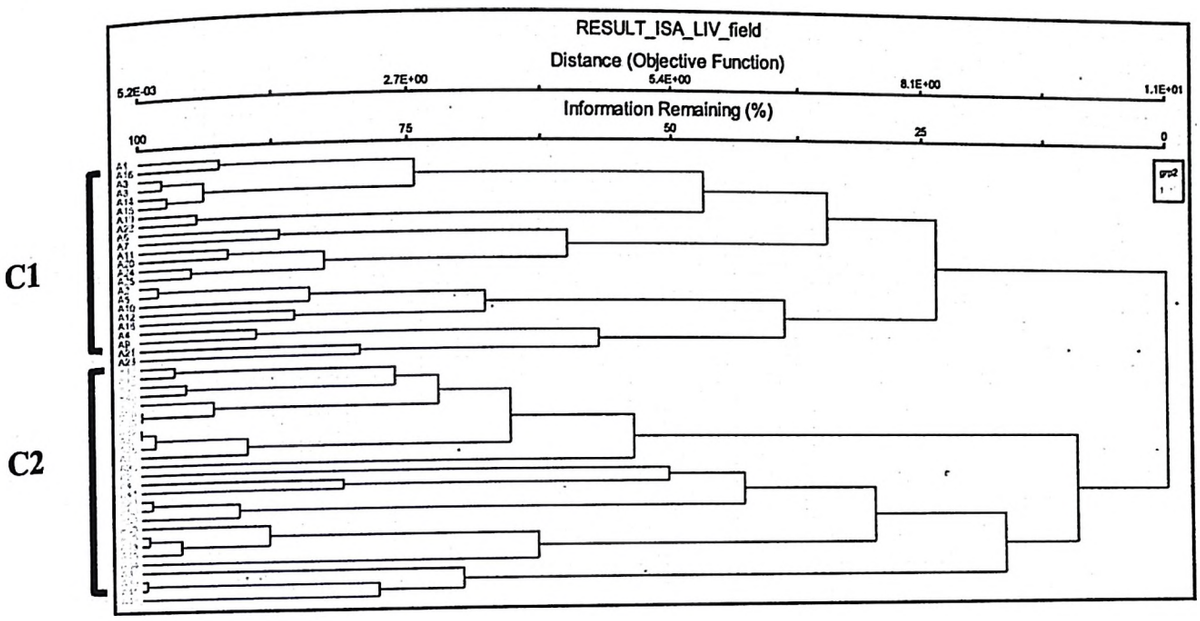


Figure 6.17 Dendrogram classification shows the grouping of two communities in Moraine in Lower Indus valley

Wakha–chu: In Wakha–chu, valley 125 quadrats across five sites were sampled and 44 species were recorded in the habitat. Figure 6.18 shows the grouping of three communities in Moraine in Wakha-chu valley.

Community 1 *Acantholimon sp.-Lycopodioides-Scutellaria heydei*: There were 7 species in the community. *Acantholimon lycopodioides* have highest indicator value (OIV=73.9: P=0.001) followed by *Scutellaria heydei* (OIV=65.2: P=0.001). The other associated species includes *Polygonum paronychioides, Silene moorcroftiana, Aconogonum tortuosum* etc.

Community 2 *Draba setosa-Carex nivalis*: There are 13 species in the community and *Draba setosa* (OIV=48.1: P=0.001) have highest indicator value followed by *Carex nivalis* (OIV=48: P=0.001). The other associated species includes *Waldheimia glabra, Allium prezewalskianum, Artemisia salsoloides, Corydalis* sp. etc.

Community 3 *Lagotis kunawurensis-Potentilla argyrophylla:* There were 24 species in this community. *Lagotis kunawurensis* (OIV=64.6: P=0.001) have highest indicator value followed by *Potentilla argyrophylla* (OIV=60.6: P=0.001).

The other associated species includes *Cremanthodium arnicoides, Aconitum rotundifolium, Swertia petiolata, Rhodiola heterodonta Anemone pulsatilla* etc.

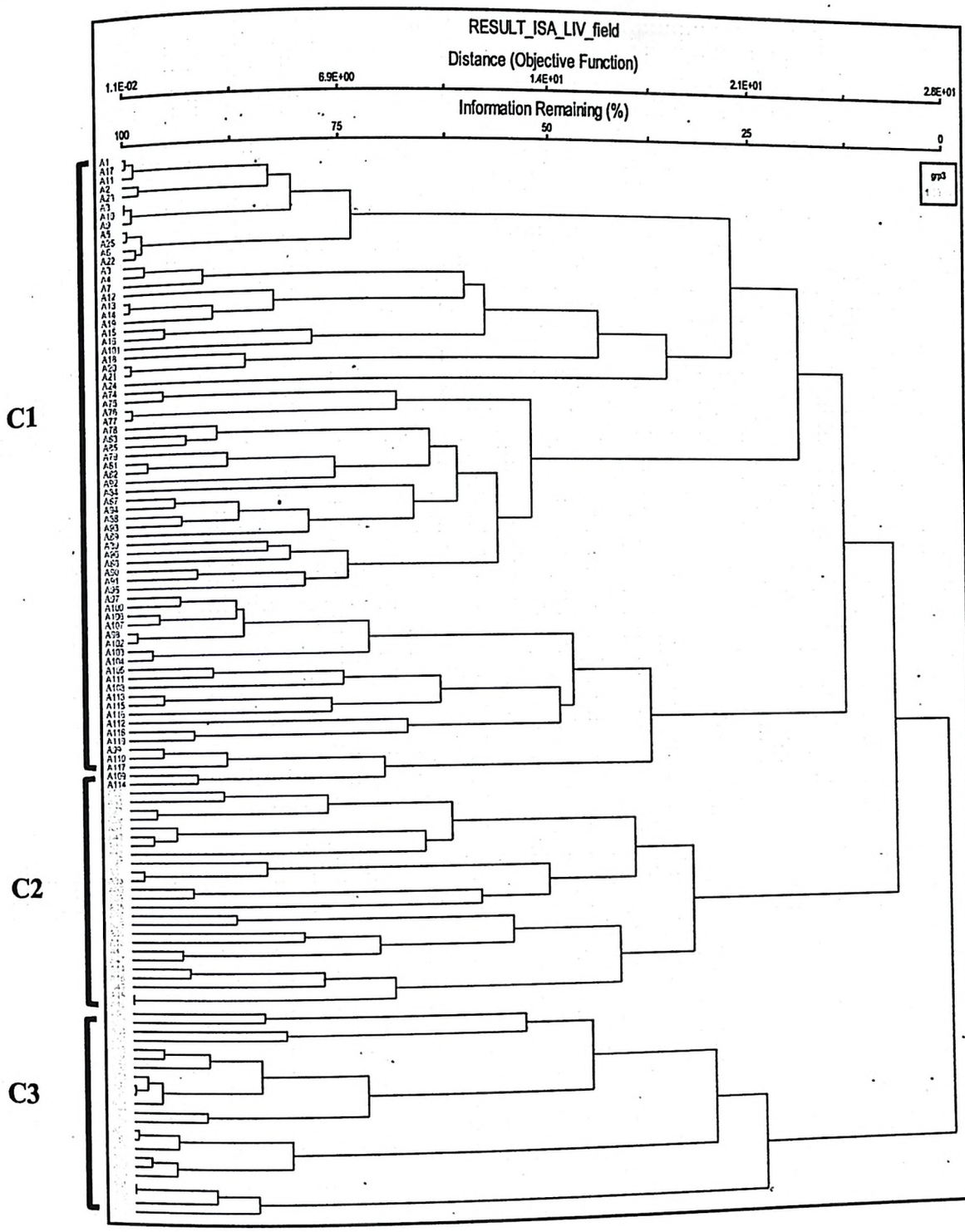


Figure 6.18 Dendrogram classification shows the grouping of three communities in Moraine in Wakha-chu valley

Suru valley: In Suru valley five sites with 124 quadrats were sampled and total 47 species were recorded in this habitat. Figure 6.19 shows the grouping of five communities in Moraine in Suru valley.

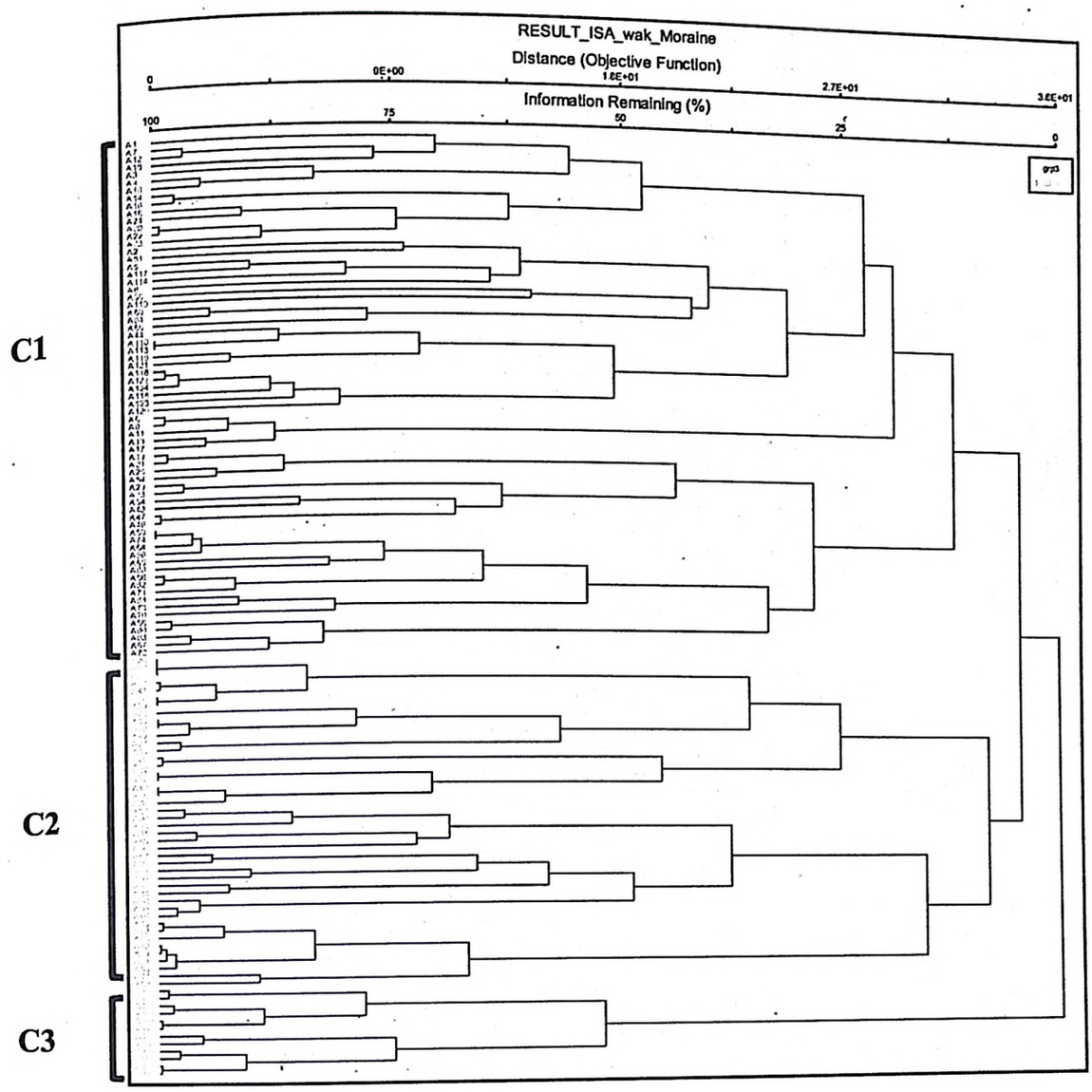


Figure 6.19 Dendrogram classification shows the grouping of five communities in Moraine in Suru valley.

Community 1 *Geranium* sp.-*Bistorta affinis*: There were 30 species in the group and *Geranium* sp. (OIV=34.3: P=0.021) is have highest indicator value followed by *Bistorta affinis* (OIV=64.5: P=0.04). The other associated species includes *Epilobium angustifolium, Lonicera hispida, Pedicularis ophiocephala, Thalictrum rutifolium* etc.

Community 2 *Festuca* sp-*Arnebia euchroma*: There were 11 species in the group and *Festuca* sp (OIV=28.3: P=0.002) have the highest indicator value followed by *Arnebia euchroma* (OIV=27.3: P=0.04). The other associated species includes *Sedum ewersii, Cicer microphyllum, Ephedra gerardiana* etc.

Community 3 *Allium carolinianum-Aquilegia fragrans*: There were 6 species in the group and *Allium carolinianum* (OIV=85.3: P=0.001) has highest indicator value followed by *Aquilegia fragrans* (OIV=66.7: P=0.001). The other associated species includes *Pleurospermum* sp., *Nepeta podostachys, Rhodiola tibetica* etc.

Plateau:

The landform associated with these areas are consisted of extensive area of flat upland usually bounded by an escarpment on all sides but sometimes enclosed by mountains. Soil moisture is low to deficit, due to sheet erosion. The elevation varies between 3500-4500m. The vegetation cover varies from 15% to 55%.

Lower Indus valley: In Lower Indus Valley, 50 quadrats across two sites was sampled in plateau and 17 species were recorded. Figure 6.20 the dendrogram classification shows the grouping of two communities in Plateau in Lower Indus valley.

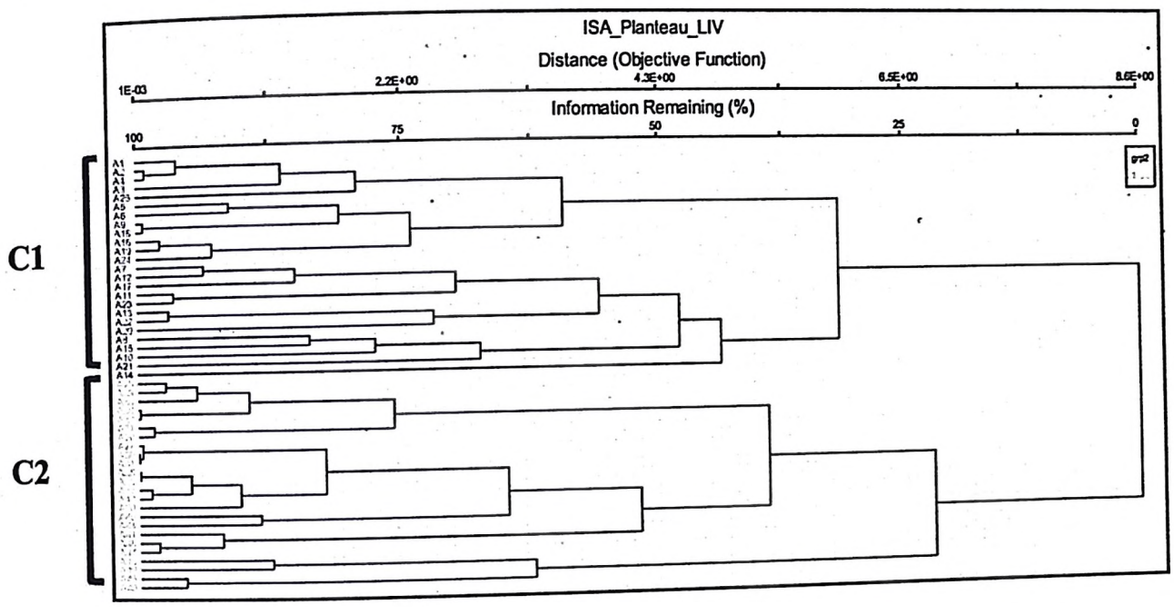


Figure 6.20 Dendrogram classification shows the grouping of two communities in Plateau in Lower Indus valley

Community 1 *Bistorta affinis-Potentilla* sp.: There were 11 species in this group. *Bistorta affinis* (OIV=96: P=0.001) was recorded as the highest indicator value followed by *Potentilla* sp. (OIV=80.8: P=0.001). The other associated species includes *Allium prezewalskianum, Anemone rupicola, Nepeta podostachys, Rosularia alpestris* etc.

Community 2 *Acantholimon lycopodioides-Polygonum paronychioides*: There are 6 species in the community and *Acantholimon lycopodioides* (OIV=83.3: P=0.001) is calculated as the highest indicator value followed and *Polygonum paronychioides* (OIV=79.2: P=0.001). The other associated species includes *Veronica biloba, Carex* sp. etc

Wakha–chu: In Wakha-chu, valley 50 quadrats across two sites were sampled in plateau and 18 species were recorded. Figure 6.21 shows the grouping of two communities in Plateau in Wakha-chu valley.

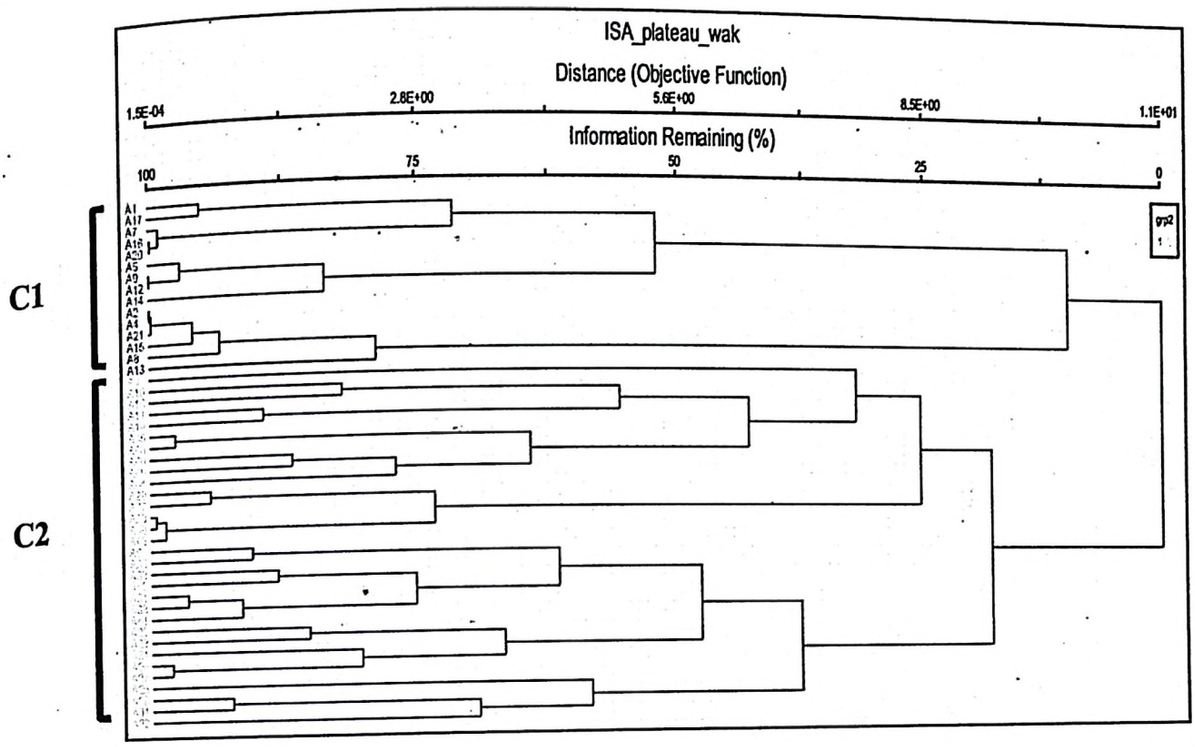


Figure 6.21 Dendrogram classification shows the grouping of two communities in Plateau in Wakha-chu valley

Community 1 *Ajania tibetica-Carex* sp.: There are 5 species in the group and *Ajania tibetica* (OIV=55.9: P=0.001) was recorded as the highest indicator value species followed *Carex* sp (OIV=51: P=0.002). The other associated species includes *Corydalis* sp., *Cousinia thomsonii, Salsola kali* etc.

Community 2: *Artemisia maritima-Allium przewalskianum*: There are 13 species in the group and *Artemisia maritima* (OIV=56.1: P=0.002) is recorded as the highest indicator value species followed *Allium przewalskianum* (OIV=50.2: P=0.01). The other associated species includes *Euphorbia tibetica, Nepeta podostachys, Oxytropis tatarica* etc.

Suru valley: In Suru valley 75 quadrats across three sites were sampled in plateau habitat, 41 species were recorded. Figure 6.22 shows the grouping of three communities in Plateau in Suru valley.

Community 1 *Filago* sp-*Leontopodium* sp: There were 16 species in the group and *Filago* sp. (OIV=71.5: P=0.001) was recorded as the highest indicator value species followed *Leontopodium* sp. (OIV=69.3: P=0.001).The other associated

species in plateau includes *Dianthus harrissii, Rosularia alpestris; Nepeta podostachys, Rheum webbianum, Cousinia thomsonii Bistorta affinis* etc.

Community 2 *Kobresia pygmaea -Saussurea atkinsonii:* There were 12 species in the group and *Kobresia pygmaea* (OIV=87.5: P=0.001) was calculated as the highest indicator value species followed *Saussurea atkinsonii* (OIV=83.3: P=0.001). The other associated species in plateau includes *Allium prezewalskianum, Sibbaldia* sp., *Rhodiola tibetica* etc.

Community 3: *Androsace* sp.-*Polygonum paronychioides:* There were13 species in this group and *Androsace* sp. (OIV=69.2: P=0.001) is calculated as the highest indicator value species followed *Polygonum paronychioides* (OIV=62.3: P=0.001). The other associated species in plateau includes *Draba setosa, Oxytropis tatarica, Papaver nudicaule* etc.

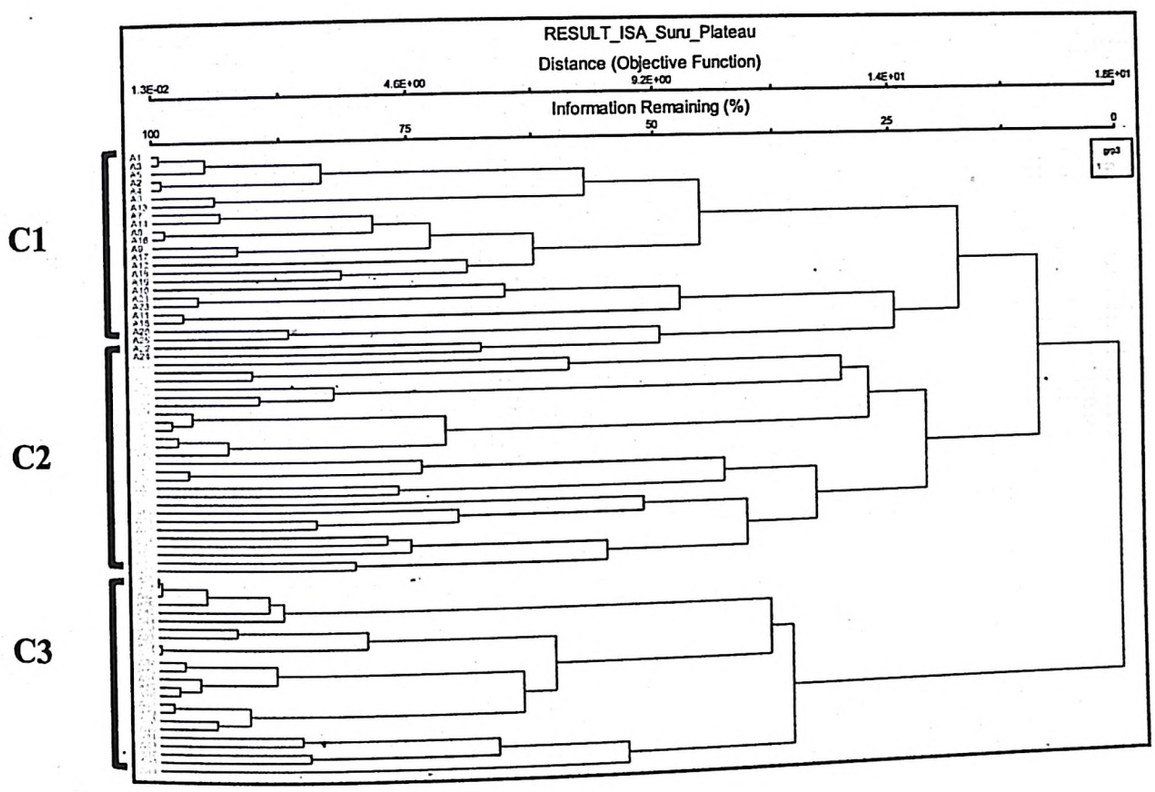


Figure 6.22 Dendrogram classification shows the grouping of three communities in Plateau in Suru valley

Marsh meadows:

Marsh meadows in western Ladakh occurred mainly along streams with permanent fresh-water bodies or places with excessive water supply during most of the year. The substrate consisted of sandy silt and clay, nutrient and salinity levels were moderate to low. The altitudinal optimum was between 2900m and 4000 m. The vegetation cover was very high. Sturdy *Carex* sp. mats represented large proportion of alpine meadows.

Lower Indus valley: Sampling was carried out in five sites in moist meadows, consisting of 125 quadrats. A total 54 species were recorded from these sites. Figure 6.23 shows the grouping of three communities in Marsh meadows in Lower Indus valley.

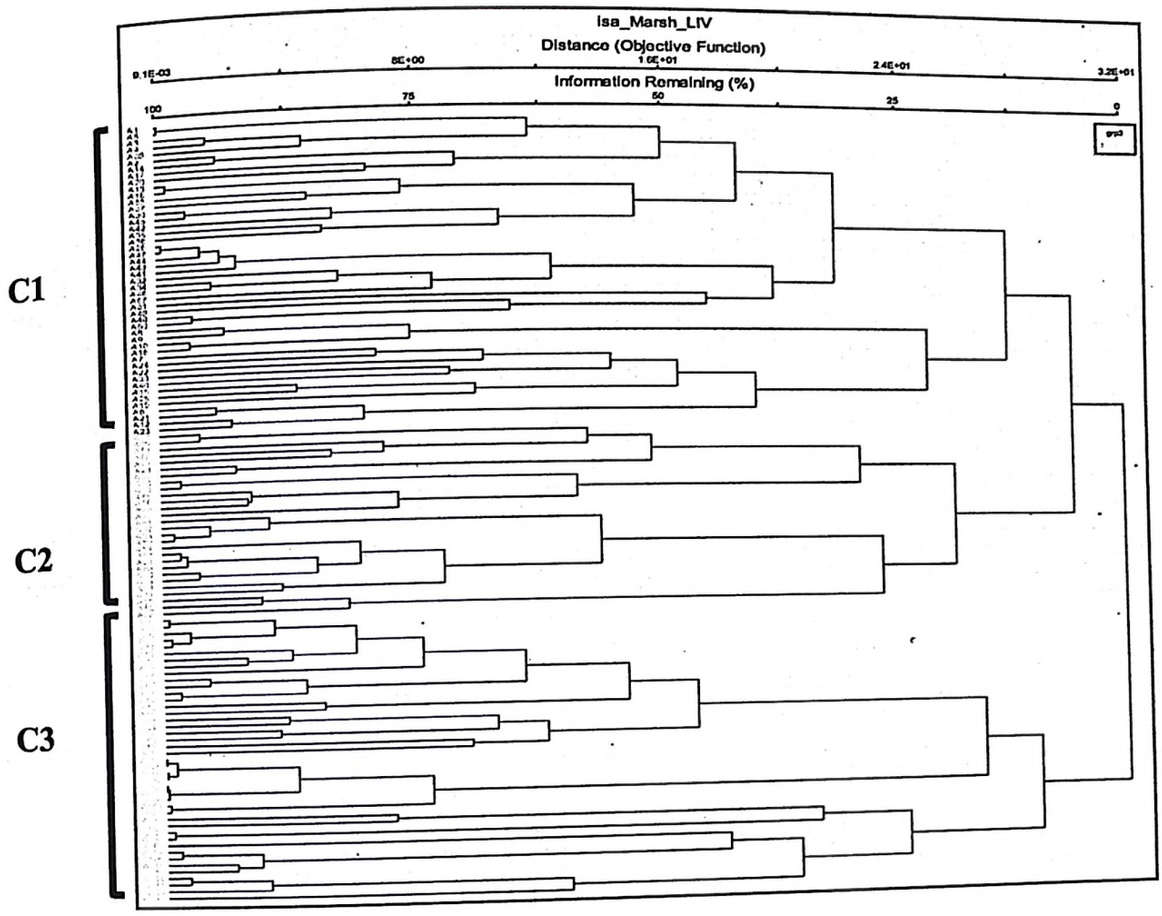


Figure 6.23 Dendrogram classification shows the grouping of three communities in Marsh meadows in Lower Indus valley

Community 1 *Impatiens racemosa-Trifolium repens*: There were 20 species in the group and *Impatiens racemosa* (OIV=59: P=0.001) recorded as the highest indicator value species followed by *Trifolium repens* (OIV=52.6: P=0.001). The other associated species are *Aquilegia fragrans, Equisetum arvense, Medicago sativa, Cheilanthes grisea* etc.

Community 2 *Heracleum pinnatum-Lancea tibetica*: There are 16 species in the group. *Heracleum pinnatum* (OIV=60.7: P=0.001) was recorded as the highest indicator value species followed *Lancea tibetica.* (OIV=57.1: P=0.001). The other associated species are *Gentiana tubiflora, Geranium* sp., *Oxyria digyna* etc.

Community 3 *Leontopodium* spp. *Carex* sp: There were 18 species in the group and *Leontopodium* spp. (OIV=79.1: P=0.001) was recorded as the highest indicator value species followed by *Carex* sp. (OIV=78.4: P=0.001). The other

associated species are *Pedicularis longiflora, Ranunculus* sp., *Bistorta affinis, Euphrasia himalayica* etc.

Wakha–chu: In Wakha-chu, valley two sites with 50 quadrats were sampled in moist meadow habitat and total 29 species were recorded. Figure 6.24 shows the grouping of two communities in Marsh meadows in Wakha-chu valley.

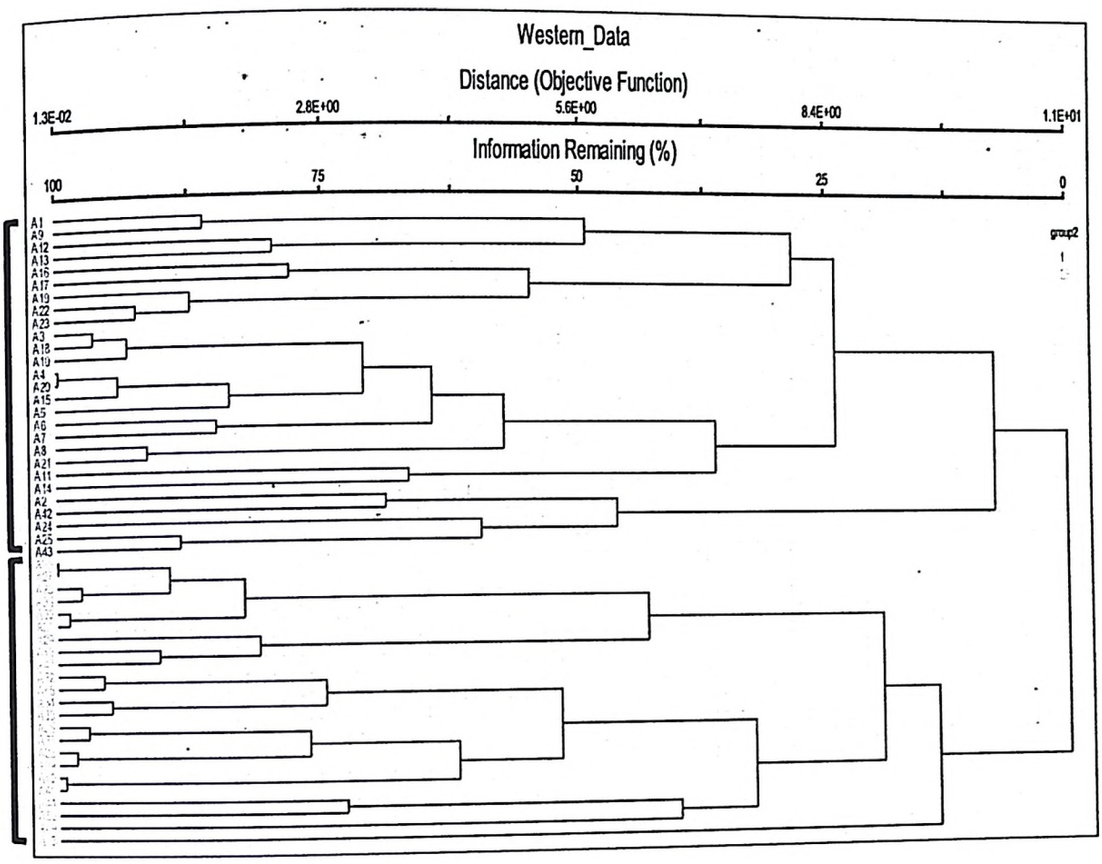


Figure 6.24 Dendrogram classification shows the grouping of two communities in Marsh meadows in Wakha-chu valley

Community 1 *Euphrasia himalayica-Trifolium repens:* There were18 species in the group and *Euphrasia himalayica* (OIV=58.4: P=0.06*)* was recorded as the highest indicator value species followed by *Trifolium repens* (OIV=51: P=0.22). The other associated species are *Equisetum arvense, Dactylorhiza hatagirea , Lactuca sativa, Hippophae rhamnoides, Heracleum pinnatum* etc

Community 2: *Parnassia palustris-Bistorta affinis:* There are 11 species in the group and *Parnassia palustris* (OIV=69.6: P=0.001) is recorded as the highest indicator value species followed by *Bistorta affinis* (OIV=58.9: P=0.001). The other associated species are *Gentianella moorcroftiana, Senecio chrysanthemoides, Silene vulgaris, Taraxacum officinale* etc.

Suru valley: In Suru, 225 quadrats across nine sites were sampled and total 74 species were recorded and grouped into three major communities. Figure 6.25 shows the grouping of three communities in Marsh meadows in Suru valley.

Community 1 *Kobresia pygmaea-Gentianella moorcroftiana*: There were 18 species in the group and *Kobresia pygmaea* (OIV=79.7: P=0.001) was recorded as the highest indicator value species followed by *Gentianella moorcroftiana* (OIV=31.2: P=0.001). The other associated species are *Allium* sp., *Aster flaccidus, Bupleurum longicaule, Dactylorhiza* sp. etc.

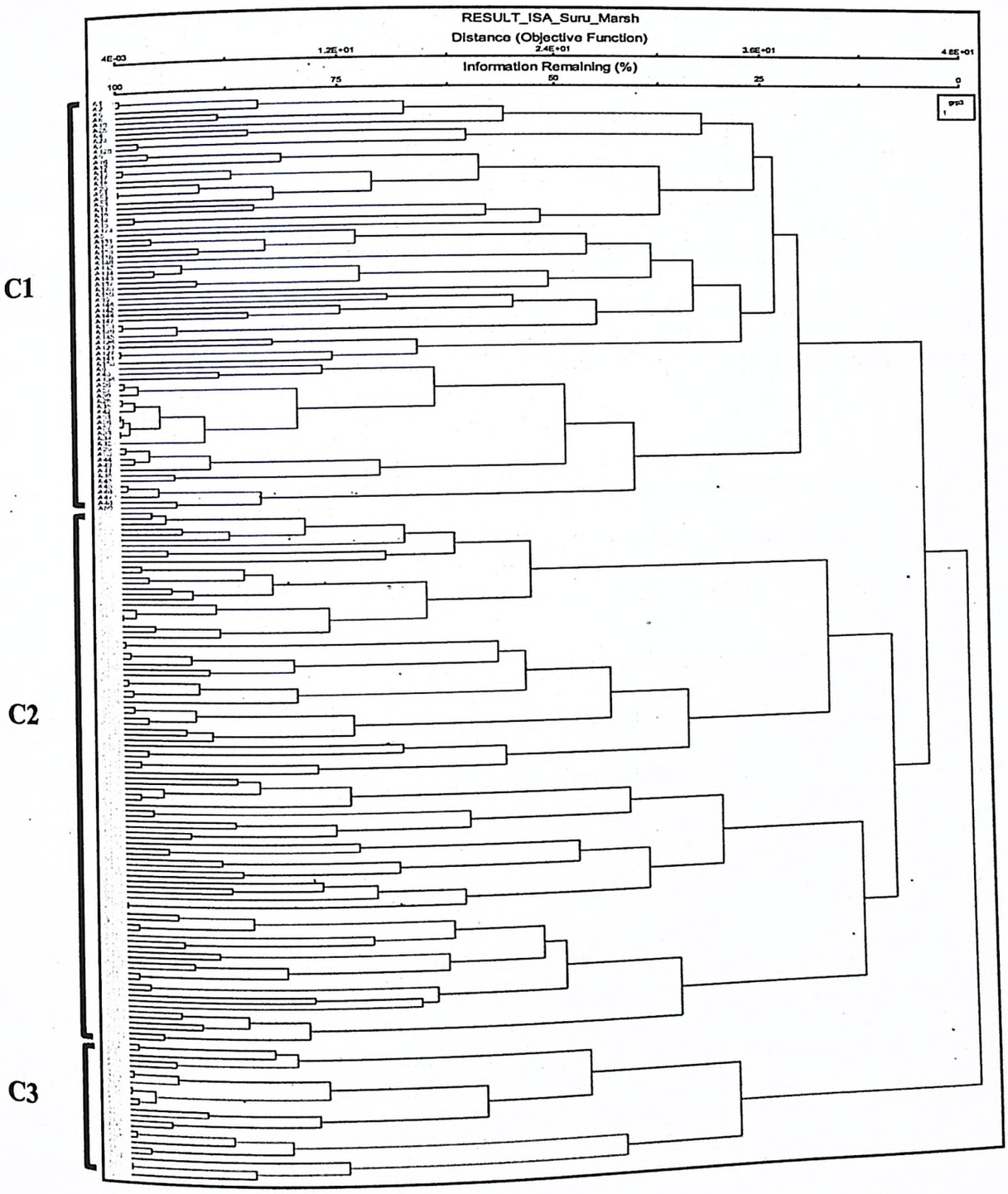


Figure 6.25 Dendrogram classification shows the grouping of three communities in Marsh meadows in Suru valley.

Community 2 *Crepis* sp.-*Oxytropis tatarica*: There are 8 Species in the community. *Crepis* sp. (OIV=92: P=0.001) was calculated as the highest indicator value species followed by *Oxytropis tatarica.* (OIV=80: P=0.001). The other associated species are *Heracleum pinnatum, Arnebia euchroma, Polygonum cognatum* etc.

Community 3 *Taraxacum officinale-Euphrasia himalayica:* There were 45 species in this group. *Taraxacum officinale* (OIV=74.5: P=0.001) is calculated as the highest indicator value species followed by *Euphrasia himalayica* (OIV=32.6: P=0.01). The other associated species are *Chaerophyllum villosum, Pedicularis punctata, Plantago tibetica, Gentiana capitata, Oxytropis hypoglottoides, Trifolium repens, Pedicularis bicornuta* etc.

Scree

The landform unit covered steep slopes with unstable substrate accumulation of broken rock fragments at the base of crags, mountain cliffs mainly at altitudes (2800-4600m). The soil moisture was low and vegetation cover was poorly developed and in most plots varied from 25% to 30%.

Lower Indus valley: A total of 125 quadrats were sampled across six sites and 35 species were recorded. Figure 6.26 the dendrogram classification shows the grouping of three communities in Scree in Lower Indus valley.

Community 1 *Scrophularia desertorum-Artemisia maritima*: There are 15 species in the community spread across the 47 quadrats. *Scrophularia desertorum* (OIV=21.3: P=0.003) was calculated as the highest indicator value species followed by *Artemisia maritima* (OIV=16.4: P=0.001). The other associated species are *Ajania tibetica, Capparis spinosa, Inula obtusifolia* etc.

Community 2 *Nepeta floccosa-Silene moorcroftiana:* There were 9 species in the group and *Nepeta floccosa* (OIV=35.2: P=0.001) was calculated as the highest indicator value species followed by *Silene moorcroftiana.* (OIV=43.1: P=0.001). The other associated species are *Hyoscyamus pusillus, Psychrogeton andryaloides, Eritrichium canum* etc.

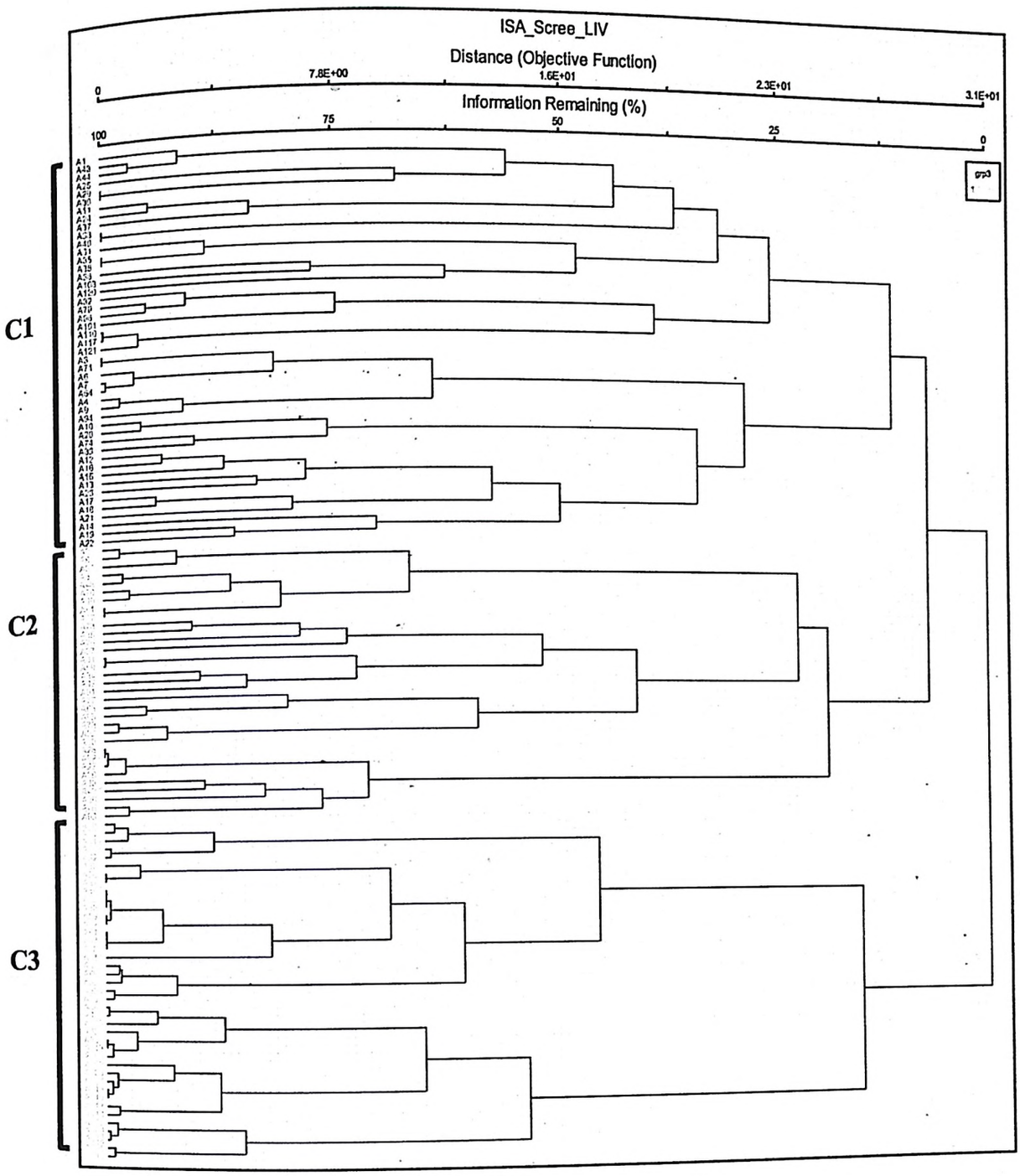


Figure 6.26 Dendrogram classification shows the grouping of three communities in Scree in Lower Indus valley

Community 3 *Acantholimon lycopodioides-Krascheninikovia* sp.: There were 11 species in the group and *Acantholimon lycopodioides* (OIV=84.6: P=0.001) was calculated as the highest indicator value species followed by *Krascheninikovia* sp (OIV=61: P=0.001). The other associated species are *Tanacetum fruticosum; Cicer microphyllum, Arnebia euchroma* etc.

Wakha–chu: In Wakha-chu, valley four sites with 193 quadrats were sampled and 53 species were recorded. Figure 6.27 The dendrogram classification shows the grouping of three communities in Scree in Wakha-chu valley.

Community 1 *Artemisia maritima-Allium przewalskianum:* There were 30 species in the group. *Artemisia maritima* (OIV=32.4: P=0.007) was calculated as the

highest indicator value species followed by *Allium przewalskianum* (OIV=17.2: P=0.07). The other associated species, *Astragalus oplites, Cousinia thomsonii, Lonicera caerulea, Arnebia euchroma, Rosa webbiana Echinops cornigerus* etc.

Community 2 *Scrophularia desertorum-Orobanche* sp.: There were 12 species in this group. *Scrophularia desertorum* (OIV=97.9: P=0.001) is calculated as the highest indicator value species followed by *Orobanche* sp. (OIV=36.1: P=0.001). The other associated species are *Lactuca orientalis, Chesneya cuneata, Medicago lupina* etc.

Community 3 *Potentilla-Caragana versicolor:* There were 11 species in this group. *Potentilla* sp. (OIV=83: P=0.001) is calculated as the highest indicator value species followed by *Caragana versicolor* (OIV=75: P=0.001). The other associated *Silene moorcroftiana, Chrysanthemum pyrethroides, Rheum moorcroftianum* etc.

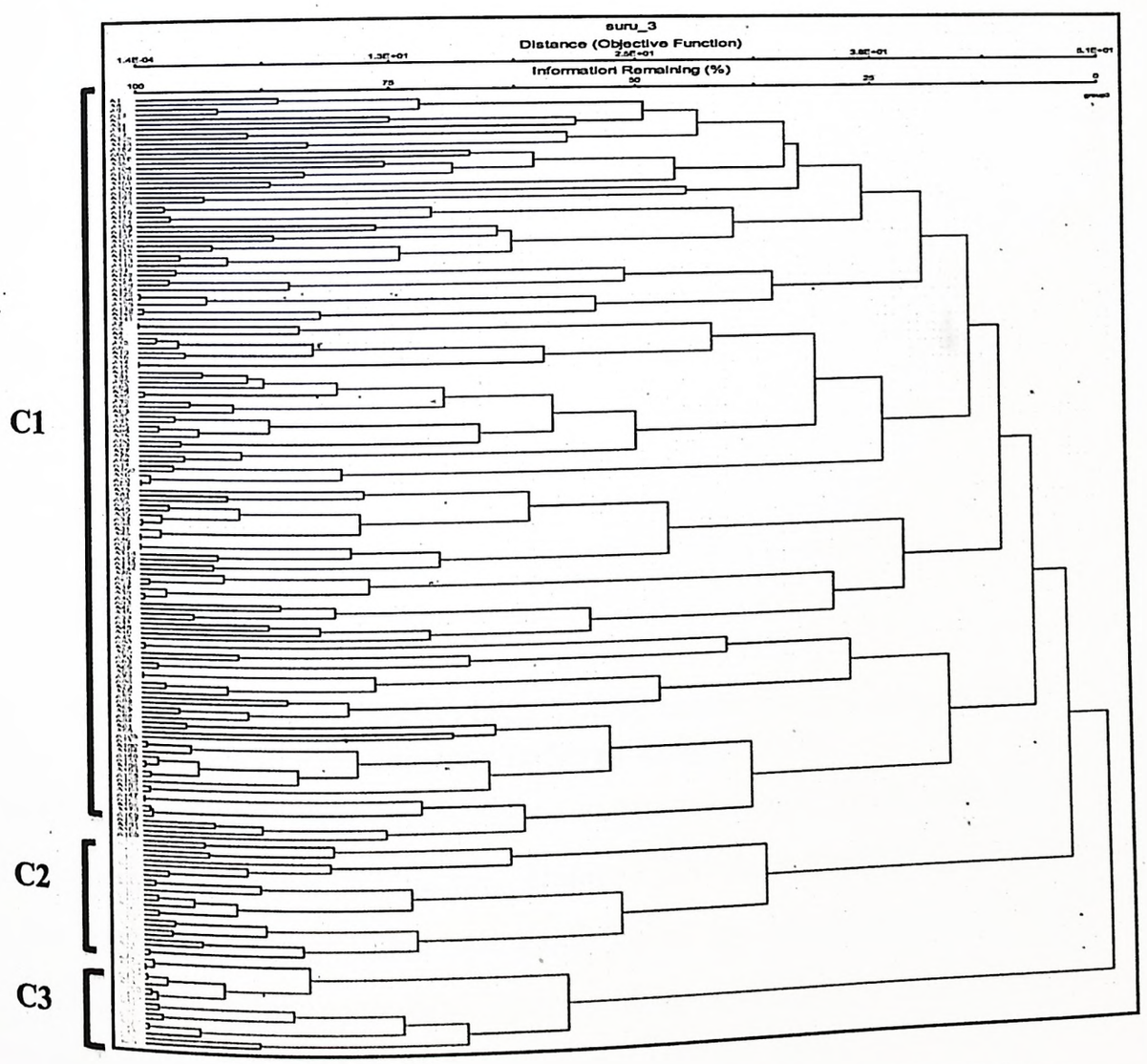


Figure 6.27 Dendrogram classification shows the grouping of three communities in Scree in Wakha-chu valley

***Suru valley*:** In Suru valley 125 quadrats across five sites were sampled, 34 species recorded, and vegetation was grouped into four major communities. Figure 6.28 shows the grouping of three communities in Scree in Suru valley.

Community 1 *Geranium* sp.-*Corydalis crassifolia*: There were 11 species in the group. *Geranium* sp. (OIV=94.9: P=0.001) was calculated as the highest indicator value species followed by *Corydalis crassifolia* (OIV=80.3: P=0.001). The other associated species are *Waldheimia tomentosa, Salsola kali, Saussurea atkinsonii* etc.

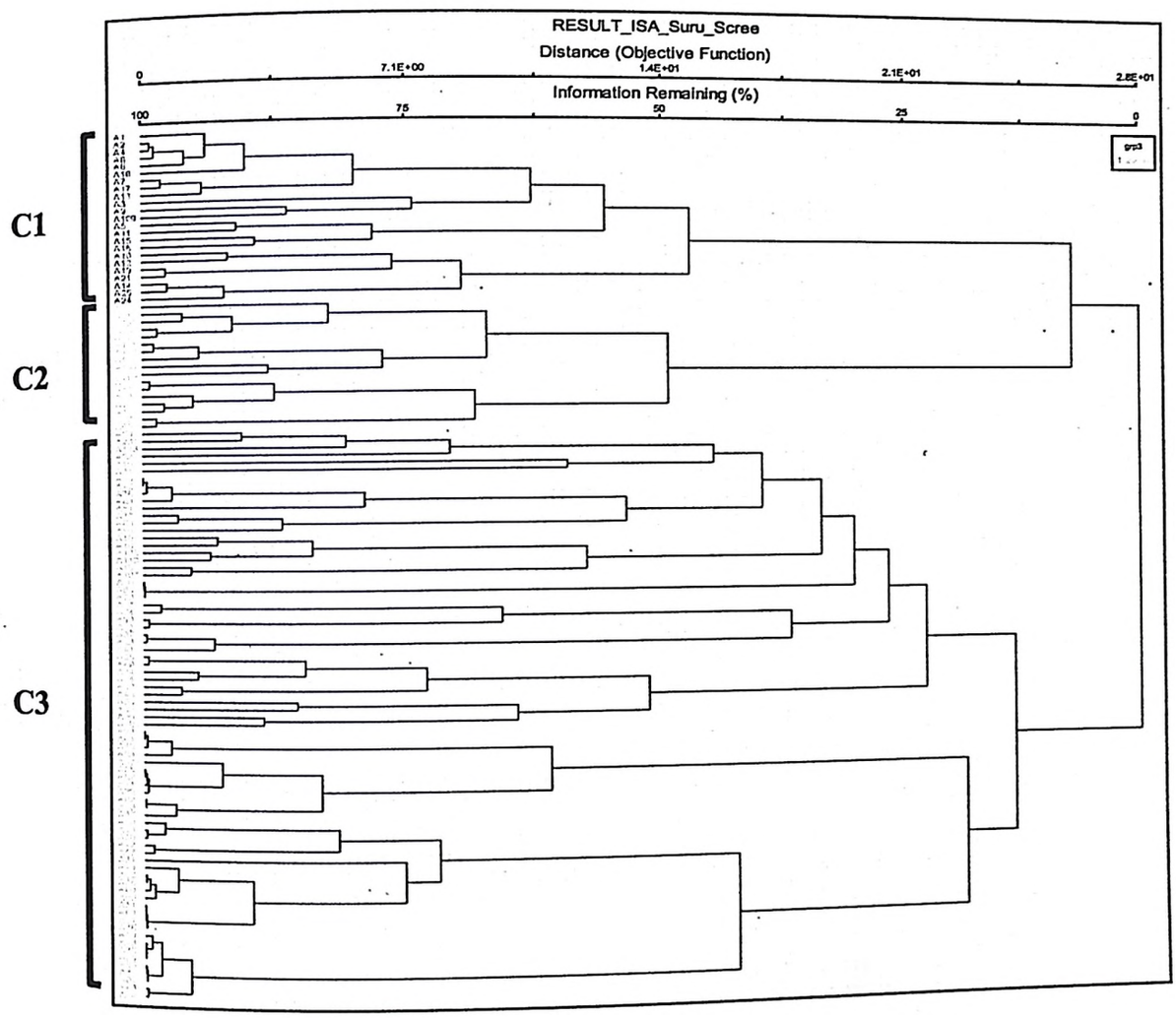


Figure 6.28 Dendrogram classification shows the grouping of three communities in Scree in Suru valley

Community 2 *Polygonum paronychioides-Ajania tibetica:* There were 15 species in the group and *Polygonum paronychioides* (OIV=46.2: P=0.001) was calculated as the highest indicator value species followed by *Ajania tibetica* (OIV=39.5: P=0.001). The other associated species *Rosa webbiana, Lactuca orientalis, Artemisia maritima, Scrophularia desertorum, Silene moorcroftiana* etc.

Community 3 *Rheum moorcroftianum-Psychrogeton andryaloides:* There were 8 species in the group and *Rheum moorcroftianum* (OIV=92.9: P=0.001) was

calculated as the highest indicator value species followed by *Psychrogeton andryaloides* (OIV=56.3: P=0.001). The other associated species are *Nepeta podostachys, Oxytropis tatarica, Pedicularis ophiocephala* etc.

Stable Slope

The vegetation types occupied by the stable slopes were mostly occuring in the higher elevations where maximum plant communities are present. Surface stability is moderate to high, although little affected by solifluction. Soils were poorly developed and consisted mainly of sand and bigger stable stones. Water availability was good to moderate due to high amount of precipitation. This vegetation type occurred at altitudes from 3500 to 5000 m, but at extreme altitudes near the snow line, only individual plants were discovered. The vegetation cover varied greatly among plots, mostly between 30% and 80%. The majority of species were low-growing hemicryptophytes (e.g. *Draba altaica, Saussurea gnaphalodes* or *Saxifraga* sp.).

Lower Indus valley: In Lower Indus, valley four sites were sampled which comprises of 100 quadrats and 49 species were recorded in the habitat. Figure 6.29 shows the grouping of two communities in Stable slopes in Lower Indus valley.

Community 1 *Arenaria* sp.-*Festuca* sp.: There were 28 species in the group. *Arenaria* sp (OIV=46; P=0.001) is calculated as the highest indicator value species followed by *Festuca* sp. (OIV=44: P=0.001). The other associated species are *Ephedra* sp., *Draba setosa, Cicer microphyllum, Leontopodium* sp., *Pedicularis oderii, Elymus* sp., *Nepeta podostachys, Thymus linearis* etc.

Community 2 *Bistorta affinis-Potentilla argyrophylla*: There were 21 species in the group and *Bistorta affinis* (OIV=62.9: P=0.001) was calculated as the highest indicator value species followed by *Potentilla argyrophylla* (OIV=52.9: P=0.001). The other associated species followed by *Aconitum rotundifolium, Oxytropis tatarica, Papaver nudicaule, Silene gonosperma, Rhodiola tibetica, Lagotis kunawurensis, Waldheimia stoliczkae* etc.

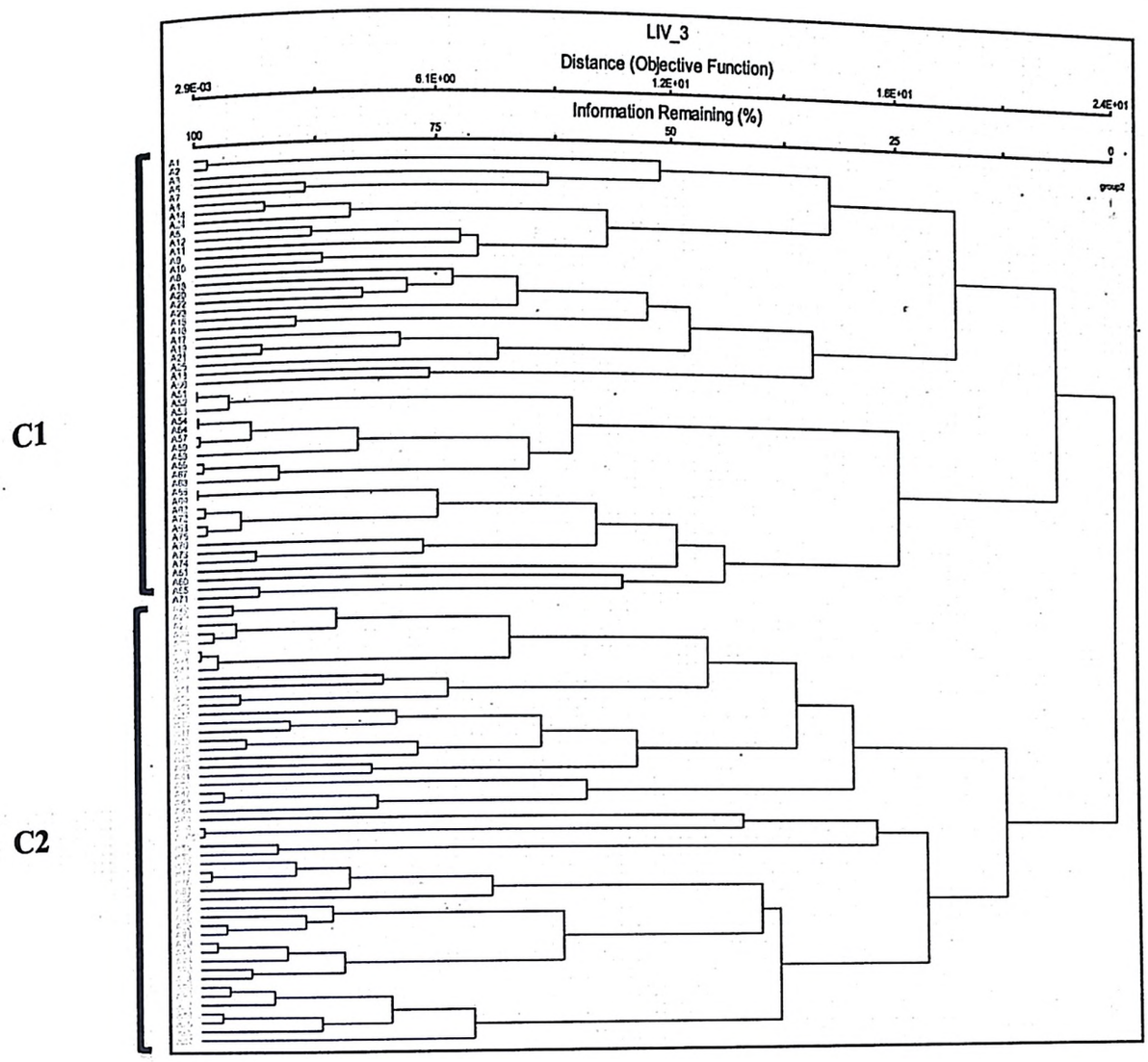


Figure 6.29 Dendrogram classification shows the grouping of two communities in Stable slopes in Lower Indus valley

Wakha–chu: In this valley, 518 quadrats were sampled across 21 sites and total 123 species were recorded in the habitat. Figure 6.30 shows the grouping of three communities in Stable slopes in Wakha-chu valley.

Community 1 *Geranium* sp.-*Aconogonum tortuosum*: There were 83 species in the group. *Aconogonum tortuosum* (OIV=23.3: P=0.002) was calculated as the highest indicator value species followed by *Acantholimon lycopodioides* (OIV=19.8: P=0.003) .The other associated species are *Pseudomertensia echioides, Festuca kashmiriana, Rosularia alpestris, Caragana versicolor* etc.

Community 2 Artemisia maritima-Chrysanthemum sp.: There were 21 species in the group and *Artemisia maritima* (OIV=87.7: P=0.001) was calculated as the highest indicator value species followed by *Chrysanthemum* sp. (OIV=31.9: P=0.001). The other associated species are *Dianthus chinensis, Lonicera caerulea, Viola pilosa* etc.

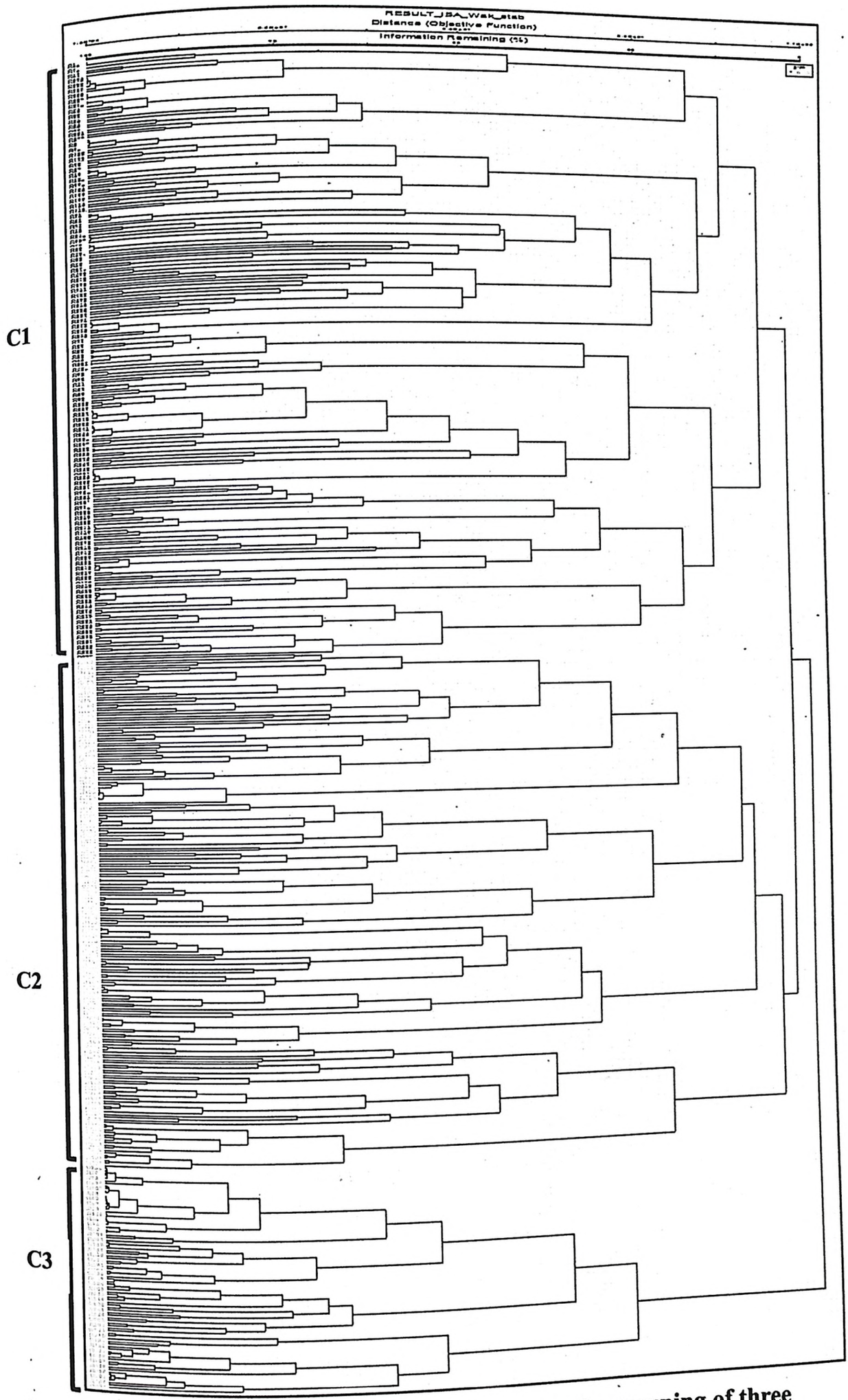


Figure 6.30 Dendrogram classification shows the grouping of three communities in Stable slopes in Wakha-chu valley

Community 3 Aster flaccidus-Rhodiola tibetica: There were 19 species in the group and *Aster flaccidus* (OIV=70.8: P=0.001) was calculated as the highestindicator value species followed by *Rhodiola tibetica* (OIV=52.7, P=0.001). The other associated species are *Swertia petiolata, Saxifraga sp., Pedicularis* sp., *Jurinea ceratocarpa, Potentilla argyrophylla* etc.

Suru valley: A total of 475 quadrats were sampled across 19 sites, total 121 species were recorded, and vegetation was grouped into five major communities. Figure 6.31.

Community 1 *Carex nivalis-Nepeta podostachys*: There were 32 species in the community and *Carex nivalis* (OIV=22.9: P=0.001) was calculated as the highest indicator value species followed by *Nepeta podostachys* (OIV=22.8: P= 0.001). The other associated species are *Acantholimon lycopodioides, Aconogonum rumicifolium, Anemone pulsatilla* etc.

Community 2 *Anemone rupicola-Astragalus rhizanthus*: There were 8 species in the group and *Anemone rupicola* (OIV=95.4: P=0.001) was calculated as the highest indicator value species followed by *Astragalus rhizanthus* (OIV=81.3: P=0.001). The other associated species are *Pedicularis ophiocephala, Arnebia euchroma* etc.

Community 3 *Rhodiola tibetica-Waldheimia tomentosa:* There were 24 species in the group. *Rhodiola tibetica* (OIV=55.6: P=0.001) was calculated as the highest indicator value species followed by *Waldheimia tomentosa* (OIV=43.2: P=0.001). The other associated species are *Pedicularis roylei, Oxytropis lapponica* etc.

Community 4 *Bistorta affinis-Elymus:* There were 35 species in the group and *Bistorta affinis* (OIV=37.9: P=0.001) is calculated as the highest indicator value species followed by *Elymus* sp. (OIV=37.3: P=0.001). The other associated species are *Veronica laxa, Primula denticulate, Rubia tibetica, Saussurea roylei, Thymus linearis* etc

Community 5 *Kobresia pygmaea-Lloydia serotina:* There were 22 species in the group and *Kobresia pygmaea* (OIV=76.7: P=0.001) was calculated as the highest indicator value species followed by *Lloydia serotina* (OIV=72.8: P=0.001). The other associated species are *Rhodiola heterodonta, Epilobium angustifolium, Cremanthodium ellisii, Aconitum violaceum* etc

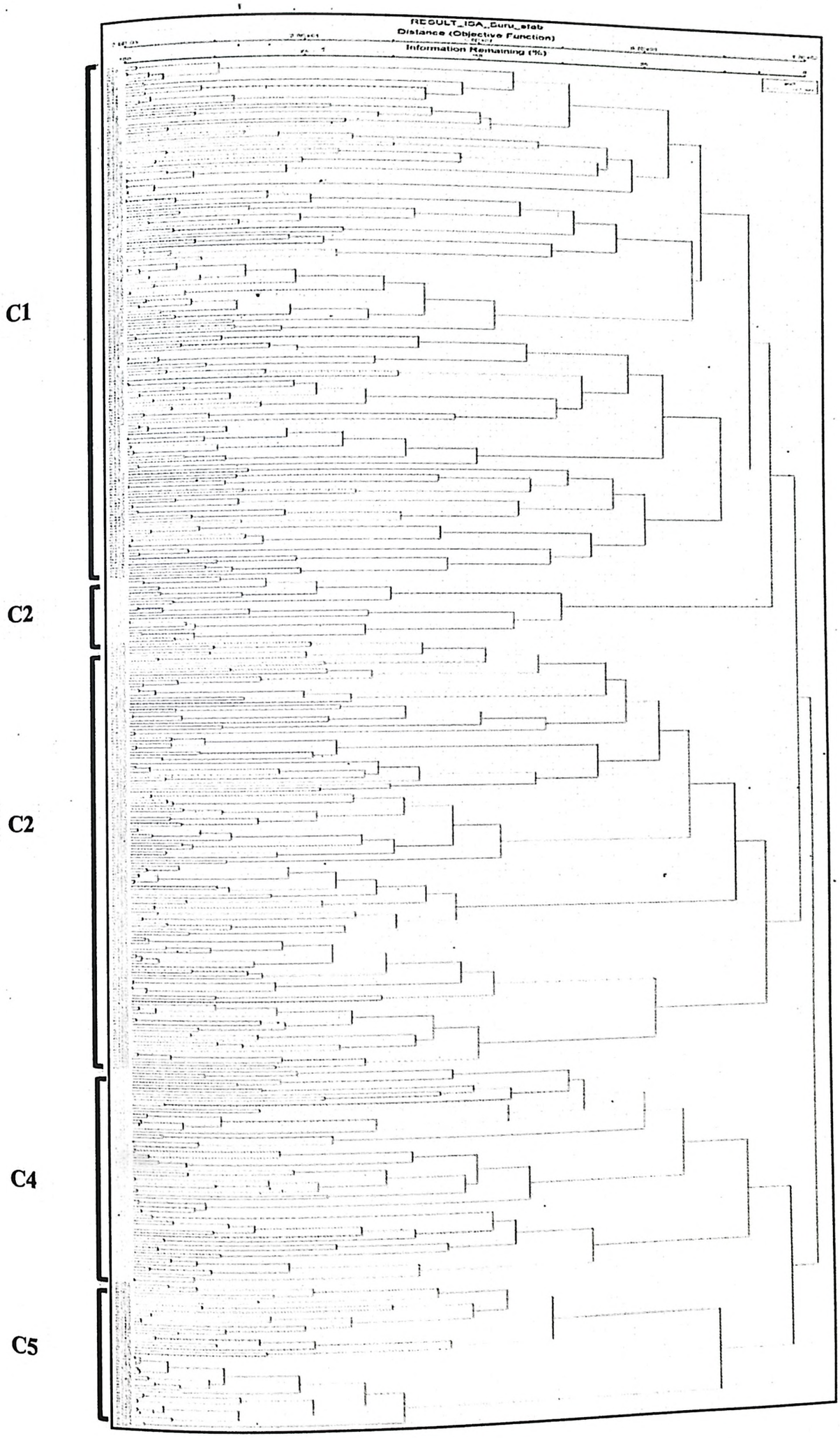


Figure 6.31 Dendrogram classification shows the grouping of five communities in Stable slopes in Suru valley

Commoness among the Communities

In most of the landform units like rock and cliff, moraine, plateau, marshmeadow and stable slope there was no similar plant communities. In alpine meadows *Carex* sp. dominated the community in Lower Indus valley and Wakha-chu valley, in boulder slope *Artemisia* sp. dominated the community in Wakha-chu and Suru valley. In Scree slope *Scrophularia desertorum* dominated the community in Lower Indus and Wakha-chu valley, whereas *Medicago sativa* with different associates formed the community in all three valleys.

6.3.5 Plant communities and medicinal plants

The plant communities with respect to important medicinal plants are given in Table 6.9, Lower Indus, Table 6.10, Wakha-chu and Table 6.11, Suru valley respectively. Some of the species were found in more than one or different habitats such as *Veronica laxa, Carex* sp., *Androsace* sp., *Artemisia* sp., *Primula denticulate, Bistorta affinis, Rhodiola tibetica, Cicer microphyllum, Delphinium brunonianum, Geranium* sp. etc. are found in bouldery and stable slope habitats in the high-elevated areas. However, some of the species are restricted to only particular habitats and are those elevations only like *Corydalis* sp., *Astragalus munroi,* in moraine. Species like *Meconopsis aculeata* was found only in Suru valley in Rangdum area in bouldery slope. In Lower Indus valley, the highest number of medicinal plants was recorded from bouldery landform unit.i.e (24 species) in *Bistorta affinis-Aconitum rotundifolium* community (Figure 6.32). In Wakha-chu *Geranium* sp.-*Aconogonum tortuosum* community in stable slope has recorded the highest number of medicinal plants (48 species) Figure 6.33. In Suru valley *Taraxacum officinale-Euphrasia himalayica* community was recorded as the highest 27 species of medicinal plants (Figure 6.34).

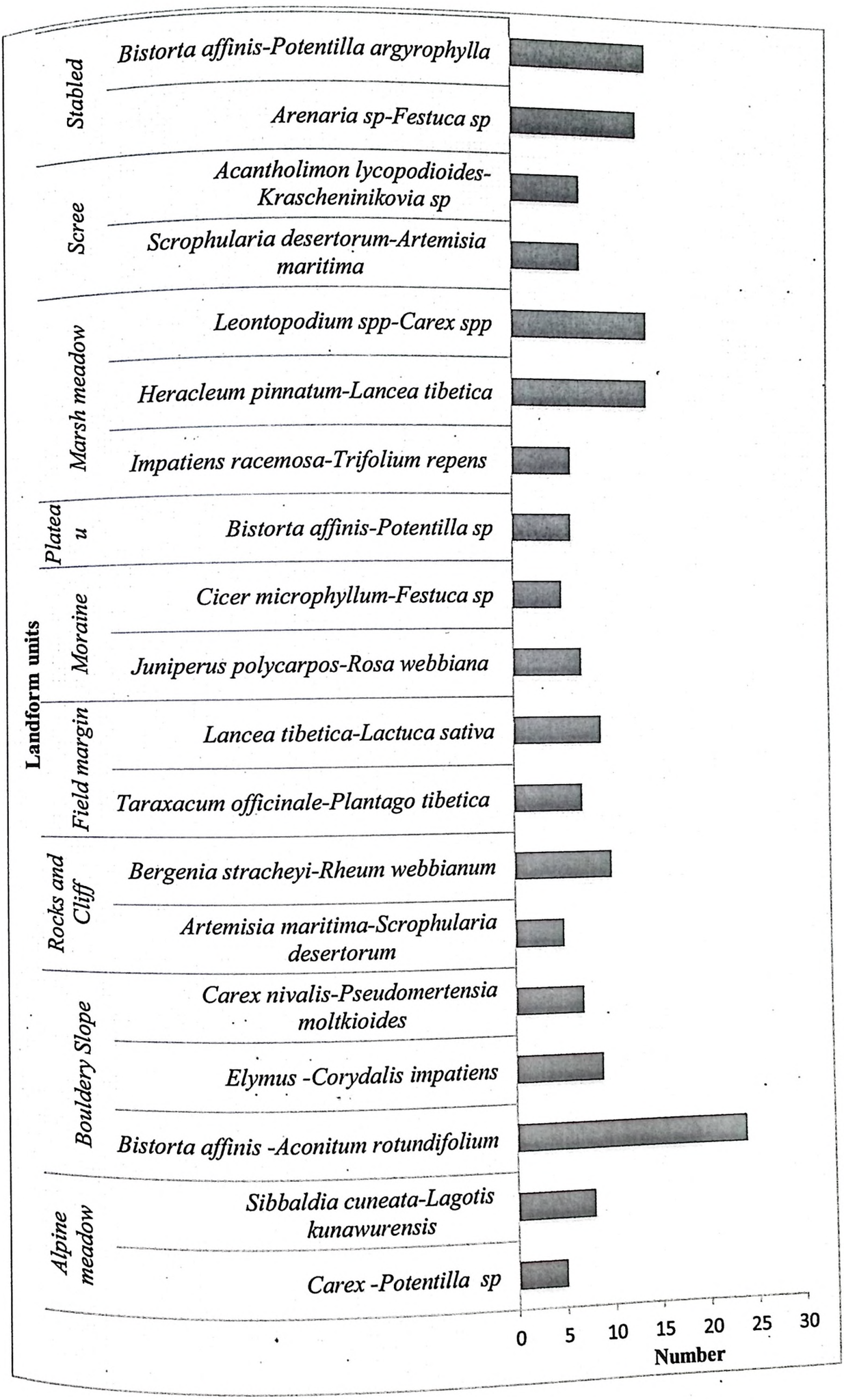


Figure 6.32 Plant communities and number of ethomedicine across communities in Lower Indus valley

Table 6.9 Important medicinal plants across different Landform units in Lower Indus valley

Landform	Community	Medicinal Plants
Alpine meadow	*Carex* sp *Potentilla* sp.	*Saxifraga* sp., *Leontopodium* sp.
	Sibbaldia cuneata-Lagotis kunawurensis	*Lagotis kunawurensis, Aconitum rotundifolium, Aster flaccides*
Bouldery slope	*Bistorta affinis-Aconitum rotundifolium*	*Papaver nudicaule, Aconitum rotundifolium, Primula macrophylla*
	Elymus-Corydalis impatiens	*Corydalis impatiens, Delphinium brunonianum, Rheum webbianum*
	Carex nivalis-Pseudomertensia moltkioides	*Saussurea bracteata, Rhodiola imbricata, Waldheimia glabra*
Rocks and cliff	*Artemisia maritima-Scrophularia desertorum*	*Hyoscyamus pusillus, Artemisia maritima*
	Bergenia stracheyi-Rheum webbianum	*Bergenia stracheyi, Rheum webbianum, Ephedra gerardiana*
	Lysimachia sp.-*Nepeta* sp.	*Inula obtusifolia, Rosa webbiana, Stachys tibetica*
Field margin	*Taraxacum officinale, Plantago tibetica*	*Codonopsis ovata, Plantago tibetica*
	Lancea tibetica-Lactuca sativa	*Lancea tibetica, Ranunculus* sp., *Oxyria digyna*
Moraine	*Juniperus* sp.-*Rosa webbiana*	*Juniperus* sp., *Rosa webbiana, Stachys tibetica, Rosa webbiana*
	Cicer microphyllum-Festuca sp.	*Cicer microphyllum, Rhodiola tibetica*
Plateau	*Bistorta affinis Potentilla* sp.	*Allium przewalskianum, Ephedra gerardiana*
Marsh meadows	*Heracleum pinnatum-Lancea tibetica*	*Oxyria digyna, Pedicularis punctata*
	Leontopodium spp. *Carex* spp.	*Leontopodium* sp., *Pedicularis longiflora, Aster flaccides, Saxifraga* sp.
Scree	*Scrophularia desertorum - Artemisia maritima*	*Rosa webbiana, Artemisia maritima*
	Nepeta floccose- Silene moorcroftiana	*Hyoscyamus pusillus, Stachys tibetica*
Stable slope	*Bistorta affinis-Potentilla argyrophylla*	*Lagotis kunawurensis, Waldheimia glabra, Allium przewalskianum, Aster flaccides, Papaver nudicaule*
	Veronica biloba-Festuca sp.	*Thermopsis inflata, Rheum,Cicer webbianum microphyllum, Delphinium* sp.

Table 6.10 Important medicinal plants, across different landform units in Wakha-chu valley

Landform	Community	Medicinal Plants
Alpine meadow	*Carex* sp.-*kobresia* sp.	*Aster flaccides, Leontopodium* sp., *Viola kunawurensis*
	Caragana versicolor-Codonopsis ovata	*Codonopsis ovata, Myosotis sylvatica*
	Bistorta affinis-Potentilla sp.	*Plantago tibetica, Dactylorhiza* sp.
Bouldery slope	*Potentilla argyrophylla-Elymus* sp.	*Saussurea bracteata,Rhodiola tibetica*
	Primula macrophylla-Delphinium brunonianum	*Aconitum rotundifolium, Primula macrophylla*
Rocks and cliff	*Ribes orientale-Juniperus* sp.	*Rosa webbiana, Bergenia stracheyi, Rheum webbianum*
	Androsace muscoidea-Ajania tibetica	*Ephedra gerardiana, Arnebia euchroma, Viola pilosa, Allium stoliczkii*
Field margin	*Convolvulus arvensis-Rumex nepalensis*	*Convolvulus arvensis, Rumex nepalensis, Carum carvi*
	Medicago sativa-Pedicularis punctata	*Plantago tibetica, Lancèa tibetica, Mentha longifolia*
	Seseli mucronatum-Veronica biloba	*Codonopsis ovata, Aconitum violaceum, Delphinium cashmerianum*
	Kobresia macrantha-Arenaria griffithii	*Swertia thomsonii, Dactylorhiza hatagirea*
Moraine	*Acantholimon lycopodioides-Scutellaria heydei*	*Acantholimon lycopodioides,Scutellaria heydei*
	Draba setosa-Carex nivalis	*Corydalis govaniana, Saussurea bracteata, Rhodiola tibetica, Waldheimia glabra*
	Lagotis kunawurensis-Potentilla argyrophylla	*Lagotis kunawurensis, Leontopodium* sp., *Swertia petiolata, Cremanthodium arnicoides*
Plateau	*Artemisia maritime-Allium przewalskianum*	*Artemisia maritima, Allium przewalskianum*
Marsh meadows	*Euphrasia himalayica-Trifolium repens*	*Dactylorhiza hatagirea , Pedicularis punctata*
	Parnassia palustris–Bistorta affinis	*Gentiana moorcroftiana, Carum carvi, Hippophae rhamnoides*
Scree	*Artemisia maritima-Cousinia thomsonii*	*Geranium* sp., *Rosa webbiana, Artemisia maritima*
	Potentilla sp.-*Caragana versicolor*	*Ephedra gerardiana, Rheum moorcroftianum*
Stable slope	*Geranium* sp.-*Aconogonum tortuosum*	*Geranium* sp., *Rhodiola imbricata, Lagotis kunawurensis, Gentiana tianschanica, Allium carolinianum*
	Artemisia maritima-Chrysanthemum pyrethroides	*Allium przewalskianum, Viola pilosa, Artemisia maritima*
	Aster flaccidus-Rheum tibetica	*Aster flaccidus, Rhodiola tibetica, Swertia petiolata,Waldheimia tomentosa, Delphinium cashmerianum*

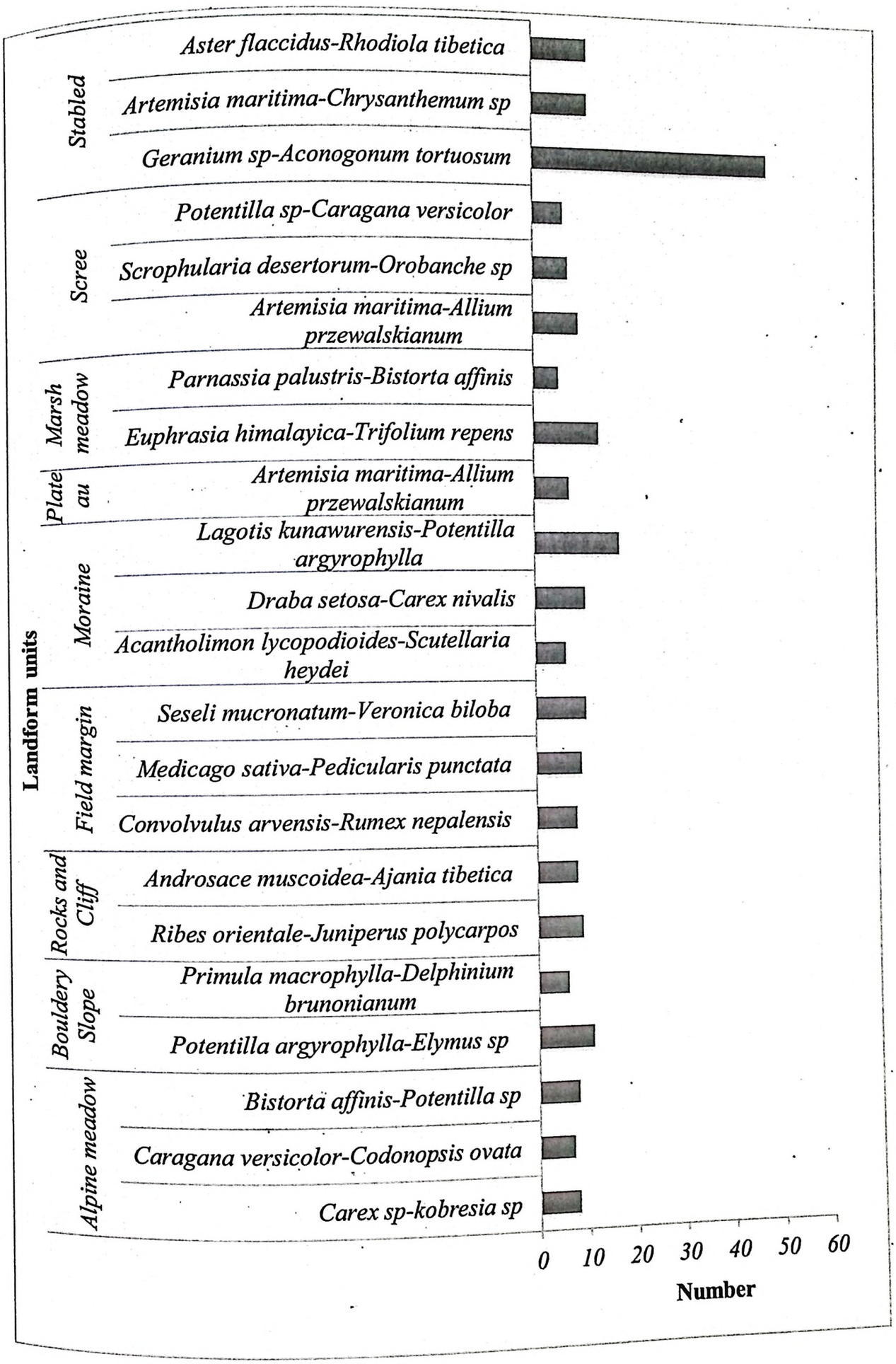


Figure 6.33 Plant communities and number of ethomedicine across communities in Wakha-chu valley

Table 6.11 Important medicinal plants, across different landform units in Suru valley

Landform	Community	Medicinal Plants
Alpine meadow	*Oxygraphis* sp.-*Kobresia pygmaea*	*Aster flaccides, Aconitum rotundifolium*
	Taraxacum officinale-Inula rhizocephala	*Inula rhizocephala, Leontopodium* sp., *Plantago tibetica, Swertia petiolata*
Bouldery Slope	*Corydalis* sp.-*Meconopsis aculeata*	*Corydalis meifolia, Meconopsis aculeata , Saussurea bracteata*
	Artemisia-Nepeta glutinosa	*Delphinium cashmerianum, Cicer microphyllum, Waldheimia stoliczkae*
	Rhodiola imbricate-Pedicularis pectinata	*Rhodiola imbricate, Pedicularis pectinata, Tulipa stellate, Papaver nudicaule*
	Draba setosa-Pedicularis ophiocephala	*Ephedra gerardiana,Rhodiola heterodonta*
Rocks and Cliff	*Festuca kashmiriana-Chrysanthemum tibeticum*	*Rhodiola heterodonta, Rosa webbiana, Allium carolinianum*
	Polygonum paronychioides-Tulipa stellata	*Tulipa stellate, Ephedra gerardiana, Juniperus* sp.
Field margin	*Galium* sp.-*Festuca* sp.	*Codonopsis ovata, Aconitum heterophyllum,Carum carvi*
	Erigeron multicaulis-Podophyllum hexandrum	*Podophyllum hexandrum, Swertia thomsonii, Platago* sp.
	Poa sp.-*Plantago depressa*	*Delphinium cashmerianum, Plantago tibetica, Aconitum violaceum*
	Medicago sativa-Taraxacum officinale	*Dactylorhiza hatagirea , Aster flaccides Hippophae rhamnoides*
	Pedicularis bicornuta-Carex sp.	*Pedicularis bicornuta, Swertia petiolata, Geranium* sp.,
Moraine	*Geranium* sp.-*Bistorta affinis*	*Epilobium latifolium, Rhodiola tibetica, Rheum moorcroftianum, Waldheimia tomentosa*
	Festuca sp.-*Arnebia euchroma*	*Arnebia euchroma, Cicer microphyllum, Ephedra gerardiana*
	Allium carolinianum-Aquilegia fragrans	*Allium carolinianum, Aquilegia fragrans, Rheum tibeticum*
Plateau	*Kobresia pygmaea-Saussurea atkinsonii*	*Allium przewalskianum*
Marsh meadows	*Kobresia pygmaea-Gentianella moorcroftiana*	*Gentianella moorcroftiana, Primula denticulata, Pedicularis bicornuta, Dactylorhiza* spp.
	Crepis sp.-*Oxytropis tatarica*	*Arnebia euchroma, Ephedra gerardiana*
	Taraxacum officinale -Euphrasia himalayica	*Clematis tibetica, Carum carvi, Leotopodium* sp., *Oxyria digyna*
Scree	*Geranium* sp.-*Corydalis crassifolia*	*Stachys tibetica, Rhoidiola imbricata, Rosa webbiana, Artemisia maritima*
	Polygonum paronychioides-Ajania tibetica	*Waldheimia tomentosa, Rhoidiola tibetica*

Landform	Community	Medicinal Plants
Stable slope	*Carex nivalis-Nepeta podostachys*	*Cicer microphyllum, Inula rhizocephala, Podophyllum hexandrum, Swertia thomsonii,Rheum webbianum*
	Rhodiola tibetica-Waldheimia tomentosa	*Waldheimia-tomentosa,Rhodiola tibetica, Corydalis meifolia, Corydalis impatiens*
	Elymus-Bistorta affinis	*Aconitum rotundifolium, Delphinium cashmerianum, Aster flaccides, Swertia thomsonii*
	Kobresia pygmaea-Lloydia serotina	*Cremanthodium ewersii, Pedicularis bicornuta, Saussurea roylei, Pedicularis pectinata*

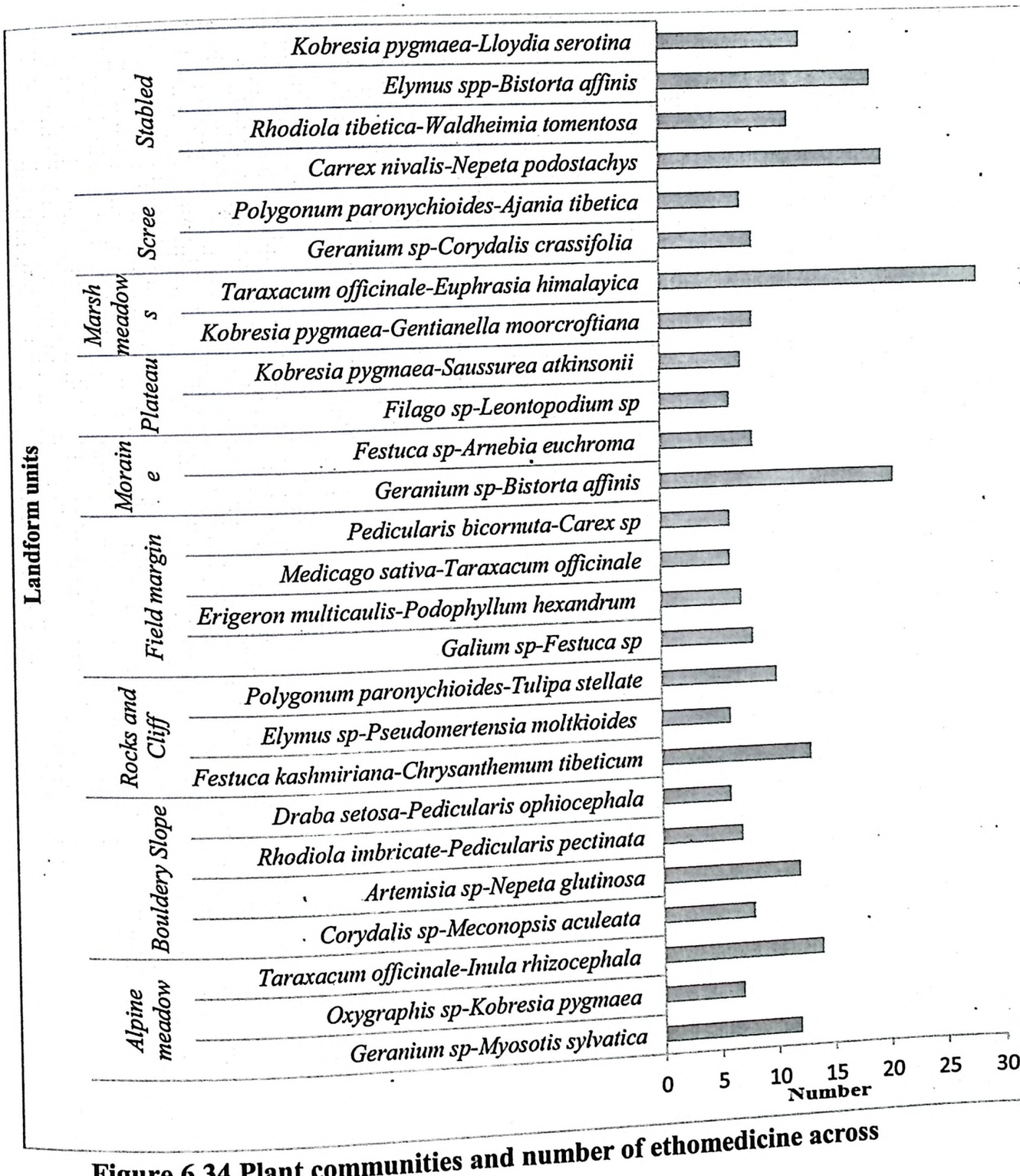


Figure 6.34 Plant communities and number of ethomedicine across communities in Suru valley

6.3.6 Endemic and Threatened taxa

The endemic flora of Western Ladakh, *Allium loratum, Anaphalis royleana, Arenaria stracheyi, Astragalus munroi, Astragalus zanskarensis, Berberis ulcina, Christolea stewartii, Corydalis crassifolia, Dactylorhiza hatagirea, Draba cashmirica, Ferula jaeschkeana, Lancea tibetica, Poa ladakhensis, Potentilla thomsonii, Ranunculus trivedii Saussurea graminifolia, Silene stewartii, Thalictrum rutaefolium and Waldheimia stoliczkei*. Some species are 'endemic' or 'near endemic' to Ladakh had been studied *Corydalis adiantifolia, Astragalus tribulifolius, Inula rhizocephala, Saussurea thomsonii, Senecio tibeticus, Waldhemia vestita and Acantholimon lycopodioides, Draba alshehbazii, Betula utilis, Hippophae rhamnoides, Ephedra gerardiana* and *Juniperus communis.* Some of the rare and threatened species of medicinal plants (listed in various threat categories of Indian Red Data Book include *Aconitum violaceum* (Critically Endangered – CR), *Arnebia euchroma* (Endangered – E), *Artemisia maritima* (E), *Dactylorhiza hatagirea* (CR), *Hippophae rhamnoides* (Low risk, not threatened; LR-NT), *Hyoscyamus niger* (LR-NT), *Juniperus recurva* (Rare – R), *Lancea tibetica* (R), *Meconopsis aculeata* (CR), *Physochlaina praealta* (Vulnerable – Vu), *Rheum speciforme* (Vu), *Saussurea bracteata* (R), *Saussurea gnaphaloides* (R), and *Saussurea obvallata* (Vu).

6.4 CONCLUSIONS

A total of 301 species belonging to 51 families were recorded in the survey area. Species richness was higher in areas close to the Ladakh range and Zanskar range. Dominant plant families in Western Ladakh were Asteraceae (58), Fabaceae (22) and Ranunculaceae (17). Suru Indus valley has the maximum diversity of species followed by Wakha-chu and Lower Indus valley.

A total of 81 plant communities in nine different habitat types were seggregated (24 in Lower Indus; 25 in Wakha-chu and 32 in Suru valleys). The field margins supported higher number of communities. Highest number of medicinal plants was reported from the sites dominated by *Geranium-Aconogonum tortuosum* community. Alpine meadows and the subnival vegetation are abundant at higher elevations (rock and talus substrates at an elevation of 3,000-4,000m). Stable slopes are most species-rich, harboring the highest number of species i.e., 123.

Screes are relatively poorer in the number of species but they harbor highest diversity of growth forms. Most plant species were restricted to one habitat type reflecting narrow ecological amplitude of these species. The upper eroded slopes and rocky outcrops had least vegetation cover.

Plate VA Important medicinal plants collected by Amchis in Ladakh.



Aconitum heterophyllum



Aconitum violaceum



Aconitum rotundifolium



Primula macrophylla



Delphinium cashmerianum



Papaver nudicaule



Aster flaccidus



Arnebia euchroma



Dactylorhiza hatagirea

Plate V(B). Important medicinal plants collected by Amchis in Ladakh.



Saussurea schultzii



Rhodiola imbricata



Swertia petiolata



Saussurea roylei



Podophyllum hexandrum



Cremanthodium arnicoides



Hyoscyamus niger



Rhodiola tibetica



Meconopsis aculeata

CHAPTER 7

Ethnoecology and Conservation Prioritization of Ethno-flora

7.1 INTRODUCTION

Natural resources play a major role in the livelihoods of people living in remote areas. However their overexploitation may cause depletion of these resources and hence there is a need for sustainable use of natural resources and ultimately the need for conservation. The Indian Trans-Himalaya is well known for a large number of wild medicinal plants which have been in local and commercial use since long time. With increasing demand for herbal medicines, several species are declining rapidly and require proper documentation in terms of availability, use pattern and conservation priority ranking. At present harvesting is mostly determined by the needs of the local community and availability of resources. Increased demand of some species in recent years has caused heavy extraction of these plants from the wild posing threat to their survival (Rai 2000).

The amount of resources, both human and financial, available for conservation is insufficient to satisfy all the demands being made (Biodiversity International 2006). Wild resources are no exception and actions to conserve them have to be based on some form of priority setting. Considering the fact that the number of wild resources identified will be so large that it would not be feasible to prepare management plans and monitoring regimes for all of them, some form of selection should be used so that the candidate species can be placed in different priority categories and appropriate forms of conservation applied to them. These may range from population and habitat recovery programmes, conservation plans with various levels of management intervention, through conservation statements to simply monitoring the status of the wild resources populations. In some cases, no formal conservation plan may be possible and alternative arrangements may be made that limit the threats to them or their habitats.

Prioritizing medicinal plants for conservation requires not only the dynamics of their population, but also their harvesting potentials. The level to which species are available and harvested, as well as the plant parts that are harvested and their regeneration potential, should be considered when designing and implementing sustainable harvesting systems (Boot and Gullison 1995, Obiri et al. 2002).

However, species response to harvesting, their distributions and densities requires a complex approach that may not be feasible in the present context of study. There is no precise or agreed methodology for selecting the species or populations that should be given priority as targets for in situ conservation and mostly it depends on local requirements and circumstances (Biodiversity International 2006). According to Heywood and Dulloo (2005), commonly used criteria for prioritizing species for in situ conservation could be as follows.

- What is the actual or potential use of the target species?
- What is the current conservation status of the target species?
- Is the species endemic with a restricted range or is it widely distributed?
- Is the species experiencing a continuing decline in its occurrence?
- Does the species have cultural importance or is it in high social demand?
- Does the species occur in a protected area, or does it have legal or community protected status?

Using methods such as those of Obiri et al. (2002) and Lykke (1998) enables species to be categorized according to their harvesting potentials and thus be more easily incorporated into management plans.

Once species are prioritized, it is necessary to identify those areas where these species grow in abundance. Collecting information on the occurrence of these species based on ground sampling alone may not be feasible for large areas hence preparing distribution maps using geographical information system (GIS) could be the best way to delineate conservation areas. Mapping the potential distribution of plants follow ecological niche theory and assumes that vegetation distribution can be predicted from the spatial distribution of environmental variables such as soils and climate. Distribution maps are of immense potential and are increasingly being used for biodiversity conservation (Haines-Young 1991). Generating distribution maps in GIS requires information on the most important environmental and geographical variables that favors the growth of species being studied. There are many factors that govern the survival and abundance of these plants. The vegetation in high altitudes is subjected to various extreme climatic

factors like heavy rainfall and snowfall, fluctuating humidity and temperature, high levels of UV radiations apart from topographical and physical factors such as direction and precipitousness of slopes, chemical composition of substratum, water-holding capacity (Rau 1975). However unavailability of appropriate variables at desired scale is a major problem in distribution mapping. Topographical variables used in the present study are easy to calculate and has a strong influence on the distribution of plants in mountain regions.

The aim of this chapter is to categorize species according to their harvesting potential based on size of the population, habitat specificity, regeneration capacity and the level of utilization. Another aim is to map the distribution range of species of high conservation priority based on geographical variables.

7.2. METHODS

7.2.1 Conservation priority

Species were prioritized for conservation score based on the method developed by Mander et al. (1997) and modified by Dzerefos and Witkowski (2001). The rating system of Conservation priority score (CPS) was based on ecological and social data. The CPS was calculated for selected species based on four parameters, i.e., average density (within valley), the risk of harvesting due to specific parts (root, leaf, etc.), the frequency of harvesting and the diversity of uses Table 7.1.

Conservation score = 0.5 (Biological score) + 0.5 (utilization score)

$$\text{Biological score} = \text{Average density} \times 10$$

$$\text{Utilization score} = \frac{\text{Harvesting risk}}{2} + \frac{\text{Frequency of collection}}{2} + \frac{\text{Diversity of uses}}{2} \times 10$$

Conservation score was used to categorise species according to their management needs which are as follows.

- Category 1 (CPS>100) - Species that require strict conservation due its very low density and requires further study.

- Category 2 (CPS=90-100) - These species also require conservation due its very low density can be harvested but only in limited quantity to ensure its sustainability.
- Category 3 (CPS<90) - These species have high potential of harvesting but may require some management initiatives to set up harvesting zones.

Table 7.1 Scoring criteria used for medicinal plants relating to plant density, harvesting risk, local importance and diversity of use (Dzerefos and Witkowski 2001; Mander et al. 1997)

Criterion	Score
A. Density in valley (mean number m^{-2})	
Not recorded – very low (0–1)	10
Low (1 < 3.5)	7
Medium (3.5 < 7)	4
High (≥7)	1
B. Harvesting risk	
Destructive harvesting of entire plant ,bulb and corms or overexploitation of rhizomes, roots, bark and tubers	10
Removal without causing individual mortality of perennial structures such as bark and roots	7
Removal of aerial permanent structures such as leaves, stems and sap effecting survival and reproductive success	4
Aerial structures such as flowers and fruits removed unaffecting the plant	1
C.Frequency of collection (few months)	
Often collected (several times a week)	10
Commonly collected (several times a month)	7
Occassionally collected (few times a year)	4
Not collected	1
D. Local use	
Most important (cannot live without this species)	10
Very important	7
Important	4
Not important	1
E. Diversity of use	
For each use add one point to maximum of 8	1–8

Information on the risk of harvesting and diversity of uses was collected during questionnaire survey. The harvesting risk was assigned according to the plant part collected and its impact on regeneration. Information on the diversity of uses has been taken from chapters 4 and 5. The frequency of collection has three broad categories, i.e., frequent (> 3 times a year), occasional (2-3 times a year) and annual collection (once a year).

7.2.2 Participatory resource mapping

Resource maps of the three valleys were prepared with the help of village head, healers and other participants in order to understand how the local residents viewed the present landscape. A meeting was arranged with all participants to explain the purpose of resource mapping. The participants were explained the procedure and shown examples of resource maps from other studies (Kalibo 2007, Nemarundwe and Richards 2002). At first a preliminary map with major landscape features (river, mountains) was prepared and later, the distribution of different plant resource was added with the help of herbal healers. Participants were provided large sheets of paper (50cm×50cm), pencils, erasers, and sharpeners. The placement of different landscape features were achieved by consensus among the locals. They were asked to show where they obtained their resources (fodder, fuel-wood, food, medicinal, ornamental, religious, dye and other) and also the and also the protected areas by the village groups, which had been under strict rules. The final map was prepared by incorporating all the information given in separate maps by the participants. They provided descriptive captions that characterized features on the landscape and identified some opportunities and constraints for resource conservation.

7.2.3 Habitat suitability mapping

Habitat suitability map of priority species were prepared using habitat suitability (deductive) model in GIS domain. Five variables, i.e., slope, aspect, elevation, soil and land use/cover, were used to predict the potential habitat of species. The first three variables were derived from Aster Global Digital Elevation Model (AGDEM) which is available at 30m resolution. Soil data were taken from Harmonized World Soil Database (FAO 2012). Since, the soil data are available at 1km resolution, resampling was done at 30m resolution before using it as input for

the model. Land use/cover map was prepared from Landsat TM image of August 2009. Six major classes' *viz.*, plantation, agriculture, scrub, meadow, glacier and very sparse vegetation or bare ground, were derived using unsupervised classification. These classes were interpreted based on the field data collected during the survey work. Only three bands (2, 3 and 4) were used to perform classification. All the above mentioned operations were carried out in ERDAS Imagine 9.3 software.

DEM derived variables were first categorized into discrete classes at equal interval and then each class was assigned a value from one of the four rating classes (0, 1, 2, 3) based on the proportion of its area falling within the 60 m buffer of presence locations. Consideration of buffer area is based on assumption that surrounding environment of presence location is more important compared to the microhabitat condition itself for large scale distribution mapping. Soil and land use/cover classes were also assigned ranks in the similar way. Derivation and ranking of elevation classes are based on mean value obtained within the buffer area. Finally all the five layers were added together and the resultant map was classified in four suitability classes, i.e, unsuitable (1-9), least suitable(10-11), moderately suitable (12-13) and highly suitable (14-15).

Performance of the suitability model was evaluated using Boyce index (Hirzel et.al. 2006) which is a ratio between observed proportion (number of presence in a class/total presence location) and expected proportion (suitability class area / total area). Index was calculated for four suitability class and was plotted as graph. A large graph area above the value 1 indicates higher probability of finding a species in its suitable habitat than merely by chance. Half of the presence location of species was used to develop the model and remaining was used to calculate Boyce index.

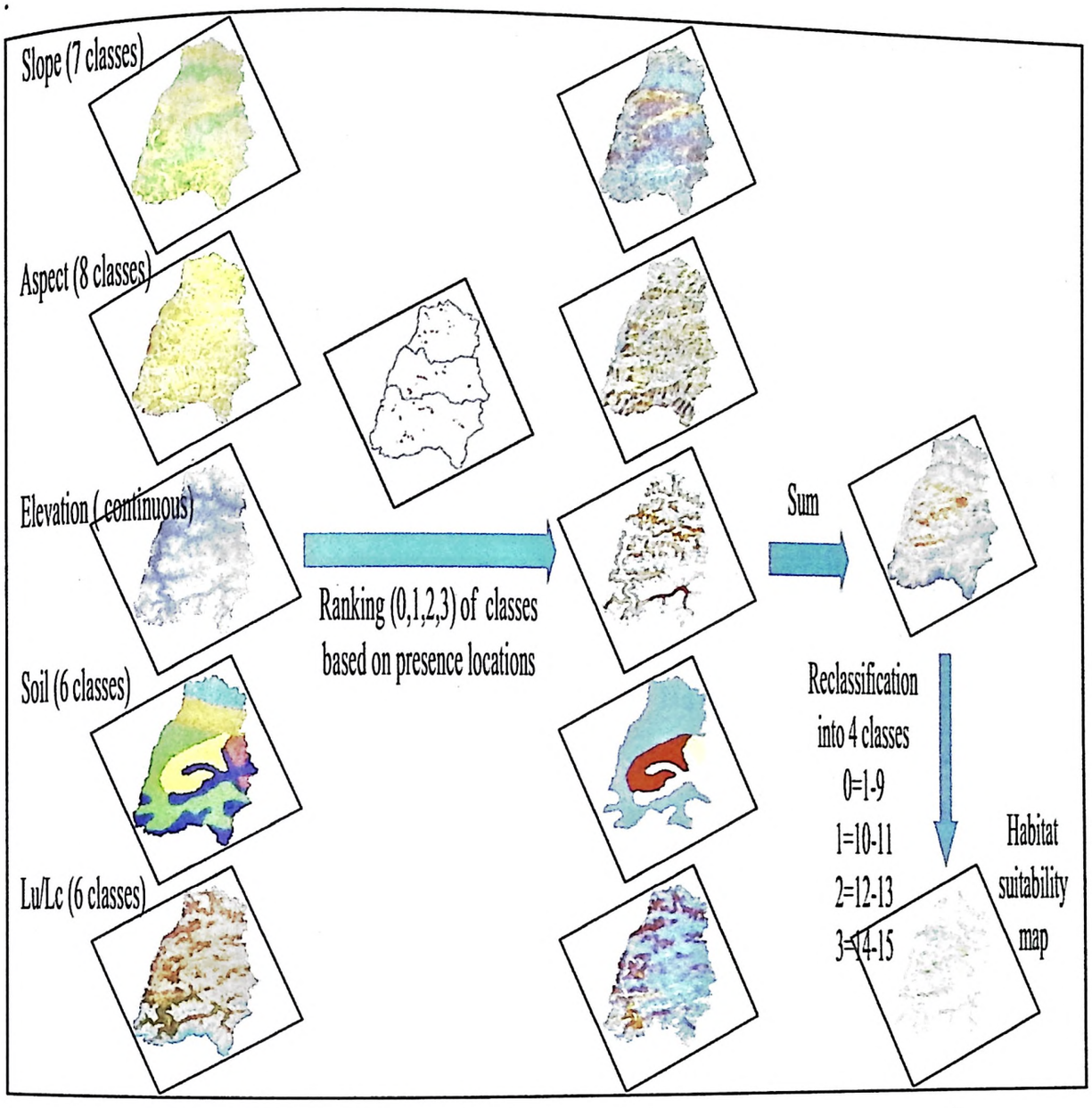


Figure 7.1 Proceesing of Habitat suitability maps

7.3. RESULTS AND DISCUSSION

7.3.1 Species of conservation priority

A total of 84 species has high conservation score above 90 and were kept under category 1 (33 species) and category 2 (51 species). Out of 33 species under category 1, 19 were found mainly in Lower Indus valley (Table 7.2), 18 in the Suru valley (Table 7.3) and 14 in the Wakha-chu (Table 7.4). Species which do not face immediate threat due to harvesting are placed in category 3. Although, some of these species have been listed threatened under various threat categories as per IUCN criteria (Nayar and Sastry, 1987; IUCN, 2001; Ved and Tandon, 1998), they do not fall under high priority in the present study area due to their moderate density and high frequency of occurrence. These species include *Delphinium cashmerianum, Meconopsis aculeata, Rhodiola heterodonta,*

Aconitum violaceum, Lancea tibetica, Lloydia serotina, Physochlaina praealta, Bergenia stracheyi, Podophyllum hexandrum, Clematis orientalis and *Plantago himalaica*. These species are collected less frequently in the study area but have a high diversity of use and harvesting risk (removal of entire plant) in comparison to other species.

Six species were common in all valleys under category 1, which are *Acantholimon lycopodioides* (Girard) Boiss, *Cicer microphyllum* Benth, *Arnebia euchroma* (Royle) I.M.Johnst, *Stachys tibetica* Vatke, *Dactylorhiza* spp and *Aconogonum tortuosum* (D. Don) H. Other species such as *Carum carvi* L, *Aconitum rotundifolium* Kar. & Kir and *Artemisia* spp. were common between Suru and Wakha chu valley. *Junipèrus communis* L., *Rosa webbiana* Wall. ex Royle and *Ephedra gerardiana* Wall. ex Stapf were common between Lower Indus and Suru valley. *Waldheimia glabra* (Decne.) Regel and Hara, *Rhodiola imbricata* Edgew were common between Lower Indus and Wakha-chu. In Lower Indus valley two species *Berberis brandisiana* Ahrendt, *Dactylorhiza* spp. were considered as the most vulnerable plants due to their absence from the sampling quadrats. In Wakha-chu *Arnebia guttata* Bunge was the only species, which was not present in the quadrat sampling.

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Table 7.2 Species of high conservation priority in Lower Indus valley

Plant Species	AD	DS	HR	FC	UD	BS	US	CS	CT
Acantholimon lycopodioides	0.57	10	10	10	10	100	150	125	1
Cicer microphyllum	0.30	10	10	10	10	100	150	125	1
Artemisia maritima	0.78	10	10	10	7	100	135	118	1
Arnebia euchroma	0.11	10	10	7	7	100	120	110	1
Rosa webbiana	0.31	10	4	10	10	100	120	110	1
Aconogonum tortuosum	1.88	7	7	10	10	70	135	103	1
Berberis brandisiana	0.00	10	7	7	7	100	105	103	1
Dactylorhiza spp.	0.00	10	10	4	7	100	105	103	1
Ephedra gerardiana	0.88	10	7	7	7	100	105	103	1
Galium pauciflorum	0.46	10	7	7	7	100	105	103	1
Juniperus communis	0.00	10	4	7	10	100	105	103	1
Oxyria digyna	0.93	10	7	7	4	100	105	103	1
Papaver nudicaule	0.80	10	7	7	4	100	105	103	1
Pedicularis punctata	0.70	10	7	7	4	100	105	103	1
Rhodiola imbricata	0.35	10	10	7	4	100	105	103	1
Stachys tibetica	0.17	10	7	7	7	100	105	103	1
Waldheimia glabra	1.64	7	10	7	10	70	135	103	1
Codonopsis ovata	0.55	10	7	7	7	100	100	100	1
Aconitum rotundifolium	2.1	7	7	7	4	70	120	95	2
Anaphalis busua	0.11	10	7	7	4	100	90	95	2
Artemisia spp.	0.40	10	10	4	4	100	90	95	2
Artemisia sieversiana	0.97	10	10	4	4	100	90	95	2
Clematis orientalis	0.28	10	7	7	4	100	90	95	2
Corydalis govaniana	0.40	10	7	4	7	100	90	95	2
Delphinium brunonianum	0.22	10	7	4	7	100	90	95	2
Hippophae rhamnoides.	0.06	10	4	7	7	100	90	95	2
Rheum moorcroftianum	0.00	10	7	7	4	100	90	95	2
Rheum webbianum	0.32	10	7	7	4	100	90	95	2
Saussurea bracteata	0.05	10	7	7	4	100	90	95	2

(AD= Average density, DS= Density score, HR= harvesting risk, FC= frequency of collection and UD= Use diversity, US=Utilization score, Conservation score, CT=Category)

Conservation priority score of 32 species were kept under category 2 of which 12 were prioritized in Lower Indus valley, 10 in Suru valley and 10 in Wakha-chu. *Hippophae rhamnoides* L. and *Rheum moorcroftianum* Royle were common between Lower Indus and Wakha-chu valley. *Aconitum violaceum,* Jacquem. ex Stapf.was the only species common between Wakha-chu and Suru. *Corydalis govaniana* Wall. was common only between Lower Indus and Suru valley. *Rheum*

webbianum Royle that belongs to category 2 was not recorded in any of the sampling plots and only few individuals were recorded from Lower Indus valley (Table 7.2).

Table 7.3 Species of high conservation priority in the Wakha-chu valley

Plant Species	AD	DS	HR	FC	UD	BS	US	CS	CT
Acantholimon lycopodioides	0.26	10	10	7	3	100	120	110	1
Aconogonum tortuosum	0.41	10	10	7	4	100	120	110	1
Arnebia guttata	0	10	10	7	1	100	120	110	1
Artemisia spp.	0.07	10	10	7	3	100	120	110	1
Carum carvi.	0.33	10	10	7	2	100	120	110	1
Aconitum rotundifolium	0.47	10	10	4	3	100	105	103	1
Arnebia euchroma	0.41	10	10	4	7	100	105	103	1
Cicer microphyllum	0.13	10	7	7	3	100	105	103	1
Corydalis govaniana	0.22	10	7	7	4	100	105	103	1
Rhodiola imbricata	0.51	10	7	7	3	100	105	103	1
Stachys tibetica	0.05	10	7	7	5	100	105	103	1
Waldheimia glabra	0.41	10	10	4	3	100	105	103	1
Delphinium brunonianum	0.89	10	10	7	3	100	105	103	1
Thymus linearis	0.3	10	10	7	3	100	105	103	1
Dactylorhiza spp.	2.66	7	10	7	4	70	120	95	2
Capparis spinosa	0	10	4	7	3	100	90	95	2
Hippophae rhamnoides	0.86	10	4	7	6	100	90	95	2
Rosa webbiana	0.23	10	4	7	8	100	90	95	2
Aconitum violaceum	0.63	10	10	4	2	100	90	95	2
Convolvulus arvensis	0.18	10	7	7	2	100	90	95	2
Delphinium cashmerianum	0.5	10	7	7	2	100	90	95	2
Ephedra gerardiana	0.73	10	7	7	4	100	90	95	2
Nepeta longibracteata	0.1	10	10	4	3	100	90	95	2
Potentilla sp.	0.9	10	10	4	3	100	90	95	2
Rheum moorcroftianum	0.33	10	10	4	4	100	90	95	2

(AD= Average density, DS= Density score, HR= harvesting risk, FC= frequency of collection and UD= Use diversity, US=Utilization score, Conservation score, CT=Category)

Frequency of collection depends on the local and market demand. For most of the species the demand has been fluctuating. However, according to many informers, the local traders have been increasingly exploiting many species for commercial purpose in recent years that is the cause of serious concern. All these factors were considered while calculating the conservation priority score. Number of plants with conservation priority score above 100 varied from 10-15 in different valleys. Only these species were considered for distribution mapping. However, lack of

sufficient number of presence location further restricted the total number up to 16 only.

Table 7.4 Species of high conservation priority in the Suru valley

Plant name	AD	DS	HR	FC	UD	BS	US	CS	CT
Arnebia euchroma	0.31	10	10	7	10	100	135	118	1
Acantholimon lycopodioides	0.083	10	10	7	7	100	120	110	1
Cicer microphyllum	0.101	10	7	10	7	100	120	110	1
Juniperus communis	0.034	10	4	7	10	100	105	103	1
Rosa webbiana	0.067	10	4	7	10	100	105	103	1
Aconitum rotundifolium	0.849	10	7	7	7	100	105	103	1
Aconogonum tortuosum	0.122	10	7	7	7	100	105	103	1
Aquilegia fragrans	0.224	10	7	7	7	100	105	103	1
Artemisia spp.	0.432	10	7	7	7	100	105	103	1
Carum carvi	0.006	10	7	7	7	100	105	103	1
Ephedra gerardiana	0.743	10	7	7	7	100	105	103	1
Hippophae rhamnoides	0.522	10	7	7	7	100	105	103	1
Hippophae tibetana	0.41	10	7	7	7	100	105	103	1
Rheum moorcroftianum	0.103	10	7	7	7	100	105	103	1
Saussurea bracteata	0.476	10	7	7	7	100	105	103	1
Stachys tibetica	0.024	10	7	7	7	100	105	103	1
Waldheimia tomentosa	0.312	10	7	7	7	100	105	103	1
Dactylorhiza spp.	2.573	7	10	7	10	70	135	103	1
Aconitum violaceum	0.881	10	7	4	7	100	90	95	2
Allium przewalskianum	0.401	10	4	7	7	100	90	95	2
Corydalis govaniana	0.463	10	7	4	7	100	90	95	2
Swertia thomsonii	0.143	10	4	7	7	100	90	95	2
Galium pauciflorum	0.868	10	7	7	4	100	90	95	2
Gentianella moorcroftiana	0.698	10	7	7	4	100	90	95	2
Oxyria digyna	0.235	10	7	7	4	100	90	95	2
Plantago tibetica	0.921	10	7	7	4	100	90	95	2
Ribes sp.	0.069	10	7	7	4	100	90	95	2
Thymus linearis	0.113	10	7	7	4	100	90	95	2
Tulipa clusiana	0.979	10	7	7	4	100	90	95	2

7.3.2 Participatory resource mapping

Resource maps prepared by the local communities show a diverse landscape composed of both manmade and natural features. It depicts grazing land on the mountains, shrub land in the lowland, farms and settlements with roads, river and rivulets. Distribution of wild predators was also shown in the grazing lands, which indicate potential danger to livestock in the high altitude pastures. Other important

areas in the map include areas of collection of plant resources and protected areas. Names of different areas may represent unique habitat of a plant species or any geographical feature, hence many areas have similar names in different valleys. Example *"Sari-chen"* named after the place where *Sari* (*Cicer microphyllum*) was collected and *"Lachu-tse"* is a place from where *Lachu* (*Rheum tibeticum*) is collected. Landscape features in the resource map can be described under below mentioned broad categories.

Villages and Pasturelands

Almost every village in Ladakh has its own summer pasture, which is restricted for the people of other villages. The maps produced by the participants showed different landform units based on their usages. In Lower Indus, pasturelands are used during summer and rotational grazing is practiced to avoid over grazing. Families make their own groups and use their respective pasturelands. The person looking after the animals are replaced every week by another family member.

Though, keeping livestock is a major source of livelihood of people of Western Ladakh some villages such as Hanu-thang in Lower Indus do not follow this trend. They are mainly dependent on horticultural activities. Some of the families such as those in Hanu-yokma (LIV) have their own summer pasture, which was restricted to their use only. *Chopodok* is the largest grazing lands where people from all the three villages (or sub-valley) can take their livestock. However, it is no more as productive as before because the presence of Army settlement and construction of infrastructure had led to the deteriotation of the pastureland. There are few small lakes in the valley and *Starkpuchan* lake is the largest among them and is considered as most auspicious lake in the Lower Indus. *Chopodok* is also connected to *Dha-Lungba* which is second largest and important grazing area in Lower Indus valley. People of Batalik take their cattle to *Gargardoh lungba* and *Serchey lungba* where maximum number of depredation was reported. In *Chopodok* the feral dogs annually kill 8-10% of the livestock.

In Wakha-chu valley locals rear their cattle through both migratory and semi-migratory grazing pattern. The valley is comparatively larger with more population of cattle and livestock. The number of livestock has abruptly come down due to scarcity in fodder and the old tradition is changing at faster rate.

People of this valley practice semi migratory system of livestock rearing except in Kanji village where migratory grazing pattern is still being followed. In this valley, also veterans reported a decline in species availability in *Rong, Lachu*-tse.

Except Rangdum, people of all the villages in Suru valley practice semi migratory system of livestock rearing. The farmers in this valley generally hire professional grazers (*Gujars*) who collect the livestock and take them to high pasture in sub-alpine and alpine zones. The livestock are brought back during autumn (June-to August).

Distribution and collection of plant resource

Collection of fuel wood and fodder is done in the same pastureland that is used for grazing. Fuel wood resources have been highlighted in the maps according to their specific habitats such as *Juniperus* sp. (*Shukpa)* in high scrublands and *Hippophae rhamnoides* (*Tsestalulu*), *Salix* spp. (*Brokchang*) and *Myricaria elegans* (*Umbu*). in riverine areas. Fuel-wood are collected in large quantity during the summer. It was estimated that approximately 60-100 kg of fuel-wood is collected per household (n=540) per year. The most extensively collected plants are *Cicer microphyllum* and *Aconogonum tortuosum,* which were used as fodder. Table 7.5, Table 7.6, Table 7.7 shows the plants and area of collection fodder, fuel-wood, medicinal, ornamental, food, dye, religious, other category species were collected as subsidiary species. Kanji, Sapi, Sangra and Rangdum in Suru valley are the hot spots of medicinal plant collection. There are some rules made by the local group, which consist of seven people including village head. But merely with a token of INR 60-100, one can collect medicinal plants from the wild. There is no restriction on the quantity of medicinal plants collected.

Natural /Protected areas

In Western Ladakh, officially, there are four protected areas notified as wildlife reserves (Randum, Brako and Kanji) and game reserves (Bodh Karbu). Other than that, in Lower Indus valley there are two locally protected areas managed by the local women group for ten years on rotational basis. These areas are *Ruray* and *Bunos Bar* where collection of Junipers and any other plants were banned. Other than these two protected areas, a few small areas are also protected because of

their religious significance. These areas are marked with pagoda and Juniper stem with white satin scarf placed on the hilltop with or without animal horns.

The protected area in Wakha-chu valley includes *Wakha-rong*, which is in Wakha village, *Mulbek-rong* in Mulbek, *Phololing-chen*, *Gongma spangbu* and *yokma spangbu* in Darket village are the community-protected valleys, which are partially restricted for 3-4 years from collection. Apart from these protected areas, there is one sacred groove, *Chomo shukpa*, in Western Ladakh, which is in *Phokar-Phu* and consists of strictly protected stand of Junipers. This Juniper patch is supposed to be the abode for their deity. They have a belief that any destruction in the patch will leads to something bad not only to the individual person but also to the whole village. People in this valley are strong believer of this deity (*Shaman*).

Table 7.5 Villages of Lower Indus valley and their pasturelands

S.N	Village	Pasture lands	S.N.	Village	Pasture lands
1	Chullichan	*Wachara, Serchey brok, Mushbar*	8	Beema	*Lastiang dok, Sanit dok, Nirda, Yaldoh dok, Baldez lungba, Phildor lungba*
2	Shertsey	*Mushbar, Serchey brok*	9	Dha	*Yaldor lungba, Nirda, Dha lungba*
3	Batalic	*Serchey Brok, Gar-gar lungba, lahlung dok*	10	Sanatse	*Langtot, manta*
4	GarGardoh	*Gargardoh lungba*	11	Hanugogma	*Spangkhang, Dwazam, Chopodok, Phatalungba*
5	Hurdas	*Hurdas Lungba*	12	Hanu yokma	*Atakur, Chopodok,Khas-khas lungba Tsemomor, Stakpa lungba, Silmor, Spangkhang, Bila-gu*
6	Darchik	*Shashi thang, Manta and Langtot*	13	Hanu thang	*Chopodok*
7	Garkon	*Garkon lungba, Bararu, Yaldor, Nirda, Dah Lungba*			

Table 7.6 Villages of Wakha-chu valley and their pasturelands

S.N.	Village	Pasture lands	S.N.	Village	Pasture lands
1	Minji	*Lamathang, Lunpo-zang, Thalichen*	7	Karamba	*Chumik - gu, Tsos-Tiang, Daser, Samer, Ralambapa, Thang bu*
2	Shargole	*Dip, Sarichen*	8	Khatsey	*Tyan-doh, Apodong, Nei-ngos, Ka-chok, Tai-chu, Lora, Skimthang, Spangthang, Chaba-brok, Tapir*
3	Paskum	*Nangmikkok, Shakulekchey, Kapiloo, Kurbathang, Farki haltab*	9	Phokar-Phu	*Sapila, Chumi-gu, Gangma-go, Samikchan and yukpol*
4	Lotsum	*Lungbar, Kasbuchan, Stothang sandar*	10	Mulbek	*Mulbek rong, Kumber, Brak-kar, Tser-zey, Byang-sa, Mas-pus, khansar, Chomolung, Lungnis*
5	Darket	*Darket Lungba, Skangbu, Ri-si thang, Bill billthang*	11	Wakha	*Kum-bar, Namikila, Lambar thang, Wakha Rong,*

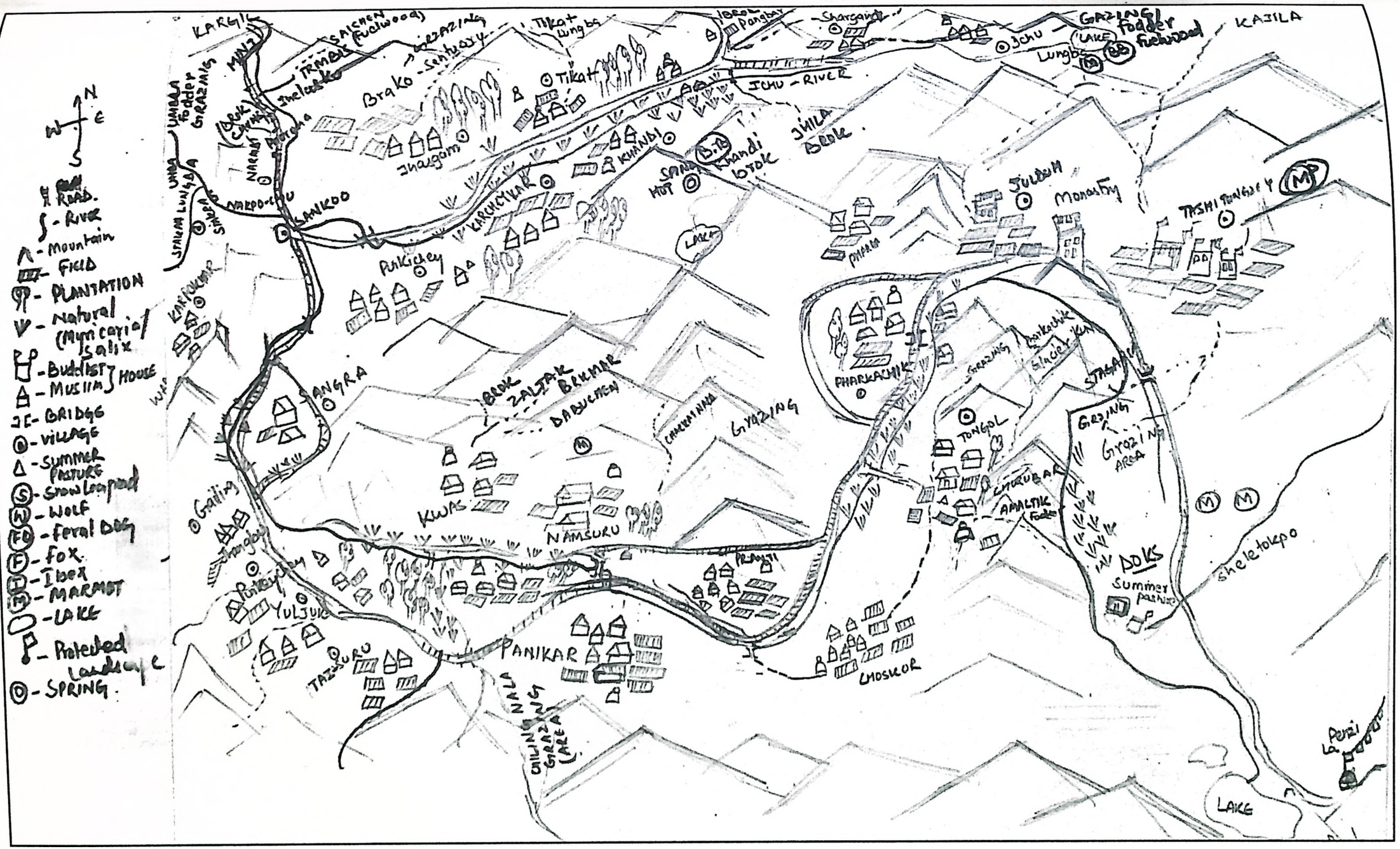

Figure 7.2 Map of the Suru valley drawn by the participants to indicate where natural resources are found and their collection area

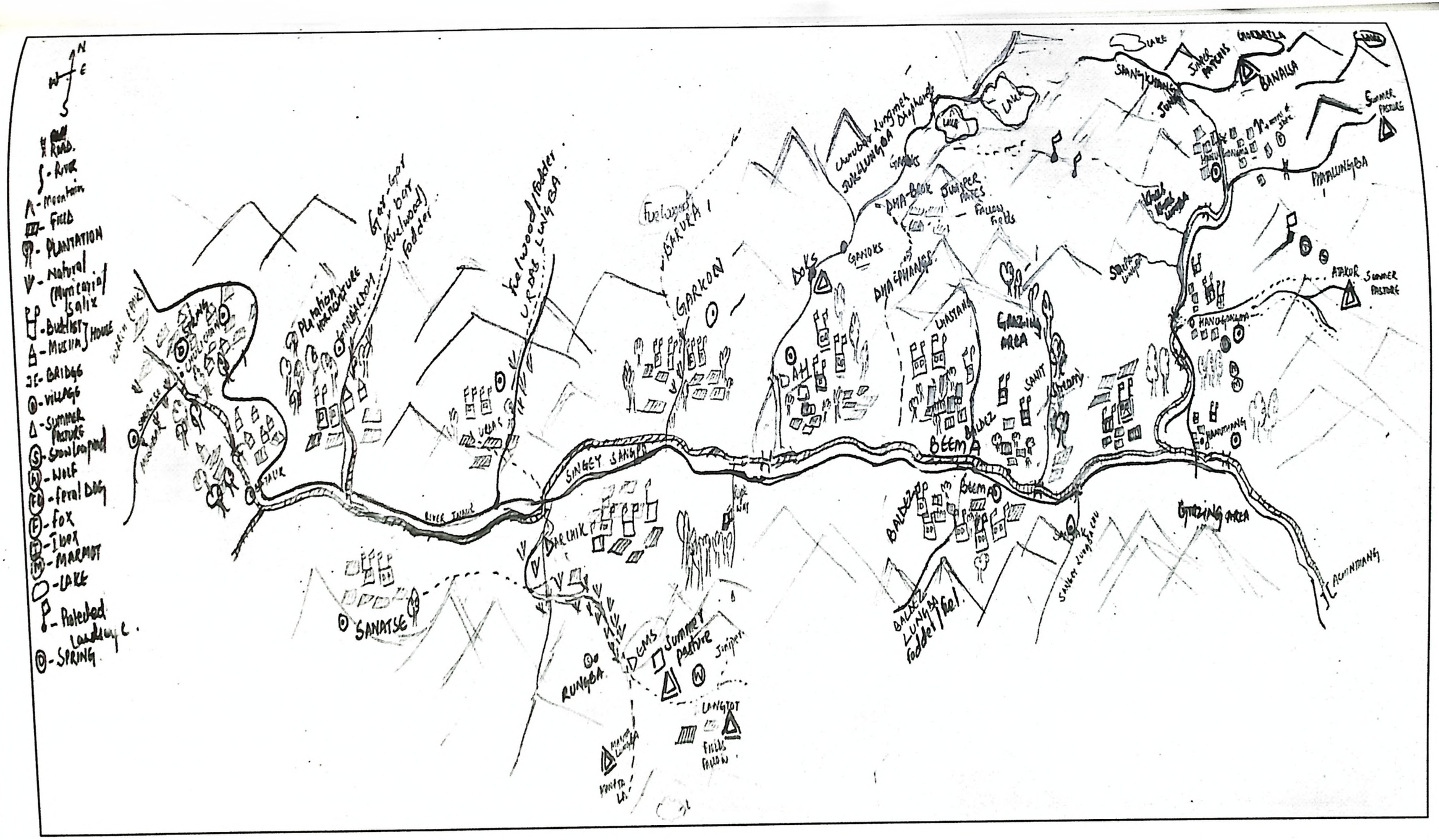

Figure 7.3 Map of the Lower Indus valley drawn by the participants to indicate where natural resources are found and their collection area

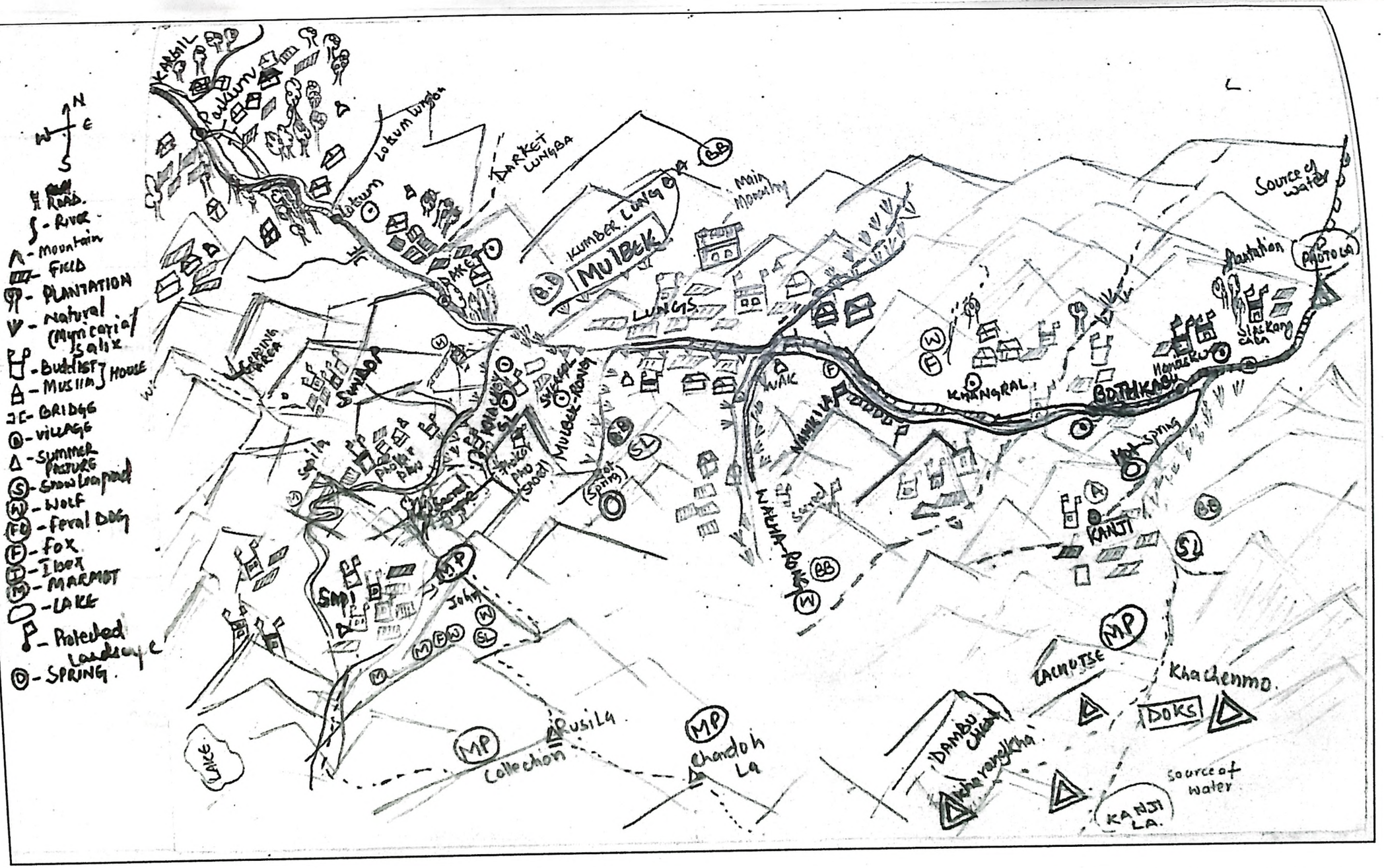

Figure 7.4 Map of the Wakha-chu valley drawn by the participants to indicate where natural resources are found and their collection area

Table 7.7. Villages of Suru valley and their pasture lands

S.N.	Village	Pasture lands	S.N.	Village	Pasture lands
1	Tashi tongzey	*Rong, Stagabsa, Khosokla, Sheletokpo, Penzila, Doks*	21	Nakma, Kusar	*Nakpo-chuRi, Ri nakpo*
2	yul-Doh	*Stagabsa, Rong, Shapat nalla*	22	Karchey Khar	*Ser-Ser mo, Sari-Brok, Gana brok, Yokma- gato khar, Che lasa*
3	Pharkachik	*Phrka Ri, Shapat nalla*	23	Thasgam-thuina	Ri,
4	Tongol	*Chubar, Thanak, Amaltik*	24	Barsoo	*Brokchong, Choo-brok, Nizar, Biangszgam, Dambutse*
5	Achambur	*Ri, Rong*	25	Thila	Thila Brok
6	Kochik	Rong	26	Khandi	*Khandi brok, Tik-Tik lungba, jongkhangsa, Zgangbar lungba,*
7	Choskar	*Pranti or Chokor lungba*	27	Shargandi	*Rongtse*
8	Pranti	*Pranti Ri*	28	Ichhu	*Icchu Lungba, wakha la*
9	Panikar	*Chilling nala*	29	Pangbar	*Chargot la, Rusi la*
10	Thulus Pursa	*Nam-suru nalla*	30	Lankerchey	*Mesarsok,Dambutsrwa, Ritwrstwa, Sumdoh nalla, Shakring*
11	Kargee	*Chilling nala*	33	Phurana	*Laser, Gongpodoks, Brokchung, Kamburat*
12	Taisuru	*Chilling nala*	34	Selaskot	*Spang, langma,*
13	Namsuru	*Chrkat nalla*	35	Gon Mamgalpur	*Rigabsa,*
14	Kwas	*Zaltak,kunchung,gakschung,chu-ink, chudoktse spang, brok, Dambu, Brakmar*	36	Trespone	*Sarichen la, Brok-chung, Dips*
15	Yuljuk	*Shangshing nalla*	37	Kanor	*Sapi nalla*
16	Putikchey	*Spanglung, sailung, Kapaling, Naksbur shishing, sari Nagma, Shadmarigmo*	38	Trambis	*Saichen, Sharul*
17	Gailing	*Phu*	39	Sapi	*John, brakar*
18	Sangra	*Nakpo-sbrok*	40	Minji	*Lamathang, Lunpo-zang, Thalichen*
19	Karpokhar	*Har-kor nalla, Stak-sok, Burtse thang, Diks, Lunrtse-thang*	41	Baru	*Baru*-rong
20	Thang-dumbur	*-Rong*	42	Stakpa	*Stakpa* ri



Plate VI: Anthropogenic Pressure in Western Ladakh

7.3.3 Harvesting potential

Category 1 includes species not found during the sampling in the Lower Indus valley but are listed as key species from the same valley, which is *Dactylorhiza kafiriana* and *Berberis brandisiana*. All the species in category 1 and category 2 have very low densities. However, conservation score was base on the utilization risk also.

Species categorized under high conservation priority have limited harvesting potential and they needed immediate attention from the healers, locals as well as conservation agencies. Species with limited use and medium conservation priority can be allowed to harvest after deciding their harvesting potential based on scientific guidelines. Species, kept under medium or low conservation priority (Table 7.2, Table 7.3, and Table 7.4), can be harvested to meet the current local requirements but must be monitored regularly to ensure their healthy population size.

Harvesting potential of species depends on regeneration capacity of species, life form of plants (annual or perennial), and various other factors. Several medicinal herbs, e.g., *Dactylorhiza hatagirea, D. kafiriana, Aconitum rotundifolium, Aconitum heterophyllum,* and *Aconitum violaceum* perennate through tubers and seeds. They can withstand exploitation if not harvested for tuber. But these species are harvested for tubers by the healers and upper stem by the locals for fodder. Harvesting after flowering and fruiting is suggested to increase both the yield and the quality of resources while this practice also ensures natural regeneration (Dzerefos and Witkowski 2001). Species like *Aster glaccides*, *Saussurea* sp. are as they are perrnnial and they have compararably less harvesting risk. Species such as *Aconitum heterophyllum,* and *Aconitum violaceum* are threatened and do not need any specific conservation measure, but leaving at least one area (habitat) intact will ensure their continuous availability in future.

Though livestock grazing per se does not affect the populations of medicinal plants (most of them being unpalatable), excessive grazing can lead to soil erosion and habitat degradation (Thapa and Chapman 2010). It is noteworthy that more than 40,000 cattle and 50,000 sheep and goats use the pastures of Western Ladakh every year and creates immense pressure on the plant resource available in the area. Obnoxious species such as *Rumex nepalensis* and *Polygonum paronychioides* grow in abundance on places where grazing intensity is high and these plants create hindrance in the growth of several dwarf

medicinal herbs. Grazing pressure is low in Lower Indus valley as compared to other two valleys.

Providing alternatives to fuel wood and fodder species along with the cultivation of commercially important species may be helpful in conservation planning. There is immense potential to grow some wild species in home gardens in Western Ladakh. Efforts to cultivate some medicinally important species have not been fully successful in this region and more research and development is required.

Category 3 species such as *Delphinium cashmerianum* was found at high densities and is widely distributed across Suru, but is scarcely found in Lower Indus valley. *Aconitum violaceum* was found in Suru valley in field margin habitat with high density. *Tulipa stellata* are widely distributed across Suru valley but has low densities in Wakha-chu valley and was absent in Lower Indus valley. Average densities of harvestable species range from 12.6 individual's m^{-2} to 0.01 individuals m^{-2} while non-harvestable species range from 0.8 individuals m^{-2} to 0.02 individuals m^{-2}. The proposed harvesting zone in the Suru valley has high density of several harvestable species.

7.3.4 Geographical distribution of species of conservation priority

Habitat suitability map of 14 species out of 16 species predicted reasonable results as more species presence location was found in suitable habitat than unsuitable habitat, however in case of *Dactylorhiza* spp. (*Dactylorhiza kafiriana* and *Dactylorhiza hatagirea)* and *Rhodiola* sp. the performance of model was poor (Figure G and H). Boyce index performs reasonable for species which are not very specific to a particular habitat (Hirzel et. al. 2006), but it does not imply to *Dactylorhiza* which was found growing in more diverse habitat than Rhodiola. Other possible reason of poor performance of model could be a lack of randomness in presence locations. (Appendix V).

Number of species needing conservation assistance for survival is increasing day by day due to their reduced extent of distribution as a result of either change in environmental factors associated with their habitat or overexploitation by human beings. Human and financial resource available for conservation activities are limited and hence careful selection of approaches for conservation is necessary. In comparison to methods that require extensive data and are more time and resource consuming, the current method

provides a fast and reliable approach to identify action priorities in geographical space with lesser information on species occurrence.

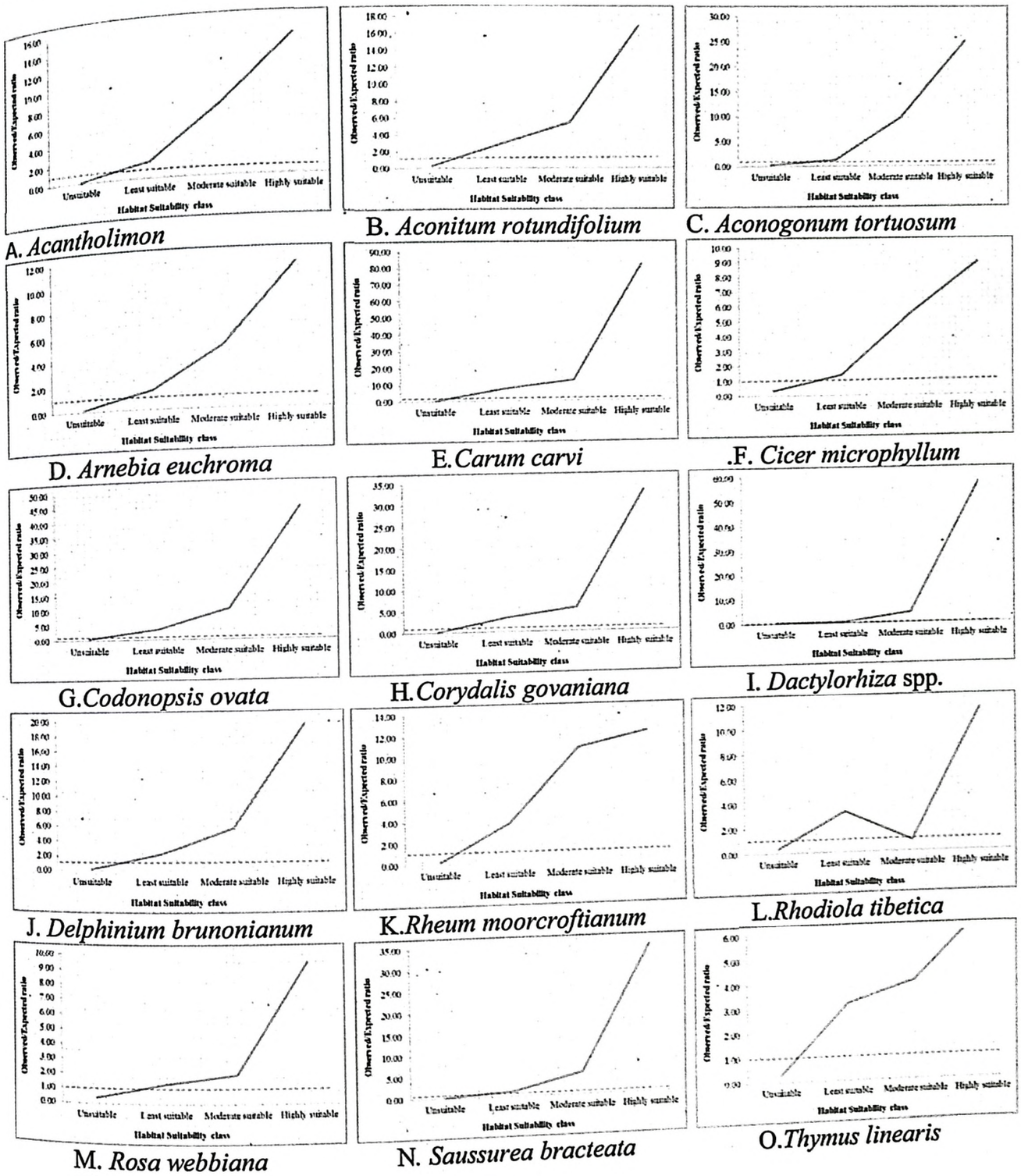

Figure7.5 Boyce index for the habitat suitability map of different species (A-O)

Total geographic area covered under highly and moderately suitable class of different species suggests that 3 (*Carum carvi, Codonopsis ovata*. and *Rheum moorcroftianum* out of 16 species have narrow geographic range (1-3% of total area) while 3 species (*Rheum*

tibeticum, Rhodiola tibetica and *Arnebia euchroma*) have wide range of distribution (10-16% of total area).

Orientation of mountain in different valleys greatly affects the proportion of aspect classes and hence the distribution of species. Wakha-chu and Lower Indus valley has almost similar orientation with dominating North-East and South-West aspect while Suru valley has more East and North-West aspect (Chapter-1). Most of the species are distributed on North and North-West aspect. Species, which has considerable area of its habitat on South-West aspect, includes *Aconitum rotundifolium, Aconogonum tortuosum, Codonopsis clematidea, Dactylorhiza* spp. and *Rheum* sp.

The most preferred slope class for most of the species is 20-30° followed by 10-20° while, species such as *Dactylorhiza hatagirea* , *Carum carvi*, and *Codonopsis ovata* species preferred less than 10° slope. Species which were found on slopes steeper than 30° include *Rheum moorcroftianum*, *Saussurea bracteata* and *Rhodiola tibetica*. The areas with steeper slopes (20-40°) are present more in Suru valley hence, it consists more suitable habitat in comparison to other two valleys.

Elevation was considered as proxy for several environmental factors, most importantly temperature, hence it represents environmental limit that constitutes species habitat. Suitable habitats of most of the species are distributed within the elevation range of 3500-4500m. Species which are distributed at higher elevation (>4000m) includes *Saussurea bracteata, Corydalis govaniana, Gentiana transalaica* and *Rheum moorcroftianum* while *Carum carvi*, *Codonopsis ovata* and *Dactylorhiza* spp. are distributed at comparatively lower elevation (<4000m). Areas above 4500m elevation are mainly present in Suru valley.

Composition of soil is different in three valleys which caused considerable spatial variation in the distribution of species across valleys. Cambisol of Suru valley is most suitable soil for 10 out of 16 species followed by Leptosol, which was preferred, by four species. *Aconitum rotundifolium*, *Saussurea bracteata*, *Rhodiola tibetica* and *Delphinium brunonianum* were also found on Acrisol soil which is mainly composed of rock. While number of presence location could have affected the class representation, it can be assumed that species has more chance to be encountered in most suitable habitat.

Land use/cover of an area represents both differences between natural and human dominated landscape as well as variation within each type. Three classes that were found associated with most of the species are alpine meadow, alpine scrub and areas with sparse vegetation. Presence of species in later class indicates their adaptation to more harsh condition than those species found in other two classes. 12 out 16 species occurred mainly in alpine meadow class. *Codonopsis ovata* and *Dactylorhiza* sp. has most of its suitable habitat under alpine scrub class while *Acantholimon lycopodioides.*, *Arnebia euchroma* and *Rheum moorcroftianum* were found equally associated with alpine meadow and very sparse vegetated surface class. *Carum carvi* and *Codonopsis ovata* were distributed around agricultural field indicating that human intervention could have added to its regeneration status.

Suitable range of temperature and availability of soil moisture are probably the most important factor for plant growth in high altitudes. The accuracy of present distribution map can be improved by incorporating these variables in the model. However, one can assume that all the three valley fall within same climatic zone and hence there is no spatial variation due to climate. Some species show adaptation to a wide range of climatic condition such as *Delphinium brunonianum* was found from 3200 to 4600 m elevation range while *Corydalis govaniana* were found within a narrow range (3900-4600m) of geographic and climatic parameters.

Habitat suitability map generated with the help of geographical variables provide a broad idea regarding the possible extent of species habitat. Despite several limitation of the adapted method, it has been used successfully to make a preliminary estimation of extent of occurrence of species. However, a further refinement in the mapped distribution is necessary to improve its accuracy, which can be done through verifying areas depicted in the map. The rapid loss of biodiversity worldwide, mainly due to anthropogenic activity, has led to the need to search areas of high conservation importance (Kati et al. 2004, García 2006). However, identification of such areas is not enough and further assessment of different aspects such as the requirement of rapidly growing human population is also necessary (Cincotta et al. 2000). Human activities in all the three valleys are increasing day by day due to tourism and developmental activities, which need to be managed to add conservation efforts.





Figure 7.6 *Acantholimon lycopodioides* and its habitat

***Acantholimon lycopodioides* (Girard) Boiss.** is commonly known as *Longzey* and are valued as one of the most important plants among the locals as firewood and fodder species. The species blooms in July-September. The species is distributed in all the three valleys. The presence of this species is mostly in the high elevations areas in stable and alpine meadows and may also occurs in cliff, stable slopes, at plateau table and scree.

Table7.8 Class rank of variables for *Acantholimon lycopodioides* habitat mapping

Variable	Class	Area (%) within buffer	Rank
Aspect	337.5-22.5	35.25	3
	22.5-67.5	19.35	2
	67.5-112.5	3.61	1
	112.5-157.5	6.56	1
	157.5-202.5	3.36	1
	202.5-247.5	7.46	1
	247.5-292.5	7.87	1
	292.5-337.5	16.56	2
Slope	<10	6.80	1
	10to20	27.70	2
	20-30	43.52	3
	30-40	16.72	2
	>40	5.16	1
Elevation	3400-3600	-	1
	3600-3800	-	2
	3800-4100	-	3
	4100-4300	-	2
	4300-4500	-	1
Soil	Acrisol	9.71	1
	Cambisol (moist)	16.89	2
	Cambisol (dry)	60.47	3
	Leptosols	4.39	1
	Leptosols (cryic)	8.53	1
Lu/Lc	Plantation	0.00	0
	Agriculture	0.00	0
	Alpine scrub	5.49	1
	Alpine Meadow	52.46	3
	Snow / Glacier	0.00	0
	Sparse vegetation	42.05	2

Table 7.9 Density of *Acantholimon lycopodioides* across different landform units in three valleys

Habitat	Density /Ind m-2		
	Lower Indus	Wakha-chu	Suru
Alpine meadow	-	0.04±0.00	-
Plateau	1.98±0.48	0.14±0.0	-
Stable	0.19±0.07	0.27±0.06	0.0001±0.00
Rock and cliff	0.027±0.0	0.40±0.19	0.16±0.06
Scree	0.38± 0.06	0.46±0.14	-
Moraine	0.25±0.17	0.25±0.11	-

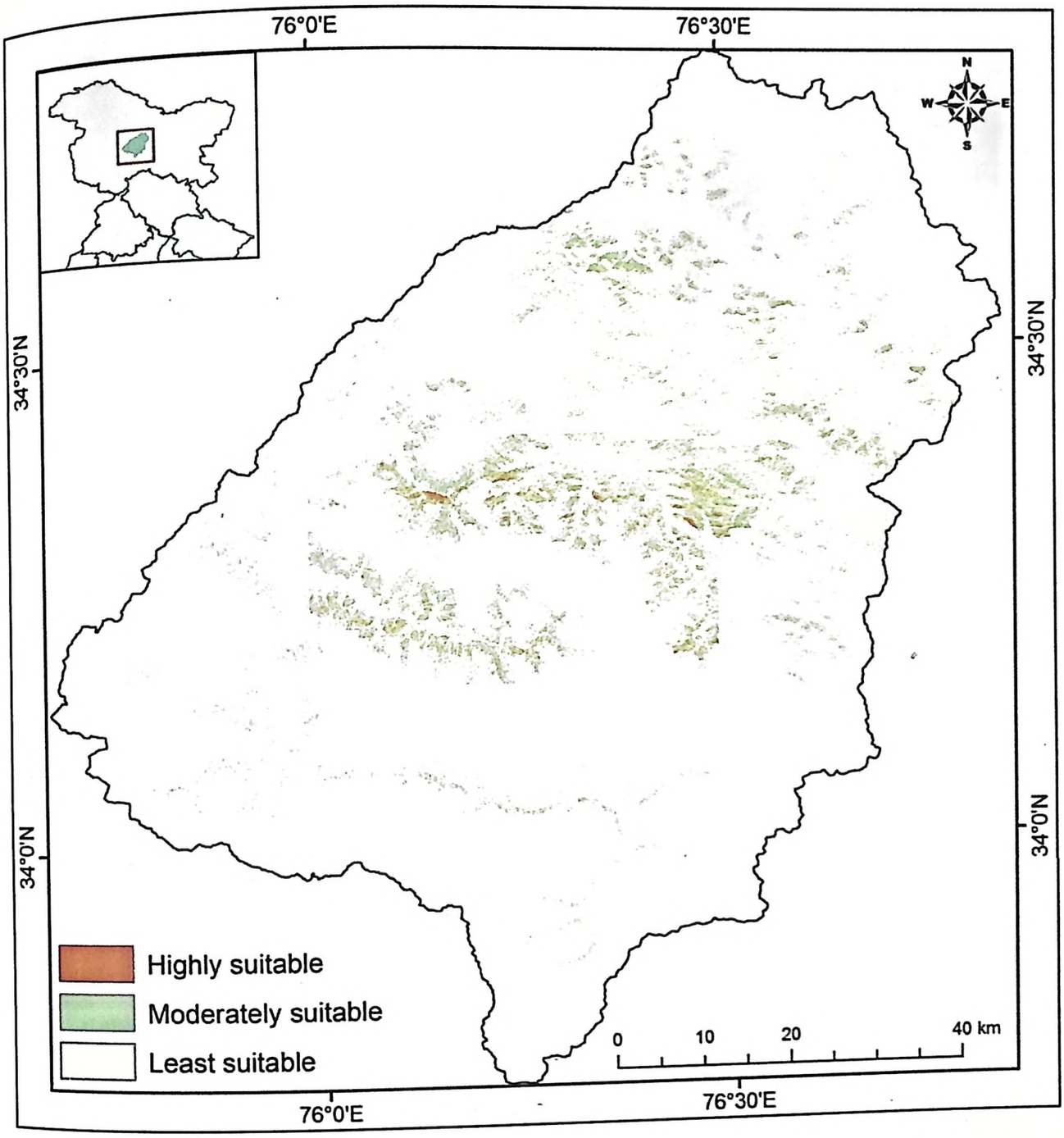

Figure 7.7 Distribution of suitable habitat of *Acantholimon lycopodioides*

Table 7.10 Area under different suitability class of *Acantholimon lycopodioides* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	639.09	2062.35	454.86	3156.30
Moderately suitable	9244.44	20184.93	10438.02	39867.39
Least suitable	36017.37	53382.60	40787.73	130187.70





Figure 7.8 *Aconitum napellus var. rotundifolium* and its habitat

Aconitum napellus var. rotundifolium (Kar. & Kir.) Hook. f. & Thomson is commonly known as *Boga* and was encountered on the higher elevations in Western Ladakh mostly recorded above 3800-4500m. It was encountered in the high stable and alpine meadows in Suru valley, in stable and moranic slopes in Wakha-Chu valley and in boulder, stable and marsh meadows in Lower Indus valley. The plant appears in late June and flowers till early August-September.

Table 7.11 Class rank of variables for *Aconitum rotundifolium* habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	31.79	3
	22.5-67.5	4.42	1
	67.5-112.5	8.17	1
	112.5-157.5	2.21	1
	157.5-202.5	1.99	1
	202.5-247.5	14.79	2
	247.5-292.5	11.70	2
	292.5-337.5	24.94	3
Slope	<2	0.00	0
	2to10	13.69	2
	10to20	40.40	3
	20-30	36.20	3
	30-40	9.49	1
	>40	0.22	0
Elevation	3400-3600	-	1
	3600-3800	-	2
	3800-4100	-	3
	4100-4300	-	2
	4300-4500	-	1
Soil	Acrisol	33.55	2
	Cambisol (moist)	11.04	1
	Cambisol (dry)	0.00	0
	Leptosols	11.48	1
	Cryic Leptosols	43.93	3
LU/LC	Plantation	0.00	0
	Agriculture	0.00	0
	Alpine scrub	37.75	2
	Alpine Meadow	51.66	3
	Snow / Glacier	0.00	0
	Sparse vegetation	10.60	1

Table 7.12 Comparison of density of *Aconitum rotundifolium* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Alpine meadow	1.72±0.69	-	1.688±0.01
Stable slope	2.28± 0.83	0.07±0.0	0.01±0.0
Moraine	-	0.87±0.37	-
Boulders	2.33±0.3	-	-

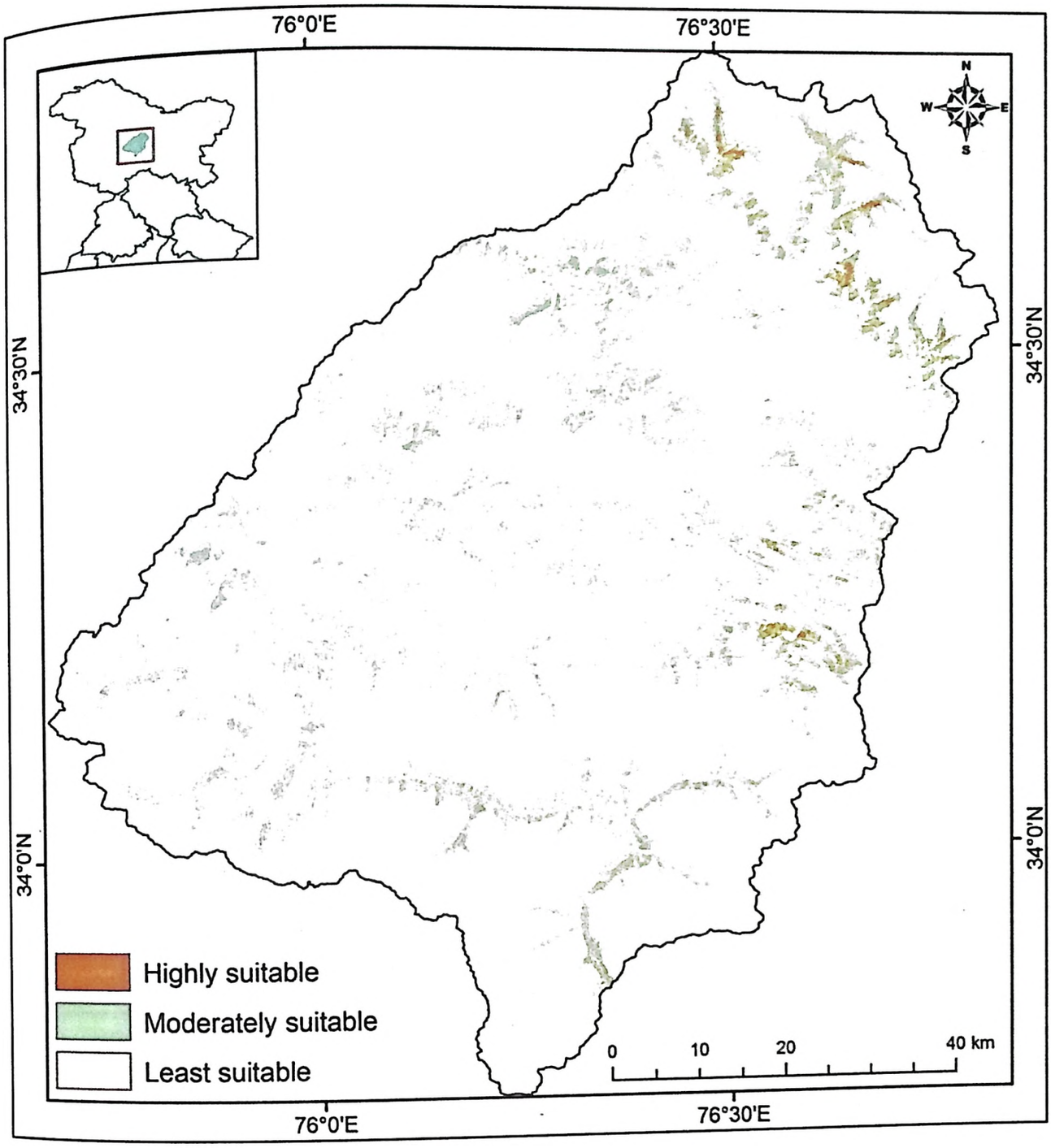

Figure 7.9 Distribution map of *Aconitum rotundifolium*

Table 7.13 Area under different suitability class of *Aconitum rotundifolium*

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	41.76	610.29	2576.52	3228.57
Moderately suitable	7813.26	8919.36	13426.29	30158.91
Least suitable	32446.17	31977.72	29289.06	93712.95





Figure 7.10 *Aconogonum tortuosum* and its habitat

Aconogonum tortuosum commonly known as *Nyalo* and are found along the elevation of 3500-4600m in Stable and Moraine. It is used as one of the important fodder species and is extracted in large quantaties. It is also used in religious, ornamental and medicine. The plant appears in late May and flowers till early July-August.

Table 7.14 Class rank of different variables for *Aconogonum tortuosum* habitat

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	25.13	3
	22.5-67.5	10.81	2
	67.5-112.5	6.56	1
	112.5-157.5	7.61	1
	157.5-202.5	7.16	1
	202.5-247.5	10.89	2
	247.5-292.5	10.89	2
	292.5-337.5	20.95	3
Slope	<2	0.00	0
	2to10	4.40	1
	10to20	24.76	2
	20-30	46.23	3
	30-40	20.95	2
	>40	3.65	1
Elevation	3400-3600	-	1
	3600-3800	-	2
	3800-4200	-	3
	4200-4400	-	2
	4400-4600	-	1
Soil	Acrisol	18.72	2
	Cambisol (moist)	7.38	1
	Cambisol (dry)	61.07	3
	Leptosols	7.76	1
	Cryic Leptosols	5.07	1
LU/LC	Plantation	0.00	0
	Agriculture	0.07	0
	Alpine scrub	22.30	2
	Alpine Meadow	54.59	3
	Snow / Glacier	0.00	0
	Sparse vegetation	23.04	2

Table 7.15 Comparison of density of *Aconogonum tortuosum* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Alpine meadow	-	-	0.10±0.07
Plateau	-	-	0.15±0.04
Stable	1.49±0.38	0.79±0.15	-
Rock and cliff	-	-	0.04±0.0
Scree	-	0.36±0.16	0.12±0.01
Moraine	2.26±0.22	0.4±0.18	0.19±0.13

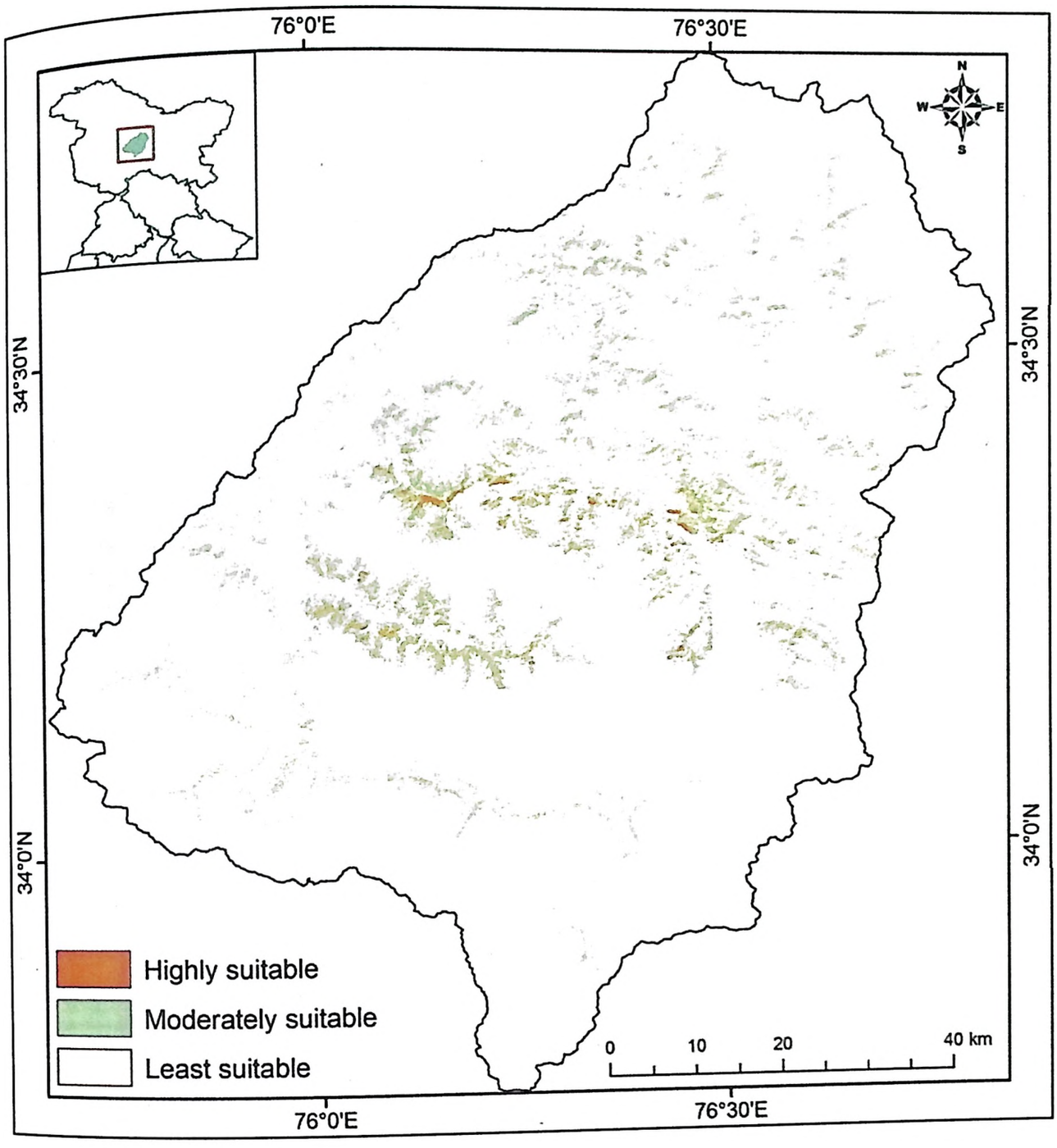

Figure 7.11 Distribution map of *Aconogonum tortuosum* habitat

Table 7.16 Area under different suitability class of *Aconogonum tortuosum* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	1051.56	2327.94	0.09	3379.59
Moderately suitable	9609.93	15835.95	5803.38	31249.26
Least suitable	34009.74	44990.37	23551.92	102552.03





Figure 7.12 *Arnebia euchroma* its habitat

***Arnebia euchroma* (Royle) I.M.Johnst.,** commonly known as *Demok* and are found along the elevation of 3500-4600m in stable, rock and cliff, moraine, scree and marsh meadow. It is used in food, fodder, fuelwood, ornamental, religious, dye, medicinal and other use categorized. It is in flower from June to August, and the seeds ripen from July to September.

Table 7.17 Class rank of variables for *Arnebia euchroma* habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	24.71	3
	22.5-67.5	20.93	3
	67.5-112.5	6.42	1
	112.5-157.5	8.36	1
	157.5-202.5	6.95	1
	202.5-247.5	8.80	1
	247.5-292.5	12.23	2
	292.5-337.5	11.61	2
Slope	<2	0.09	0
	2to10	7.92	1
	10to20	22.78	2
	20-30	42.04	3
	30-40	24.10	2
	>40	3.08	1
Elevation	3400-3600	-	1
	3600-3800	-	2
	3800-4100	-	3
	4100-4300	-	2
	4300-4500	-	1
Soil	Acrisol	0.00	0
	Cambisol (moist)	4.63	1
	Cambisol (dry)	63.16	3
	Leptosols	23.23	2
	Cryic Leptosols	8.98	1
LU/LC	Plantation	0.00	0
	Agriculture	0.00	0
	Alpine scrub	15.30	2
	Alpine Meadow	43.36	3
	Snow / Glacier	0.00	0
	Sparse vegetation	41.34	3

Table 7.18 Comparison of density of *Arnebia euchroma* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Stable	-	0.23±0.08	0.002±0.0
Rock and cliff	0.06±0.02	0.58±0.12	0.2±0.12
Moraine	-	-	0.18±0.07
Scree	0.15±0.13	0.43±0.19	-
Marsh meadow	-	-	0.85±0.37

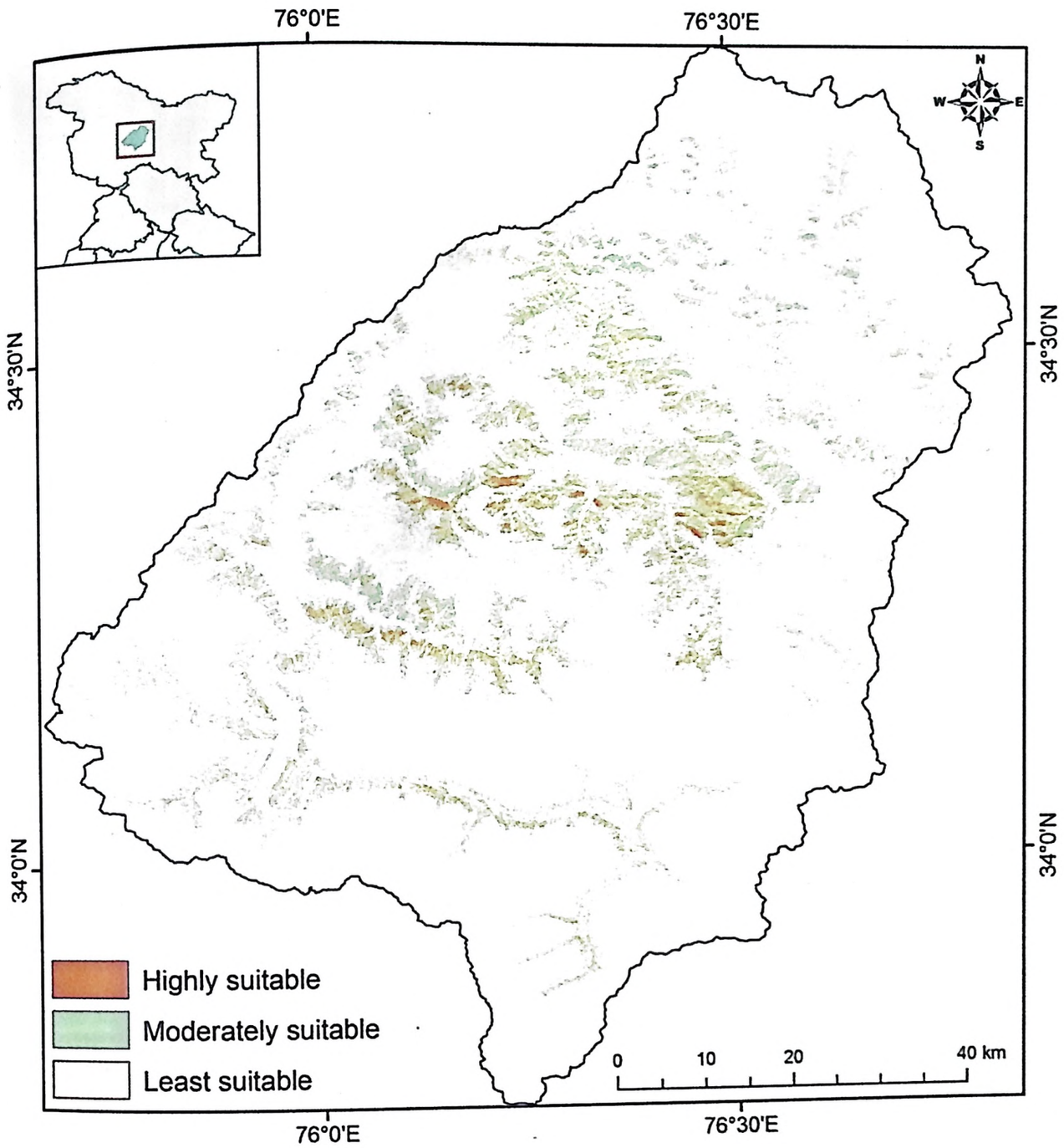

Figure 7.13 Distribution map of *Arnebia euchroma* habitat

Table 7.19 Area under different suitability class of *Arnebia euchroma* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	2429.10	5633.55	667.80	8730.45
Moderately suitable	19107.00	28722.51	12239.19	60068.70
Least suitable	46192.23	50802.12	32619.69	129614.04



Figure 7.14 *Carum carvi* and its habitat

Carum carvi L commonly known as *Nyotse* and are found along the elevation of 2900-3700m in Field margins and Marsh meadow. It is used in food, fodder, and medicinal categories. It is in flower from June to July, and the seeds ripen from July to August.

Table 7.21 Class rank of variables for *Carum carvi* habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	10.86	2
	22.5-67.5	13.09	2
	67.5-112.5	6.42	1
	112.5-157.5	3.21	1
	157.5-202.5	4.69	1
	202.5-247.5	6.67	1
	247.5-292.5	30.62	3
	292.5-337.5	24.44	3
Slope	<2	0.25	0
	2to10	65.19	3
	10to20	26.91	2
	20-30	3.70	1
	30-40	3.46	1
	>40	0.49	0
Elevation	2800-3000	-	1
	3000-3200	-	2
	3200-3400	-	3
	3400-3600	-	2
	3600-3800	-	1
Soil	Acrisol	0	
	Cambisol (moist)	0	
	Cambisol (dry)	12.59	1
	Leptosols	87.41	3
	Cryic Leptosols	0	
LU/LC	Plantation	6.67	1
	Agriculture	61.98	3
	Alpine scrub	18.27	2
	Alpine Meadow	11.60	1
	Snow / Glacier	0	
	Sparse vegetation	1.48	1

Table 7.21 Comparison of density of *Carum carvi* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Field margin	-	0.23±0.15	1.47±0.24
Marsh meadow	-	0.42±0.28	1.28±0.54

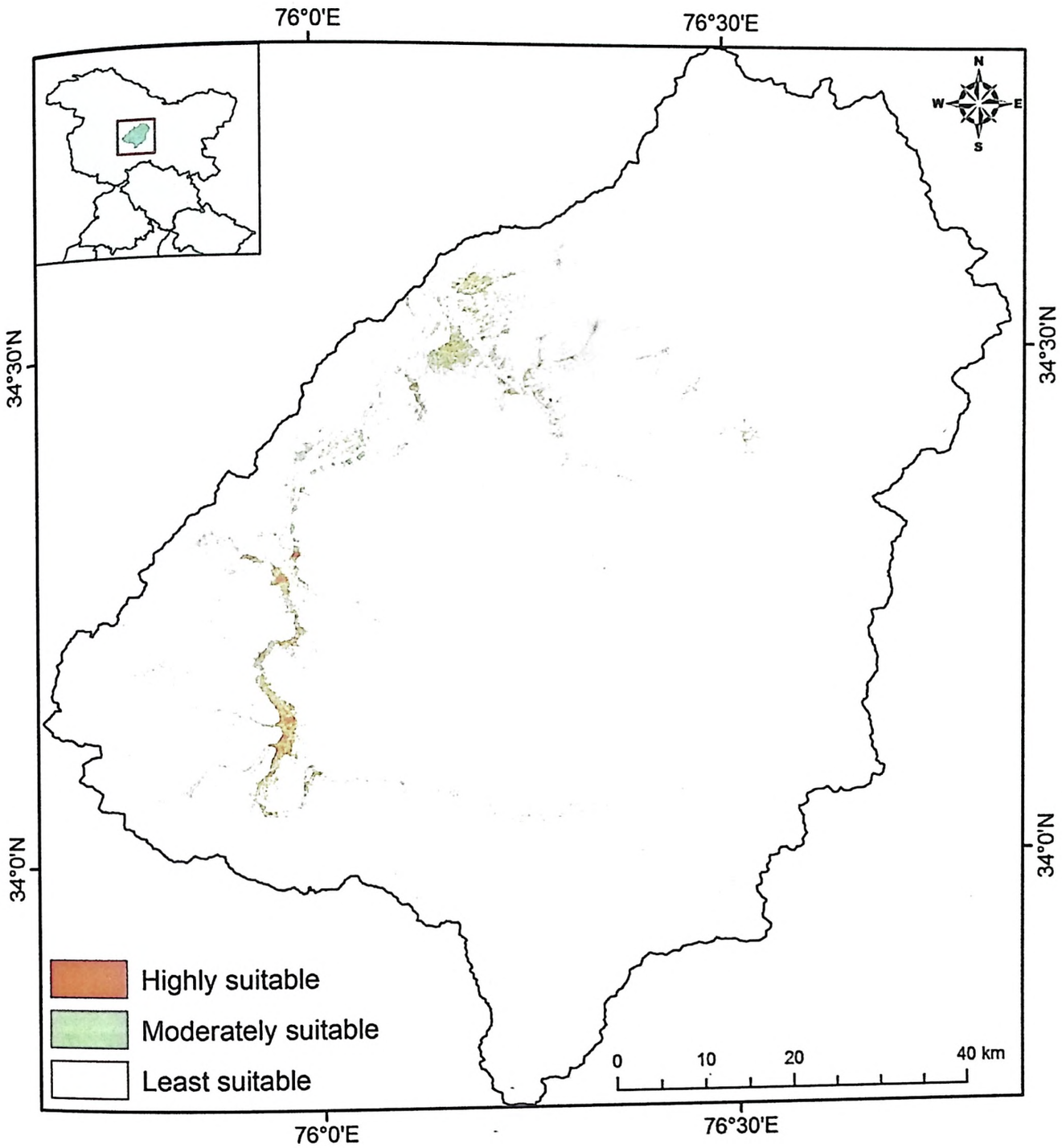

Figure 7.15 Distribution map of *Carum carvi* habitat

Table 7.22 Area under different suitability class of *Carum carvi* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	1318.05	502.47	16.11	1836.63
Moderately suitable	4082.40	3810.06	305.19	8197.65
Least suitable	17875.35	14093.82	2592.27	34561.44





Figure 7.16 *Cicer microphyllum* and its habitat

Cicer microphyllum is commonly known as *Sari* is one of the most important fodder species of Western Ladakh and had been extracted in bulk from the wild. It is used in *Amchi* system of medicine and also used locally by the people for curing ulcer in animals. The pods and leaves are edible and eaten as local delicacy. It is distributed at an elevation of 3500-4500m. It is in flower from June to August.

Table 7.23 Class rank of variables for *Cicer microphyllum* habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	22.71	3
	22.5-67.5	15.39	3
	67.5-112.5	6.03	1
	112.5-157.5	4.52	1
	157.5-202.5	8.40	1
	202.5-247.5	8.40	1
	247.5-292.5	11.19	2
	292.5-337.5	14.85	3
Slope	<2	0.12	0
	2to10	4.00	1
	10to20	17.88	2
	20-30	43.65	3
	30-40	27.65	2
	>40	6.71	1
Elevation	3500-3700	-	1
	3700-3900	-	2
	3900-4100	-	3
	4100-4300	-	2
	4300-4500	-	1
Soil	Acrisol	0.00	0
	Cambisol (moist)	17.65	2
	Cambisol (dry)	47.18	3
	Leptosols	17.41	2
	Cryic Leptosols	17.76	2
LU/LC	Plantation	0.00	0
	Agriculture	0.00	0
	Alpine scrub	31.88	2
	Alpine Meadow	48.24	3
	Snow / Glacier	0.00	0
	Sparse vegetation	19.88	1

Table 7.24 Comparison of density of *Cicer microphyllum* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Bouldery	0.10±0.07	-	0.13±0.10
Stable	0.13±0.07	0.15±0.05	0.002±0.0
Rock and cliff	-	-	0.04±0.0
Scree	0.13±0.08	0.17±0.10	-
Moraine	0.84±0.12	-	0.14±0.06
Field margin	-	0.06±0.01	-
Marsh meadow	-	-	0.17±0.01

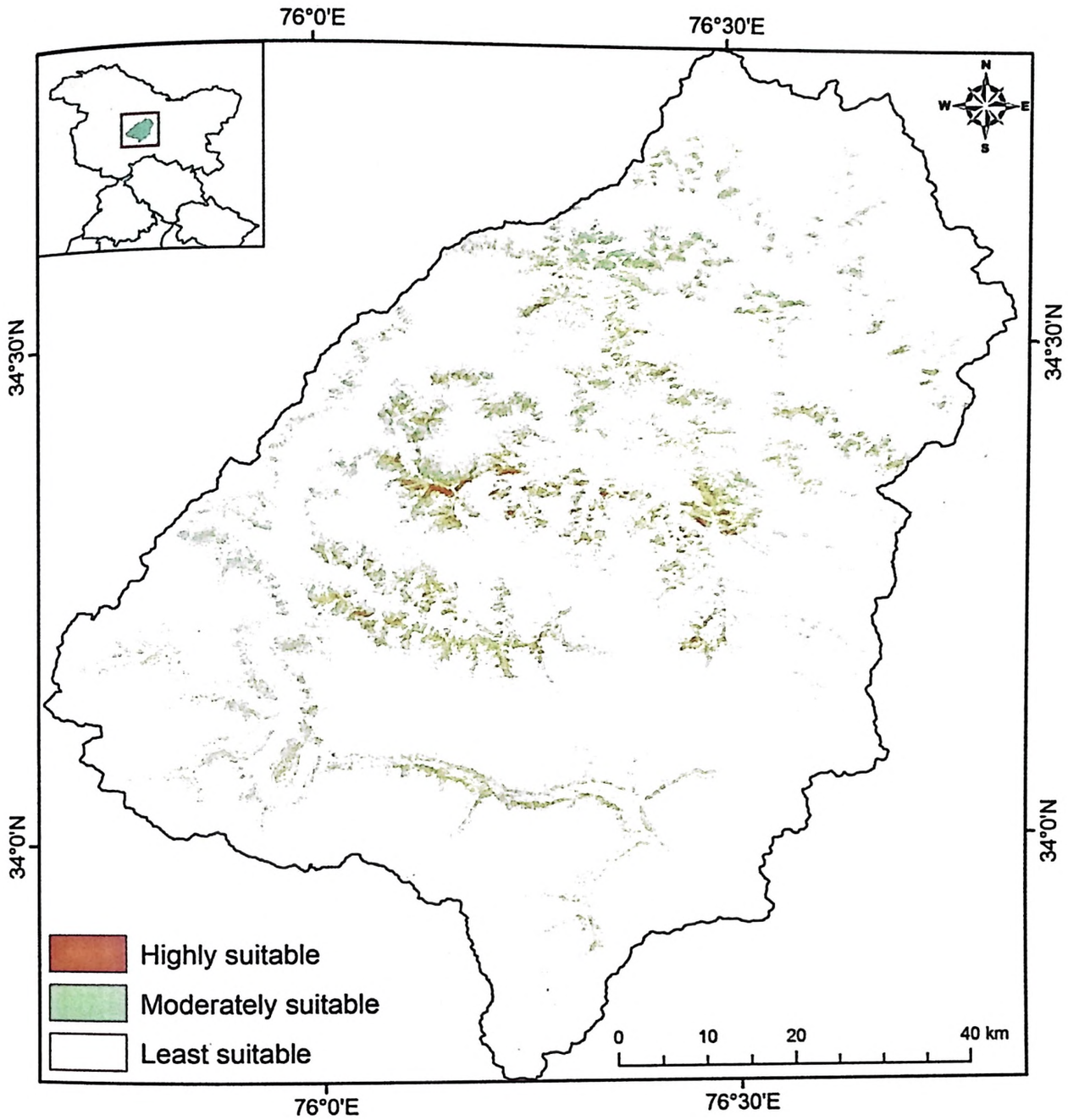

Figure 7.17 Distribution map of *Cicer microphyllum* habitat

Table 7.25 Area under different suitability class of *Cicer microphyllum* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	1654.29	3314.97	1059.03	6028.29
Moderately suitable	18688.32	18873.81	12408.39	49970.52
Least suitable	44387.01	45430.65	29190.15	119007.81





Figure 7.18 *Codonopsis ovata* and its habitat

Codonopsis ovata commonly known as *Lurdud dorjey* and are found along the elevation of 2700-4500m. It is used in food, fodder, ornamental and medicine. The plant is mostly found in the fallow fields and field margins. It is in flower from June to August, and the seeds ripen from August to September.

Table 7.26 Class rank of variables for *Codonopsis ovata* habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	17.78	2
	22.5-67.5	10.95	2
	67.5-112.5	9.53	1
	112.5-157.5	5.69	1
	157.5-202.5	7.11	1
	202.5-247.5	10.53	2
	247.5-292.5	21.05	3
	292.5-337.5	17.35	2
Slope	<2	0.14	0
	2to10	37.55	3
	10to20	23.76	2
	20-30	22.05	2
	30-40	11.10	1
	>40	5.41	1
Elevation	2800-3000	-	1
	3000-3200	-	2
	3200-3600	-	3
	3600-3800	-	2
	3800-4000	-	1
Soil	Acrisol	0.00	0
	Cambisol (moist)	7.82	1
	Cambisol (dry)	56.90	3
	Leptosols	28.31	2
	Cryic Leptosols	6.97	1
LU/LC	Plantation	14.37	2
	Agriculture	27.74	3
	Alpine scrub	28.59	3
	Alpine Meadow	11.10	1
	Snow / Glacier	0.00	0
	Sparse vegetation	18.21	2

Table 7.27 Comparison of density of *Codonopsis ovata* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Alpine meadow	-	4.38±2.69	-
Bouldery	0.29±0.05	-	-
Moraine	-	-	0.07±0.0
Field margin	0.8±0.25	4.54±0.67	2.44±0.52
Marsh meadow	-	-	1.27±0.75

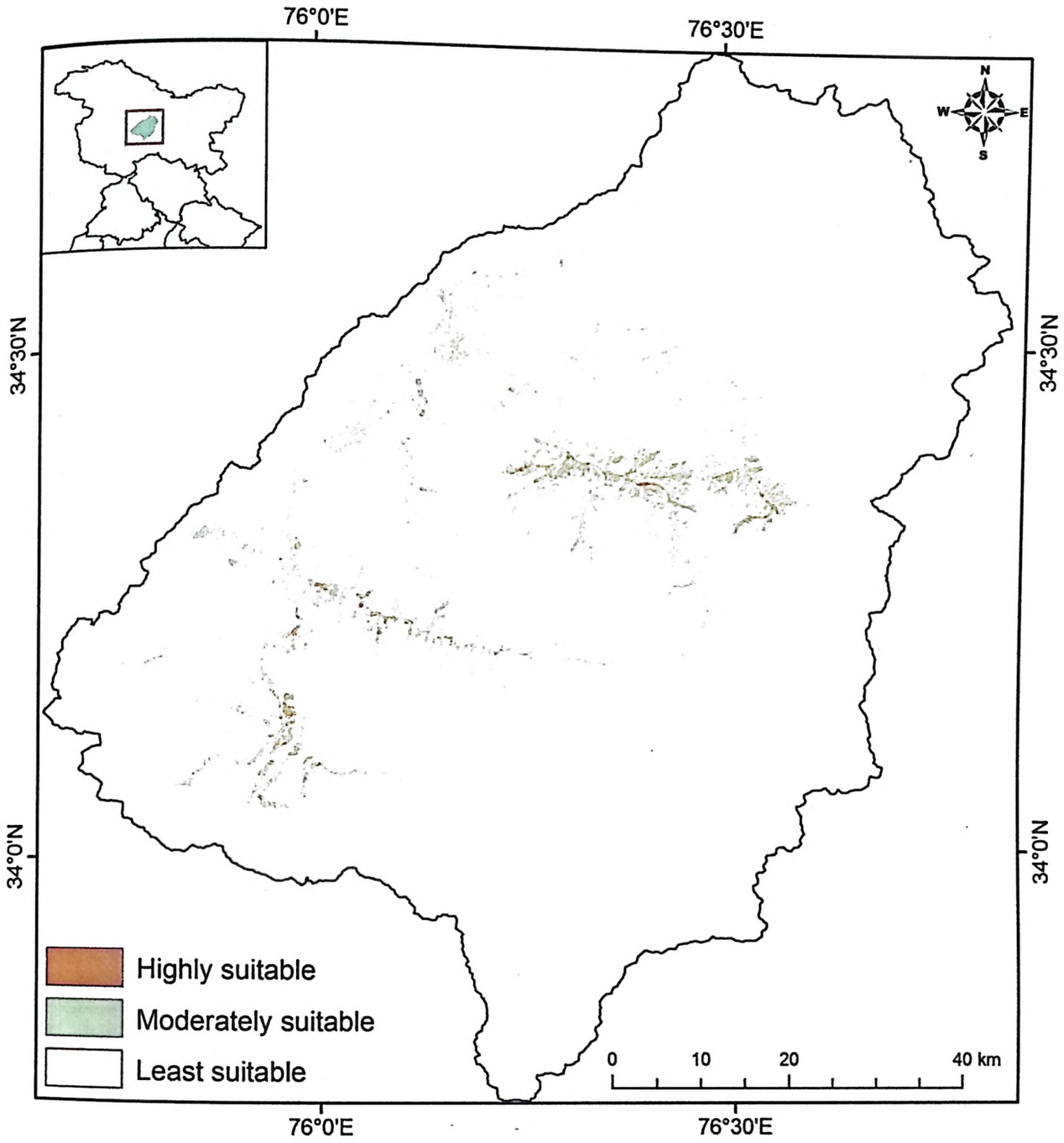

Figure 7.19 Distribution map of *Codonopsis ovata* habitat

Table 7.28 Area under different suitability class of *Codonopsis ovata* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	896.04	902.52	47.88	1846.44
Moderately suitable	2615.4	5025.78	275.76	7916.94
Least suitable	20740.86	28479.33	9435.87	58656.06

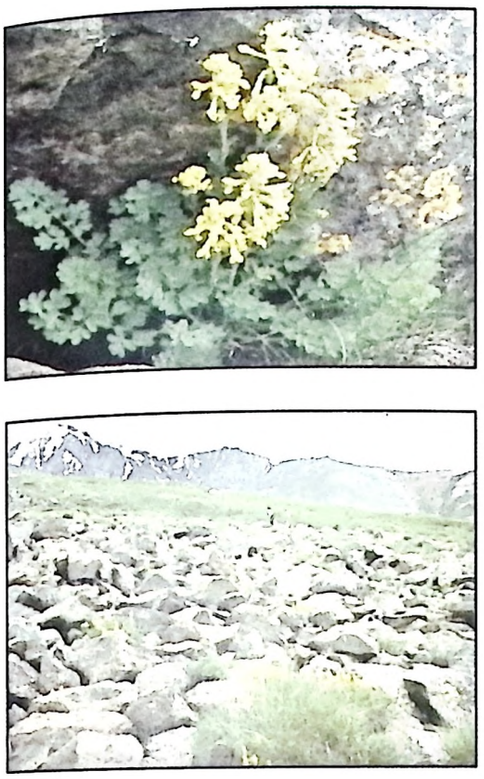

Figure7.20 *Corydalis govaniana* and its habitat

Corydalis govaniana commonly known as *Makshang* and is one of the frequently herb in *Amchi* system of medicine. It is not only used by the Amchis but also by the locals. The leaves edible and are used as highly nutritious vegetable. The species found in high elevation varies from 3500-4600m. It is in flower from end of May- August

Table 7.29 Class rank of variables for *Corydalis govaniana* habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	34.41	3
	22.5-67.5	6.48	1
	67.5-112.5	0.75	0
	112.5-157.5	4.24	0
	157.5-202.5	1.25	0
	202.5-247.5	6.98	1
	247.5-292.5	5.49	1
	292.5-337.5	40.40	3
Slope	<2	0.00	0
	2to10	4.24	0
	10to20	26.18	2
	20-30	57.11	3
	30-40	12.47	1
	>40	0.00	0
Elevation	3900-4000	-	1
	4000-4200	-	2
	4200-4400	-	3
	4400-4600	-	2
	4600-4700	-	1
Soil	Acrisol	12.47	1
	Cambisol (moist)	12.72	1
	Cambisol (dry)	44.89	3
	Leptosols	29.93	2
	Cryic Leptosols	0.00	0
LU/LC	Plantation	0.00	0
	Agriculture	0.00	0
	Alpine scrub	31.67	2
	Alpine Meadow	54.61	3
	Snow / Glacier	0.00	0
	Sparse vegetation	13.72	1

Table7.30 Comparison of density of *Corydalis govaniana* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Alpine meadow	-	-	1±0.61
Stable	-	0.26±0.10	0.01±0.01
Bouldery	0.4±0.19	0.25±0.18	0.38±0.12
Moraine	-	0.28±0.15	-

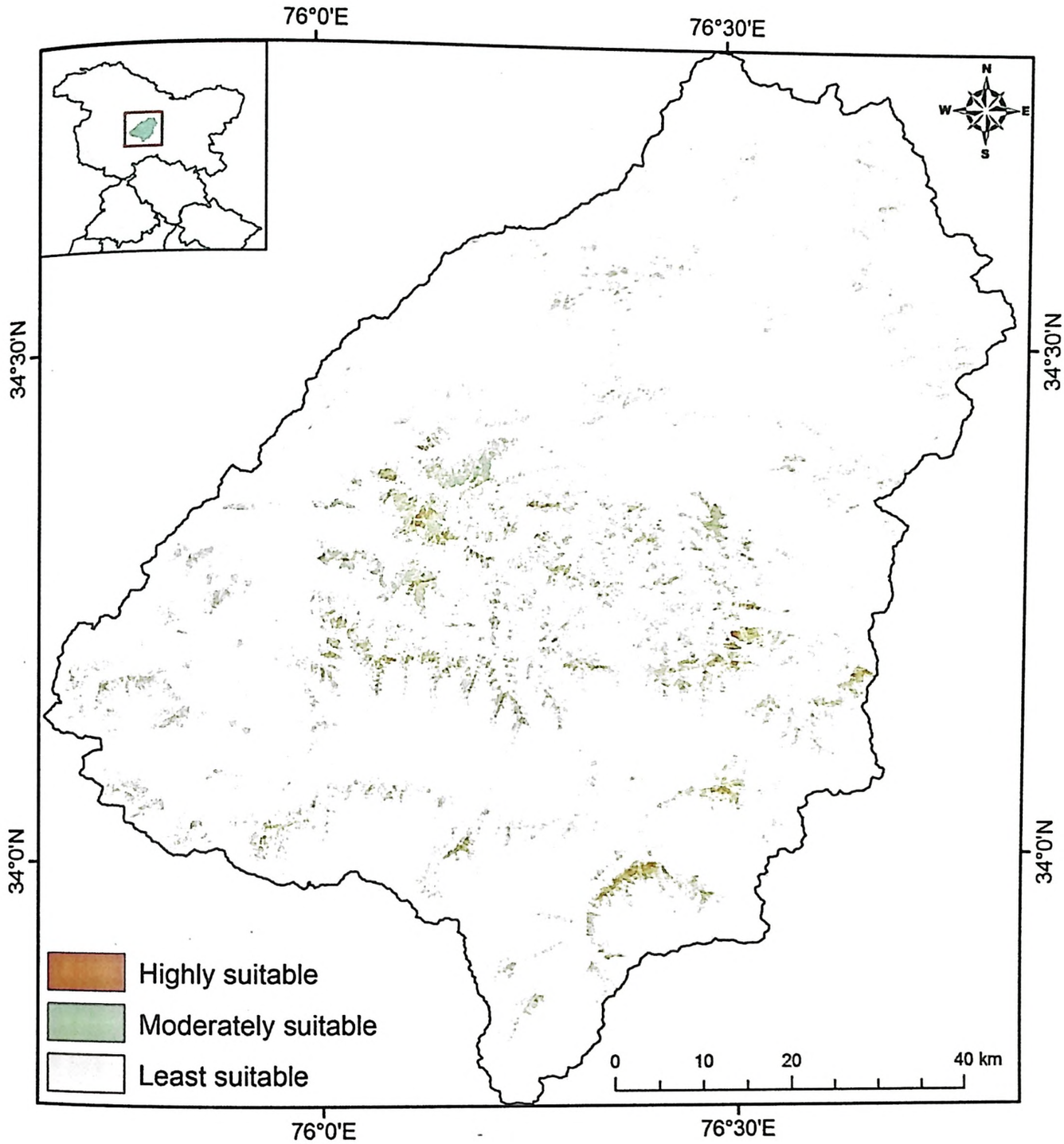

Figure 7.21 Distribution map of *Corydalis govaniana* habitat

Table 7.31 Area under different suitability class of *Corydalis govaniana* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	1492.29	1527.30	0.00	3019.59
Moderately suitable	12807.00	12042.36	2244.60	27093.96
Least suitable	39745.08	33937.38	14638.77	88321.23





Figure 7.22 *Dactylorhiza* spp. *and its* habitat

***Dactylorhiza* sp.** is commonly known as *Wanglak or Wangbolakpa* is distributed across Suru valley in a continuous manner along. Several large patches of this species had been destroyed in the valley due to construction of roads and other infrastructure development. It is distributed along the valley bottoms at an elevation of 2700-4000m. It is in flower from May end to August.

Table7.32 Class rank of variables for *Dactylorhiza* spp.habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	21.75	3
	22.5-67.5	8.25	1
	67.5-112.5	3.00	0
	112.5-157.5	9.50	1
	157.5-202.5	13.25	2
	202.5-247.5	13.25	2
	247.5-292.5	12.25	2
	292.5-337.5	18.75	2
Slope	<2	0.25	0
	2to10	66.50	3
	10to20	22.50	2
	20-30	4.25	0
	30-40	3.25	0
	>40	3.25	0
Elevation	2800-3000	-	1
	3000-3200	-	2
	3200-3600	-	3
	3600-3800	-	2
	3800-4000	-	1
Soil	Acrisol	0.00	0
	Cambisol (moist)	0.00	0
	Cambisol (dry)	49.25	3
	Leptosols	50.75	3
	Cryic Leptosols	0.00	0
LU/LC	Plantation	8.75	1
	Agriculture	17.50	2
	Alpine scrub	49.25	3
	Alpine Meadow	8.25	1
	Snow / Glacier	0.00	0
	Sparse vegetation	16.25	2

Table 7.33 Comparison of density of *Dactylorhiza* spp.in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Alpine meadow	-	0.64±0.32	-
Marsh meadow	-	5.76±0.59	3.47±0.86
Field margin	-	1.58±0.49	1.67±0.71

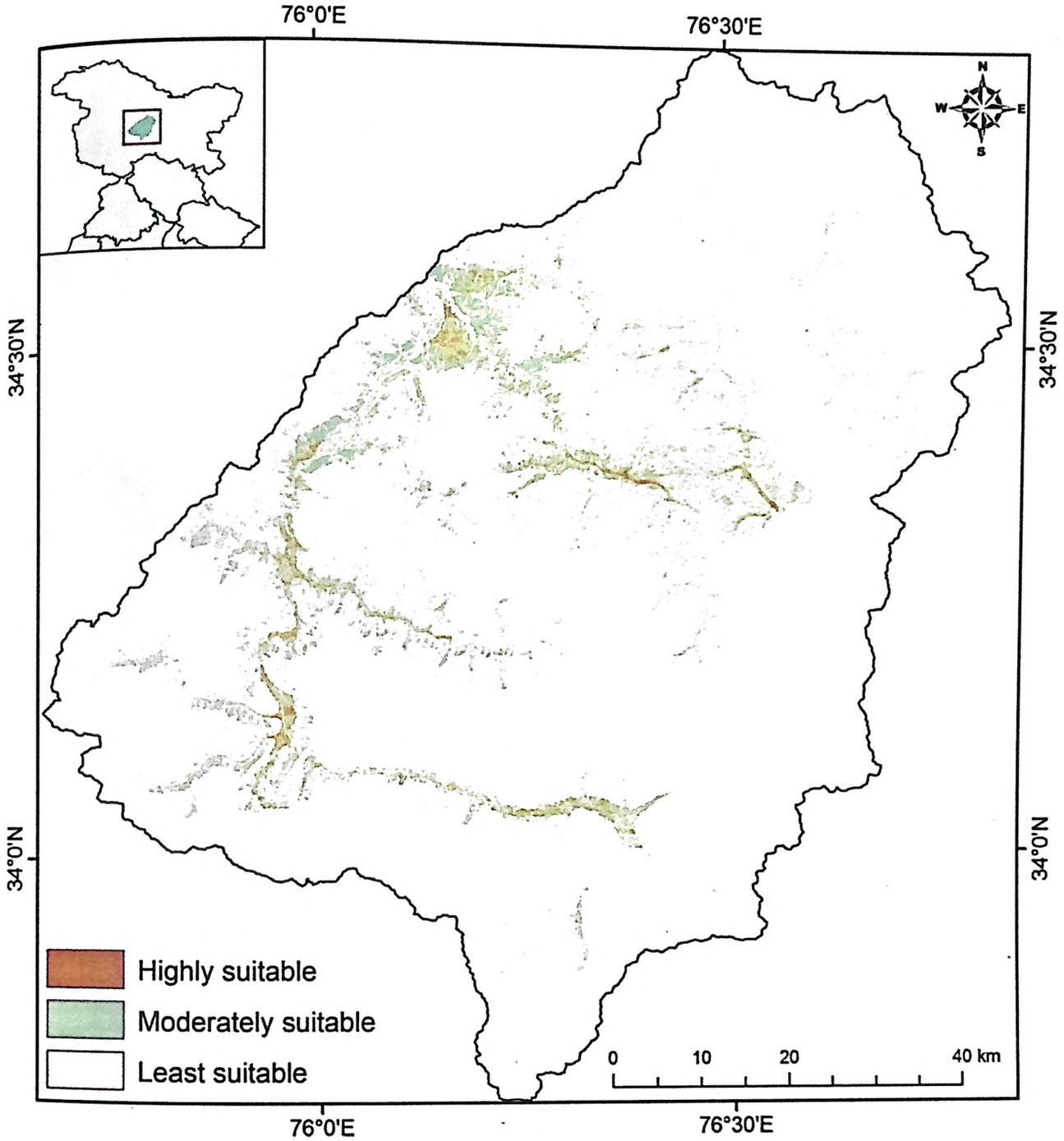

Figure 7.23 Distribution map of *Dactylorhiza* spp. Habitat

Table 7.34 Area under different suitability class of *Dactylorhiza* spp.habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	2555.73	2050.83	130.95	4737.51
Moderately suitable	17263.71	20078.01	2489.67	39831.39
Least suitable	40434.84	48871.17	25062.21	114368.2

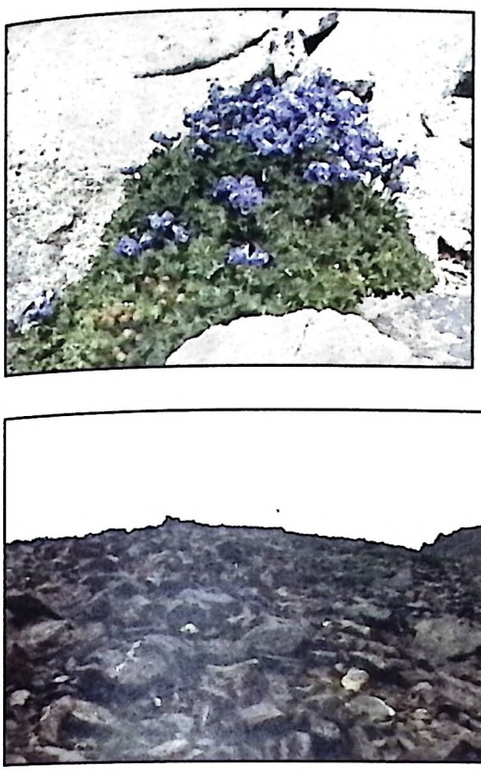

Figure 7.24 *Delphinium brunonianum* and its typical habitat

Delphinium brunonianum commonly known as *Makhoting* are found along the elevation of 3200-4600m in Plateau, Bouldery, Rock and cliff, Moraine and Stable. It is used in fodder, ornamental, medicinal and religious. It starts flowering in June till September.

Table: 7.35 Class rank of variables for *Delphinium brunonianum* habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	13.92	2
	22.5-67.5	9.80	1
	67.5-112.5	1.96	0
	112.5-157.5	7.45	1
	157.5-202.5	6.08	1
	202.5-247.5	5.49	1
	247.5-292.5	11.37	2
	292.5-337.5	43.92	3
Slope	<2	0.00	
	2to10	5.29	1
	10to20	23.53	2
	20-30	52.55	3
	30-40	15.69	2
	>40	2.94	0
Elevation	3300-3500	-	1
	3500-3700	-	2
	3700-4200	-	3
	4200-4400	-	2
	4400-4600	-	1
Soil	Acrisol	20.98	2
	Cambisol (moist)	10.20	1
	Cambisol (dry)	49.22	3
	Leptosols	19.61	2
	Cryic Leptosols	0.00	0
LU/LC	Plantation	0.00	0
	Agriculture	0.00	0
	Alpine scrub	27.06	2
	Alpine Meadow	57.45	3
	Snow / Glacier	0.00	0
	Sparse vegetation	15.49	1

Table 7.36 Comparison of density of *Delphinium brunonianum* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Plateau	-	-	0.16±0.11
Stable	0.11±0.05	0.09±0.07	-
Bouldery	0.10±0.0	1.70±0.21	0.35±0.13
Moraine	0.04±0	0.87±0.27	0.40±0.07

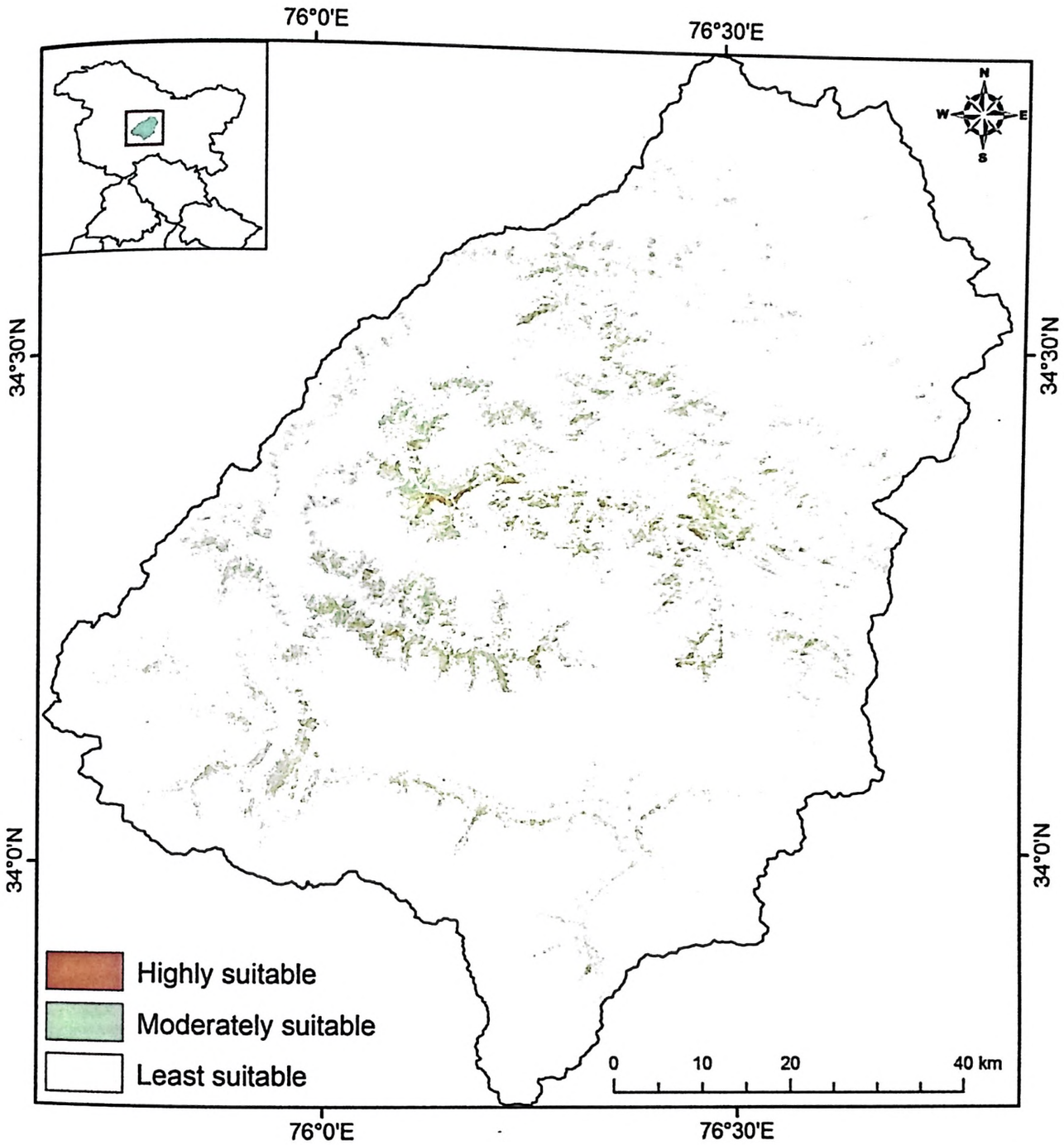

Figure 7.25 Distribution map of *Delphinium brunonianum* habitat

Table7.37 Area under different suitability class of *Delphinium brunonianum* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	818.91	1876.05	102.87	2797.83
Moderately suitable	15486.12	18050.31	4837.14	38373.57
Least suitable	45602.82	52161.39	21911.94	119676.20





Figure 7.26 *Rosa webbiana and its* typical habitat

Rosa webbiana commonly known as *Sai* are found along the elevation of 3000-4500m in Scree, Rock and cliff, Moraine, Field margin and Stable. It is used in fodder, fuelwood, ornamental, medicinal and religious. It flowers in June, and the seeds ripen from August to October.

Table7.38 Class rank of variables for *Delphinium brunonianum* habitat mapping

Variable	Class	Area (%) within buffer	Rank
Aspect	337.5-22.5	23.44	3
	22.5-67.5	7.81	2
	67.5-112.5	4.17	1
	112.5-157.5	4.69	1
	157.5-202.5	1.30	1
	202.5-247.5	5.47	1
	247.5-292.5	0.78	0
	292.5-337.5	14.06	3
Slope	<2	0.00	0
	2 to 10	9.38	1
	10to20	11.72	2
	20-30	21.61	3
	30-40	16.93	2
	>40	2.08	1
Elevation	3400-3600	3000-3200	1
	3600-3800	3200-3400	2
	3800-4100	3400-3800	3
	4100-4300	3800-4000	2
	4300-4500	4000-4200	1
Soil	Acrisol	0	0
	Cambisol (moist)	22.14	3
	Cambisol (dry)	17.19	2
	Leptosols	22.40	3
	Leptosols (cryic)	0.00	0
Lu/Lc	Plantation	2.86	1
	Agriculture	6.51	1
	Alpine scrub	3.13	1
	Alpine Meadow	23.44	3
	Snow / Glacier	0.00	0
	Sparse vegetation	25.78	3

Table 3.39 Comparison of density of *Rosa webbiana* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Rocks and cliff	0.04±0.0	0.64±0.36	0.13±0.06
Scree	0.07±0.06	0.02±0.03	0.02±0.0
Moraine	0.82±0.18	-	-
Stable	-	0.02±0.14	-
Field margin	-	-	0.05±0.03

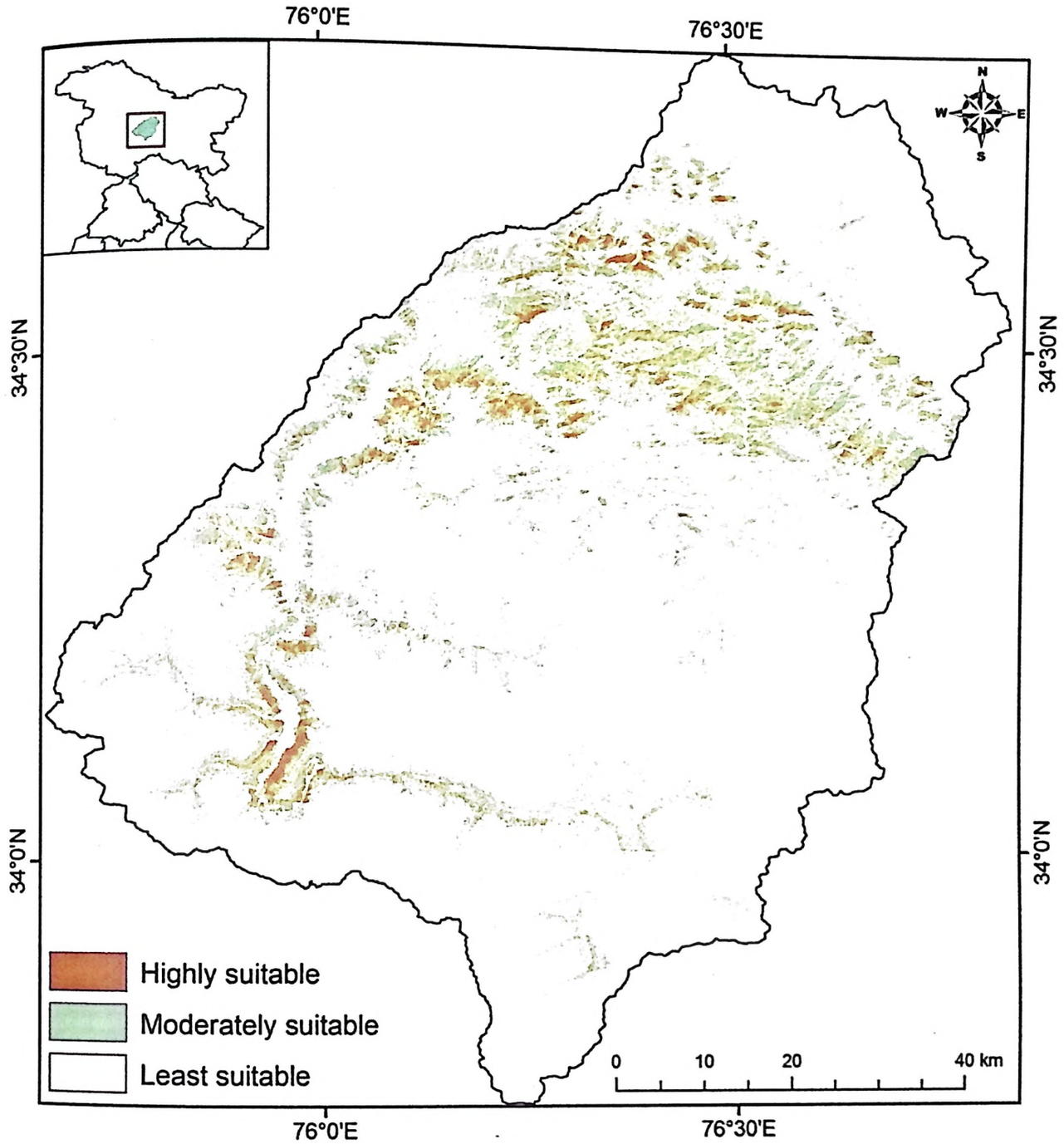

Figure 7.27 Distribution map of *Rosa webbiana* habitat

Table 7.40 Area under different suitability class of *Rosa webbiana* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	6220.17	4992.93	7218.99	18432.09
Moderately suitable	17740.26	18812.70	29642.04	66195.00
Least suitable	43904.88	42657.48	42483.33	129045.69





Figure 7.28: *Rheum moorcroftianum* and its habitat

Rheum moorcroftiana commonly known as *Khakol* are found along the elevation of 3500-4600m in Plateau, Scree, Rock and cliff, Moraine and Stable. It is used in food, fodder, medicinal, dye and other categories. It flowers in August till September.

Table 7,41 Class rank of variables for *Rheum* habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	39.60	3
	22.5-67.5	8.69	1
	67.5-112.5	2.22	0
	112.5-157.5	7.07	1
	157.5-202.5	6.06	1
	202.5-247.5	9.70	1
	247.5-292.5	10.30	2
	292.5-337.5	16.36	2
Slope	<2	0.00	0
	2to10	6.46	1
	10to20	19.80	2
	20-30	40.20	3
	30-40	28.48	3
	>40	5.05	1
Elevation	3500-3700	-	1
	3700-3900	-	2
	3900-4200	-	3
	4200-4400	-	2
	4400-4600	-	1
Soil	Acrisol	19.39	2
	Cambisol (moist)	0.00	0
	Cambisol (dry)	60.40	3
	Leptosols	20.20	2
	Cryic Leptosols	0.00	0
LU/LC	Plantation	0.00	0
	Agriculture	0.00	0
	Alpine scrub	14.75	2
	Alpine Meadow	46.46	3
	Snow / Glacier	0.00	0
	Sparse vegetation	38.79	3

Table7.42 Comparison of density of *Rheum moorcroftianum* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Plateau	-	-	0.09±0.10
Stable	-	0.12±0.05	0.0001±0.0
Rock and cliff	-	0.56±0.13	-
Scree	-	0.32±0.09	0.29±0.09
Moraine	-	-	0.03±0.01

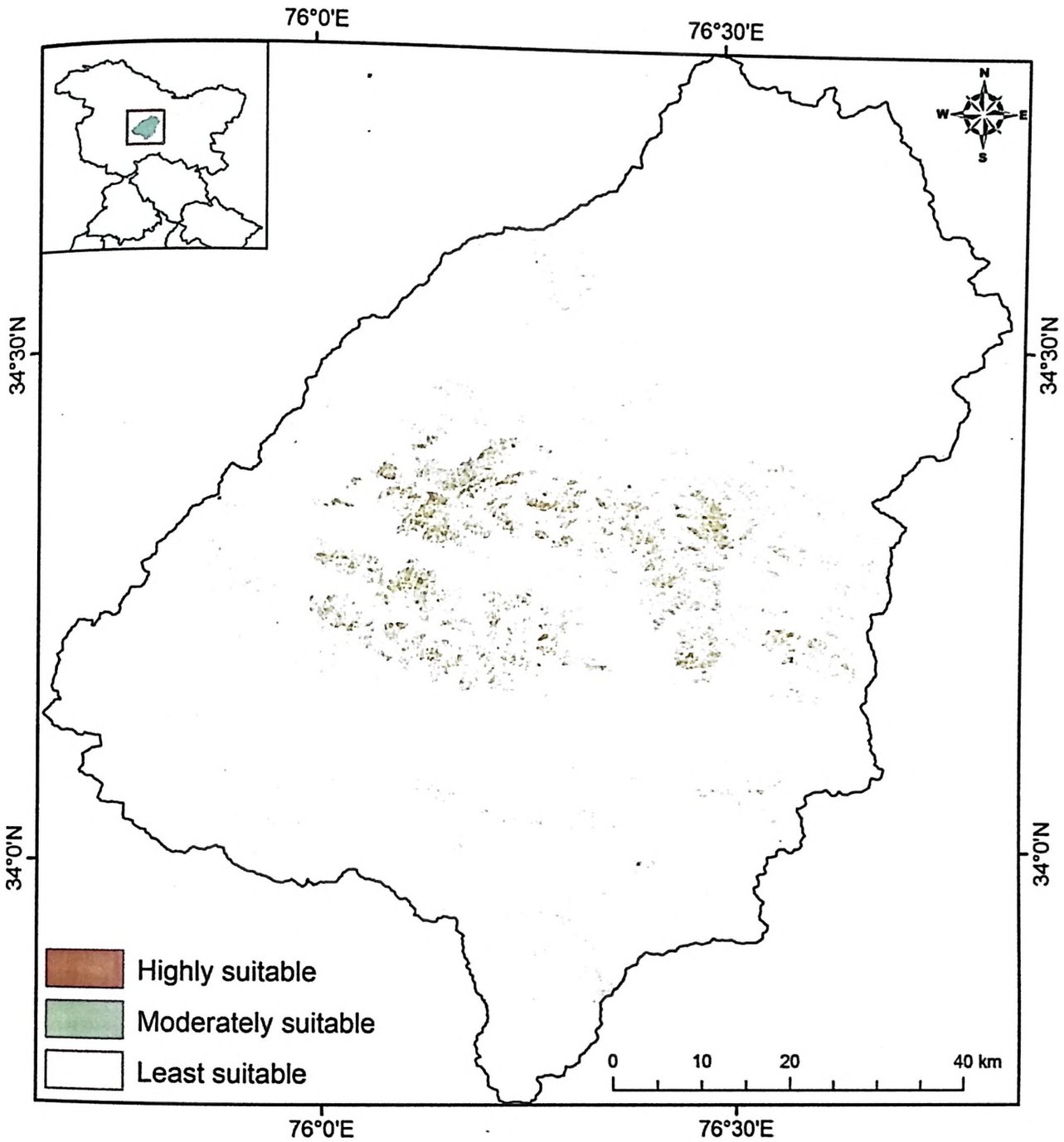

Figure 7.29 Distribution map of *Rheum moorcroftianum* habitat

Table 7.43 Area under different suitability class of *Rheum moorcroftianum* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	1248.12	2888.01	0.00	4136.13
Moderately suitable	4843.08	8990.19	258.66	14091.93
Least suitable	35637.03	49190.85	8590.05	93417.93

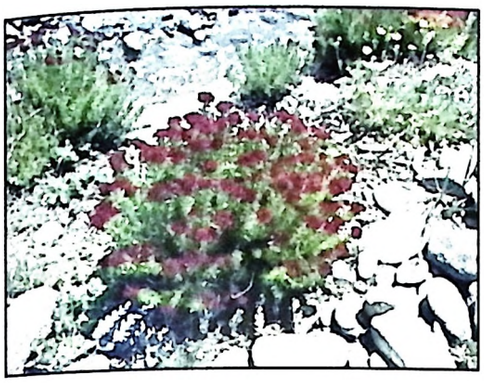



Figure 7.30: *Rhodiola tibetica and* its Habitat

***Rhodiola tibetica* (Hook. f. & Thomson) S.H. Fu.** commonly known as *Rrolo* and are found along the elevation of 3800-5000m. It is used in food, fodder, fuelwood and medicine. One of the delicacies *Tang-thur* of Ladakh is prepared using this herb. It flower from July to August, and the seeds ripen from August to September.

Table 7.44 Class rank of variables for *Rhodiola tibetica* habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	28.02	3
	22.5-67.5	10.18	2
	67.5-112.5	6.51	1
	112.5-157.5	6.67	1
	157.5-202.5	5.92	1
	202.5-247.5	7.26	1
	247.5-292.5	6.17	1
	292.5-337.5	29.27	3
Slope	<2	0.00	0
	2to10	5.17	1
	10to20	25.85	2
	20-30	42.79	3
	30-40	23.60	2
	>40	2.59	0
Elevation	3400-3600	-	1
	3600-3800	-	2
	3800-4200	-	3
	4200-4400	-	2
	4400-4600	-	1
Soil	Acrisol	25.74	3
	Cambisol (moist)	12.62	2
	Cambisol (dry)	24.92	3
	Leptosols	16.25	2
	Cryic Leptosols	20.46	3
LU/LC	Plantation	0.00	0
	Agriculture	0.00	0
	Alpine scrub	28.77	2
	Alpine Meadow	50.79	3
	Snow / Glacier	0.00	0
	Sparse vegetation	20.43	2

Table 7.45 Comparison of density of *Rhodiola tibetica* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Alpine meadow	5.94±1.57	0.76±0.21	-
Bouldery	2.3±0.22	1.3±0.16	-
Moraine	0.08±0.0	0.93±0.18	0.72±0.28
Stable	1.83±0.25	0.28±0.08	0.010±0.0
Plateau	-	-	1.10±0.35
Scree	-	-	0.14±0.12

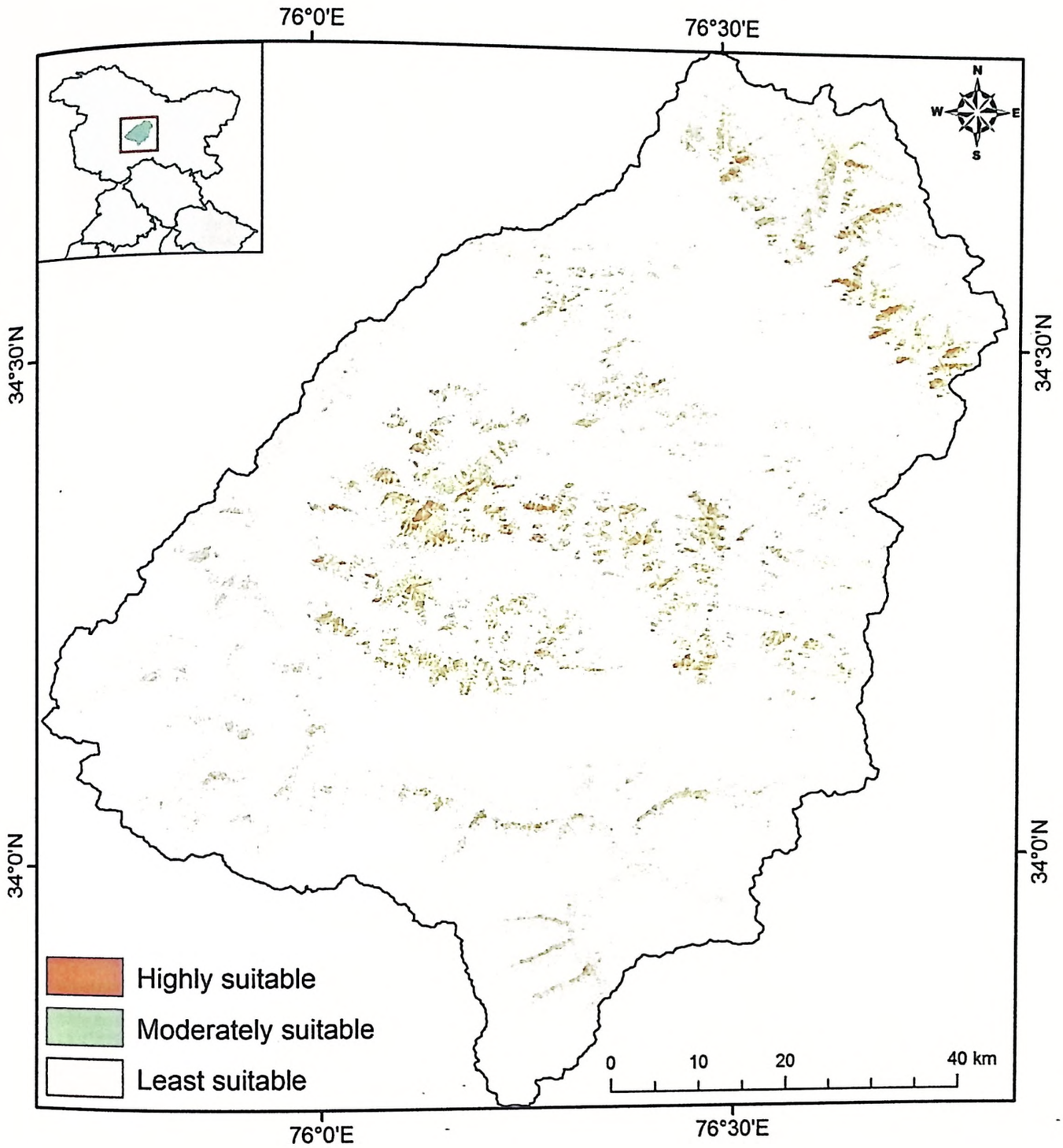

Figure 7.31 Distribution map of *Rhodiola tibetica* habitat

Table 7.46 Area under different suitability class of *Rhodiola tibetica* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	2231.55	4244.22	2901.24	9377.01
Moderately suitable	28454.31	31647.87	22120.74	82222.92
Least suitable	34875.90	31999.86	20527.83	87403.59

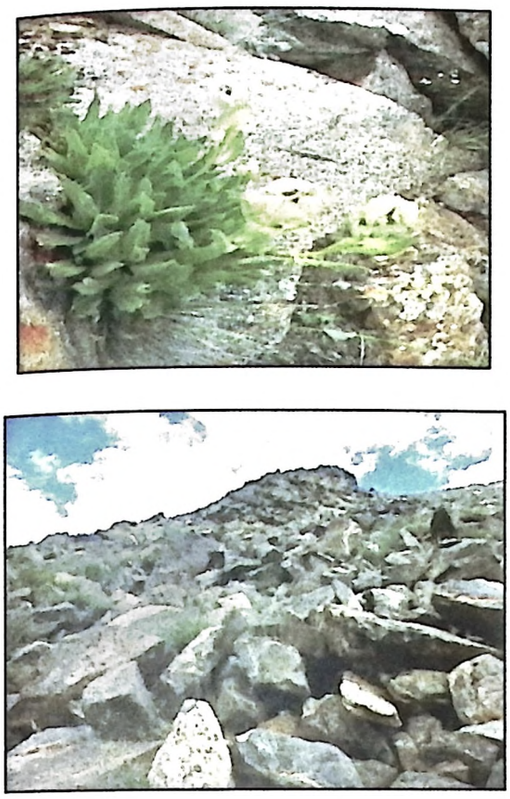

Figure 7.32 *Sassurea obvallata* and its habitat

***Saussurea obvallata* (DC.) Edgew.** commonly known as *Jarbaq* is found across the elevation of 3900-4600m. The plant was found in the Bouldery, Moraine and Stable slope. It is used in ornamental, fodder and medicinal. It flowers in June-August.

Table 7.47 Class rank of variables for *Sassurea obvallata* habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	42.53	3
	22.5-67.5	17.93	2
	67.5-112.5	4.60	1
	112.5-157.5	5.52	1
	157.5-202.5	0.46	0
	202.5-247.5	3.45	0
	247.5-292.5	4.83	0
	292.5-337.5	20.69	2
Slope	<2	0.00	0
	2to10	5.75	1
	10to20	18.85	2
	20-30	48.97	3
	30-40	22.99	2
	>40	3.45	0
Elevation	4000-4200	-	1
	4200-4400	-	2
	4400-4600	-	3
	4600-4800	-	2
	4800-5000	-	1
Soil	Acrisol	34.25	3
	Cambisol (moist)	0.00	0
	Cambisol (dry)	42.53	3
	Leptosols	11.72	2
	Cryic Leptosols	11.49	2
LU/LC	Plantation	0.00	0
	Agriculture	0.00	0
	Alpine scrub	28.74	2
	Alpine Meadow	45.98	3
	Snow / Glacier	0.00	0
	Sparse vegetation	25.29	2

Table 7.48 Comparison of density of *Saussurea obvallata* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Alpine meadow	-	-	-
Stable	-	0.2±0.09	-
Moraine	-	0.70±0.16	0.37±0.35
Bouldery	0.05±0.02	2.74±0.33	1.38±0.12

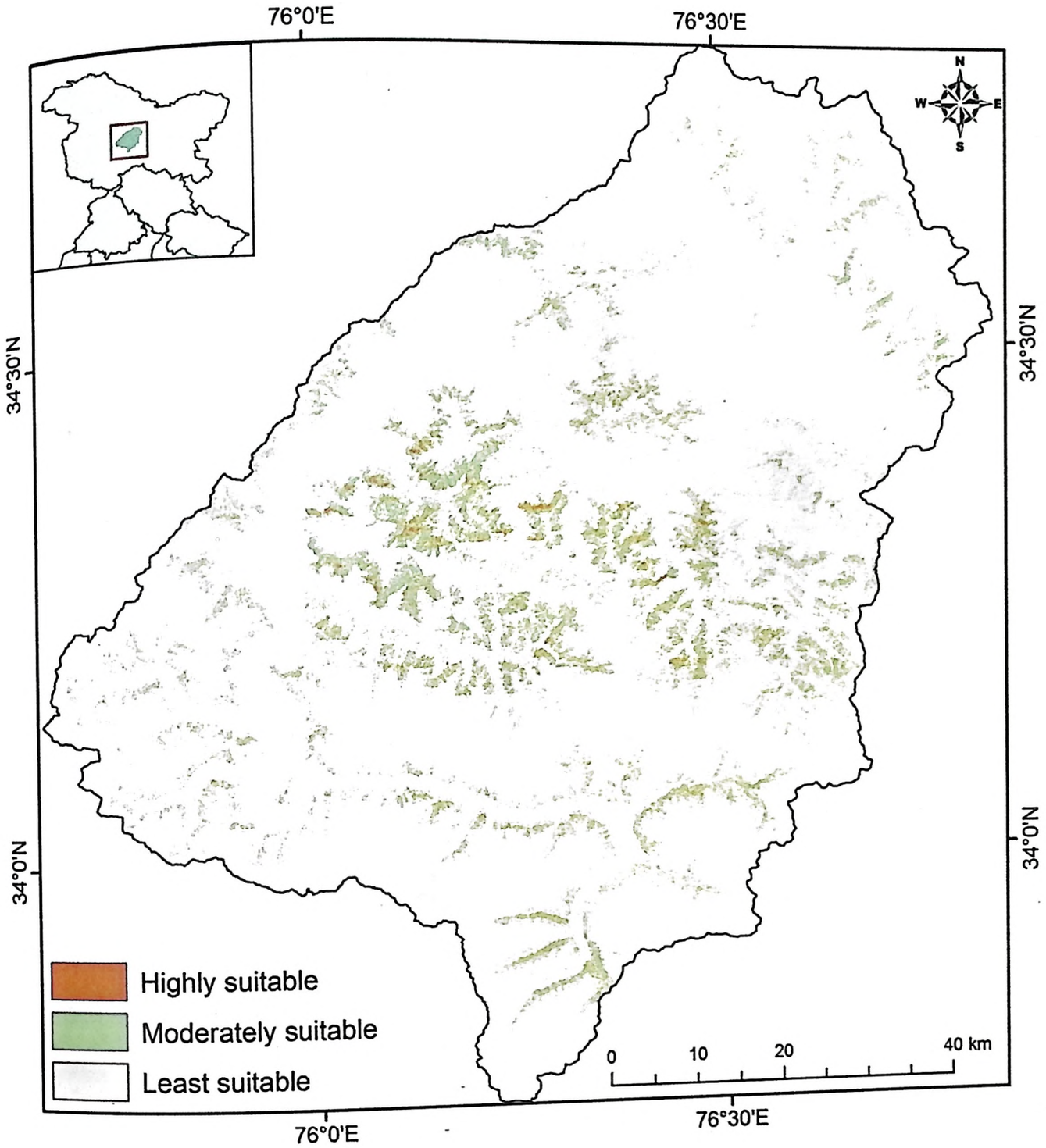

Figure 7.33 Distribution map of *Sassurea obvallata* habitat

Table 7.49 Area under different suitability class of *Sassurea obvallata* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	1631.97	2847.78	192.78	4672.53
Moderately suitable	22767.66	25153.92	5325.93	53247.51
Least suitable	64174.50	58914.00	23787.54	146876.04





Figure 7.34 *Thymus linearis and its* habitat

***Thymus linearis* Benth** commonly known as *Tumburu* is used as spice, vegetable in traditional meals (*Thukpa*) and nutritious soups. It is also used as medicine, and ornamental plant. The plant is mostly found in the Alpine meadow, Rock and cliff, Stable slope, Moraine and Plateau landform units. It flowers in May till September.

Table 7.50: Class rank of variables for *Thymus linearis* habitat mapping

Variable	Category	Area (%) within buffer	Rank
Aspect	337.5-22.5	38.24	3
	22.5-67.5	12.67	2
	67.5-112.5	10.41	2
	112.5-157.5	2.71	0
	157.5-202.5	6.33	1
	202.5-247.5	4.52	0
	247.5-292.5	5.20	1
	292.5-337.5	19.91	2
Slope	<2	0.00	0
	2to10	5.88	1
	10to20	23.30	2
	20-30	53.17	3
	30-40	9.95	1
	>40	7.69	1
Elevation	3400-3600	-	1
	3600-3800	-	2
	3800-4000	-	3
	4000-4200	-	2
	4200-4400	-	1
Soil	Acrisol	0.00	0
	Cambisol (moist)	22.85	2
	Cambisol (dry)	32.13	2
	Leptosols	45.02	3
	Cryic Leptosols	0.00	0
LU/LC	Plantation	0.00	0
	Agriculture	0.00	0
	Alpine scrub	24.89	2
	Alpine Meadow	51.36	3
	Snow / Glacier	0.00	0
	Sparse vegetation	23.76	2

Table 7.51 Comparison of density of *Thymus linearis* in different valleys

Habitat	Density /Ind m^{-2}		
	Lower Indus	Wakha-chu	Suru
Alpine meadow	-	-	0.15±0.02
Plateau	-	0.58±0.37	-
Stable	0.77±0.35	0.02±0.004	0.015±0.0
Rock and cliff	-	-	0.24±0.01
Bouldery	0.09±0.05	-	-
Moraine	-	-	0.04±0.02

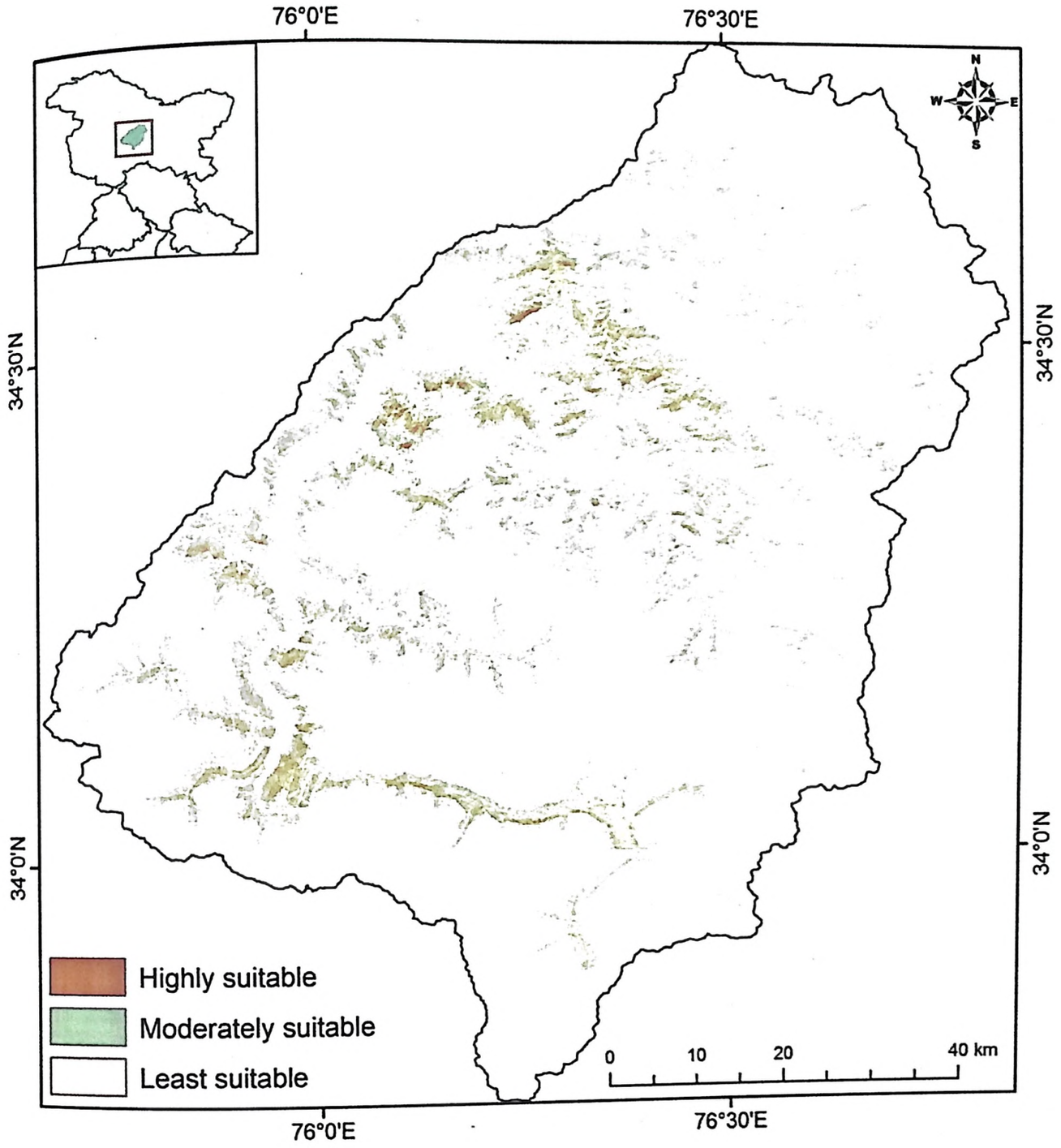

Figure 7.35 Distribution map of *Thymus linearis* habitat

Table 7.52 Area under different suitability class of *Thymus linearis* habitat

Habitat	Area (ha)			
	Suru	Wakha-chu	Lower Indus	Total
Highly suitable	3398.85	2870.01	1108.26	7377.12
Moderately suitable	17578.98	13278.33	6447.78	37305.09
Least suitable	37551.69	38423.43	19493.01	95468.13

7.3.5 Resource management

There exist two approaches to harvesting and management of ethno-flora in the study area. First is sustainable harvesting, conducted by some *Amchis* and the second is destructive harvesting which is typical of exploitation of these plants by the locals or some local trader. In addition, other local management approaches applied on the site are as follows.

i) certain levels of controlled access to the harvesting sites;
ii) social and cultural rules limiting harvest to specific periods;
iii) transplanting of ramets in situ and exsitu cultivation in home gardens; and
iv) rotational grazing of livestock. rotational grazing of livestock is the only known management approach aimed at limiting pressure on pasture resources

Sustainable harvesting, mainly applied by *Amchi*, is based on their ethnobiological and ethnoecological knowledge. According to *Amchi* knowledge, the harvesting stage of MPs depends upon the nature of diseases, nature of plant parts used, and recipes of the codified Amchi medicine. The periods chosen for harvesting of MPs in general are determined first by availability of the target parts (e.g., spring for young leaves, summer for flowers and autumn for fruits, seeds, and rhizomes). Spring is said to be the best season for collecting tree bark, whereas autumn is considered to be the best season for collecting rhizomes. Over 91% of *Amchis* said that they harvest species during September and October (Table 6). Harvesting of MPs by *Amchi* is also regulated by religious practices and beliefs. Harvesting is undertaken after a specific religious ritual was performed, in which they propitiate the menlha-medicine (*men*) diety (*Lha/Shaman*) prior to collecting the plants. *Amchis* also determine harvesting periods according to the cultural and religious calendar. The "tahangsung rikhi" is a specific period of about 7 days (in late September or early October) determined by the Tibetan calendar. This is the period when most of the alpine herbs are close to complete their life cycle and hence is a perfect period for harvesting fodder grass for winter and high altitude MPs whose underground parts are used. Main hot spots for medicinal plant collection are Sapi, Kanji, Sanra, Rangdung, Panikar villages and also important passes such as Kardhungla, Changla, North Pullu, South Pullu, and. *Amchis* from all over Ladakh travel to these hot spots to collect MAPs.

In LIV, large-scale collection of some species was reported from the pasturelands (chapter 6). Collection of fodder and fuel-wood species were from the higher elevation areas. The exploitation of two other fodder species collected together is restricted to 2 days. Grass (Festuca sp.) and *Aconogonum* sp. collection allowed for 3 days. There is no temporal regulation on the collection of the two shrubs (*Caragana versicolor, Betula utilis* and *Lonicera* sp.) used for house building and fuel. However, the collection of *Caragana versicolor* was prohibited in approximately half of Wakha-chu pastures. All collection dates, pertaining to both dung and plants are restricted to periods with the lowest labor demands for agriculture and other activities, thus neutralizing to a substantial extent the potential disparity in access to these common resources. At the same time, no collection is allowed on days of festivity such as marriage celebrations, to ensure the participation and collective sharing of responsibilities during such occasions by the entire village. There are similar regulations on fodder collection in Suru and Wakha-chu. Collection of *Cousinia thomsonii* nearby pastures and of *Artemisia* sp. (for fodder) in distant ones is restricted to the month of October. The village council decides the date of collection. In privately owned pastures, the owner families have exclusive rights for the first five days of collection, after which collection is open to all families.

7.4. CONCLUSION

Several plant species of Western Ladakh are facing serious threat due to harvesting pressure and there is an urgent need to formulate appropriate management plan to conserve these species. A complete ban on collection activity may not be supported by local people and hence developing strategy for sustainable harvest could be the best option to conserve threatened species. Allowing only limited amount of harvesting of species may improve the regeneration status. However, a single approach may not be sufficient and options such as increasing the yield using appropriate harvesting methods such as coppice harvesting, timing of harvests, rotating between harvesting areas and restricting which plant parts are harvested are some of the best options available.

Local people's knowledge on the physical features of the landscape and the distribution of resources helps them to sustain their life by adopting the specific environment. Participatory resource mapping helped to exchange information among local people regarding the scarcity and abundance of plant resource in different part of the Western Ladakh. These maps can be used to get first-hand information on the distribution of

resources. Most of the species of high conservation priority have more suitable habitat in Wakha-chu valley than the other two valleys and hence it can be considered to select site for conservation purpose. Species with high harvesting potential are distributed mainly in Suru valley followed by Wakha-chu valley.

Support for conservation can be gained by involving local communities in formulating polices for sustainable resource management. Considering the fact that the distribution and abundance of species are not similar in different valleys, management plan should be prepared according to the specific needs of these valleys. Local people's participation can make it possible to provide a certain level of protection to the target species by maintaining viable populations.

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Appendix IA

THCP Questionaire Survey

1. Name:-
2. Age:-
3. Sex:-
4. Profession:-
5. Amchi Education System :-
    - School of Amchi in Leh
    - School of Amchi in Dharamsala
    - Guru/shishya System.
6. Existence of Amchi System:-
    - Family Traditional
    - Learned from Somebody.
7. Experience as an Amchi:-
    - Less than 5 years
    - 5-10 years
    - 10-15 years
    - 15-20 years
    - 20-25 years or more than 25years.
8. Specialist in Which Particular Diseases:-
    - Cold /Cough
    - Ache specialist
    - Fracture
    - Cancer specialist
    - Heart Diseases
    - Acidity
    - Other (specify)
9. Animal Parts use:-yes/no; which parts?
10. Plants used:-Yes/No: which all?
11. Do you make your own Medicine? If yes, for which treatment?
12. Do you get it from somebody or market?
13. Which is the most sales/wanted medicine out Medicine?
14. Medicinal Plants used from Ladakh in making Medicine?
15. Do you believe that Traditional health practice should be registered?
16. Do you think that you should work with the modern Docters?
17. Do you think your practice need certification?
18. Do you have speciality?
19. Disease treated?
20. Do you Charge? Or Do you have clinic?
21. How many medicines do you make?
22. What are the techniques?
23. Do you use stone or minerals?

24. What are the other methods in yourr practice?
25. How much plants do you extract amount of plants every year?
26. Do you treat animals also? If yes what kind of diseases and wat plants?
27. Do you get any govt allowance? How much?
28. Expenses on medicine making?
29. Do you exchange medicine(Barter system)
30. Where do you go for collection? In group or individually?
31. Important hot- spots for MPs according to you?
32. What do you think about the status of the medicinal plants?
33. What is the status of *Amchis* earier and now?
34. How many times do you go for collection?
35. Do you visit other villages also?
36. Number of patients per day?
37. People visit more in summer or winter?
38. Do other people also come for collection in your village?
39. Name the plants used according to the rank of use?
40. What is the status of MPs in your place? is it Increasing/decresing/same

Appendix IB

Health Professionals (Allopathic)

1. Do you think traditional health system is to be regarded as an important health care facility in any society?
2. Do you believe that other diseases need traditional healers?

Health care	Yes/No	Reason(if yes, what are diseases)I(if no, why)
Akhon		
Shaman (Lha/Lhamo)		
Amchi		

3. Because you are one of the multi-disciplinary team, can you accept a traditional healer in this team?

Yes	
No	

4. While in hospital situation, did you ever came across a situation where a patient needed traditional healers or relatives demanding discharge of their family member for traditional health care?

Yes	
No	
Uncertain	

5. Do you want traditional healers to be legalized?

Traditional healer	Yes/No/Uncertain	Reason
Akhon		
Shaman(Lha/Lhamo)		
Amchi		

6. If the answer in Question 5 is yes, will you suggest referrals to and from these people?

Yes	
No	

7. If you are a nurse, doctor or paramedic etc., in your practice will you accept traditional healers to come and visit their patients?

Yes	
No	
Uncertain	

8. Is there anything you are not in favor of with traditional healing? If yes state briefly

THS	Reasons
Akhons	
Shamans	
Amchis	

9. Do you know of any person who was completely cured by a traditional healer?

THS	If yes defend this practice.(Diseases name)
Akhons	
Shamans	
Amchis	

10. Do you think traditional healing practice is fading way?

Yes	
No	
Uncertain	

Why?.....

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11. Give your general comment regarding traditional healing practice and their inclusion into mainstream of health care ministry.

Appendix 1I A

List of plants parts used in Sowa-rigpa system of medicine

Botanical name	Family	Medicinal properties	Parts used
Acantholimon lycopodioides (Girard) Boiss.	Plumbaginaceae	Cardiac disorders	L/F
Achillea millefolium L.	Asteraceae	Urinary problem, toothache and gum problem inflammation, astringent, diaphoretic, treatment for cold	L/F
Aconitum heterophyllum Wall. ex Royle.	Ranunculaceae	Toothache, fever, stomach complaint, gastric problem, headache and antiperiodic	T
Aconitum violaceum Jacquem. ex Stapf.	Ranunculaceae	Cold, cough, asthma, fever and gastric problems	R/T
Aconogonum tortuosum (D. Don) H. Hara.	Polygonaceae	Blood purifier	L
Allium carolinianum DC.	Amaryllidaceae	Constipation, feminine problems and joint pains	B/L
Allium cepa L.	Amaryllidaceae	Appetizer and vomiting	R/L
Allium przewalskianum Regel.	Amaryllidaceae	Stomachache and dysentery	L
Allium sativum L.	Amaryllidaceae	digestion and appetizer	L
Anaphalis triplinervis (Sims). Sims ex C.B.Clarke.	Asteraceae	Wounds and chronic diseases and genital problems	S/L/F/Fr
Anaphalis busua (Buch.-Ham.) DC.	Asteraceae	Cold & cough	L
Androsace aizoon Duby.	Primulaceae	Fever, cough and indigestion	S/W
Androsace rotundifolia Hardw.	Primulaceae	Tonic	W
Anemone rivularis Buch.-Ham. ex DC.	Ranunculaceae	Cold & cough, fever, wounds and cuts	W
Arabidopsis himalaica (Edgew.) O.E.Schulz.	Brassicaceae	Indigestion and appetizer	W
Arctium lappa Kalm.	Asteraceae	Astringent, blisters, burns and ulcers	W
Arenaria griffithii Boiss.	Caryophyllaceae	Mensuration disorder and bile disorder	L/Sh
Arnebia euchroma (Royle) I.M.Johnst.	Boraginaceae	Hair tonic, Cough, backache, cold & cough, lung & pulmonary problems and blood vomit	R
Arnebia guttata Bunge.	Boraginaceae	Hair tonic and blood purifier	R
Artemisia absinthium L.	Asteraceae	Rheumatism, malaria, anti-worm	W
Artemisia brevifolia Wall. ex DC.	Asteraceae	Gastrointestinal disorder, anthelmintic, aphrodisiac, antiseptic, laxative and blood purifier	L/F

Artemisia maritima L. ex Hook.f.	Asteraceae	Skin diseases and intestinal parasites	L/S
Artemisia moorcroftiana Wall. ex DC.	Asteraceae	Cure malaria fever	W
Aster flaccidus Bunge.	Asteraceae	Eye treatment, liver disease and fever	F/S
Astragalus zanskarensis Bunge.	Fabaceae	Intestinal worms	R
Berberis brandisiana Ahrendt	Berberidaceae	Eye problems and tonic	R/B
Bergenia stracheyi (Hook.f. & Thomson) Engl.	Saxifragaceae	Stone problems, cuts & wounds, urinary problems and stomach-ache	L/R/F
Betula utilis D.Don.	Betulaceae	Jaundice, burns, leprosy and bronchitis	B/R
Biebersteinia odora Stephan ex Fisch.	Geraniaceae	Cuts & wounds, peptic ulcer diarrhea and kidney problem	W
*Bistorta vivipara (*L.) Gray.	Polygonaceae	Abdominal pain and backache	F/S
Bunium persicum (Boiss.) B.Fedtsch.	Apiaceae	Abdominal pain, cold, cough, fever, loss of appetite, back pain and liver problems	S
Bupleurum longicaule Wall. ex DC.	Apiaceae	Stomach-ache, tonic, antidote and gastric problem	Fl
Capparis spinosa L.	Capparidaceae	Paralysis and gout, tonic and toothache	L/R/Sh
Capsella bursa-pastoris (L.) Medik.	Brassicaceae	Anti-vomit	L
Caragana versicolor Benth	Fabaceae	Food poisoning, fever and throat infection	S
Carum carvi L.	Apiaceae	Cold, nose-pain, carminative, stimulant, stomach-ache and tonic	R
*Cerastium cerastoides (*L.) Britton.	Caryophyllaceae	Headache, renal colic and body-ache	L/Sh
Chenopodium botrys L.	Chenopodiaceae	Anthelmintic, laxative and stomach complaints	F/L
Chenopodium glaucum L.	Chenopodiaceae	Purgative	L
Chrysanthemum tibeticum C.B.Clarke.	Asteraceae	Antiseptic paste	Sh
Cicer microphyllum Benth.	Fabaceae	Jaundice and sore throat	L
Cirsium arvense (L.) Scop.	Asteraceae	Anti-vomit and headache	L
Clematis orientalis L.	Ranunculaceae	Digestion	Sh
Clematis tibetana Kuntze.	Ranunculaceae	Indigestion and scabies	R/S/L
Colchicum luteum Baker.	Liliaceae	Colchicine and gout	Rh
Codonopsis ovata Benth.	Campanulaceae	Chest conjunction, lung and liver problems, ulcer and blood disorder	Sh/L
Corydalis megacalyx Ludlow & Stearn.	Fumariaceae	Pus dry	W

Corydalis govaniana Wall.	Fumariaceae	Antipyretic, febrifuge, diuretic, gastric problem and muscular pain	R/L
Corydalis meifolia Wall.	Fumariaceae	Fever	W
Cousinia thomsonii C.B.Clarke.	Asteraceae	Body pain, sprain and arthritis	L/R/F
Cremanthodium arnicoides (DC. ex Royle) R.D.Good.	Asteraceae	Peptic ulcer, dysentery, fever and liver disorder	F/Sh/S
Crepis flexuosa (Ledeb.) Benth. ex C.B.Clarke.	Asteraceae	Fever, backache, abdominal disorder and urinary problems	W
Cynoglossum wallichii G.Don.	Boraginaceae	Anti-vomit, wounds, swelling and cough	L/Sh/Fl/F
Dactylorhiza hatagirea (D.Don) Soó.	Orchidaceae	Health tonic and aphrodisiac	T/L
Datura stramonium L.	Solanaceae	Ear problems, impotence, intestinal worms and respiratory problems	L/S
Delphinium cashmerianum Royle.	Ranunculaceae	Insecticide, swelling and wounds	Sh/F/S
Delphinium viscosum Hook.f. & Thomson.	Ranunculaceae	Cold & cough and fever	R/S/F/Sh
Descurainia sophia (L.) Webb ex Prantl.	Brassicaceae	Chicken pox	S
Dianthus anatolicus Boiss.	Caryophyllaceae	Stomach complaints, cough & cold	L
Dracocephalum heterophyllum Benth.	Lamiaceae	Peptic ulcer, Hypertension, Cold	Sh/L/F
Echinops cornigerus DC	Asteraceae	Food poisoning and tonic	R/S/F/Sh
Ephedra gerardiana Wall. ex Stapf.	Ephedraceae	Asthma, rheumatism and Heart stimulant	Sh/Fr
Epilobium angustifolium L.	Onagraceae	Abdominal pain, intestine and renal complaints	F/S
Epilobium latifolium L.	Onagraceae	Acidity	F
Equisetum arvense L.	Equisetaceae	Diuretic , kidney problems and acidity	W
Erodium tibetanum Edgew. & Hook.f.	Geraniaceae	Wounds & burns and hair tonic	S/F
Euphrasia himalayica Wettst.	Scrophulariaceae	Eye problems and cardiac ailments	L
Ferula jaeschkeana Vatke.	Apiaceae	Chest pain	R/S
Galium pauciflorum Willd. ex K.Schum.	Rubiaceae	Throat infection	L
Gentiana nubigena Edgew.	Gentianaceae	Cough & cold, throat disorder and bronchitis	L
Gentiana tubiflora (G.Don) Griseb.	Gentianaceae	Cough, stomach disorder, joint pain and loss of appetite	W
Gentianella moorcroftiana (Wall. ex Griseb.) Airy Shaw.	Gentianaceae	Fever, giddiness, cough & cold and nausea	W
Geranium pratense L.	Geraniaceae	Analgesic, influenza , pneumonia and swelling	W
Heracleum pinnatum	Apiaceae	Leprosy, chicken pox and	S

C.B.Clarke.		small pox	
Hippophae rhamnoides L.	Elaeaganaceae	Anti-ageing, anti-cold, memory restoration and energy boosting	F/L/S
Hippophae tibetana Schltdl.	Elaeaganaceae	Revitalizing, and rejuvenations	F/L/S
Hyoscyamus niger L.	Solanaceae	Sedative, toothache, headache, asthma and cough	L/S
Hyoscyamus pusillus L	Solanaceae	Antiseptic, expectorant and diuretic	L
Hypecoum leptocarpum Hook. f. & Thomson.	Papaveraceae	Stomach disorder and acidity	R
Inula racemosa Hook.f.	Asteraceae	Rheumatism, gastro-intestinal complaints, Acidity	R/L
Inula rhizocephala Schrenk.	Asteraceae	Chest pains and common cold, constipation, intestinal infections and ulcers	W
Juglans regia L.	Juglandaceae	Constipation and Toothache	F/B
Juniperus communis L.	Cupressaceae	Kidney disorder	B/Fr
Juniperus recurva Buch.-Ham. ex D.Don.	Cupressaceae	Diarrhea, indigestion and cough, kidney disorder, paralysis and skin diseases	B/T
Jurinea ceratocarpa (Dcne.).	Asteraceae	Headache, backache, lung tuberculosis, asthma and bronchitis	R
Lactuca lessertiana Wall. ex C.B.Clarke.	Asteraceae	Rheumatism	L/Sh
Lactuca tatarica (L.) C.A.Mey.	Asteraceae	Headache, fever, internal wounds	L
Lagotis kunawurensis Rupr.	Scrophulariaceae	Fever, blood purification and bile disorder	R
Lancea tibetica Hook. f. & Thomson.	Scrophulariaceae	Heart diseases, cough, and chest congestion	R/L
Leontopodium alpinum Colm. ex Cass.	Asteraceae	Septic wounds	W
Leontopodium himalayanum DC.	Asteraceae	Septic wounds and headache	L
Lepidium latifolium L.	Brassicaceae	Rheumatism	S/L
Lloydia serotina (L.) Rchb.	Liliaceae	Eye disorders and fever	F
Malva verticillata L.	Malvaceae	Treatment of piles	R/S
Meconopsis aculeata Royle.	Papaveraceae	Headache, against ulcers, disorders of lungs, liver and inflammation, pharyngitis, stomachache	L/Sh/R
Melica persica Kunth.	Poaceae	Eye disorders, rheumatism, gout and joint pain	W
Mentha longifolia (L.) L.	Lamiaceae	Dysentery, vomiting and diarrhea	L/Sh
Myricaria elegans Royle.	Tamaricaeae	Blood purifier	L
Nepeta floccosa Benth.	Lamiaceae	Fever, cough and cold	L

Nepeta glutinosa Benth.	Lamiaceae	Diarrhea, dysentery and stomach-ache	F/L
Nepeta longibracteata Benth.	Lamiaceae	Stomach complaints, acidity, liver and kidney	L/F
Oxyria digyna (L.) Hill.	Polygonaceae	Digestion appetizer and gastritis	L/Sh
Papaver nudicaule L.	Papaveraceae	Analgesic and cold	L
Paraquilegia microphylla (Royle) J.R. Drumm. & Hutch.	Ranunculaceae	Gynecological diseases, uterine tumors, and blood disorder	S/L/F
Pedicularis bicornuta Klotzsch.	Scrophulariaceae	Burns, Rheumatism, gout, general inflammation and acidity	L/F
Pedicularis longiflora Rudolph.	Scrophulariaceae	Vertigo, dry tongue, diuretic, liver, gall bladder problems, excessive seminal discharge and edema	L/St
Pedicularis oederi Vahl.	Scrophulariaceae	Headache, backache, body-ache, food poisoning and sedative	W
Peganum harmala L.	Zygophyllaceae	Stomach complaints, eye disorders, measles, asthma, and menstrual disorder	S
Perovskia abrotanoides Kar.	Lamiaceae	Burning sensation	L/FI
Phlomis rotata Benth. ex Hook.f.	Lamiaceae	Bone fracture and healing bone marrow and joint swelling	W
Physochlaina praealta (Decne.) Miers.	Solanaceae	Ulcer and toothache	L/F/S
Plantago depressa Willd	Plantaginaceae	Diarrhea and gastric disorder	L
Plantago himalaica Pilg.	Plantaginaceae	Diarrhea	S
Plantago major L	Plantaginaceae	Dysentery, gastric problems, gum problem and toothache	S
Podophyllum hexandrum Royle.	Podophyllaceae	Skin diseases, blood dysentery and constipation	F/Fr
Potentilla anserina L.	Rosaceae	Diarrhea, kidney stone and stomach complaints	L
Potentilla argyrophylla Wall. ex Lehm.	Rosaceae	Chest and Throat pain	R
Potentilla multifida L.	Rosaceae	Insomnia	S
Prangos pabularia Lindl.	Apiaceae	Carminative, stimulant and diuretic	Fr
Primula denticulata Sm.	Primulaceae	Cold, headache and gastric problems	Sh
Primula macrophylla D. Don.	Primulaceae	Cough &cold and joint pain	W
Primula rosea Royle.	Primulaceae	Muscular pain	R
Psychrogeton andryaloides (DC.) Novopokr. ex Krascha.	Asteraceae	Wounds	W
Ranunculus brotherusii Freyn.	Ranunculaceae	Indigestion	L/Fr / S
Rheum australe D. Don.	Polygonaceae	Internal injuries, bone fracture, indigestion and general weakness	R

Rheum spiciforme Royle.	Polygonaceae	Rheumatism and veterinary	R
Rheum webbianum Royle.	Polygonaceae	Appetizer, purgative, astringent and wounds	R
Rhodiola fastigiata (Hook. f. & Thomson) S.H. Fu.	Crassulaceae	Congestion in chest and cough	W
Rhodiola himalensis (D. Don) S.H. Fu.	Crassulaceae	Headache	L/Sh
Rhodiola imbricata Edgew.	Crassulaceae	Tonic	R
Rosa webbiana Wall. ex Royle.	Rosaceae	Bleeding, jaundice and liver problems	Fr/F
Rumex patientia L	Polygonaceae	Fever, skin disorder, rheumatism and backache	L/Sh
Sagina saginoides (L.) H.Karst.	Caryophyllaceae	Food poisoning, diarrhea, cold and fever	W
Salix alba L.	Salicaceae	Knee, hip pain and fever	B
Salix denticulata Andersson.	Salicaceae	Joint pain and menstrual disorder	L/S
Saussurea obvallata (DC.) Edgew.	Asteraceae	Kidney problems	W
Saussurea bracteata Decne.	Asteraceae	Wounds & cut, boil, headache, fever, cough and veterinary	R/F
Saussurea gnaphalodes (Royle) Sch.Bip.	Asteraceae	Retardness and depression	L/F/R
Saussurea schultzii Hook.f.	Asteraceae	Headache cough, fever and throat ache	L/S
Saxifraga flagellaris Willd.	Saxifragaceae	Increasing of life span	W
Sedum ewersii Ledeb.	Crassulaceae	External injury and toothache	W
Senecio chrysanthemoides DC.	Asteraceae	Dysentery problems	W
Silene moorcroftiana Wall. ex Benth.	Caryophyllaceae	Ear and nose problems(ENT) and anemia	L
Sisymbrium orientale L.	Brassicaceae	Appetizer and carminative	S
Stachys tibetica Vatke.	Lamiaceae	Insecticide, mites and lice control	Sh
Swertia petiolata Royle ex D.Don.	Gentianaceae	Headache and body-ache	W
Swertia thomsonii C.B.Clarke.	Gentianaceae	Stomach disorder	W
Tanacetum gracile Hook.f. & Thomson.	Asteraceae	Anti-worm	L/F
Taraxacum officinale Webb.	Asteraceae	Mouth blisters, liver problems and digestive system, alcoholism and intestinal worms	F
Thlaspi arvense L.	Brassicaceae	Digestion and gastritis	W
Thalictrum minus L.	Ranunculaceae	Gout and rheumatism	Sh/L
Thermopsis inflata Cambess.	Fabaceae	Swelling	W
Thymus linearis Benth.	Lamiaceae	Stomachache, gastrointestinal problems and used in pregnancy	W
Tragopogon gracilis D.Don.	Asteraceae	Laxative	F

Trigonella emodi Benth.	Fabaceae	Fever, anemia and peptic ulcer	L/S
Urtica hyperborea Jacq. ex Wedd.	Utricaceae	Cold & cough, stomach ache and rheumatism	W
Verbascum thapsus L.	Scrophulariaceae	Used as diuretic, blood disorder, sores, infections, bleeding wounds and cuts	L/S /Fr
Viola kunawurensis Royle.	Violaceae	Heart diseases	F
Waldheimia glabra (Decne.) Regel.	Asteraceae	Headache and fever	W
Waldheimia tomentosa (Decne.) Regel.	Asteraceae	Joint pain and headache	W

Appendix 1IB

Animal parts used in Sowa-rigpa system of medicine

Animal organ	Animal	Use
Horns/ Antelers	Rhinoceros (*seru*)	Liver
	Reindeer (*Shawa*)	Drying of pus
	Wild yak (*Dong*)	Indigestion
	Spotted deer	Drying up pus
	Argali (*Nyan*)	Fever and lungs problem
	Gazelle	Diarrhea
	Tibetan antelope (*Tsod*)	Gynecological disorder
	Urial(*shapo*)	Drying of pus
	Wild sheep	Antibiotic
Bone	Human skull (Me Go)	Drying up pus
	Human scapular	Chronic fever
	Leopard bones	Tonic
	Domestic sheep (*Raluk*)	Intestinal pain
	Tiger	Arthritis and fracture
	Domestic pig (*Phak*)	Intestinal pain
	Monkey (*Manu*)	Child birth
	Wild yak (*Dong*)	Aphrodisiac
	Ungulate bones	Drying up lymph and pus
Flesh	Human (Me-sha)	Poison, plague, epilepsy
	Snake small (chaks-sbrul) skin	Eye problems
	Vulture (Khowa)	Digestion and goiter
	Peacock (Map-ja)	Poisoning and throat infection
	Otter liver	Liver related disease and reproductive disorder
	Marmot (*phai*) liver	Bone fracture and stomach pain
	Domestic goat (*Rama*)	Liver, lung, kidney eye and lung disorders
	Wolf (Changku) tongue, stomach	Tongue cures inflammation and stomach cures digestion problems
	Pig tongue	Cure growth of nodules in the bones
	Dog tongue	Ulcer
	Ass tongue	diarrhea
	Fox (Watsey) lung	Lung ulcer
	Bat	Antivomitive
	Sparrow	Kidney problems
	Lizards	Promotes semen production
	White-breasted dipper	Poisoning
	Pigeon (flesh)	Semen production
	Chukar	Impotence cure
	Tortoise	Diphtheria and tongue swelling
	Fish	Acidity
	Crab	Kidney disease and Urinary infection

	Goat (liver)(Flespa)	Liver, bile
	Elephant(liver)	Antipyretics
Blood	Shawa	Anti-worm
	Tibetan antelope (Tsod)	Diarrhea and dysentery
	Pig	Acidity and blood vomiting
	Wild yak (Dong)	Anemia and heart disease
	Goat(Rathak)	Small-pox, arthritis, bruises, anemia
	Donkey	Wounds and joint pain
Fat	Pig	Wounds and skin diseases
	Reindeer (Shawa)	Skin diseases, lice control, antiworm
Brain	Sheep (*look*)	Vertigo, ear problems
	Rabbit *(Ribong)*	Diarrhea and dysentery
Heart	Wild yak (Dong)	Retarders
	Rabbit (*Ribong)*	Retarders
Bile	Bear(Denmo)	Dysentery and treatment of wounds
	Elephant(liver- part)(Gibang)	Fever
Urine/stool	Cow urine(only reddish color cow)	Infection and antipyretics
	Horse (Sta) droppings	Infection and anti-vomit
	Rabbit (*Ribong*)droppings	Skin diseases
	Pigeon (*Phorgon*)	Inflammation, ointment wound
Other	Shell(*Puskyok*)	Weakness and edema
	Musk deer(*Lhasi*)	Anti-vomit and liver problems
	Pearl(*motik*)	Paralysis and nerve pain

Appendix III

Average ranking and frequency citation of Lower Indus valley

Food	Av_Rank	Citation	Food	Av_Rank	Citation
Prunus domestica	4.327778	116	*Lagotis kunawurensis*	0.65	14
Rheum moorcroftianum	3.861111	84	*Aconitum heterophyllum*	0.605556	16
Hippophae rhamnoides	3.711111	64	*Dactylorhiza kafiriana*	0.583333	13
Thymus linearis	3.588889	95	*Cicer microphyllum*	0.572222	7
Carum carvi	3.244444	76	*Aster flaccidus*	0.538889	18
Rumex angulatus	3.222222	82	*Ephedra intermedia*	0.516667	8
Allium przewalskianum	3.116667	53	*Taraxacum officinale*	0.472222	10
Rhodiola imbricata	3.05	95	*Codonopsis ovata*	0.433333	6
Lactuca sativa	2.955556	82	*Gentiana tianschanica*	0.4	11
Plantago major	2.538889	89	*Arabidopsis himalaica*	0.35	5
Morus alba	2.538889	85	*Chenopodium botrys*	0.327778	7
Medicago sativa	2.494444	118	*Ribes sp*	0.277778	6
Rheum webbiana	2.427778	52	*Arabis tibetica*	0.266667	4
Rosa webbiana	2.277778	36	*Potentilla argyrophylla*	0.266667	6
Plantago himalaica	2.144444	39	*Corydalis govaniana*	0.227778	5
Arnebia euchroma	2.138889	110	*Rumex patientia*	0.194444	3
Urtica hyperborea	2.1	33	*Avena fatua*	0.183333	4
Ephedra gerardiana	1.861111	117	*Trifolium repens*	0.133333	2
Capparis spinosa	1.605556	43	*Oxyria digyna*	0.122222	3
Bunium persicum	1.511111	21	*Ribes orientale*	0.111111	3
Codonopsis clematidea	1.461111	18	*Rhodiola fastigiata*	0.105556	1
Aconogonum tortuosum	1.333333	26	*Convolvulus arvensis*	0.077778	1
Allium tortuosum	1.327778	21	*Silene setisperma*	0.077778	2
Lonicera sp.	1.294444	16	*Bergenia stracheyi*	0.077778	2
Viola kunawurensis	1.272222	76	*Draba alpina*	0.072222	2
Anaphalis triplinervis	1.194444	29	*Pedicularis punctata*	0.061111	2
Rosa ecae	1.072222	13	*Plantago depressa*	0.055556	2
Chenopodium glaucum	0.955556	22	*Cerastium cerastoides*	0.05	1
Potentilla anserina	0.827778	14	*Primula denticulata*	0.05	2
Vitis vinifera	0.805556	19	*Primula minutissima*	0.033333	1
Mentha longifolia	0.722222	14	*Elshotzia densa*	0.027778	2
Echinops cornigerus	0.716667	9			
Fodder	**Av_Rank**	**Citation**	**Fodder**	**Av_Rank**	**Citation**
Cicer microphyllum	2.255556	107	*Caparis spinosa*	0.194444	4
Stachys tibetica	2.166667	82	*Aquilegia fragrans*	0.177778	4
Artemisia spp.	2.016667	90	*Salix sclerophylla*	0.172222	7
Geranium sibiricum	1.977778	84	*Delphinium cashmerianum*	0.166667	7

Aconogonum tortuosum	1.733333	103	*Bupleurum longicaule*	0.166667	3
Oxyria digyna	1.216667	37	*Phragmites australis*	0.161111	3
Rumex nepalenisis	1.116667	44	*Avena fatua*	0.144444	4
Convolvulus arvensis	1.105556	23	*Caragana versicolor*	0.144444	6
Cotoneaster sp.	1.044444	22	*Ephedra gerediana*	0.133333	3
Medicago sativa	0.916667	106	*Plantago depressa*	0.127778	5
Corydalis govaniana	0.888889	22	*Physochlaina praealta*	0.111111	4
Codonopsis ovata	0.888889	20	*Chenopodium botrys*	0.105556	3
Allium tortosum	0.861111	29	*Matthiola flavida*	0.105556	4
Rosa webbiana	0.822222	27	*Mentha longifolia*	0.1	3
Clematis orientalis	0.722222	17	*Pseudomertensia echioides*	0.094444	3
Rheum webbiana	0.638889	28	*Anaphalis busua*	0.083333	2
Gentiana	0.6	20	*Astragalus sp*	0.077778	1
Carum carvi	0.572222	28	*Krascheninnikovia ceratoides*	0.072222	6
Rumex angulatus	0.572222	14	*Rheum moorcroftianum*	0.044444	2
Medicago lupulina	0.566667	17	*Nepeta glutinosa*	0.038889	1
Acantholimon lycopodioides	0.561111	18	*Artemisia siversiana*	0.038889	2
Breea arvenensis	0.55	18	*Tragopogon gracilis*	0.038889	2
Chenopodium album	0.538889	14	*Biebersteinia odora*	0.033333	1
fagopyrum esculentum	0.538889	12	*Galium pauciflorum*	0.033333	2
Rumex patientia	0.472222	8	*Holoxylon thomsonii*	0.033333	1
Artemisia sp.	0.422222	9	*Saxifraga* spp.	0.033333	1
Plantago major	0.411111	21	*Myricaria elegans*	0.033333	1
Mulgedium tataricum	0.377778	8	*Cheilanthes grisea*	0.027778	1
Oxytropis sp.	0.327778	8	*Heracleum pinnatum*	0.022222	1
Taraxacum officinale	0.316667	12	*Pedicularis punctata*	0.022222	1
Cousinia thomsonii	0.261111	9	*Lonicera spinosa*	0.022222	1
Lactuca tatarica	0.233333	6	*Bergenia stracheyi*	0.022222	1
Seseli mucronatum	0.211111	7	*Urtica hyperborea*	0.022222	1
Bromus tectorum	0.205556	11	*Poa falconeri*	0.016667	2
Ribes orientale	0.205556	9	*Lindelofia stylosa*	0.016667	2
Arctium lappa	0.194444	5	*Salix tetrasperma*	0.016667	1
Lactuca sativa	0.194444	9	*Kochia stellaris*	0.005556	1
Fuelwood	**Av_Rank**	**Citation**	**Fuelwood**	**Av_Rank**	**Citation**
Juniperus communis	1.983333	171	*Lonicera spinosa*	0.777778	26
Artemisia spp	1.9	86	*Populus alba*	0.744444	37
Ribes orientale	1.533333	60	*Atriplex hortensis*	0.638889	19
Hippophae tibetana	1.5	64	*Morus alba* .	0.638889	27
Salix sclerophylla	1.472222	77	*Ribes sp*	0.255556	8
Lonicera spp	1.472222	78	*Rosa webbiana*	0.194444	5

Rosa ecae	*1.166667*	*57*	*Caragana versicolor*	*0.166667*	*4*
Salix tetrasperma	*1.161111*	*56*	*Salix alba*	*0.144444*	*5*
Myricaria elegans	*1.144444*	*61*	*Ephedra gerardiana*	*0.105556*	*4*
Cotoneaster microphyllus	*0.977778*	*34*	*Astragalus sp*	*0.077778*	*5*
Populus nigra	*0.955556*	*46*	*Prunus domestica*	*0.066667*	*4*
Acantholimon lycopodioides	*0.805556*	*35*			
Ornamental	**Av_Rank**	**Citation**	**Ornamental**	**Av_Rank**	**Citation**
Rosa webbiana	*2.577778*	*65*	*Lagotis kunawurensis*	*0.594444*	*25*
Anemone rivularis	*2.561111*	*90*	*Viola* sp.	*0.594444*	*13*
Aster flaccidus	*2.405556*	*68*	*Saussurea bracteata*	*0.527778*	*13*
Primula macrophylla	*2.211111*	*60*	*Thermopsis inflata*	*0.5*	*8*
Arenaria griffithii	*2.105556*	*74*	*Pedicularis punctata*	*0.483333*	*14*
Aquilegia fragrans	*1.827778*	*45*	*Pseudomertensia* sp.	*0.422222*	*11*
Delphinium cashmerianum	*1.738889*	*125*	*Saxifraga* sp.	*0.388889*	*5*
Rosa ecae	*1.7*	*35*	*Trifolium repens*	*0.244444*	*5*
Codonopsis ovata	*1.622222*	*54*	*Dactylorhiza kafiriana*	*0.238889*	*8*
Biebersteinia odora	*1.594444*	*137*	*Potentilla* sp.	*0.138889*	*2*
Geranium spp.	*1.572222*	*96*	*Primula minutissima*	*0.133333*	*3*
Corydalis govaniana	*1.416667*	*51*	*Lyodia serotina*	*0.122222*	*3*
Primula denticulata	*1.277778*	*28*	*Lindelofia anchusoides*	*0.116667*	*6*
Lomatogonum sp.	*1.238889*	*38*	*Chrysanthamum* sp.	*0.094444*	*13*
Aconitum rotundifolium	*1.211111*	*39*	*Caparis spinosa*	*0.072222*	*2*
Waldheimia glabra	*1.116667*	*27*	*Potentilla argyrophylla*	*0.066667*	*2*
Bergenia stracheyi	*1.066667*	*45*	*Thymus linearis*	*0.044444*	*4*
Papaver nudicaule	*0.944444*	*24*	*Cerastium cerastoides*	*0.038889*	*1*
Swertia thomsonii	*0.916667*	*22*	*Inula obtusifolia*	*0.027778*	*1*
Silene moorcroftiana	*0.688889*	*18*	*Pedicularis longiflora*	*0.005556*	*1*
Berberis brandisiana	*0.6*	*21*			
Medicine	**Av_Rank**	**Citation**	**Medicine**	**Av_Rank**	**Citation**
Thymus linearis	*2.166667*	*85*	*Saussurea bracteata*	*0.266667*	*6*
Pedicularis longiflora	*1.855556*	*89*	*Trifolium repens*	*0.255556*	*5*
Hyoscyamus pusillus	*1.755556*	*58*	*Viola sp*	*0.255556*	*7*
Salajit	*1.516667*	*38*	*Geranium himalayense*	*0.255556*	*11*
Mentha longifolia	*1.505556*	*48*	*Artemisia spp*	*0.25*	*8*
Aconitum rotundifolium	*1.466667*	*144*	*Papaver nudicaule*	*0.244444*	*10*
Carum carvi	*1.372222*	*41*	*Tragopogon gracilis*	*0.222222*	*7*
Corydalis govaniana	*1.222222*	*51*	*Lindelofia anchusoides*	*0.138889*	*3*
Lagotis kunawurensis	*1.105556*	*34*	*Physochlaina praealta*	*0.133333*	*10*
Allium carolinianum	*1.061111*	*24*	*Cicer microphyllum*	*0.116667*	*3*
Aconitum violaceum	*0.844444*	*48*	*Aconitum heterophyllum*	*0.105556*	*4*

Rheum spiciforme	*0.783333*	*32*	*Rhodiola himalensis*	*0.105556*	*3*
Dactylorhiza kafiriana	*0.661111*	*26*	*Gentianella moorcroftiana*	*0.094444*	*6*
Ranunculus brotherusii	*0.588889*	*17*	*Acantholimon lycopodioides*	*0.066667*	*2*
Oxyria digyna	*0.55*	*18*	*Juglans regia*	*0.066667*	*5*
Rheum webbiana	*0.505556*	*21*	*Delphinium cashmerianum*	*0.055556*	*3*
Arnebia euchroma	*0.472222*	*13*	*Aconogonum tortuosum*	*0.05*	*1*
Berberis brandisiana	*0.466667*	*16*	*Waldheimia glabra*	*0.044444*	*1*
Rosa webbiana	*0.422222*	*12*	*Swertia thomsonii*	*0.033333*	*1*
Aster flaccidus	*0.416667*	*14*	*Allium przewalskianum*	*0.027778*	*2*
Taraxacum officinale	*0.355556*	*11*	*Inula obtusifolia*	*0.022222*	*1*
Codonopsis ovata	*0.35*	*18*	*Plantago major*	*0.016667*	*1*
Cousinia thomsonii	*0.344444*	*11*	*Clematis tibetana*	*0.011111*	*1*
Stachys tibetica	*0.338889*	*8*	*Thermopsis inflata*	*0.005556*	*1*
Primula denticulata	*0.311111*	*7*	*Urtica hyperborea*	*0.005556*	*1*
Primula macrophylla	*0.311111*	*13*	*Saxifraga flagellaris*	*0.005556*	*1*
Pulsatilla wallichiana	*0.272222*	*16*	*Biebersteinia odora*	*0.005556*	*1*
Dye	**Av_Rank**	**Citation**	**Dye**	**Av_Rank**	**Citation**
Arnebia euchroma	*1.094444*	*132*	*Oxyria digyna*	*0.188889*	*10*
Rheum webbianum	*1.011111*	*85*	*Bergenia strachyi*	*0.183333*	*10*
Rheum spiciforme	*0.816667*	*45*	*Primula denticulata*	*0.111111*	*4*
Juglans regia	*0.755556*	*83*	*Aconitum rotundifolium*	*0.094444*	*4*
Galium pauciflorum	*0.555556*	*35*	*Artemisia sieversiana*	*0.088889*	*4*
Urtica hyperborea	*0.411111*	*18*	*Aconogonum tortuosum*	*0.05*	*2*
Rosa webbiana	*0.355556*	*15*	*Geranium* spp.	*0.033333*	*1*
Religeous	**Av_Rank**	**Citation**	**Religeous**	**Av_Rank**	**Citation**
Arnebia euchroma	*2.116667*	*123*	*Berberis bradisiana*	*0.427778*	*20*
Prunus armeniaca	*2.038889*	*82*	*Populus spp*	*0.405556*	*13*
Malus domestica	*1.95*	*86*	*Hordeum vulgare*	*0.344444*	*11*
Juniperus communis	*1.8*	*172*	*Aconitum rotundifolium*	*0.216667*	*6*
Juglens regia	*1.65*	*63*	*Rosa webbiana*	*0.216667*	*21*
Biebersteinia odora	*1.411111*	*35*	*Myricaria elegans*	*0.172222*	*7*
Bergenia stracheyi	*1.083333*	*28*	*fagopyrum esculentum*	*0.133333*	*5*
Delphinium cashmerianum	*1.022222*	*21*	*Salix sclerophylla*	*0.122222*	*4*
Artemisia sieversiana	*0.816667*	*42*	*Salix tetrasperma*	*0.033333*	*1*
Waldheimia glabra	*0.755556*	*51*	*Morus alba*	*0.033333*	*1*
Aconitum heterophyllum	*0.444444*	*14*	*Viola kunawurensis*	*0.005556*	*1*
Waldheimia tomentosa	*0.433333*	*21*			
Other	**Av_Rank**	**Citation**	**Other**	**Av_Rank**	**Citation**
Poplar spp.	*2.794444*	*102*	*Juniperus communis*	*0.711111*	*39*
Morus alba	*2.255556*	*62*	*Ribes alpestre*	*0.677778*	*32*
Prunus armeniaca	*2.233333*	*69*	*Lonicera spp*	*0.555556*	*58*

Juglens regia	2.016667	87	*Salix tetrasperma*	0.488889	40
Salix alba	1.966667	107	*Artemisia* spp.	0.311111	23
Myricaria elegans	1.933333	96	*Rosa webbiana*	0.255556	35
Stachys tibetica	1.166667	27	*Acantholimon lycopodioides*	0.072222	5
Hippophae rhamnoides	1.038889	39	*Cotoneaster integerrimus*	0.05	2
Salix sclerophylla	1.027778	61	*Malus domestica*	0.027778	1
Potentilla fruticosa	0.877778	65	*Poplus nigra*	0.016667	1
Stipa sp.	0.727778	22	*Arnebia euchroma*	0.011111	1

Average ranking and frequency citation of Wakha-chu valley

Food	Av_Rank	Citation	Food	Av_Rank	Citation
Allium tortosum	2.677778	107	*Tulipa stellata*	0.305556	8
Rheum australe	2.65	146	*Gentiana tianschanica*	0.255556	11
Rheum webbianum	2.611111	117	*Nepeta longibracteata*	0.227778	7
Allium przewalskianum	2.127778	110	*Bergenia stracheyi*	0.211111	8
Capparis spinosa	1.788889	54	*Hippophae rhamnoides*	0.211111	11
Cicer microphyllum	1.75	98	*Prunus armeniaca*	0.188889	6
Rhodiola fastigiata	1.483333	145	*Corydalis govaniana*	0.177778	3
Potentilla toma	1.35	27	*Potentilla fruticosa*	0.172222	7
Rosa webbiana	1.161111	31	*Chenopodium botrys*	0.138889	5
Lactuca sativa	0.983333	29	*Elsholtzia densa*	0.127778	3
Codonopsis ovata	0.944444	17	*Rosa ecae*	0.127778	9
Trifolium repens	0.944444	19	*Thymus linearis*	0.105556	6
Oxyria digyna	0.844444	18	*Medicago sativa*	0.1	2
Potentilla anserina	0.833333	24	*Chesneya cuneata*	0.094444	4
Plantago depressa	0.772222	24	*Allium oreoprasum*	0.077778	4
Dactylorhiza kafiriana	0.761111	23	*Aconogonum tortuosum*	0.066667	2
Mentha longifolia	0.572222	21	*Lactuca lessertiana*	0.061111	3
Carum carvi	0.561111	16	*Arnebia euchroma*	0.055556	1
Pedicularis punctata	0.538889	14	*Lagotis kunawurensis*	0.055556	2
Allium carolinianum	0.5	37	*Ribes orientale*	0.044444	1
Rumex Angulatus	0.488889	10	*Artemisia brevifolia*	0.044444	1
Plantago himalaica	0.455556	14	*Fagopyrum tataricum*	0.038889	2
Taraxacum officinale	0.427778	12	*Artemisia spp*	0.033333	2
Bunium persicum	0.411111	13	*Ephedra gerardiana*	0.033333	2
Chenopodium glaucum	0.388889	6	*Echinops cornigerus*	0.016667	2
Urtica hyperborea	0.322222				
Fodder	**Av_Rank**	**Citation**	**Fodder**	**Av_Rank**	**Citation**
Artemisia brevifolia	1.944444	109	*Rhodiola imbricata*	0.072222	7
Cicer microphyllum	1.844444	136	*Salix sclerophylla*	0.066667	2
Aconogonum tortuosum	1.827778	96	*Juncus triglumis*	0.066667	2
Cousinia thomsonii	1.783333	88	*Trigonella corniculata*	0.066667	3
Artemesia spp.	1.616667	158	*Lindelofia anchusoides*	0.066667	3
Stachys tibetica	1.388889	68	*Euphrasia himalayica*	0.061111	3
Trifolium repens	0.722222	25	*Bunium persicum*	0.061111	2

Geranium spp.	0.572222	22	*Hippophae tibetana*	0.061111	2
Bromus sp.	0.538889	27	*Salix tetrasperma*	0.05	2
Medicago sativa	0.527778	20	*Bergenia stracheyi*	0.05	2
Rumex patientia	0.483333	22	*Aconitum rotundifolium*	0.044444	1
Acantholimon lycopodioides	0.422222	15	*Lactuca lessertiana*	0.044444	2
Dactylorhiza kafiriana	0.35	10	*Avena fatua*	0.038889	1
Corydalis govaniana	0.338889	9	*Crepis stoliczkai*	0.038889	2
Heracleum pinnatum	0.305556	15	*Taraxacum officinale*	0.038889	1
Saussurea bracteata	0.294444	12	*Myricaria elegans*	0.038889	2
Caragana versicolor	0.288889	11	*Breea arvenensis*	0.033333	2
Mentha longifolia	0.272222	10	*Rosa ecae*	0.033333	1
Pleurospermum candollei	0.272222	9	*Astragalus peduncularis*	0.033333	1
Convolvulus arvensis	0.238889	8	*Echinospermum redowskii*	0.033333	2
Rosa webbiana	0.188889	6	*Chenopodium botrys*	0.027778	1
Ribes orientale	0.188889	7	*Cotoneaster microphyllus*	0.027778	1
Chesneya cuneata	0.183333	6	*Indigofera heterantha*	0.027778	1
Codonopsis ovata	0.155556	5	*Bupleurum longicaule*	0.022222	1
Rheum spiciforme	0.133333	11	*Kraschenninnikovia ceratoides*	0.016667	1
Rheum webbiana	0.1	6	*Chaerophyllum villosum*	0.011111	1
Pedicularis punctata	0.1	3	*Lonicera spinosa*	0.005556	1
Fuelwood	**Av_Rank**	**Citation**	**Fuelwood**	**Av_Rank**	**Citation**
Myricaria elegans	1.822222	107	*Euphorbia tibetica*	0.127778	5
Artemisia spp.	1.361111	102	*Salix tetrasperma*	0.116667	4
Acantholimon lycopodioides	1.355556	91	*Epilobium angustifolium*	0.105556	2
Salix sclerophylla	1.277778	57	*Rosa ecae*	0.1	4
Arnebia euchroma	1.266667	78	*Heracleum pinnatum*	0.1	6
Rosa webbiana	1.2	50	*Astragalus frigidus*	0.072222	3
Hippophae tibetana	1.194444	68	*Populus nigra*	0.066667	2
Betula utilis	0.911111	66	*Dianthus anatolicus*	0.061111	4
Ribes orientale	0.683333	32	*Artemisia burnak*	0.055556	2
Lonicera sp.	0.405556	26	*Medicago sativa*	0.05	2
Cotoneaster microphyllus	0.388889	26	*Salix alba*	0.05	4
Caragana versicolor	0.377778	30	*Aconogonum tortuosum*	0.05	3
Juniperus communis	0.366667	24	*Kraschenninnikovia ceratoides*	0.038889	3
Ephedra gerardiana	0.366667	16	*Artemisia* sp.	0.022222	2
Lonicera spinosa	0.227778	10	*Bergenia stracheyi*	0.022222	1
Inula obtusifolia	0.15	6	*Astragalus* sp.	0.022222	1
Stachys tibetica	0.15	8	*Rumex patientia*	0.016667	1
Galium pauciflorum	0.138889	6	*Potentilla fruticosa*	0.016667	3
Erysium odoratum	0.138889	3	*Geranium pratense*	0.011111	1
Ornamental	**Av_Rank**	**Citation**	**Ornamental**	**Av_Rank**	**Citation**
Delphinium viscosum	1.655556	78	*Gentiana tubiflora*	0.194444	8
Biebersteinia odora	1.294444	66	*campanula latifolia*	0.188889	11
Aster flaccidus	1.244444	50	*Primula macrophylla*	0.188889	5
Pulsatilla wallichiana	1.066667	49	*Androsace* sp.	0.172222	8
Saussurea bracteata	1.027778	73	*Aconitum violaceum*	0.166667	9
Rosa ecae	0.905556	58	*Iris* sp.	0.166667	8
Arenaria griffithii	0.877778	38	*Capparis spinosa*	0.166667	11

Pedicularis punctata	*0.805556*	*30*	*Thymus linearis*	*0.155556*	*10*
Codonopsis ovata	*0.755556*	*42*	*Thermopsis inflata*	*0.15*	*5*
Pedicularis bicornuta	*0.75*	*26*	*Corydalis govaniana*	*0.138889*	*5*
Inula obtusifolia	*0.677778*	*15*	*Delphinium cashmerianum*	*0.133333*	*5*
Chesneya cuneata	*0.616667*	*23*	*Lomatogonium carinthiacum*	*0.116667*	*7*
Bergenia stracheyi	*0.572222*	*26*	*Lindelofia anchusoides*	*0.105556*	*4*
Rosa webbiana	*0.561111*	*36*	*Pseudomertensia echioides*	*0.088889*	*3*
Paraquilegia microphylla	*0.544444*	*30*	*Convolvulus arvensis*	*0.083333*	*3*
Cremanthodium arnicoides	*0.472222*	*13*	*Chrysanthemum pyrethroides*	*0.083333*	*4*
Saxifraga sp.	*0.411111*	*34*	*Nepta logibracteata*	*0.072222*	*7*
Aquilegia fragrans	*0.377778*	*15*	*Corydylis mefolia*	*0.066667*	*3*
Anemone rivularis	*0.35*	*10*	*Lactuca lesseriania*	*0.066667*	*3*
Aconitum heterophyllum	*0.327778*	*22*	*Swertia petiolata*	*0.066667*	*3*
Juniperus communis	*0.327778*	*13*	*Viola kunawurensis*	*0.061111*	*5*
Ranunculus sp.	*0.327778*	*13*	*Draba* sp.	*0.055556*	*2*
Papaver nudicaule	*0.316667*	*19*	*Lloydia serotina*	*0.055556*	*3*
Lagotis kunawurensis	*0.272222*	*9*	*Arnebia euchroma*	*0.044444*	*3*
Geranium spp.	*0.272222*	*21*	*Aconitum rotundifolium*	*0.033333*	*1*
Taraxacum officinale	*0.266667*	*14*	*Waldheimia glabra*	*0.033333*	*1*
Stachys tibetica	*0.266667*	*11*	*Silene* sp.	*0.027778*	*3*
Gentiana kurroo	*0.266667*	*7*	*Potentilla* spp.	*0.016667*	*1*
Gentianella moorcroftiana	*0.261111*	*5*	*Epilobium angustifolium*	*0.016667*	*1*
Potentilla argyrophylla	*0.255556*	*6*	*Dactylorhiza kafiriana*	*0.016667*	*2*
Tulipa stellata	*0.25*	*10*	*Primula denticulata*	*0.016667*	*1*
Epilobium latifolium	*0.238889*	*8*	*Rhodiola imbricata*	*0.011111*	*2*
Trifolium repens	*0.211111*	*7*	*Lotos cuneata*	*0.005556*	*1*
Medicinal	**Av_Rank**	**Citation**	**Medicinal**	**Av_Rank**	**Citation**
Potentilla anserina	*1.688889*	*60*	*Gentianella moorcroftiana*	*0.127778*	*6*
Bunium persicum	*1.666667*	*49*	*Mentha longifolia*	*0.127778*	*5*
Latuca sativa	*1.555556*	*39*	*Papaver nudicaule*	*0.127778*	*5*
Thermopsis inflata	*1.438889*	*57*	*Myricaria elegans*	*0.122222*	*4*
Hyoscyamus pusillus	*1.266667*	*68*	*Juglans regia*	*0.111111*	*7*
Aconitum heterophyllum	*1.238889*	*69*	*Melica persica*	*0.105556*	*3*
Chenopodium botrys	*1.233333*	*47*	*Pedicularis longiflora*	*0.1*	*10*
Rheum webbiana	*1.166667*	*45*	*Lancea tibetica*	*0.083333*	*5*
Swertia thomsonii	*1.072222*	*66*	*Primula denticulata*	*0.083333*	*5*
Dactylorhiza kafiriana	*1.038889*	*40*	*Lactuca lessertiana*	*0.077778*	*5*
Arnebia euchroma	*1.005556*	*36*	*Stachys tibetica*	*0.066667*	*2*
Aconitum rotundifolium	*0.877778*	*35*	*Saxifraga* sp.	*0.061111*	*2*
Codonopsis ovata	*0.861111*	*43*	*Plantago major*	*0.055556*	*3*
Lagotis kunawurensis	*0.738889*	*27*	*Pedicularis bicornata*	*0.055556*	*2*
Saussurea bracteata	*0.622222*	*13*	*Rosa ecae*	*0.055556*	*4*
Aster flaccidus	*0.594444*	*23*	*Echinops cornigerus*	*0.05*	*1*
Heracleum pinnatum	*0.566667*	*22*	*Waldheimia glabra*	*0.05*	*2*
Rumex patientia	*0.516667*	*15*	*Bergenia stracheyi*	*0.05*	*1*
Oxyria digna	*0.494444*	*18*	*Swertia petiolata*	*0.044444*	*1*
Rosa webbiana	*0.488889*	*8*	*Allium przewalskianum*	*0.044444*	*2*
Nepeta longibracteata	*0.472222*	*14*	*Paraquilegia microphylla*	*0.044444*	*6*

Corydalis govaniana	0.4	12	*Anaphalis busua*	0.044444	1
Delphinium cashmerianum	0.4	14	*Viola piolosa*	0.044444	2
Tulipa stellata	0.366667	11	*Waldheimia tomentosa*	0.044444	2
Leontopodium himalayanum	0.294444	6	*Potentilla fruticosa*	0.044444	1
Thymus linearis	0.294444	18	*Ranunculus brotherusii*	0.038889	3
Chrysanthemum tibeticum	0.283333	13	*Arenaria griffithii*	0.033333	2
Biebersteinia odora	0.283333	6	*Taraxacum gracile*	0.033333	2
Geranium pratense	0.277778	11	*Ephedra gerardiana*	0.027778	1
Trifolium repens	0.261111	11	*Salajit*	0.022222	1
Cremanthodium arnicoides	0.255556	9	*Cicer microphyllum*	0.022222	2
Corydalis megacalyx	0.238889	12	*Juniperus communis*	0.022222	1
Cousinia thomsonii	0.233333	8	*Prunus armeniaca*	0.016667	1
Rhodiola imbricata	0.211111	6	*Medicago sativa*	0.016667	1
Carum carvi	0.2	20	*Delphinium viscosum*	0.016667	1
Lindelofia anchusoides	0.2	12	*Artemesia sp*	0.016667	3
Aconitum violaceum	0.194444	10	*Silene moorcroftiana*	0.011111	1
Hippophae rhamnoides	0.172222	9	*Pedicularis punctata*	0.011111	1
Potentilla sp	0.15	3	*Anemone rivularis*	0.011111	1
Clematis orientalis	0.144444	5	*Crepis flexuosa*	0.011111	1
Rheum spiciforme	0.144444	4	*Capparis spinosa*	0.011111	1
Viola kunawurensis	0.138889	6	*Rhodiola himalensis*	0.005556	1
Allium carolinianum	0.133333	4	*Plantago himalayana*	0.005556	1
Urtica hyperborea	0.133333	6	*Gentiana capitata*	0.005556	1
Dye	**Av_Rank**	**Citation**	**Dye**	**Av_Rank**	**Citation**
Oxyria digyna	0.744444	84	*Rosa webbiana*	0.261111	20
Rheum spiciforme	0.7	58	*Artemisia sieversiana*	0.155556	11
Arnebia euchroma	0.572222	61	*Galium pauciflorum*	0.066667	4
Arnebia guttata	0.527778	56	*Juglans regia*	0.066667	8
Geranium pratense	0.311111	23	*Rosa eace*	0.022222	1
Rheum webbianum	0.305556	28	*Rumex patientia*	0.022222	2
Aconogonum tortuosum	0.305556	24	*Bergenia stracheyi*	0.016667	2
Religeous	**Av_Rank**	**Citation**	**Religeous**	**Av_Rank**	**Citation**
Arnebia euchroma	1.311111	112	*Poplar nigra*	0.05	2
Juniperus communis	1.311111	134	*Salix alba*	0.038889	5
Waldheimia glabra	1.1	97	*Hordeum vulgare*	0.033333	1
Artemisia siversiana	0.494444	35	*Salix tetrasperma*	0.033333	3
Hippophae rhamnoides	0.4	29	*Delphinium cashmerianum*	0.027778	1
Prunus armeniaca	0.211111	11	*Rosa webbiana*	0.027778	1
Viola kunawurensis	0.183333	17	*Populus alba*	0.022222	1
Betula utilis	0.1	6	*Salix sclerophylla*	0.011111	1
Malus domestica	0.083333	3	*Oxyria digna*	0.005556	1
Waldheimia tomentosa	0.055556	4	*Myricaria elegans*	0.005556	1
Other	**Av_Rank**	**Citation**	**Other**	**Av_Rank**	**Citation**
Salix sclerophylla	1.911111	155	*Caragana versicolor*	0.172222	6
Salix tetrasperma	1.861111	93	*Prunus armeniaca*	0.155556	8
Hippophae rhamnoides	1.338889	80	*Rosa ecae*	0.15	6
Stachys tibetica	1.077778	71	*Elaeagnus angustifolia*	0.122222	9
Populus alba	0.994444	65	*Artemisia brevifolia*	0.116667	7

Ephedra gerardiana	0.988889	60	*Arnebia euchroma*	0.044444	3
Myricaria elegans	0.811111	30	*Rheum spiciforme*	0.033333	1
Rosa webbiana	0.722222	45	*Populus alba*	0.027778	1
Lonicera spp	0.666667	41	*Cotoneaster integerrimus*	0.022222	3
Ephedra intermedia	0.633333	36	*Bergenia stracheyi*	0.022222	2
Juglens regia	0.355556	11	*Morus alba*	0.022222	1
Salix alba	0.316667	20	*Datura inoxia*	0.016667	1
Ribes alpestre	0.294444	19	*Betula utilis*	0.016667	1
Juniperus communis	0.222222	9	*Potentilla fruticosa*	0.011111	1
Acantholimon lycopodioides	0.222222	6	*Artemisia* sp.	0.005556	1

Average ranking and frequency citation of Suru valley

Food	Av_Rank	Citation	Food	Av_Rank	Citation
Rheum webbianum	2.338889	122	*Hippophae rhamnoides*	0.322222	14
Rheum australe	2.25	130	*Lathyrus humilis*	0.272222	9
Latuca lessertiana	1.794444	86	*Echinops cornigerus*	0.272222	9
Allium przewalskianum	1.6	61	*Ephedra intermedia*	0.244444	6
Rhodiola fastigiata	1.505556	126	*Cerastium vulgatum*	0.211111	6
Corydalis govaniana	1.344444	93	*Chenopodium botrys*	0.205556	8
Cicer microphyllum	1.311111	47	*Arnebia euchroma*	0.177778	5
Tulipa stellata	1.233333	35	*Ribes orientale*	0.155556	5
Pedicularis punctata	0.788889	19	*Dactylorhiza kafiriana*	0.15	4
Urtica hyperborea	0.772222	22	*Potentilla anserine*	0.144444	4
Mentha longifolia	0.722222	36	*Elsholtzia densa*	0.127778	4
Anaphalis triplinervis	0.666667	26	*Prunus armeniaca*	0.116667	5
Chenopodium glaucum	0.661111	22	*Rhodiola imbricata*	0.116667	3
Taraxacum officinale	0.638889	20	*Aconitum heterophyllum*	0.105556	3
Oxyria digyna	0.594444	15	*Lagotis kunawurensis*	0.077778	3
Bergenia stracheyi	0.594444	28	*Avena fatua*	0.077778	2
Codonopsis ovata	0.527778	11	*Artemisia* sp.	0.061111	3
Plantago himalaica	0.488889	16	*Ephedra gerardiana*	0.061111	2
Sonchus oleraceus	0.488889	9	*Rumex Angulatus*	0.055556	1
Thymus linearis	0.483333	16	*Allium ramosum*	0.05	2
Rosa webbiana	0.472222	17	*Trifolium repens*	0.05	5
Bunium persicum	0.455556	15	*Codonopsis clematidea*	0.044444	1
Potentilla fruticosa	0.411111	12	*Allium sp.*	0.033333	1
Allium carolinianum	0.394444	26	*Lactuca sativa*	0.027778	2
Plantago depressa	0.394444	16	*Hippophae tibetana*	0.027778	1
Capparis spinosa	0.372222	11	*Potentilla argyrophylla*	0.022222	1
Gentiana tianschanica	0.366667	12	*Lonicera* sp.	0.016667	1
Aconogonum tortuosum	0.35	14	*Malva verticillata*	0.005556	1
Carum carvi	0.344444	18	*Morus alba*	0.005556	1

Fodder	Av_Rank	Citation	Fodder	Av_Rank	Citation
Aconogonum tortuosum	2.244444	109	*Rosa ecae*	0.111111	2
Artemesia spp.	2.061111	83	*Echinospermum redowskii*	0.105556	7
Anaphalis sp.	1.733333	163	*Bromus scoparius*	0.105556	4
Artemisia brevifolia	1.65	104	*Primula denticulata*	0.105556	3
Cicer microphyllum	1.505556	154	*Heracleum pinnatum*	0.094444	2
Dactylorhiza kafiriana	0.983333	30	*Swertia thomsonii*	0.088889	2
Rumex patientia	0.894444	35	*Matthiola flavida*	0.088889	2
Medicago lupulina	0.816667	17	*Festuca cumminsii*	0.083333	2
Geranium pratense	0.777778	25	*Corydalis govaniana*	0.083333	4
Chaerophyllum villosum	0.755556	16	*Pedicularis punctata*	0.083333	2
Bupleurum longicaule	0.744444	14	*Chenopodium botrys*	0.077778	2
Trifolium repens	0.722222	24	*Convolvulus arvensis*	0.072222	2
Indigofera heterantha	0.666667	13	*Lonicera spinosa*	0.066667	2
Gentianella moorcroftiana	0.661111	21	*Astragalus frigidus*	0.066667	2
Lotos corniculatus	0.611111	14	*Chenopodium foliosum*	0.061111	3
Prangos pabularia	0.583333	17	*Epilobium angustifolium*	0.055556	2
Podophyllum hexandrum	0.577778	17	*Carum carvi*	0.055556	3
Arnebia euchroma	0.572222	26	*Rheum speciforme*	0.055556	2
Mentha longifolia	0.566667	18	*Acantholimon lycopodioides*	0.055556	2
Stachys tibetica	0.544444	18	*Hippophae tibetana*	0.055556	2
Codonopsis ovata	0.505556	13	*Saussurea bracteata*	0.044444	1
Trigonella corniculata	0.488889	11	*Salix tetrasperma*	0.044444	2
Ferula jaeschkeana	0.488889	15	*Delphinium cashmerianum*	0.038889	1
Aconitum heterophyllum	0.472222	17	*Chesneya cuneata*	0.038889	1
Aconitum violaceum	0.455556	14	*Rhodiola imbricata*	0.038889	2
Pleurospermum candollei	0.422222	10	*Breea arvenensis*	0.033333	1
Euphrasia himalayica	0.411111	10	*Salix sclerophylla*	0.033333	1
Crepis stoliczkai	0.405556	12	*Juncus triglumis*	0.033333	2
Swertia petiolata	0.394444	9	*Ribes orientale*	0.033333	1
Brachyactis pubescens	0.344444	11	*Poa* sp.	0.033333	2
Lindelofia anchusoides	0.338889	12	*Echinops cornigerus*	0.027778	1
Plantago major	0.244444	8	*Taraxacum officinale*	0.027778	1
Clematis orientalis	0.227778	7	*Gentiana tubiflora*	0.027778	1
Oxyria digyna	0.205556	7	*Cotoneaster microphyllus*	0.022222	1
Chenopodium spp.	0.194444	5	*Bunium persicum*	0.022222	1
Cousinia thomsonii	0.155556	4	*Pedicularis bicornuta*	0.022222	1
Caragana versicolor	0.155556	6	*Arctium lappa*	0.016667	1
Lactuca lessertiana	0.144444	4	*Myricaria elegans*	0.016667	1
Rheum webbiana	0.127778	4	*Krascheninnikovia ceratoides*	0.011111	1
Delphinium viscosum	0.116667	4	*Astragalus peduncularis*		

Betula utilis	0.116667	4	*Bergenia stracheyi*	0.011111	1
Saxifraga spp.	0.116667	4			
Fuelwood	**Av_Rank**	**Citation**	**Fuelwood**	**Av_Rank**	**Citation**
Betula utilis	2.122222	129	*Heracleum pinnatum*	0.233333	10
Artemisia spp.	1.8	122	*Lonicera sp*	0.227778	9
Acantholimon lycopodioides	1.711111	106	*Lindelofia anchusoides*	0.211111	7
Cynoglosum planisiliqua	1.688889	102	*Euphorbia tibetica*	0.2	8
Dianthus anatolicus	1.322222	68	*Caragana versicolor*	0.2	4
Hippophae rhamnoides	1.244444	86	*Salix tetrasperma*	0.15	6
Juniperus communis	1.222222	60	*Lindelofia stylosa*	0.122222	3
Anaphalis sp.	1.144444	55	*Rosa webbiana*	0.1	3
Ribes orientale	0.838889	31	*Potentilla fruticosa*	0.077778	2
Ribes sp.	0.75	35	*Arabidopsis humile*	0.077778	3
Lycopsis arvensis	0.511111	13	*Aconogonum tortuosum*	0.077778	2
Krascheninnikovia ceratoides	0.494444	18	*Atriplex hortensis*	0.077778	2
Ephedra gerardiana	0.427778	20	*Arnebia euchroma*	0.072222	2
Cotoneaster microphyllus	0.405556	16	*Salix sclerophylla*	0.072222	3
Rosa ecae	0.35	13	*Anaphalis busua*	0.061111	2
Epilobium angustifolium	0.327778	9	*Hippophae tibetana*	0.061111	3
Myricaria elegans	0.311111	7	*Astragalus frigidus*	0.055556	2
Salix alba	0.272222	8	*Lonicera asperifolia*	0.033333	1
Rhodiola sp.	0.272222	7	*Rheum speciforme*	0.027778	1
Artemisia brevifolia	0.266667	16	*Galium pauciflorum*	0.027778	1
Ornamental	**Av_Rank**	**Citation**	**Ornamental**	**Av_Rank**	**Citation**
Rosa webbiana	1.888889	103	*Trifolium repens*	0.216667	4
Dactylorhiza kafiriana	1.65	78	*Saxifraga sp.*	0.205556	9
Delphinium viscosum	1.65	54	*Arenaria griffithii*	0.2	6
Gentianella moorcroftiana	1.588889	100	*Arnebia euchroma*	0.188889	8
Biebersteinia odora	1.327778	44	*Nepta logibracteata*	0.166667	6
Pedicularis oederi	1.3	65	*Lotos cuneata*	0.161111	4
Papaver nudicaule	1.261111	84	*Epilobium latifolium*	0.144444	6
Aconitum violaceum	1.233333	43	*Senecio chrysanthemoides*	0.116667	3
Inula obtusifolia	1.138889	59	*Lomatogonium carinthiacum*	0.1	5
Aquilegia fragrans	1.05	31	*Primula macrophylla*	0.061111	3
Corydalis govaniana	0.983333	34	*Ferula jaeschkeana*	0.061111	3
Rosa ecae	0.944444	42	*Pedicularis pyramidata*	0.061111	3
Tulipa stellata	0.872222	32	*Primula denticulata*	0.055556	2
Aconitum heterophyllum	0.855556	33	*Pedicularis longiflora*	0.05	3
Swertia thomsonii	0.705556	20	*Lloydia serotina*	0.05	1
Aster flaccidus	0.644444	21	*Campanula latifolia*	0.044444	2
Anemone rivularis	0.627778	23	*Delphinium cashmerianum*	0.038889	1

Geranium pratense	*0.583333*	*19*	*Iris sp.*	*0.038889*	*1*
Cremanthodium arnicoides	*0.55*	*18*	*Anaphalis sp*	*0.038889*	*1*
Hypericum leptocarpus	*0.516667*	*41*	*Corydalis mefolia*	*0.038889*	*2*
Lindelofia anchusoides	*0.494444*	*30*	*Pseudomertensia echioides*	*0.033333*	*1*
Swertia petiolata	*0.422222*	*18*	*Prangos pabularia*	*0.033333*	*1*
Pedicularis bicornuta	*0.394444*	*15*	*Corydalis megacalyx*	*0.033333*	*1*
Lactuca lesseriania	*0.372222*	*18*	*Taraxacum officinale*	*0.027778*	*1*
Codonopsis ovata	*0.283333*	*7*	*Gentiana tubiflora*	*0.027778*	*4*
Aconitum rotundifolium	*0.266667*	*6*	*Pulsatilla wallichiana*	*0.011111*	*2*
Bergenia stracheyi	*0.238889*	*9*	*Cynoglossum sp.*	*0.005556*	*1*
Ranunculus sp.	*0.233333*	*10*	*Verbascum thapsus*	*0.005556*	*1*
Medicinal	**Av_Rank**	**Citation**	**Medicinal**	**Av_Rank**	**Citation**
Thymus linearis	*1.977778*	*80*	*Allium przewalskianum*	*0.15*	*3*
Aconitum violaceum	*1.433333*	*82*	*Mentha longifolia*	*0.15*	*9*
Swertia thomsonii	*1.322222*	*81*	*Papaver nudicaule*	*0.15*	*4*
Trifolium repens	*1.172222*	*27*	*Plantago depressa*	*0.15*	*7*
Dactylorhiza kafiriana	*1.144444*	*59*	*Jurinea ceratocarpa*	*0.144444*	*5*
Clematis tibetana	*1.038889*	*57*	*Pedicularis bicornuta*	*0.144444*	*3*
Saussurea bracteata	*0.861111*	*35*	*Echinops cornigerus*	*0.144444*	*3*
Aconitum heterophyllum	*0.677778*	*21*	*Allium carolinianum*	*0.133333*	*15*
Viola kunawurensis	*0.611111*	*28*	*Lactuca lessertiana*	*0.133333*	*4*
Hyoscyamus pusillus	*0.611111*	*22*	*Potentilla fruticosa*	*0.127778*	*6*
Corydalis govaniana	*0.611111*	*19*	*Veronica koelzii*	*0.122222*	*1*
Swertia petiolata	*0.561111*	*10*	*Hippophae tibetana*	*0.116667*	*1*
Aster flaccidus Bunge	*0.55*	*24*	*Euphorbia hispida*	*0.116667*	*7*
Hyoscyamus niger	*0.522222*	*27*	*Lindelofia anchusoides*	*0.111111*	*5*
Tulipa stellata	*0.516667*	*20*	*Melica persica*	*0.1*	*4*
Utrica hyperborea	*0.505556*	*10*	*Rhodiola himalensis*	*0.1*	*4*
Salijit	*0.483333*	*10*	*Thlaspi arvense*	*0.088889*	*3*
Rheum spiciforme	*0.466667*	*16*	*Primula macrophylla*	*0.077778*	*1*
Rheum webbiana	*0.455556*	*9*	*Lancea tibetica*	*0.077778*	*1*
Arnebia euchroma	*0.455556*	*32*	*Pedicularis punctata*	*0.072222*	*2*
Codonopsis ovata	*0.444444*	*14*	*Saxifraga sp.*	*0.061111*	*2*
Aconitum rotundifolium	*0.427778*	*15*	*Solanum nigrum*	*0.055556*	*4*
Podophyllum hexandrum	*0.416667*	*25*	*Anaphalis sp.*	*0.055556*	*4*
Carum carvi	*0.394444*	*7*	*Stachys tibetica*	*0.05*	*2*
Bunium persicum	*0.388889*	*13*	*Chenopodium botrys*	*0.044444*	*2*
Ribes sp.	*0.388889*	*20*	*Morina longifolia*	*0.044444*	*2*
Saxifraga flagellaris	*0.383333*	*19*	*Waldheimia glabra*	*0.044444*	*2*
Oxyria digyna	*0.355556*	*12*	*Prangos pabularia*	*0.044444*	*2*
Epilobium latifolium	*0.333333*	*7*	*Juniperus communis*		

Ranunculus brotherusii	0.305556	11	*Corydalis mefolia*	0.038889	2
Anemone rupicola	0.266667	10	*Meconopsis aculeata*	0.033333	2
Capparis spinosa	0.261111	6	*Lactuca tatarica*	0.033333	2
Ephedra gerardiana	0.244444	9	*Leontopodium himalayanum*	0.027778	1
Cicer microphyllum	0.233333	10	*Galium pauciflorum*	0.027778	1
Crepis flexuosa	0.227778	3	*Delphinium cashmerianum*	0.022222	1
Verbascum thapsus	0.194444	3	*Delphinium viscosum*	0.022222	1
Rosa webbiana	0.194444	6	*Primula denticulata*	0.022222	1
Cremanthodium arnicoides	0.172222	5	*Gentianella moorcroftiana*	0.022222	1
Anaphalis virgata	0.172222	4	*Bromus sp.*	0.016667	1
Artemisia brevifolia	0.166667	2	*Plantago major*	0.016667	1
Nepeta longibracteata	0.166667	5	*Anaphalis busua*	0.016667	1
Bergenia stracheyi	0.161111	8	*Geranium pratense*	0.016667	1
Rosa ecae	0.155556	4	*Biebersteinia odora*	0.011111	1
Salix sclerophylla	0.15	5	*Rumex patientia*	0.005556	1
Dye	**Av_Rank**	**Citation**	**Dye**	**Av_Rank**	**Citation**
Rheum webbianum	1	112	*Oxyria digyna*	0.183333	11
Rheum spiciforme	0.472222	34	*Rosa webbiana*	0.122222	7
Arnebia euchroma	0.45	59	*Artemisia sieversiana*	0.066667	5
Cynodon sp.	0.261111	23	*Aconogonum tortuosum*	0.038889	3
Galium pauciflorum	0.188889	16			
Religeous	**Av_Rank**	**Citation**	**Religeous**	**Av_Rank**	**Citation**
Viola kunawurensis	0.494444	71	*Artemisia sieversiana*	0.194444	10
Juniperus communis	0.438889	63	*Waldheimia glabra*	0.127778	7
Hippophae rhamnoides	0.238889	14	*Myricaria elegans*	0.116667	8
Ismaan	0.233333	26	*Prunus armeniaca*	0.1	5
Arnebia euchroma	0.222222	20	*Betula utilis*	0.027778	2
Waldheimia tomentosa	0.2	15			
Other	**Av_Rank**	**Citation**	**Other**	**Av_Rank**	**Citation**
Salix sclerophylla	1.422222	128	*Juglens regia*	0.244444	14
Juniperus communis	1.311111	80	*Betula utilis*	0.211111	10
Populus nigra	1.027778	60	*Ephedra gerardiana*	0.188889	16
Rosa webbiana	0.816667	52	*Artemisia* spp.	0.161111	10
Hippophae tibetana	0.805556	51	*Rheum webbianum*	0.15	8
Populus alba	0.788889	44	*Potentilla fruticosa*	0.133333	6
Myricaria elegans	0.722222	52	*Arnebia euchroma*	0.083333	10
Salix alba	0.638889	33	*Ribes alpestre*	0.033333	1
Stachys tibetica	0.516667	33	*Cotoneaster integerrimus*	0.027778	1
Salix tetrasperma	0.5	30	*Acantholimon lycopodioides*	0.027778	5
Prunus armeniaca	0.411111	22	*Morus alba*	0.022222	2
Lonicera sp.	0.405556	28	*Stipa* sp.	0.016667	1

Appendix IV

Indicator value with indicator species analysis with group ID

Landform	Lower Indus Valley					Wakha_chu Valley			Suru Valley			
	Grp ID	Species	OIV	p*	Grp ID	Species	OIV	p*	Gr ID	Species	OIV	p*
Alpine	24	AcoRo	40	0.00	33	BistSp	67.2	0.00	51	Acorou	64	0.00
meadow	24	AllPee	52	0.00	33	PotSp	58.6	0.00	51	AreS	44	0.00
	24	Astfla	36	0.00	33	Platib	50	0.00	51	Astflacc	9.9	0.15
	24	Cortde	52.5	0.04	33	Dachat	44.1	0.28	51	BistAff	40	0.00
	24	Cristol	52	0.00	33	Thimin	40	0.04	51	CerCer	52	0.00
	24	Dralik	28	0.01	33	Rubtic	21.4	0.46	51	EltSp	40	0.00
	24	Ericcan	56	0.00	33	Andmu	20	0.00	51	FesSp	44	0.00
	24	Kobpy	54.2	0.00	33	Aregra	18.6	0.00	51	Kobpyg	69	0.00
	24	Lagroti	60	0.00	33	GalSp	9.8	0.00	51	Oxogra	76	0.00
	24	PinkSp	56	0.00	26	CaraVe	69.5	0.06	51	OxytrSp	36	0.00
	24	SausRo	36	0.00	26	ConOva	66	0.00	51	Oxytar	24	0.00
	24	Sibcun	84	0.00	26	Myotis	30.1	0.01	51	PotAgr	30	0.00
	24	Draset	12	0.25	26	Polypar	26.7	0.00	51	Rhoimb	28	0.00
	1	BIsAff	39.5	0.01	26	Lonic	20	0.00	51	SauAtk	20	0.00
	1	Carex	85.4	0.00	26	Polcog	17.5	0.00	51	Saxtw	40	0.00
	1	Filago	54.2	0.00	26	GerPre	16.4	0.06	51	SaxSp	36	0.00
	1	Gencap	40.9	0.04	26	AcaLy	13.3	0.36	51	SibCun	24	0.00
	1	LeoSp	40.9	0.30	26	Tarzan	13.3	0.11	26	Acotor	16	0.01
	1	Potsp	75.4	0.00	26	Chovi	8.3	0.01	26	Aregraf	6	0.20
	1	Ranun	37.5	0.00	1	CarSp	84	0.13	26	Brearv	30	0.00
	1	Rhotib	66.7	0.00	1	Kobres	75.1	0.03	26	EpiSP	22	0.00
	1	SaxSp	31.6	0.82	1	AstSp	68	0.00	26	Genmor	20	0.00
	-	-	-	-	1	Leo	64	0.00	26	Gencap	43	0.00
	-	-	-	-	1	Priden	52	0.53	26	InuRhi	60	0.00
	-	-	-	-	1	Rhotib	52	0.00	26	LeoS	34	0.00
	-	-	-	-	1	kobmeth	44	0.01	26	Linans	16	0.00
	-	-	-	-	1	Primula	44	0.15	26	Menthlon	48	0.00
	-	-	-	-	1	OxySp	42.6	0.00	26	Mush	2	1.00
	-	-	-	-	1	GenCap	40	0.00	26	PlatDep	28	0.00
	-	-	-	-	1	ViolaSp	40	0.03	26	PlolCog	10	0.06
	-	-	-	-	1	TarOff	24.2	0.02	26	PotSp	38	0.00
	-	-	-	-	-	-	-	-	26	Psypyr	7.6	0.25
	-	-	-	-	-	-	-	-	26	Swepet	26	0.00
	-	-	-	-	-	-	-	-	26	TarOff	48	0.00
	-	-	-	-	-	-	-	-	26	Thylin	10	0.04
	-	-	-	-	-	-	-	-	26	Trirep	26	0.00
	-	-	-	-	-	-	-	-	26	Verana	12	0.02
	-	-	-	-	-	-	-	-	1	Anepul	30	0.00
	-	-	-	-	-	-	-	-	1	Artmar	40	0.00
	-	-	-	-	-	-	-	-	1	Astrhi	6	0.21
	-	-	-	-	-	-	-	-	1	Carniv	8	0.06
	-	-	-	-	-	-	-	-	1	cormak	34	0.00
	-	-	-	-	-	-	-	-	1	CoryStON	38	0.00
	-	-	-	-	-	-	-	-				

	-	-	-	-	-	-	-	-	1	Galium	16	0.01
	-	-	-	-	-	-	-	-	1	GerSp	78	0.00
	-	-	-	-	-	-	-	-	1	Kobmeth	30	0.00
	-	-	-	-	-	-	-	-	1	kobpig	22	0.00
	-	-	-	-	-	-	-	-	1	LeoL	8	0.07
	-	-	-	-	-	-	-	-	1	LindSty	10	0.03
	-	-	-	-	-	-	-	-	1	MyosSy	72	0.00
	-	-	-	-	-	-	-	-	1	NepPod	34	0.00
	-	-	-	-	-	-	-	-	1	Papnau	54	0.00
	-	-	-	-	-	-	-	-	1	Parnes	28	0.00
	-	-	-	-	-	-	-	-	1	RanIch	10	0.87
	-	-	-	-	-	-	-	-	1	ThaIch	6	0.20
	-	-	-	-	-	-	-	-	1	Tharut	32	0.00
	-	-	-	-	-	-	-	-	1	Tulste	24	0.00
Bouldery	98	CarNiv	34.2	0.00	45	ArtYH	56.1	0.00	74	Draset	63	0.00
	98	PseMal	31	0.00	45	Fescas	38.1	0.01	74	Pedoph	59	0.00
	98	WalPal	28.9	0.00	45	Corymef	18.1	0.07	74	Neppo	43	0.00
	98	SilGon	28.5	0.00	3	PotArg	48.8	0.00	74	Epdger	41	0.00
	98	Rhoim	22.1	0.00	3	ElySp	38.7	0.00	74	Artmar	38	0.00
	98	Bibad	18.4	0.00	3	SasRoy	35.5	0.00	74	Rhohet	30	0.00
	98	FestSp	18.4	0.00	3	BisAff	35.1	0.02	74	Ananub	19	0.00
	98	DraLik	15.8	0.00	3	Artmar	33.2	0.01	74	AstSP	19	0.00
	98	PrDen	15.6	0.07	3	Anerup	32.4	0.01	74	GerSp	12	0.05
	98	Artmar	12.9	0.01	3	Saubra	32.4	0.21	74	Draliph	8.7	0.10
	98	SauBra	10.5	0.02	3	SaxSp	29	0.01	74	Polpar	4.7	0.39
	98	Acoru	9.1	0.21	3	ChryPyr	25.8	0.01	23	Rhoimb	72	0.00
	24	ElySp	56.7	0.00	3	Rhotib	23.8	0.31	23	Prpra	63	0.00
	24	CorMa	51.2	0.00	3	LeotSp	22.9	0.09	23	Potagr	25	0.00
	24	DelBro	43.5	0.00	3	AndSp	19.4	0.03	23	TulSte	23	0.00
	24	PriDb	34.8	0.00	3	Aregra	19.4	0.05	23	CarTy	16	0.04
	24	Aregra	26.7	0.00	3	Sillon	16.1	0.07	23	Parnau	15	0.01
	24	RheWe	23	0.00	3	PolySp	15	0.13	23	Psemer	14	0.26
	24	Andbal	21.7	0.00	1	Primac	43.5	0.00	23	LeoSp	14	0.09
	24	Delcas	21.7	0.00	1	Delbru	34.9	0.05	23	MedSp	8.3	0.04
	24	BerStr	17	0.00	1	Corydsto	34.8	0.00	2	ArtS	51	0.00
	24	Leo	12.2	0.16	1	Priden	34.8	0.00	2	Nepglu	36	0.00
	24	Cicmic	6.2	0.23	1	Fern	26.1	0.01	2	SilSon	21	0.00
	1	BisAff	60.2	0.00	1	Silmo	24.4	0.03	2	Welsto	21	0.00
	1	Acorot	47.1	0.00	1	SalSp	21.7	0.01	2	Delcas	17	0.01
	1	PotAgr	40.7	0.00	1	Berstra	15.6	0.14	2	Rhotib	17	0.04
	1	Papnau	32.4	0.00	-	-	-	-	2	RheWeb	14	0.00
	1	Rhotib	27.3	0.13	-	-	-	-	2	Oxytat	13	0.05
	1	Astfla	26.4	0.00	-	-	-	-	2	Pedode	13	0.02
	1	SedEw	21.6	0.01	-	-	-	-	2	Cicmac	11	0.03
	1	Ger	20.6	0.01	-	-	-	-	2	Elys	8.8	0.18
	1	Kobpy	20.6	0.00	-	-	-	-	2	Chaevil	7.1	0.11
	1	Neppo	20.6	0.01	-	-	-	-	2	SaxSp	2.4	1.00
	1	AreSm	19.6	0.00	-	-	-	-	1	Cormef	53	0.00

	1	Carmet	18.6	0.01	-	-	-	-	1	Mecacu	50	0.00
	1	Elylon	17.6	0.01	-	-	-	-	1	Delbr	37	0.00
	1	GenTia	16.7	0.02	-	-	-	-	1	Saubr	35	0.00
	1	TarOff	15.7	0.02	-	-	-	-	1	AstFlac	20	0.00
	1	SilSp	10.8	0.05	-	-	-	-	1	Primac	20	0.00
	1	YTM	10.8	0.06	-	-	-	-	1	FesSp	17	0.00
	1	SauRo	9.8	0.05	-	-	-	-	1	Cortaz	10	0.03
	1	Kum	8.8	0.08	-	-	-	-	1	Ranhir	6.7	0.12
	1	DraSep	8.6	0.26	-	-	-	-	1	BisAff	5.6	0.75
	1	GenCa	7.8	0.12	-	-	-	-	1	StelSP	5.2	0.47
	1	LonCa	7.8	0.11	-	-	-	-	1	Carmeth	3.3	0.66
	1	Primac	7.8	0.11	-	-	-	-	1	Psyand	2.8	0.71
	1	ConOv	6.9	0.14	-	-	-	-	-	-	-	-
	1	Lagku	6.9	0.14	-	-	-	-	-	-	-	-
	1	SweTh	6.9	0.15	-	-	-	-	-	-	-	-
	1	Allprez	6.1	0.42	-	-	-	-	-	-	-	-
	1	A	5.9	0.21	-	-	-	-	-	-	-	-
	1	Oxycas	5.9	0.22	-	-	-	-	-	-	-	-
	1	Pleu	5.9	0.19	-	-	-	-	-	-	-	-
	1	SilSon	5.9	0.20	-	-	-	-	-	-	-	-
	1	TraGra	4.9	0.30	-	-	-	-	-	-	-	-
	1	ThalSp	4.9	0.30	-	-	-	-	-	-	-	-
	1	EphSax	3.9	0.34	-	-	-	-	-	-	-	-
	1	HerPin	3.9	0.35	-	-	-	-	-	-	-	-
	1	SteSp	2.9	0.49	-	-	-	-	-	-	-	-
	1	ThaMi	2.9	0.56	-	-	-	-	-	-	-	-
	1	Fern	2	0.86	-	-	-	-	-	-	-	-
	1	ThyLin	2	0.87	-	-	-	-	-	-	-	-
Rock	68	A	53.4	0.00	24	Anjtib	48	0.00	49	Polcog	53	0.00
And	68	Nepeta	35.8	0.00	24	AllStoli	48	0.00	49	TulSte	49	0.00
Cliff	68	RosWe	27.3	0.00	24	AndMuc	68	0.00	49	Oxyyefr	46	0.00
	68	InuOb	22.7	0.00	24	AreGre	20	0.07	49	Say	38	0.00
	68	Statib	22.7	0.00	24	Arnebia	28	0.12	49	Aregra	33	0.00
	68	BluFlr	9.1	0.03	24	ChyPre	8	0.50	49	PsyPar	31	0.00
	34	BerStr	21.3	0.00	24	RedGra	48	0.00	49	Filago	30	0.00
	34	RheWe	21.3	0.00	24	Couth	32	0.00	49	PotSp	30	0.00
	34	EphGer	21.1	0.01	24	EphGer	29.5	0.46	49	Taroff	26	0.00
	34	ElySp	12.2	0.02	24	HerPi	4	1.00	49	Kun	16	0.00
	34	Herpin	10.6	0.03	24	NepBle	4	1.00	49	Linanc	16	0.00
	34	Halo	10.5	0.12	24	PsyAnd	48	0.00	49	Sedum	16	0.00
	34	LacOr	9.6	0.26	24	RdGr	40	0.00	49	Pedophe	14	0.00
	34	AcaLy	8.5	0.03	24	SilMor	32	0.01	49	Andbal	13	0.07
	34	ArnEuc	8.5	0.03	24	Viola	32	0.00	49	Anepul	12	0.00
	34	JunSp	8.5	0.03	1	AcaLy	10.8	0.83	49	Thylin	10	0.01
	34	Rhamp	8.5	0.04	1	Anavir	39.1	0.00	49	Ephger	9	0.34
	34	Cotin	8.5	0.02	1	ArtMau	8.4	0.83	49	Priden	8	0.02
	34	ChrCli	6.4	0.11	1	BerStr	54.6	0.00	49	Herpin	7.2	0.23
	34	MedSp	6.4	0.09	1	Carver	26.1	0.01	49	Scrdec	6.5	0.18

	34	BisAff	4.3	0.14	1	JunSp	65.2	0.00	2	ElySp	53	0.00
	34	Redsn	4.3	0.16	1	LonCae	60.9	0.00	2	Psemal	28	0.00
	34	Anabus	3.5	0.59	1	CheCu	26.1	0.01	2	AraEuc	23	0.00
	34	FesSp	2.1	0.52	1	RheMor	54.7	0.00	2	Loncae	18	0.00
	34	Cogni	1.6	0.95	1	RebOri	87	0.00	2	RosWeb	18	0.00
	1	Artmar	57.3	0.00	1	RosWe	47.8	0.00	2	BisA	18	0.00
	1	Scrdec	49.4	0.00					2	AliCar	15	0.00
	1	CapSpi	25.4	0.00	-	-	-	-	2	Rhohet	13	0.00
	1	Silmor	20.7	0.01	-	-	-	-	2	Draset	10	0.00
	1	Hyopus	18.9	0.02	-	-	-	-	2	Junimac	5.5	0.16
	1	Polcog	11.9	0.02	-	-	-	-	2	AstW	4.4	0.14
	1	PotSp	11.9	0.03	-	-	-	-	2	Diachi	2.5	0.29
	1	Sendub	7.5	0.08	-	-	-	-	1	Chypra	39	0.00
	-	-	-	-	-	-	-	-	1	fesSp	30	0.00
	-	-	-	-	-	-	-	-	1	ArtSal	29	0.00
	-	-	-	-	-	-	-	-	1	PleuSp	26	0.00
	-	-	-	-	-	-	-	-	1	ArtMar	23	0.05
	-	-	-	-	-	-	-	-	1	AcaLy	23	0.00
	-	-	-	-	-	-	-	-	1	Euptib	15	0.00
	-	-	-	-	-	-	-	-	1	CotSp	14	0.00
	-	-	-	-	-	-	-	-	1	RosAlp	9.7	0.02
	-	-	-	-	-	-	-	-	1	Acorum	8.9	0.01
	-	-	-	-	-	-	-	-	1	Acotor	7.1	0.03
	-	-	-	-	-	-	-	-	1	Ananep	7.1	0.05
	-	-	-	-	-	-	-	-	1	Silmor	6.8	0.27
	-	-	-	-	-	-	-	-	1	RibSp	6.3	0.24
	-	-	-	-	-	-	-	-	1	Rubtib	5.4	0.11
	-	-	-	-	-	-	-	-	1	ArtBlu	3.6	0.31
	-	-	-	-	-	-	-	-	1	Cicmac	2.9	0.44
Field	29	BreArv	15.2	0.00	97	Aregra	44.4	0.00	101	ThiJav	16	0.00
margin	29	ElySp	24.4	0.01	97	ArtSal	13.6	0.00	101	ChryVil	22	0.00
	29	LacSat	49	0.00	97	AstRhi	13.6	0.00	101	EuARv	27	0.00
	29	Lactib	49.1	0.00	97	Carex	19.2	0.00	101	GenTub	28	0.00
	29	MenL	29.3	0.01	97	Cyno	4.3	0.17	101	RanL	28	0.00
	29	OxyDi	40.2	0.00	97	Dachat	30.8	0.00	101	GerSp	28	0.00
	29	PedPun	10.4	0.02	97	Kobmac	47.7	0.00	101	Swepet	39	0.00
	29	RanSp	38.9	0.00	97	KobPyg	22.3	0.00	101	AreS	44	0.00
	29	Sanchu	19.1	0.00	97	Leo	8.1	0.03	101	BisAff	52	0.00
	29	Sesmuc	44.8	0.00	97	Nepflo	9.1	0.02	101	Grass	60	0.00
	29	Thimin	18.8	0.00	97	Oxytropi	30.8	0.00	101	Pedbic	75	0.00
	5	Chebot	7.5	0.49	97	Poa	6.3	0.15	51	SalSp	7.8	0.02
	5	HipRh	9.4	0.01	97	potsp	16.3	0.09	51	BreeArv	11	0.02
	5	Iris	5.1	0.16	97	RanL	43.2	0.00	51	AstSp	12	0.01
	5	MedSat	42.7	0.00	97	Rumpat	9.1	0.03	51	HipRh	19	0.00
	5	Rumpa	12.4	0.14	97	Sonchu	9.1	0.03	51	Pedpun	21	0.01
	5	Trirep	9.5	0.58	97	FesSp	4.4	0.19	51	Menlon	24	0.00
	4	ElzSp	5.4	0.20	97	Silfie	4.5	0.16	51	PotSp	26	0.00
	4	Fern	10.6	0.03	97	Sawtho	4.5	0.16	51	EphHim	36	0.00

	4	GerSp	20.5	0.30	74	Acovio	65.2	0.00	51	Dachet	43	0.00
	4	Penan	4.4	0.29	74	Acotor	13	0.01	51	TarOff	50	0.00
	4	RumNe	20.7	0.00	74	Ares	69.6	0.00	51	medsat	66	0.00
	4	Statib	16.7	0.01	74	Cicmac	13	0.00	26	Yellhead	8.5	0.01
	4	Stiypa	3.1	0.50	74	Conovo	37	0.00	26	Lam	18	0.00
	4	Z	36	0.00	74	DelCas	36.2	0.00	26	Sibcuni	27	0.00
	1	A	17.7	0.01	74	FesSp	47.8	0.00	26	Trirep	35	0.00
	1	Aqufra	23.4	0.00	74	EpiLo	26.1	0.00	26	Sesmuc	41	0.00
	1	Artlap	17.1	0.00	74	Genttub	40.5	0.00	26	DelCash	44	0.00
	1	ArtSp	6.8	0.08	74	GerPre	32.2	0.00	26	LyoSp	51	0.00
	1	ArtSiv	5.8	0.69	74	Neppod	34.8	0.00	26	AcoVio	57	0.00
	1	B	10.5	0.01	74	Oxyhy	59.1	0.00	26	ElySed	68	0.00
	1	ConOv	27.5	0.00	74	Pedbi	41	0.00	26	Pladep	73	0.00
	1	HerPin	25	0.01	74	Rumtib	21.7	0.00	26	Poa	78	0.00.
	1	Phypra	21.5	0.00	74	ScorSp	37.5	0.00	8	Orob	1.9	0.81
	1	PlaTib	28.3	0.01	74	SesMuc	26.1	0.02	8	Sweth	1.9	0.76
	1	PruDo	14.7	0.02	74	Sestri	73.9	0.00	8	Rosweb	4.9	0.19
	1	CotSp	13	0.01	74	thiSp	21.7	0.00	8	Verlax	5.8	0.13
	1	TarOff	46.3	0.00	3	BisAff	26.5	0.00	8	ArtF	7.8	0.07
	-	-	-	-	3	BraCom	6.5	0.16	8	Platib	10	0.05
	-	-	-	-	3	ChaeVill	3.4	0.74	8	EpiLo	14	0.01
	-	-	-	-	3	CheBot	11.3	0.03	8	Silinf	14	0.01
	-	-	-	-	3	EuiArv	5.3	0.42	8	Silemor	17	0.00
	-	-	-	-	3	EupHim	25.8	0.00	8	Neppod	29	0.00
	-	-	-	-	3	GenCap	12.9	0.02	8	ElySp	32	0.00
	-	-	-	-	3	Herpin	4.7	0.59	8	Rumnep	38	0.00
	-	-	-	-	3	Lantib	19.4	0.01	8	dambu	40	0.00
	-	-	-	-	3	Meddsat	46.2	0.00	8	OxyHy	41	0.00
	-	-	-	-	3	Menlon	11.3	0.02	8	Podhex	54	0.00
	-	-	-	-	3	Pedpun	39.1	0.00	8	EriSp	60	0.00
	-	-	-	-	3	Pladep	18.1	0.02	1	HerPin	11	0.11
	-	-	-	-	3	Plama	26.8	0.00	1	SenChr	21	0.13
	-	-	-	-	3	Potans	16.1	0.01	1	Iri	27	0.00
	-	-	-	-	3	Potbif	22.6	0.00	1	Carcar	32	0.00
	-	-	-	-	3	Sonkus	34	0.00	1	Lacless	33	0.00
	-	-	-	-	3	taroff	26.4	0.04	1	ConOva	40	0.00
	-	-	-	-	3	Trirep	9.7	0.04	1	Lotcun	44	0.00
	-	-	-	-	1	BreArv	8.6	0.10	1	Acohet	52	0.00
	-	-	-	-	1	Carcar	17.6	0.00	1	Sonchus	71	0.00
	-	-	-	-	1	ChrSp	12.8	0.01	1	FesSp	73	0.00
	-	-	-	-	1	Conarv	28.4	0.00	1	galSp	97	0.00.
	-	-	-	-	1	Drali	25.6	0.00	-	-	-	-
	-	-	-	-	1	Lacalt	11.2	0.02	-	-	-	-
	-	-	-	-	1	Lacsat	16.4	0.04	-	-	-	-
	-	-	-	-	1	Linanc	26	0.00	-	-	-	-
	-	-	-	-	1	Myosil	7.8	0.09	-	-	-	-
	-	-	-	-	1	Oxycas	7.7	0.04	-	-	-	-
	-	-	-	-	1	Rumnep	28.2	0.00	-	-	-	-

Moraine	13	CicMa	43.4	0.01	51	AcaLyc	73.9	0.00	1	Acotor	10	0.11
	13	Fest	39.9	0.02	51	Yakim	65.2	0.00	1	Acoumba	16	0.05
	13	Acotor	39.7	1.00	51	PolPar	52.2	0.00	1	AnaSp	1.4	1.00
	13	ElySp	37	0.00	51	Acotor	42.9	0.00	1	AndBal	4.4	0.39
	13	Fern	14.8	0.10	51	Silmor	31.7	0.00	1	Anerup	5.9	0.28
	13	RhoTib	14.8	0.12	51	Car	21.7	0.00	1	Artmar	19	0.03
	13	RibSp	11.1	0.23	51	ElySp	16.3	0.19	1	Artgre	11	0.68
	13	Silene	7.4	0.49	26	DraSes	48.1	0.00	1	AstOL	10	0.10
	13	DelCah	3.7	1.00	26	Carniv	48	0.00	1	AstSp	4.4	0.48
	1	Juni	60.7	0.00	26	CorMak	48	0.00	1	BisAff	25	0.01
	1	RosWe	60.7	0.00	26	Saubra	43.7	0.00	1	ArtY	2.6	0.89
	1	RibOri	43.5	0.00	26	Rhotib	39.8	0.00	1	Oxydig	19	0.02
	1	Statib	26.1	0.01	26	Oxymac	32	0.00	1	Corwhit	4.4	0.44
	1	NepGl	21.7	0.02	26	DelBru	30.8	0.01	1	EpiLo	8.7	0.20
	1	LoniSp	17.4	0.04	26	AlPez	28	0.00	1	GerSp	34	0.02
	1	A	10.8	0.77	26	FestKas	25.1	0.01	1	Lonihis	13	0.35
	1	Neppo	10.2	0.27	26	walglab	20	0.00	1	MyoSy	8.8	0.14
	1	Rhoim	9.1	0.46	26	Waltom	20	0.00	1	Oxytat	8.9	0.57
	1	AcaLy	8.9	1.00	26	ArtYh	18.8	0.04	1	Pedophe	4.4	0.41
	1	Anaph	8.7	0.21	26	ArtSal	12	0.02	1	PotAgr	3.4	0.67
	-	-	-	-	1	LagKun	64.6	0.00	1	PsySp	2.2	0.85
	-	-	-	-	1	PotArg	60.6	0.00	1	Rheweb	8	0.19
	-	-	-	-	1	GerPra	32.4	0.00	1	Rhemoo	2.9	0.63
	-	-	-	-	1	LeoL	29.6	0.00	1	Rhoimb	16	0.10
	-	-	-	-	1	BisAff	28.2	0.00	1	SauObv	15	0.04
	-	-	-	-	1	AnePul	26.8	0.00	1	DraSet	8.8	0.11
	-	-	-	-	1	AliAwa	25.4	0.00	1	Taroff	10	0.16
	-	-	-	-	1	Astwh	25.4	0.00	1	ThiRut	8.8	0.13
	-	-	-	-	1	Kobpyg	25.4	0.00	1	WhiTser	8.8	0.13
	-	-	-	-	1	Sauroy	23.9	0.01	1	WalTom	8.8	0.17
	-	-	-	-	1	Acorot	22.5	0.01	26	AreS	16	0.02
	-	-	-	-	1	MenLo	21.1	0.01	26	AreEch	27	0.00
	-	-	-	-	1	Swepet	21.1	0.01	26	Cicmac	15	0.07
	-	-	-	-	1	CreArn	19.7	0.01	26	DelBru	15	0.02
	-	-	-	-	1	OxyLap	19.7	0.01	26	ElySp	18	0.04
	-	-	-	-	1	PedRoy	18.3	0.01	26	Fessp	28	0.00
	-	-	-	-	1	Rhodim	18.3	0.01	26	Ephger	19	0.04
	-	-	-	-	1	FGenTra	16.9	0.02	26	Potbif	18	0.04
	-	-	-	-	1	AstRhi	15.5	0.03	26	Sedewe	14	0.01
	-	-	-	-	1	SaxSp	11.4	0.28	26	SilLon	14	0.02
	-	-	-	-	1	Parnes	11.3	0.06	26	Thylin	6.8	0.07
	-	-	-	-	1	Rhohet	11.3	0.08	100	Allcar	85	0.00
	-	-	-	-	1	CynSp	4.2	0.41	100	AquSp	67	0.00
	-	-	-	-	1	SalSp	2.8	0.71	100	ConSp	15	0.00
	-	-	-	-	-	-	-	-	100	PleuSp	3	0.67
	-	-	-	-	-	-	-	-	100	Neppod	38	0.00
	-	-	-	-	-	-	-	-	100	Rhetib	24	0.00
	-	-	-	-	-	-	-	-	45	Andsp	69	0.00
Plateau	26	AcaLy	83.3	0.00	3	AcaLyco	14.4	0.39				

	26	AreS	66.7	0.00	3	Allijac	50.2	0.02	45	Polpar	62	0.00
	26	Carex	37.5	0.00	3	Andbal	38.7	0.01	45	Oxytat	57	0.00
	26	Kobpig	54.2	0.00	3	Artmar	56.1	0.00	45	Draset	50	0.00
	26	Polpar	79.2	0.00	3	Astmun	3.2	1.00	45	Ephger	45	0.00
	26	Utrica	29.2	0.00	3	Euptib	14.2	0.40	45	Parnau	42	0.00
	1	Allipre	36	0.00	3	lacSp	45.2	0.01	45	Dralik	35	0.00
	1	Anerup	60	0.00	3	Netpodo	24.5	0.46	45	pSYand	31	0.00
	1	AstrNS	64	0.00	3	Oxytar	9.6	0.74	45	Salka	27	0.00
	1	BisAff	96	0.00	3	PleuSp	6.5	0.57	45	pedOph	23	0.01
	1	Ephedr	20	0.06	3	PolAn	34	0.28	45	Artmar	22	0.07
	1	Neppo	44	0.00	3	PsygAnd	29	0.04	45	Rhemor	19	0.01
	1	PotSp	80.8	0.00	3	Thylin	22.6	0.07	45	AcoSp	15	0.03
	1	Psyand	21.1	0.27	1	Anjatib	55.9	0.00	26	Kobpig	88	0.00
	1	RosAlp	60	0.00	1	Carex	51	0.00	26	Sauatk	83	0.00
	1	SaxSp	32	0.00	1	Corshr	10.1	0.41	26	Rhotib	79	0.00
	1	Taroff	24	0.02	1	Coutho	14.4	0.62	26	whiflr	75	0.00
	-	-	-	-	1	Salkal	6.7	0.33	26	PotaGR	67	0.00
	-	-	-	-	-	-	-	-	26	SaxSp	58	0.00
	-	-	-	-	-	-	-	-	26	Kobmeth	46	0.00
	-	-	-	-	-	-	-	-	26	Sibcu	42	0.00
	-	-	-	-	-	-	-	-	26	ElySp	23	0.00
	-	-	-	-	-	-	-	-	26	Taroff	21	0.01
	-	-	-	-	-	-	-	-	26	AllJac	15	0.02
	-	-	-	-	-	-	-	-	26	AstFla	7.9	0.28
	-	-	-	-	-	-	-	-	1	FilSp	72	0.00
	-	-	-	-	-	-	-	-	1	LeoLon	69	0.00
	-	-	-	-	-	-	-	-	1	Diahar	44	0.00
	-	-	-	-	-	-	-	-	1	pedpec	44	0.00
	-	-	-	-	-	-	-	-	1	ArtY	40	0.00
	-	-	-	-	-	-	-	-	1	BisAff	40	0.00
	-	-	-	-	-	-	-	-	1	ElyBi	36	0.00
	-	-	-	-	-	-	-	-	1	Rosalp	36	0.00
	-	-	-	-	-	-	-	-	1	AstSp	28	0.00
	-	-	-	-	-	-	-	-	1	Neppod	23	0.03
	-	-	-	-	-	-	-	-	1	AreGra	20	0.00
	-	-	-	-	-	-	-	-	1	Waltom	20	0.01
	-	-	-	-	-	-	-	-	1	Rheweb	16	0.02
	-	-	-	-	-	-	-	-	1	Delbru	12	0.07
	-	-	-	-	-	-	-	-	1	GerSp	12	0.07
	-	-	-	-	-	-	-	-	1	Couth	8	0.20
	-	-	-	-	-	-	-	-	76	Taroff	75	0.00
Marsh	76	AreS	2.3	0.60	26	Parnes	69.6	0.00	76	Euphim	33	0.01
Meadow	76	AstW	4.7	0.18	26	BisAff	58.9	0.00	76	Hiprhm	32	0.00
	76	BisAff	53.5	0.00	26	Genmor	56.5	0.00	76	Carcar	31	0.00
	76	CarSp	78.4	0.00	26	YHF	56.5	0.00	76	Chyvill	30	0.00
	76	Cordep	34.9	0.00	26	TarOff	51.1	0.01	76	Pedpun	30	0.00
	76	Eup	9.3	0.02	26	Gencap	49.3	0.00	76	LeoL	28	0.01
	76	Gencap	23.3	0.00	26	Medsat	38.4	0.05	76	GerFie	25	0.00
	76	Gentik	20.9	0.00	26	CarCar	34.8	0.00	76			

	76	Kobme	20.9	0.00	26	Oxythyp	30.4	0.01	76	AreS	24	0.00
	76	Kobpig	60.5	0.00	26	SenChr	17.4	0.04	76	MedSat	24	0.00
	76	LeoSp	79.1	0.00	26	silvul	13	0.09	76	Plattib	24	0.00
	76	OxySp	16.3	0.01	1	EupHim	58.4	0.06	76	ConOva	23	0.00
	76	Pedlon	34.9	0.00	1	Trirep	51	0.23	76	Trirep	23	0.00
	76	Pedwh	16.3	0.00	1	DacHat	47.9	0.13	76	Lotcor	21	0.00
	76	Potagr	11.6	0.01	1	EquArv	44.4	0.00	76	Dambu	18	0.00
	76	RanB	37.2	0.00	1	Pedpun	40.2	0.47	76	ElySp	18	0.00
	76	Rhoim	14	0.00	1	BreArv	39.4	0.01	76	SenChy	17	0.00
	76	SaxSp	11.6	0.02	1	Hiprham	32.8	0.04	76	Gentub	17	0.01
	11	AstSp	3.6	0.25	1	Sesmuc	30.7	0.35	76	Pedbi	15	0.01
	11	CleOr	21.4	0.00	1	Pladep	30	0.31	76	GalSp	14	0.01
	11	conarv	7.9	0.08	1	PotSp	25.9	0.02	76	AnnL	13	0.01
	11	Gentub	32.1	0.00	1	Potansr	22.2	0.02	76	Pódhex	13	0.01
	11	GerSp	39.1	0.00	1	Menlon	18.5	0.04	76	Oxyhyp	13	0.14
	11	Herpin	60.7	0.00	1	Rumpat	18.5	0.05	76	Parnes	12	0.02
	11	lantib	57.1	0.00	1	SalSca	14.8	0.12	76	BreArv	11	0.02
	11	Oxydig	31	0.00	1	Gentub	11.1	0.23	76	Silinf	10	0.03
	11	Pedpun	24.7	0.00	1	lacsat	11.1	0.26	76	Cicmac	10	0.03
	11	Phypra	25	0.00	1	SonSp	11.1	0.22	76	EriSp	9.2	0.02
	11	Potans	14	0.00	1	Herpin	7.4	0.50	76	RumNep	9.2	0.03
	11	RanL	31.3	0.00	-	-	-	-	76	EquArv	7.1	0.48
	11	Rumex	15.7	0.03	-	-	-	-	76	PedOde	7.1	0.08
	11	Sesmuc	23.3	0.00	-	-	-	-	76	Poa	7.1	0.05
	11	thamin	42.9	0.00	-	-	-	-	76	Artsal	6.1	0.06
	11	WhiFlr	24.4	0.00	-	-	-	-	76	Astrhi	6.1	0.05
	1	A	4.3	0.36	-	-	-	-	76	AstZan	5.1	0.15
	1	Aqufra	10.4	0.13	-	-	-	-	76	Cletib	5.1	0.10
	1	Art_eig	30.8	0.00	-	-	-	-	76	Menlon	5.1	0.11
	1	CarSp	17	0.00	-	-	-	-	76	Galtri	4.9	0.13
	1	Elzto	14.9	0.01	-	-	-	-	76	GenCap	4.3	0.63
	1	ElySp	34.8	0.00	-	-	-	-	76	Parnud	4.1	0.16
	1	EquAr	8.5	0.06	-	-	-	-	76	Silmor	4.1	0.13
	1	Fern	8.5	0.07	-	-	-	-	76	Oxydig	3.1	0.21
	1	K	10.6	0.02	-	-	-	-	76	PotAgr	3.1	0.29
	1	MedSp	21.8	0.02	-	-	-	-	76	Gal	2	0.61
	1	Menlon	43.8	0.00	-	-	-	-	76	Thyhim	2	0.57
	1	Pladep	15.1	0.16	-	-	-	-	51	Crepis	92	0.00
	1	Platib	6.7	0.72	-	-	-	-	51	Oxytat	80	0.00
	1	Prudo	6.4	0.11	-	-	-	-	51	AreEuc	71	0.00
	1	Sonch	4.8	0.58	-	-	-	-	51	EphGer	56	0.00
	1	Spang	8.5	0.07	-	-	-	-	51	Polco	55	0.00
	1	Statib	8.5	0.06	-	-	-	-	51	Herpin	39	0.00
	1	Tiboff	27.9	0.00	-	-	-	-	51	ArtY	20	0.00
	1	Trirep	52.6	0.00	-	-	-	-	51	PsyAnd	20	0.00
	1	Z	59	0.00	-	-	-	-	1	Kobpig	80	0.00
	-	-	-	-	-	-	-	-	1	GenMor	31	0.00
	-	-	-	-	-	-	-	-	1	Dachat	30	0.00

	-	-	-	-	-	-	-	-	1	BisAff	22	0.01
	-	-	-	-	-	-	-	-	1	AllSp	18	0.00
	-	-	-	-	-	-	-	-	1	Hip[tib	16	0.01
	-	-	-	-	-	-	-	-	1	PedPec	16	0.00
	-	-	-	-	-	-	-	-	1	Astfla	15	0.01
	-	-	-	-	-	-	-	-	1	kobmeth	14	0.09
	-	-	-	-	-	-	-	-	1	Pedroy	13	0.01
	-	-	-	-	-	-	-	-	1	Salix	11	0.08
	-	-	-	-	-	-	-	-	1	Sonchus	11	0.30
	-	-	-	-	-	-	-	-	1	Buplau	6.5	0.03
	-	-	-	-	-	-	-	-	1	Swethom	5.2	0.32
	-	-	-	-	-	-	-	-	1	Priden	4.7	0.22
	-	-	-	-	-	-	-	-	1	Awa	3.9	0.10
	-	-	-	-	-	-	-	-	1	Potbifu	2.6	0.28
	-	-	-	-	-	-	-	-	1	Andmuc	1.3	0.51
Scree	1	Anavar	14.9	0.00	149	PotSp	82	0.00	92	Rhemor	93	0.00
	1	Anjtib	14.9	0.01	149	Carver	75	0.00	92	Psyand	56	0.00
	1	Artmar	16.4	0.14	149	Chrpre	55.4	0.00	92	Pedophe	48	0.00
	1	capspi	16.2	0.01	149	Silmor	35.9	0.00	92	AcoSp	41	0.00
	1	CheSp	10.6	0.01	149	PotLi	33.3	0.00	92	Oxytat	28	0.00
	1	GalSp	9.4	0.10	149	Rhemor	32.3	0.00	92	Dralik	12	0.14
	1	InuObt	12.8	0.00	149	Acotor	31.1	0.00	92	Neppod	3.4	0.30
	1	LactOri	10.1	0.07	149	Andmus	29.5	0.00	92	Potagr	3	0.86
	1	LonCa	8.5	0.04	149	Neppod	28.2	0.00	20	Polcog	46	0.00
	1	MedSp	4.3	0.34	149	AcaLyco	25.3	0.01	20	Anjtib	40	0.00
	1	Orobr	2.1	1.00	149	EphGer	20	0.00	20	Artmar	29	0.09
	1	Roswe	7.8	0.17	50	Herpin	63.9	0.00	20	Lactor	16	0.04
	1	Scrdec	21.3	0.00	50	Astopi	35.2	0.00	20	Scrdec	16	0.06
	1	Statib	10.6	0.02	50	InuObu	20	0.00	20	PleuSp	13	0.08
	1	TrSa	8.5	0.04	50	Conarv	15	0.00	20	FesSp	12	0.14
	2	Elylon	4.1	0.34	50	Asp	10.2	0.01	20	Silmor	11	0.15
	2	Erican	24.2	0.00	50	Bup	10	0.02	20	AstOpi	3.9	0.51
	2	Euptib	12.1	0.00	50	Cicmar	7.5	0.19	20	haan	3.9	0.53
	2	HyoPu	12	0.01	50	Kraspun	3.8	0.38	20	Statib	3.9	0.65
	2	MathS	32	0.00	50	Astmun	2.2	0.66	20	Rhoimb	3.1	0.73
	2	NepFlo	35.2	0.00	44	Scrdec	96.2	0.00	20	Rosweb	2.6	1.00
	2	Psyand	20.1	0.10	44	OroSp	35.2	0.00	20	EphGer	1.3	1.00
	2	Silgre	21.5	0.00	44	Haan	21.3	0.00	20	Pinfr	1.3	1.00
	2	Silmor	43.1	0.00	44	ElySp	12.6	0.02	1	GerSp	95	0.00
	48	AcaLy	84.6	0.00	44	Ches	10.7	0.18	1	CorWhi	80	0.00
	48	AndBal	12.2	0.01	44	MedSp	6.2	0.26	1	ElySp	57	0.00
	48	ArnEu	17.1	0.00	44	Lactala	5.8	0.12	1	Draset	52	0.00
	48	BerStr	16.2	0.00	44	Statib	4.9	0.19	1	Anerup	35	0.00
	48	Cicmac	22	0.00	44	AstFlacc	2.3	0.62	1	Waltom	26	0.00
	48	Epger	8.2	0.56	1	Artmar	37	0.00	1	Rhotib	21	0.00
	48	KrasSp	61	0.00	1	Coutho	21.8	0.01	1	Salkal	21	0.01
	48	Nepglu	9.8	0.02	1	AlliPrez	20.7	0.02	1	SauAtk	17	0.00
	48	Polcog	22	0.00	1	Aregra	16.4	0.02	1	WalSto	17	0.00

	48	RibSp	9.8	0.03	1	Polpar	15.5	0.23	1	SteSp	13	0.01
	48	TanFru	21.7	0.00	1	PedOphi	12.6	0.03	-	-	-	-
	-	-	-	-	1	Psyand	11.8	0.05	-	-	-	-
	-	-	-	-	1	Ajatib	10.7	0.06	-	-	-	-
	-	-	-	-	1	AreEu	8.8	0.49	-	-	-	-
	-	-	-	-	1	VioPio	8.1	0.09	-	-	-	-
	-	-	-	-	1	LyoSer	5.4	0.21	-	-	-	-
	-	-	-	-	1	OxyCas	5.4	0.21	-	-	-	-
	-	-	-	-	1	RousAlp	5.4	0.22	-	-	-	-
	-	-	-	-	1	Oxytar	4.8	0.31	-	-	-	-
	-	-	-	-	1	Bersta	4.5	0.31	-	-	-	-
	-	-	-	-	1	Loncae	3.6	0.40	-	-	-	-
	-	-	-	-	1	RosWeb	3.6	0.34	-	-	-	-
	-	-	-	-	1	carniv	3	0.55	-	-	-	-
	-	-	-	-	1	Astcon	2.7	0.68	-	-	-	-
	-	-	-	-	1	WhFrW	2.4	0.74	-	-	-	-
	-	-	-	-	1	Pleu	2.1	0.70	-	-	-	-
	-	-	-	-	1	Astzan	1.8	0.89	-	-	-	-
	-	-	-	-	1	EchCor	1.8	1.00	-	-	-	-
	-	-	-	-	1	RibOri	1.8	0.90	-	-	-	-
	26	BisAff	62.9	0.00	419	AstFla	70.8	0.00	1	AcoLyc	1.7	0.32
Stable	26	Potary	52.9	0.00	419	Rhetib	52.7	0.00	1	AcoRum	9.5	0.02
slope	26	Lagkun	46	0.00	419	AetYH	50	0.00	1	AnePul	7.1	0.05
	26	Rhotib	37.2	0.00	419	Stell	42	0.00	1	Aregra	1.1	0.59
	26	Acorot	36	0.00	419	Kobpig	39.6	0.00	1	ArtMar	11	0.09
	26	Oxytat	36	0.00	419	jurcer	37.5	0.00	1	ArtSal	12	0.00
	26	Walpal	34	0.00	419	AlliAwa	35.4	0.00	1	CarNiv	23	0.00
	26	PotSp	31.1	0.00	419	Saxsp	34.2	0.00	1	KarPig	7.8	0.01
	26	AstFla	30	0.00	419	Pedmak	31.2	0.00	1	CerCer	2.8	0.22
	26	AllPrez	24	0.00	419	pedS	30.7	0.00	1	ChrPry	4.5	0.05
	26	Dralik	22	0.00	419	BistAff	29	0.00	1	CicMac	8.3	0.02
	26	Gencap	20	0.00	419	ligpur	27.1	0.00	1	EqAr	3.6	0.17
	26	Carniv	16	0.01	419	Delbru	26.3	0.00	1	Erinan	1.7	0.29
	26	Rhoim	16	0.01	419	WalTom	22.1	0.00	1	GalSp	1.7	0.30
	26	Bislik	14	0.02	419	PotAgr	21.4	0.00	1	Gennub	4.5	0.04
	26	Taroff	13.1	0.07	419	Swepet	18.7	0.00	1	InuRhi	5	0.05
	26	Sibcun	12	0.03	419	FestSp	16.7	0.00	1	kumbu	5.5	0.04
	26	Papnau	10.9	0.06	419	LeoSp	9.5	0.11	1	LeoAL	16	0.00
	26	RheWe	10.5	0.54	419	Saubra	7.3	0.03	1	LinSty	1.7	0.32
	26	SilD	10	0.05	45	Artbre	87.7	0.00	1	Nepglu	3.4	0.10
	26	Kobma	8.1	0.20	45	Chypyr	31.9	0.00	1	Neppod	23	0.00
	1	AreSp	46	0.00	45	Andsp	31.8	0.00	1	ParNud	5.7	0.03
	1	Festuca	44	0.00	45	Nepglu	25.4	0.00	1	PodHex	2.2	0.22
	1	Ephe	44	0.00	45	Viopil	24.1	0.00	1	PedPra	13	0.00
	1	Polcog	42	0.00	45	Pedpod	23.6	0.00	1	PedLe	6.7	0.02
	1	Therin	42	0.00	45	Salsp	22	0.00	1	PseMalt	7.7	0.02
	1	ElymS	40	0.00	45	Alliprez	18.6	0.00	1	PsyAnd	5	0.05
	1	Acotor	32.5	0.01	45	Pleurosp	16.9	0.00	1	RheWeb	7.8	0.05

1	Thylin	30.	0.00	45	Psyand	16	0.00	1	Rhoimb	13	0.02
1	Ped	26	0.00	45	Diachen	12.3	0.00	1	SweSp	4.5	0.18
1	Acalyc	24	0.00	45	Allistoc	11.9	0.00	1	Thirut	16	0.00
1	Draset	22	0.00	45	LactOrit	8.5	0.00	1	YelFlS	4.5	0.06
1	Andbal	20	0.00	45	Polypar	6.8	0.38	27	Andmuc	41	0.00
1	NepPo	18.3	0.07	45	Rheuce	6.8	0.00	27	AneRup	95	0.00
1	Psemal	18	0.00	45	Tragra	5.3	0.03	27	AreEch	32	0.00
1	AstNS	16	0.00	45	BupYel	5.2	0.16	27	AstRhi	81	0.00
1	Cicmac	14	0.01	45	RosaWe	5.1	0.00	27	BisViv	25	0.00
1	Leo	13.8	0.15	45	Thylin	4.9	0.01	27	Ephger	2.9	0.15
1	Menlon	12	0.03	45	Lonicae	4.4	0.13	27	PedOphi	43	0.00
1	EriCan	10.7	0.76	45	Elylike	3.4	0.22	27	PriDB	17	0.00
1	Aregra	10	0.07	1	GerSp	23.3	0.00	76	AlliCon	17	0.00
1	Bupleu	10	0.06	1	AcoTor	19.8	0.00	76	AndBal	8.4	0.02
1	CarSp	10	0.06	1	FestKas	19	0.01	76	Andye	2.7	0.11
1	Daith	10	0.06	1	ElymSp	17.2	0.02	76	Awa	11	0.00
1	NepGl	10	0.05	1	Rhoimb	15.6	0.00	76	CorMak	14	0.00
1	DelCas	8	0.12	1	Neppod	15	0.01	76	Cortaz	6.8	0.01
1	GerSp	8	0.12	1	LeoL	13.4	0.01	76	Dralik	37	0.00
1	Juniper	2	1.00	1	Priden	12.4	0.01	76	DraSet	9.6	0.02
1	Rosalp	2	1.00	1	RosuAlp	11.4	0.01	76	GenCap	4.1	0.01
-	-	-	-	1	Aregraff	10.8	0.16	76	GrassG	15	0.00
-	-	-	-	1	LogKuw	10.8	0.05	76	LeoS	13	0.03
-	-	-	-	1	Gentrans	10.7	0.02	76	MyoSil	6.8	0.04
-	-	-	-	1	Anerup	10.2	0.01	76	Oxydig	2.7	0.12
-	-	-	-	1	Draset	9.5	0.04	76	Oxylap	7.5	0.08
-	-	-	-	1	Ares	9.2	0.04	76	Pedroy	15	0.00
-	-	-	-	1	PotSp	9	0.03	76	Polmac	14	0.00
-	-	-	-	1	Rhotibet	9	0.03	76	PotSp	2.9	0.22
-	-	-	-	1	AlliCar	8.3	0.04	76	Rhotib	56	0.00
-	-	-	-	1	Oxycash	8.3	0.04	76	SalSec	11	0.00
-	-	-	-	1	AcaLyco	8	0.24	76	SauAtk	27	0.00
-	-	-	-	1	Rheumo	7.3	0.04	76	SaxFla	15	0.00
-	-	-	-	1	Carex	6.6	0.06	76	DraSet	27	0.00
-	-	-	-	1	OxySp	6.1	0.08	76	WalSt	18	0.00
-	-	-	-	1	Oxymac	5.8	0.17	76	Waltom	43	0.00
-	-	-	-	1	ArneEuc	5.3	0.31	141	AcoRot	22	0.00
-	-	-	-	1	LinAnch	5.1	0.11	141	AreSp	30	0.00
-	-	-	-	1	CarVer	4.9	0.13	141	Artmac	5.1	0.12
-	-	-	-	1	Cletib	4.6	0.10	141	ArtSp	7.4	0.04
-	-	-	-	1	Coutho	4.6	0.12	141	AstFla	17	0.00
-	-	-	-	1	Dicmac	4.6	0.15	141	BisAff	38	0.00
-	-	-	-	1	Oxytat	4.6	0.14	141	KarMet	16	0.00
-	-	-	-	1	Therinf	4.6	0.11	141	Coutho	7.4	0.01
-	-	-	-	1	MedSp	4.3	0.18	141	Cyno	16	0.00
-	-	-	-	1	silmoor	4.2	0.27	141	DelCash	18	0.00
-	-	-	-	1	CynoSp	4.1	0.15	141	DiatCh	26	0.00
-	-	-	-	1	Delcash	4.1	0.14	141	ElyS	38	0.00

	-	-	-	-	1	TarOff	4.1	0.14	141	Euphim	12	0.00
	-	-	-	-	1	Papnau	3.9	0.18	141	Carex	17	0.00
	-	-	-	-	1	CorMak	3.6	0.20	141	Gentra	22	0.00
	-	-	-	-	1	Matdis	3.6	0.18	141	GerSp	25	0.00
	-	-	-	-	1	Thilac	3.6	0.20	141	HerPin	1.3	0.37
	-	-	-	-	1	Pedpec	3.4	0.19	141	LoniSp	4	0.04
	-	-	-	-	1	Androb	3.2	0.22	141	PotAgr	17	0.00
	-	-	-	-	1	AstGree	3.2	0.22	141	Priden	16	0.00
	-	-	-	-	1	Thilmin	3.2	0.22	141	Rhemoor	2	0.25
	-	-	-	-	1	AstNS	2.9	0.24	141	RosAlp	28	0.00
	-	-	-	-	1	Gennub	2.9	0.26	141	Rubtic	2.7	0.17
	-	-	-	-	1	AlliSp	2.7	0.28	141	SauRoy	8.1	0.01
		-	-	-	1	Cordep	2.7	0.31	141	ScorSp	1.3	0.38
		-	-	-	1	KrasSp	2.7	0.30	141	JunCer	6	0.02
		-	-	-	1	Pinkste	2.7	0.31	141	Sibcun	2.7	0.11
		-	-	-	1	Cicmac	2.4	0.33	141	Silinf	1.2	0.58
		-	-	-	1	CorYeFr	2.4	0.32	141	SilSon	3.4	0.09
		-	-	-	1	AcoVio	2.2	0.39	141	Sokheart	3.4	0.05
		-	-	-	1	Anepul	2.2	0.38	141	Sonc	10	0.00
		-	-	-	1	AstMun	2.2	0.40	141	Swetho	10	0.00
		-	-	-	1	Carniv	2.2	0.42	141	TarOff	12	0.00
		-	-	-	1	Crass	2.2	0.37	141	Thylin	22	0.00
		-	-	-	1	Herlik	2.2	0.39	141	Verlax	8.6	0.01
		-	-	-	1	Ephger	1.9	0.46	301	Acovio	44	0.00
		-	-	-	1	Gallium	1.9	0.41	301	BupLon	14	0.00
		-	-	-	1	LinSty	1.9	0.44	301	Buplon	48	0.00
	-	-	-	-	1	ScrSp	1.9	0.41	301	CheVil	24	0.00
	-	-	-	-	1	Acorot	1.7	0.46	301	CreEwr	46	0.00
	-	-	-	-	1	ArtSel	1.7	0.49	301	Elylo	18	0.00
	-	-	-	-	1	Genmoo	1.7	0.47	301	EpiL	6.4	0.13
	-	-	-	-	1	Rhohet	1.7	0.46	301	FesSp	13	0.03
	-	-	-	-	1	HerSp	1.5	0.54	301	kobpig	77	0.00
	-	-	-	-	1	Parnes	1.5	0.54	301	Kobmet	68	0.00
	-	-	-	-	1	oxygra	1.2	0.74	301	Lyoser	73	0.00
	-	-	-	-	1	SilWpod	1.2	0.67	301	Oxygra	20	0.00
	-	-	-	-	1	Anjtib	1	0.91	301	PedBic	26	0.00
	-	-	-	-	1	Pseudo	1	0.91	301	PedPec	15	0.00
	-	-	-	-	1	AxySp	0.7	1.00	301	Plegov	10	0.00
	-	-	-	-	1	BieOda	0.7	0.92	301	Ranlon	44	0.00
	-	-	-	-	1	Rubtib	0.7	1.00	301	Rhohet	7.9	0.04
	-	-	-	-	1	Scrdec	0.7	1.00	301	OxoSp	38	0.00
	-	-	-	-	1	Thyhim	0.7	1.00	301	SalSp	22	0.00
	-	-	-	-	1	Poa	0.5	1.00	301	SauRoy	28	0.00
	-	-	-	-	1	Creflex	0.2	1.00	301	SaxSp	8.9	0.06
	-	-	-	-	1	LydSer	0.2	1.00	301	SedEwe	15	0.00
	-	-	-	-	1	Oxyden	0.2	1.00	-	-	-	-
	-	-	-	-	1	Sty	0.2	1.00	-	-	-	-

Appendix V

Validation of Habitat suitability model

A. *.Aconogonum tortuosum*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	515799.00	3	0.20	0.79	0.25
Least suitable	102552.03	3	0.20	0.16	1.27
Moderate suitable	31249.26	7	0.47	0.05	9.82
Highly suitable	3379.59	2	0.13	0.01	25.12

B. *Acantholimon lycopodioides*

Suitability class	Area (ha)	No. of presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	479768.49	1	0.071	0.735	0.10
Least suitable	130187.70	5	0.357	0.199	1.79
Moderate suitable	39867.39	7	0.467	0.061	7.64
Highly suitable	3156.30	1	0.071	0.005	14.78

C. *Arnebia euchroma*

Suitability class	Area (ha)	No. of presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	454566.69	1	0.08	0.70	0.11
Least suitable	129614.04	4	0.31	0.20	1.55
Moderate suitable	60068.70	6	0.46	0.09	5.02
Highly suitable	8730.45	2	0.15	0.01	11.51

D. *Aconitum rotundifolium*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	525879.45	3	0.27	0.81	0.34
Least suitable	93712.95	5	0.45	0.14	3.17
Moderate suitable	30158.91	3	0.18	0.05	3.94
Highly suitable	3228.57	1	0.09	0.00	18.39

E. *Cicer microphyllum*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	477973.26	3	0.25	0.73	0.34
Least suitable	119007.81	3	0.25	0.18	1.37
Moderate suitable	49970.52	5	0.42	0.08	5.44
Highly suitable	6028.29	1	0.08	0.01	9.03

F.*Corydalis govaniana*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	534545.10	2	0.15	0.82	0.19
Least suitable	88321.23	6	0.46	0.14	3.41
Moderate suitable	27093.96	3	0.23	0.04	5.56
Highly suitable	3019.59	2	0.15	0.00	33.27

G.*Dactylorhiza* spp.

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	494042.76	3	0.25	0.76	0.33
Least suitable	114368.22	1	0.08	0.18	0.48
Moderate suitable	39831.39	3	0.25	0.06	4.10
Highly suitable	4737.51	5	0.42	0.01	57.43

H.*Rhodiola tibetica*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	473976.36	5	0.28	0.73	0.38
Least suitable	87403.59	8	0.44	0.13	3.32
Moderate suitable	82222.92	2	0.11	0.13	0.88
Highly suitable	9377.01	3	0.17	0.01	11.61

I *Rosa webbiana*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	439307.1	4	0.27	0.67	0.40
Least suitable	129045.7	4	0.27	0.20	1.35
Moderate suitable	66195.0	3	0.20	0.10	1.97
Highly suitable	18432.1	4	0.27	0.03	9.45

J. *Thymus linearis*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	512829.5	3	0.23	0.79	0.29
Least suitable	95468.1	6	0.46	0.15	3.16
Moderate suitable	37305.1	3	0.23	0.06	4.04
Highly suitable	7377.1	1	0.08	0.01	6.81

K. *Cicer microphyllum*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	608384.16	2	0.23	0.93	0.25
Least suitable	34561.44	5	0.31	0.05	5.81
Moderate suitable	8197.65	2	0.23	0.01	18.38
Highly suitable	1836.63	3	0.23	0.00	82.05

L. *Codonopsis ovata*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	584560.4	7	0.44	0.90	0.49
Least suitable	58656.1	5	0.31	0.09	3.48
Moderate suitable	7916.9	2	0.13	0.01	10.31
Highly suitable	1846.4	2	0.13	0.00	44.21

M. *Saussurea bracteata*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	448183.80	1	0.08	0.69	0.12
Least suitable	146876.04	3	0.25	0.22	1.11
Moderate suitable	53247.51	5	0.42	0.08	5.11
Highly suitable	4672.53	3	0.25	0.01	34.94

N. *Delphinium brunonianum*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	492132.3	2	0.23	0.75	0.31
Least suitable	119676.2	5	0.08	0.18	0.42
Moderate suitable	38373.6	4	0.31	0.06	5.24
Highly suitable	2797.8	1	0.38	0.00	89.76

O.*Rheum moorcroftianum*

Suitability class	Area (ha)	Species presence	Observed (O) proportion	Expected (E) proportion	O/E ratio
Unsuitable	541333.89	2	0.15	0.83	0.19
Least suitable	93417.93	7	0.54	0.14	3.76
Moderate suitable	14091.93	3	0.23	0.02	10.69
Highly suitable	4136.13	1	0.08	0.01	12.14

Appendix VI

Local names of the species

Botanical name	Local name
Acantholimon lycopodioides (Girard) Boiss.	*Longzey*
Aconitum heterophyllum Wall. ex Royle.	*Boga-karpo*
Aconitum rotundifolium Kar. & Kir.	*Boga*
Aconitum violaceum Jacquem. ex Stapf.	*Boga-karpo*
Aconogonum tortuosum (D. Don) H. Hara.	*Nyalo*
Allium carolinianum DC.	*Skotse, Arum*
Allium cepa L.	*Tsong, chong*
Allium oreoprasum Schrenk.	*Richong*
Allium ramosum L.	*Skotse, Arum*
Allium przewalskianum Regel.	*Kangmar*
Allium tortosum	*Chong*
Anaphalis triplinervis (Sims) Sims ex C.B.Clarke.	*Spra-rgo*
Anaphalis busua (Buch.-Ham.) DC.	*Shishing*
Androsace aizoon Duby.	*Zatikmukpo*
Anaphalis virgata	*Simala*
Androsace rotundifolia Hardw.	*Zigsolo marpo*
Anemone rivularis Buch.-Ham. ex DC.	*Zukpa*
Arabidopsis himalaica (Edgew.) O.E.Schulz.	*Sbiu-lapug*
Arctium lappa Kalm.	*Jisung, Byi zaung*
Aquilegia fragrans	*Bhati*
Arenaria griffithii Boiss.	*Oma-strwa*
Arabidopsis humile	*Chikki*
Arabidopsis himalaica	*Tarpu*
Arnebia euchroma (Royle) I.M.Johnst.	*Demok, Sbrimok, senmotsi*
Arnebia guttata Bunge.	*Deemok*
Artemisia absinthium L.	*Burtse-karapo, Burur kar*
Artemisia brevifolia Wall. ex DC.	*Khampa*
Artemisia maritima L. ex Hook.f.	*Burtse*
Artemisia moorcroftiana Wall. ex DC.	*Burtse*
Aster flaccidus Bunge.	*Lukmik*
Astragalus zanskarensis Bunge.	*Chisigma*
Astragalus peduncularis Royle.	*tserser*
Atriplex hortensis L.	*Rakpa*
Astragalus frigidus (L.) A.Gray.	*Shingalo*
Avena fatua	*Jakmak*
Berberis brandisiana Ahrendt.	*Skerpa*
Bergenia stracheyi (Hook.f. & Thomson) Engl.	*Gatikpa, Shapur*
Betula utilis D.Don.	*Towa*
Biebersteinia odora Stephan ex Fisch.	*Drakspos, shondol*

Bistorta vivipara (L.) Gray.	*Langna*
Bunium persicum (Boiss.) B.Fedtsch.	*Zera nakpo*
Brachyactis pubescens Aitch. & Clarke.	*Sathi*
Bupleurum longicaule Wall. ex DC.	*Sah-kukchak*
Capparis spinosa L.	*Capra*
Capsella bursa-pastoris (L.) Medik	*Medikus*
Bromus scoparius L	*Piantso*
Campanula latifolia L	*Za tik*
Caragana versicolor Benth.	*Trama*
Carum carvi L.	*Kosnyot*
Cerastium cerastoides (L.) Britton.	*Spang-yan-karpo*
Cerastium vulgatum L.	*Spangyan*
Chenopodium botrys L.	*Snue*
Chenopodium glaucum L.	*Sanek*
Chaerophyllum villosum Wall. ex DC.	*padamatswo*
Cheilanthes grisea Blanf.	*Charrpa*
Chrysanthemum tibeticum C.B.Clarke.	*Phematso*
Chrysanthemum pyrethroides (Kar. & Kir.) B.Fedtsch.	*Rekons-pa*
Cicer microphyllum Benth.	*Sari*
Cirsium arvense (L.) Scop.	*Biangtser*
Clematis orientalis L.	*Emong*
Clematis tibetana Kuntze.	*Emong nakpo*
Colchicum luteum Baker.	*Tukpa*
Codonopsis ovata Benth.	*Lurdud-dorjey, brukuting*
Corydalis megacalyx Ludlow & Stearn.	*Stongzil*
Corydalis govaniana Wall.	*Stongzil, Makshang*
Corydalis meifolia Wall.	*Tongrusilva*
Cousinia thomsonii C.B.Clarke.	*Biangtser nakpo*
Convolvulus arvensis L.	*Krikkrikmo*
Cotoneaster integerrimus Medik..	*Khirak*
Cotoneaster microphyllus Wall. ex Lindl.	*Khirak*
Cremanthodium arnicoides (DC. ex Royle) R.D.Good.	*Nimma-gorgos, Sga sho ringwa*
Crepis multicaulis Ledeb.	*Richkut*
Crepis flexuosa (Ledeb.) Benth. ex C.B.Clarke.	*Gulthak*
Cynoglossum wallichii G.Don.	*Nima-jarma*
Chesneya cuneata (Benth.) Ali.	*Spichi gamburu*
Dactylorhiza hatagirea (D.Don) Soó.	*Wangbolakpa, wanglak*
Datura stramonium L.	*Datura*
Delphinium brunonianum Royle.	*Chargotpa, Makhoting*
Delphinium viscosum Hook.f. & Thomson.	*Chargos*
Descurainia sophia (L.) Webb ex Prantl.	*Khampa*
Dianthus anatolicus Boiss.	*Thangthorn*
Draba alpina L	*Piang*

Dracocephalum heterophyllum Benth.	*Zinzer, Zypsi*
Echinops cornigerus DC.	*Ekzima*
Echinospermum redowskii (Hornem.) Lehm.	*bhukpma*
Elsholtzia densa	*khachutse*
Ephedra gerardiana Wall. ex Stapf.	*Tsepath*
Epilobium angustifolium L.	*Utpalwampo, Bilchang*
Epilobium latifolium L.	*Utpalwampo*
Equisetum arvense L.	*Kihnn,khuyug tsa jang*
Erysimum odoratum Ehrh.	*trwa*
Erodium tibetanum Edgew. & Hook.f.	*Zemma*
Euphrasia himalayica Wettst.	*Skianglo*
Euphorbia hispida Boiss.	*Tharu*
Festuca cumminsii Stapf.	*Jakmag*
Fagopyrum esculentum Moench.	*Cha*
Fagopyrum tataricum (L.) Gaertn.	*Cha*
Ferula jaeschkeana Vatke.	*Thurnak*
Galium pauciflorum Willd. ex K.Schum.	*Rangche, tse-ut*
Gentiana nubigena Edgew.	*Spangyan mentok*
Gentiana capitata Buch.-Ham. ex D.Don.	*tikta, spangyan*
Gentiana tubiflora (G.Don) Griseb.	*Spangyan snonpo*
Gentiana tianschanica Rupr. ex Kusn.	*Wanglo*
Gentianella moorcroftiana (Wall. ex Griseb.) Airy Shaw.	*Chumbutik*
Geranium pratense L.	*Katur, Sprolo*
Heracleum pinnatum C.B.Clarke.	*Spishow, spru dkar*
Hippophae rhamnoides L.	*Tsestallullu*
Hippophae tibetana Schltdl.	*Tsernak,Tshubshilulu*
Hyoscyamus niger L.	*Gya-Lhathang*
Hyoscyamus pusillus L.	*Sastalulu*
Hypecoum leptocarpum Hook. f. & Thomson.	*Parpata*
Hordeum vulgare L.	*Toh*
Inula racemosa Hook.f.	*Manu*
Inula rhizocephala Schrenk.	*Turzit*
Indigofera heterantha Brandis.	*Spoto*
Iris sp.	*Tresma*
Juglans regia L.	*Starga*
Juniperus communis L.	*Shukpa*
Juniperus recurva Buch.-Ham. ex D.Don.	*Lha-shook*
Jurinea ceratocarpa (Dcne.)	*Turzith*
Juncus triglumis L.	*Swa*
Krascheninnikovia ceratoides (L.) Gueldenst.	*Kras*
Kochia stellaris Moq.	*Jakmag*
Lomatogonium carinthiacum (Wulfen) Rchb.	*Tikta*
Lactuca lessertiana Wall. ex C.B.Clarke.	*Tharnue*

Lactuca tatarica (L.) C.A.Mey.	*Bshakha*
Lactuca sativa L.	*khala*
Lagotis kunawurensis Rupr.	*Honglen*
Lancea tibetica Hook. f. & Thomson.	*Raksa*
Leontopodium alpinum Colm. ex Cass.	*Tzima*
Leontopodium himalayanum DC.	*Tawa*
Lepidium latifolium L.	*Seoji*
Lathyrus humilis (Ser.) Spreng.	
Lindelofia stylosa (Kar. & Kir.) Brand.	*Bonsna*
Lindelofia anchusoides (Lindl.) Lehm.	*Bongna*
Lonicera asperifolia Hook.f. & Thomson.	*khirak*
Lonicera spinosa Jacq. ex Walp.	*Khishing*
Lloydia serotina (L.) Rchb.	*Tsa-wa*
Lycopsis arvensis L.	*pho-ling*
Lotus corniculatus L.	
Malva verticillata L.	*Chiroti*
Matthiola flavida Boiss.	
Meconopsis aculeata Royle.	*AchaK-srmum*
Melica persica Kunth.	*Awa*
Medicago sativa L.	*Buksuk, ole*
Medicago lupulina L.	*ole*
Mentha longifolia (L.) L.	*Phololing*
Melica persica Kunth.	*Awa*
Myricaria elegans Royle.	*Umbu*
Morus alba L.	*Osey*
Mulgedium tataricum (L.) DC.	
Nepeta floccosa Benth.	*Shamagok*
Nepeta glutinosa Benth.	*Jatukpa*
Nepeta longibracteata Benth.	*Piangku*
Oxyria digyna (L.) Hill.	*Chumtswa, lungsho*
Oxytropis sp.	*Srad snon*
Papaver nudicaule L.	*Tshersngon-serpo*
Paraquilegia microphylla (Royle) J.R. Drumm. & Hutch.	*Yumo deujin*
Pedicularis bicornuta Klotzsch.	*Peyasang*
Pedicularis longiflora Rudolph.	*Luguruk serpo*
Pedicularis oederi Vahl.	*Luguruk serpo*
Pedicularis punctata Decne.	*Shapu-chotma*
Peganum harmala L.	*Sepan*
Perovskia abrotanoides Kar.	*Iskilling*
Phlomis rotata Benth. ex Hook.f.	*Tapaq*
Physochlaina praealta (Decne.) Miers.	*Langtang*
Plantago depressa Willd.	*Humbuksuk*
Plantago himalaica Pilg.	*Tharum*

Plantago major L.	
Pleurospermum candollei Benth. ex C.B.Clarke.	*kumbuk*
Phragmites australis (Cav.) Trin. ex Steud.	*Tse-goe*
Podophyllum hexandrum Royle.	*Dambu*
Potentilla anserina L.	*Denmokuschu, olmotse*
Potentilla argyrophylla Wall. ex Lehm.	*Toma*
Potentilla multifida L.	*Skyaldaypo*
Potentilla fruticosa L.	*Thak-toma*
Populus alba L.	*Sonamchespa*
Populus nigra L.	*Yarpa*
Prangos pabularia Lindl.	*Yarnak*
Primula denticulata Sm.	*Prangos*
Primula minutissima Jacquem. ex Duby.	*Tarla-iching*
Primula macrophylla D. Don.	*Spang punar*
Primula rosea Royle.	*Khi-chey*
Prunus domestica L.	*Troma*
Psychrogeton andryaloides (DC.) Novopokr. ex Krascha.	*Phating*
Pseudomertensia echioides (Benth.) Riedl.	*Lukchung*
Pulsatilla wallichiana (Royle) Ulbr.	*Khi nama*
Poa falconeri Hook.f.	*lakhililo*
Cynodon dactylon	*Fukche*
Ranunculus brotherusii Freyn.	*Rampa*
Rheum australe D. Don.	*Chu-rugpa*
Rheum spiciforme Royle.	*Chun-tswa*
Rheum webbianum Royle.	*Lacchu*
Rhodiola fastigiata (Hook. f. & Thomson) S.H. Fu.	*Lacchu*
Rhodiola himalensis (D. Don) S.H. Fu.	*Rholo mukpo*
Rhodiola imbricata Edgew.	*Rholo*
Ribes orientale Desf.	*Rrholo karpo*
Ribes alpestre Wall. ex Decne.	*Shing goe, Akskuta*
Rosa webbiana Wall. ex Royle.	*Askuta*
Rosa ecae Aitch.	*Sai marpo*
Rumex patientia L.	*Sai ser*
Sagina saginoides (L.) H.Karst.	*Shoma*
Salix alba L.	*Gangachon*
Salix denticulata Andersson.	*Malchang*
Salix sclerophylla Andersson.	*Langma*
Salix tetrasperma Roxb.	*Brokchang*
Saussurea obvallata (DC.) Edgew.	*Selchang*
Saussurea bracteata Decne.	*Yuling*
Saussurea gnaphalodes (Royle) Sch.Bip.	*Spangsi-tawo*
Saussurea schultzii Hook.f.	*Panespa*
Saxifraga flagellaris Willd.	*Jarbag*
	Serchen, Sumchutik

Sedum ewersii Ledeb.	*Dachungpa*
Senecio chrysanthemoides DC.	*Rgu-dus*
Seseli mucronatum (Schrenk) Pimenov & Sdobnina.	*Kumbulik*
Sinopodophyllum hexandrum (Royle) T.S. Ying.	*Tandik, Denmokuchu*
Silene moorcroftiana Wall. ex Benth.	*Sugpadagbyed*
Sisymbrium orientale L.	*Staga*
Stachys tibetica Vatke.	*Churukpa*
Swertia petiolata Royle ex D.Don.	*Zatik*
Swertia thomsonii C.B.Clarke.	*Tikta*
Sonchus oleraceus (L.) L.	
Elaeagnus angustifolia L.	*Sersing*
Stipa sp.	*Sipskya*
Tanacetum gracile Hook.f. & Thomson.	*Kham-chu*
Taraxacum officinale Webb.	*Khorma*
Thlaspi arvense L.	*Brega*
Thalictrum minus L.	*Chak-ackoo*
Thermopsis inflata Cambess.	*Dugsrad*
Thymus linearis Benth.	*Tumburu*
Tragopogon gracilis D.Don.	*Tharnoo*
Trigonella emodi Benth.	*Shamilik*
Urtica hyperborea Jacq. ex Wedd.	*Zahchot,*
Veronica koelzii	*Shoipa*
Verbascum thapsus L.	*Ngo-serjee*
Viola kunawurensis Royle.	*Gunapsha,Sgo-ta-mik*
Waldheimia glabra (Decne.) Regel	*Thumba ,Palu*
Waldheimia tomentosa (Decne.) Regel.	*Lukmik sepo,Palu*

Appendix VII

Traditional Health care Practitioners of Western Ladakh

Amchis

Name	Age	Village	Name	Age	Village
Lobzang Rinchen	77	Tashi-Tongzey	Smala Tsomo	63	Mulbek
Tsewang Paldey	79	Tashi-Tongzey	Smanla Tundup	45	Mulbek
Tashi Dorjey	25	Tashi-Tongzey	Namgail Tundup	31	Mulbek
Tashi Tobgais	46	Tashi-Tongzey	Tsering Kunzes	34	Wakha
Jamyang Tashi	48	Tashi-Tongzey	Stanzin Murup	68	Wakha
Akbar	40	Trambis	Tundup Norfail	65	Bothkharbu
Aba Jafer	81	Trambis	Tsering Smanla	40	Bothkharbu
Stanzin Chospel	30	Sapi	Gatso	45	Henasku
Tsering Smanla	62	Sapi	Nawang Sherap	49	Kargil
Padma Namgail	45	Sapi	Yangchen	41	Kargil
Tsering Tundup	66	Sapi	Aba	51	Kanji
Tsering Angchuk	62	Sapi	Padma Ladol	29	Phokar
Sangyas	30	Sapi	Tsering Tundup	57	Hanu Yokma
Yanskit	60	Sapi	Skarma Stanfel	43	Hanu Gongma
Sonam	31	Sapi	Smala Rigzin	56	Hanu Gongma
Smanla Tsewang	55	Phokar- Phu	Tashi Tsepal	81	Hanu Gongma
Smanla Tundup	67	Shargole	Dawa	89	Garkon
Tsering Smanla	29	Phokar- Phu	Onpo	47	Darchik

Akhon

Name	Age	Village	Name Of Akhon	Age	Village
Abdul Hussain	40	Pharkachik	Sayid Mohd	53	Gon Mangalpur
Haji Musa	72	Pharkachik	Mohd Ali	50	Trespone
Aga Sayid Hassan	42	Pharkachik	Mohd Hussain	55	Kanor
Ali	60	Pharkachik	Mirza	48	Kanor
Sajad Hussain	45	Tongol	Aga Sayid Kazim	32	Trambis
Gulam Ali	63	Tongol	Aga Sayid Mehdi	48	Trambis
Ahamad Ullah	80	Pranti	Mohd Abdula	57	Minji
Aga Sayid Bakir	36	Taisuru	Maqbul Ahamed	43	Baru
Akiel	52	Pursa	Haji Gulam Abas	60	Minji
Gulam Hyder	55	Yuljuk	Mohd Hussain	67	Minji
Madhi	68	Kargee	Mohd Ali	83	Paskum
Gulam Mohd	80	Sanra	Abdul Karim	70	Paskum
Gulam Mohd	50	Sanra	Mohd Musa	50	Lotsum
Gulam Hyder	50	Sanra	Mohd Hassan	40	Lotsum
Fida Hussain	48	Karpokar	Tasaduk Hussain	53	Lotsum
Mohd Beikh	80	Brako	Akbar	56	Darket
Mohd Musa	50	Sankoo	Yusuf Ali	63	Shargole

Abdul Hussain	51	Lankerchey	Abdula	50	Mulbek
Mohd Bakier	62	Lankerchey	Mohd Musa	67	Wakha
Mohd Hassan	78	Lankerchey	Akbar	47	Wakha
Mohd Ali	72	Lankerchey	Mohd Toha	48	Wakha
Mohd Ali	50	Sankoo	Mohd	27	Sapi
Gulam	49	Thila- Brok	Akhon	39	Hanu Yokma
Gulam Hussain	60	Phurana	Akhon	42	Battalic
Gulam Hyder	48	Selaskot	Akhon	55	Chulichan
Sayid Ali	57	Selaskot	Akhon	45	Gar-Gardoh
Mohd Ali	56	Gon Mangalpur			

Shaman

Name	**Age**	**Village**	**Name**	**Age**	**Village**
Mansora Bano	21	Purtikchey	Amin	22	Sankoo
Suriya Bano	25	Sankoo	Khatija	19	Sankoo
Khatija Bano	21	Trespone	Dorjey	18	Sankoo
Fatima Bano	35	Trespone	Cho	78	Mulbek
Azara Bano	21	Trambis	Tsering	37	Sapi
Fiza Bano	19	Trambis	Lha	41	Kanji
Amina Bano	36	Kanor	Angmo	33	Beema
Khati	27	Kanor	Tsering	34	Dha
Anzar	33	Sankoo	Sonam	45	Hanu
Raziya	22	Sankoo	Tsewang	46	Hanu
Nagma	29	Sankoo			

Appendix VII

List of Villages Surveyed

Villages			
Tashi Tongzey	Gailing	Gon Mamgalpur	Wakha
Yul-Doh	Sangra	Trespone	Stakchey/Kharal
Pharkachik	Stakpa	Kanor	Bothkharbu
Tongol	Karpokhar	Trambis	Skilmartse
Achambur	Thang-Dumbur	Minji	Henaskot
Kochik	Nakma,Kusar	Baru	Kanji
Choskar	Karchey Khar	Paskum	Chullichan
Pranti	Thasgam-Thuina	Lotsum	Shertsey
Panikar	Barsoo	Darket	Batalic
Thulus Pursa	Thila	Shargole	Darchik
Kargee	Pangbar	Karamba	Garkon
Taisuru	Lankerchey	Khatsey	Beema
Namsuru	Phurana	Phokar-Phu	Sapi
Kwas	Selaskot	Mulbek	Umba
Yuljuk	Putikchey		

Appendix IX

Herbarium Collection list of plants from Western Ladakh

Botanical name	Number	Altitude (m)	Date	Locality	Habitat
Aconitum heterophyllum	80	3085	7/27/2010	Sangra	Field margins and fallow moist land
Aconitum rotundifolium	115	4500	8/14/2010	Rangdum Ri	Stable slopes, Alpine meadows
Aconitum violaceum	118	4060	8/13/2010	Rangdum Ri	Stable slopes, Alpine meadows and fields
Allium carolinianum	49	4000	7/12/2010	Ichu Lungba	Stable slope
Boschniakia himalaica	2	3000	8/3/2010	Bema	Dry rocky slope
Arenaria muscoides	7	2900	6/13/2010	Nakpo Chu	Moist meadows
Anaphalis virgata	116	4060	8/13/2010	Rangdum Ri	Dry slopes
Androsace rotundifolia	62	3900	7/11/2010	Ichu Lungba	Open rocky slopes
Anemone rupicola	61	4100	8/12/2010	Sapi	High Stabled slopes
Arabidopsis himalaica	182	3200	6/9/2010	Narambi	Scree slopes
Arnebia euchroma	103	3900	6/12/2010	Panikar	High Stabled slopes
Artemisia maritima	175	3500	6/10/2010	Narambi	Dry slopes
Aster flaccidus	67	3900	7/9/2010	Pangbarok	Alpine slopes
Astragalus munroi	32	3781	8/12/2010	Sapi	Dry scree slope
Bistorta affinis	87	2800	7/28/2010	Trambis	Field margin
Astragalus rhizanthus	162	3000	6/3/2010	Brako	Stoney slopes
Astragalus tecti-mundi	137	4325	8/13/2010	Rangdum Ri	Shrubberies
Astragalus densiflorus	86	2800	7/27/2010	Trambis	Field margin
Bergenia stracheyi	(2009)24	4200	9/7/2009	Langtot Lungba	Under rocks
Astragalus zanskarensis	10	3500	7/18/2010	Phokarzong	Dry slopes
Biebersteinia odora	(2009)6	4300	8/29/2009	Khardongla	Stony slopes
Bistorta vivipara	51	4200	7/12/2010	Ichu Lungba	Open slopes
Bupleurum longicaule	110	4402	8/14/2010	Rangdum Ri	Fields, fallow lands
Carex nivalis	35	4215	7/11/2010	Ichu Lungba	Alpine slopes
Chrysanthemum tibeticum	33	3500	7/30/2010	Langtot Lungba	Dry slopes
Chrysanthemum pyrethroides	(2009) 48	4000	9/7/2009	Langtot Lungba	Upper slopes
Corydalis govaniana	41	4000	7/12/2010	Ichu Lungba	Alpinemeadows
Corydalis meifolia	9	4000	7/30/2010	Langtot Lungba	Alpinemeadows
Cortia depressa	3	4000	8/2/2010	Chopo Dok	Open slopes in drier areas
Cremanthodium arnicoides	139	4400	8/13/2010	Rangdum Ri	Wet shrubberies
Crepis flexuosa	129	4060	8/14/2010	Rangdum Ri	Stony rivurian
Dactylorhiza hatagirea	113	4060	8/13/2010	Rangdum Ri	Moist meadow, Alpine meadow
Delphinium brunonianum	112	4061	8/14/2010	Rangdum Ri	Stabled high slopes

Draba altaica	·5	4100	8/2/2010	Chopo Dok	Scree slopes
Elaeagnus angustifolia	12	2900	*8/1/2011*	Bema	Field margins and fallow moist land
Epilobium angustifolium	78	3085	7/27/2010	Sangra	Field margins
Epilobium latifolium	127	4100	8/13/2010	Rangdum Ri	Pebbly or moranic deposites
Erigeron acer	50	4200	7/12/2010	Ichu Lungba	Fallowland
Erigeron multiradiatus	37	4001	7/12/2010	Ichu Lungba	Dry slopes
Euphorbia tibetica	(2009) 35	3700	9/29/2009	Khardongla	Open dry slopes
Eritrichium canum	38	4000	7/11/2010	Ichu Lungba	Dry slopes
Gentiana crassuloides	(2009)23	4160	9/7/2009	Langtot Lungba	Alpine meadows
Gentiana tubiflora	79	3085	7/28/2010	Sangra	Fields margins
Gentiana tianschanica	130	4300	13-18-2010	Rangdum Ri	Stable shrubbery slope
Gentianella moorcroftiana	72	3000	7/9/2010	Bartu Village	Irrigated areas
Geranium pratense	83	2800	7/27/2010	Trambis	Irrigated areas
Hippophae rhamnoides	53	3600	7/13/2010	Shargandi	Field margins
Hyoscyamus niger	90	2800	7/28/2010	Trambis	Fields
Hyoscyamus pusillus	(2009)20	3350	8/10/2009	Nirda Lungba	Road side
Hypecoum leptocarpum	108	4404	8/16/2010	Rangdum	Fields small streams
Glechoma thibetica	26	4000	8/22/2010	Kanji	Scree slopes
Inula racemosa	(2009)34	3200	8/10/2009	Nirda Lungba	Alpinemeadows
Juniperus recurva	(2009)12	4100	9/7/2009	Lagtot Lungba	Dry slopes
Lactuca lessertiana	136	4456	8/13/2010	Rangdum Ri	Shrubberies open stable slopes
Lancea tibetica	92	2800	7/27/2010	Trambis	Field small stream
Leontopodium himalayanum	43	4000	7/12/2010	Ichu Lungba	Stabled high slopes
Lindelofia stylosa	163	3000	6/3/2010	Brako	Dry slopes
Lloydia serotina	54	4100	7/14/2010	Ichu Lungba	Moist slope
Lotus corniculatus	119	2900	6/13/2010	Nakpo Chu	Moist meadow
Matthiola chorassanica	120	3200	6/9/2010	Narambi	Dry habitat
Mentha longifolia	121	3085	7/27/2010	Sangra	Field margins
Morina coulteriana	122	3500	7/18/2010	Phokarzong	Open slopes
Nepeta glutinosa	(2009)17	4145	9/7/2009	Langtot Lungba	Stabled high slopes
Nepeta longibracteata	29	4400	8/24/2010	Kangi	Dry pebbly slope
Oxytropis tatarica	193	4200	7/28/2010	Umba La	Dry plateau
Papaver nudicaule	58	4200	7/15/2010	Ichu Lungba	Bouldery slope, talus
Paraquilegia microphylla	16	4000	6/21/2010	Phokar Phu	Rock crevices
Pedicularis longiflora	25	4000	8/1/2010	Dha Lungba	Damp places
Pedicularis pyramidata	69	3500	7/12/2010	Shargandi	Moist meadows/Stable upper slopes
Pleurospermum stellatum	.138	4500	8/13/2010	Rangdum Ri	Stabled high slopes
Linum perenne	13	3200	6/9/2010	Narambi	Dry slope
Potentilla salesovii	24	4000	8/24/2010	Kangi	Small stream side

Parrya nudicaulis	70	4200	7/9/2010	Pangbarok	High Stabled slopes
Potentilla salesovii	23	4000	8/24/2010	Kangi	Small stream side
Potentilla eriocarpa	40	4000	7/12/2010	Ichu Lungba	Rock crevices
Ephedra gerardiana	39	3200	6/8/2010	Stakpa Ri	Rocks and cliffs
Primula denticulata	73	4501	8/12/2010	Rangdum Ri	Alpine meadow,Open stable slope
Primula macrophylla	11	4300	7/28/2010	Umba La	Damp plaes and streams
Psychrogeton andryaloides	6	3437	6/10/2010	Panikar Ri	Dry slopes
Pseudomertensia echioides	104	3437	6/13/2010	Panikar Ri	Under the rock, open dry slopes
Ranunculus hirtellus	164	3000	6/3/2010	Brako	Alpine slopes
Rhodiola fastigiata	71	4200	7/9/2010	Pangbarok	Open slopes and bouldery slopes
Rhodiola heterodonta.	74	4200	8/12/2010	Rangdum Ri	Bouldery /Stoney slope
Rubia tibetica	45	4000	7/12/2010	Ichu Lungba	Dry slopes
Ribes alpestre	44	4000	7/12/2010	Ichu Lungba	Dry slopes
Silene songarica	46	4000	7/12/2010	Ichu Lungba	Dry stable slpoe
Scutellaria heydei	20	4400	8/24/2010	Kanji	Dry rivurian pebbly habitat
Saxifraga sibirica	128	4000	8/13/2010	Rangdum Ri	Shrubberies
Saussurea bracteata	47	4400	7/12/2010	Ichu Lungba	Bouldery slope, talus
Saussurea roylei	111	4401	8/13/2010	Rangdum Ri	Shrubberies, open stable slopes
Saussurea schultzii	(2009)3	4000	8/29/2009	Khardongla	Stabled high slopes and bouldery slope
Saxifraga flagellaris	(2009)2	3600	8/29/2009	Khardongla	Stable slope
Senecio chrysanthemoides	(2009)43	2717	9/10/2009	Garkon	Dry slopes
Sisymbrium irio	91	2800	7/28/2010	Trambis	Field margins
Swertia petiolata	114	4300	7/19/2010	Chilling Nala	Shrubberies,open slopes
Silene conoidea L	85	2800	7/27/2010	Trambis	Dry slope road side
Tanacetum tibeticum	(2009)1	3200	8/10/2009	Nirda Lungba	Dry slope, roadside
Taraxacum officinale	(2009)42	4100	9/7/2009	Langtot Lungba	Small streams
Thermopsis inflata	4	4000	8/2/2010	Chopo Dok	Pebbly scree slopes
Thymus linearis	60	4250	7/9/2010	Pangbarok	Rocky dry slopes
Tragopogon gracilis	88	2800	7/28/2010	Trambis	Field margin
Trifolium repens	93	2801	7/28/2010	Trambis	Field margins
Veronica laxa	1	3700	8/8/2010	Shishing Lungba	Stable slope
Verbascum thapsus	89	2800	7/28/2010	Trambis	Field margins
Waldheimia glabra	135	4400	8/13/2010	Rangdum Ri	Stony slopes, drier areas
Waldheimia tomentosa	194	4553	7/28/2010	Umba La	Stony slopes
Thlaspi andersonii	8	4000	8/2/2010	Chopo Dok	Open slopes, damp places
Tulipa stellata	105	3500	6/14/2010	Panikar Ri	Rocky slopes

Identified by Dr. GS Rawat and collected by Kunzes Angmo