CHAPTER 2

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2.1. TRANS-HIMALAYAN COLD DESERT

2.1.1. Geographical setting

The Himalayas are youngest mountain system on the earth, comprising two major biogeographic zones, the Trans-Himalaya and the main Himalaya. Trans-Himalaya, the rain-shadow zone of the main Himalayan massif, is spread over about 3 million km$^2$ area and is commonly known as cold desert (Anonymous, 1994). It covers part of Afghanistan, Pakistan, India and Tibetan plateau in China. In India, this ecoregion covers Ladakh region of the State of Jammu and Kashmir, Lahaul-Spiti district and parts of Kinnaur and Chamba districts in the State of Himachal Pradesh, and very small portion of the States of Uttaranchal and Sikkim. Elevations vary from 3000 m to >6500 m. The climate is arid showing wide annual and diurnal variations in temperature. Average annual rainfall is 100 mm. The area comprises a large number of lake basins of varying size. Cold desert is legally the least protected region; <1% of total area of Indian cold desert territory (85,000 km$^2$) is covered in protected area network (Anonymous, 1994).

Tribes inhabiting the Spiti and neighbouring region belong to Mongoloid race. People have faith in Buddhism and so have a religious appreciation for wildlife. There are many permanent settlements above 4000 m, the highest cultivation at 4400 m, and the highest temporary grazing settlements at about 4750 m. The region was isolated from the mainstream society until 1994 when it was opened to tourism. Cold deserts are perhaps the most thinly populated regions of south Asia.

2.1.2. Geology, rock and soil

The geological importance of Lahaul-Spiti district lies in fact that there is a complete sequence of geological formations dating from the Pre-Cambrian to the cretaceous with short breaks in upper Carboniferous and upper Jurassic time (Rana 1994). The Mesozoic period is represented is represented by Spiti shales often micaceous having a maximum thickness and form a conspicuous horizon in the
Tethys Himalaya. These shales have yielded extremely rich and varied fossils ammonite fauna. The most ancient rocks found in the area belong to Pre-Cambrian period. The formation of fossiliferous containing types of Brachiopods, Echinoderms, Gastropods, Ostracods and Cephalopods. It is believed that after the deposition of the Spiti shales, Tethys Sea gradually became shallow and unsuitable for supporting a rich fauna. There is distinct difference between Spiti shales fossil fauna and the cretaceous fossil fauna since the two have very few common elements. The Pleistocene is the period glaciations in northern India. The Himalayan sediments were deposited in the Tethyan Sea and were raised as a result of its closing due to the movement of Gondwana land continent northward. The drift took place in the late Mesozoic to earliest Cenozoic times. The Tethys Sea between India and rest of the Asia started to close during the Cretaceous. This caused the doubling of the crustal thickness and uplift of the Tibetan plateau. Regarding soil, the depth of soil cap in the upland area is generally shallow, whereas it is slightly better in the middle plateau areas. The series near the Kibber wildlife sanctuary is a member of the fine/loamy mixed calcareous and have dark brown to dark yellowish brown mildly alkaline, gravelly sandy loam (Rana 1994). They have developed on old colluvium consisting of Spiti shales, limestones and dolomites. As the soil is mainly derived from the rocks, which crop out in its immediate neighbourhood, it varies as rapidly as the parent rock. The mica-schists most commonly give a stiff reddish loam or stiff red clay. The shales and slates are rather soft and the covered soil supports some vegetation.

2.1.3. Flora

Aswal and Mehrotra (1994), in a regional floristic survey, sampled 985 species belonging to 353 genera and 79 families. Asteraceae was the most dominant family followed by Poaceae and Brassicaceae. The flora comprises four major types of elements viz., boreo-alpine elements, Euro-Siberian or the Trans Palaearctic elements, Southern European or the Mediterranean elements and Siberian-Mongolian elements. *Meconopsis bikramii, Microsymbrium axillare ssp brevipedicellatum, Pseudomertensia lahulensis* and *Ranunculus bikrammi* are among species endemic to the Indian cold desert (Anonymous, 1994). *Saxifraga flagellaris, Astragalus munroi, Saussurea gossipyphora* and *Soroseris glomerata* are cited as ‘botanical curiosities’ of Indian cold desert (Aswal and Mehrotra, 1994).
The area is a repository of medicinal plants. Many medicinal species are given a status of rare and endangered species. Kala (2000) identified 62 plant species used for local health care but could capture only 23 species, *Saussurea gnaphaloides* and *Picrorhiza kurrooa* being the most frequent ones, in a phytosociological survey indicating rare status of most medicinal species.

### 2.1.4. Fauna

Among large mammals, four species viz., snow leopard (*Panthera uncia*), wolf (*Canis lupus*), ibex (*Capra ibex*) and bharal (*Pseudois nayaur*) exhibit almost a continuous distribution across the region, whereas urial (*Ovis vignei*), Tibetan argali (*Ovis ammon*), wild ass (*Equus kiang*), Tibetan gazelle (*Procapra picticaudata*), Tibetan antelope (*Pantholops hodgsoni*), wild yak (*Bos grunniens*), wild dogs (*Cuon alpinus*), lynx (*Lynx lynx*) and brown bear (*Ursus arctos*) are confined to isolated pockets. Small mammals include Himalayan marmot (*Marmota himalayana*), Royle’s pica (*Ochotona roylei*) and Stone’s marten (*Martes fiona*). Bearded vulture (*Gypastus barbatus*) and Himalayan griffon (*Gypus himalayensis*), competing with snow leopard for carcasses, and Tibetan snowcock (*Tetrogalus tibetanus*) and Himalayan snowcock (*Tetrogallus himalayensis*), a common prey of snow leopard, is the important avifauna (Rana 1994).

Conservation status given to different species varies among different agencies. Snow leopard and wild yak are listed as endangered species and Tibetan wolf and wild ass as vulnerable species in the Red Data Book of the International Union for the Conservation of Nature and Natural Resources (Anonymous, 1990a). Tibetan argali, Tibetan antelope and urial have been treated as 'threatened with extinction' in the Convention on International Trade in Endangered Species of Fauna and Flora (Anonymous, 1990b).

### 2.2. LAND USE IN SPITI

The regional landscape could be differentiated into three interspersed elements:

(i) Settled crop-livestock mixed farming landscapes characterized by moderately dissected terrain, gentle slopes, lower altitudes (< 4300 m) and a high frequency of sub-surface water flows. These village-scale landscapes vary in area (1 to 5 km²), are highly dispersed (distance between two adjacent villages varying from 1 to > 10
km) and are differentiated into the central core of cultivated land surrounded by meadows grazed by local livestock.

(ii) Almost pristine areas including permanent snow area and adjoining alpine vegetation practically impossible to access for any consumptive resource use.

(iii) The remaining areas characterized by a highly dissected terrain and steep slopes used for summer grazing by nomads (locally called as Gaddis) bringing livestock from far away foothill regions (i.e. outside the cold desert region).

2.2.1. The village landscape

All through the region, the village community is differentiated into large holders (> 1 ha) and small holders (< 1 ha). The village landscapes, based on geomorphological features, could be stratified into two groups: the river-side village landscapes and hill-side village landscapes. The river-side villages are smaller in size, located at lower altitudes and are characterized by a larger cultivated land to pasture land ratio as compared to the hill-side villages. Pastures of river-side villages are mostly insufficient to meet local requirements, while hill-side villages have a surplus of forage.

Meadows of the hill-side villages are differentiated into two regions: (a) the area close to dwellings where all households have equal resource use rights (b) the area away from dwellings locally called as Doksa which can be used only by small holders who assume the role of Dokpa and Tarjia. Dokpas take the milking zomos (cross breed of yak and cow) and cows, and Tarjia horses of their own and nearby villages for summer grazing (July to September) to Doksa where they stay for the entire period. In return, Dokpas traditionally are entitled to 50% of milk or milk products. Tarjias are paid in the form of grains or cash. Grazing area of cattle is isolated from that of horses. Thus, securing livelihood by Dokpa/Tarjia profession is an option available only to small holders in hill-side villages with a surplus of fodder and not to the river-side villages with relatively scarce fodder resources.

2.2.2. The study area: Spiti catchment

Spiti, a land of rugged mountains, deep gorges and sparsely distributed vegetation lies in northernmost part of Indian sub-continent between 31°42' -32°58' N latitude and 77°21' -78°35' E longitude (Figure 2.1). The Lahaul-Spiti district
Figure 2.1 Location of study area.
comprising two subdivision viz. Lahaul and Spiti occupies an area of 12,210 sq. km. The region falls in the rain shadow of great Himalayan range. Entire terrain is dry with annual rainfall of 17 cm (Aswal and Mehrotra, 1994; Kala, 2000). The vegetation of Spiti is broadly classified as dry alpine steppe (Champion and Seth, 1968).

Till late sixties Spiti region was cut off from the mainstream Indian society as there were no motorable roads or other quick means of transport. The Spitian society used to interact more with Changpas (inhabitants of Changthang region covered in Ladakh in India and Tibetan autonomous region of China), where environmental conditions are too harsh to cultivate any food crops. Some of the male members used to go to urban places in the lower hills like Shimla during winters for wage earning. With the wages earned, they used to buy rice and come back to native places before the onset of agricultural operations in the month of March. From 1980 onwards, people started getting employment opportunities in the government development projects implemented in the region. People get a quota of food items at subsidized price from public distribution system (100 kg wheat, 100 kg rice and 70 kg sugar per family per year). From 1990s onwards, government started promoting seeds of some crops such as green pea and mustard by providing 50% subsidy on the cost of seeds and storage devices. With road connectivity and changes in socio-political relations, the Spitian society and economy is getting integrated with the mainstream Indian society and economy. However, the region is difficult to access and the road connectivity remains viable only from around mid of July to mid of August with frequent blockades due to landslides. This has limited the potential of the area as a tourist destination and other developmental activities.

As described above, two contrasting village landscape were observed in the area: i) River-side villages characterized by relatively warmer climate (located at lower elevations in broad river-valleys), small size, easy accessibility by road, a high farm land: common grazing land ratio and absence of any direct interactions/exchanges with the Changpas. ii) Hill-side villages characterized by relatively cooler climate (located at higher elevations on hill-side), poorer accessibility by road, large size, a low farmland: grazing land ratio and direct exchanges/interactions with Changpas.

One river-side village viz. Lidang (3450 m asml.) and one hill-side village viz., Demul (4400 m asml) located at a distance of 12 km and 28 km, respectively
from Kaza, the headquarters of Spiti sub-division were selected for detailed studies. These villages are covered in micro-watershed of Lingti, a tributary of the Spiti river system.

The climatic year consists of three seasons viz. summer season (June-September), spring season (March-May) and winter season (October-February). In the hill-side village (4400 m) daily maximum and minimum temperature measurements during April-October, 1999 showed monthly minimum and maximum temperatures to vary between -5°C to 4°C and 8°C to 17°C, respectively.