

Land Capability Classes and Management Needs for Sustained Productivity in Semi-Arid Regions of North-West Himalayas

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Abstract: A reconnaissance survey of medium intensity was carried out in upper transect of Satluj catchment comprising an area of about 12693 sq. km in Kinnaur and Lahul-Spiti districts of Himachal Pradesh. The area was divided into different associations of land capability classes and sub-classes, and management needs for each association were suggested for sustaining the yield potential and for restoration of rapidly deteriorating ecosystem. An area of about 18,450 ha in Kinnaur and 1,46,775 ha in Spiti was found suitable for cultivation. About 21,000 ha in Kinnaur could be used for plantation of temperate fruits. The afforestation may be introduced in an area of about 90,450 ha in Kinnaur and 3,06,825 ha in Spiti area. Alpine pastures, having enormous role in hydrological functioning of the ecosystem, need to be preserved.

Increasing pressure of human and live-stock, and unplanned indiscriminate use of land and water resources of the Himalayan zone is causing concern as this slopy landscape is highly prone to soil erosion. There is also a tremendous loss of soil and plant nutrients from this mountainous transect every year. It is, thus, imperative to study the soils of this area for assessing the magnitude of erosion and suggesting scientific land use pattern. It will facilitate in sustaining the yield potential of these slopy lands on a long term basis.

MATERIAL AND METHODS

About the area: The study area (Satluj

catchment) is situated in north-eastern part of Himachal Pradesh comprising Kinnaur district and Lahul and Spiti district. It extends from latitude 31°5' to 32°5'15" N and longitude 77°45' to 75°0'35" E. It is mainly mountainous. River Satluj flows in the middle of Kinnaur crossing successively the Zaskar, the Great Himalayas and the Dhauladhar ranges. The crests of these mountain ranges lie generally under perpetual snow with many peaks rising up between 5180 and 6770 m. Spiti is cold mountain desert. The valley has a minimum altitude of 3120 m at Samdoh and maximum of 5,000 m at Kunzem La. (Fig. 1).

The climate of Kinnaur is characterised by the absence of monsoons and is sub-humid

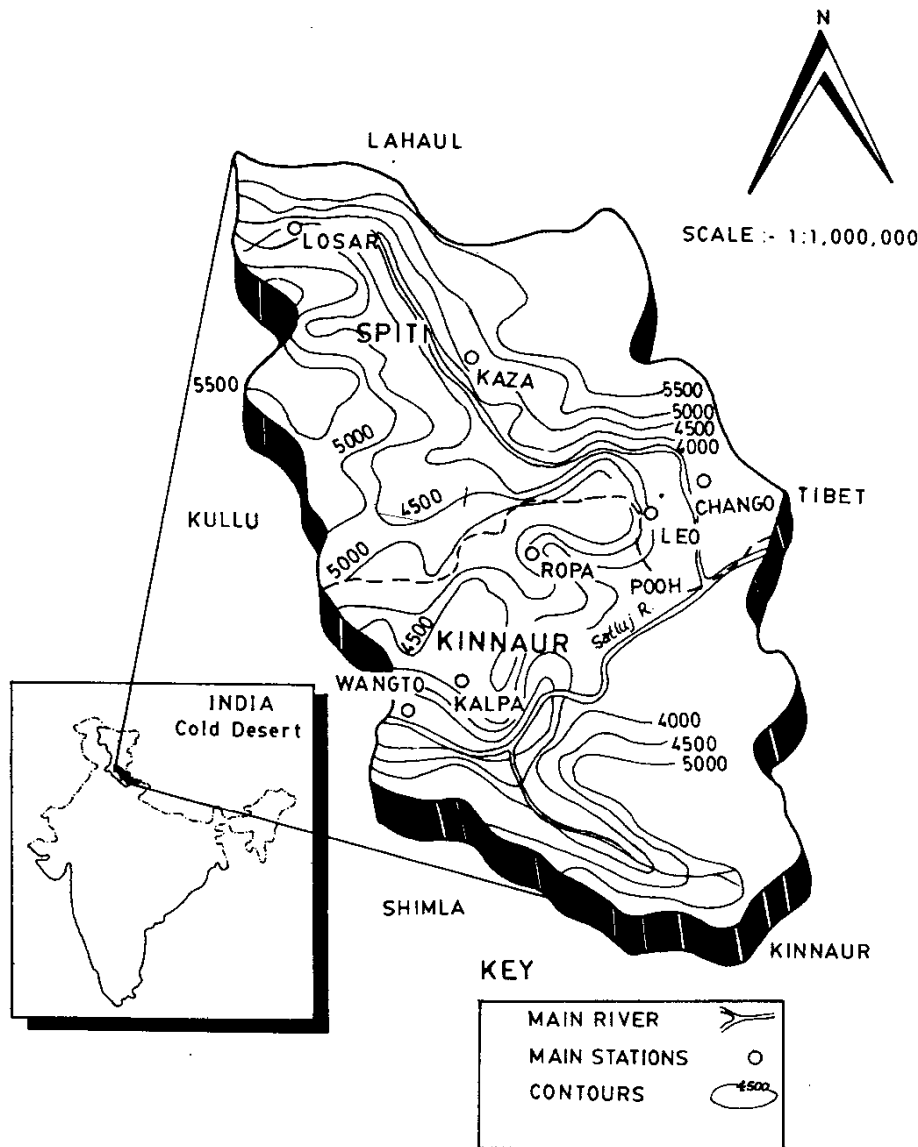


Figure 1. Mapped area in Kinnaur and Spiti showing contours.

in the lower part of Satluj valley and semi-arid to arid in further up. The average annual rainfall and snowfall in the lower part of valley are 80 cm and 137 cm, respectively. The Spiti falls in the main shadow of Himalayas, having annual rainfall and snowfall of 12 cm and 19 cm, respectively. Temperature goes down to around -20°C

during peak winter.

Geographically, it forms a part of Tethys belt and Great Himalayan range (Wadia, 1953). A complete succession of rocks from Precambrian to Cretaceous is exposed in this region. Granite, mica-schist, phyllite, gneiss and other similar metamorphic rocks

are exposed in the Southern Kinnaur.

In Spiti valley, a complete sequence of fossiliferous Paleozoic and Mesozoic is laid bare in NW-SE direction. The base of the sedimentary column in this region is formed by a thick formation comprising largely mica and talc schist and phyllites of Vaikrita system. The region is known for its fossil rich rocks.

The total geographical area of district Kinnaur (excluding some part of Nichar tehsil not within the study area) is 5,62,012 ha, of which about 45.32 and 17 per cent are under alpine, miscellaneous unculturable lands and culturable wastelands, respectively. The area under cultivation constitutes only 1.4 per cent. Fallow and grassland is about 0.3 per cent each.

The total area under 148 estates in Spiti is 1,67,805 ha, of which 69 per cent is under miscellaneous wastelands and that of 18 and 12 per cent is under alpine pastures and culturable wastelands, respectively. Area under cultivation is about 0.6 per cent of the total. The fallow lands, grasslands and forests form negligible area (Table 1).

TABLE 1. Present land use pattern (area in ha)

Land use	Kinnaur*	Spiti**
Cultivated	7871(1.40)	1068 (0.64)
Cultivable wasteland	98003(17.44)	19638(11.70)
Forest	15761(2.80)	644 (0.38)
Grassland	3753 (0.67)	496 (0.30)
Alpine pastures	254389 (45.26)	30547 (18.21)
Miscellaneous	182235 (32.43)	115412 (68.77)
Total :	562012	167805

The values in parantheses are percentages of the total area ; * Revenue records; ** Based on 148 estates.

Survey: A reconnaissance soil survey of medium intensity was carried out by following the techniques given in Soil Survey Manual (Soil Survey Staff 1962). The soil mapping was done using Survey of India toposheets in the scale of 1:50,000. Major differentiating characteristics for identification of soils were the horizon sequence and salient land features (like drainage, erosion and stony phases). Physiographic units as developed by Sharma and Singh (1991) and identified on the topographical map were as follows:

Kinnaur District

Glaciers

Alpines/Meadows (75 per cent slope)

Steep to excessively steep hill slopes (alpines).

Cliffs, escarpments (and rock outcrops)

Steep to excessively steep hills with forest cover (and rock outcrops)

Steep to excessively steep hills with pastures and bushes and rock outcrops

Steep to very steep hill slopes with chilgoza forests, cultivable wastelands and sporadic patches under cultivation.

Steep to very steep hill slopes with dense forests.

Cultivated bench terraces on steep to very steep hill slopes

River terraces

Lahul and Spiti Districts

Glaciers

Scree

Rock outcrops

Alpines on steep to excessively steep slopes

Moderately to strongly sloping cultivated lands

Old terraces of Spiti river

Keeping in view the topography and the prevailing climatic conditions, some modifications have been made in the scheme of land capability classification developed by the USDA (Soil Survey Staff 1962). In the modified scheme, the lands having 33-50 per cent slope & and very deep soils (100 cm) have been placed in class VI and earmarked exclusively for plantation of orchards. Using the assumption of Klingebiel (1958) and taking into consideration the rating criteria used by various workers (Aandahl 1958; Beek *et al.* 1964; Tejwani 1975; Bhardwaj 1979; Khybri 1979), the lands have been grouped into the associations of land capability classes and sub-classes.

RESULTS AND DISCUSSION

Owing to steep to excessively steep slopes, abundant coarse fragments, very shallow to moderately deep soils and severe to very severe erosion caused by glaciers and wind, no land was placed in capability class I and II in the catchment. A detailed description of the associations of land capability sub-classes and their suggested land uses for sustained productivity is given in table 2.

Problems, potential and management: Broadbased management needs for the associations of the sub-class IIIes-IVes, IIIe-IVe and IVes-IVes include growing of

leguminous crops and millets in rotation, application of organic manures, cultivation across the slope and remodelling of old bench terraces with inward gradient (Table 2). The lands located near natural streams can be brought under lift irrigation. Special attention needs to be paid for soil and water conservation and careful selection of crops. While coarse textured soils of upper Kinnaur and whole Spiti suffer from severe drought and wind erosion problems, especially those situated on the southern aspect, the terraced lands with shallow soils in Kinnaur area are ideally suited for growing saffron, kalazira, cabbage, chikori, hops, celery, sugarbeet, resin and grapes. However, deep soils are mostly used for growing quality fruits like apples, apricot, walnut and almond. The soils under alpine pastures above the tree line, having enormous role in hydrological functioning of the ecosystem, are highly productive and thus recommended for rotational grazing and hay making.

In soils of the associations of sub-class Vles and VIes, the main limitations are moderate to severe soil erosion by wind and glaciers, coarse texture, shallowness, high detrital content, low water holding capacity and low fertility status (Sharma & Singh 1991). However, the most serious problems of Spiti soils are the presence of hard pan (caliche) in sub-surface horizons causing impedienc in permeability, formation of scree and talus on excessively steep slopes devoid of vegetal cover, scarcity of moisture leading to drought conditions which encourages erosion hazard by wind, extremely cold conditions during winters restricting the agriculture to a single cropping season.

TABLE 2. Associations of land capability sub-classes and suggested land use

Sub-class association	Description	Area	Suggested land use
1	2	3	4
Kinnaur District			
IIles-IVes	Good to marginally cultivated and eroded soils of low moisture retentivity.	5225 (0.92)	Moderate to marginal cultivation, with careful management, orchards of temperate fruits.
IIIe-IVe	Good to marginally cultivated and eroded soils.	6475 (0.15)	--do--
IIles-IVes	Good to marginally cultivated and eroded soils of low moisture retentivity.	850 (0.15)	--do--
IVes-VIles	Association of marginally cultivated lands and lands gravelly	6225 (1.12)	Occasional cultivation, pastures or forestry on severely eroded soils.
VIIes-IVes	Association of bad lands and marginally cultivated lands comprising severely eroded and moderately deep to deep soils.	5900 (1.04)	--do--
Vles	Alpine and pasture soils, occasionally with thick forests comprising severely eroded soils.	21200 (3.78)	Orchards of temperate fruits.
Vles-VIles	Alpine pasture and forest soils, comprising severely eroded soils of low moisture retentivity.	875 (0.15)	Orchards of temperate fruits, pastures or forestry.
Vles	Mostly alpine and pasture soils comprising severely eroded and stony soils of low moisture retentivity.	89575 (15.93)	Pastures or forestry or both.
Vles-VIII	Wastelands with sparse vegetation comprising severely eroded soils of very low moisture retentivity.	113100 (20.12)	Watershed, wildlife, pastures, and forestry.
VIII-VIles	Wastelands and rocky lands with thin cover of soils having very severe limitations of soil moisture retentivity and erosion.	119100 (21.20)	--do--
VIII	Rocky lands, cliffs, escarpments and glaciers with perpetual snow cover, also includes moraines and screes.	193550 (34.44)	Watershed, recreation and wildlife.

1	2	3	4
Lahul and Spiti Districts			
IVcs	Marginally cultivated soils with limitation of severe climate and calcareousness.	22650 (3.27)	Occasional cultivation, orchards of temperate fruits.
IVes-IVcs	Marginally cultivated soils with limitations of erosion, calcareousness and severe climate.	99300 (14.33)	--do--
IVes-VIes	Marginally cultivated and cultivated wastelands with limitations of erosion, calcareousness and severe climate.	7000 (6.78)	Occasional cultivation, pastures or forestry or both.
Vles-IVcs	Cultivable wastelands and marginal soils cultivated to fruit and cereal crops, limitations of erosion, calcareousness and severe climate.	15450 (2.23)	Occasional cultivation, pastures or forestry or both.
Vles-IVes	Cultivated wastelands and marginal soils, cultivated primarily to cereal crops and sporadically to fruit crops, limitations of erosion, coarse texture, gravelliness, calcareousness and climate.	135875 (19.62)	--do--
Vles-VIs	Alpine and pasturelands, limitations of erosion, gravelliness and severe climate.	133325 (19.25)	Pastures and forestry.
VIIes-VIII	Alpine and rocky lands	23750 (3.44)	Watershed, wildlife, pastures, and forestry.
Vles-VIII	Cultivable wastelands and pasture lands, limitations of erosion, hard pan (caliche) and severe climate.	22900 (3.30)	--do--
VIII	Rocky lands with very shallow soils in patches.	90125 (13.01)	Watershed, recreation and wildlife.
VIII	Lands with screes and talus	27175 (3.92)	--do--
VIII	Glaciers with perpetual snow cover	75275 (10.86)	--do--

The values in parenthesis are percentage of the total area.

Proper management practices for Spiti soils include the plantation of adapted tree species like willows, poplar and juniper, erection of stone walls to protect crops from frost injuries through high velocity winds and growing of dwarf bushes like chir and chartta on the risers of bench terraces.

The class VIII lands are under perpetual snow, screes, rocky cliffs, escarpments, gorges and rock outcrops.

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