551.578.43 : 551.588 (235.24)

EFFECT OF MACROFLORA ON PERIGLACIAL ENVIRONMENT OF HIMALAYAS

1. A vegetative canopy or crown density affects the amount of snow reaching the ground. The biomass extending above the snowpack governs the energy exchange process. Herein, over five years of snowfall data in the similar geographical terrain has been analysed with respect to varying vegetation coverage at two stations near Kothi area (H.P.) with a view to evolve its influence on snowfall and snow-cover of the region.

2. The area around Kothi (H.P.) has experienced extensive deforestation especially in the last decade. This has adversely affected the snowfall pattern and ecological balance of the region. In this paper two areas have been so chosen around Kothi, which are almost at similar altitude (2500 m) but one station (A) has adequate vegetation and other station (B) is almost devoid of it, rather sparsely vegetated. It has been observed from the data collected and various ground reconnaisances that open patch receives more snowfall than the closely forested area. Since India is a tropical country the effect of vegetation, temperature gradient aspects and vast climatic differences present an unique feature for veritable study of snow-cover distribution.

Macroflora and avalanching terrain scenario in Indian condition can be suitably divided into two categories: one area above the tree-line and the other within the tree-line. In the present context both stations fall well within tree-line zone. Macroflora of the study area are of the type : evergreen pine, fir, oak and also of conifer varieties trees. The soil obtained herein is generally unconsolidated type. Law (1968) has also very vividly described the macroflora of Western Himalayan region including the study area. The three papers published by author (Pathak and Rao 1987, Pathak *et al.* 1986a, Pathak 1986b) cover the vegetation type and its ensuing effects on geotechnical aspects of snow-pack structure. Upadhaya (1983) also has given genesis of effect of forest-cover on snow-pack accumulation listing the studies as back as Carpenter (1901), to Reifsnyder & Lull (1965), Kuzmin (1960) & Meiman (1970). A linear increase of 0.33 inch to 0.42 inch of accumulation for 10% decrease in forest canopy has been recorded by these authors.

The type and magnitude of vegetation may give a rough estimate of snow-pack stability on ground. High value of free water content in a snow-pack caused by large positive values of heat budget is primarily due to existing vegetation (Ambach & Howorka 1962). Over five years of snowfall data has been studied and analysed for environmental parameters (Annual Reports, Snow & Avalanche Study Establishment, SASE 1981-86). Vegetation also influences wind velocity, thereby affecting erosional, transportation and depositional characteristics of the top veneer of soil.

3. *The experiment & discussion on result* — The two areas of study are so chosen that station 'A' (Solang) is fully forested and station 'B' (Kothi-Gulaba) is generally devoid of vegetation. The altitude of both the stations are around 2500 m. Both the stations are situated in Himachal Pradesh. At ground level small grass grows on both the cases. The study area is towards southern side of Pir Panjal ranges and receives snow precipitation primarily due to western disturbances (WD). The readings of over 5 years have been collected for standing snowfall and number of snowfall days monthwise. The ambient temperature, density and stratigraphy also has been recorded. The average density during stratigraphic studies and wind speed were noted at the two stations as these appreciably affect the snowfall pattern, evolution and its deposition. These data are presented at the Table 1. The terrain characteristics have been studied with a view to its geomorphological configuration and influencing to snowfall pattern. Generally the winter snowfall has been found to be more intense during Jan/Feb months every winter.

From the snowfall data of over 5 years it will be observed that the peak period of precipitation is around Jan-Feb of the year. Therefore, the period of Jan/Feb, month's snowfall data has been chosen for plot on the basis of average standing snow keeping in mind the number of days of snow-precipitation (refer Fig. 1). It is further appreciated that wind speed at station 'B' is more (around 60-70 kmph) and station 'A' is (10-20 kmph). This has pronounced effect on drifting of snow phenomenon. Therefore, even sometime the intensity of snowfall at station 'B' has been more than 'A' still the standing snow may not have been that appreciable as it might have blown off and drifted as the observatory in this case is an isolated knoll on the wind

TABLE 1

Maximum snowfall data

(No. of snowfall days given in brackets)

Year	Station	Month	Snowfall (cm)	Density (g/cc)	Wind speed Avg. (kmph)
1985-86	'A'	Feb	378 (13)	0.100	5-10
	'B'	Feb	386 (13)	0.118	30-40
1984-85	'A'	Jan	323 (12)	0.090	Do.
	'B'	Jan	340 (12)	0.110	
1983-84	'A'	Feb	267 (17)	0.085	Do.
	'B'	Feb	363 (17)	0.090	
1982-83	'A'	Feb	274 (8)	0.120	Do.
	'B'	Feb	298 (8)	0.130	
1981-82	'A'	Feb	410 (16)	0.090	Do.
	'B'	Feb	435 (16)	0.100	

A—Solang and B—Kothi (Gulaba)

Remarks : Max. wind speed at stn. 'B' goes up to 80-90 kmph

approach funnel. The following few substantial findings and observations are noted :

(*a*) Station 'B' received more snow precipitation than station 'A'.

(*b*) Wind activity markedly influence deposition of snow.

(*c*) Air in conjunction with macroflora available has been found to regulate the temperature of the snow. In this connection it is brought out that gliding phenomenon is more pronounced in Himalayan region than Swiss Alps or Colorado rocky mountainous terrain because of tropical climate and warm wet ground covered with vegetation.

(*d*) Bushes and shrubs help to anchor snow-cover but once covered generate surface avalanches. The space between branches and twigs buried in snow help air to circulate and due to equi-temperature (ET) metamorphism give rise to reduced strength grains and density making snowpack unstable. Gliding has been found more on grassy and leaves-littered south-easterly slopes.

(*e*) The lower density has been found over vegetated areas and higher at exposed terrain. This is in conformity with the European researches.

(*f*) High avalanche activity has been found more with high percentage of free water caused by large positive value of heat budget which is an outcome of densely vegetated slopes.

(*g*) Due to more snow precipitation in the exposed area (devoid of macroflora) more erosional features of the terrain is observed. The slopes also become unstable in less forested type of terrain.

(*h*) Since snow accumulation is a very complex variable of many physiographic features like elevation, slope, aspects and optical and thermal properties of the underlying materials, it is very difficult to arrive at an empirical relationship. But generally it can be said that

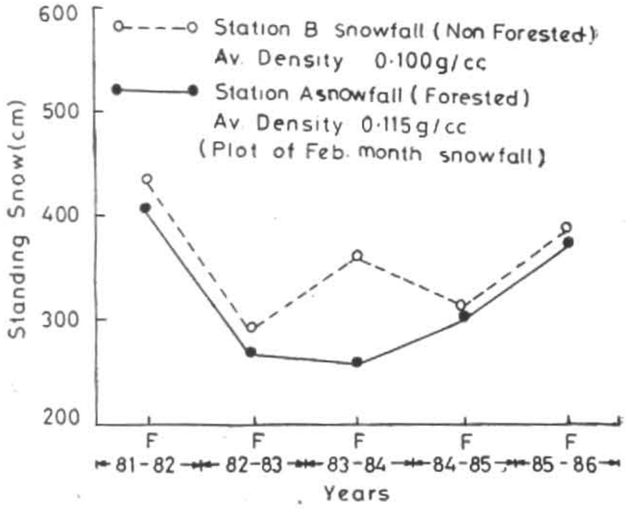

Fig. 1. Typical relation between snowfall data at two stations Solang (A) and Kothi (B) in Himachal Pradesh

mathematically, the orographic precipitation rate is predominantly related to terrain slope and windflow rather than elevation. Kuzmin (1960) reports that snow-cover water equivalents in a fir forest (WEPF) and in a clearing (WPEc) can be related to tree density (expressed as a fraction), as follows :

$$\text{WEPf} = (1 - 0.37\, p)\ \text{WEPc} \qquad (1)$$

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