

*CHAPTER VI*

CONTROLS  
OF  
GLACIAL RETREAT

## CONTROLS OF GLACIAL RETREAT

The glaciers within the Baspa valley can be classified into two groups namely 1] south facing and 2] north facing glaciers. The data generated (Table 6.1) suggests, retreat of the glaciers since the glacial maxima as demarcated from the satellite data. Careful observation of inventory reflects the role of various factors i.e., size of accumulation and ablation zone, slope of accumulation and ablation zone, nature of rock types, and amount of moraine cover on ablation zone. In addition to all these factors which are closely interrelated to each other, orientation of the glaciers also controls the percentage of retreat.

Each of these parameters is considered as separate theme and overlay analysis method of GIS is used to understand the relation amongst them. Overlay is a spatial operation which superimposes one coverage onto another coverage. Like this, we can overlay one polygon coverage onto another and can generate the information by union, intersect and identity command. This information can be saved in the form of attribute data or it can be represented in the form of map. In the present study, the information from overlay analysis is recorded as attribute data (Table 6.1) and the relation of each theme with glacial retreat is explained separately.

### VI. 1. SLOPE

The development of slope is controlled by the lithology. The layer of lithology (Fig.2.1), layer of geomorphology for each glacier and layer of slope has been considered for the overlay analysis. The results indicate that, the ablation zone fall under the category of 0-9° and at places reaches up to 18° of slope under the granitoid gneisses and quartzitic rocks. The siltstone, phyllites and slates encountered in ablation zone makes it more steep i.e., 19-35° and at places 36-45° of slope. Overall the glacier retreat is directly proportional to the slope of ablation.

### VI. 2. Mcab/Exab RATIO

The type of moraines which are derived by frost shattering, mass wasting and transported by glacier itself is also dependant on the rock types. Mostly boulder tills are found during the field work. The data generated (Table 6.1) shows a significant relation between the ratio of moraine covered ablation zone (Mcab) to exposed ablation zone (Exab). As this ratio increases the percentage of retreat of the glacier decreases and vi-s-vis. The Mcab/Exab ratio thus develops inverse relationship with percentage of retreat. There are certain case specific glaciers which does not follow this relation 1] The glacier

no. 15 as compared to 16 shows less percentage of retreat though it is devoid of moraine cover. This is mainly on account of gentle accumulation and ablation zone.

Similarly, glacier no.17, 18 and 19, in spite of having low value of  $M_{cab}/Exab$  ratio, show low percentage of retreat. The size of the ablation zone and its gentle slope may be accounted for this situation. 2] As compared to glacier no.15, the glacier no. 16 shows high percentage of retreat in spite of, high value of  $M_{cab}/Exab$  ratio. This could be on account of steep slope of ablation zone i.e.  $19-35^\circ$ . Similarly, in spite of high value of  $M_{cab}/Exab$  ratio, compared to glacier no.25, the glacier no.26 shows more percentage of retreat. This could be on account of steep slope of ablation zone.

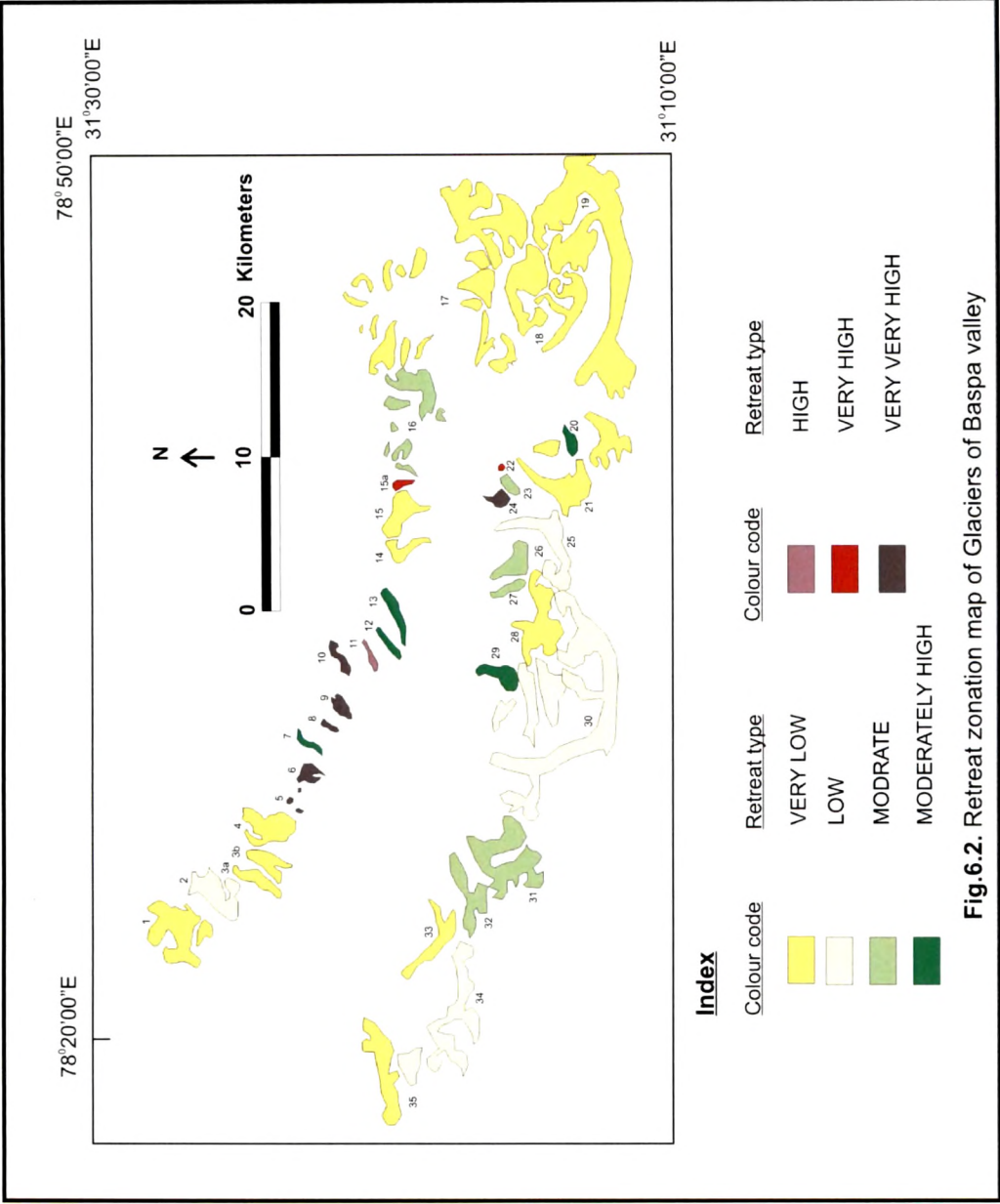
### **VI. 3. SIZE OF ACCUMULATION AND ABLATION ZONE**

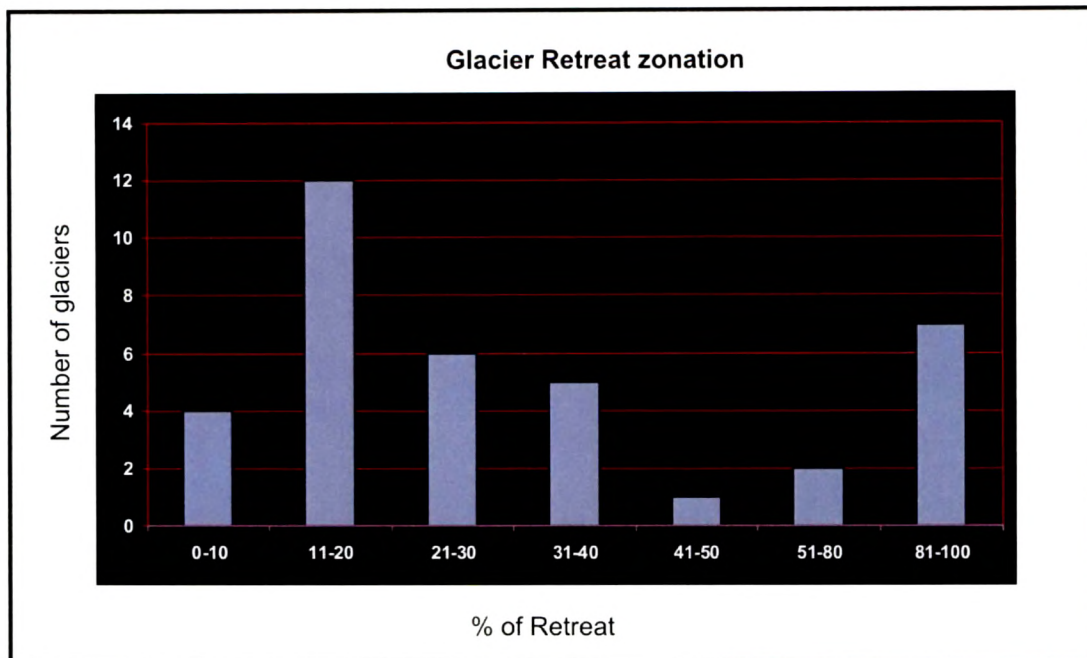
The size of accumulation and ablation zone is comparatively larger for north facing glacier than south facing glaciers. The maximum accumulation area is found in case of Jorya garang (glacier no. 30) i.e.  $23.48 \text{ km}^2$  which show very low percentage of retreat while minimum accumulation is found for glacier no.10. i.e.  $0.04 \text{ km}^2$  which exhibits very very high retreat. The maximum size of ablation zone is found in case of glacier no. 17 i.e.  $19.61 \text{ km}^2$  and shows very low percentage of retreat. The glacier no.22 shows very less area of ablation zone i.e.,  $0.12 \text{ km}^2$  resulting into very high percentage of retreat. Overall, the percentage of glacier retreat forms inverse relationship with the size of accumulation and ablation zone.

### **VI. 4. ORIENTATION OF GLACIER**

The facing direction is very important since it provides information about period of solar radiation. The south facing glaciers are exposed to solar radiation for longer time as compared to north facing glaciers. The longer time for solar radiation increases the rate of melting for south facing glacier than the north facing glacier. The subsequent information generated for 18 south facing glaciers (Table 6.1) exhibit average retreat of 33.92 % and fall under the category of moderately high retreat. The study of 17 north facing glacier (Table 6.1) exhibit 22.20% and fall under the category of moderate retreat. The overall retreat of Baspa valley is 28.6% suggesting moderate retreat.

For studying the percentage of retreat all the factors has to be taken in toto as they are interdependent. By considering theses factors the percentage of retreat is calculated from the glacial maximum limit demarcated from the satellite data. The glaciers of Baspa valley are then classified into seven zones of retreat (Table 6.2). These zones of retreat are represented in the form of bar diagram (Fig 6.1) and map with colour code (Fig. 6.2)





**Fig. 6.1.** Bar diagram of Glacial Retreat

The retreat is supported by the presence of many empty cirques, hanging valleys, horns, and aretes of different shape and size. The striations on granitoid boulders formed due to abrasion by debris laden ice on the surface of granitoid (Plate 5.7), indicates past glacial activity. Trimlines observed on the surface of valley wall incase of Jorya garang glacier (Plate 6.1 and 6.2), can be identified by the contrast of vegetation and debris cover. The trimline mark the height up to which the glacier had scoured the valley wall which indicate the thickness of glacier in the past.



**Plate 6.1.** Trimline, Jorya garang glacier



**Plate 6.2** Trimline, Jorya garang glacier

The enhanced retreating trend reveals the exposure of individual limbs of many glaciers in Baspa valley, which were initially flowing as a single glacier. This could be attributed

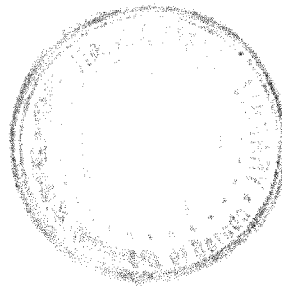
to the fragmentation process which was induced as the hanging glaciers and tributary glaciers stopped nourishing the main glacier. In case of Shaune garang glacier, the three

limbs of Shaune garang were initially flowing as a single glacier. But due to fragmentation of Shaune garang glacier after the maxima its individual limbs were exposed.

Table 6.1. Glacier inventory

Glacier No.	Slope of Accumulation	Slope of Ablation	Mcab/Exab	% of Retreat	Accumulation area	Ablation area	Retreat code
1	35-45	0-9	10.71	17	2.47	7.38	L
2	19-35	9-18	14.25	7.7	2.36	3.66	VL
3.1	19-35	9-18	1.89		0.28		L
3.2	19-36	9-18	6.24	13.19	0.4	2.1	L
4	9-18	9-18	3.56	15.04	1.54	3.88	L
5	19-35	35-45, 19-35		88.03	0.14	NIL	VH
6	--	--	EMPTY	EMPTY	EMPTY	EMPTY	VH
7	19-35, 36-45	9-18, 19-35	0.46	34	0.27	0.46	MH
8	--	--			empty		VH
9	--	--			empty		VH
10	19-35		0	92.45	0.04	NIL	VH
11	19-35	9-18, 19-35	1.48	47.78	0.54	0.55	H
12	19-35	36-45	2.5	37.76	0.12	0.49	MH
13	19-35	9-18, 0-9	2.92	38.65	0.39	1.61	MH
14	45-70	9-18, 19-35	0.74	13.76	1.14	0.74	L
15	0-9, 9-18	0-9, 9-18	0	17.33	2.33	1.58	L
15.1	0-9, 9-18	9-18, 19-35	1.91	-50.93	0.44	0.12	VH
16	19-35	19-35	20.64	27.24	1.66	5.41	M
17	35-45	0-9	0.91	18	12.69	19.61	L
18	19-35, 9-18	0-9	0.19	10.09	8.62	6.59	L
19	9-18, 0-9	0-9	0.45	12.17	17.32	17.36	L
20	9-18, 19-35	19-35	0.41	36.94	0.27	0.72	MH

Glacier No.	Slope of Accumulation	Slope of Ablation	Mcab/Exab	% of Retreat	Accumulation area	Ablation area	Retreat code
21	9-18	0-9	1.15	13.46	3.68	4.29	L
22		19-35	0.12	65.71	--	0.12	VH
23	35-45;19-35	9-18	0.19	23	0.68	0.19	M
24	EMPTY				empty		VVH
25	9-18;0-9	0-9	2.7	7.72	3.8	3.85	VL
26	19-35	35-45;19-35	5.12	22.71	1.32	1.47	M
27	35-45;19-35	19-35	0.39	29.01	0.76	0.39	M
28	0-9;9-18	19-35	1.26	12.83	5.29	4.25	L
29	9-18	9-18	1.04	32.66	1.31	1.04	MH
30	19-35;0-9	0-9	1.21	7.16	23.48	16.72	VL
31	9-18;0-9	0-9	0.32	23.33	5.75	6.40	M
32	19-35	9-18	1.33	27.77	2.52	2.87	M
33	19-35	9-18;0-9	14	14.37	0.74	3.6	L
34	19-35;9-18	0-9;9-18	1.48	9.35	3.28	9.6	VL
35	10-18;0-9	0-9;9-18	1.33	16.98	3.51	4.3	L





From the critical analysis of glacial geomorphic inventory of 35 glaciers on the basis of percentage of retreat, the glaciers of Baspa valley are classified into 7 groups.

**Table 6.2. Retreat zonation**

<b>Sr. No.</b>	<b>% of Retreat</b>	<b>Category of Retreat</b>	<b>No. of Glaciers</b>	<b>Glacier No.'s</b>
1	<10 %	Very low	4	2,25,30,34
2	11-20 %	Low	12	1,3,2,4,14,15,17,18,19,21,28,33,35
3	21-30 %	Moderate	6	16,23,26,27,31,32
4	31-40 %	Moderately high	5	7,12,13,20,29
5	41-50 %	High	1	11
6	51-80 %	Very high	2	22,15.1
7	>80 %	Very very high	7	5,10,6,8,9,24