

Characteristics of the distribution of glaciers in China

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ABSTRACT. About 80% of the glaciers in China have been inventoried. Based on the inventory and an estimate of the area that has not been inventoried, there are about 45 375 glaciers in China, with a total area of 58 735 km² and an ice volume of about 5.31×10^{12} m³. These glaciers are widespread in high mountains and in highland areas in western China, between 27°06' to 49°09' N and 71°32' to 103°54' E. The glacierized area in China comprises about 16% of the alpine glacier area in the world, and 47% of that in Asia. There are about 230 large glaciers, with areas exceeding 100 km², in the world outside Antarctica and Greenland. Among them, 65 (28%) are in Asia and 31 (13%) in China.

1. RELATIVE GLACIER AREA IN VARIOUS MOUNTAINOUS REGIONS

Table 1 gives the distribution of glaciers in various

mountainous regions in China (Fig. 1), and Table 2 provides statistics on the largest of the glaciers. Only those parts of the glaciers that lie within the territory of China are included.

Table 1. Statistics on the number of glaciers in various glacierized areas

Mountainous region (1)	Mountainous area	Highest peak	Number of glaciers	Glacierized area	Ice volume	Snowline	Relative glacier area	Mean glacier area	Glacierized ratio
	km ²	m a.s.l.		km ²	10 ⁸ m ³	m a.s.l.	%	km ²	%
Altay	28 800	4374	403	280	159	2800–3350	0.48	0.69	0.97
Tarbagatay	4400	3835	21	17	7	3310–3380	0.03	0.80	0.38
Tien Shan	211 900	7435	9128	9257	10 122	3620–4450	15.76	1.01	4.37
Pamirs (2)	23 800	7649	1823	2623	2176	4400–5860	4.47	1.44	11.10
Karakoram (3)	26 600	8611	1926	4769	6114	4900–6010	8.12	2.48	15.64
Kunlun	478 100	7167	7615	12 263	12 857	4500–6080	20.87	1.61	2.56
Altun	56 300	6295	229	266	151	4800–5360	0.45	1.16	0.47
Qilian	132 500	5827	2815	1930	935	4300–5160	3.29	0.69	1.46
Qiangtang Plateau (4)	441 900	6822	2283	3355	2739	5700–6200	5.71	1.45	0.76
Tanggula range (5)	141 300	6621	1570	2206	1264	5300–5800	3.76	1.41	1.56
Gandise range (5)	158 300	7095	2982	1615	635	5000–6200	2.75	0.54	1.02
Nyainqêntanglha range (5)	110 600	7162	3900	7536	4900	4200–5700	12.83	1.93	6.81
Himalayas (6)	202 500	8848	9000	11 000	10 000	5400–6250	18.73	1.22	5.43
Hengduan	356 300	7556	1680	1618	1070	4600–5100	2.75	0.96	0.45
Total	2 373 300	8848	45 375	58 735	53 129	2800–6250	100.00	1.29	2.47

Remarks: (1) Divided according to Chinese glacier inventory (Wang, 1988). For the transnational regions only those parts in the territory of China are accounted (the same below).

(2) Exclusive of data in the disputed area between China and former Soviet Union.

(3) Exclusive of data in source of Shiyork River.

(4) Exclusive of data in eastern tributary of Indus and source of Shiquan River.

(5) Parts are accounted by inventory, the rest are estimated on air photographic maps.

(6) Estimated on air photographic maps and Landsat images.

Table 2. Data on large glaciers in China

No	Glacier	Mountainous region	Nearest mountain peak and its altitude	Length	Area	Snowline	Altitude of glacier front	Morphological type of glacier
			m a.s.l.	km	km ²	m a.s.l.	m a.s.l.	
1	Mainbari	Himalayas	Kamit (7730)	15.0	130.00	5750	5100	Valley
2	Qiaqing	Nyainqêntanglha	6356	35.0	151.50	4510	2530	Valley
3	Jiangpu	Nyainqêntanglha	6382	21.0	132.70	4495	3160	Valley
4	Tanggulha	Tanggulha	Mt Tanggulha (6099)	17.0	188.00	5720–5740	5380–5420	Ice cap/valley
5	Jingyanggangri	Qiangtang Plateau	Jingyanggang (6136)	12.0	105.30	5340–5540	5120–5950	Small ice cap
6	Tuzegangri	Qiantang Plateau	Mt Tuzegang (6356)	21.0	127.20	5740–5940	5380–5950	Small ice cap
7	Zangsergangri	Qiangtang Plateau	Mt Zangser (6508)	29.0	191.60	5740–5940	5260–5930	Small ice cap
8	Purongangri	Qiantang Plateau	Mt Purog (6482)	30.0	263.40	5660–5820	5300–5800	Small ice cap
9	Malan	Hohxili	Mt Malan (6056)	25.0	172.80	5340–5630	4971–5204	Small ice cap
10	Chongce	Kunlun (south)	Mt Kunlun (7167)	28.7	163.06	6120	5320	Wide-terminus
11	Gongxing	Kunlun (south)	Mt Kunlun (7167)	20.5	113.80	5940	5360	Highland valley
12	Zhongfeng	Kunlun (south)	Mt Kunlun (7167)	23.4	241.00	5965	5400	Highland valley
13	Keliya	Kunlun	Mt Kunlun (7167)	12.4	119.33	6100	5500	Flat topped
14	Muztag	Kunlun	Mt Muztag (6973)		240.00	5500	5100–5350	Small ice cap
15	Yulong	Kunlun (north)	Mt Kunlun (7167)	30.9	137.07	6020	5140	Valley
16	Duofeng	Kunlun (north)	Mt Kunlun (7167)	31.0	251.70	5760	4590	Branched valley
17	Kunlun	Kunlun (north)	Mt Kunlun (7167)	23.6	200.02	5920	4882	Valley
18	W. Yulong	Kunlun (north)	Mt Kunlun (7167)	21.9	125.86	5900	5140	Valley
19	W. Kunlun	Kunlun (north)	Mt Kunlun (7167)	18.5	131.78	5900	5120	Valley
20	Yengisogat	Karakoram	Mt Kalang (7295)	42.0	379.97	5420	4000	Branched valley
21	Muztag	Karakoram	Mt of No Name (7410)	29.4	196.76	5230	4100	Turkistan valley
22	Taram Kangri	Karakoram	Mt Taramkangri (7441)	28.0	124.53	5390	4520	Turkistan valley
23	Gashelolum	Karakoram	Mt Bulod (8501)	26.0	119.80	5540	4250	Turkistan valley
24	Kyagir	Karakoram	Mt Apusalasesi (7243)	20.8	105.60	5420	4760	Turkistan valley
25	Chemurke	Pamirs	Mt Gongar (7649)	20.5	106.81	4808	3500	Valley
26	Tomur	Tien Shan	Mt Tomur (7435)	41.5	337.85	4350	2780	Turkistan valley
27	Qongterarg	Tien Shan	Mt Tomur (7435)	23.8	165.38	4300	3038	Turkistan valley
28	Tukbiniqi	Tien Shan	Mt Tomur (7435)	36.1	313.69	4200	2680	Turkistan valley
29	Wukor	Tien Shan	Mt Hantangri (6995)	32.4	184.95	4240	2790	Turkistan valley
30	Muzart	Tien Shan	Mt Xuelian (6627)	33.0	137.70	4220	2950	Turkistan valley
31	Inylchek	Tien Shan	Mt Tomur (7435)	63.5	392.84*	–	2900	Turkistan valley

* Glacier area within the territory of China only.

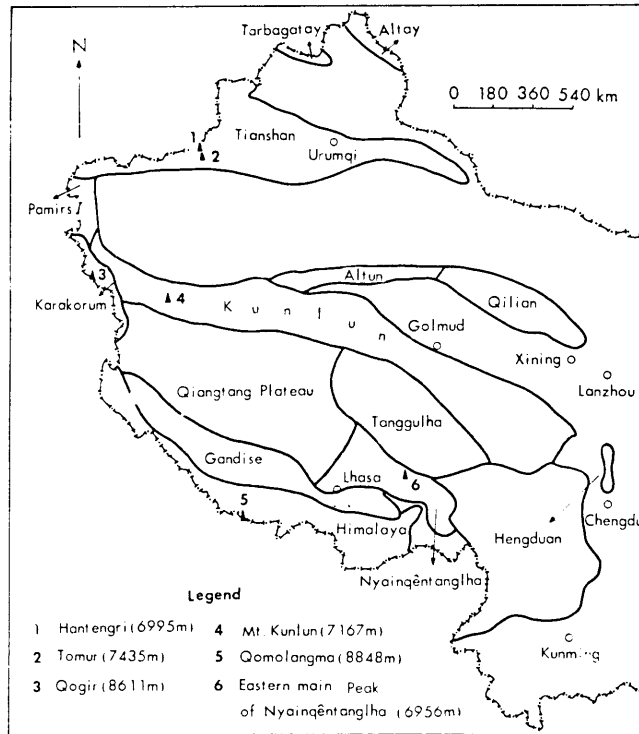


Fig. 1. Map showing the mountainous regions and main peaks in western China.

In Table 1, relative glacier area is the glacierized area in a region divided by the total glacier area in the country. This provides a comparative measure of the glacierized area in various mountain masses.

The figures in Table 1 indicate that many glaciers develop in the Kunlun mountains, the Himalayas, the Tien Shan mountains, the Nyainqentanglha range, and the Karakoram mountains. There are about 44 800 km² of glacierized area in these five mountainous regions, making up 76.3% of the glacierized area of China. Of 31 large glaciers with areas more than 100 km², 24 are located in these regions (Table 2). In these regions, furthermore, glaciers are concentrated in five large centres (Fig. 1), namely, the Mount Qogir area of the Karakoram mountains, the Mount Hantengri-Tomur area of the Tien Shan mountains, the Kunlun Peak area of the Kunlun mountains, eastern main peak area of the Nyainqentanglha range, and the Mount Qomolangma (Everest) area of the Himalayas.

In the Mount Qogir area, there is a total of 8000 km² of glacierized area, of which 2300 km² is located in the territory of China, and there are five large glaciers, including Yengisogat Glacier, the largest one in China, with a length of 42 km and an area of 379.97 km². In the Mount Hantengri-Tomur area, the glacierized area is more than 5000 km², also including five large glaciers, with an area of 2808 km² in the territory of China. In the Kunlun Peak area, there is about 4000 km² of glacierized area with nine large glaciers. Here is the largest glacier centre completely located within the territory of China. In the eastern main peak area of the Nyainqentanglha range, there is about 3700 km² of glacierized area with two large glaciers. Here is the largest maritime glacier

region in China. In the Mount Qomolangma area, the entire glacierized area is ~1976 km², of which 772 km² is within the territory of China. The total glacierized area in these five centres is 14 000 km², making up 31% of the glacierized area in the five mountainous areas mentioned above. Of 24 large glaciers developed in these five areas, 21 are located in these glacier centres.

2. MEAN GLACIER AREA IN VARIOUS MOUNTAINOUS REGIONS

Mean glacier area, which can be used as a measure of glacier scale, is the total area divided by the number of glaciers in a mountainous area. As shown in Table 1, the mean glacier area is 1.29 km² in China. There are six mountainous areas with the mean glacier areas more than 1.29 km². They are the Karakoram mountains, the Nyainqentanglha range, the Kunlun mountains, the Qiangtang Plateau, the Pamirs, and the Tanggula range. The mean glacier area is smaller in the Altay mountains, Qilian mountains and Gandise range. The distribution of mean glacierized areas is not identical with that of relative glacierized areas. For example, the relative glacierized area is 0.48% in the Altay mountains, which is much larger than the value of 0.03% in the Tarbagatay mountains, but the mean glacierized area in the Altay mountains is 0.69 km², which is close to the value of 0.8 km² in the Tarbagatay mountains. The relative glacierized area is 20.87% in the Kunlun mountains, the maximum in China, and is about 8.12% in the Karakoram mountains. However, the mean glacierized area is as large as 2.48 km² in the Karakoram mountains, which is much larger than the value of 1.61 km² in the Kunlun mountains.

3. GLACIERIZED RATIO IN VARIOUS MOUNTAINOUS REGIONS

The glacierized ratio is defined, in this paper, as the glacier area divided by the area of the mountain. This can be used to evaluate the concentration of glaciers in a mountainous area. The area of the mountains can be calculated by the following methods: when the outline of the mountain is clear and compact, as in the Altay and Tien Shan mountains, the area is bounded by the break in slope at the base of the range; when the mountains are composed of several ranges like the Himalayas, the area is calculated from the break in slope of the outermost range; when the area is in a plateau, as in the Qiangtang Plateau, the whole plateau, including some of the area of the valleys and lake basins, is included.

The mean glacierized ratio is 2.47%. There are six regions having glacierized ratios greater than 2.47%. They are the Karakoram mountains, the Pamirs, the Nyainqentanglha range, the Himalayas, the Tien Shan mountains, and the Kunlun mountains (Table 1). In the five large glacier centres mentioned above, the glacierized ratio becomes larger: 45.7% in the Mount Qogir area, 30.7% in the Hantengri-Tomur area, 19.5% in the eastern main peak area of Nyainqentanglha, and 14.1% in the Mount Qomolangma area.

Glacierized ratio is not entirely coincident with the relative glacier area. The maximum relative glacier area is in the Kunlun mountains, for example, while the maximum glacierized ratio is in the Karakoram mountains. Also, glacierized ratio does not completely coincide with mean glacier area. The minimum glacier area is in the Gandise range, while the minimum glacierized ratio is in the Tarbagatay mountains.

It is clear that one of the three indices (relative glacier area, mean glacier area, and glacierized ratio) or the glacierized area on its own account, represent only one aspect of the distribution of glacier area in a mountainous region. For instance, the relative glacier area is 8.12% in the Karakoram region, which is the fifth highest among the 14 mountainous regions in China, but the mean glacier area here is 2.48 km², and the glacierized ratio is 15.6%. Both of the latter are maximum values in China. Similarly, the total glacier area in the Karakoram mountains is not particularly large, but the glaciers themselves are large in scale, with the highest concentration of large glaciers in China.

Generally speaking, glacierized ratio is more important than relative glacier area or mean glacier area. The larger the glacierized area, for example, the higher

potential for utilization of glacier meltwater, the greater the influence on local climate, and the greater the problems caused by glacier floods and debris flows. With increasing glacierized ratio, the importance of glaciers to human activities increases in significance.

4. CONCLUSIONS

Glaciers in China are distributed inhomogeneously in and among the various mountainous areas. They are concentrated in a few mountainous regions, especially in five large glaciated centres. Analyses using the relative glacier area, mean glacier area, and glacierized ratio indices contribute to our understanding of potential for utilization of glaciers and for problems related to glaciers.

REFERENCE

- Wang Zongtai. 1988. New statistical figures and distribution feature of glaciers on the various mountains in China. *Arid Land Geography*, **11**(3), 8–14. [In Chinese with English abstract.]