The glacier outburst floods in the Yarkand River of the Karakoram Mountains an their geomorphic effects

Autor(en): **Zhang, X.S. / Xie, Z.C.**

Objekttyp: **Article**

Zeitschrift: **Ingénieurs et architectes suisses**

Band (Jahr): **116 (1990)**

Heft 18

PDF erstellt am: **02.05.2024**

Persistenter Link: https://doi.org/10.5169/seals-77307

LES CRUES EXCEPTIONNELLES ET LEURS EFFETS MORPHOLOGIQUES

THE GLACIER OUTBURST FLOODS IN THE YARKAND RIVER OF THE KARAKORAM MOUNTAINS AN THEIR GEOMORPHIC EFFECTS

X.S. ZHANG & Z.C. XIE
Lanzhou Institute of Glaciology & Geocryology Academia Sinica, Lanzhou 730000, PRC.

ABSTRACT
Large floods of the Yarkand River are usually caused by outbursts of glacier-dammed lakes. The outburst mechanism Ls assumed to be the rapid expansion of subglacial channels, probably combined with sudden-break processes within the ice of the ice dam. Kyagar Glacier on the upper reaches of the Shaksgam River and Singhi Glacier are the chief birth-places of this kind of flood. Up to the end of this century, since the global climate has become warmer, the glaciers have shrunk accordingly and become thinner, with the result that the size and dimensions of the glacier-dammed lakes and their outburst floods have diminished. Such floods are specific external agents of geomorphic development and make up many geomorphological characteristics of the Karakoram Mountains.

FLOOD DISASTERS AND THEIR CHARACTERISTICS

The Yarkand River in South Xinjiang mainly originates from the north side of Karakoram Mountains and the south of the Tarim Basin. The Yarkand River is the largest in the Kasghar region, South Xinjiang. The river supplies plenty of water and the annual normal runoff amounts to 63.75×10^8 m³. Long-term average runoff volume at the Kachun Hydrometric Station (1420, m a.s.l.) at the outlet of the lower reaches of the Yarkand river is 202 m³/s and the runoff depth is 132.6 mm (Fig. 1).
Since the establishment of the Kachun Hydrometric Station in 1953 fifteen glacier floods have happened in the Yarkand River during until 1987. Fig 2 shows the times of these floods and their peak discharge.
At 4 o'clock on 4 September 1961, the discharge increased very rapidly and steeply from the initial 806 to 6270 m³/s within the short interval of 20 minutes only at the Kachun Hydrometric Station (see Fig. 3). The corresponding hydrograph has the following characteristics: flood rising at an enormous rate, giant flood peak with sharp and single peak shape, small flood volume, short flood duration, occurrence late in the flood season and representing greater danger. With respect to meteorological conditions during the flood occurrence as well as concerning the relationship between flood volume and peak discharge, it is quite different from hydrographs of floods caused by ice and snow melt or of storm floods. Such hydrograph characteristics are typical for sudden-break-mechanisms as described by Haeberli (1983) from the Alps.

WHAT BRINGS ABOUT THE FLASH FLOOD

Flash floods can be caused by cloudburst, or else by the failure of any natural levees (glacier dams or other blocking levees formed due to some other causes such as rockfalls, landslides or mudflows) or man-made dams.

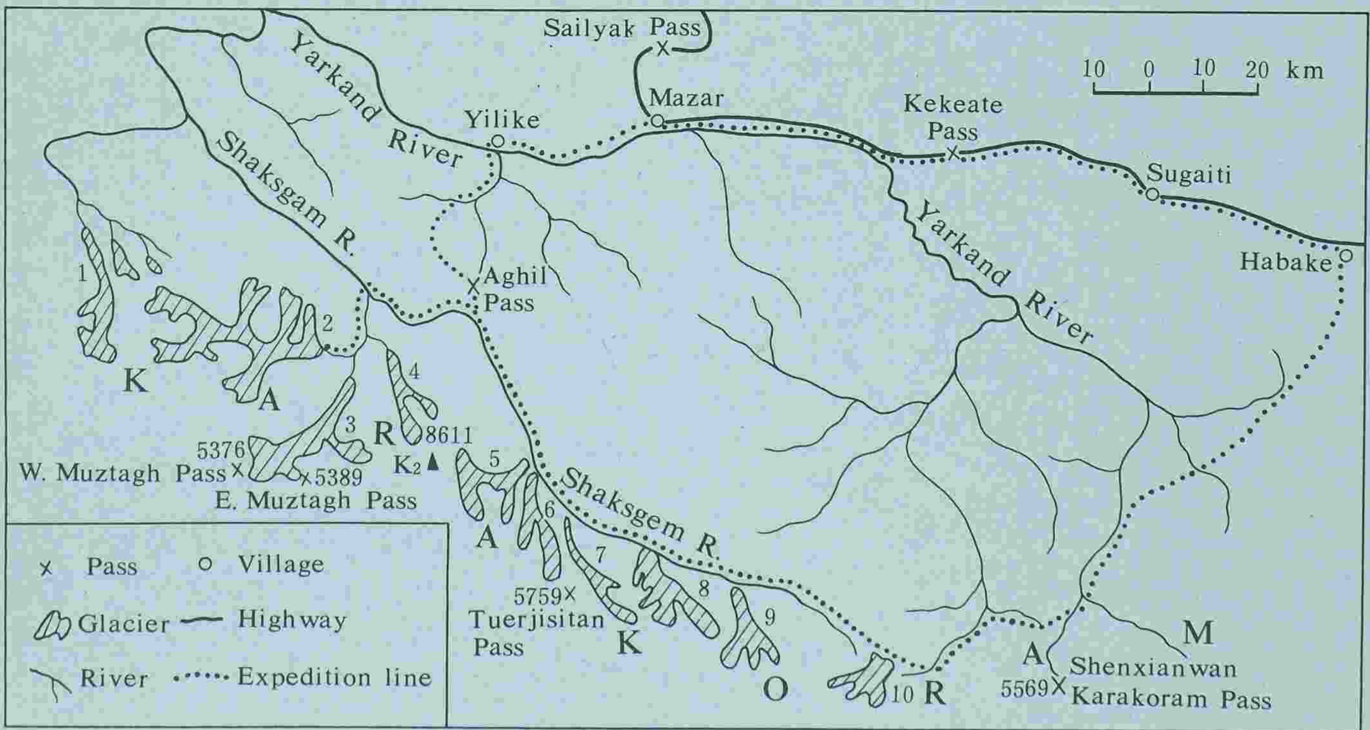

Fig. 1. The distribution of large glaciers in the Shaksgam River on the northern slope of the Karakoram Mountains. (1 – Braldu Gl., 2 – Insukati Gl., 3 – Sarpo Laggo Gl., 4 – K Gl., 5 – Gasherbrum Gl., 6 – Urdok Gl. 7 – Staghar Gl., 8 – Singhi Gl., 9 – Kyagar Gl., 10 – South Victory Pass Gl.)

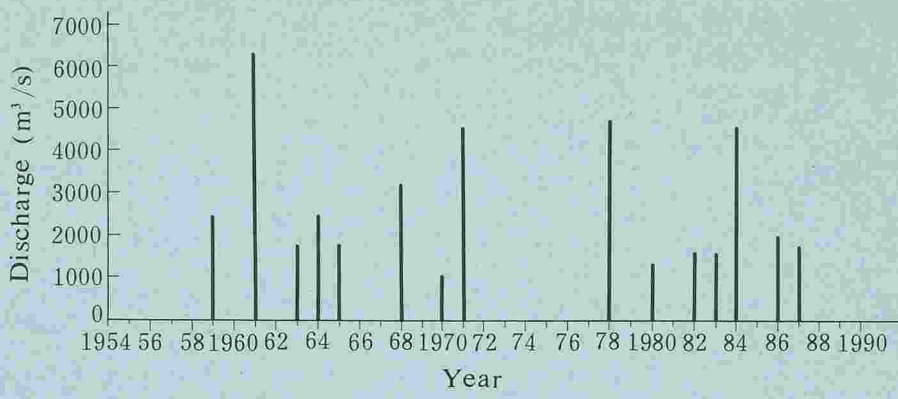

Fig. 2. Date of occurrence and peak discharge of glacier floods in the Yarkand River.

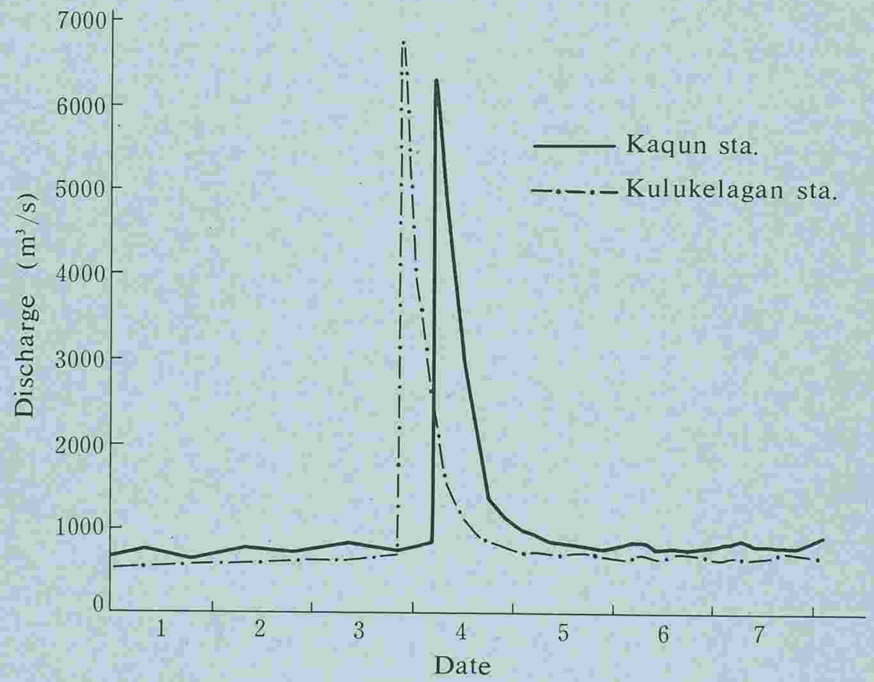

Fig. 3. Hydrographs of a glacier flood in 1961 in the Yarkand River.

Field evidence collected during three consecutive years from 1985 to 1987 proved that the cause of the flood disaster in the Yarkand River Basin was the sudden drainage of lakes impounded by the Kyagar and Singhi Glaciers in the upper reaches of the Shaksgam River. Other causes of the flash flood can essentially be ruled out. The floods that happened many times in the past all come from the Shaksgam River but have nothing to do with the main stream of the Yarkand River, nor with its western tributary, the Taxkorgan River.

RELATION BETWEEN GLACIER FLOODS AND GLACIER FLUCTUATIONS

The Shaksgam River is a longitudinal valley whose direction is roughly parallel to the main ridge of the Karakoram Mountains. Therefore, the glaciers originating from the north side of the main ridge of the Karakoram Mountains are all broadwise. The advance of the glaciers blocks up the main valley and ice-dammed lakes form accordingly. The recession of the glaciers or the local destruction of the ice brings about the lake outburst floods. Therefore, fluctuations of the glacier termini directly influence the formation and deStruction of the ice-dammed lakes. In the upper reach of the Shaksgam River, there are five gigantic glaciers which are very likely to block up the main valley to form ice-dammed lakes. Some features of those glaciers are shown in Table 1.

By studying the change of these glaciers and comparing the scientific literature and pictures at different stages we find the following: Since the 1920s, Kyagar glacier has moved forward at least twice. The first advance was in the 1920s (Mason, 1927, Desio, 1930). The second was in the 1970s as documented by aerial photography taken in 1976, the topographic map from air survey in 1978 and landsat images. Kyagar Glacier which has moved forward twice as far has blocked up the Shaksgam valley. This resulted in blocking of Kyagar Glacier lake which has brought about a lot of flood disasters. This development is comparable to floods caused by glaciers in the Upper Shyok River and on the sout slope of the Karakoram Mountains.

Table 1 Some features of glaciers in the upper Shaksgam River basin

Glacier	Length (km)	Area (km^2)	Altitude of lowest point	Equilibrium line altitude
Kyagar	22	105.6	4700	5400
Singhi	24	124.5	4550	5400
Staghar	24	83.5	4430	5200
Urdok	23	97.6	4370	5350
Gasherbrum	20	119.8	4350	5350

ICE-DAMMED LAKE DRAINAGE AT KYAGAR GLACIER

Field reconnaissance in 1985 and 1987 indicated that the Kyagar Glacier lake may have emptied by rapid expansion of subglacial channels. After the flood, the inlet and outlet of the subglacial channel in the still existing ice dam could be clearly seen. The characteristics of the observed flood hydrographs, however, point to the importance of sudden-rupture mechanisms which must have accompanied the progressive expansion of channels (cf. Haeberli 1983). Not long after the outburst, the inlet and outlet were blocked up again because of plastic deformation and collapse of the ice overburden. The outburst mechanism is entirely different from that of moraine-dammed lakes in the Himalayas. Those moraine-dammed lakes discharge water rapidly due to the erosion of the terminal moraine dams (Vuichard and Zimmermann, 1986). Lake drainage at Kyagar Glacier also appears to be quite quite different from phenomena observed at Grimsvötn of Vatnajökull Ice Cap in Iceland (Thorarinsson, 1954).

FORECASTING TRENDS OF GLACIER FLOOD UAZARD

With global climate becoming warmer and glacier mass losses continuing, glacier length changes at time scales of 10 to 10 years will tend to be negative (recession). In addition, the mlnor advance at the decadal tlme scale in the second half of the 20th century has just passed. It therefore appears safe to assume that the advance climax of Kyagar and Singhi Glaciers has passed and that these glaciers will now begin to become thinner and to recede. With a certain delay, the glacier tongues may also react to the reduction of monsoon precipitation - a 100-year minimum - during the 1960s and 1970s. Because the volumes of ice-dammed lakes are related to the volumes of the blocking glacier tongues and peak discharge is related to lake volume, flood magnitude can be assumed to become smaller in the foreseeable future. However, floods of lower magnitude will probably happen again, perhaps even more frequently than ever before.

GEOMORPHOLOGICAL EFFECTS OF THE GLACIER FLOODS

Since the last Ice Age, glacier floods in the Yarkand River have occurred repeatedly Such floods make up many geomorphological characteristics of the Karakoram Mountains. Tempestuous floods dash against terminal moraines and wash them away in the Shaksgam Valley. Therefore, the Shaksgam Valley is short of terminal moraines. Subglacial channels at glacier margins eroded bedrock for a long time and formed or are still forming numerous cut-offs of meander spurs. Strand-lines of the glacier-dammed lakes formed at different periods have engendered on the slopes of the Shaksgam Valley near the termini of the Kyagar and Singhi Glaciers. At the former, for example, from the highest water level to the bottom of the valley (vertical distance = 74.5 m) there are 134 marks of water lines. A large number of water lines from old lakes not only reflect the history of the repeated formation and disappearance of former ice-dammed lakes but also indirectly prove the frequent changes of the glaciers which sometimes move forward and at other times recede and - thereby - change the height of the ice dams.

REFERENCES

Desio, A. (1930). Geological work of the Italian Expedition to the Karakoram. *Geogr. J. 75* (5), 402-411.

Haeberli, W. (1983). Frequency and characteristics of glacier floods in the Swiss Alps. *Ann. Glaciology 4*, p. 85-90.

Mason, K. (1927). The Shaksgam Valley and Aghil Range. *Geogr. J. 69* (4), 289-332.

Thorarinsson, S. (1953). Some new aspects of the Grimsvötn problem. *J. Glaciol. 2* (14), 267-275.

Vuichard, D. and Zimmermann, M. (1986). The Langmoche flash-flood. Khumbu Himal, Nepal. *Mountain Res. and Development. 6* (1), 90-94.