THE CONTRIBUTION OF GLACIER MELT TO RIVER DISCHARGE IN AN ARID REGION

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INTRODUCTION

Cities in oases surrounding the southern Taklamakan Desert derive their water supply from rivers which originate in the West Kunlun Mountains, where there are many glaciers in alpine regions. Recently, it is feared that the desert area might extend with the retreat of glaciers due to global warming and the consequent decrease of river flow caused by it. This study deals with the contribution of glaciermelt to river discharge in two rivers originating in the West Kunlun Mountains, based on the water budget in the basins.

STUDY BASINS AND DATA

Study Basins

The study basins are the Yurungkax river basin (14,575km^2) and the Keriya river basin(7,358km^2).The Yurungkax river basin has an average height of 4,750m, and has elevations ranging from 1,650 to 7,000m. Similarly, for the Keriya river basin, the height ranges from 1,880 to 6,500m, the average being 4,878m. There are many glaciers in the alpine regions, above 5,000m, of the both basins. The glacier areas of the Yurungkax river basin and the Keriya river basin are 20% and 9.26% of the basin areas respectively. Maps of the basins are shown in Figs. 1 and 2.

Data

No systematic data have been collected in the alpine regions of both the basins. Records of 34 or 35 years, of the hydrological and meteorological variables observed at the outlet of the basins and discharge, precipitation, air temperature and evaporation, and few meteorological elements from the stations surrounding the basins were available.

METHOD

Taking into account glaciermelt runoff and neglecting the mass balance of glaciers, the water budget equation of the basins can be written as (Ujihashi et al. 1995) follows.

$$Ps + Gm - Es - Q = f¢S \quad (1)$$

where Ps, Gm, Es, Q and f¢S are the precipitation on soil surface (non-glacier area), the glacier melt runoff, the evaporation from the soil surface, the outflow from basin outlet, and the increment of storage respectively. Gm can be determined as the rest term in (1), when the other terms are estimated or observed. Dividing the entire basins into 10 or 11 zones, with elevations of 500m intervals and the spatial distribution of evaporation and precipitation were determined using the following simple relationships, (Ujihashi et al. 1995).

$$Pz=0.09(Z - 1300)+28 \quad (2)$$

$$Pzij = r1(1+r2)P0j , \quad r1=Pz/P0m , \quad r2=Cr(P0i/P0m - 1) \quad (3)$$

Where Pzij is the precipitation in the zone at an elevation of zn in the j-th month and i-th ear; Pz is the precipitation in the zone at an elevation of zm; POm is the mean annual precipitation at a standard station; POi is the precipitation at the station in the i-th year; and z is the elevation.

$$Ez=C¥Ep , \quad C=1-exp(-a¥Pr) \quad (4)$$

$$Ep=8.70Tz+31.4 \text{ (Yurungkax river)}, \quad Ep=8.70Tz+31.4 \text{ (Keriya river)} \quad (5)$$

Where Ez is the evaporation in the zone at an elevation of zm; Ep is the evaporation from a pan; a is a constant value (=0.0061); Tz is the monthly mean air temperature at an elevation of zm; and Pr is the monthly precipitation in the zone. fαs is neglected because it is small.

RESULTS

The glaciermelt runoff estimated as the rest term in (1), the outflow from basin outlet, and the ratio of the glaciermelt to the total discharge are shown in Fig. 3 for Yurungkax river and Fig.4 for Keriya river. In the case of the Yurungkax river basin, the ratio ranges from 30% to 80% with an average of about 50%, with a few extraordinary values. In Keriya river, the ratio shows a wide range with the average value of about 43%. These results show that the role of glaciermelt is very important in hydrological processes in arid regions.

REFERENCES

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Ujihashi, Y. et al. 1995 'Hydrological Study on the Contribution of Glaciermelt to River Discharges in the Taklamakan Desert, China' (In Japanese). In Nkawo (ed), *Study on the History of Desert Formations Using Ice Cores Analysis* (pp156-166). Nagoya: Institute for Hydrolspheric - Atomospheric Sciences, Nagoya University.

Figure 1. Map of the Yurungkax river basin

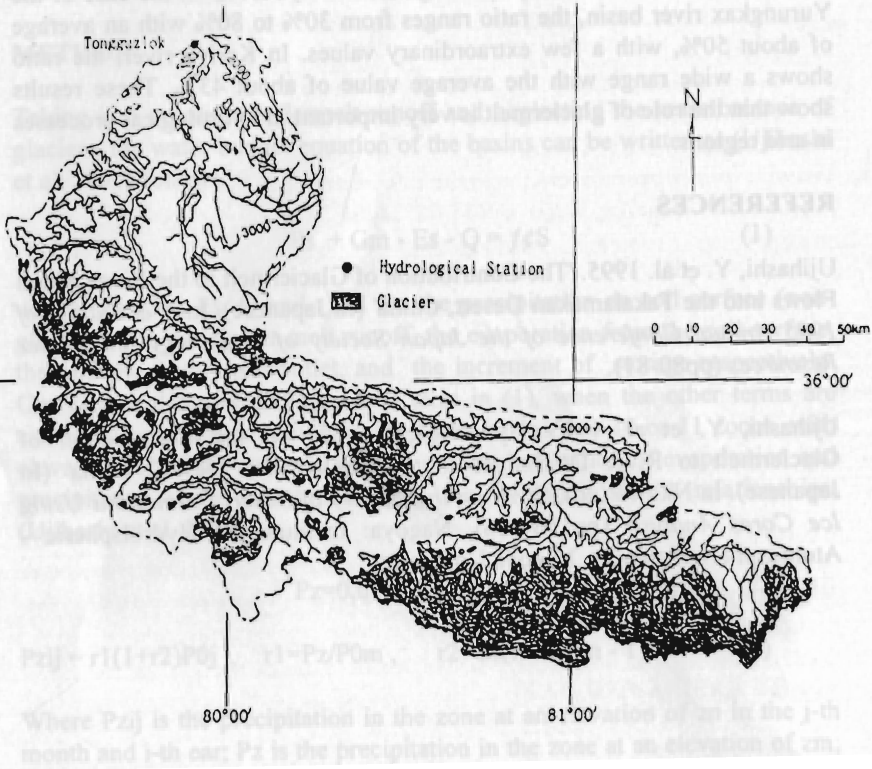

Figure 2. Map of the Keriya river basin

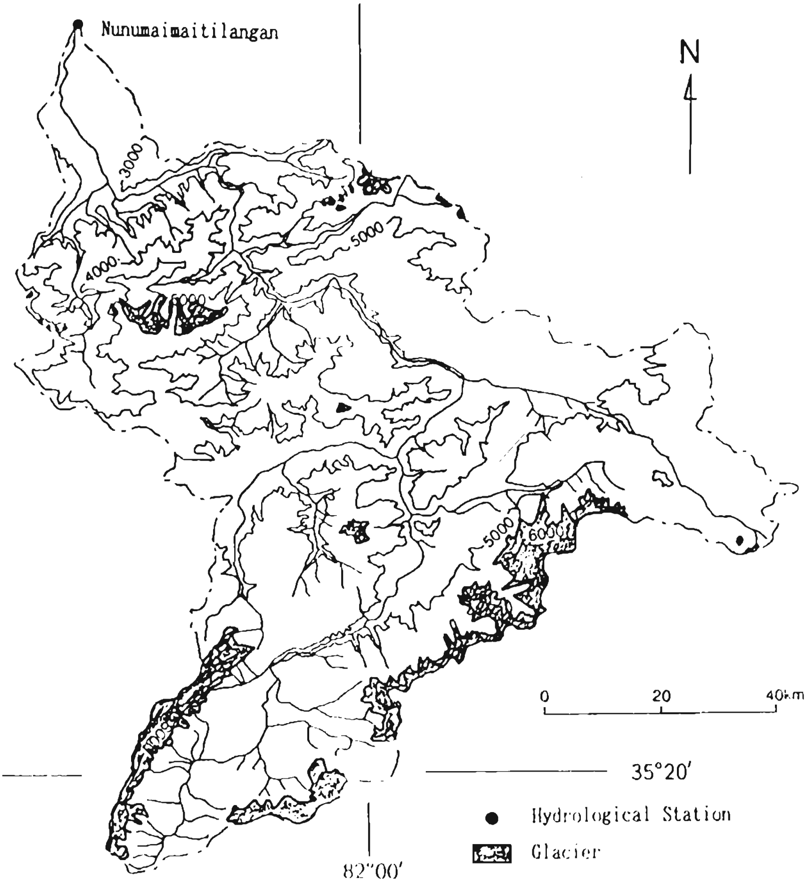

Figure 3. The time variation of glaciermelt,river discharge and the ratio of glaciermelt to river discharge in Yurungkax river basin

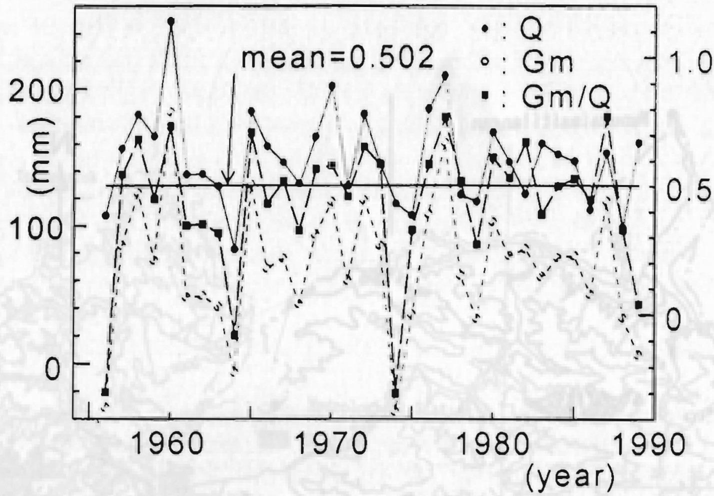

Figure 4. The time variation of glaciermelt, river discharge and the ratio of glaciermelt to river discharge in the Keriya river basin