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Remote-sensing based analysis of glacier lake hazards in the Tien Shan mountains associated with recent glacier shrinkage

C. Narama (1, 2), A. Kääb (2), I. Severskiy (3), K. Abdrakhmatov (4)

(1) Research Institute for Humanity and Nature, Kyoto, Japan, (2) Department of Geosciences, University of Oslo, Norway, (3) Institute of Geography, Almaty, (4) Institute of Seismology, Kyrgyz Academy of Science, Bishkek, (narama@chikyu.ac.jp / Phone: +81-75-707-2398)

Pronounced glacier shrinkage in the Tien Shan mountains of central Asia was found for the last 30 years by comparing Corona satellite photographs from 1968–1971 and Landsat 7 ETM+ satellite images from 1999–2002. We also investigated the distribution of glacial lakes in the Tien Shan mountains using the same satellite data. It turns out, that most glacial lakes have developed from glacial melt-water pooling inside a terminal moraine, although a few glacial lakes were observed on debris-covered dead ice zones in front of glaciers, similar to supra-glacial lakes in the southern Himalayas. The number of ice-contact glacial lakes, which have a particular probability for glacial lake outburst floods (GLOF) was analyzed using the satellite data. The appearance of these glacial lakes differed in the Tien Shan mountains in connection with recent glacier shrinkage in each of the mountain ranges investigated. In the Corona images, the number of ice-contact glacial lakes was almost the same as in Landsat images. However, most glacier lakes in the Corona images disappeared or remained at the same location, though present glaciers have retreated significantly upstream as seen from the recent Landsat images. Such development is not similar to glacial lakes in the Himalayas where many lakes have expanded continuously with glacier shrinkage. Currently, new glacial lakes have developed having a similar size compared to the 1960s, and threats from GLOFs appear, thus, to be a crucial problem in the Tien Shan for the recent decade.