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Glacier recession in the Upper Rhine river catchment between 1850 and 2000

R. Frauenfelder

Department of Geography, University of Zürich, Switzerland / currently at: Department of Geosciences, University of Oslo, Norway

Glacier recession in the Upper Rhine river catchment was analysed for the period between the end of the 'Little Ice Age' (around 1850) and 'today' (2000) in the course of an assignment of the Swiss Federal Office for Water and Geology. Glacier area changes and glacier volume changes were assessed and analysed using three existing glacier inventories dating from 1850 (based on glacier reconstructions), 1973 (based on analyses of aerial photography) and 2000 (based on analyses of satellite imagery).

At the beginning of the observation period, i.e. around 1850, 121 individual glaciers were mapped in the study area. In 2000, 86 individual glaciers were inventoried. Of these 86 glaciers 74 (or 85%) were smaller than 0.5 km2. This value is slightly higher than in the entire Alps (Switzerland, Austria, France, Italy) were 82% of the glaciers are smaller than 0.5 km2. The total glacier coverage of the study area in the year 1850 was 68.5 km2. In the year 2000 it was 21 km2 or 2.7%. Total loss in glacier area between 1850 and 2000 amounted to 47.5 km2 (-69.4% as compared to the area in 1850). A large influence of the high number of small glaciers can be seen when glacier loss is analysed in the 13 glacier regions (individual hydrological sub-catchments) of the study area: The highest percental area loss ($>$ 80%, as compared to a mean of 69%) is found in glacier regions that were characterised by a large number of small individual glaciers already in 1850. Depending on the calculation method, the total volume loss between 1850 and 2000 amounts to 1.3 to 1.36 km2 (-72.6 to -76% as compared to the volume in 1850). The amount of water released by this ice volume loss corresponds to 1.16 km3 water equivalent. This is c. 111% of the annual water runoff measured at a valley gauging station at the Upper Rhine at the border of the study area. The melt water discharge caused by the glacier recession in the period between 1850 and 2000 contributed max. 1% to the existing mean annual runoff due to precipitation and

snowmelt. These numbers should not conceal, however, that the influence of glacier meltwater discharge increases with decreasing distance of the brooks to the glaciers and that the meltwater discharge from glaciers can be much higher in very dry hot summers as e.g. during the summer of 2003. Especially in dry inner-alpine valleys, the seasonal influence of meltwater discharge due to glacier recession can be much more important than one might infer from the pure consideration of mean annual values.