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Tracer-based runoff modelling in a glacierized alpine catchment

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Water budget of high elevation catchments is dominated by snow and glacier runoff contributions. However, climate change is rapidly affecting such processes and many areas are experiencing an increasing human pressure on water resources. Therefore, it is crucial to develop reliable methods to quantify the partitioning of rainfall, snow and ice melt contribution to runoff.

This study focuses on the identification of the sources of stream runoff in a glacierized catchment in the Eastern Italian Alps by means of isotopic (δ^{18}O) and electrical conductivity data. The information is then used for the parameterization of the distributed hydrological model GEOtop 1.2, applied implementing different model scenarios.

Field work and modelling activities were carried out for the Saldur basin (South Tyrol, 62 km^2 drainage area). Catchment elevations range between 900 and 3700 m a.s.l., and the main glacier is located between 2700 and 3700 m a.s.l. (3.3 km^2 glacier extent). Water stage was continuously recorded at two cross sections at 2150 m a.s.l. (20 km^2 drainage area) and at 2350 m a.s.l. (11 km^2 drainage area). Additionally, discharge measurements (by salt dilution method) were carried out to build up the flow rating curves.

From late spring to early fall 2011, two sampling approaches were adopted to measure the spatial and temporal variability of tracer concentration:

(1) monthly or twice a month water samples were manually taken in the Saldur stream and in its tributaries at different sections ranging from 1800 m to 2400 m a.s.l., and also in some spring sources considered as possible end-members.

(2) hourly water samples over 24 hours were taken simultaneously at different stream sections, tributaries and spring sources during two glacier melt- and snowmelt-induced flood events in mid-July and mid-August.

Tracer results confirm a great contribution of snow and ice melt to runoff during warmer days, while the influence of groundwater increased during colder days. Isotope data for two daily melting cycles in mid-July and mid-August 2011 highlight different snow and ice melt contributions to river runoff, reflecting the reduced extent of snow cover in the basin during the later period.

Based on this information, for both sub-catchments, GEOtop model was run. Input data contained a digital elevation model, land cover data, and the current glacier extent. Meteorological data was provided by a weather station managed by the European Academy of Bozen/Bolzano (EURAC). In order to isolate the contribution of snow- versus ice-related runoff, model scenarios were prepared with different initial model conditions (i.e. snow cover and ice cover extent).

Model results thus provided an independent estimation of the different water sources and offered a conceptual framework for isotopic observations.