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What is the monthly share of mountain water in lowland water abstractions?

Sarah Hanus[1], Peter Burek[2], Mikhail Smilovic[2], Jan Seibert[1], and Daniel Viviroli[1]
[1]University of Zurich, Geography, Switzerland (sarah.hanus@geo.uzh.ch)
[2]International Institute for Applied Systems Analysis, Austria

Mountainous areas play a crucial role in global water resources. Orographic precipitation provides mountains with disproportionately high precipitation, which can be stored seasonally or over many years as snow and ice. Therefore, mountains are often referred to as 'water towers', emphasising their vital contribution to water provision for human use. Nevertheless, on a global scale, knowledge about their relevance for lowlands is limited, especially beyond long-term annual averages (Viviroli et al., 2020). Therefore, this study aimed to first assess differences in the water supply of mountains and lowlands in large river basins globally. Second, the share of mountain runoff in lowland water abstractions was evaluated with a focus on monthly averages and intra- and interannual variability to identify hotspots of mountain importance.

Our study is based on global simulations of the large-scale hydrological model CWatM (Burek et al., 2020) at a resolution of 5arcmin (~10km) from 1990 to 2019. The model simulates water availability, water demand and water use. A glacier representation was added to depict mountain water resources more realistically (Hanus et al., submitted). We compared water availability and demand in mountain and lowland areas within each river basin to identify the distinct patterns regarding water quantity, seasonality and interannual variability in mountains. Additionally, we derived the share of mountain runoff in lowland surface water abstractions to explore the relevance of mountains for human water use.

The analysis of around 600 river basins globally confirmed that precipitation and runoff are disproportionally higher in mountain areas in most river basins, whereas water demand is comparatively low. Additionally, we found mostly a larger intra-annual variability and lower interannual variability in mountain runoff compared to lowland runoff.

The estimated share of mountain runoff in lowland surface water abstractions is largest in High Mountain Asia, western North America, parts of South America and Southern Europe. In 250 basins, the maximum monthly relative mountain runoff share in lowland surface water abstractions exceeds 10%, and 25% of the world population lives in the lowlands of these basins. In comparison, only 7% of the world's population lives in lowlands of basins where the long-term mean annual share of mountain runoff in lowland surface water abstractions exceeds 10%. Thus, the relevance of mountains for lowland water supply becomes more apparent when distinguishing between different months compared to long-term annual averages.

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