

From dwindling ice to headwater lakes: Could dams replace glaciers in the European Alps?

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Environments significantly influenced by the presence of seasonal snow or glaciers are hotspots regarding the impacts on water availability in response to expected climate change. With warmer temperatures, both the duration and the spatial extent of the seasonal snow cover are projected to decrease, and glaciers are expected to retreat substantially. This is anticipated to have important influences on water availability, including changes in the seasonality of runoff, as well as an overall reduction in water yields from high-mountain catchments.

Here we present an estimate for the potential of mitigating projected changes in seasonal water availability from melting glaciers by managing runoff through reservoirs. We compute the water volume that, in future, is expected to be in excess during winter and spring time, and transfer it seasonally through temporary storage in order to mitigate the water deficits during summer. Projections for future runoff evolution are retrieved from the glacier evolution model GloGEM, forced with ensembles of temperature and precipitation time series derived within CIMIP5.

For the European Alps we estimate that by the end of the century, about 1 km^3 of water from presently glacierized surfaces could be seasonally reallocated in order to mitigate expected changes. On average, the strategy could offset up to 25 % of the changes in summer runoff from presently glacierized surfaces. A first order approach suggests, moreover, that the retention volume potentially available in the areas becoming deglaciated is in excess of the volume required for achieving the maximal possible mitigation by more than one order of magnitude.

Obviously, the proposed strategy cannot compensate for the reduction in annual runoff caused by glacier ice depletion. Our estimates indicate that by 2070-2099, $0.73 \pm 0.67 \text{ km}^3 \text{ a}^{-1}$ of this non-renewable component of the water cycle could be missing in Alpine water supplies.