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Potential of multi-purpose reservoirs for the reduction of water scarcity: A multi-modular assessment framework.

Manuela Irene Brunner (1,2,3), Jürg Speerli (4), Astrid Björnsen-Gurung (1), Susanne Kytzia (4), Sara Bieler (4), Sandra Volken (4), and Manfred Stähli (1)

(1) Eidg. Forschungsanstalt WSL, Birmensdorf ZH, Switzerland, (2) Université Grenoble-Alpes, CNRS, IRD, IGE, Grenoble INP, Grenoble, France, (3) Department of Geography, University of Zurich, Zurich, Switzerland , (4) Institut für Bau und Umwelt, HSR Hochschule für Technik Rapperswil, Rapperswil SG, Switzerland

Natural water storage facilities, such as snow cover and glaciers, greatly influence the runoff regime of rivers in mountainous regions by shifting high discharges from winter to summer. The capacity of these natural storage facilities is reduced under future climate conditions since a rise in temperature enhances both snow and glacier melt while precipitation will shift from snow to rain. This leads to a change in runoff regimes from snow dominated towards rainfall dominated regimes. Under a rainfall dominated regime, summer runoff will be reduced while more frequent droughts increase the probability of local water shortages. Reservoirs might alleviate the negative effects of such regime shifts if they are not limited to a single use, such as electricity production, but operated to fulfill multiple needs, e.g. water supply or flood control. Such multi-purpose reservoirs allow for the storage of winter rainfall and for water release later in the year when the natural water availability is generally lower and water demand is high not least due to irrigation requirements. The potential of such reservoirs for reducing seasonal or local water shortages in an Alpine context has not yet been investigated. We therefore propose a multi-modular framework that allows for the assessment of the potential of multi-purpose reservoirs for reducing anticipated water scarcity. The framework consists of three modules: water supply, water storage, and water demand. This modular structure allows for the consideration of different scenarios within each of the modules. It can take into account changes in water supply due to climate change, the availability of existing and new natural and artificial storage facilities, and developments in future water demand. The framework is applied in several exemplary study regions in Switzerland that might be affected e.g. by changes in water supply due to climate change, changes in storage facilities due to new glacial lakes, or changes in water demand due to population growth. The application of this framework allows for the assessment of the potential of multi-purpose reservoirs to alleviate water scarcity both under current and future climate and socioeconomic conditions.