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Water-Energy-Climate Nexus: Does glacier shrinkage matter?

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The relation between energy supply and demand, water availability and climate change provide an essential framework when dealing with the use of Variable Renewable Energies (VREs), such as hydropower, solar power and wind power. VREs integration into electricity network is driven by temporal and spatial variability of climate variables (e.g. temperature, precipitation, and solar radiation). By using the complementarity among VREs, VRE excessive variability can be reduced and thus can facilitate its integration. Many studies looked at how VRE complementarity within the climate change in water-energy-climate nexus. However, the effect of glacier shrinkage has been overlooked. Since glacier areas are sensitive to changes in climate, their contribution to hydropower generation and overall energy balance is expected to change in term of both average and timing.

The objective of this study is to analyze the effect of glacier shrinkage on electric energy balance, which is focused on power generation from Run-of-river (RoR) hydropower and solar photovoltaic (PV) in two glacierized catchments located in the Central Italian Alps (Mazia and Giveretto, located in South Tyrol). In this study, we used the most plausible future energy mixes for this area, which is 25% of solar PV and 75% of RoR hydropower.

We explored three different glacier coverage scenarios based on RCMs from recent work in the area experiment (Gobiet et al., 2014). For analyzing the effect of climate change and glacier shrinkage on the considered water-energy-climate nexus, we applied Decision Scaling (DS) framework (Brown et al., 2012). DS provides Climate Response Functions (CRF) that inform about sensitivity of the system based on the climate drivers. In this study, CRF is two-dimensional climate change space with change in temperature and precipitation.

Two main results are obtained from DS analysis framework. First is the mean of regional response (e.g. average hydropower generation or any other indicator of the energy balance) along the change of climate drivers. Second is the empirical probabilities of the future system states that are estimated from the future evolutions of climate variables that drive system performance as predicted at the regional scale by GCM experiments.

The results show that glacier shrinkage has significant impact on penetration rate of the considered energy mix. The energy penetration is expected to increase (mainly based on an increase of hydropower generation that results from a decrease in river flow seasonality). The expected change in energy penetration is also found to be more uncertain when glacier shrinkage is included as a part of the water-climate-energy nexus; as a result of weaker snowpack and glacier contribution to river flows that lead to an increased influence of precipitation variability.

Brown, C., Ghile, Y., Laverty, M. and Li, K. (2012) 'Decision scaling: Linking bottom-up vulnerability analysis with climate projections in the water sector', Water Resources Research, 48(9). doi: 10.1029/2011WR011212.

Gobiet, A., Kotlarski, S., Beniston, M., Heinrich, G., Rajczak, J. and Stoffel, M. (2014) '21st century climate change in the European Alps—A review', Science of The Total Environment, 493, pp. 1138–1151. doi: 10.1016/j.scitotenv.2013.07.050.