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Future hydropower production under climate scenarios in the Italian Alps

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The recent intensification of climate change, highlighted in the IPCC reports suggests that the latter is likely to have a significant impact on the hydrological dynamics, especially within high-altitude areas, where the coverage of permanent glacial areas will shrink worldwide. In particular, Alpine glaciers are subject lately to rapid down wasting and it is largely attributed to climate changes.
Changes in the hydrological regimes of the mountains can affect management of water, particularly for water use if highly dependent, such as for hydropower production. Given rapidly ongoing modification of the cryospheric features in this area, and their expected hydrological fallout, one needs to assess the future (i.e. along the XXI century) hydropower potential in response to the new hydrological settings.
This makes necessary the quantitative study of the dynamics of the cryosphere and of the related hydrological. Here, we assess the effects of climate change upon the production of the hydropower system in high Valtellina valley (HVV), in the Eastern Alps of Lombardia region in Italy. The backbone of the HVV hydropower system is given by two artificial reservoirs, namely San Giacomo (64 Mm3), and Cancano (124 Mm3), the latter being downstream of the former and four power stations for a total power of 250 MW.
Hydrology therein is driven by cryospheric processes, including down wasting of glaciers and seasonal snow melt, and management of this complex hydropower is pursued with the main target of profit maximization, under environmental constraints (i.e. minimum instream flows, as set out by local regulation). To do so, we rely upon recent modeling of high altitude catchments, following a well consolidated procedure to assess present and future flow regimes. We set up our Poly-Hydro model, a physically based, semi-distributed glacio-hydrological model, able to mimic the cryospheric processes driving hydrological flow formation. Then, we set up a new, properly developed optimization tool, which we called Poly-Power, to maximize the revenue of the plant manager under given hydrological regimes, namely by proper operation of the hydroelectric production scheme of the HVV.
Upon such bases, we pursued hydrological projections until 2100, feeding Poly-Hydro with the downscaled outputs of three general circulation models from the IPCC AR5, and i) assess hydrological flows in two reference decades, i.e. at half century (2040-49), and end of century (2090-99), and ii) feed these hydrological scenarios to Poly-Power, and project future production of hydroelectric power under revenues' maximization.

Keywords: hydropower; climate change; hydrological projections; glaciers; Italian Alps.