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Hydropower in the Era of Climate Change. The Case of the Sabbione Storage Plant in Italy

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Hydropower, between renewable energy sources, is probably the best candidate for reducing greenhouse emission, since it is the only renewable energy source whose production can be adapted to demand, and still has a large exploitation margin, especially in developing countries. However, in Europe the contribution of hydropower from the cold water in the mountain areas is at stake under rapid cryospheric down wasting under global warming. Italian Alps are no exception, with a large share of hydropower depending upon cryospheric water. We study here climate change impact on the iconic Sabbione (Hosandorn) glacier, in the Piemonte region of Italy, and the homonymous reservoir, which collects water from ice melt. Sabbione storage plant has operated since 1953 and it was, until recently, the highest altitude dam of Europe at 2460 m asl. Using two models, namely Poly-Hydro and Poly-Power, we assessed present hydrological budget divided by components (i.e., ice/snow melt, rainfall), and hydropower production under optimal reservoirs' management, respectively. We then project forward hydrological cycle under properly downscaled climate change scenarios (three General Circulation Models, three Representative Concentration Pathways, nine scenarios overall) from IPCC until 2100, and we assess glacier fate and consequences for hydropower production. Mean annual discharge during 2000–2017 is estimated at 0.90 m3 s−1, with ice melt contribution of ca. 11.5%, and ice cover as measured by remote sensing changing from 4.23 km2 in 2000 to 2.94 km2 in 2017 (−30%). Mean hydropower production during 2005–2017 is estimated as 46.6 GWh. At the end of the century ice covered area would be largely depleted (0–0.37 km2), and ice melt contribution would drop largely over the century (-10% to 0%, 5% on average at half century, and null in practice at the end of century). Therefore, decreased ice cover, and uncertain patterns of changing precipitation, would combine to modify the future stream fluxes (−22% to −3%, −10% on average at half century, and −28% to 1%, average −13%, at the end of century). Power production, driven by seasonal demand and water availability, would change (decrease) in the future (−27% to −8%, −15% on average at half century, and −32% to −5%, −16% at the end of century). Our results demonstrate potential for decrease of cold water in this area, paradigmatic of the present state of hydropower in the Alps, and subsequent considerable hydropower losses under climate change, and claim for adaptation measures therein.