Differential Impact of Climate Change on the Hydropower Economics of Karakoram and Himalayan River Basins

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Water stored in the form of snow and glaciers in the Hindukush Karakoram Himalayan (HKH) region regulates the water supply and resultant water-based economies that support the livelihoods of about 1.4 billion people. Trends in the seasonal and long-term melting of snow and glaciers, governed by initial ice reserves, meteorological factors and geographic features, vary across sub-basins in the HKH region. We examined the economic impacts of climate-led changes in river flow in two drainage basins, one each from Karakoram and Central Himalaya region. We used an integrated assessment framework to estimate the changes in economic value of the hydropower generation from hydropower plants on the rivers fed by snow and glacier melt in the two sub-basins. The framework, developed under a NASA High Mountain Asia project, coupled biophysical models (a suite of climate models, snow/glacial-hydrology, and hydropower models) with economic analysis. We compared the differences in estimated river flow over historic and future time periods using the water balance model in sixteen scenarios (eight climate models and two emissions scenarios) for rivers upstream of hydropower plants in each sub-basin. Using the hydropower model, we estimated the changes in hydropower generation at the Naltar IV hydropower plant, with an 18 MW capacity, located in Hunza, Karakoram, and the Trishuli hydropower plant, with a 19.6 MW capacity, in Trishuli, Central Himalaya. When compared to their baselines, the Naltar plant had a higher estimated impact of climate change and increased temporal variability than Trishuli plant. Our analysis shows that hydropower plants with water storage facilities help reduce the impact of changes but the estimated impacts are higher for the higher capacity plants. This study provides an example of the differential impacts of climate change on hydropower plants located in rivers fed by varying amounts of snow and glacier melt at different decades in this century. This type of integrated assessment of climate change impact will support scientific understanding of the hydrologic flow and impacts on hydropower economy under various climate scenarios, as well as generate information pertaining to water resource management under changing climate regime.