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CLIMATE CHANGE WILL INCREASE HYDROPOWER GENERATION IN INDIA

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Unlike coal-powered power plants, hydropower, which is the second highest power producing source at 13%, is a significant contributor to clean global electricity generation. Based on observations and climate projections, a two-member team from IIT Gandhinagar studied the hydroclimatic changes in the catchment areas and their implications for hydropower generation in 46 major dams located in north, central and south India.

The team looked at the increase in rainfall in the catchment areas and the resultant inflow into all the 46 major reservoirs in the near (2021–2040), mid (2041–2060), and far (2081–2100) periods against the reference period (1995–2014) for two shared socioeconomic pathway scenarios — SSP1-2.6 and SSP5-8.5. While SSP1-2.6 is a low-emission scenario, SSP5-8.5 is characterised by high radiative forcing by the end of the 21st century.

“Under warmer climate, we expect hydropower production to increase across the country due to substantial increase in precipitation leading to increased inflow to the reservoirs,” says Dr. Vimal Mishra, professor at the Department of Civil Engineering at IIT Gandhinagar, who led the study. Based on selected hydroelectric dams, the projected increase in hydropower potential in India is 10-23%. The results of the study are published in the journal iScience.

A warmer and wetter climate is projected to bring about 5%-33% increased rainfall. As a result, hydropower production is very likely to increase by 9%-36% for most dams and this will come from increased inflow (7-70%) into the dams. The dams in central India show significant increase compared to dams in north and south India. “But most of the increased inflow into the dams will come from extreme rainfall. And herein lies the risks to water storage in the dams,” Prof. Mishra says.

Due to global warming, there will be a simultaneous rise in extreme inflow and high reservoir storage conditions for most dams. “Our study highlights the high likelihood of increased hydropower generation but the risk comes from very high and sudden inflow due to extreme rainfall, especially when the reservoirs are already full. Any further increase in inflow when the dams have already reached their maximum storage capacity can pose challenges for reservoir operations,” he says. “Reservoirs can help prevent flooding, but when they are already full and if the inflow is high, then the dams can create a flood-like situation due to sudden water release. Chennai in 2015 and many places in Kerala in 2018 witnessed massive flooding due to heavy inflow into already full reservoirs.”

Compared with central and south India, north India is projected to experience higher warming in the future. As per the study, the highest warming (about 5 degree C) is projected for north India, while the warming is projected to be around 3-4 degree C for central and south India.

Similar to substantial warming, most reservoir catchments are likely to witness increased precipitation due to global warming. “Both north and central India are projected to receive a higher increase in precipitation than south India. The increased precipitation will alter the inflow to the dams more in north and central India than south India and also hydropower generation,” Prof. Mishra says.

The study found that inflow to a few dams in Ganga, Mahanadi, Brahmani, and west-coast river basins is projected to decline in the future. This reduction in inflow is due to increase in atmospheric water demands in response to the considerable warming compared to increase in precipitation.

The projected change in hydropower potential is the highest in the far period (-5% to 62.8%) and the lowest for the near period (-6.2% to 39%). “The potential hydropower generation is projected to rise by more than 50% in Tehri, Ramganga, Kadana, Omkareshwar, Maheshwar, and Sriramsagar dams in the far period,” he says. “In the case of south India, eight out of eleven dams are projected to experience a decline in hydropower potential. Dams in central India are projected to experience a more substantial increase in hydropower generation than north and central India.”

Substantial warming projected for north India may reduce snow and glacial storage, reducing snowmelt water contribution in the long run. But a substantial increase in rainfall is more likely to compensate for the reduction from snowmelt in north India. The projected decline in hydropower even with increased precipitation for a few dams can be attributed to the higher evapotranspiration rate than precipitation in the future.

“Our findings provide crucial insights into projected changes in hydroclimate and hydropower for the major dams in India. Reservoir operations should be strengthened through reliable weather and inflow forecasts to maintain storage that can accommodate high inflow due to extreme rainfall,” says Prof. Mishra. “India may have to change reservoir rule curves on how much storage should be permitted at different times during the monsoon season to prevent flood-like situations from sudden release of water from reservoirs.”

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