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Impact Assessment of a Storage Hydropower Project: The Case of Kulekhani

Background

Kulekhani (KL) Hydroelectric Projects (HEPs, three in cascade), located in Bagmati watershed (Figure 1), are the only storage type HEPs in Nepal. Such projects may have both negative and positive impacts such as land cover changes, socio-economic evolution, stabilizing integrated nepal power system (INPS), changes in micro-climate, etc. Earlier studies (e.g., Shrestha et al., 2020) haven't explored this aspect yet.

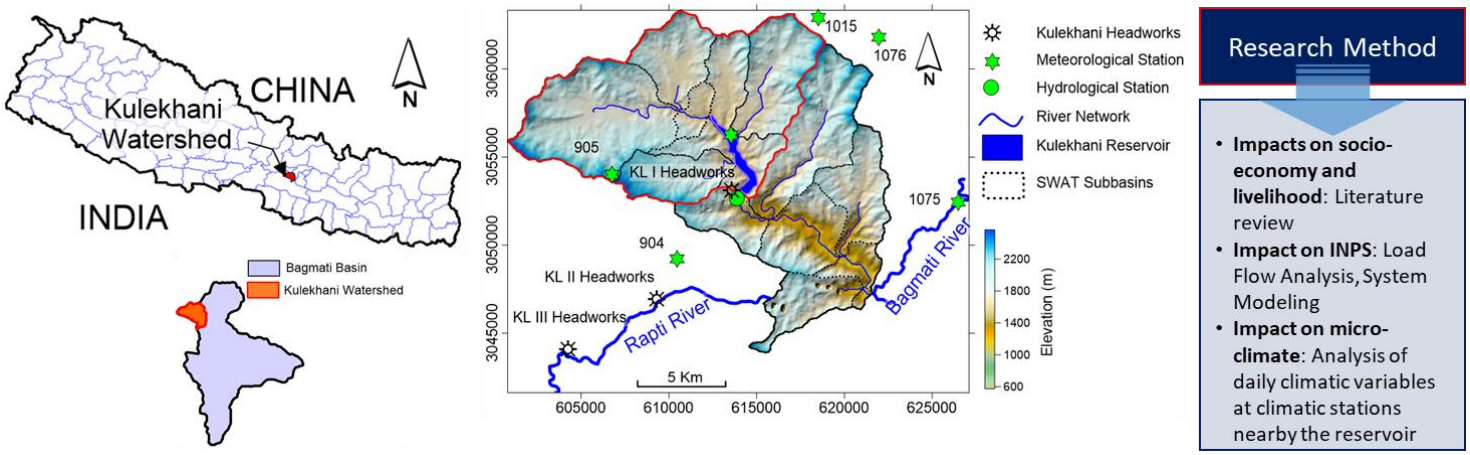

Figure 1: Location of Kulekhani HEP and research method

As Nepal is planning to develop more storage type HEPs in future for energy security, learning from thee KL HEP would be of great importance in this endeavour. This Research Letter therefore aims to highlight impacts of KL HEPs on – i) Socio-economy and livelihoods, ii) INPS, and iii) micro-climate in the watershed.

Methodology

Impacts on socioeconomy and environment were assessed based on stakeholders' consultations through key informant interviews (KIIs) using open-ended questionnaires through field studies. Impacts on INPS were assessed based on load flow analysis and avoided energy cost by running KL HEPs during dry season with reduced burden of power import from India. Impacts on micro-climatic conditions in the watershed were studied based on available climatic/meteorological variables. Finally, insights for future storage HEPs in Nepal were synthesized based on results from aforementioned impacts, review of practices elsewhere, and inputs from the expert consultation workshops.

Results

i) Impact on Socio-Economy and Livelihood

Positive impacts include,

- Contribution to energy security through hydro-energy generation
- Local employment generation: 500 construction workforce during KL I & II and another 60-70 during KL III were employed directly. Similarly, hotels/restaurants, grocery, etc. in nearby areas provided employment to many others. These days, Boat Association and Fishery Production Association are providing employment to ~35.
- Local business opportunities: Rise in tourism activities are creating local business opportunities. There are ~25 hotels/restaurants in the reservoir areas and ~150 people are employed with them. Total economic activity due to boating alone is NRs. 5.5 million/year and due to fish farming is NRs. 10.5 million.
- Environment enhancement benefits due to project-related afforestation and social service facilities (e.g., water supply, education, healthcare, etc.) from the infrastructure deployed during project construction period.

Negative impacts include,

- Integration of KL HEPs in INPS is shown in *Figure 2*. KL-1 is serving the purpose of reducing overload of 132/66 kV power transformers in Balaju, Syuchatar and Hetauda substations.
- KL has effectively reduced the overloading of Dhalkebar-Chapur 132 kV line while reducing output of PROR plants (KGA, MMRS, MRS, Chameliya) for daily peaking.
- With the installation of capacitors in Hetauda sub-station and its adjacent sub-stations, operation of KL for addressing low voltage problem can be reduced and might be used for serving other purposes.

ii) Impact on INPS

- The KL HEPs is integrated with INPS. KL-1 is serving the purpose of reducing overload of 132/66 kV power transformers in Balaju, Syuchatar and Hetauda substations.
- KL has effectively reduced the overloading of Dhalkebar-Chapur 132 kV line while reducing output of PROR plants (KGA, MMRS, MRS, Chameliya) for daily peaking.
- With the installation of capacitors in Hetauda sub-station and its adjacent sub-stations, operation of KL for addressing low voltage problem can be reduced and might be used for serving other purposes.

iii) Impact on Micro-Climate

- Due to the Kulekhani reservoir, micro-climate in the surrounding areas have been affected, as experienced by locals in the form of more cooling but increase in mosquitos. Quantifying the impacts on micro-climate requires sub-daily time series of precipitation, temperature and humidity at three stations (one in the reservoir surrounding, and two others at different distances from the reservoir). But they are not available at the moment, and therefore quantifying the impacts on micro-climate is not feasible with available data/information.

Considerations for Future Storage Projects

Storage HEPs have both negative and positive impacts (e.g., stabilizing INPS, etc.). Some of the strategies for harnessing the benefits and minimizing negative consequences could be: i) establishing appropriate monitoring system; ii) appropriate governance structure to coordinate watershed conservation activities; iii) formulation of "Protected Watershed Declaration" and review progress every year through organizing watershed forum; iv) ensure sustainable financing for watershed conservation initiatives; and v) install warning systems for the downstream communities; etc..

Reference

Shrestha, A., Shrestha, S., Tingsanchali, T., Budhathoki, A., & Ninsawat, S. (2020). Adapting hydropower production to climate change: A case study of Kulekhani Hydropower Project in Nepal. Journal of Cleaner Production, 279, 123483.

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