Adjusting hydropower dam operation to complement livelihood strategies in the Lower Mekong Basin

Julia Reis, Teresa Culver, Guillaume Lacombe, Chu Thai Hoanh, Anousith Keophaxay, Somphasith Douangsavanh, Shwu Jiau Teoh, Suan Pheng Kam, Sonali Senaratna Sellamuttu

Abstract

The Nam Gnouang dam in Lao PDR was constructed to double the capacity of the downstream Theun-Hinboun power station. About one thousand people who rely on the Nam Gnouang were resettled close to the shoreline at full supply level. Using reservoir modeling, we evaluated the water resources and hydropower implications of altering the dam operation to complement these strategies. We investigated the impacts of prolonging specific water levels to allow cultivation of profitable vegetables on exposed riverbanks and found an 8% reduction in power. Although fisheries will be constrained by impoundments and high-magnitude water level fluctuations, constructed wetlands may provide a refuge for fish. Following semi-structured surveys and consultations to learn which activities are feasible and desirable, we used linear programming to identify profitable livelihood strategies, including traditional activities (rice, shoreline gardening, livestock, fishing) and new ones (irrigated farming), given the limited labour resources. Optimization improved both energy and shoreline gardening goals compared to baseline reservoir operation.

Reservoir Simulation

Inflow to Nam Gnouang (NG): estimated based on nearby river Ban Signo, based duration curves and ratio of catchment areas; THPP rainfall data scaled to NG catchment. Net Evaporation: PET CRU data.

The recession agriculture rule A1 keeps the water level at or below 425 m during the growing season of April to August. The measure called A2 draws down the water levels to 425 m, from March to August to create a longer growing season.

The constructed wetlands would have no impact on the operation of the hydropower system. The wetlands would more likely to function as independent ponds separate from the reservoir as opposed to seasonally submerged marshes, potentially serving as a source of livelihoods for fishers.

Objectives

Simulate elevation of reservoir water level throughout the year
Evaluate the cost effectiveness of livelihood activities
Study the interaction between the reservoir operation and livelihoods

Maximal fluctuation of water level (masl)

Max G = \sum (Revenuei - Costi)

Decision Variable: Labour (2 man-days per subvillage)
Constraints: Labour ≤ 26, capital for hiring (y) ≤ 0.3 G, Fishing labor; Area of gardens; Livestock; Area of upland crops; binary variables for fixed costs

Discussion

As hydropower and storage reservoirs are being constructed enthusiastically throughout Africa and Asia, it is an important time to research techniques to mitigate the losses to local economies. We identified operational plans for the Nam Gnouang dam and quantified losses to hydropower production. If vegetable farming is unconstrained, reservoir operation would limit available land for riverbank gardens. Reservoir can be operated for recession agriculture, but only for the higher elevation gardens or only for part of the growing season for all shoreline gardens. If fishing revenues increase with expected temporary rise in yield, there may be less incentive to grow vegetable crops. The community level of the model, incorporating labor- and cost-sharing, improved the net gain of villagers. Optimization showed that even if recession agriculture were to become a goal of reservoir operation, the energy generation could still increase.

Acknowledgements

This research was supported by the Explorers’ Club Washington Group and a NSF DDEP grant.