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Understanding the impact of anthropogenic activities on river ecosystem services in India: A hydro-economic approach

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River has always played an important role in the development of human civilization. Human societies has economically benefitted in the form of development and increased economic wellbeing. Hydrological alterations of rivers flow regime while benefitting human development in many ways have damaged the delivery of ecosystem services. As we fail to understand that the river ecosystem services are governed by flow regime and it is influenced by many biotic and abiotic factors which includes topography, land cover, climatic condition and anthropogenic modifications. These interactions are the biophysical basis for providing ecosystem services. The situation is further complicated by multitude of water uses and stakeholders with conflicting interests. The Cauvery river basin in India is becoming increasingly water scare due to rapidly growing water demands for irrigation, household consumption and generation of electricity. The present study explores how anthropogenic modification in river basin including flow regime can impact the production of ecosystem services provided by the Cauvery River.

Flex-topo hydrological model is used to study the changes caused by anthropogenic modification in the form of irrigation on river flow regime. At first, landscape classes for sub-basin are delineated based on topographic information (DEM, Slope, and HAND) available on GIS platform. Then, irrigation component is added in Flex-topo model structures. The change in flow regime is estimated by creating various water demand scenarios in the sub-basin. We then explore the tradeoff between two conflicting ecosystem services (irrigation and environmental flow) generated from all possible flow regimes that emerge from various possible scenarios for irrigated agriculture. We assume that irrigation is used for the production of agricultural crops and environmental flows sustain species richness. The conceptual basis for this tradeoff is based on empirical relationship between agricultural production and species richness as a function of flow regime, both derived from hydrological modelling. Production possibility frontier is then estimated by plotting the maximum boundary of the production of ecosystem services. The boundary essentially plots irrigation and environmental flows in 2 dimensions for all possible flow regimes as simulated by the hydrological model for all possible scenarios for irrigated agriculture within the basin. Results are discussed for Muthunkera sub-basin in context of social, ecological and economic interdependence and how such a method can be used to maximize the social welfare by optimum allocation of water to various stakeholders in an equitable manner without compromising the sustainability of river.