

Barrage and dam operations, irrigation systems, and ecological flows in the Ganga and Indus basins, India: trade-offs and opportunities

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(a) Purpose of study or research hypothesis

Many rivers in South Asia are regulated and abstracted by dams, barrages, and canals for irrigation, with major impacts on water and sediment flow downstream and upstream. Such flow regulation has severely affected endangered aquatic fauna such as Ganges and Indus River Dolphins, Gharial crocodiles, freshwater turtles like *Chitra indica*, smooth-coated otters, waterbirds (e.g. Indian Skimmer), freshwater fishes (e.g. Hilsa), etc. How, then, can we reconcile ecological needs with irrigation demands in the Indo-Gangetic plains?

(b) Key issue(s) or problem(s) addressed

We examined tradeoffs between irrigation water demand and ecological flows for endangered riverine species in the dry-season for different rivers (with focus on the Gandak river) in the Indo-Gangetic plains.

(c) Methodology or approach used

We used field-based hydrological measurements, biodiversity surveys, interviews with farmers and barrage authorities, and statistical modelling of river flows, for our study.

(d) Results or conclusions derived from the project

We found that agricultural demands on surface- and groundwater irrigation sources led to differential impacts on flows in regulated rivers. Gaps between demand- and supply-side management (excesses or inefficiencies) indicated scope for reduction in water-use. In the Gandak basin, for example, in spite of extensive canal networks, irrigation is dominated by groundwater sources. Canals provide less than 60% water of their design irrigation capacity, and seepage losses regularly recharge groundwater sources in the dry-season. Increased river flows from the barrage (due to canal closure) might balance base-flow reductions by groundwater abstraction. A preliminary estimate of trade-offs between irrigation water-use and dry-season river flow for the Gandak shows that reduction of 1000 ha of canal-irrigated area, could contribute an additional 4 cumecs of river flow.

(e) Implications of the project relevant to congress themes

Estimating such tradeoffs is important for species like Ganges or Indus Dolphins that have minimum depth requirements for persistence in rivers. In other rivers (e.g. Son) of the Ganga basin, changes in timing and rates of water release from dams have had major implications for the nesting success of gharial crocodiles, Indian skimmers, etc. Limitations in existing surface-water irrigation systems lead to trade-offs and opportunities for ecological flow management in regulated riverscapes. Moderate reductions in agricultural water demand combined with adaptive management of barrage and dam operations can sustain ecological flows for endangered species. Allocating water saved from efficient irrigation practices to ecological flow regimes must be backed by a normative goal in water governance

mechanisms. An explicit Sustainable Development Goal for freshwater ecosystems and biodiversity needs to be adopted, rather than having it just as a target under Clean Water and Sanitation, to ensure greater focus on river biodiversity conservation.

Keywords : Ecological flows, regulated rivers, barrages, dams, canals, groundwater, irrigation, endangered biodiversity, Sustainable Development Goals, river dolphins