

Socio-hydrologic change in the upper Arkavathy catchment, India

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The developing world faces unique challenges in achieving water security as it is disproportionately exposed to stressors such as climate change while also undergoing demographic growth, agricultural intensification and industrialization. Investigative approaches are needed that can inform sound policy development and planning to address the water security challenge in the context of rapid change and data scarcity.

We investigated the "predictions under change" problem in the Thippagondanahalli (TG Halli) catchment of the Arkavathy sub-basin in South India. River inflows into the TG Halli reservoir have declined since the 1970s, and the reservoir is currently operating at only 20% of its built capacity. The mechanisms responsible for the drying of the river are not understood, resulting in uncoordinated and potentially counter-productive management responses. The objective of this study was to investigate potential explanations of the drying trend and thus obtain predictive insight.

Our approach was then to develop a set of hypotheses of what broad factors might be contributing to drying using available data -- was it declining rainfall, rising temperatures, groundwater pumping, eucalyptus plantations or stream fragmentation? The historical data clearly showed that changes in rainfall and temperature could not explain the sharp declines in streamflow.

Having broadly established that groundwater pumping, stream fragmentation and eucalyptus were responsible for the river drying, the next task was to understand the processes at work and their interaction. To do this we embarked on an intensive three year field study to test various hypotheses including household and farm surveys, focus group discussions, isotopic studies, analysing satellite imagery, borewell camera scans, streamflow and soil moisture sensors, weather stations and a participatory groundwater monitoring programme.

The farmer survey showed clearly that as Bangalore city grew, farmers follow a "go big or quit" strategy. It makes no sense for farmers in nearby rural areas to continue in rainfed agriculture - they were better off either putting their land under eucalyptus and going to work in the city. Farmers who remain in agriculture can only justify it by drilling deep borewells to grow irrigated high-value crops that could be sold in the city or exported. The hydrologic studies showed that the pumping was causing groundwater to decline sharply. The eucalyptus trees were taking up much of the infiltrated water and decreasing recharge. The policy response to declining groundwater was to set up check dams to boost recharge but all this did was to accelerate stream flow decline. Because electricity is free and borewell drilling is relatively affordable, there is no limit on how much water humans are abstracting from the system. The net impact is an increase in ET in the upper catchment over time and a decrease in downstream flows to the reservoir

The research led us to conclude, that first humans are both changing the system and in turn responding to environmental change. The impact of urbanisation (an exogeneous driver) was not merely hydrologic in terms of infiltration or ET but a change in land, labour and commodity markets that in turn had severe consequences on the hydrology.

Second, the hard rock geology meant that groundwater storage is limited. In effect the aquifer only acts as a buffer storage (it stores rainfall in wet periods so it can be used in dry periods); overall rainfall remains the limiting factor.

Third, not only is total use unsustainable it is also inequitable; the water is locally captured by just a handful of large irrigators. But the combination of borewells, eucalyptus and check dams results in an "upstream shift" of the water which has its own basin-level equity implications.

In the long term, the only option (in the absence of inter-basin imports) is to stay within the water resources available through enforceable limits on water abstraction via a water budgeting exercise at both the local and regional scale.

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