A Systematic Assessment of Value Addition by Stakeholder Elicitation in Socio-hydrological Modelling

Authors: Sai Veena[1], Riddhi Singh[1,2] and Ajay Gajanan Bhave[3], (1)Indian Institute of Technology Bombay, Department of Civil Engineering, Mumbai, India, (2)Indian Institute of Technology Bombay, Interdisciplinary Programme in Climate Studies, Mumbai, India, (3)Newcastle University, School of Engineering, Tyne and Wear, United Kingdom

Socio-hydrological models (SHMs) seek to qualitatively and quantitatively couple social and hydrologic processes to explore human-water interactions. Such models can help assess interactions within large-scale water infrastructure like Inter-Basin Water Transfers (IBWTs). Causal loop diagrams (CLDs) inform quantitative structure of SHMs and are often developed using expert judgement and stakeholders' inputs. Given the complex process underlying CLD development, it is important to test the sensitivity of CLDs and consequent SHMs to differing levels of stakeholder elicited information. Here, we develop three CLDs and their SHMs for an IBWT plan in southern India. These SHMs integrate rainfall-runoff processes, reservoir water balance, command area water balance and consumer water usage patterns in the project area. CLD1 includes only surface water processes, CLD2 incorporates groundwater level changes from pumping, while CLD3 additionally incorporates adaptive behavior of water users. We found that all three CLDs reproduced observed variability of reservoir storage with a correlation of 0.73 between historical and simulated seasonal surface storage anomalies for the time period of 2000-2013. Also, CLD2 and CLD3 resulted in correlation coefficient of 0.40 and 0.47 for seasonal groundwater levels for the historical period 2007-2010. Thus, we found that inclusion of feedback from consumers to adjust demands in extreme water scarce conditions in CLD3 slightly improved the reproduction of observed groundwater dynamics of the system. We then use these three SHMs to project the impact of the IBWT on water availability in participating basins under likely changes in climate as projected by five climate models under two RCPs (representative concentration pathways) and socio-economic conditions. We discover a rather complex impact on future groundwater storage in the donor and recipient basins. We found that groundwater restores at a rapid rate in case of CLD3 with a maximum of 70% increase in groundwater level compared to CLD2 in the year 2035. We show how complex bi-directional interactions between water availability and consumers' water demand affect the response of the socio-hydrologic system, especially the dynamics of groundwater has not been identified in the literature.