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Estimating current and future groundwater resources across the Cauvery basin using a macro-scale gridded water-resource model

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Groundwater is a vital source of freshwater, an estimated 39% of all freshwater withdrawals in India are from groundwater. However, groundwater is a finite resource, and there is evidence that aquifers in Peninsular India are being depleted faster than they can recharge. This imbalance is likely to get worse in the future with the effects of a changing climate and increasing population.

It is clear that an accurate assessment of groundwater availability, now and in the future, is essential, but this is a challenge. High spatial variability coupled with the difficulty in measuring aquifer properties make it difficult to model groundwater at a basin scale. To address this, the representation of groundwater within the Global Water AVailability Assessment (GWAVA) model has been developed to provide greater insight into groundwater resources as part of an integrated water availability assessment in the Cauvery basin (81,000 km^2) in Peninsula India.

For this assessment, the GWAVA model was adapted to include an improved groundwater representation, along with the effect of small-scale human interventions intended to artificially recharge groundwater. The model was calibrated against streamflow and groundwater levels across the basin. Model runs were executed for a baseline period and for future decades, using relevant combinations of CMIP5 climate (RCP) and shared socio-economic pathways (SSP) scenarios.

Over the baseline period (1986-2005), groundwater abstraction exceeded net aquifer recharge over 66% of the area of the basin. In the future (2061-2080), this was predicted to increase to 71% under the “worst-case” scenario (RCP 8.5, SSP 3) and 93% under the “best-case” scenario (RCP 4.5, SSP 1). This supports the existing evidence that groundwater resources are currently overexploited in the Cauvery basin and suggests that this situation will get worse in the future.

An additional output of this study has been to identify gaps in the data necessary for groundwater modelling (e.g. characteristics of aquifers, density of interventions, time series of aquifer levels and groundwater pumping), in terms of data availability and confidence. This knowledge can be used to inform future data collection to maximise the usefulness of future observations.

This method can be applied to other regions with a high dependency on groundwater, such as sub-Saharan Africa, for integrate water-resource assessments. It could also be extended in the future to include a water-quality component in the groundwater processes.