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Climate-influenced borewells can be statistically identified without groundwater pumping data

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Abstract: Globally, monitoring groundwater usage is very rare, and if done, it is infrequent and often discontinuous. Hence, the low availability of the data (spatially and temporally) limits the attribution of groundwater level decline to climate, pumping and land use change. This compromises groundwater management decision-making, which likely reduces water security and increases environmental damage from over-extraction. Commonly available climate and groundwater head data do, however, provide an opportunity to draw inferences on driving processes using suitable modelling approaches. Here, we show that borewells influenced by only climate and not pumping can be identified using only groundwater head and climate data and not pumping data.

Here we identified 22 borewells in a high groundwater pumping basin in North Gujarat, India. The approach uses a transfer function noise model, HydroSight, to simulate long-term groundwater head variation using only climate and head observations. The modelled groundwater head hydrographs are analysed for accurate reproduction of the observed trend and behaviour for climate influence and were further assessed through the Nash-Sutcliffe efficiency coefficient (CoE) having a value > 0.5. We found that 23% of the borewells (n=5) were climate dominated for a single-layer soil moisture model and are represented in green colour in Fig.1. The borewells shown in red colour are more likely to be influenced by pumping, while the borewells in yellow may be to some extents are influenced by climate. The results are well supported by a field visit to all the borewell sites, which confirmed that borewells 6 and 22 are unlikely to be influenced by groundwater pumping because they are located in the non-agricultural region and are only used for monitoring purposes.

Further, we hypothesise that if only climate can explain groundwater behaviour, then predictions of the head should be better than for bores influenced by pumping. To test this, we applied the split-sampling approach on the five-climate-influenced borewells and evaluated for (i) the last five years period and (ii) the last ten years period. The predicted groundwater head improved by increasing the evaluation period for three climate-influenced borewells, and the CoE values improved by 100% for the evaluation period. Further testing is now being undertaken using different types of soil moisture models available in HydroSight. Overall, this approach provides more significant insights from the commonly available data and allows the exploration of usage and climate scenarios.

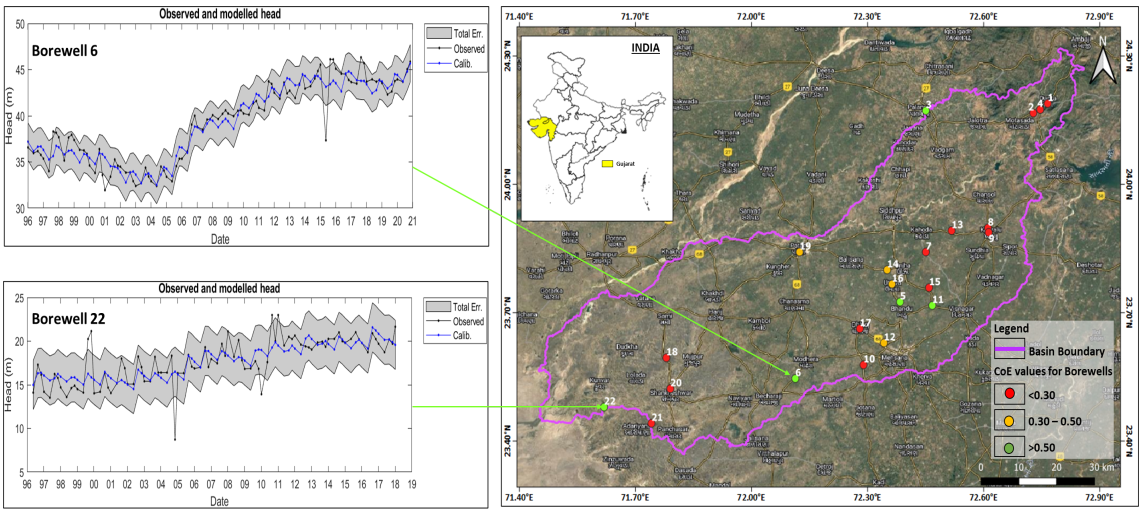

Figure 1. Hydrographs and location of climate-dominated borewells in a basin in North Gujarat, India

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