

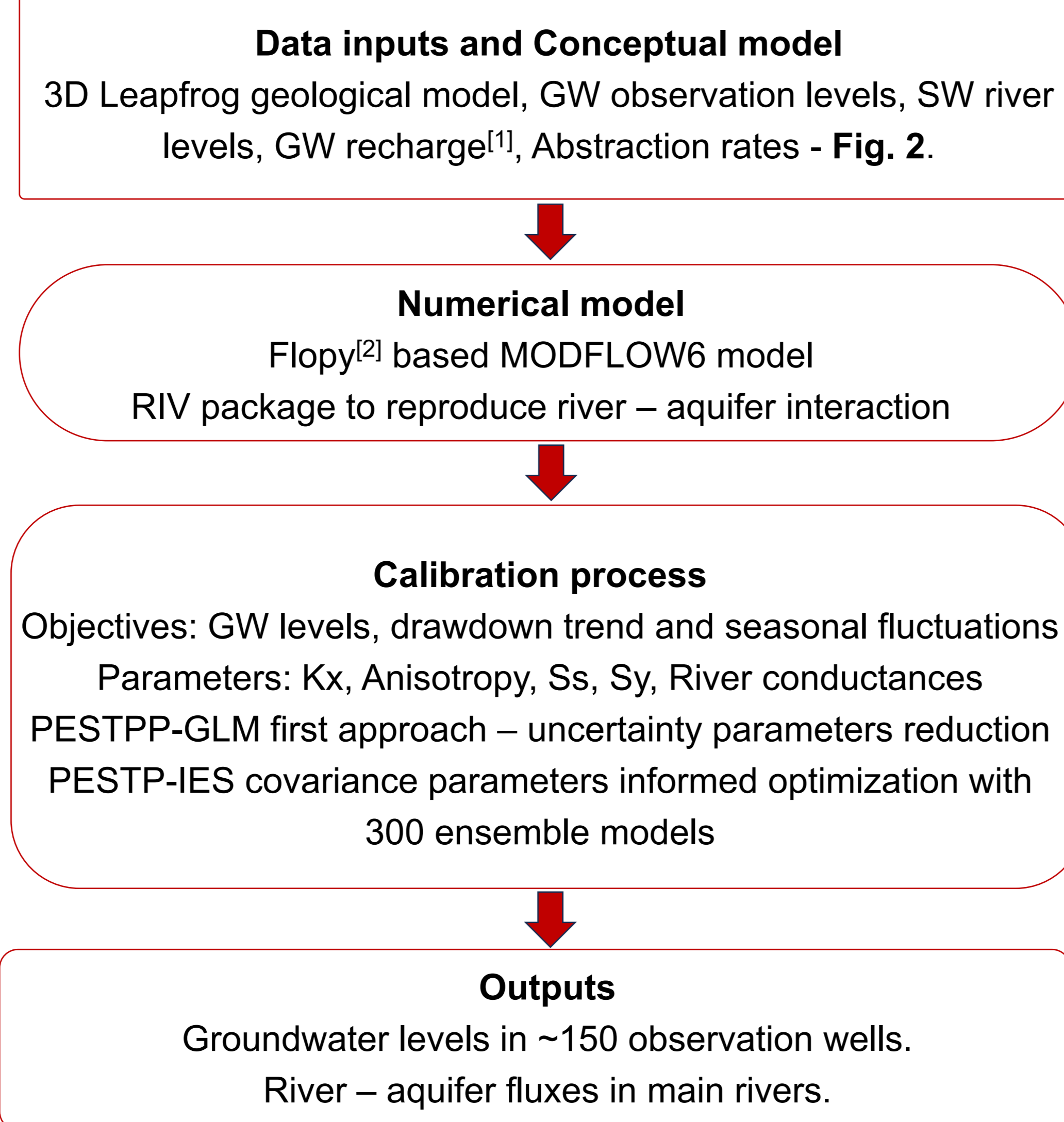
Motivation

- Bangladesh relies primarily on its irrigated agriculture. Its rapid expansion which has led to declining groundwater (GW) levels and altering river – aquifer exchange.
- Previous studies^[1] have estimated total recharge change due to abstraction, however, have not quantified the focused recharge from river leakage.
- How much have impacted the increasing abstraction in the magnitude of the focused recharge to the aquifer? Have changed the direction of the river – aquifer exchange?

Study area and numerical model

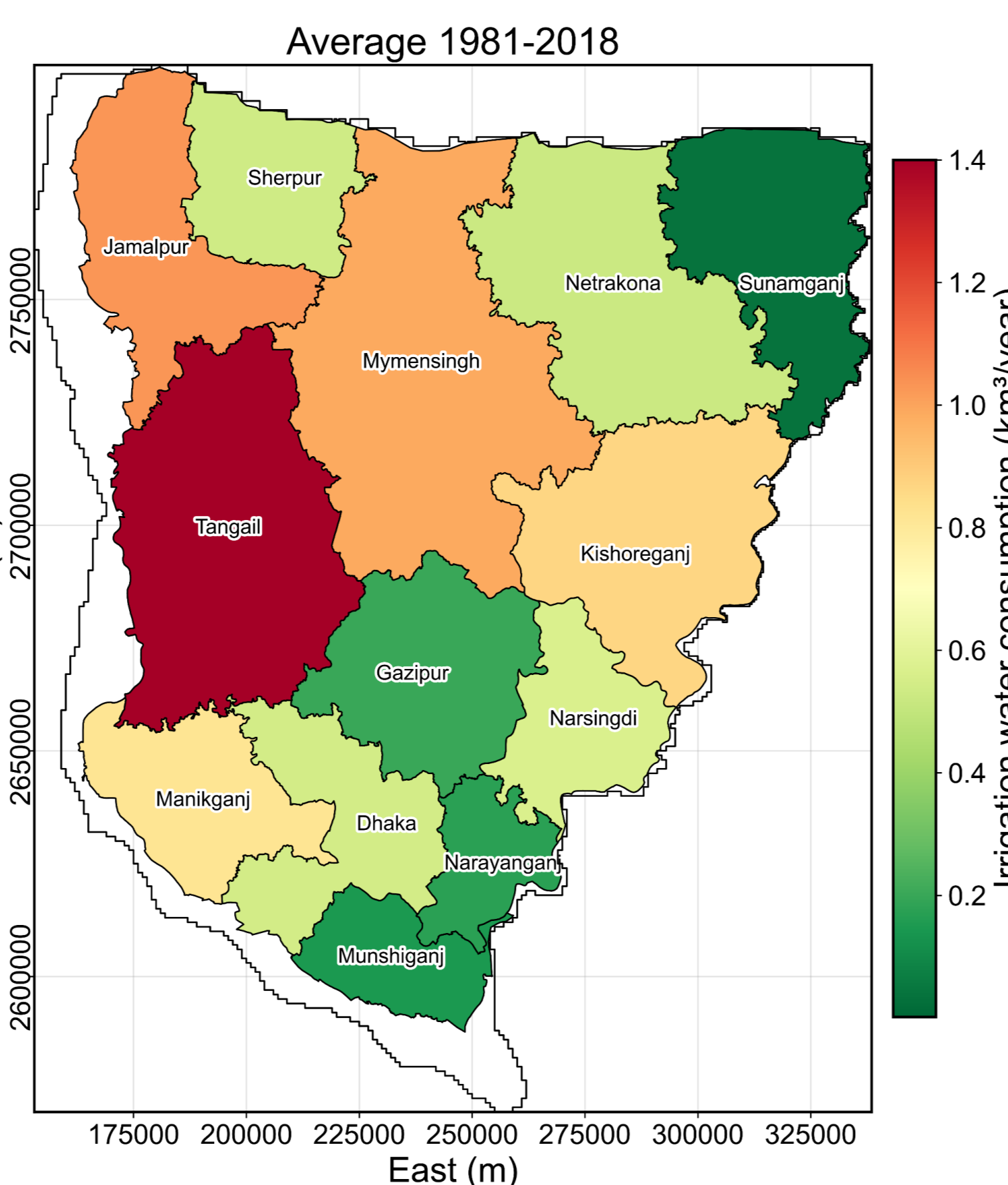
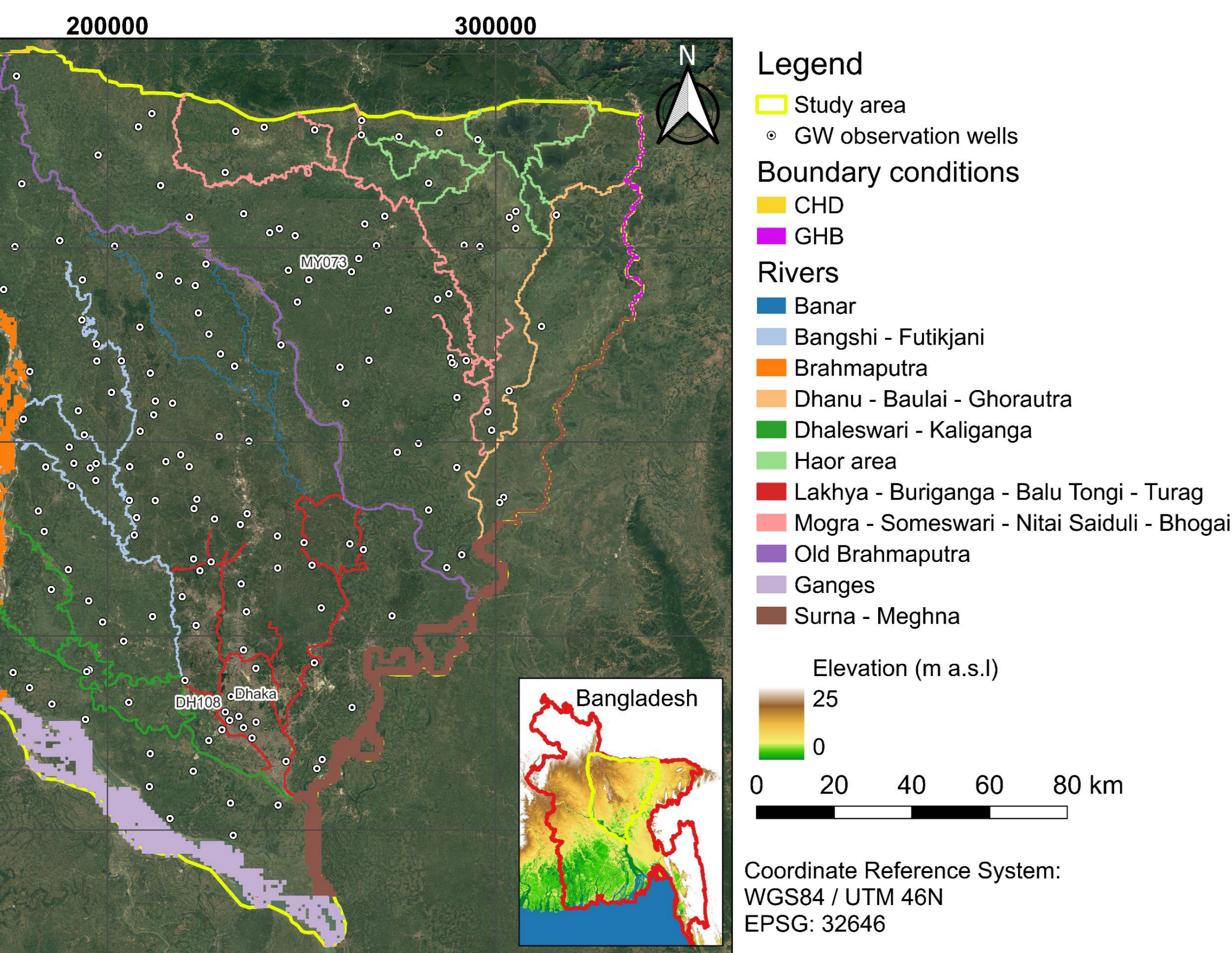
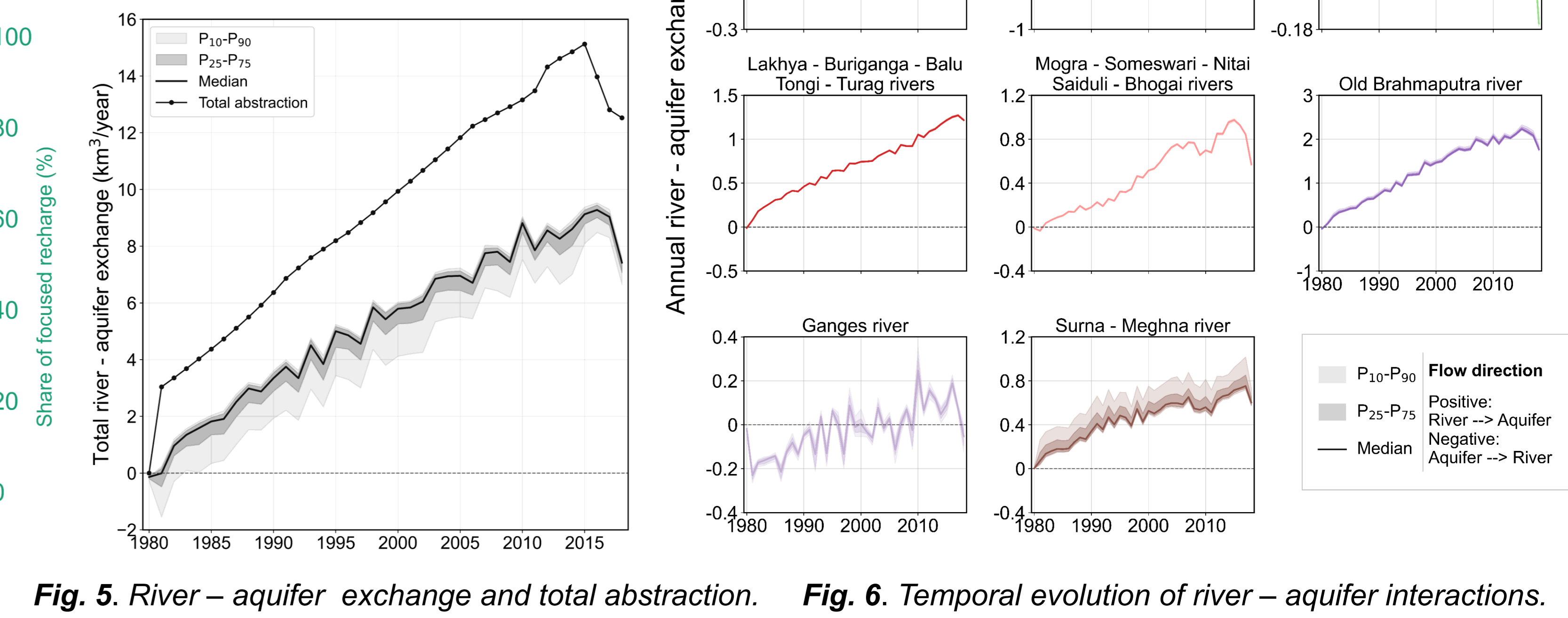
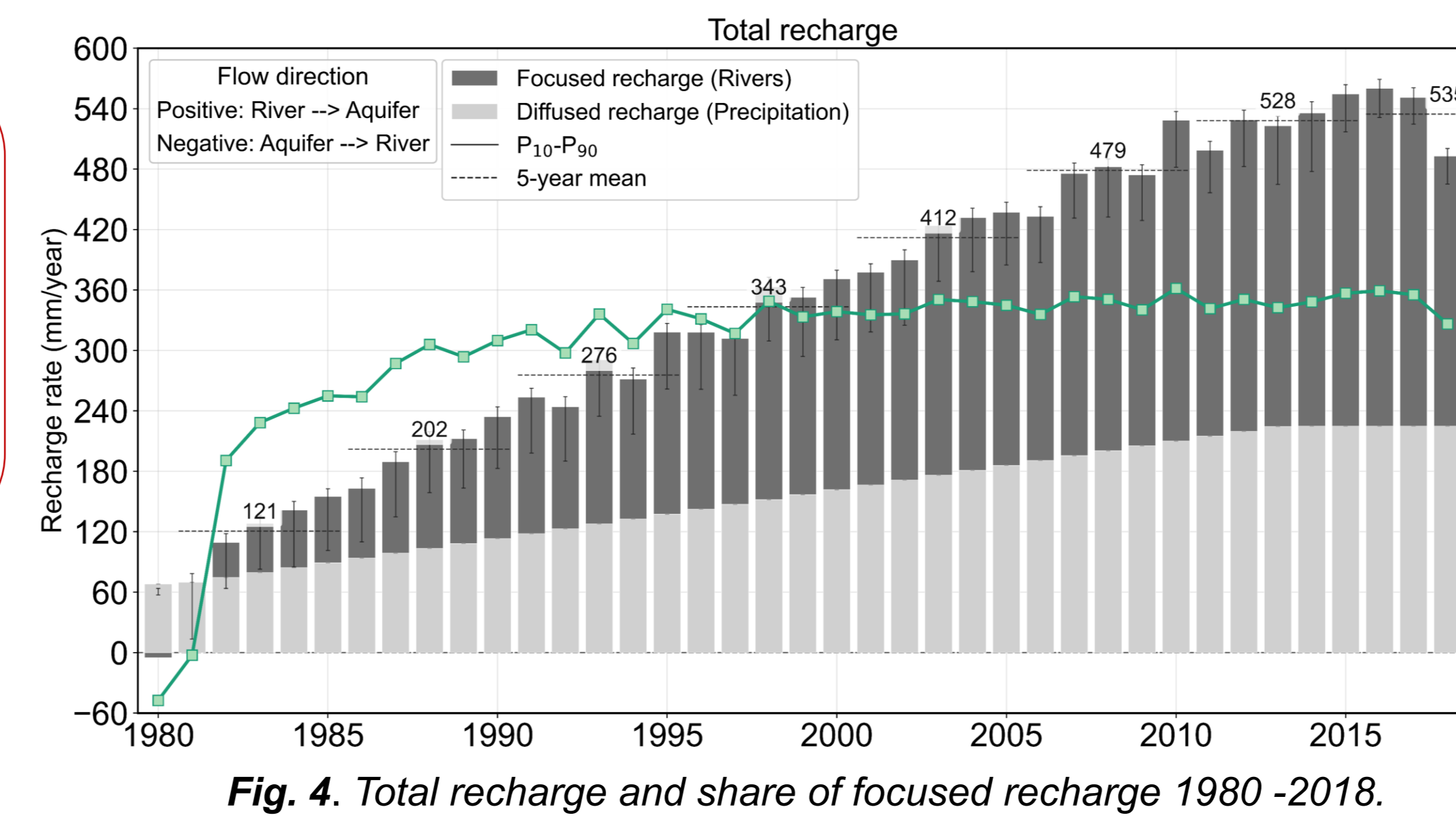
- North-central Bangladesh (28130 km², elevations between 0 and 25 m.a.s.l) delimited by Shillong Plateau (North), and Brahmaputra (West), Surna – Meghna (East) and Ganges (South) rivers . N-S main regional groundwater gradient.
- Numerical model with unstructured grid resolution between 250 m to 2000 m, and 11 layers of variable dz (3D geological model).
- Monthly temporal discretization between 1981 and 2018.
- Diffuse recharge, main rivers and GW abstraction were considered as boundary conditions.

Methodology

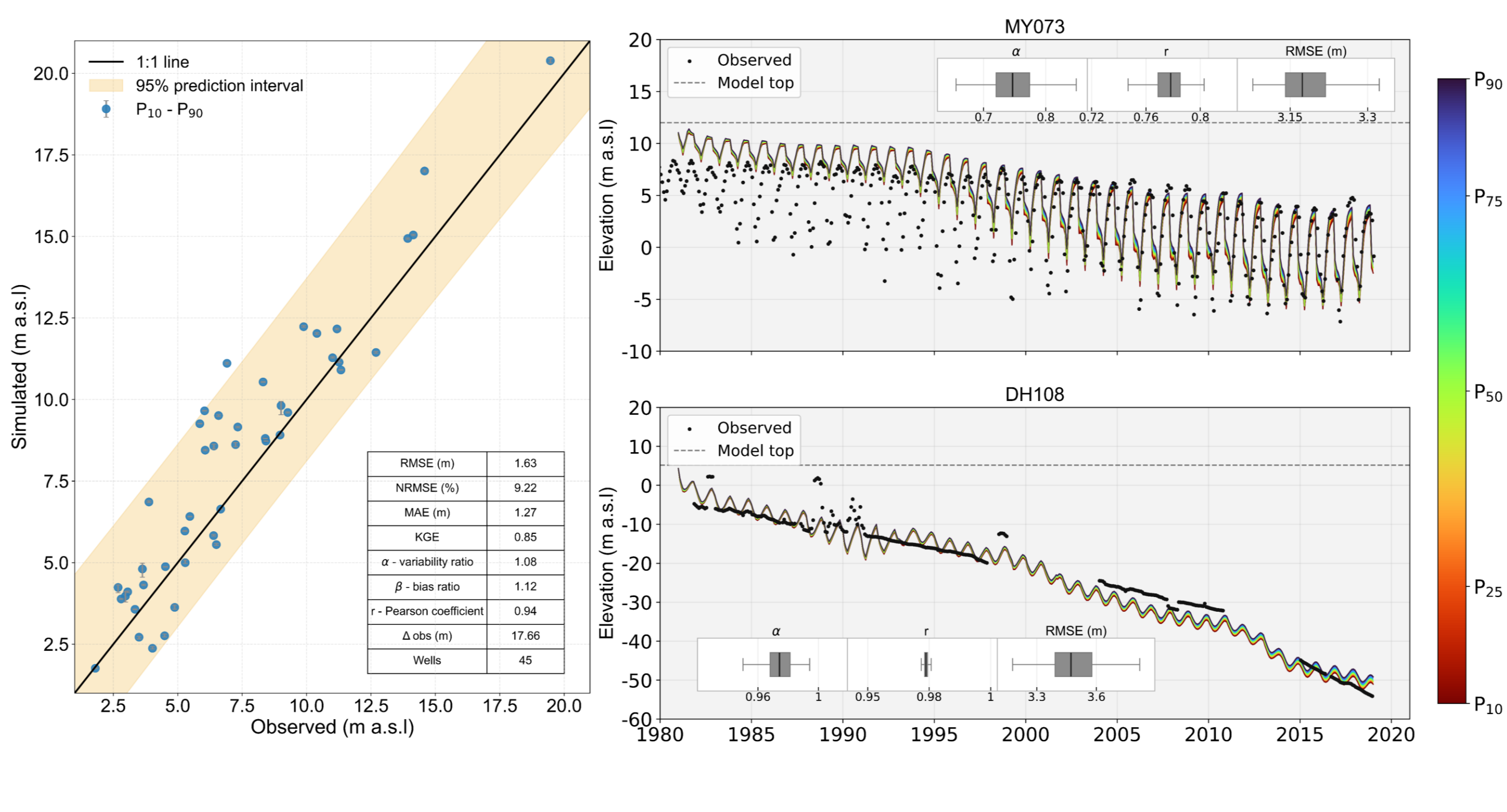


Results: Focused recharge and rivers contributions

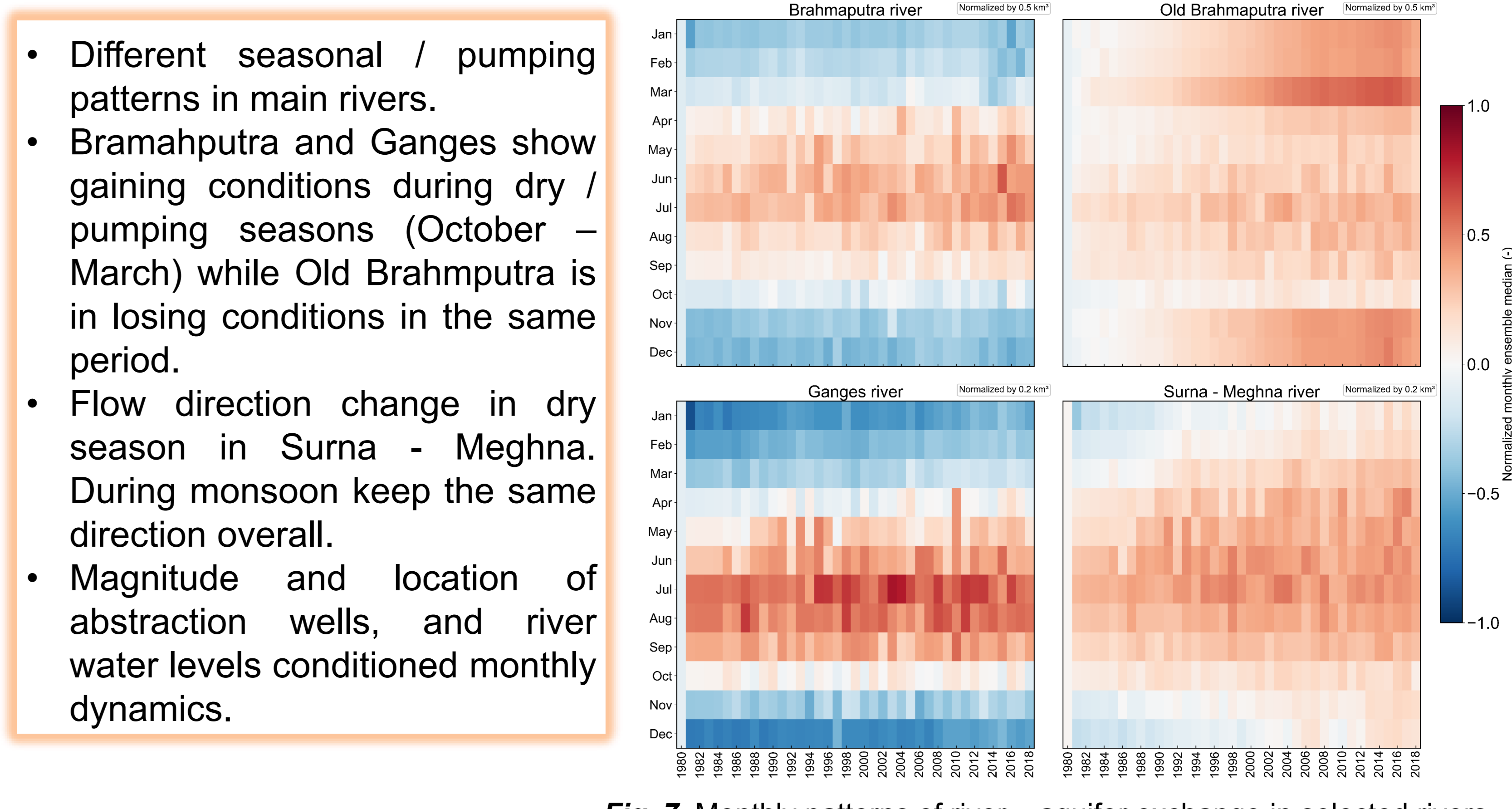
- Maximum annual abstraction in 2015 → Maximum estimated induced total recharge 560 mm/yr in 2016 (lag effect) - Fig. 4.
- Total river leakage shows an average spread of 2 km³ along the historical period, reaching a maximum of ~9 km³/yr - Fig. 5.
- Mostly losing river conditions in the main rivers. High uncertainty in Brahmaputra and Surna – Meghna rivers - Fig. 6.
- Main focused recharges comes from Old Brahmaputra (OB) and Daleswari – Kaliganga rivers, in districts with high abstraction rates - Fig. 6.



Results: Groundwater levels



Results: Monthly dynamics



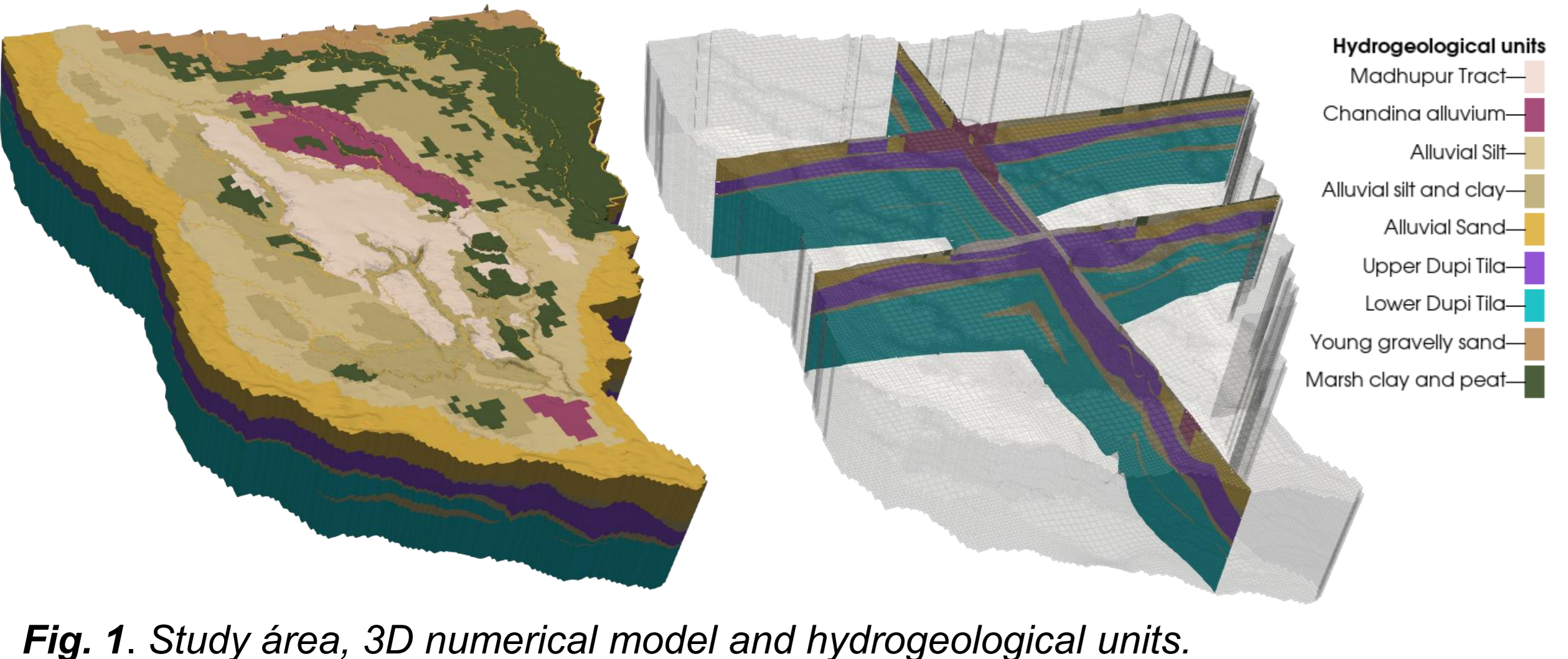
Conclusions and future work

- Uncertainty in focused recharge is bigger at the beginning of the period, decreasing along the time.
- Leakage from bigger rivers show higher uncertainty within the study area.
- Focused recharge reaches a quasi-stable share of ~60% of the total recharge after 1998.
- Model shows the impact of abstractions over river – aquifer interaction, mostly enhancing losing conditions.
- Variable river – aquifer interaction at monthly scale. Main drivers corresponds to pumping (dry season) and monsoon (high precipitation) periods. Analysis of local patterns will be carried out.

References

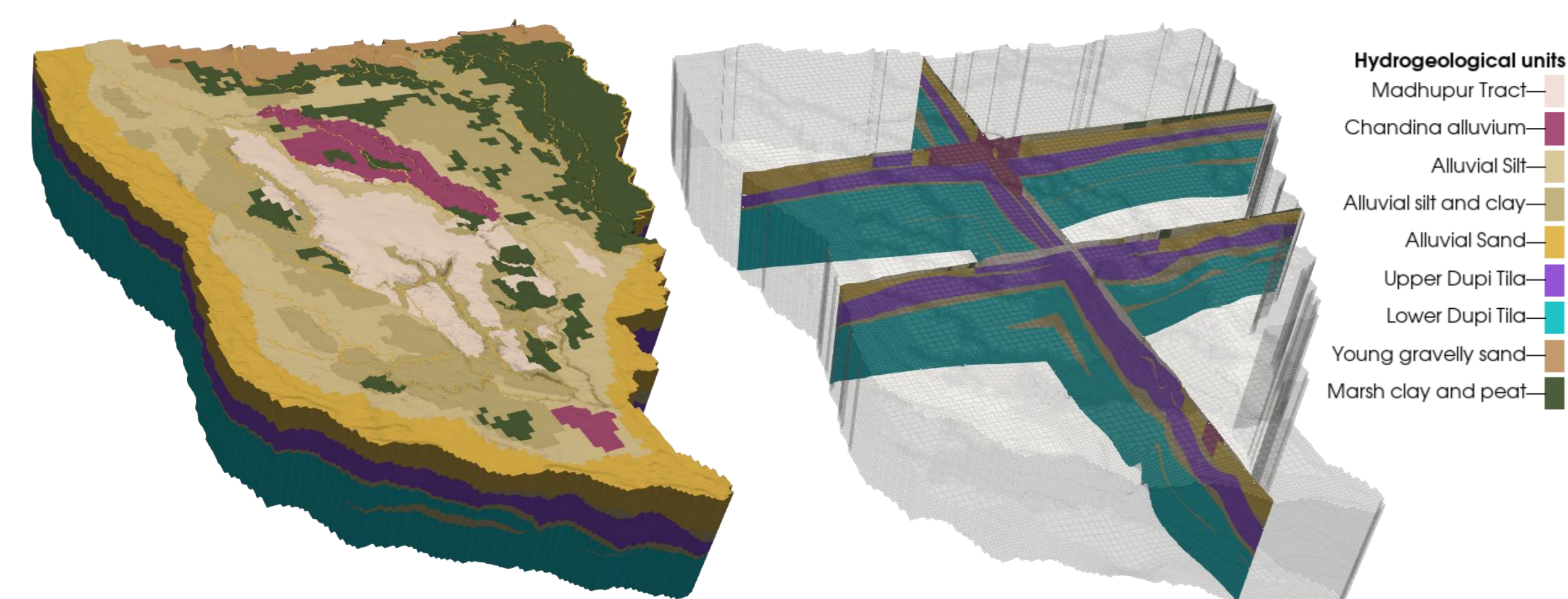
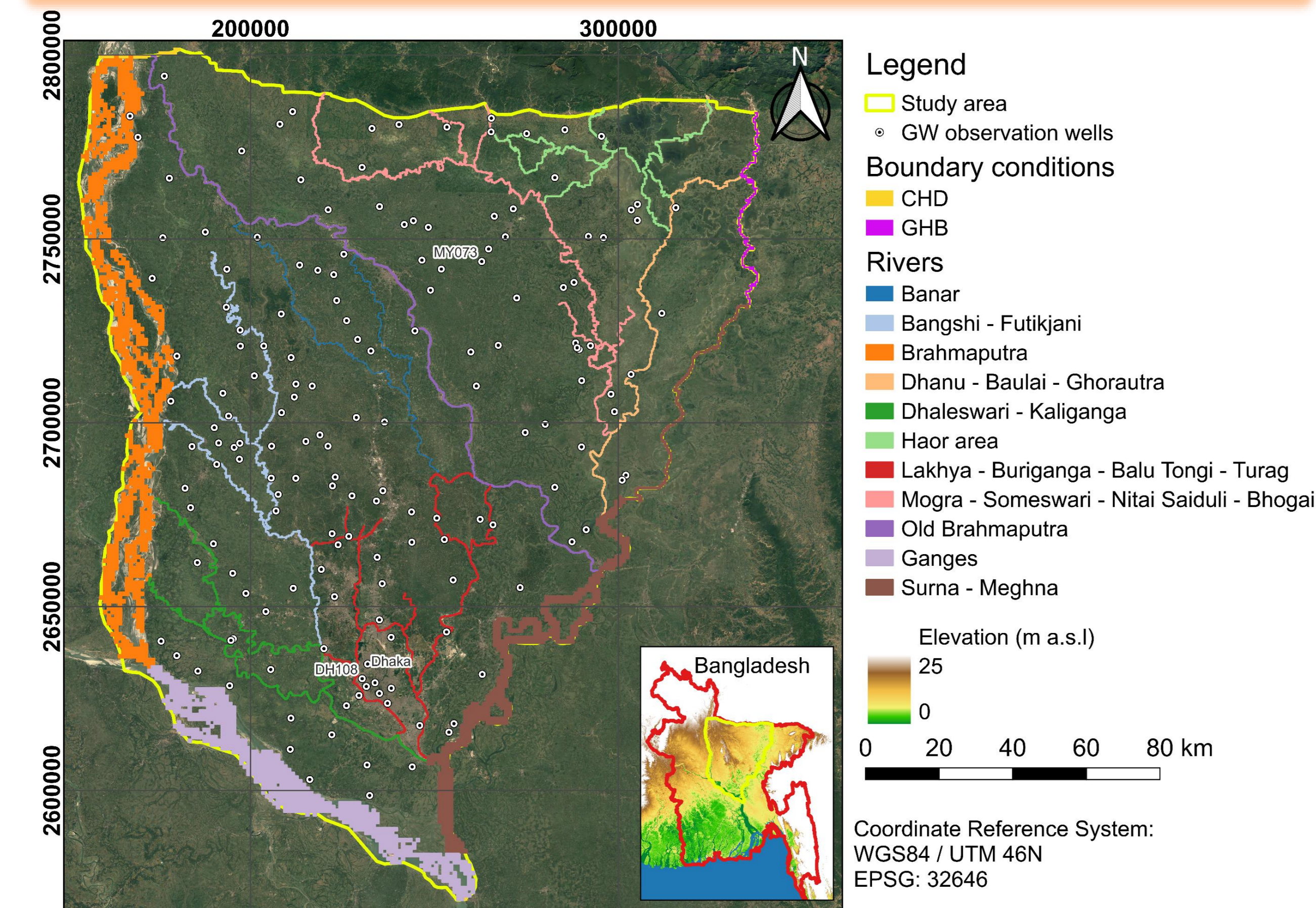
[1] Shamsudduha, M., Taylor, R. G., Haq, M. I., Nowreen, S., Zahid, A., & Ahmed, K. M. U. (2022). The Bengal Water Machine: Quantified freshwater capture in Bangladesh. *Science*, 377(6612), 1315–1319.
[2] Leaf, A. T., & Fioren, M. N. (2022). Flopy: The Python interface for MODFLOW. *Groundwater*, 60(6), 710–712.

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BANGLADESH AGRICULTURAL DEVELOPMENT CORPORATION (BADC)



Study area and numerical model

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- Numerical model with unstructured grid resolution between 250 m to 2000 m, and 11 layers of variable dz (3D geological model).
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Parameters distribution

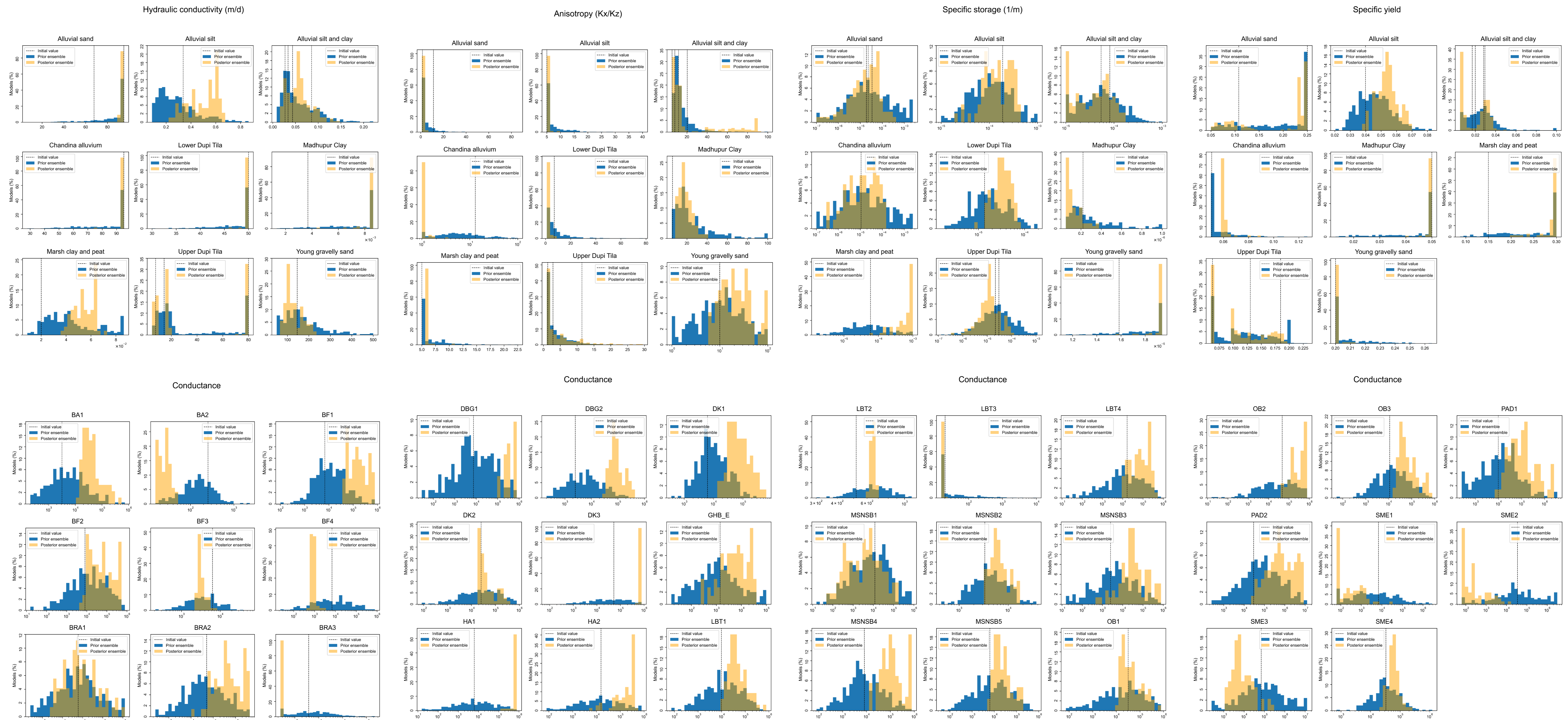


Fig. 2 Prior and posterior ensembles distribution of calibrated parameters.

Fig. 1. Study area, 3D numerical model and hydrogeological units.