Simulating Bank Filtrate Dynamics in Berlin

Decision Support Under Climate and Water Use Changes

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IMPETUS

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CHALLENGE & CONTEXT

- Berlin's drinking water relies on bank filtration and managed aquifer recharge, covering ~70% of supply in a semi-closed water cycle.
- River inflows may decline due to climate change and land use changes (e.g. lignite phase-out)
- Longer dry spells and more intense rainfall events reduce natural groundwater recharge, stressing water availability.
- The resulting impact on the share of bank filtrate remains uncertain.

GOAL

- Quantify the share of bank filtrate in a Berlin catchment across different well galleries.
- Assess how changes in groundwater recharge and water use scenarios affect the share of bank filtrate.
- Support adaptive management to ensure a resilient drinking water supply.

METHOD & RESULTS

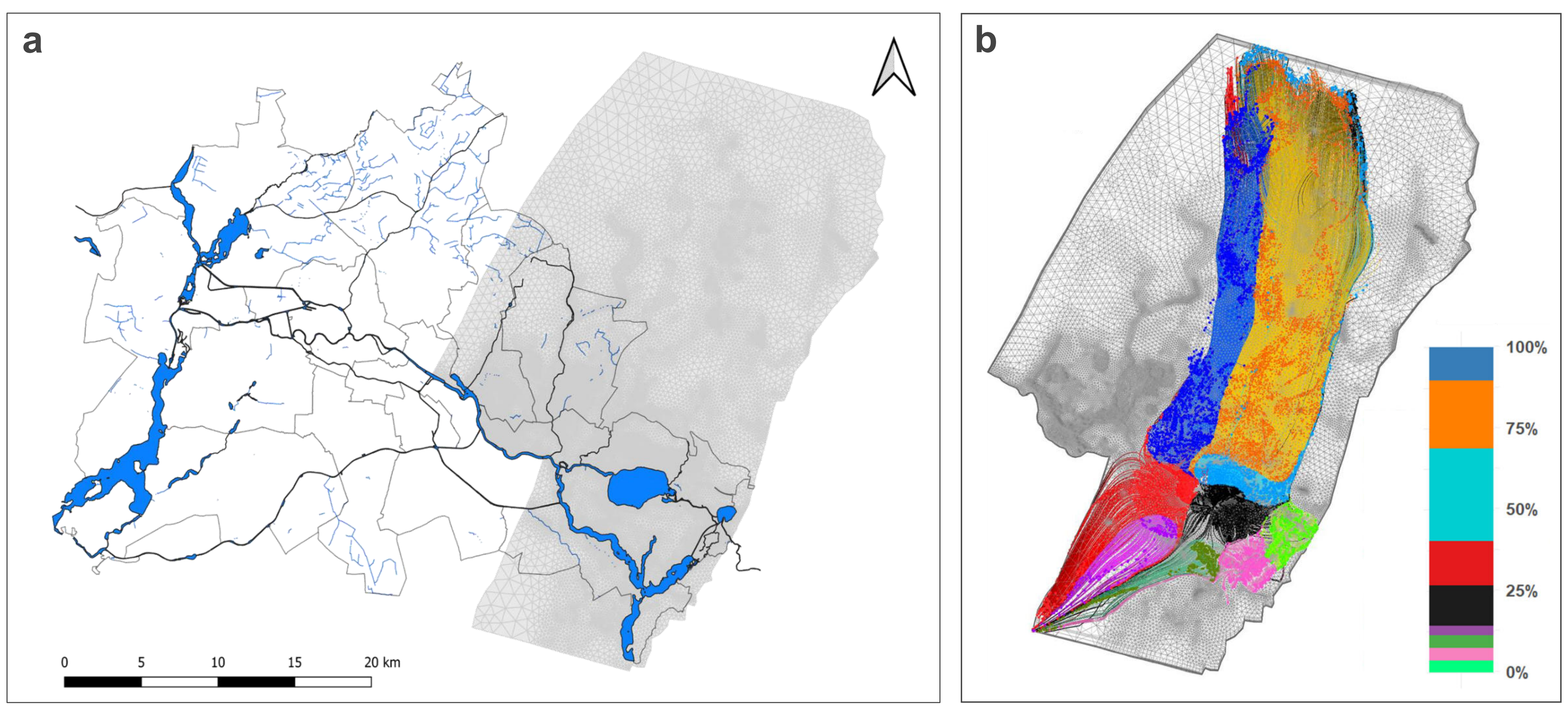
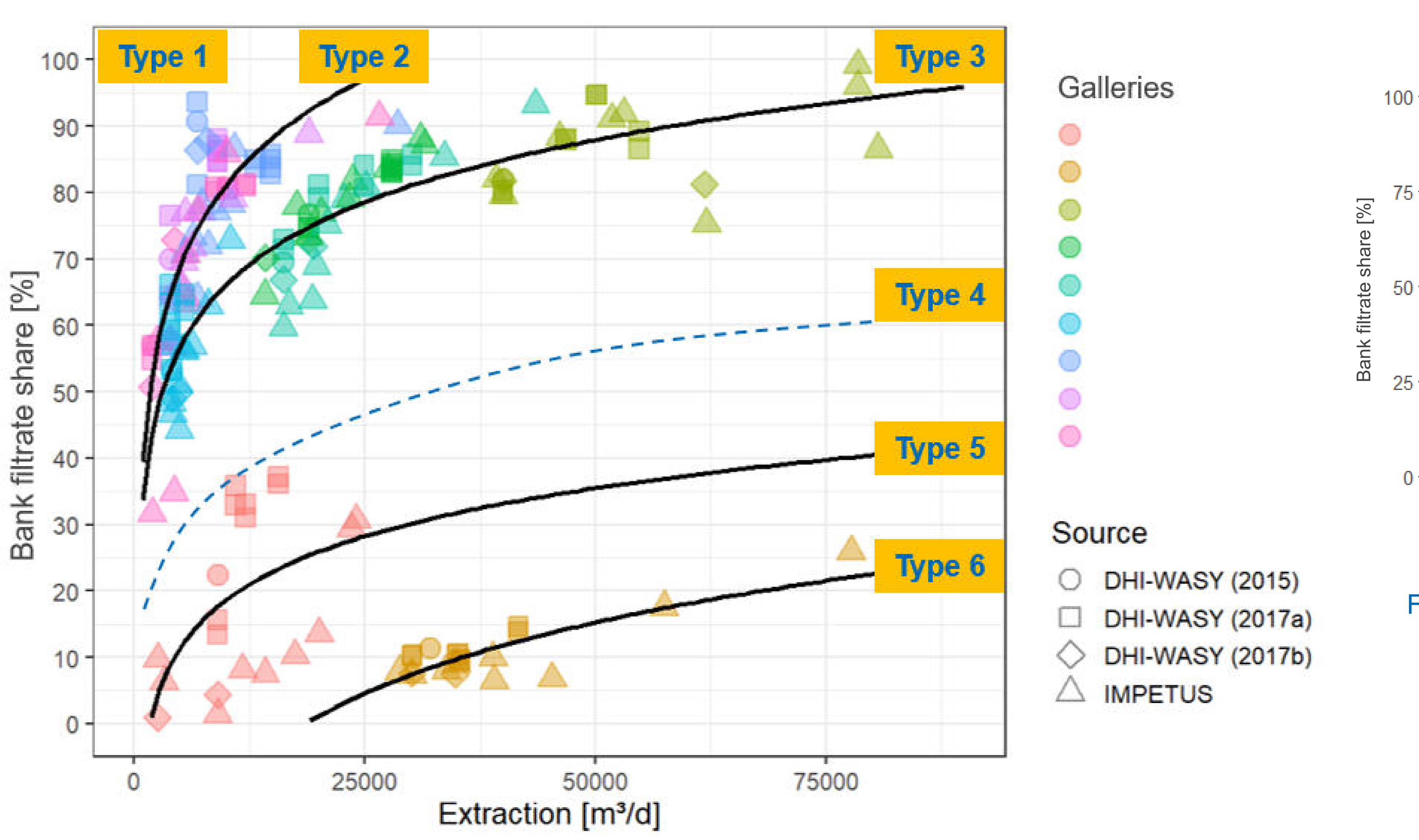


Fig.1: (a) Map of Berlin showing the city outline, surface water bodies (blue), and the model domain (grey) used for simulating bank filtration processes. (b) Simulated flow pathlines within the model domain delineate the catchment areas of different well galleries (colored). The example shown corresponds to a total extraction of 60 Mio m³/yr, based on 2019 abstraction data. The bar chart indicates the share of total extraction per gallery.

- A calibrated groundwater flow model (FEFLOW), provided by Berliner Wasserbetriebe (BWB), was used to simulate groundwater dynamics within the model area.
- A series of scenarios were developed by varying:
  → Groundwater recharge: 107 mm (baseline), 87 mm (−19%), 70 mm (−35%), and 54 mm (−50%, extreme case)
  → Pumping rates: increased by up to 30% relative to 2019 abstraction values
- Pathlines were simulated to delineate the catchment areas of different well galleries under each scenario.
- This approach allows assessing how changes in recharge and abstraction impact the spatial extent and composition of well catchments.



Type 1
SW > 90%

Type 2
SW = 50-100%
2,000 < Q < 30,000 m³/d
SW [%] = -79.3 + 17.4 × LN(Q)

Type 3
SW = 50-90%
3,000 < Q < 50,000 m³/d
SW [%] = -58.3 + 13.5 × LN(Q)

Type 4
SW = 0-60%
500 < Q < 50,000 m³/d
SW [%] = -70.34 + 12 × LN(Q)

Type 5
SW = 0-40 %
4,000 < Q < 60,000 m³/d
SW [%] = -77.4 + 10.4 × LN(Q)

Type 6
SW = 0-20 %
20,000 < Q < 70,000 m³/d
SW [%] = -151.8 + 15.4 × LN(Q)

Fig. 2: Relationship between total extraction and bank filtrate share, based on a combination of literature data and model results. The distribution allows for the identification of six distinct classes, each representing a different range of bank filtrate contribution.

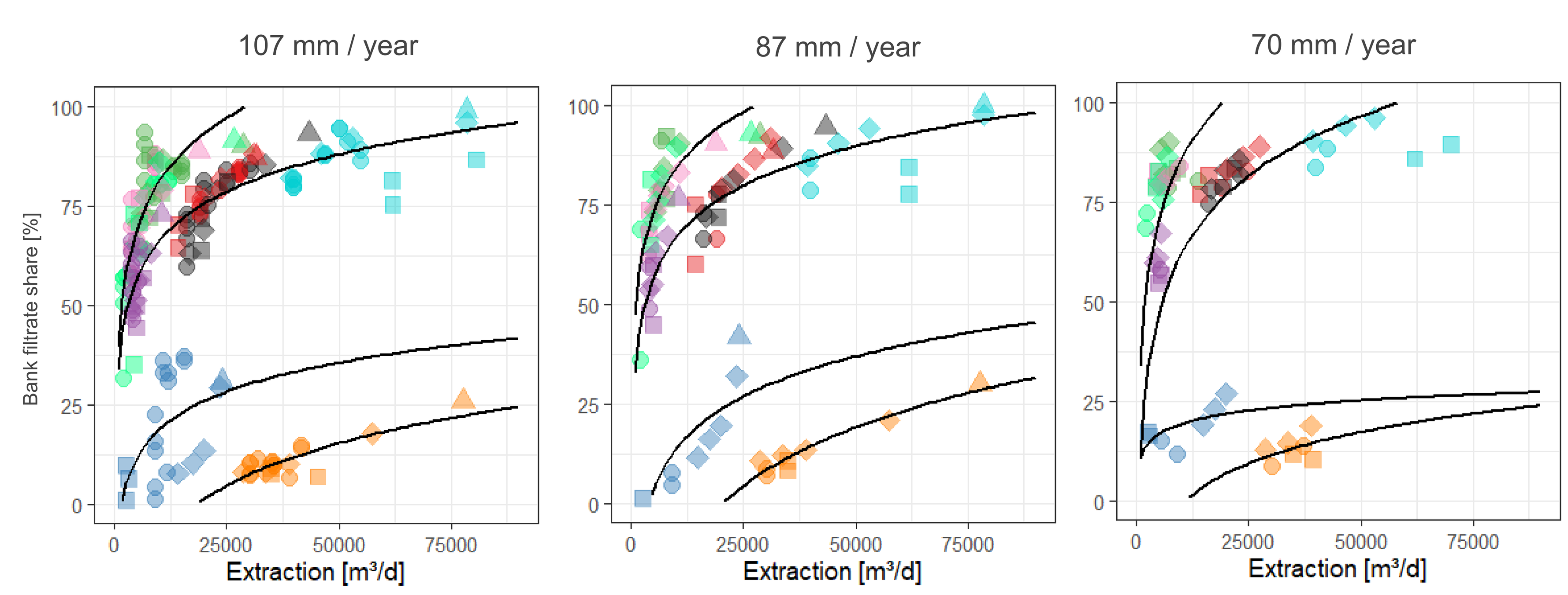


Fig. 3: Change in bank filtrate fraction across scenarios with differing groundwater recharge rates.

- Six distinct bank filtrate types were identified based on the relationship between extraction rates and filtrate share.
- Higher groundwater recharge scenarios led to a lower share of bank filtrate, while reduced recharge increased the relative contribution of bank filtrate to total extraction.
- Model results for the 70 mm recharge scenario were implausible, likely due to numerical instability under extreme combinations of low recharge and high extraction.

SUMMARY & CONCLUSION

- The study identified six characteristic types of bank filtrate contribution, which are influenced by factors such as:
  → Distance to the river bank
  → Surrounding surface water availability
  → Well depth
  → Regional groundwater levels
- Lower groundwater recharge increases the bank filtrate share, while higher recharge reduces it.
- Numerical instabilities at extreme recharge–extraction setups highlight model limitations and the need for cautious interpretation.
- Next steps should focus on scaling the analysis to all Berlin galleries and exploring the role of managed aquifer recharge (MAR) as a stabilising measure.

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