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Grasping water availability at regional scale: development of exploratory methods

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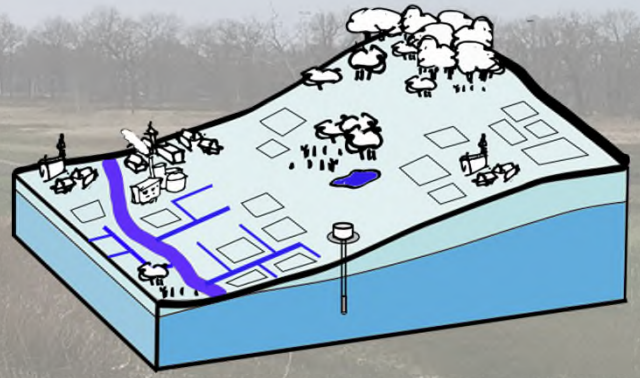
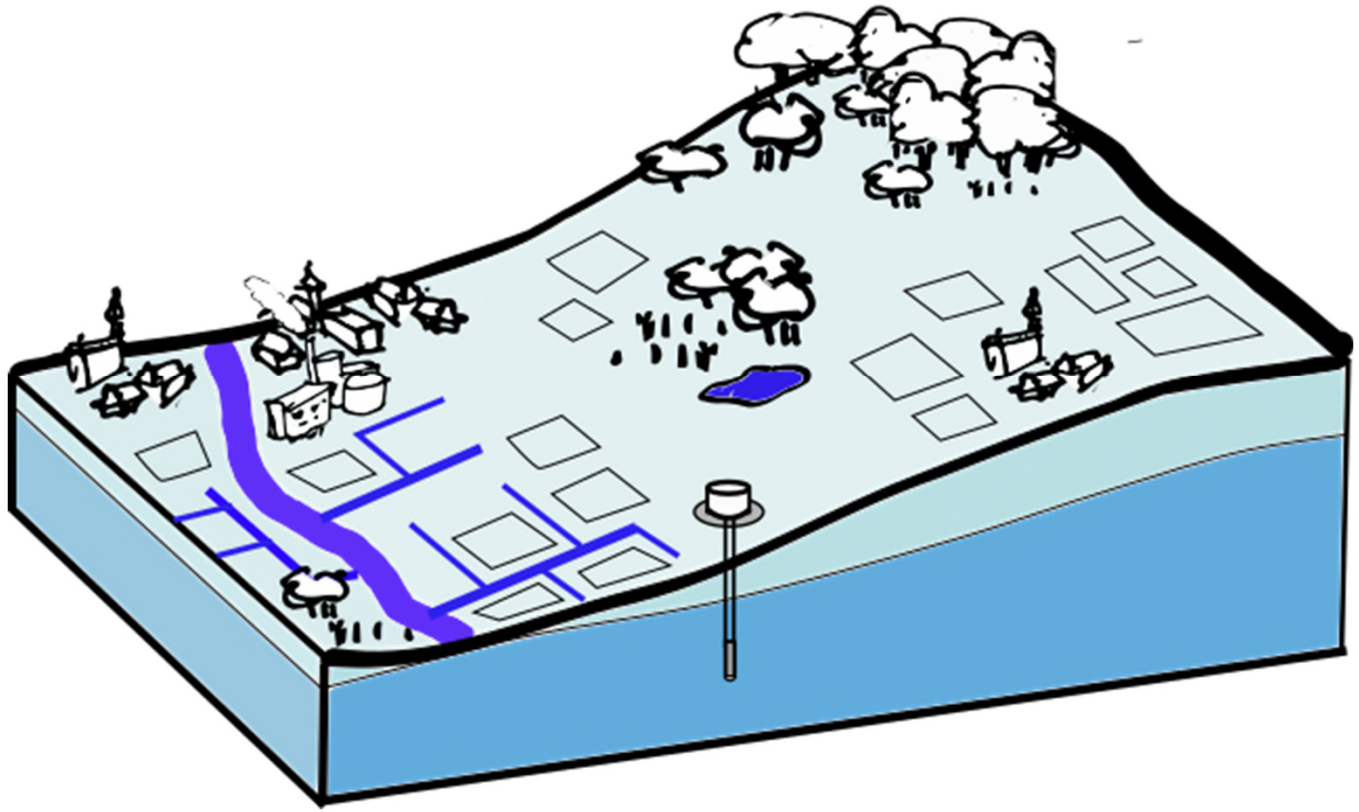


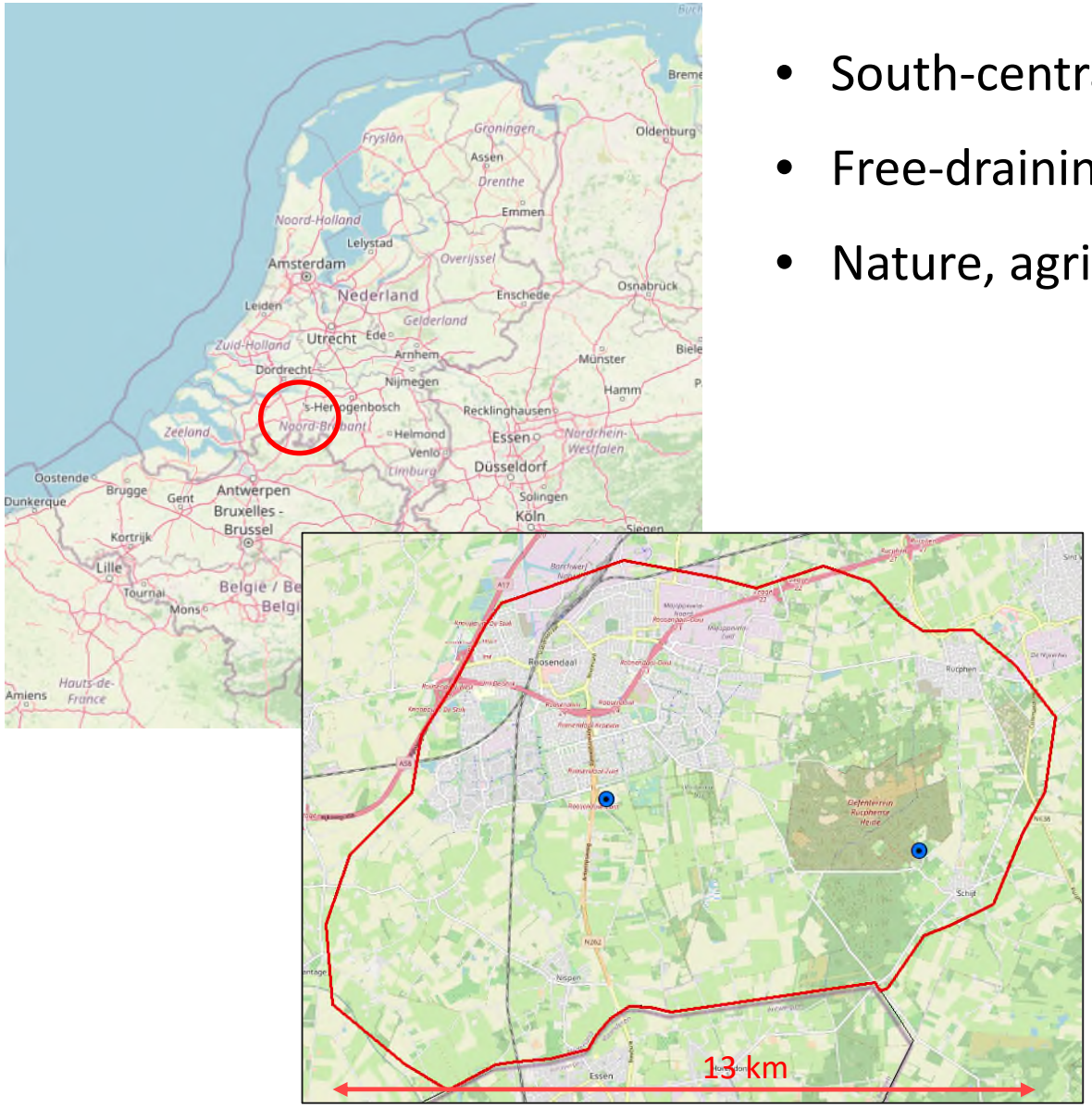
Regional water systems

- Interconnected water volumes and flows, various water functions
- Increasing pressure in dry periods

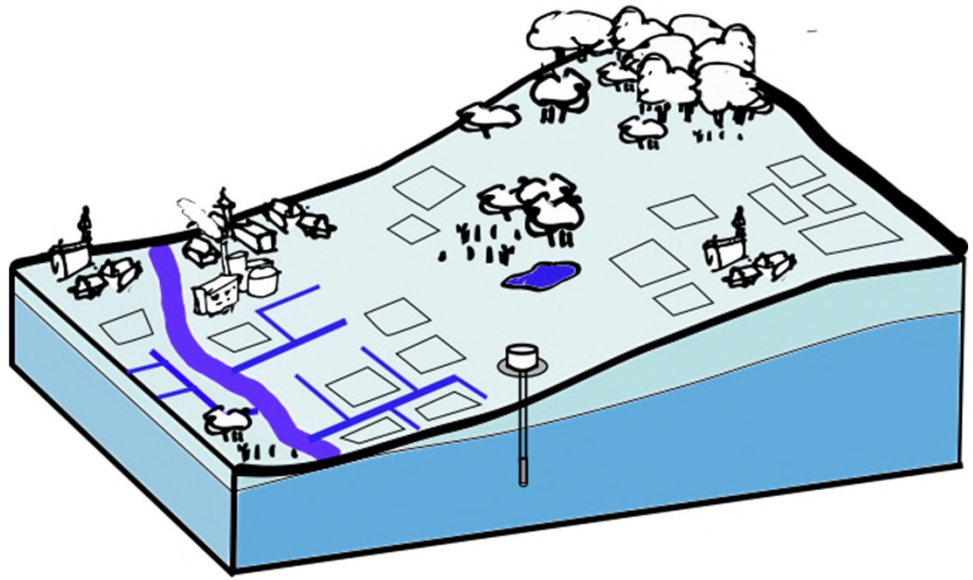
*How can **simplified (analytical) methods** be used to explore **water system functioning** and **effects** of interventions?*



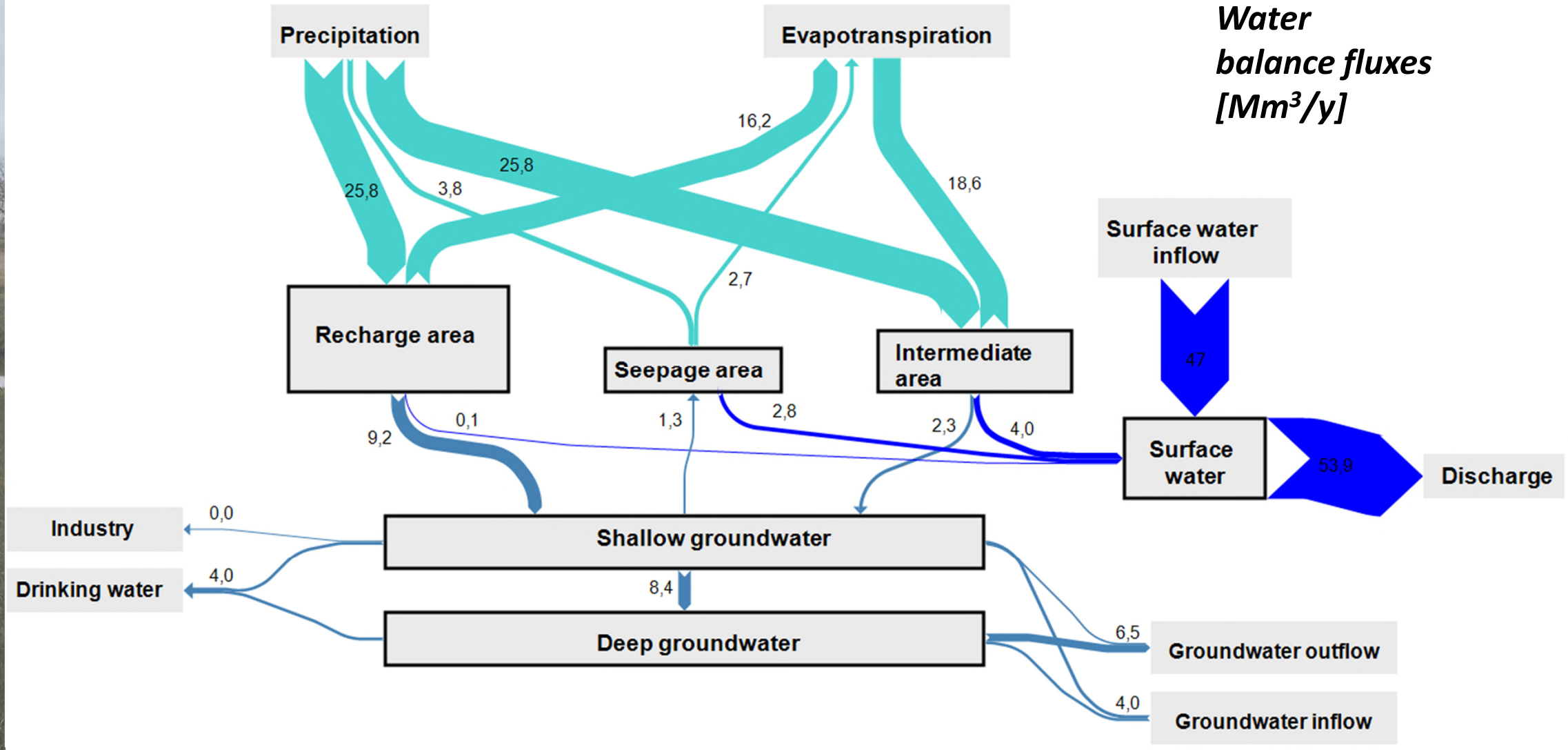
Case study area



- South-central Netherlands
- Free-draining, drought-sensitive
- Nature, agriculture, drinking water



Water balance visualisation



Effect of additional recharge: Analytical response time analysis

*What is the effect of **additional recharge** (e.g. of surface water) on groundwater storage **at different landscape positions**?*

$$Q = \frac{1}{j} * S$$

Kraijenhoff (1958): in idealised situation, lowland system can work as a **linear reservoir**

*Response time **j**: time after which 37% of instantaneous recharge addition remains*

$$j[d] = \frac{\mu L^2}{\pi^2 kD}$$

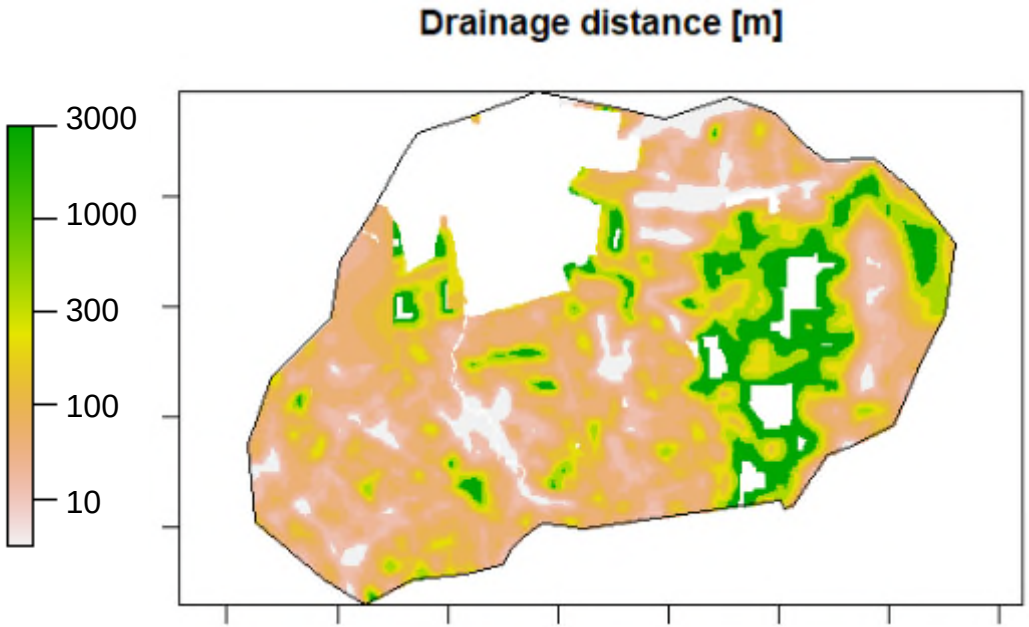
Response time **j** varies with drainage distance

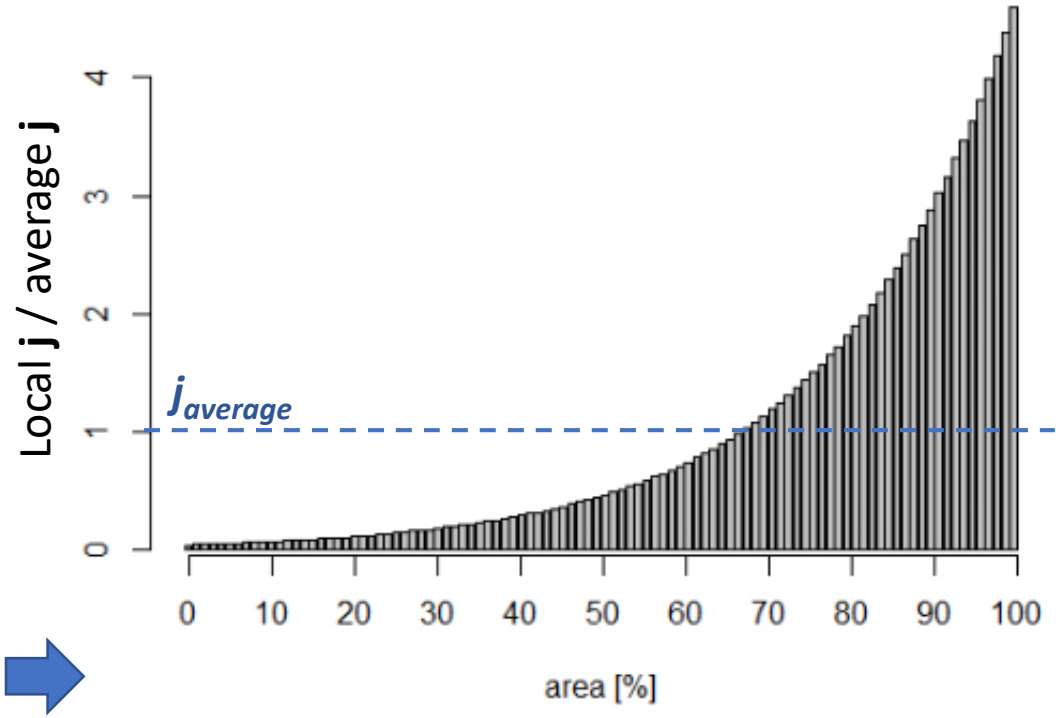
→Simple analytical modelling of hydrology + landscape variation

Analytical response time analysis

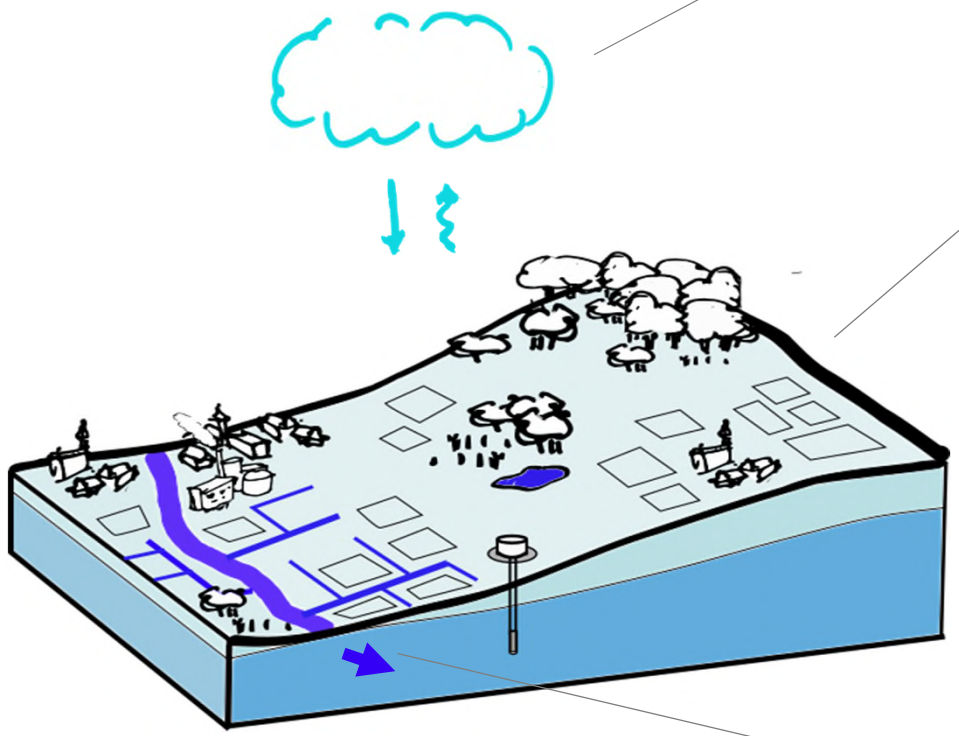
Estimate distribution of response time **j** from drainage distance maps

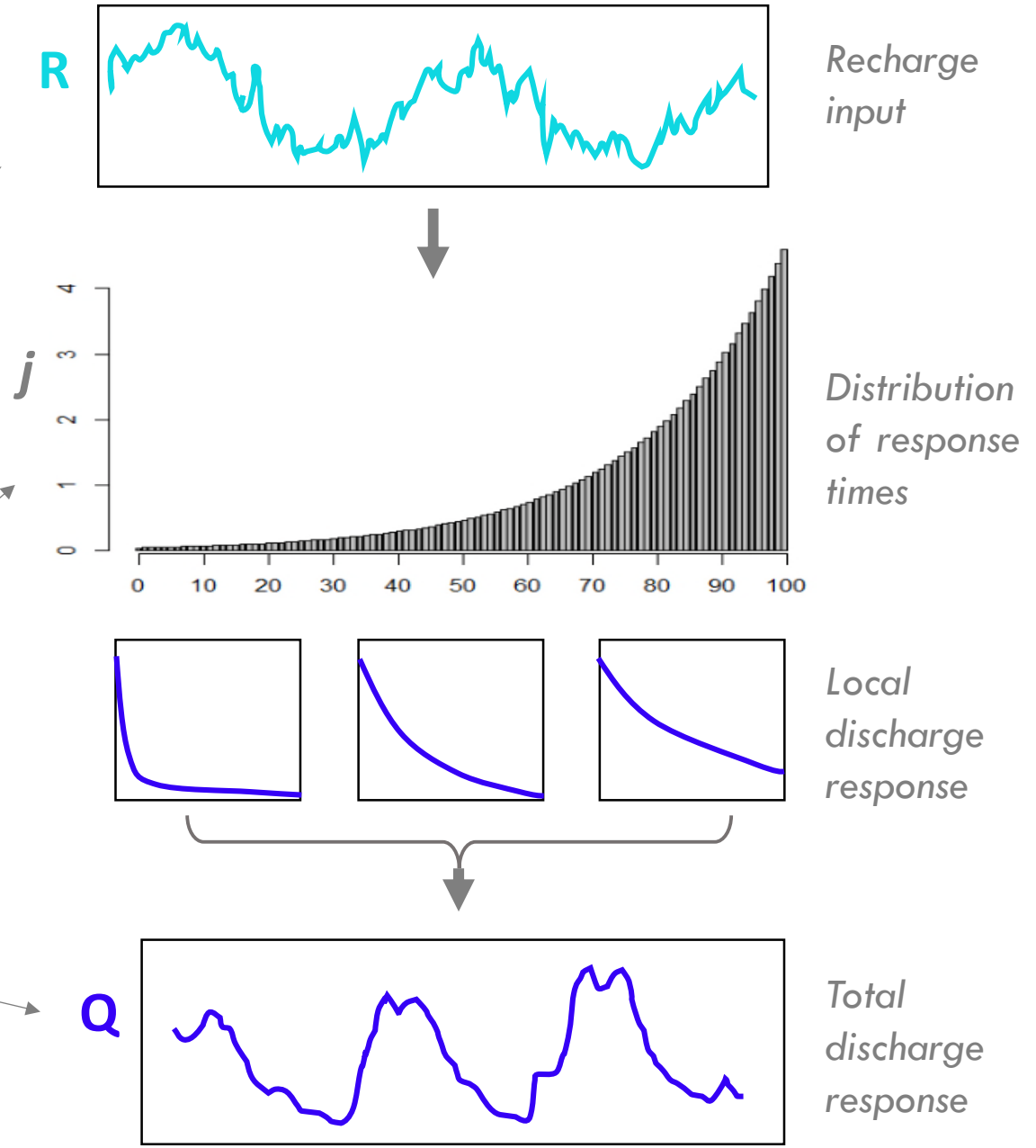
"Flattening" study area into transect of 100 independent sections with $j_{local}/j_{average}$



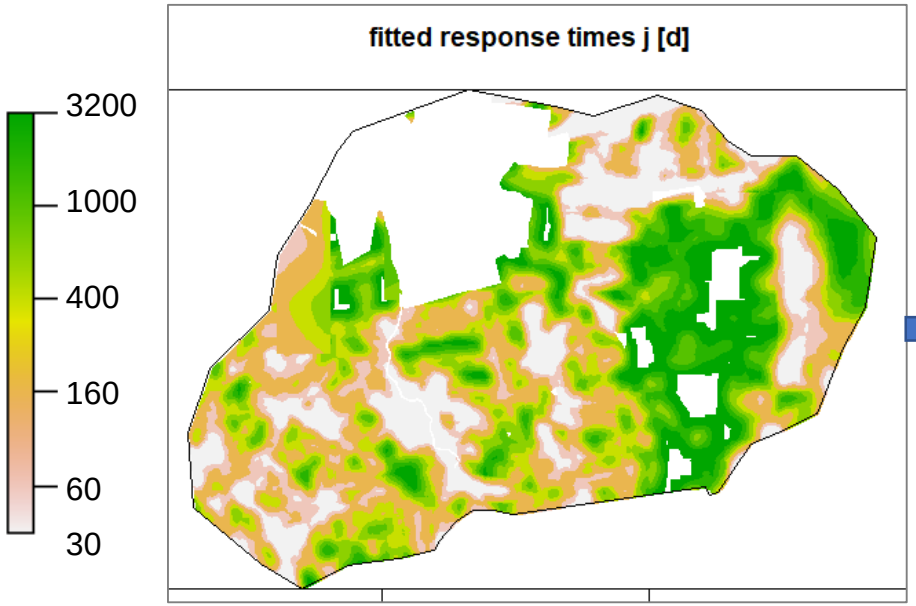


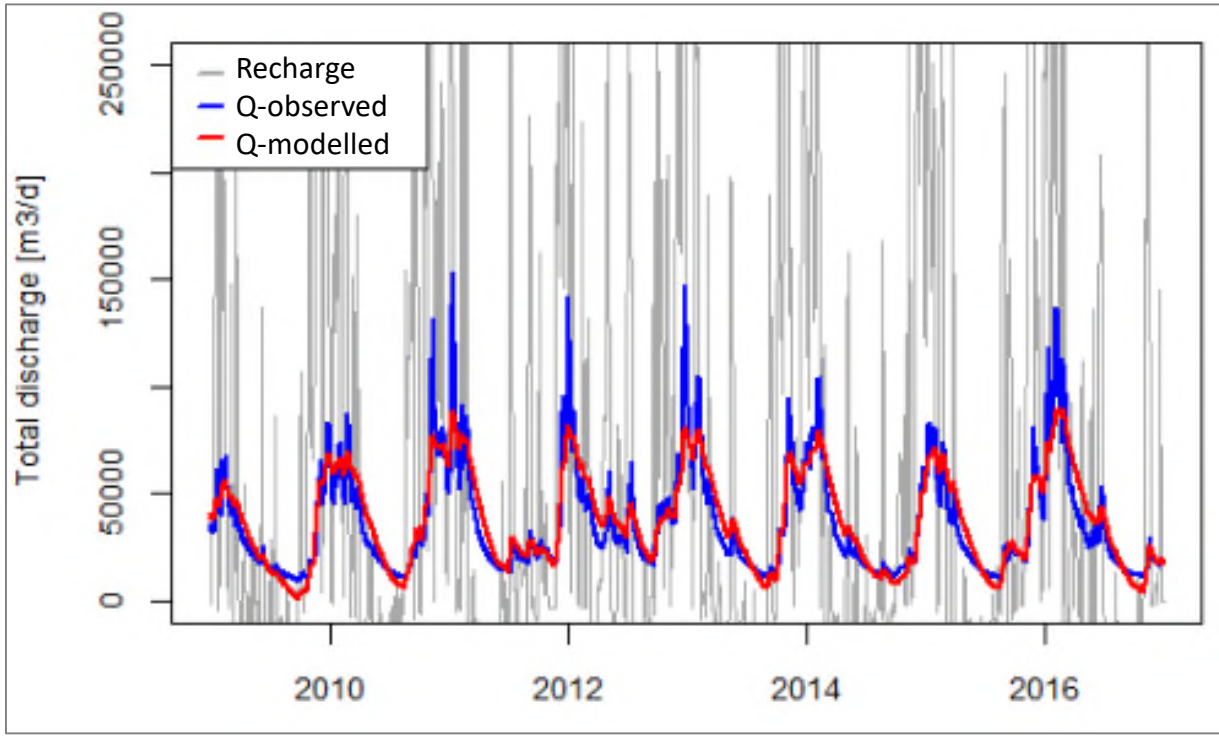
Fitting response time distribution to discharge



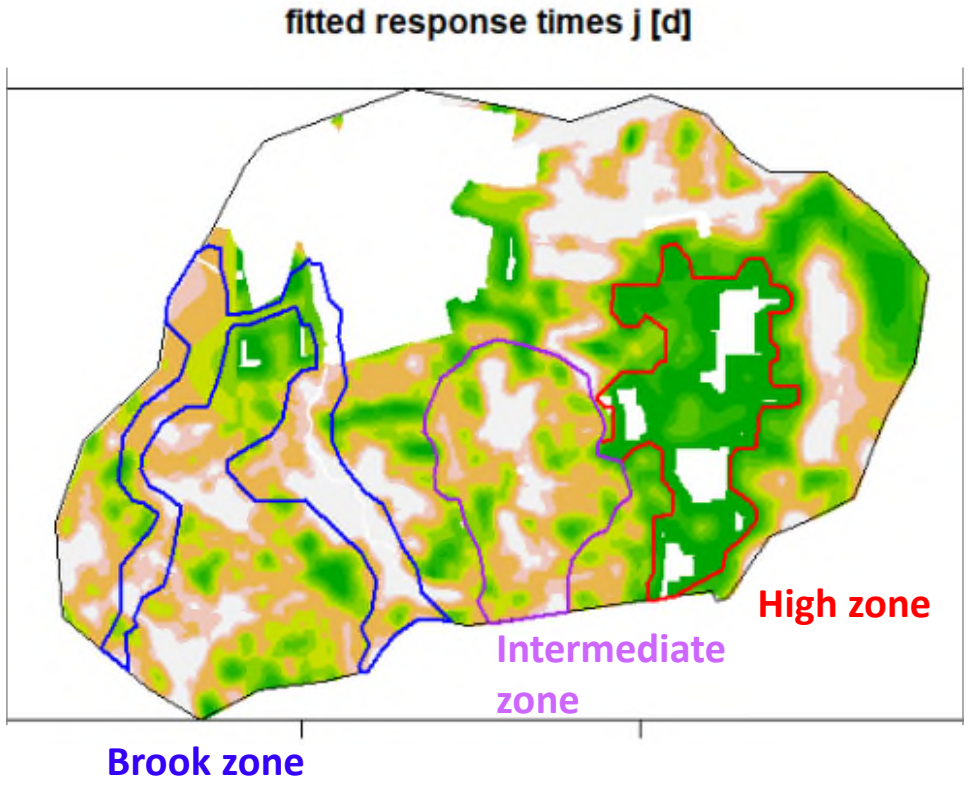


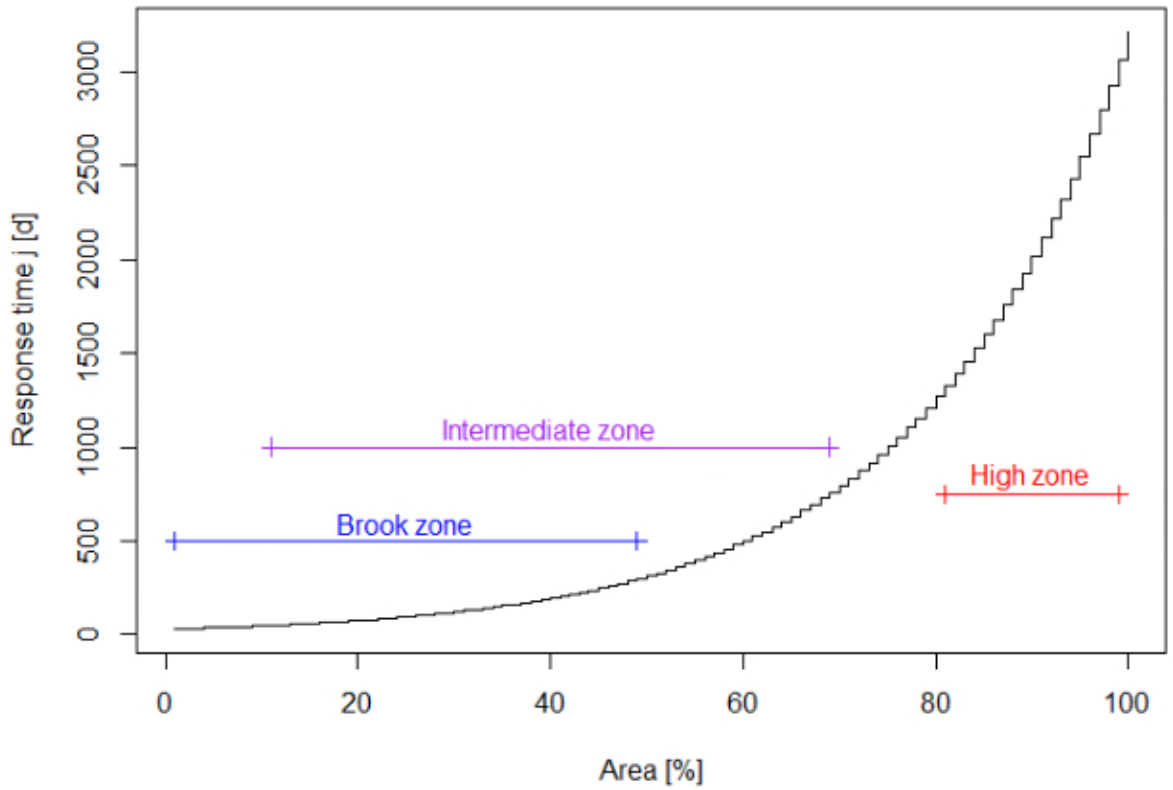
Fitting response time distribution to discharge



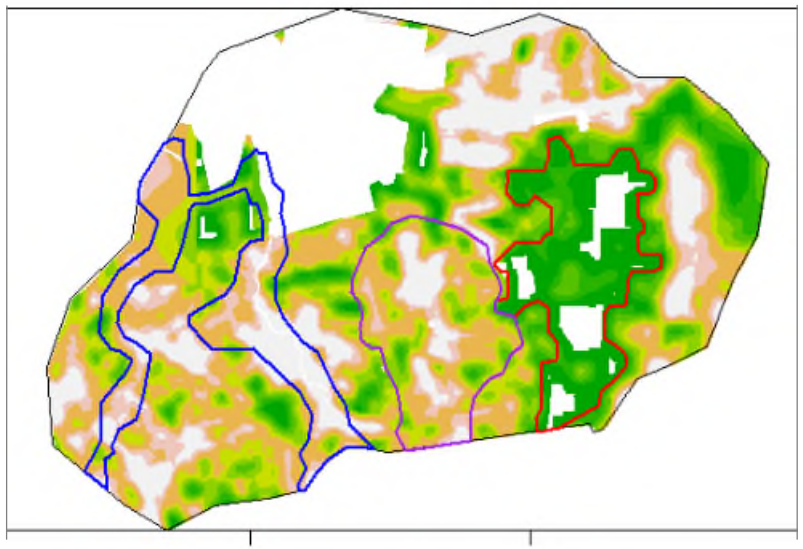


Effect of additional recharge in zones of interest

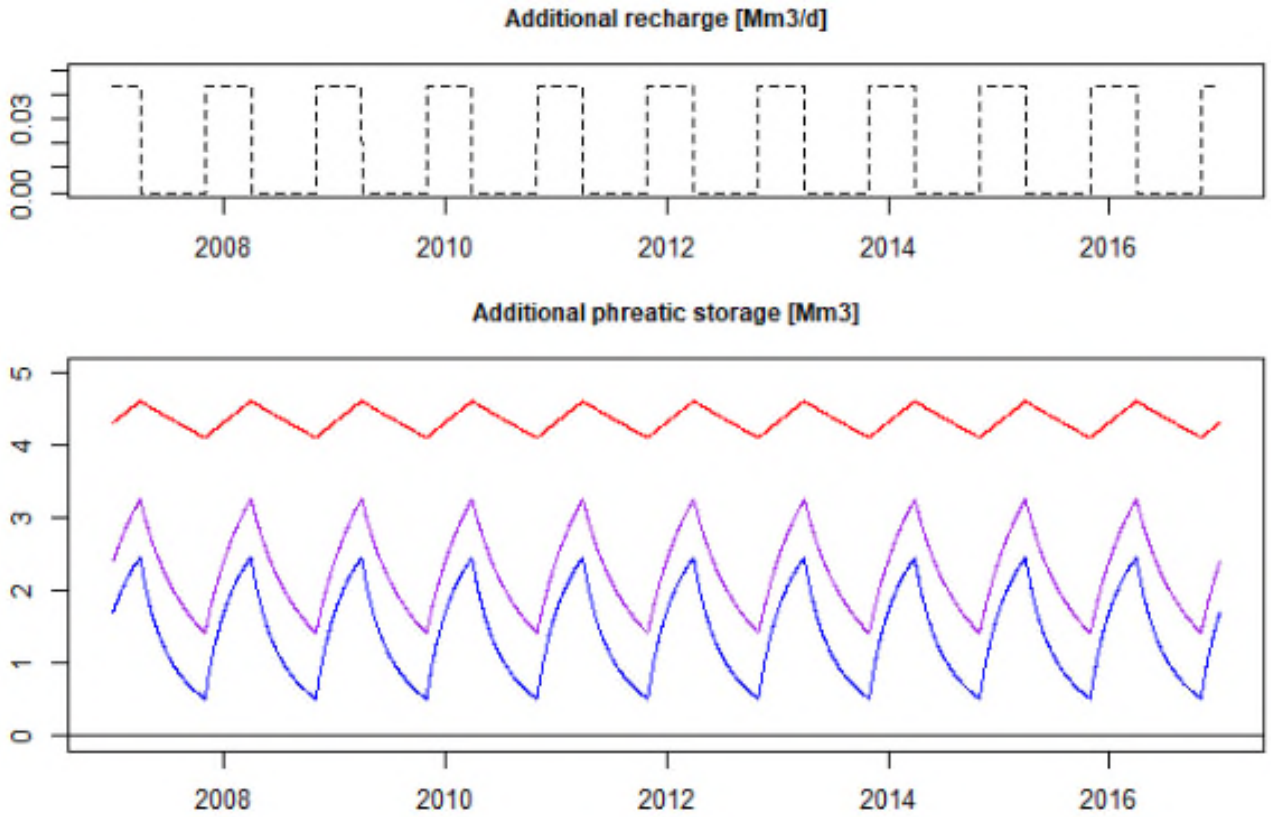




Effect of additional recharge in zones of interest



Brook zone **Intermediate zone** **High zone**



→ Landscape variation in buffering behaviour reproduced

Comparison to distributed numerical groundwater model

Zone	Additional recharge [mm/d]	Additional groundwater storage [Mm3]	
		Spatial model	Simplified method
High zone	1	4.6	1.7
	5	8.0	8.9
	14	8.5	23.4
Intermediate zone	1	1.4	0.9
	5	3.4	4.5
	14	4.6	11.9
Brook zone	1	0.6	0.5
	5	1.9	2.8
	14	2.9	7.3

- Similar order of magnitude for small recharge changes
- Overestimation for large recharge changes
- Limitation of linear response assumption
- Drainage adaptation needed for increased water storage

Use of simplified methods for effect exploration in regional water systems

- Simple analytical method useful as fast exploration
- Gives insight in landscape functioning and orders of magnitude
- Limitations of simplifying assumptions
- Drainage system important for water storage

Thank you!

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