The Finite Volume Point Dilution Method (FVPDM): a tracer technique for monitoring groundwater fluxes

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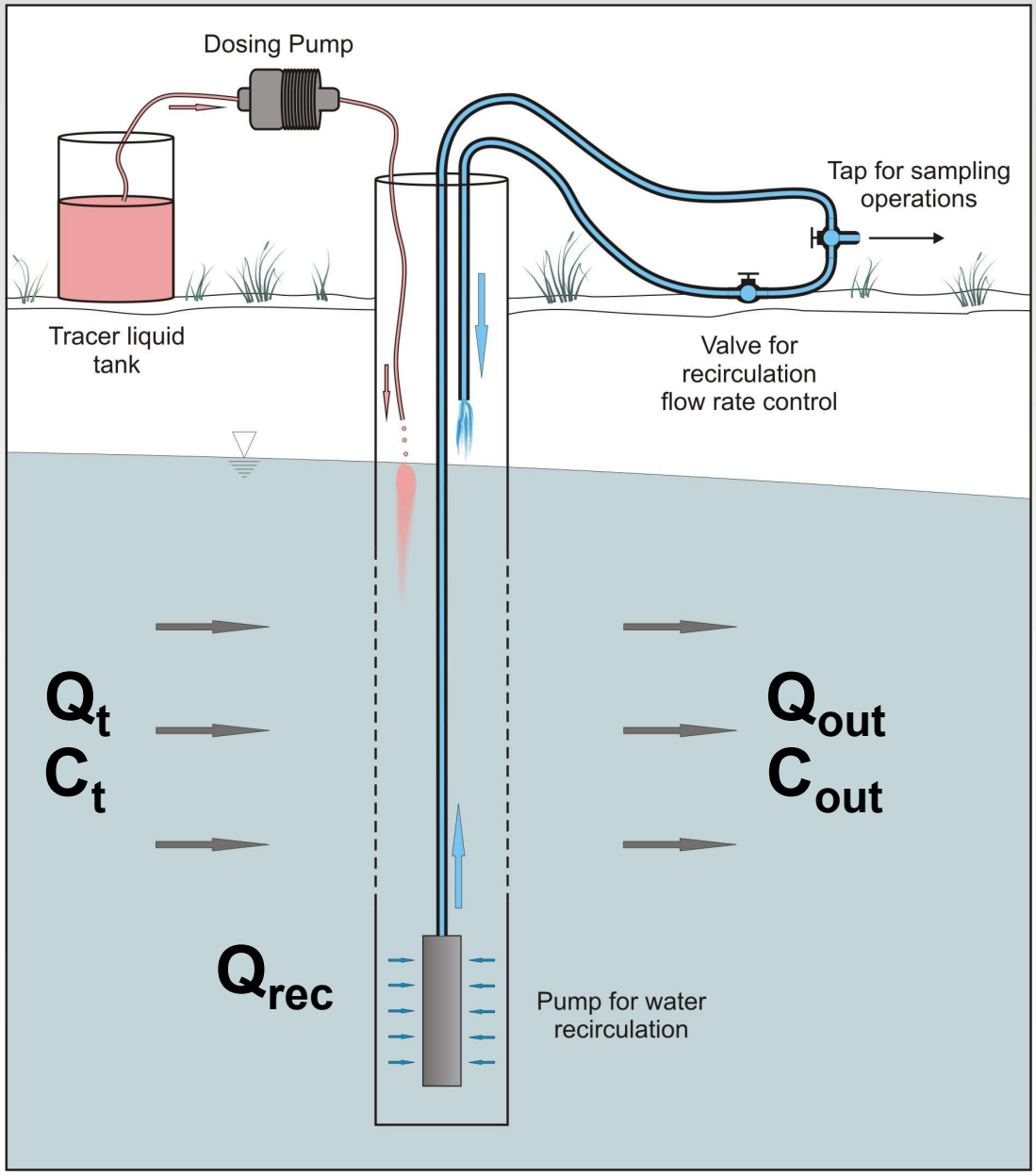
Contents of the exposition

1. General ideas of the FVPDM
2. Overview of the mathematical framework and analytical solution
3. The FVPDM as performed in the field
4. Experimental validation
5. Conclusions & perspectives

2. Mathematical framework & analytical solution (I)

(Further details in Brouyère (2001) and Brouyère (2003))

Q_{in}
C_{in}



2. Mathematical framework & analytical solution (II)

(Further details in Brouyère (2001) and Brouyère (2003))

Water conservation

$$\frac{\partial V_w(t)}{\partial t} = \pi . r_w^2 \frac{\partial h_w}{\partial t} = Q_{in}(t) + Q_t(t) - Q_{out}(t)$$

Tracer conservation

$$\frac{\partial M_t}{\partial t} = \frac{\partial}{\partial t}(V_w C_w) = \pi . r_w^2 \left(C_w \frac{\partial h_w}{\partial t} + h_w \frac{\partial C_w}{\partial t} \right) = Q_{in} C_{in} + Q_t C_t - Q_{out} C_{out}$$

Concentration evolution in the injection well

$$C_w(t) = \frac{Q_{in} C_{in} - (Q_{in} C_{in} - Q_{out} C_{w,0}) \exp\left(-\frac{Q_{out}}{V_w}(t - t_0) \right)}{Q_{out}}$$

3. The FVPDM as performed in the field

Prior calculation of the critical flow injection rate

$$Q_{cr} = 2\pi e_{scr} r_w v_{ap} = 2\pi e_{scr} \alpha_w |\underline{v}_D|$$

Where the condition to be satisfied is

$$Q_{inj} < Q_{cr}$$

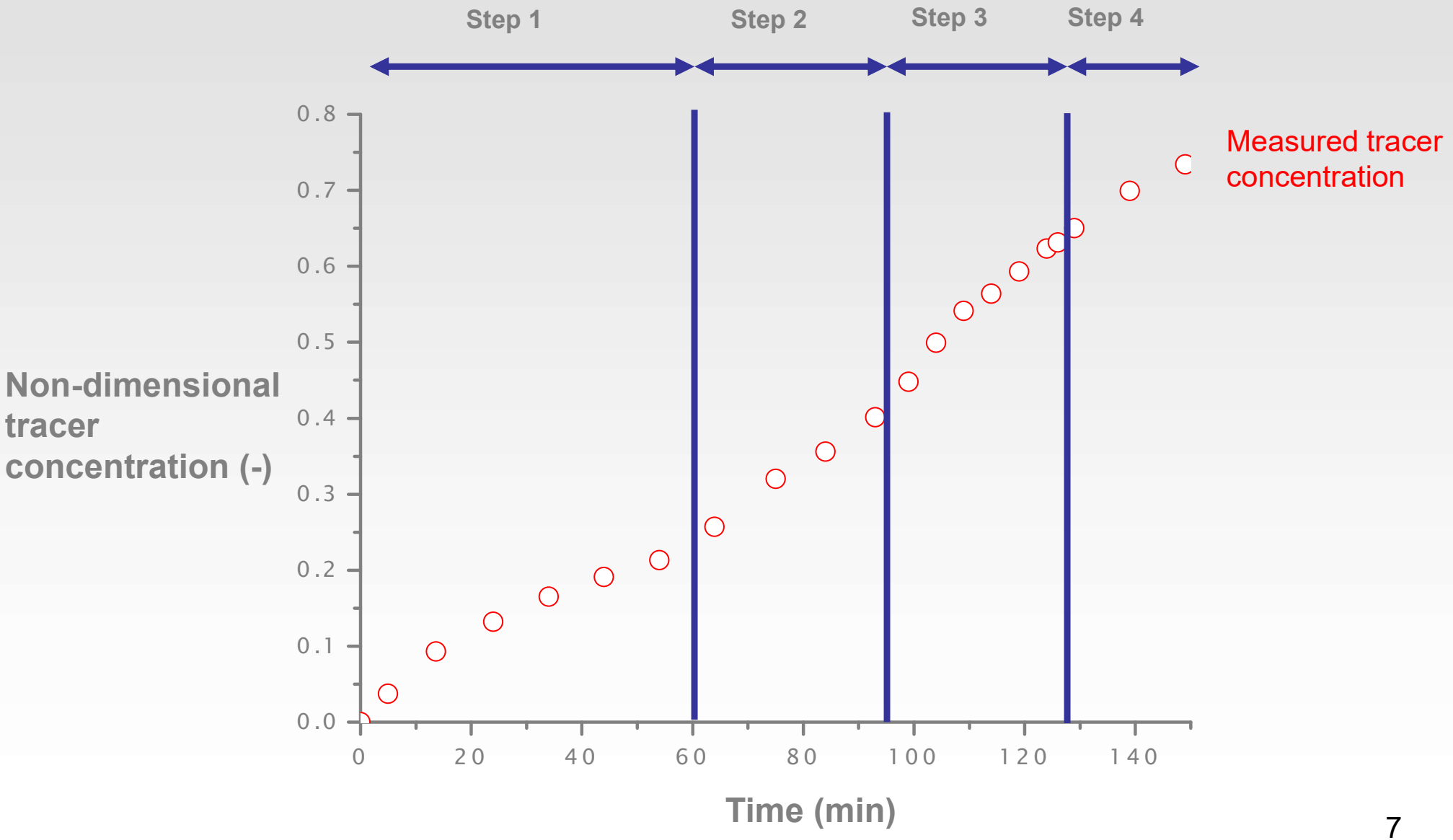
(Further practical details in Brouyère et al., (2007))

Experimental setup device in the field

4. Experimental validation

	Brévilles catchment (France)	Walloon Meuse basin (Belgium)
Geology of the aquifer	Layers of sand overburden by fractured marly limestones	Gravelly alluvial
Field conditions	• No power supply • Limited water available • No security (vandalism)	• Power supply • Water available • Field security
Objectives	Highlight vertical variations in groundwater fluxes	Evaluate GW fluxes discharging to the adjacent Meuse river

4. Brévilles catchment (France)



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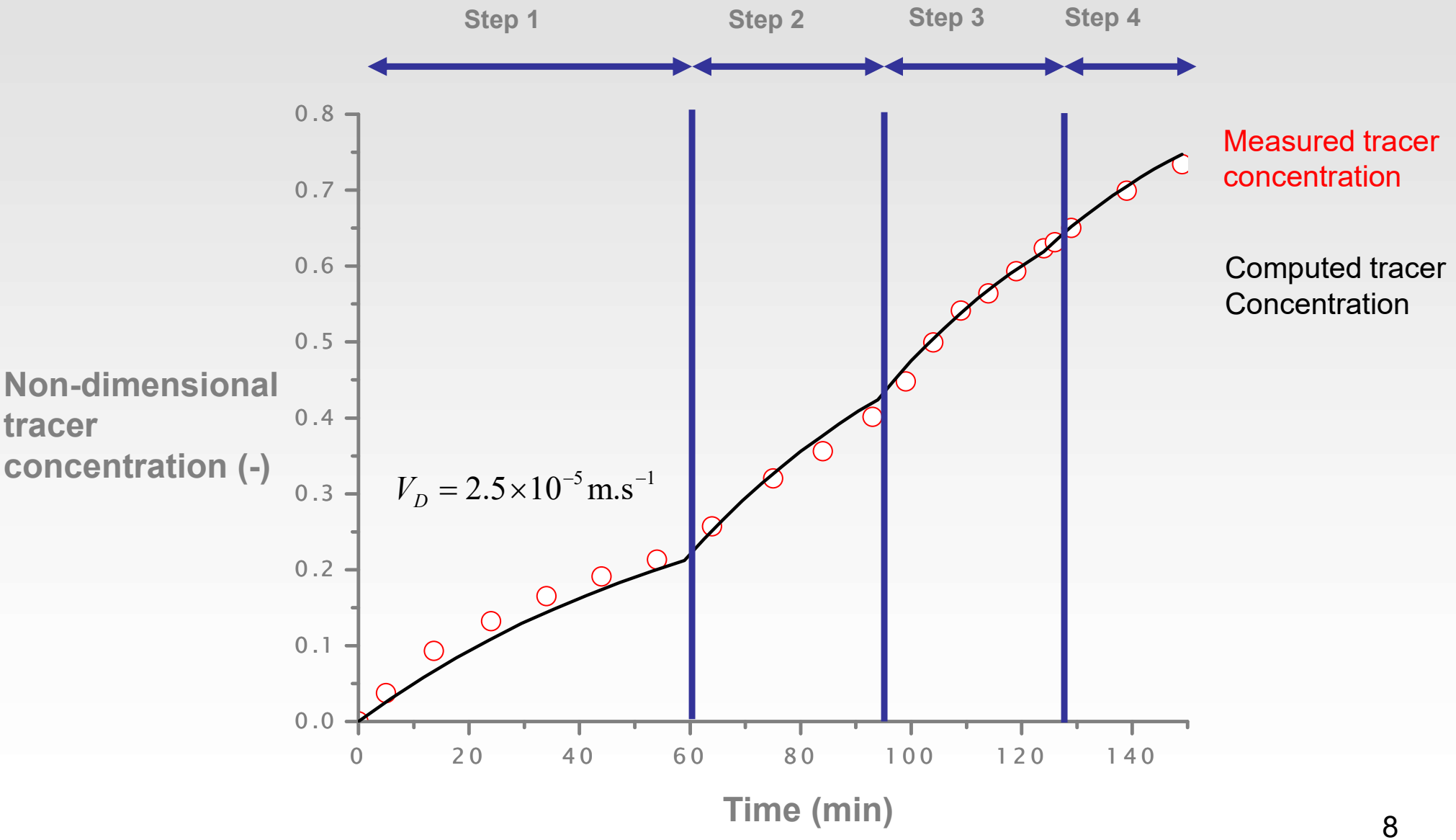
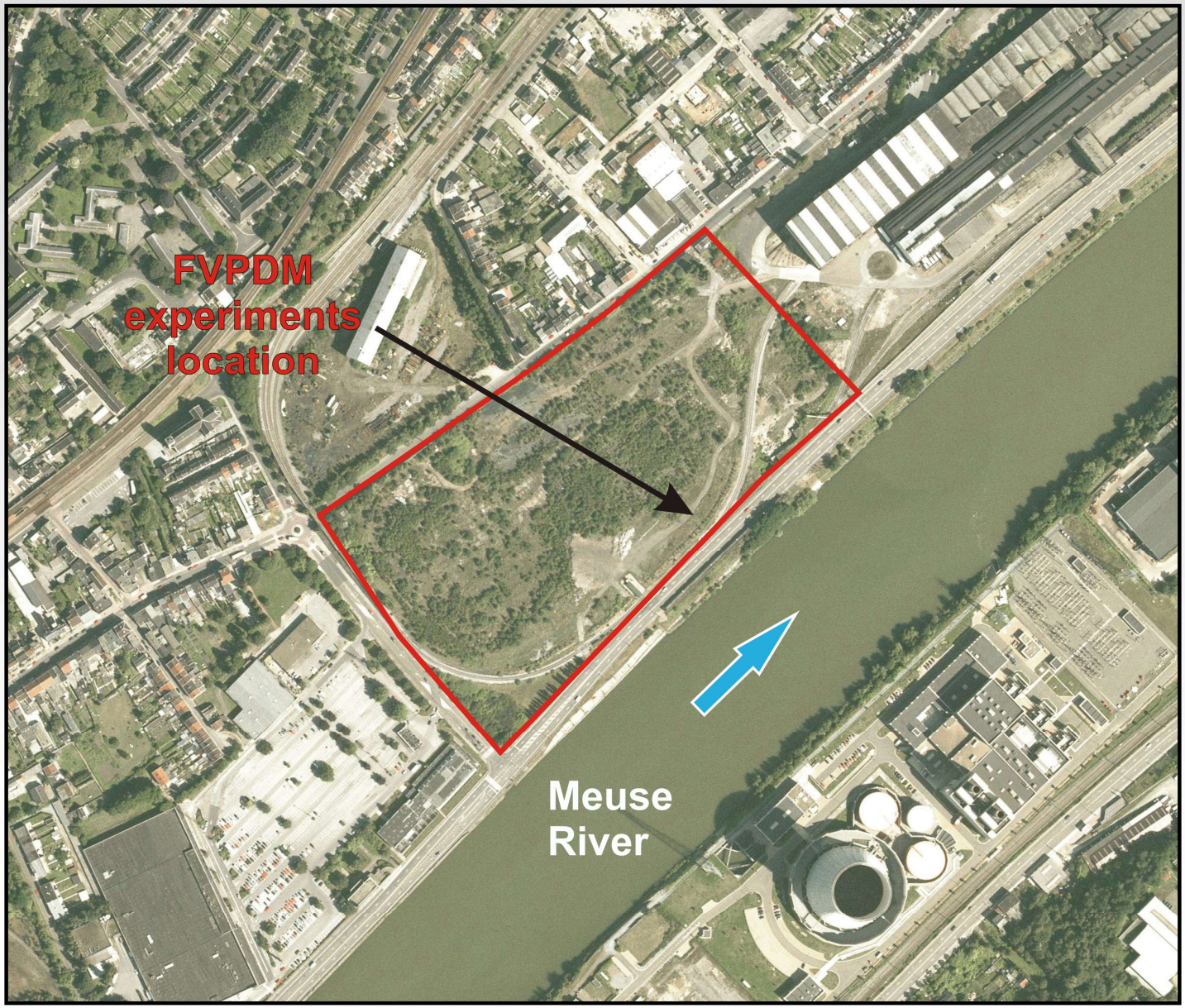


4. Brownfield site in the Walloon Meuse basin (Belgium)



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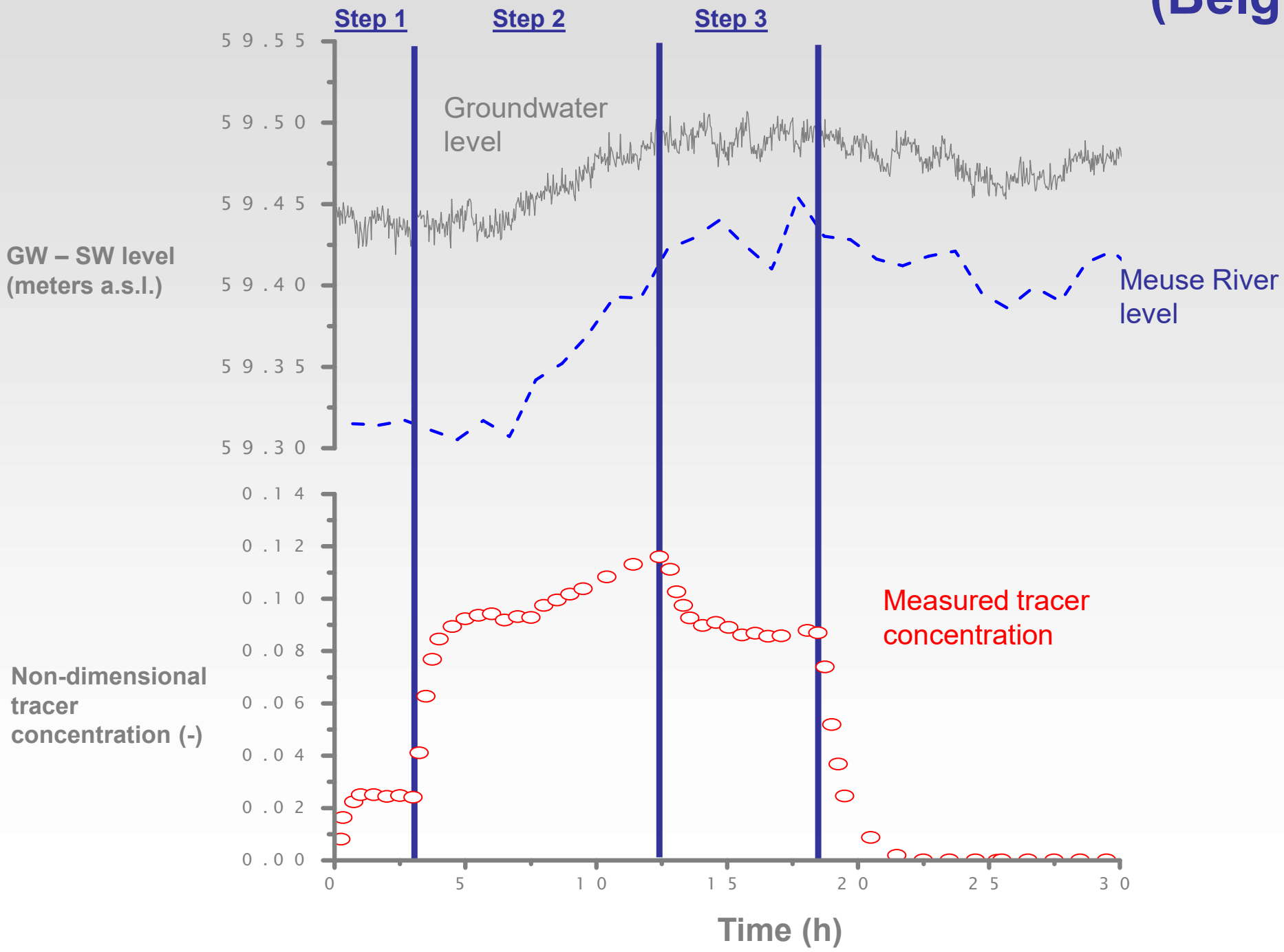

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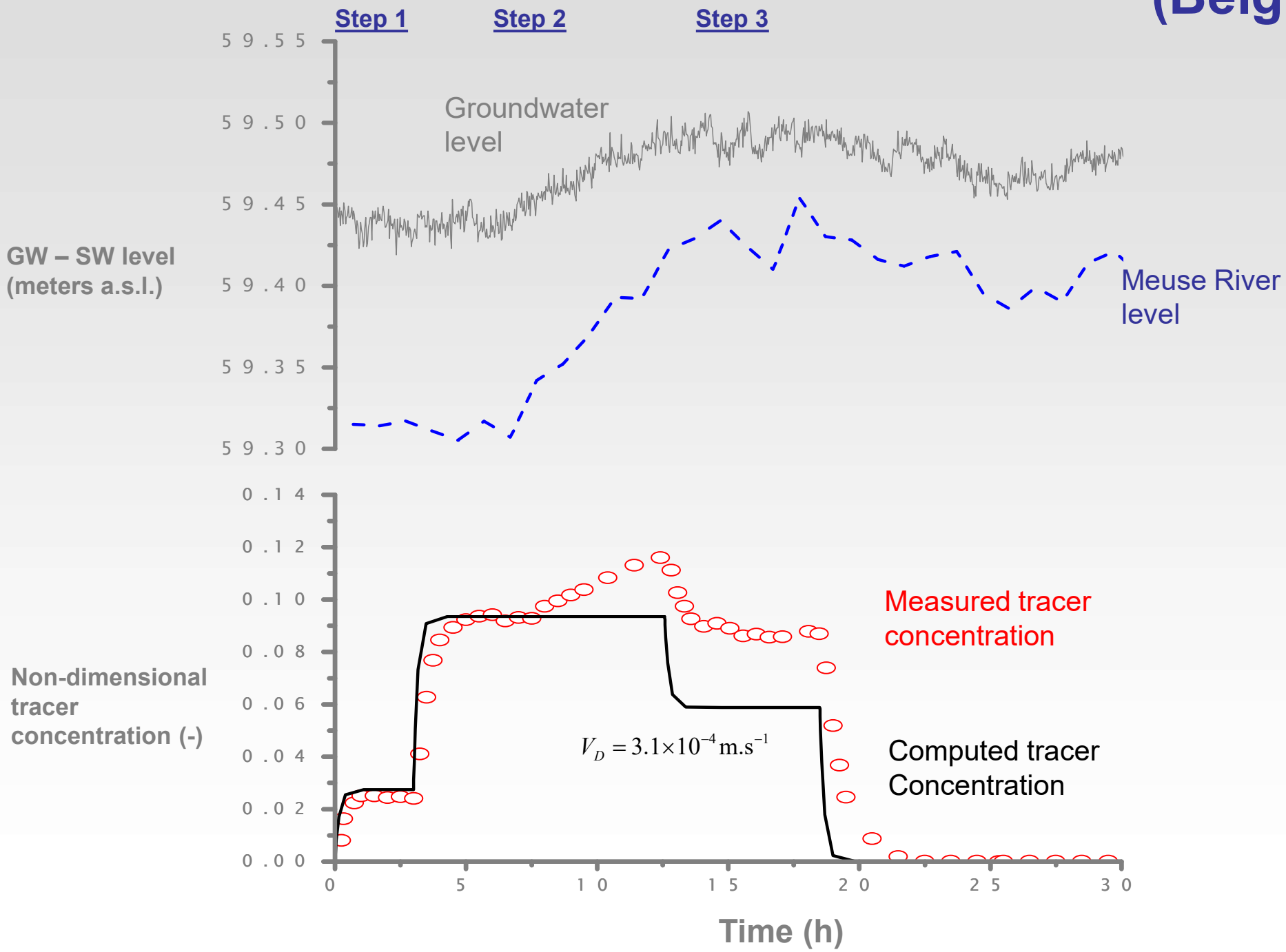

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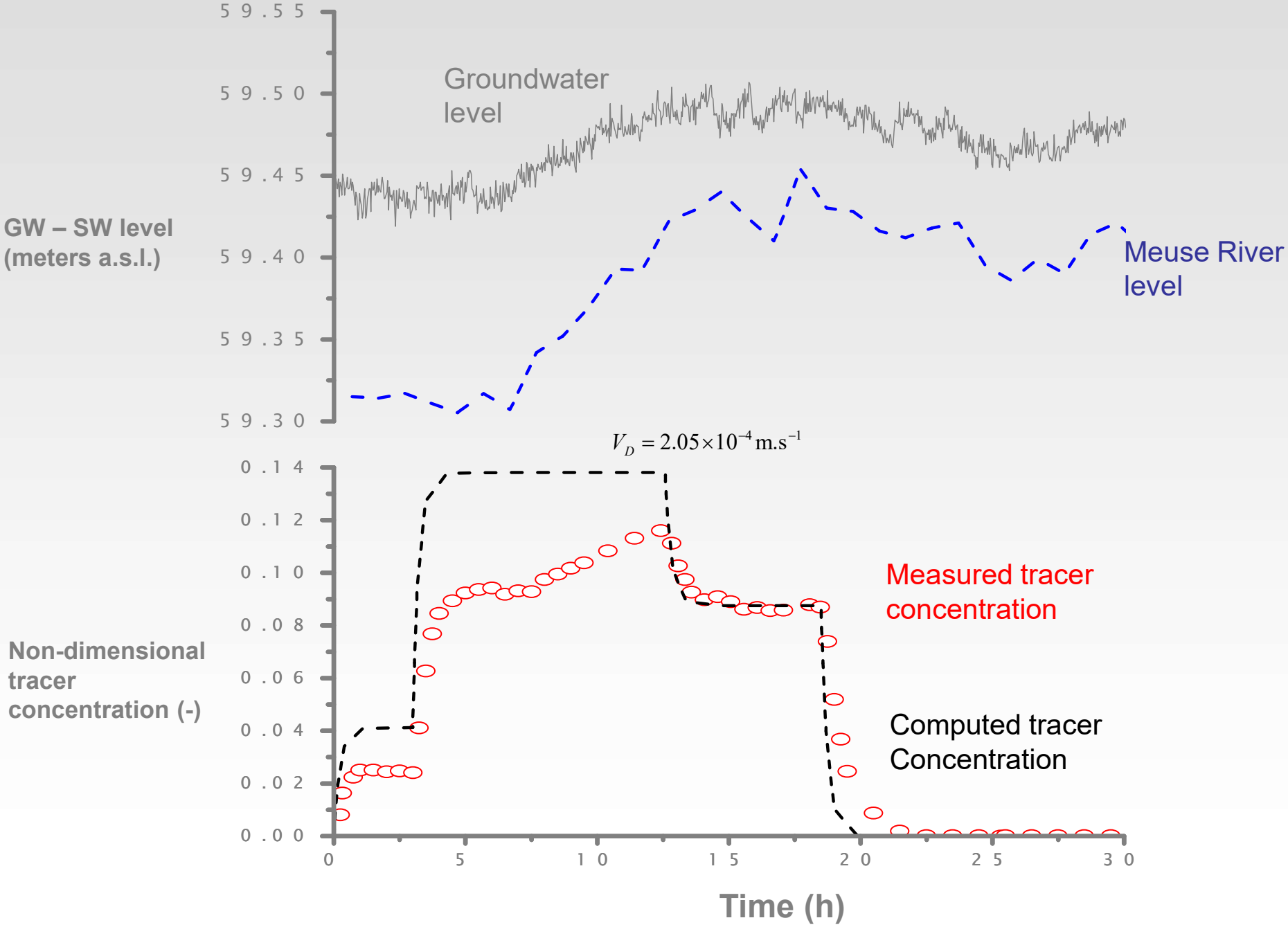

5. Conclusions & perspectives

- Injection and transit flow rates control the exchange of tracer between the well and the aquifer,
- easy experimental setup,
- wide range fields of applications in contrasted experimental conditions,
- potential applications in monitoring groundwater – surface water interaction in the hyporheic zone,
- relevant environmental value (possible impacts on contaminated releases from a contaminated site).

6. References

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