Effects of the hydrogeochemical stratification on the distribution of GHGs concentrations and their production/consumption processes in groundwater

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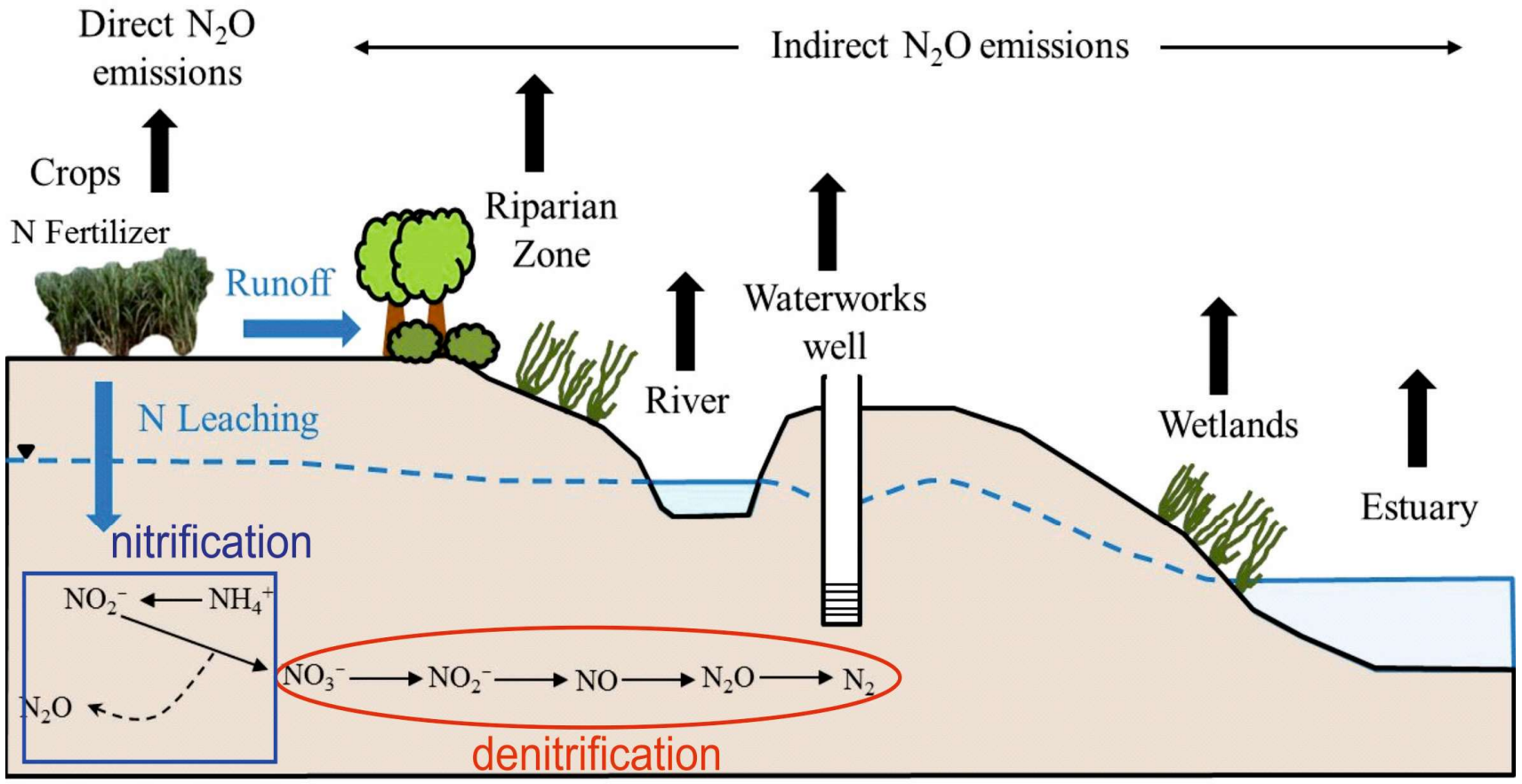
1 Background of the study

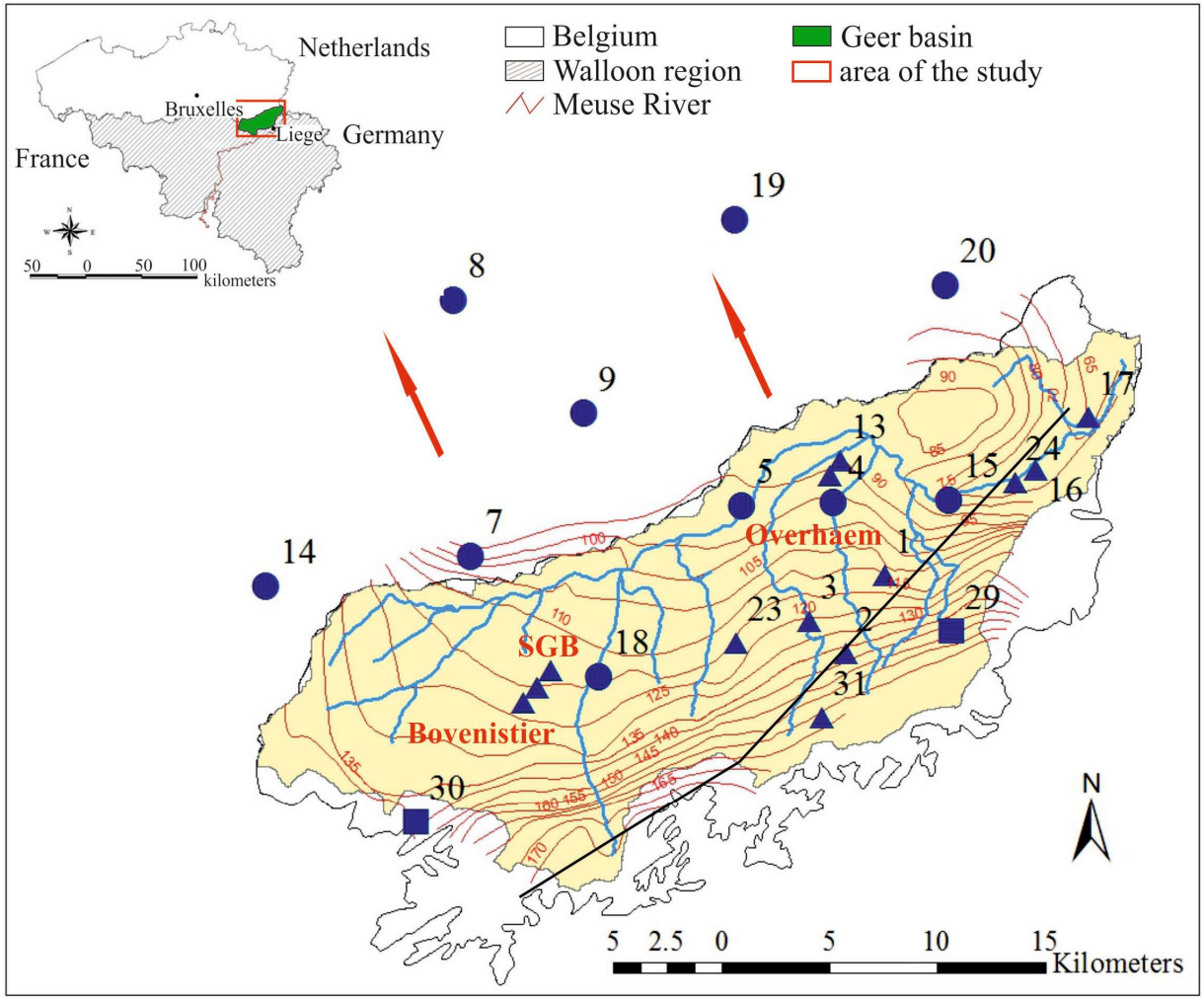
Groundwater under agricultural areas has been considered as a potential indirect source of GHGs to the atmosphere (Anderson et al., 2014; Jahangir et al., 2012; Minamikawa et al., 2011)



Source: Jurado et al., 2017

Fig.1. Types of GHGs emissions from agricultural areas

2 Regional studies



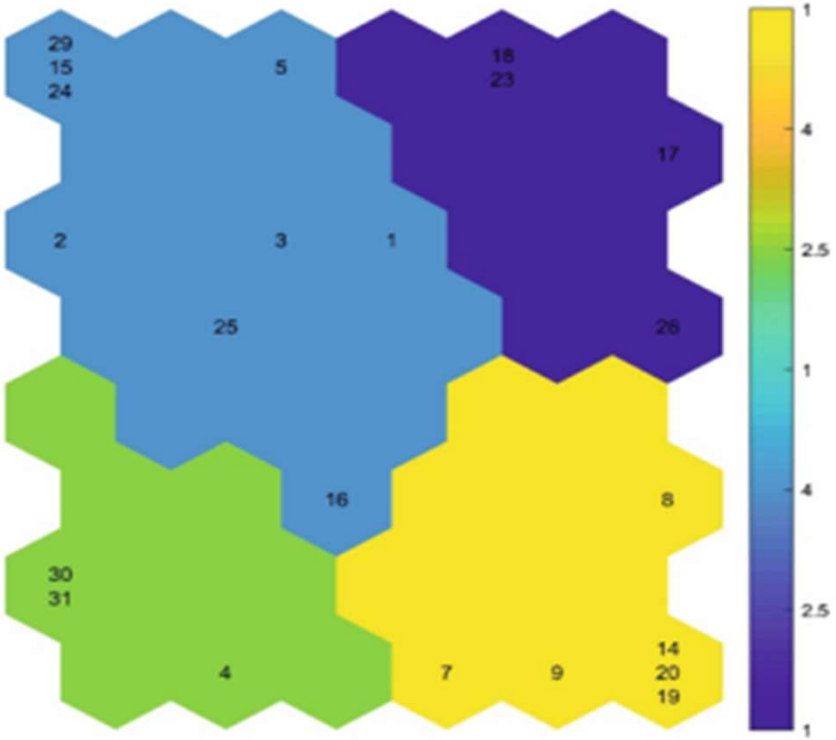
Peculiarities of the studied area:

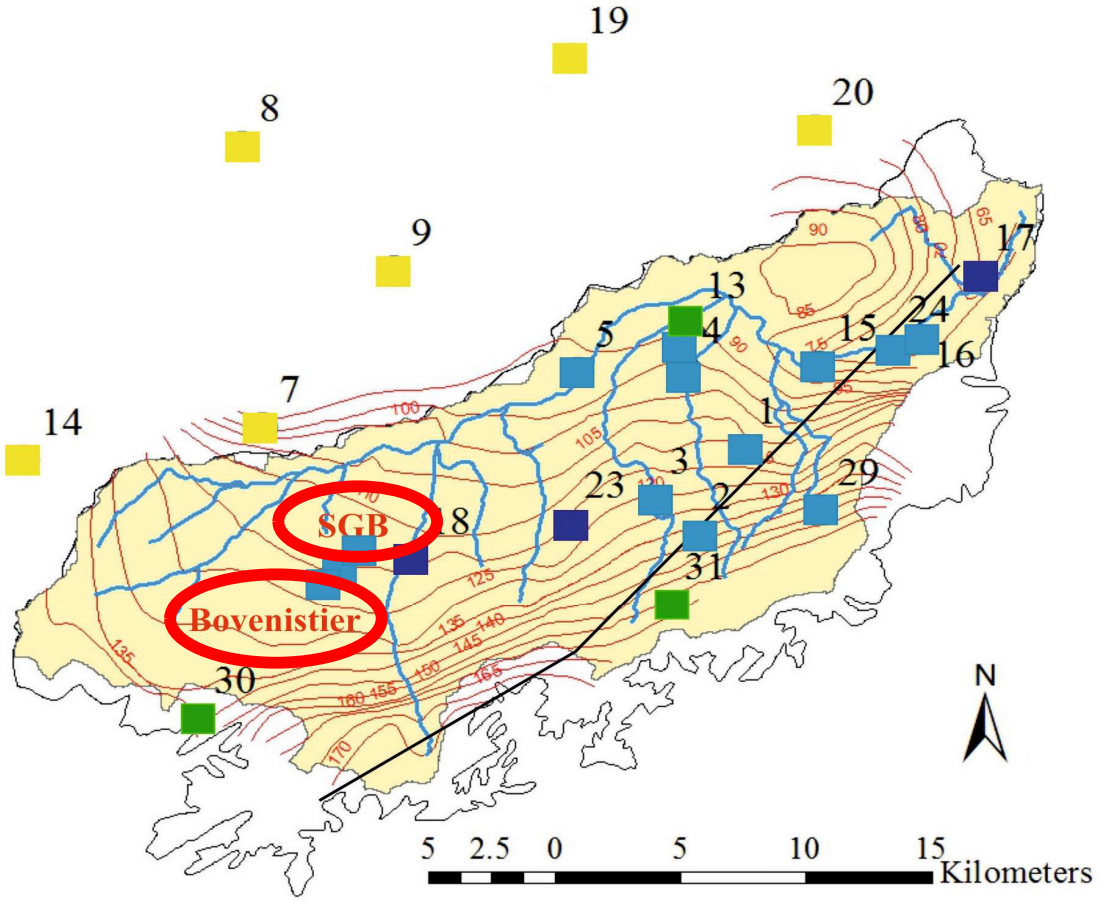
- area: 480 km^2;
- 65% of agricultural activities;
- high fracturing of chalk aquifer;
- unconfined – the South;

  semi-confined – near the Geer river;

  confined – the North-West

3 Regional studies



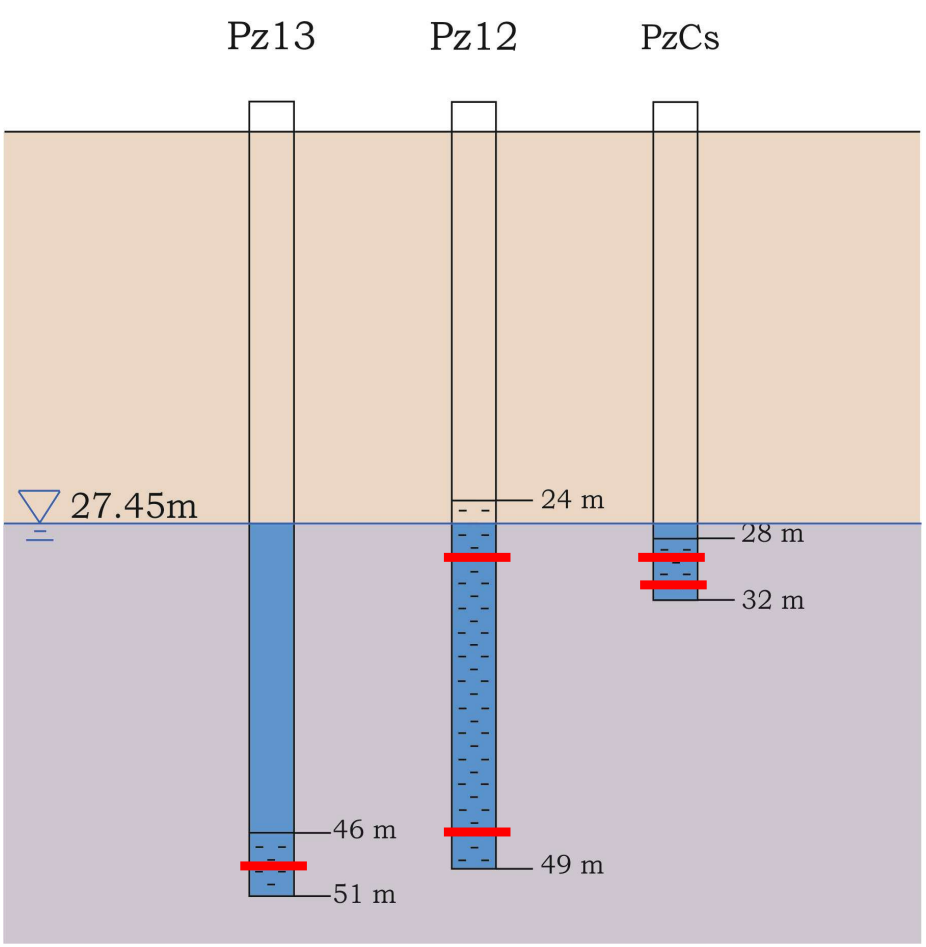


Group 1 – dark blue, group 2 – green, group 3 – blue and group 4 – yellow.

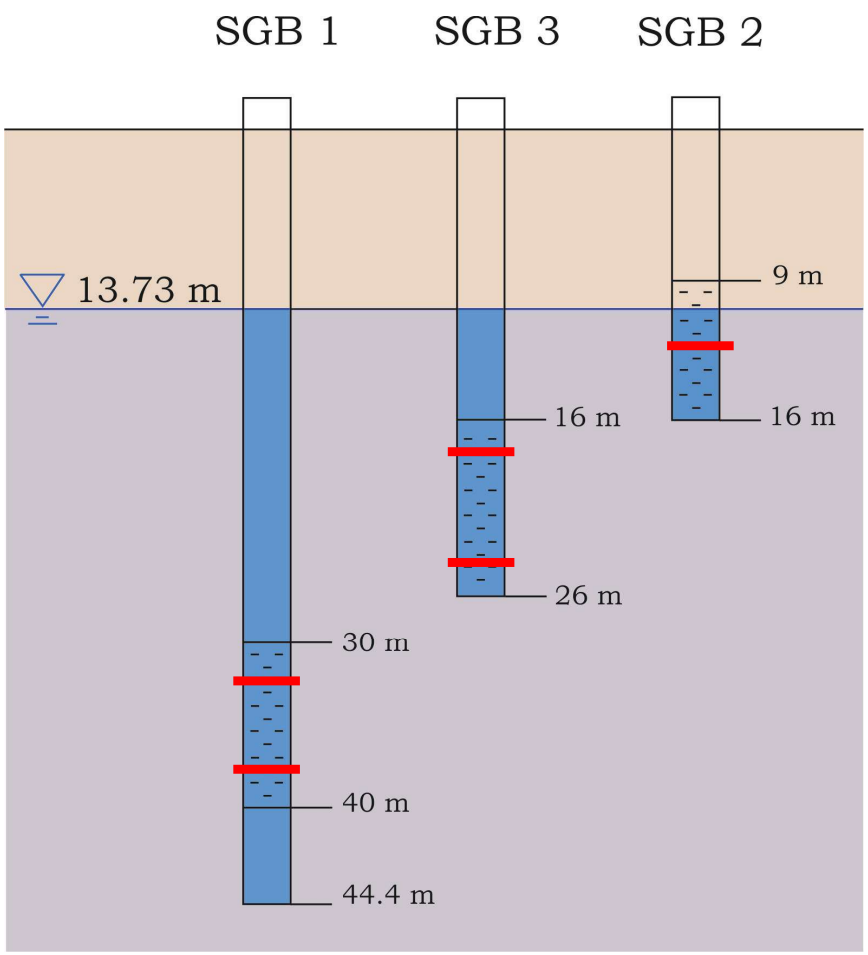
Group	*N_2O (µg N/L)*	*SP (‰)*	*DO (mg/L)*	*NO_3^- (mg/L)*	*Processes*
Group 1	3.4 ± 1.2	11.2 ± 1.6	8.2 ± 1.9	28.7 ± 3.8	nitrification and incomplete denitrification
Group 2	13.6 ± 6.3	26.1 ± 3.4	5.7 ± 2.4	48.7 ± 18.7	nitrification and complete denitrification
Group 3	6.7 ± 3.4	19.1 ± 6.7	7.2 ± 2.6	39.6 ± 16.2	nitrification and incomplete denitrification
Group 4	0.1 ± 0.1	not available	1.5 ± 2.1	0.2 ± 0.4	complete denitrification

4 Local studies

Bovenistier



SGB

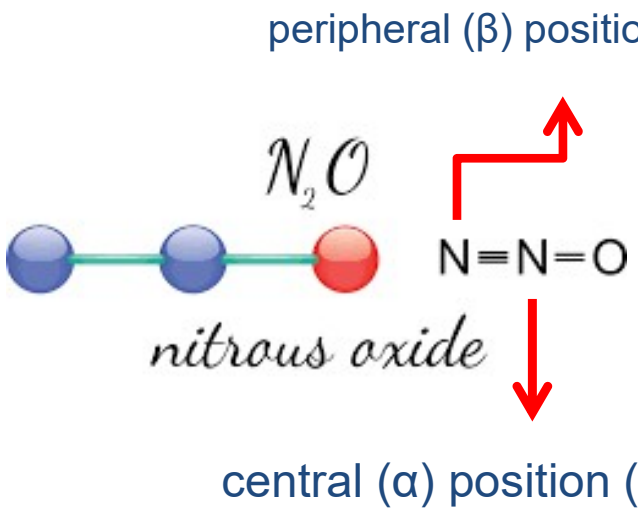


5 Applied methods

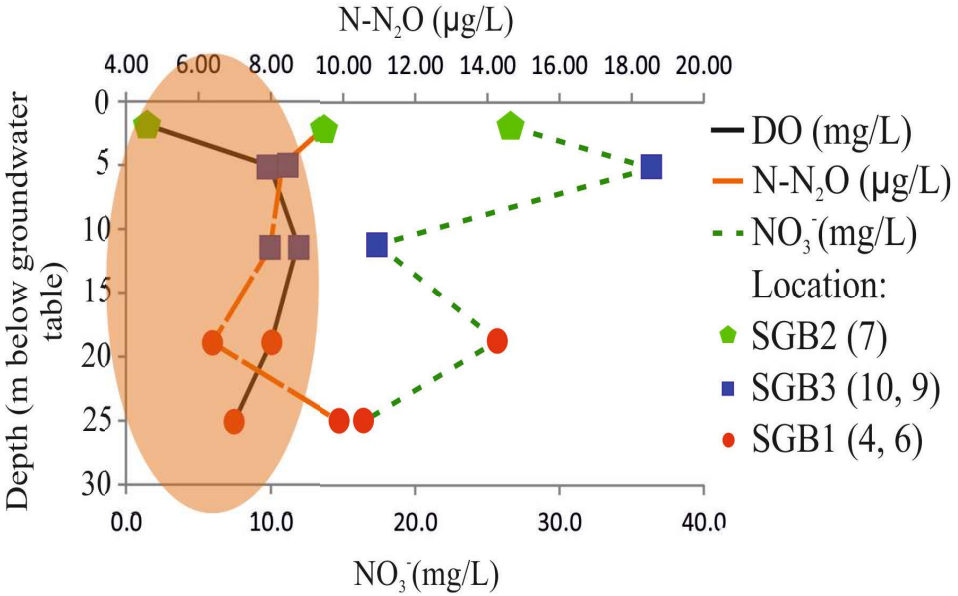
1. Low flow sampling using packer system
2. NO_3^- and N_2O isotope and isotopomer analyses.

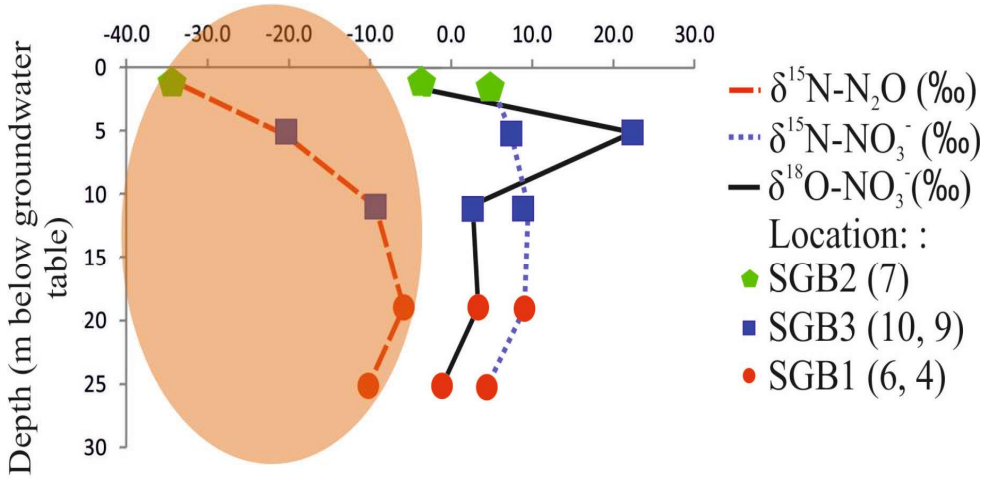
Isotopomers are molecules having the same number of each isotopic atom but differing in their positions.

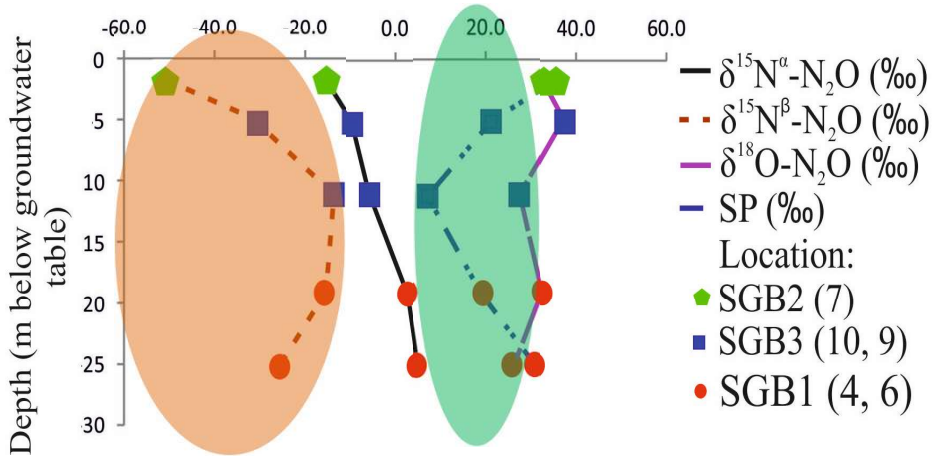
production ← decrease — Site preference = $\delta^{15}N^{\alpha} - \delta^{15}N^{\beta}$ — increase → consumption



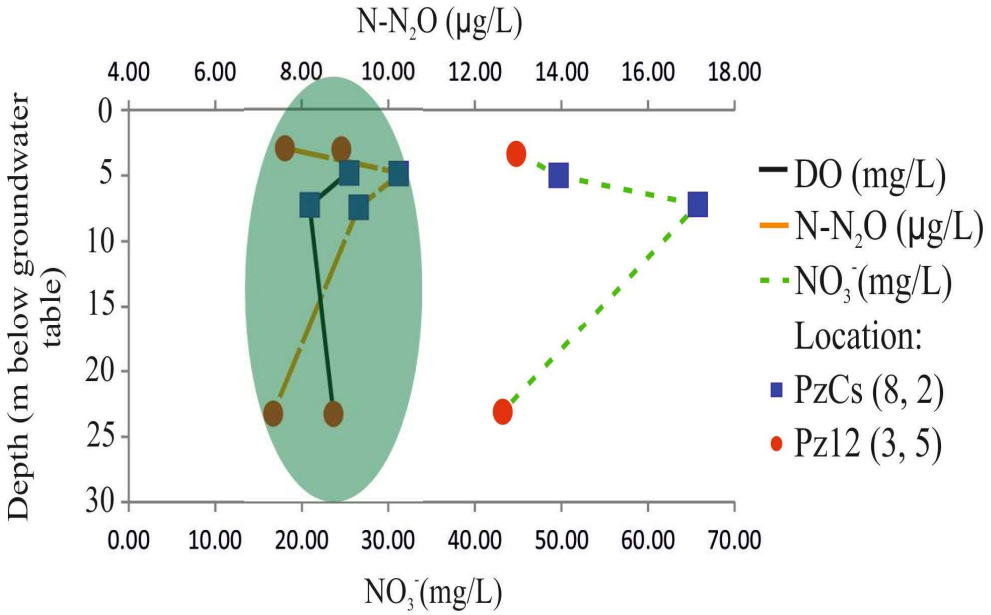
6 Local studies: SGB

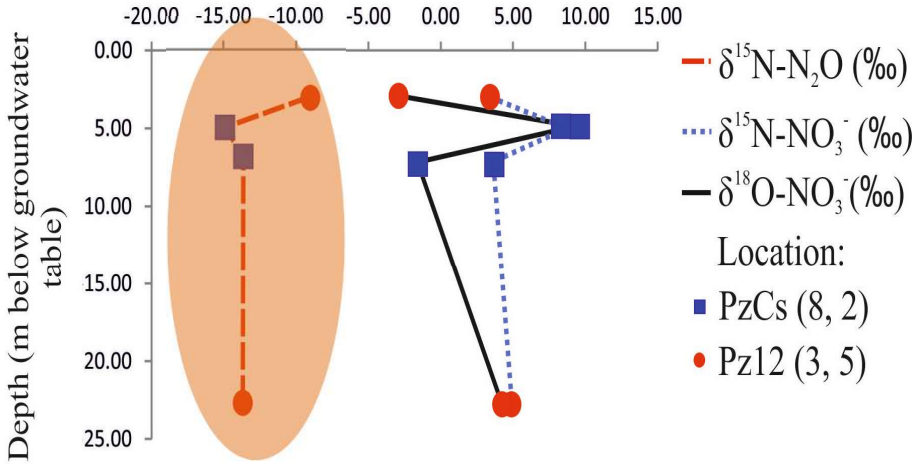


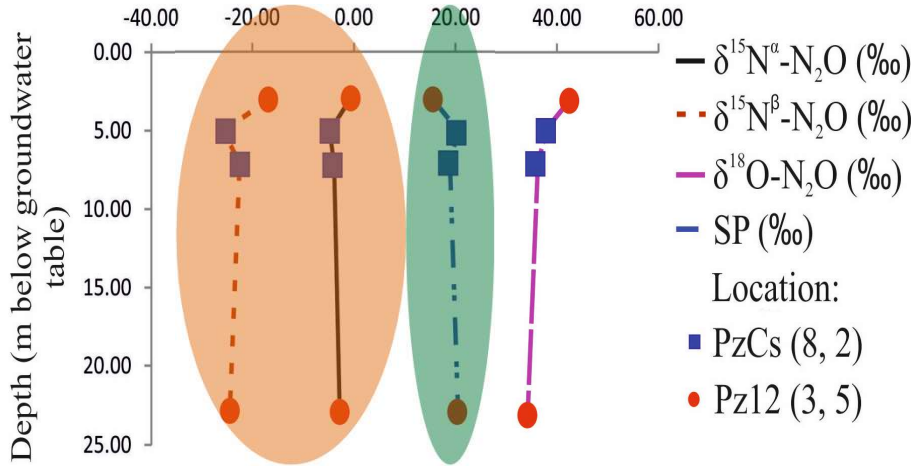




7 Local studies: Bovenistier





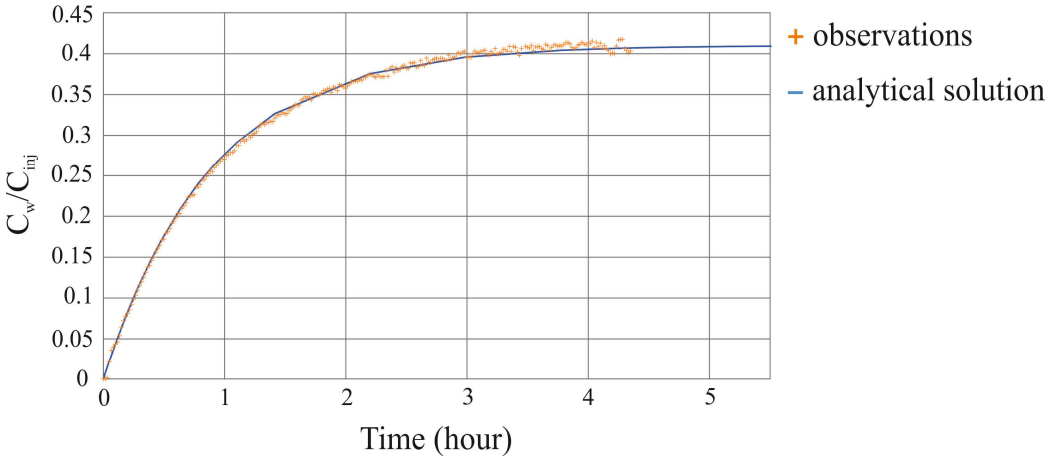


9 Perspectives: magnitude of nitrification and denitrification

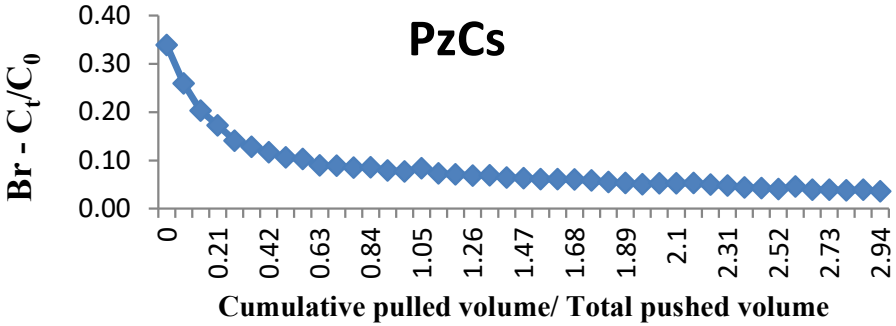
Insitu Push-Pull tracer test

- estimation of the incubation time:

✓ FVPDM tests to estimate groundwater flow rates (Jamin & Brouyère, 2018);



✓ Push-Pull pretest using Br as a conservative tracer.



Results: groundwater flow rates are to high and the incubation time is too short for the insitu Push-Pull tests.

THANK YOU

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10 Isotopomer mapping

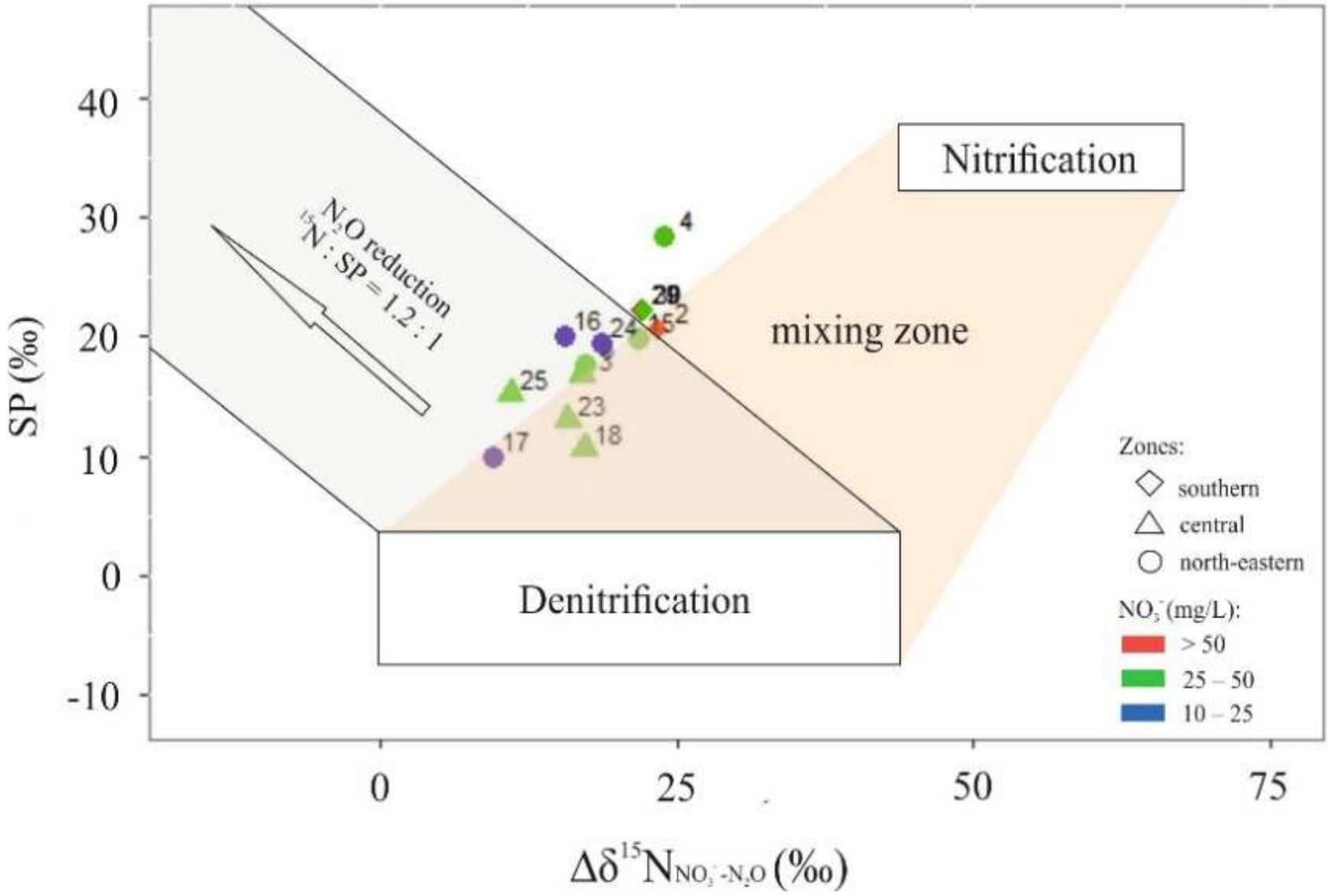
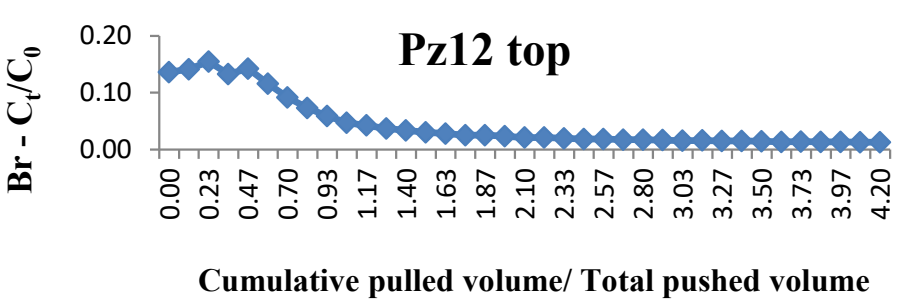


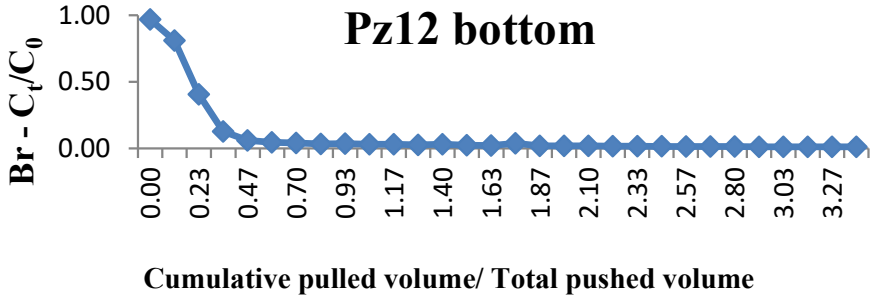
Fig. 5. $\Delta\delta^{15}N_{NO_3^-} - N_2O$ versus SP (‰) isotopomer map

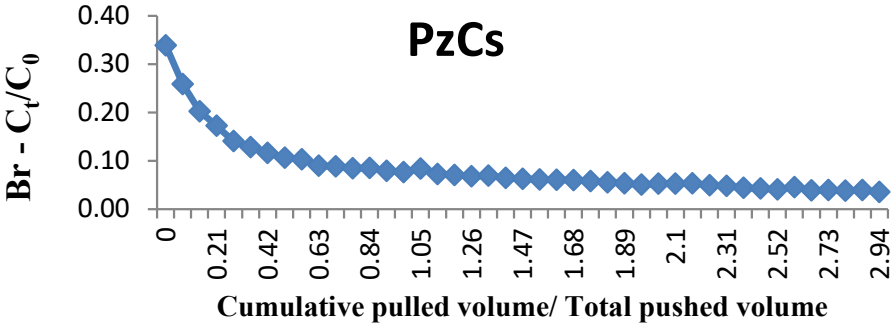
11 Push – Pull test

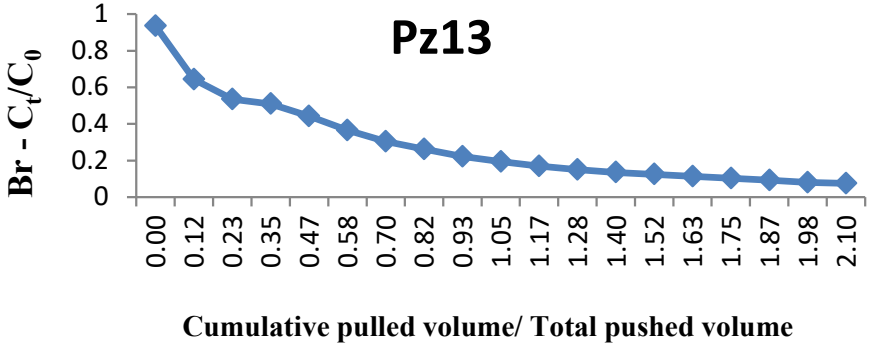
- Push-pull pretest at the Bovenistier site

Location	Incubation time (hour)	Characteristics of the injected solution		Background concentration of Br (mg/L)	Recovery of the tracer (%)
		Volume (L)	Concentration of Br (mg/L)		
Pz12 top	1	300	78.38	2.63	14.15
Pz12 bottom	3	300	71.87	0.22	89.03
PzCs	3	500	70.89	0.21	26.69
Pz13 bottom	3	300	66.62	0.20	65.59





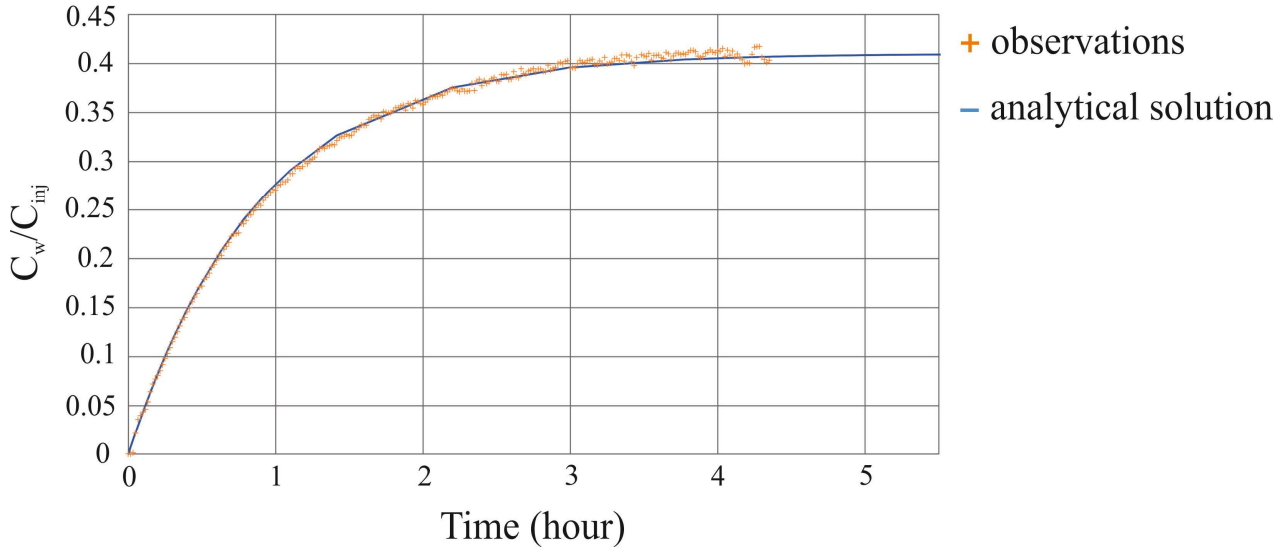


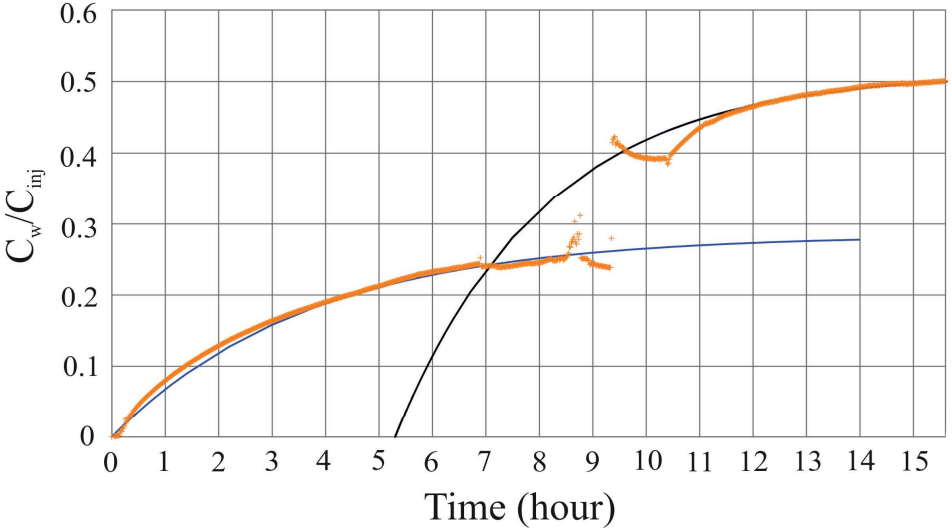


12 FVPDM

- estimation of groundwater flow rates at the SGB site

✓ PzCs – 1.5 * 10^{-5} (m^3/s)





✓ Pz13 – 3.8*10^{-6} (m^3/s)