
Characterizing background concentrations in groundwater bodies of the Brussels region: example of the Landenian sands (BR03)

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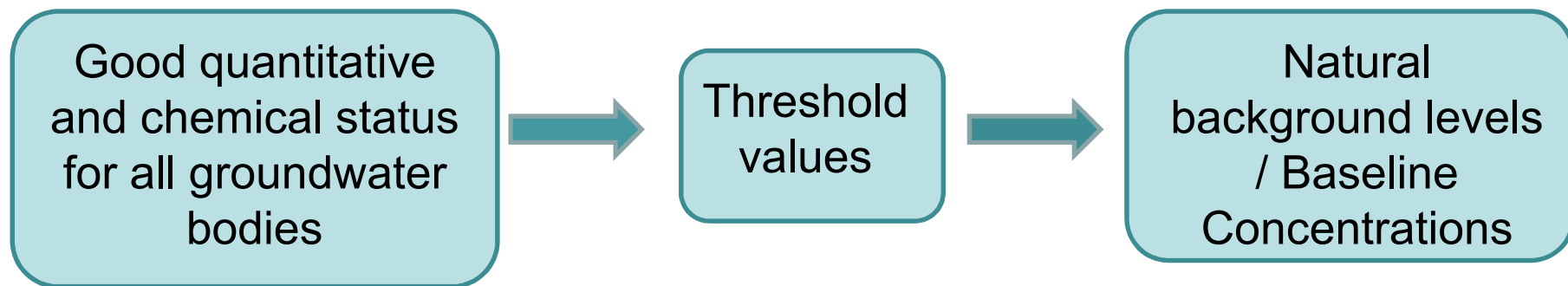
Context of the study



Convention IBGE et HGE-ULg

« Caractérisation de la concentration de référence de certains paramètres chimiques présents naturellement dans les masses d'eau souterraine captives du Socle et du Crétacé (BR01) et du Landénien (BR03) en Région de Bruxelles-Capitale »

- EU laws : Water Framework Directive (2000/60/EC)
Daughter Directive (2006/118/EC) : protection of groundwater against pollution and deterioration



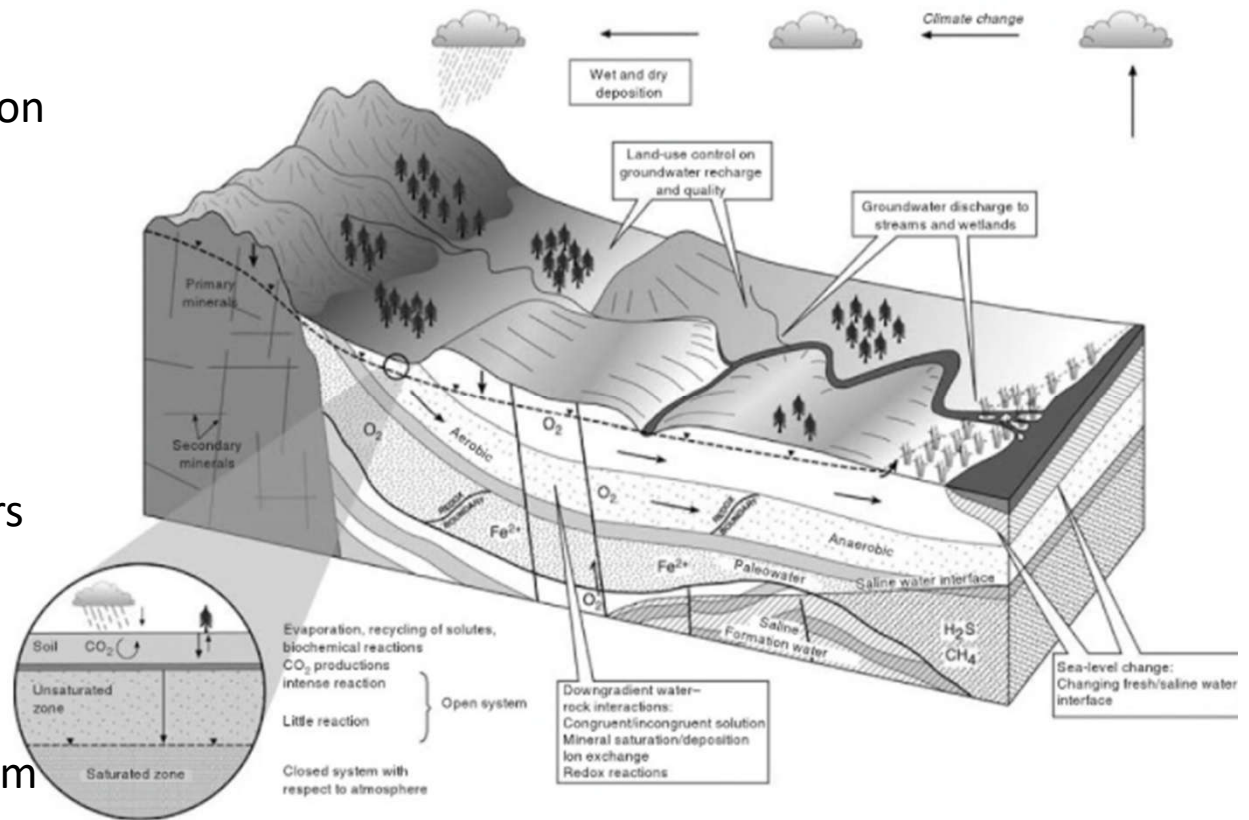
Context of the study

What controls the chemistry of groundwater?

- Rainfall composition
- Evapotranspiration – by vegetation
- Chemical composition and mineralogy of the soil
- Lithology of the underground
- Physico-chemical conditions
- Residence time
- Groundwater flow conditions
- Mixing between different waters
- [Human activities!]**

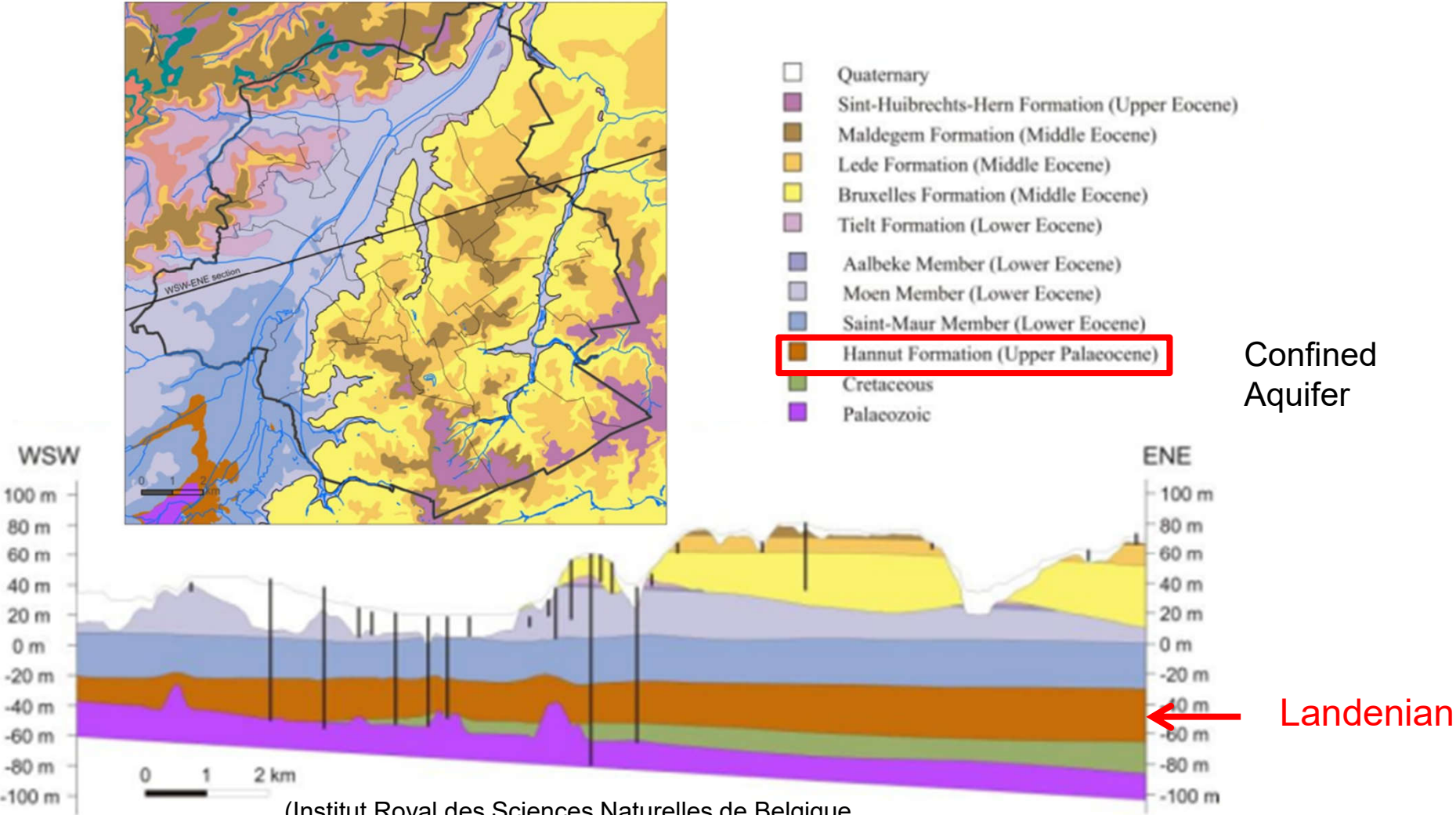


Physical & Chemical disequilibrium
→ reactions and evolution of groundwater composition



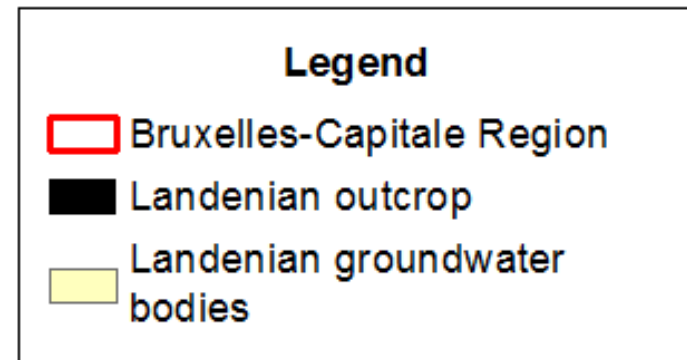
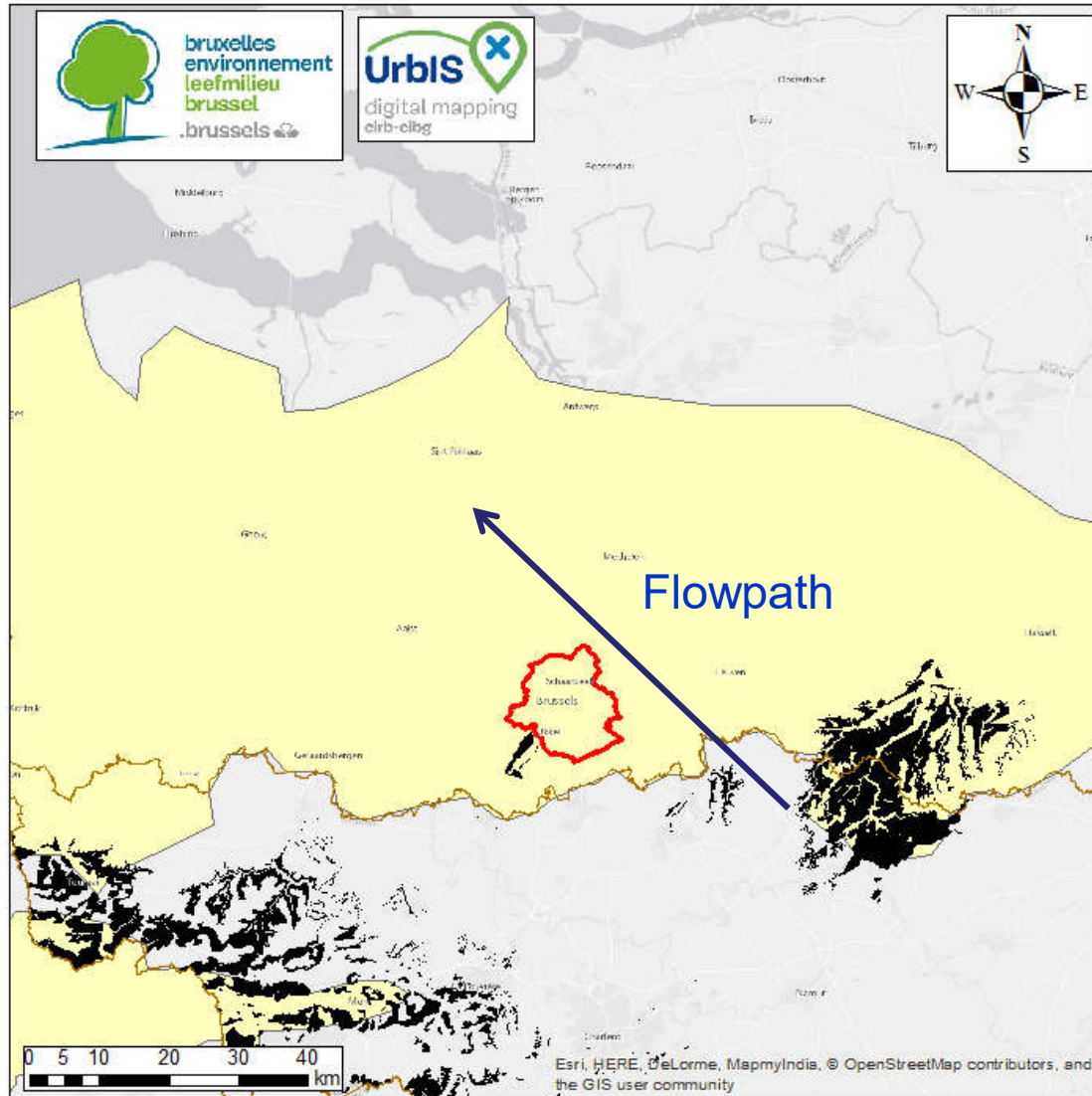
(Shand & Edmunds, 2008)

Geological and hydrogeological context



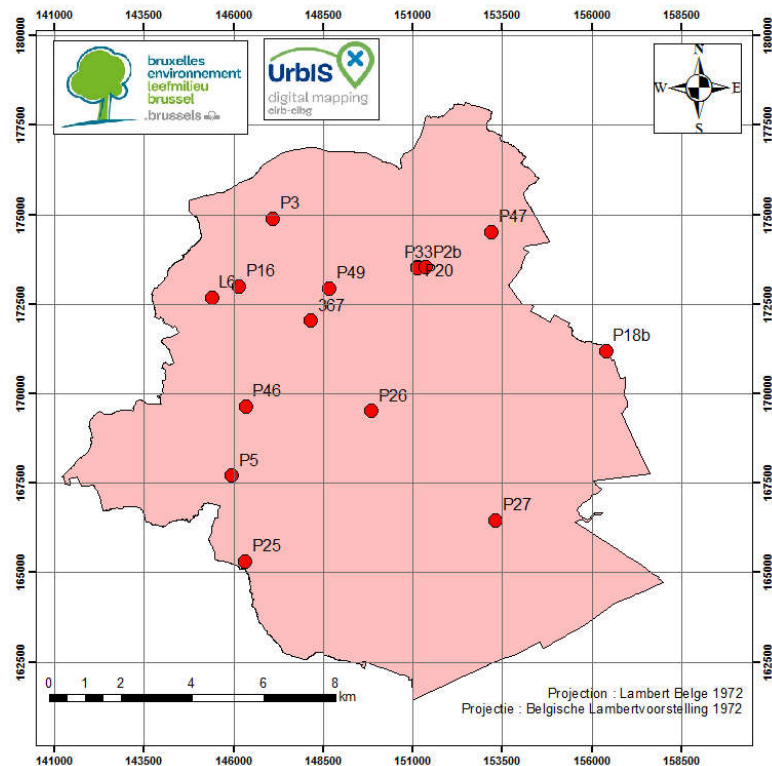
(Institut Royal des Sciences Naturelles de Belgique & Aquale, 2012 modified based on Buffel & Matthijs, 2002)

Geological and hydrogeological context



(modified based on CIE, 2009 & Service Géologique de Belgique, 2003)

Available data for Landenian aquifer



Region/ Gewest

□ Région de Bruxelles-Capitale/
Brussels Hoofdstedelijk Gewest

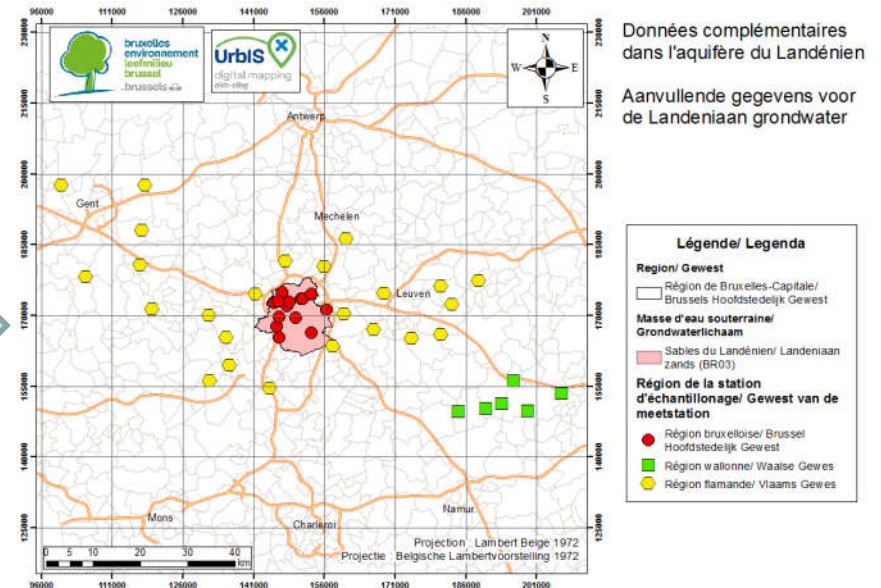
Masse d'eau souterraine/ Grondwaterlichaam

■ Sables du Landénien/
Landeniaan zands (BR03)

Stations d'échantillonnage/ Meetstations

● Masse d'eau du Landénien
(BR03) Landeniaan zand
grondwaterlichaam

Zoom out to enlarge the dataset



Données complémentaires
dans l'aquifère du Landénien

Aanvullende gegevens voor
de Landeniaan grondwater

Légende/ Legenda

Region/ Gewest

□ Région de Bruxelles-Capitale/
Brussels Hoofdstedelijk Gewest

Masse d'eau souterraine/ Grondwaterlichaam

■ Sables du Landénien/ Landeniaan
zands (BR03)

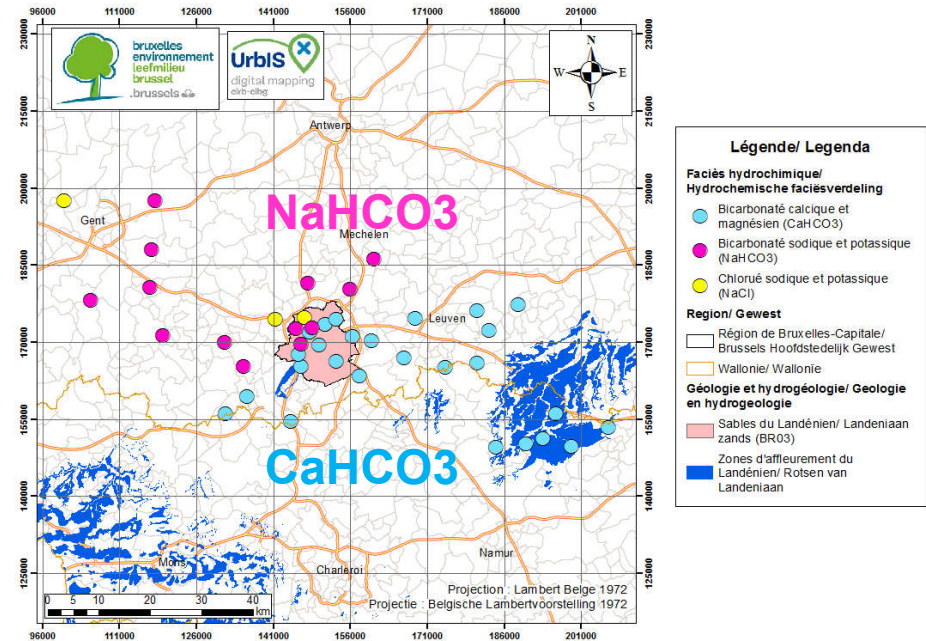
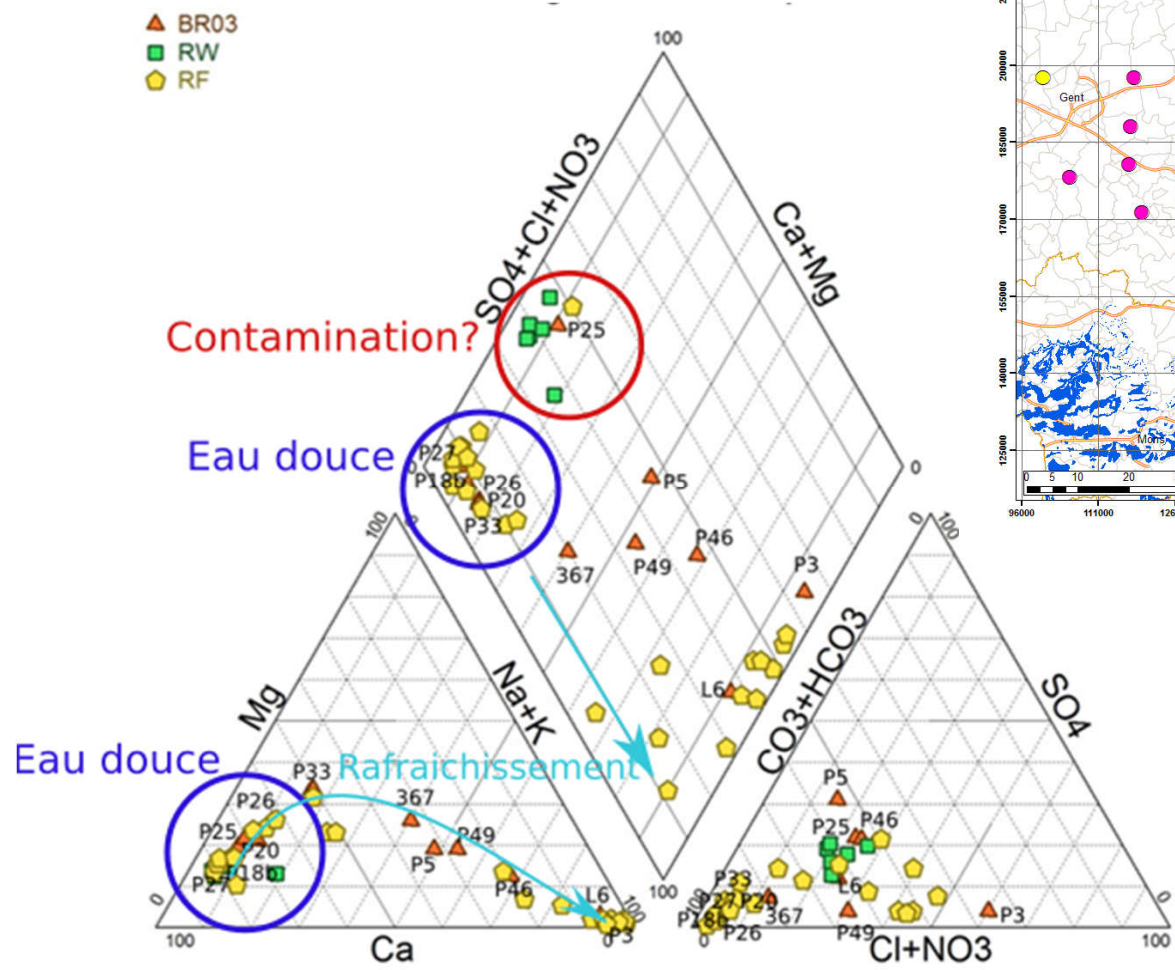
Région de la station d'échantillonnage/ Gewest van de meetstation

● Région bruxelloise/ Brussel
Hoofdstedelijk Gewest

■ Région wallonne/ Waalse Gewes

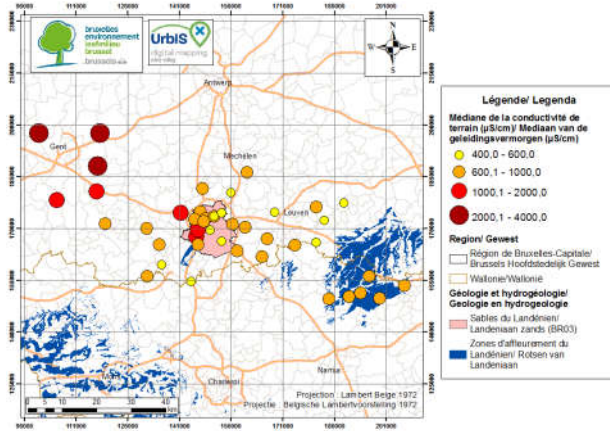
■ Région flamande/ Vlaams Gewes

Hydrochemical processes : Hydrochemical facies (Piper Diagramme)

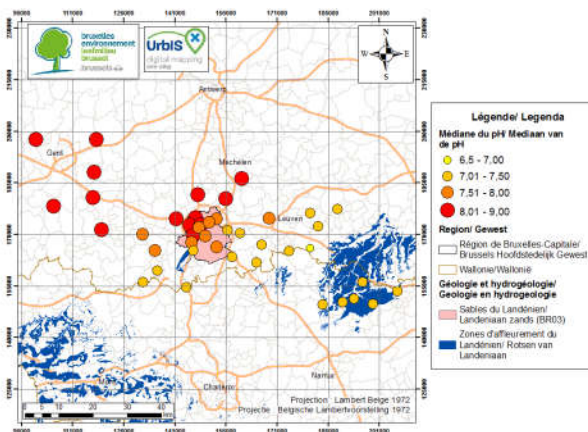


Hydrochemical processes : spatial variations

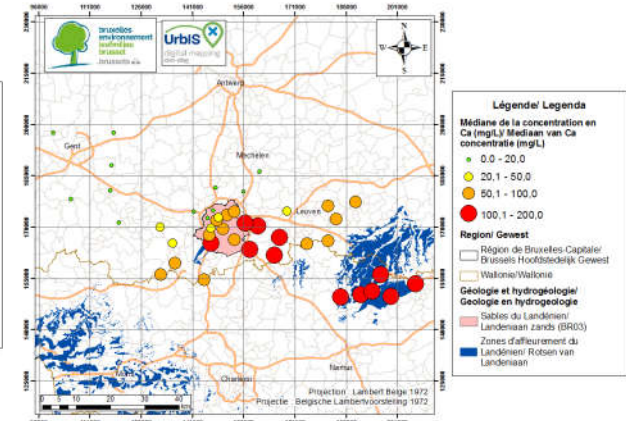
Conductivity ($\mu\text{S}/\text{cm}$)



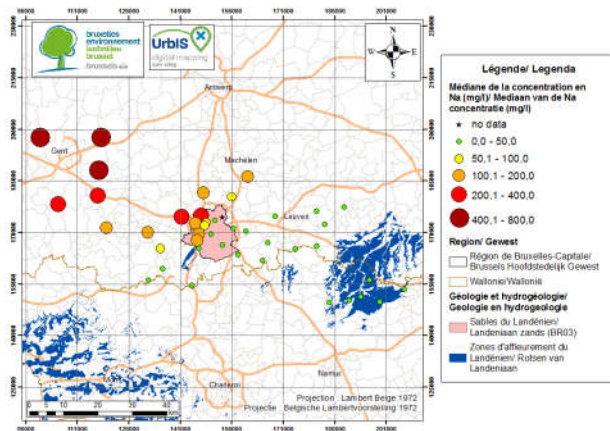
pH



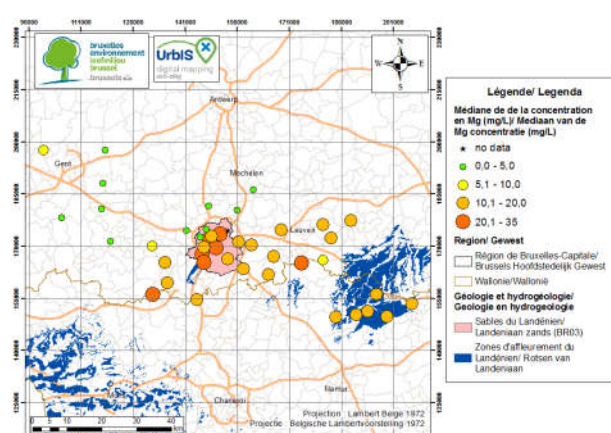
Ca



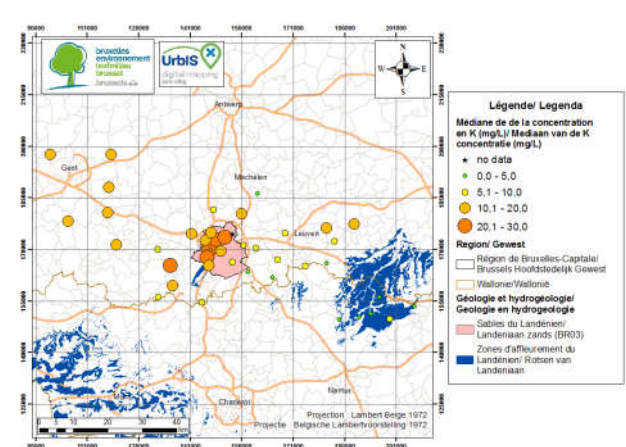
Na



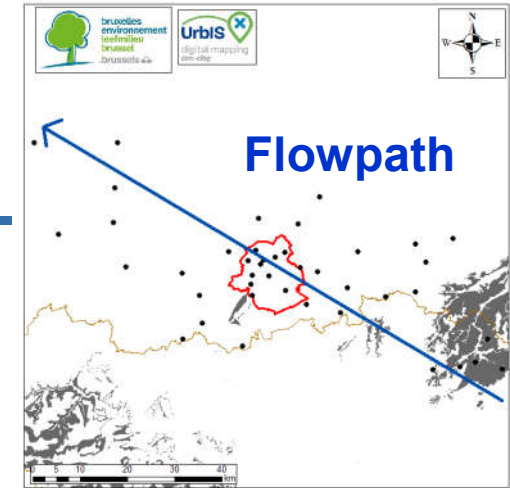
Mg



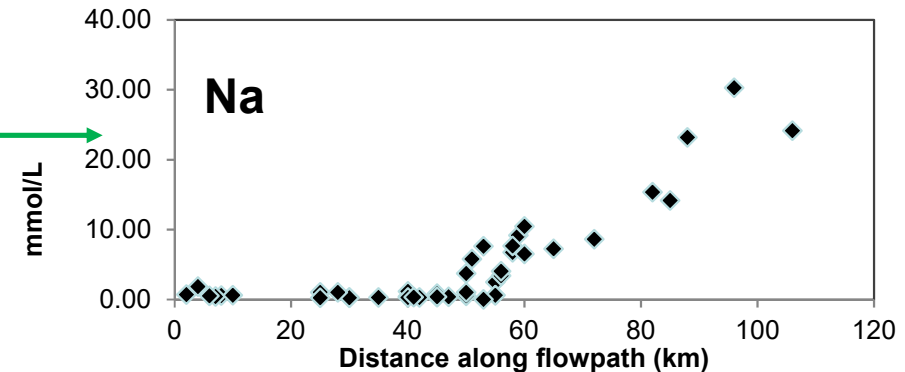
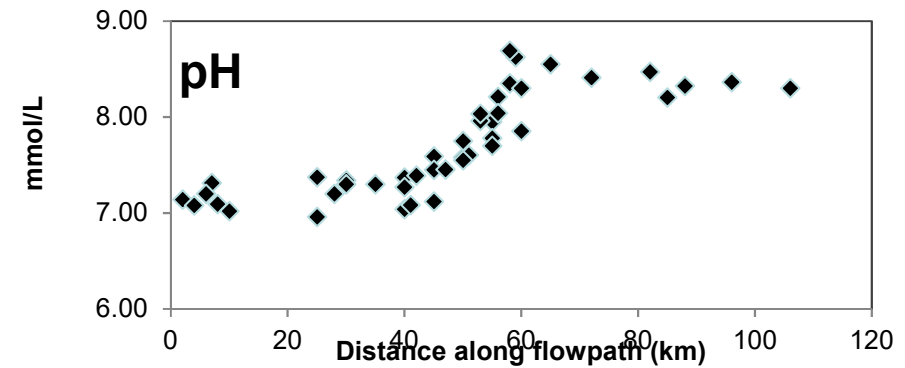
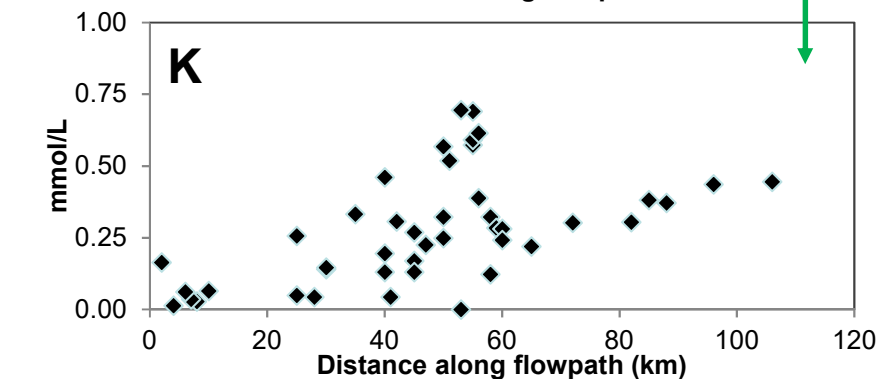
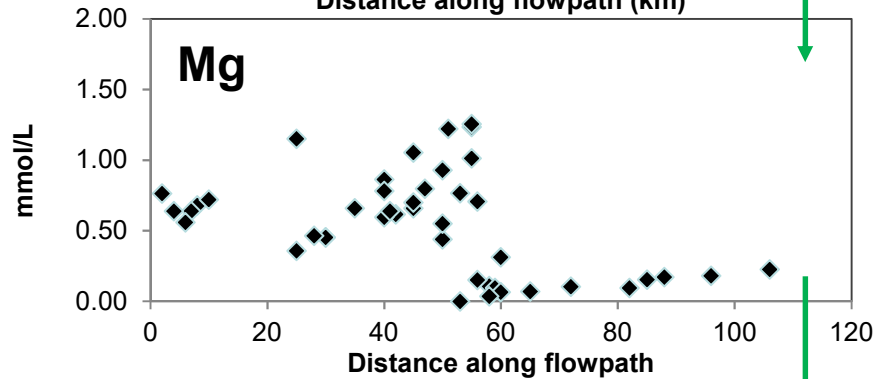
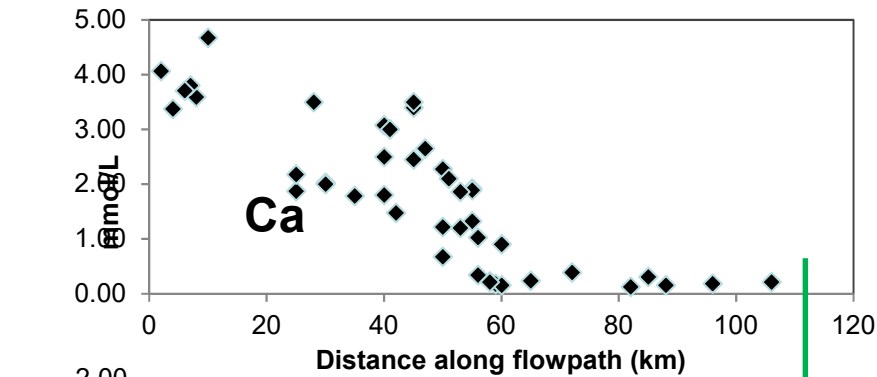
K



Hydrochemical processes : spatial variations => cation exchanges

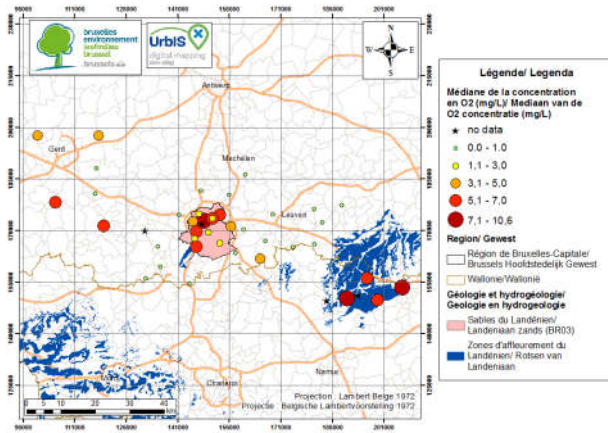


Cation selectivity
 $\text{Ca}^{2+} > \text{Mg}^{2+} > \text{K}^+ > \text{Na}^+$

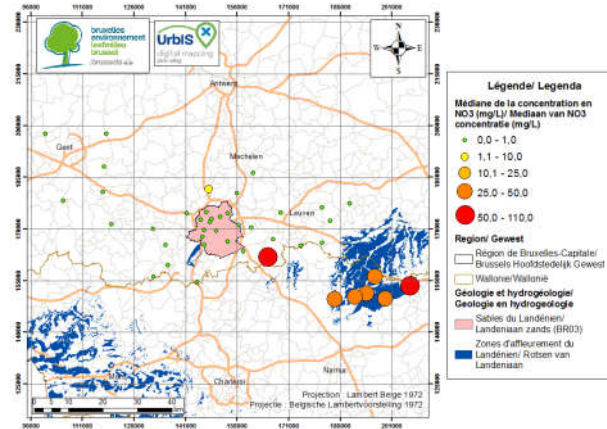


Hydrochemical processes : spatial variations

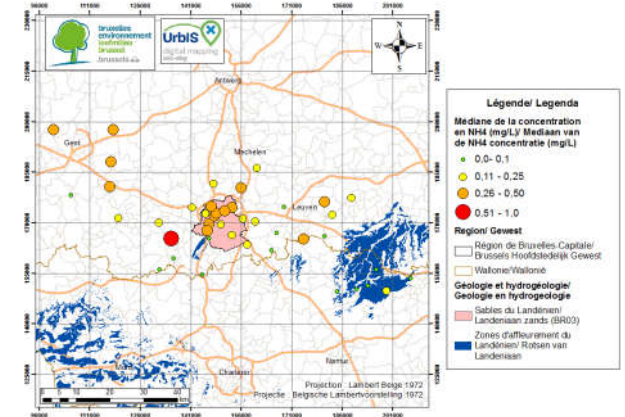
O2



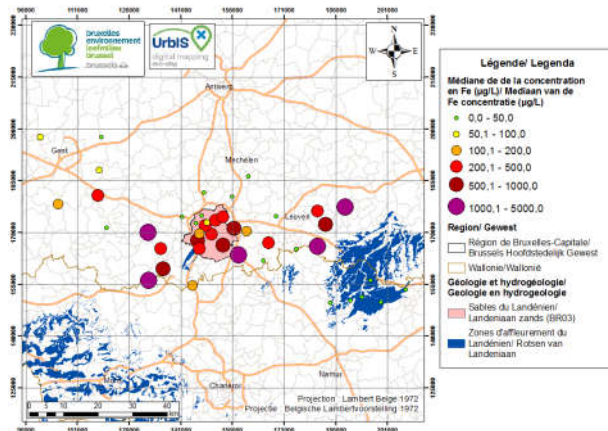
NO3



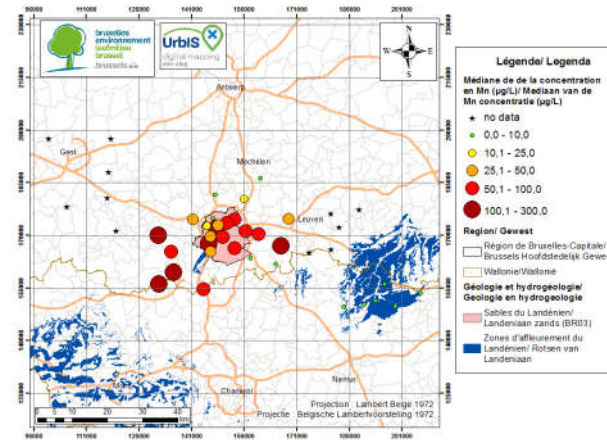
NH4



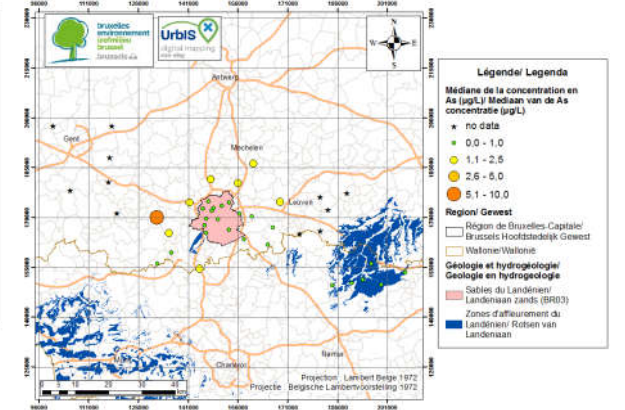
Fe



Mn

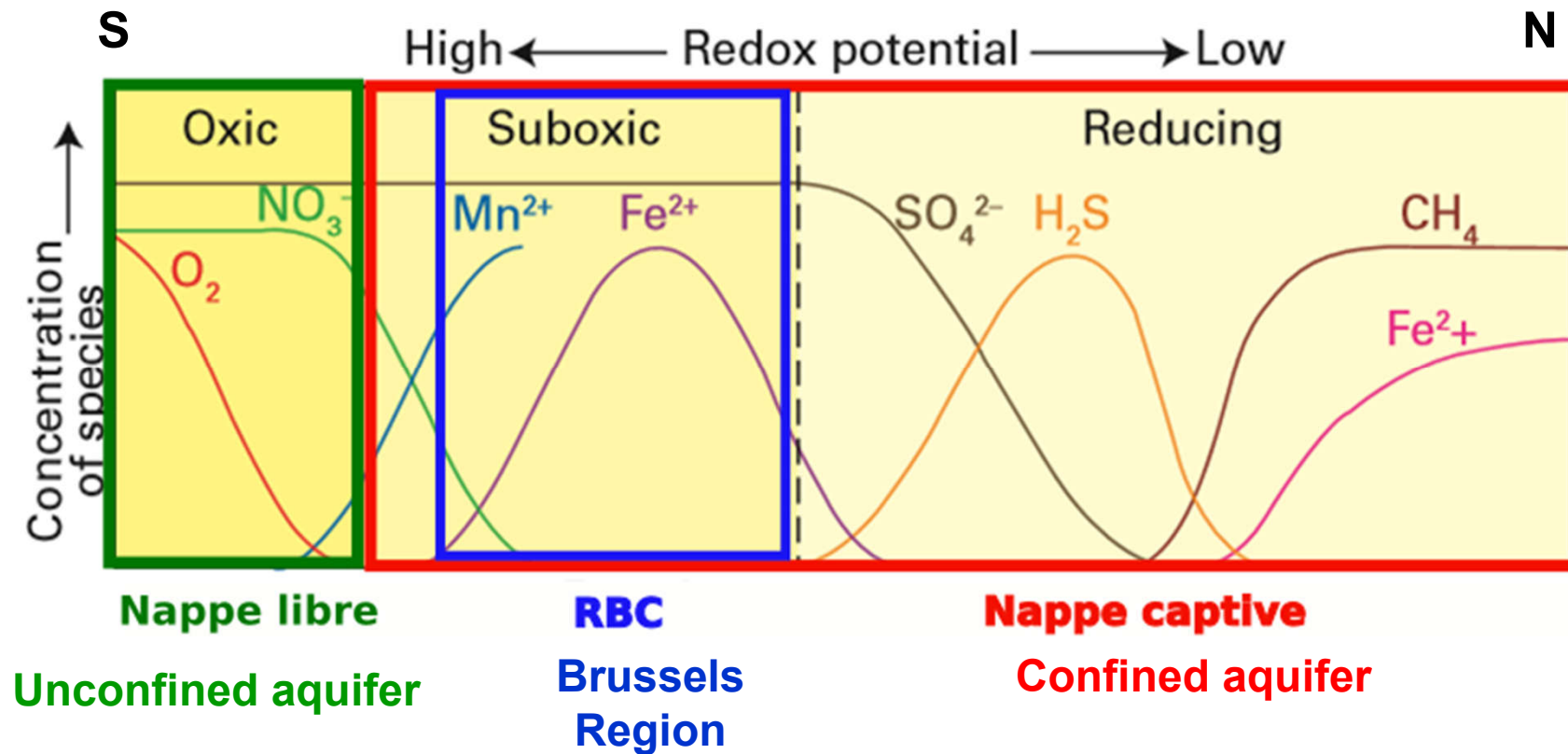


As

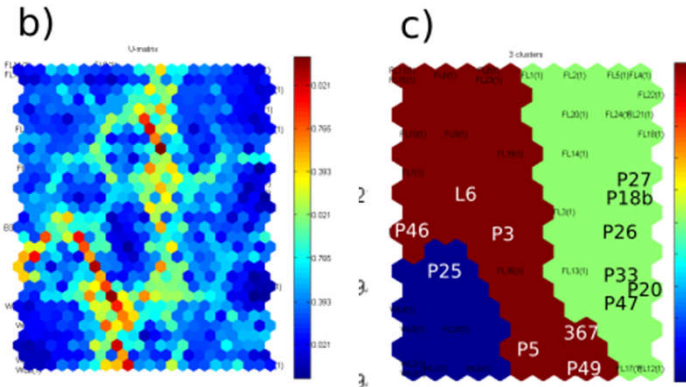
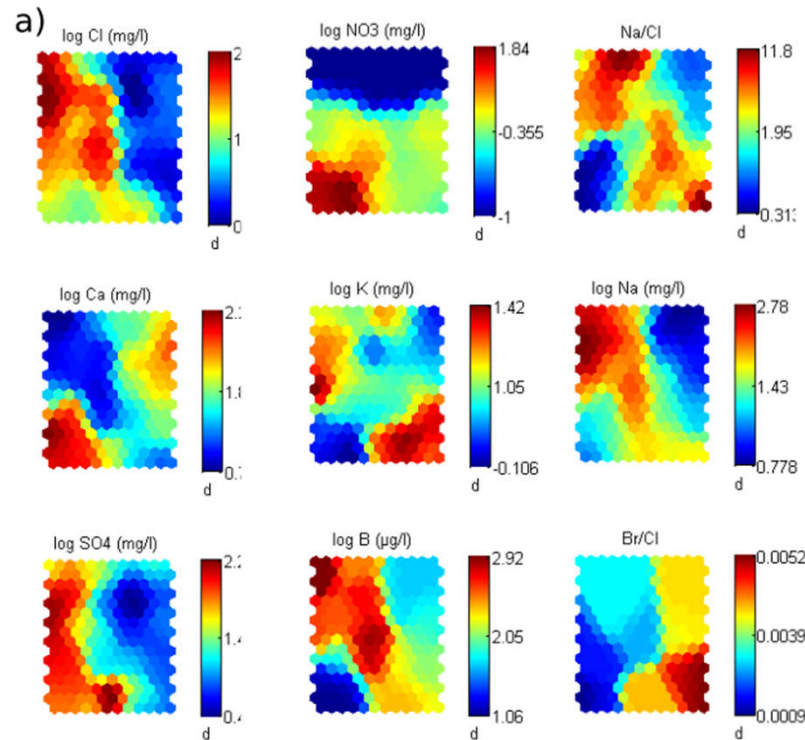


! dissolved Fe in Wallonia and Flanders vs Total FE in Brussels Region

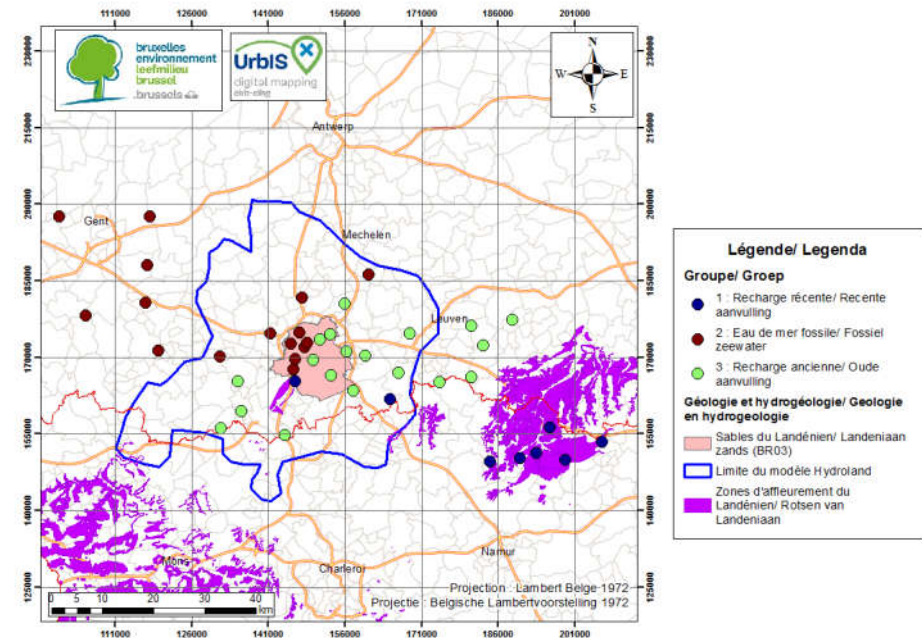
Hydrochemical processes : spatial variations => redox reactions



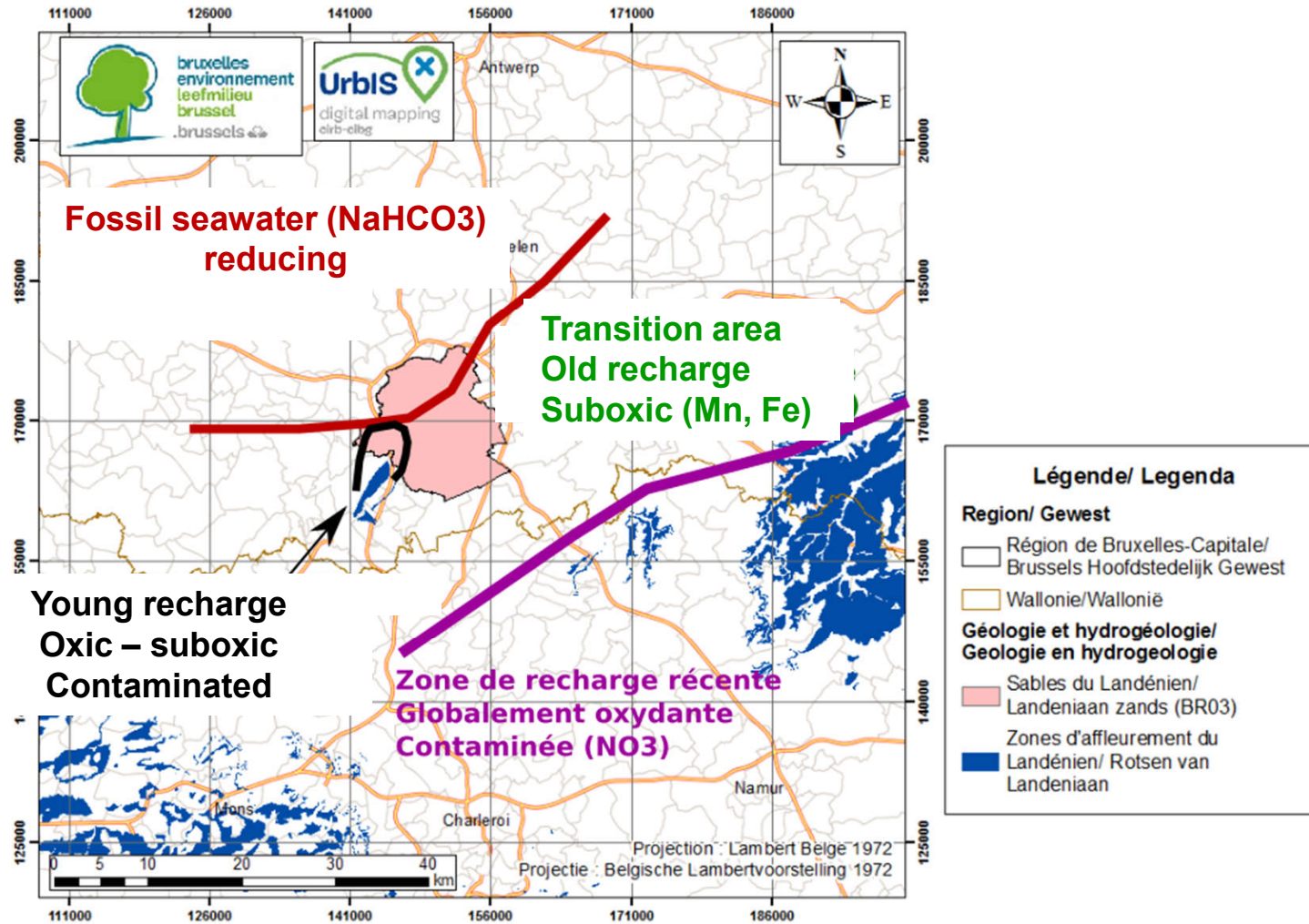
Hydrochemical processes : multivariate analysis Main mineralisation



Group	Cl	NO3	Na/Cl	Ca	K	Na	SO4	B	Br/Cl
1 : Young recharge (contaminated)	+	+	--	++	--	-	+	--	--
2 : Fossil seawater	++	-	++	--	X	++	X	++	X
3 Old recharge	--	-	X	O	X	-	--	-	+

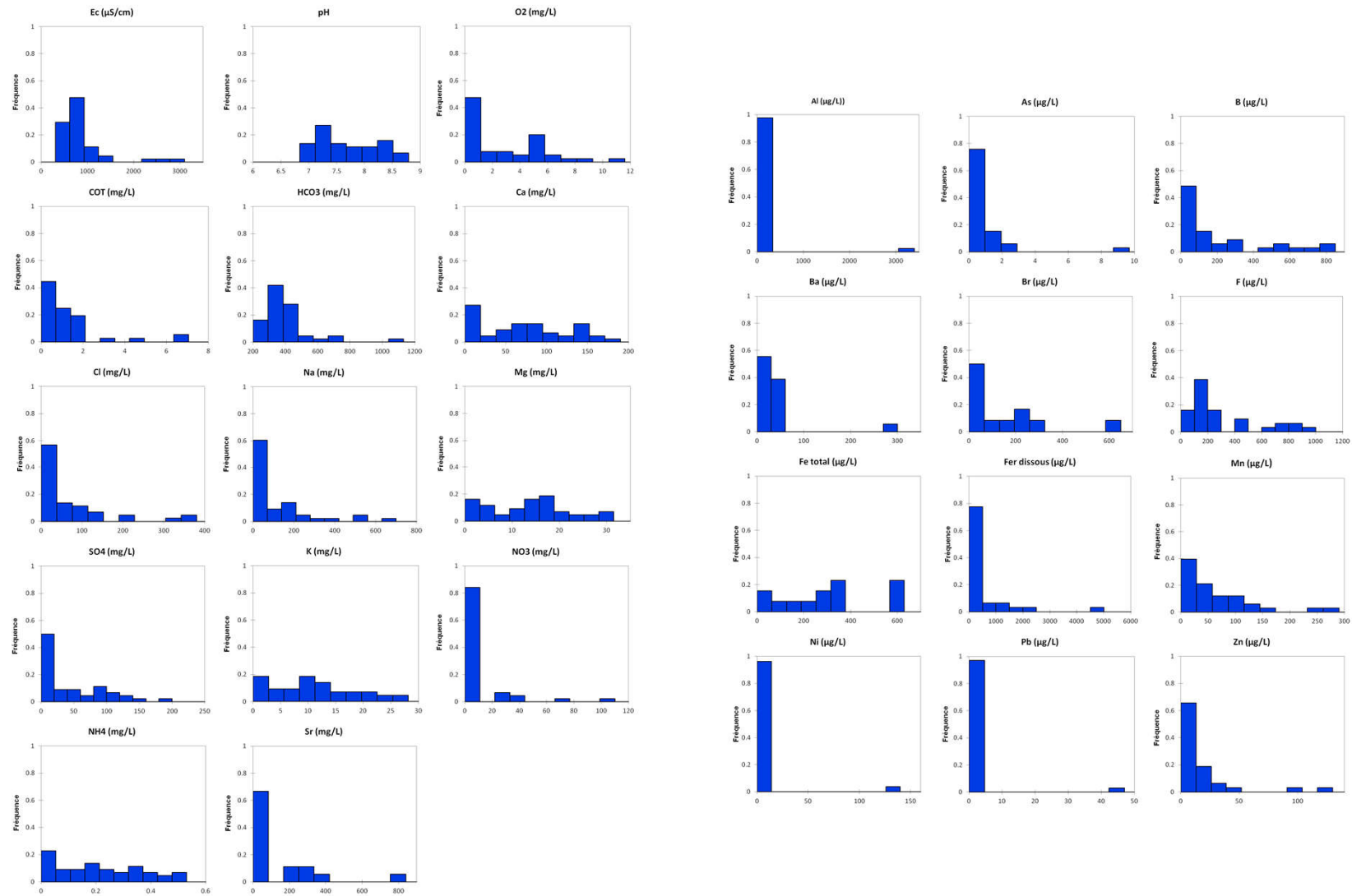


Hydrochemical processes : Conceptual model

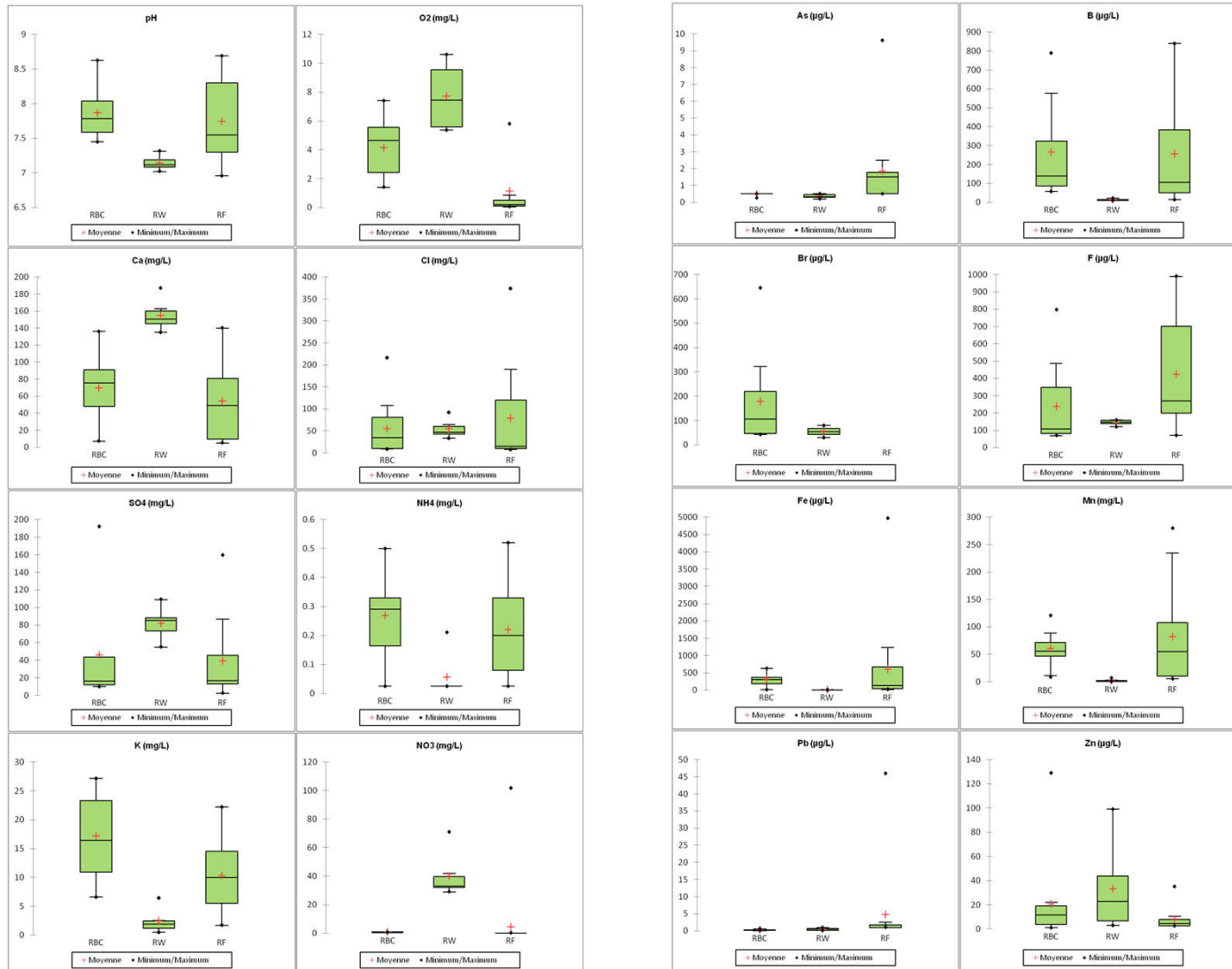


Hydrochemical processes :

Statistical distribution

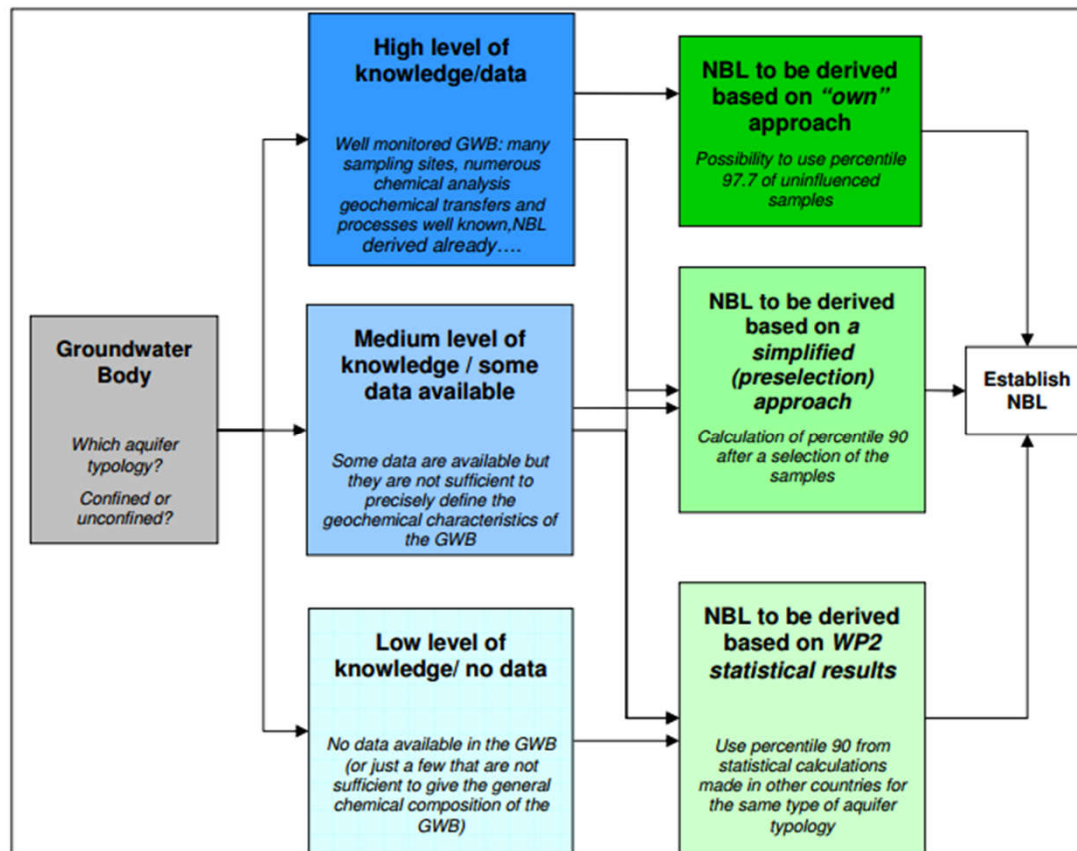


Hydrochemical processes : Box-plots & comparison between regions



❖ Détermination des concentrations de référence

FP6 BRIDGE (Müller, 2006) et BaSeLiNe (Edmunds and Shand, 2008)



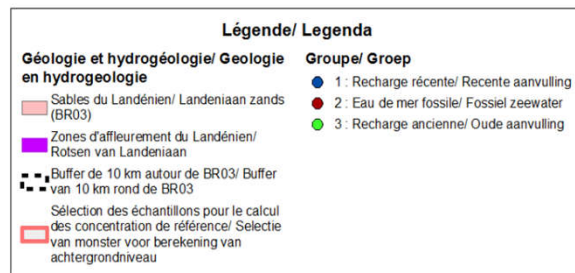
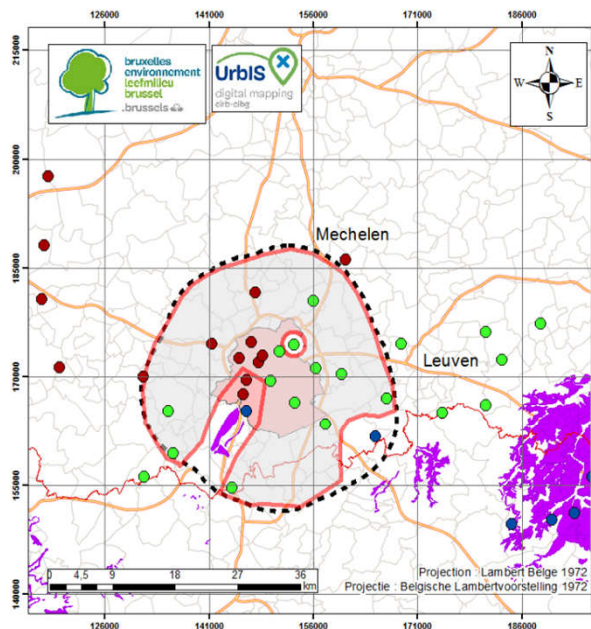
(Müller, 2006)

Recommandations :

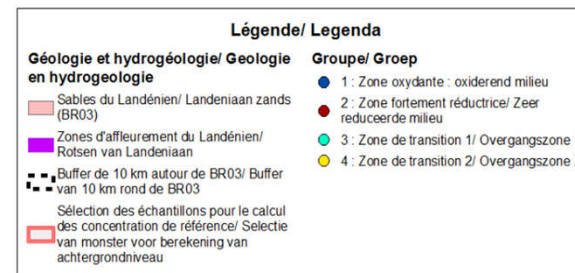
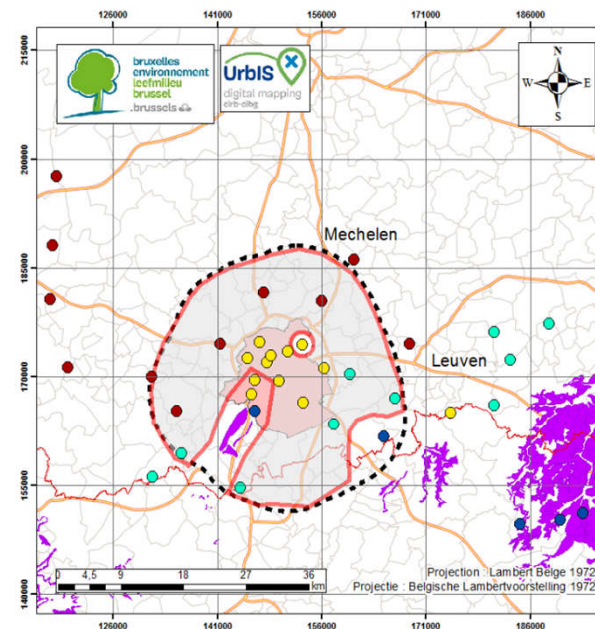
- Balance ionique <10%
- Limite de quantification /2
- Étudier séparément aquifères aérobies et anaérobies
- Utiliser la médiane pour représenter une série temporelle
- ...

Détermination des concentrations de référence

- Sélection des échantillons
Minéralisation globale



- Processus redox



Baseline concentration

compound	Unit	Brussels Region	Wallonia			Flanders	
		Baseline concentration	E031 Sables du Landénien et de l'Yprésien	E053 Sables du Landénien et de l'Yprésien	E061 Sables du Landénien et de l'Yprésien	Landénien Est BLKS_1000_GWL_2S	Landénien Ouest SS_1000_GWL_2
As *	µg/l	5	2.42	0.58	2.19	/	18
Cd *	µg/l	0.5	0.14	0.12	0.07	/	/
Cl	mg/l	141.1	115.28	79.89	107.87	35	480
EC	µS/cm	836	/	/	/	800	3500
Fe*	µg/l	606.4	3764.47	24.29	446.35	1700	1600
Hg *	µg/l	0.05	0.03	0.04	0.04	/	/
Mn *	µg/l	114.5	145.07	3.44	549.36	110	400
NH4	mg/l	0.46	0.6	0.06	0.96	0.69	0.82
Ni *	µg/l	8	5.31	2.39	6.03	/	8
NO2	mg/l	0.07	0.04	0.01	0.04	/	/
P total	mg/l	0.69	1.36	0.37	0.69	/	/
Pb *	µg/l	1.75	3.33	0.73	2.97	/	/
SO4	mg/l	31.7	286.5	122.39	229.24	84	370

Conclusions

- In the Region of Brussels, the Landenian aquifer corresponds to a zone of natural, high hydrogeochemical gradient, both in terms of mineralization and redox conditions
- This make the composition of groundwater strongly variable, even at the « local » scale of the region
- For the estimation of baseline concentrations, including information from the neighboring regions was essential to understand the processes and to derive some statistics...
- Baseline concentrations for RBC globally fall within the range of equivalent values considered respectively in Flanders and Wallonia
- More info?
http://document.environnement.brussels/opac_css/index.php?lvl=author_see&id=1254

Related report

Thomas, C, Orban, P. Brouyère, S., 2017. *Caractérisation de la concentration de référence de certains paramètres chimiques présents naturellement dans les masses d'eau souterraine captives du Socle et du Crétacé (BR01) et du Landénien (BR03) en Région de Bruxelles-Capitale*, rapport final de la convention IBGE et HGE-ULg, 202p. <http://hdl.handle.net/2268/216499>