

# Statistical description of hydrogeological parameters for the main aquifer contexts in Wallonia

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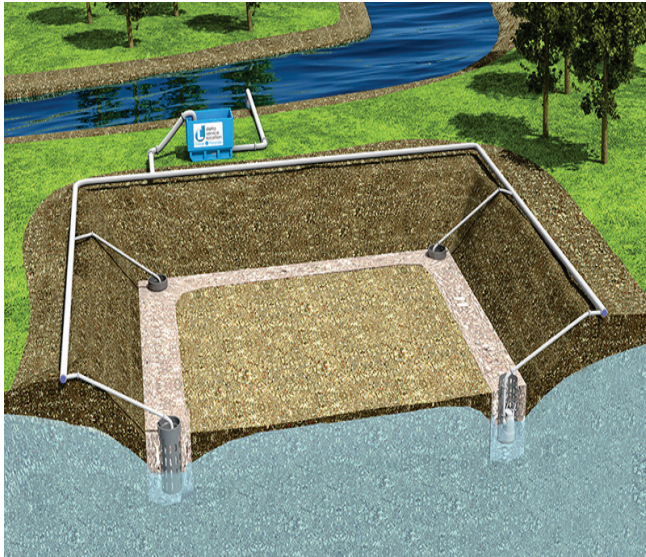
2 : Geolys sprl - Herve

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# Context of the study : We always need prior estimates of hydrogeological parameters ...

## DIMENSIONING systems

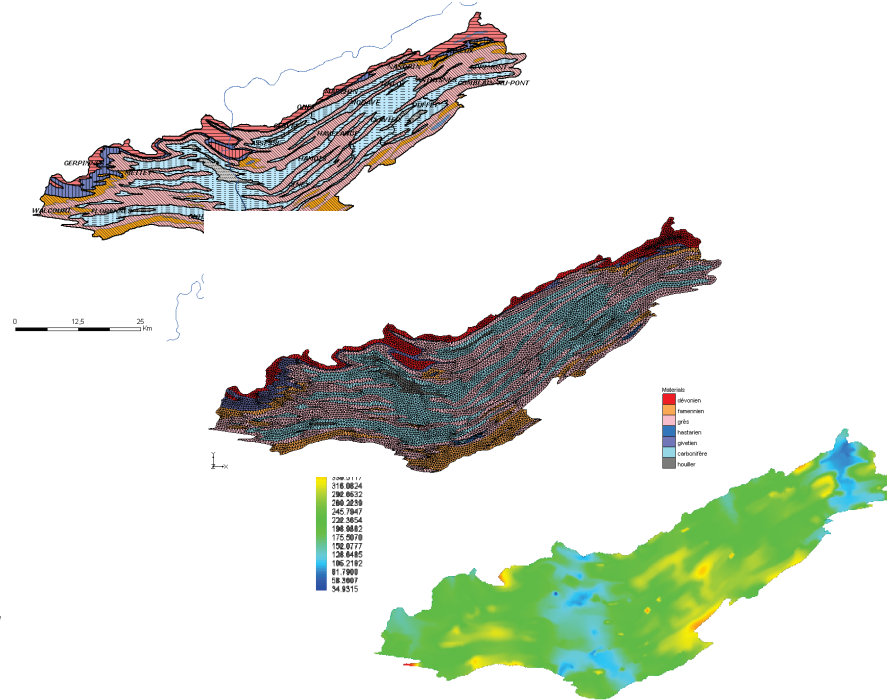
e.g. dewatering excavation works



Source image: <http://www.dsl.fr/gestion-de-projet/rabattement-de-nappe/>

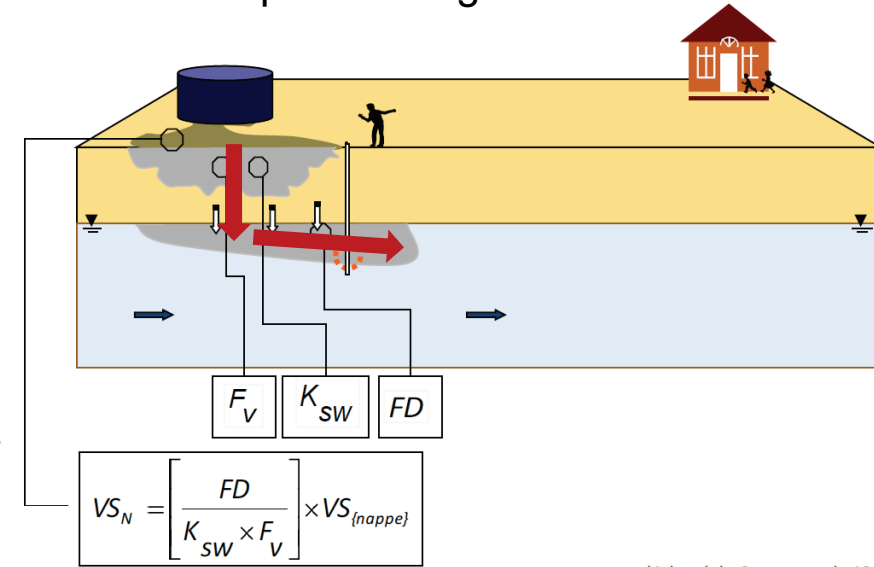
## GW flow and transport MODELLING

e.g. regional scale GW flow modelling



## RISK ASSESSMENT studies

e.g. risk of pollutant leaching and dispersion in groundwater



+ **UNCERTAINTY/SENSITIVITY** analyses related to these HG applications

# Context of the study (Walloon region context)

## Many databases and inventories but not adequate

Carte hydrogéologique de Wallonie

Planches disponibles pour l'application webGIS : avec nouvelles fonctionnalités

Au 15 février 2013, 122 cartes ont été réalisées et 42 cartes sont éditées et diffusées par le SPW (DGO 3) sur ce site. Les 7 cartes restantes à réaliser seront disponibles vers la fin 2013. Le processus d'édition, de publication et de diffusion dépendra de l'état d'avancement et de l'édition de la nouvelle carte géologique de Wallonie et du comité de lecture de la carte hydrogéologique : voir le programme de diffusion.

Point name: P23-Heure  
Well type: PF  
Operator: SWDE  
Depth [m]: 22.2

Operator: Localisation, Equipment, Well usage, Piezometric heads, Level reference, Chemistry data, Drilling

Date: 15/02/1984  
Measurement: 15.47  
Height [m]: 108.93  
Reference: ZN

Graph: Cotes [m] vs Date (1970-2010)

DixSous - Cartographie

Navigation: Coordonnée X(m): 226849, Coordonnée Y(m): 154821, Rayon (m): 4487

Actions: Home, Impression A3, Impression A4, Rapport succinct, Rapport complet

<http://environnement.wallonie.be/cartosig/cartehydrogeo/> (SPW)

BDHydro

<http://carto1.wallonie.be/10SousInt/> (SPW)

BANQUE DE DONNEES : WALSOLS

<http://www.walsols.be/> (SPAQuE)

2 main difficulties with these sources of hydrogeological information

- **DATABASE STRUCTURE** : from general information to detailed hydrogeological data
- **DATABASE CONTENT**: most often, raw data / hydrogeological parameters not directly available



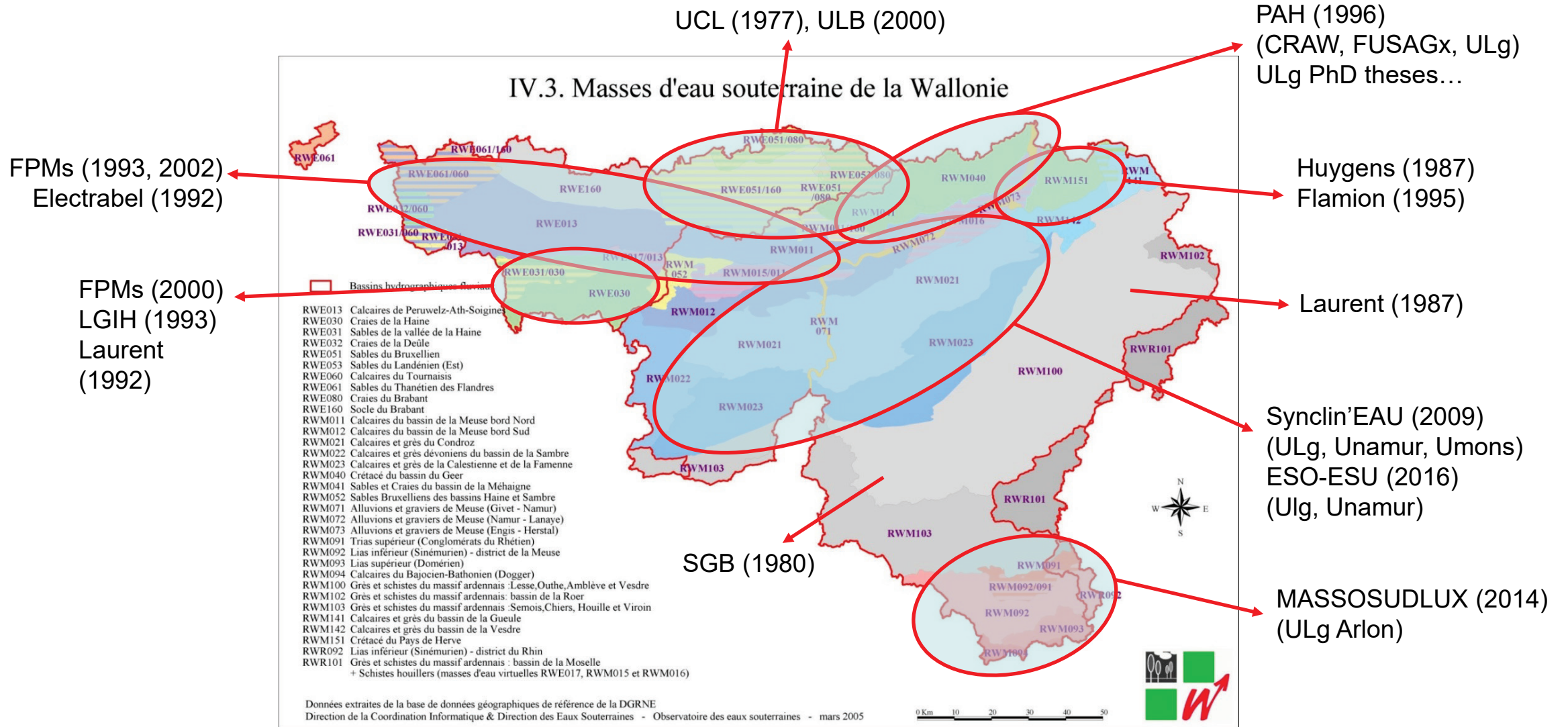
## Objectives of the project in this context:

### Collect and organize field-based estimates of hydrogeological data

- Identify relevant and adequate sources of information for collecting field-based estimates of HG data  
Redundancy, reliability, coverage in terms of territory / geology / hydrogeology contexts
- Develop a database structure that allows storing collected data and tracing relevant associated information in an efficient way  
HG Data → related information (e.g. geology) → general information (study)
- Collect and analyse/criticise available data and store them in the database
- Produce general statistical descriptors of these data  
Different possibilities for aggregation (geol, hydrogeol...), recommendations on their use...

# Available sources of information

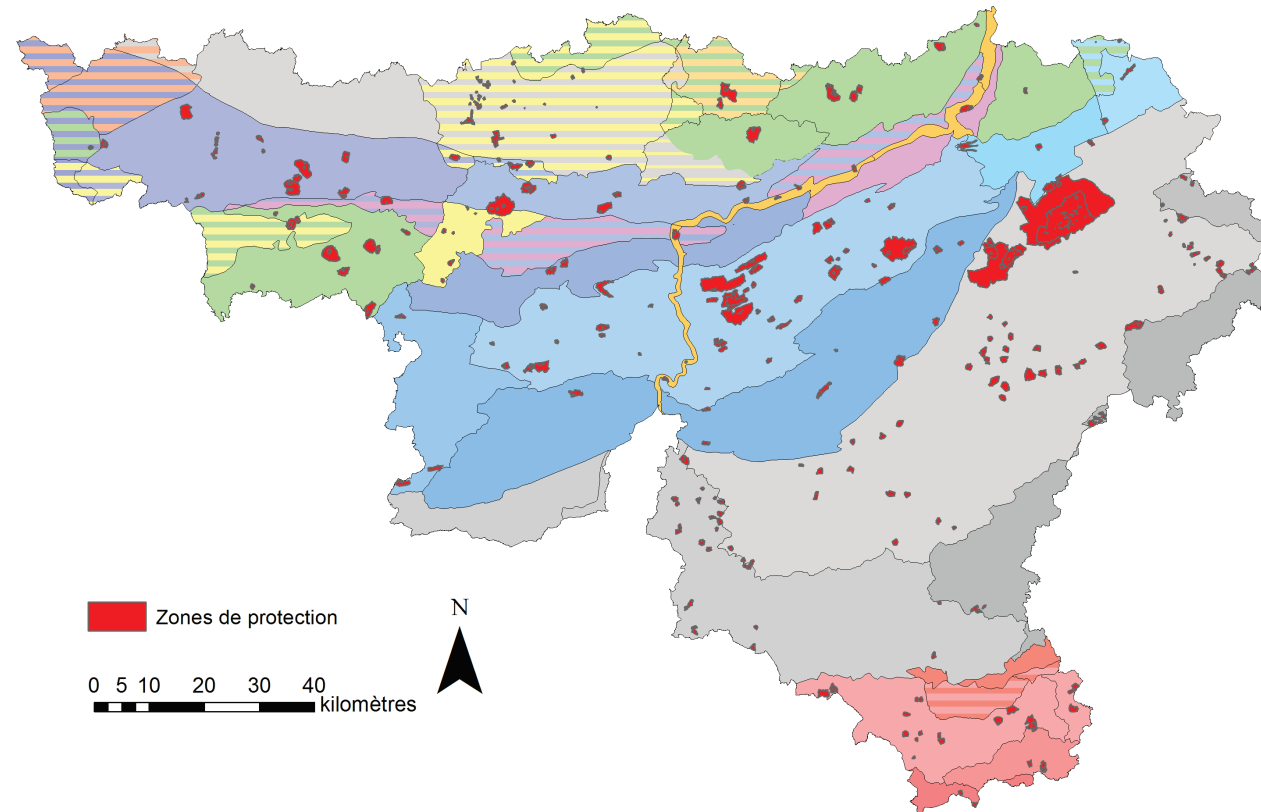
## Regional scale groundwater characterization studies



# Available sources of information

## Groundwater catchment protection zones

+/- 424 protection zones, among which 145 from where hydrogeological data can be recovered



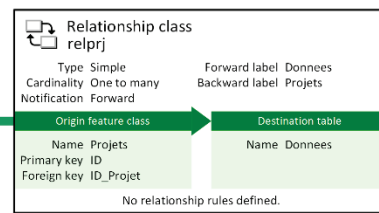
# Structure and content of the SERAN geodatabase for easy encoding and access to hydrogeological data

Simple feature class  
Projets

Geometry Polygon  
Contains M values No  
Contains Z values No

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
Intitule	String	Yes					255
Auteurs	String	Yes					255
Type	Short integer	Yes	0	Type_rapport	0		
Nappe_GRER	Short integer	Yes		GRER	0		
Nappe_SPAQuE	Short integer	Yes		SPAQuE	0		
Etendue	Short integer	Yes	0	Etendue	0		
Densite	Short integer	Yes	1	Densite	0		
SHAPE_Length	Double	Yes			0	0	
SHAPE_Area	Double	Yes			0	0	
ID	Long integer	Yes			0		
Annee	Long integer	Yes			0		
MESO	Short integer	Yes		MESO	0		
Contact	String	Yes					255
Nappe_GRER_rem	String	Yes					255
Nappe_SPAQuE_rem	String	Yes					50
MESO_rem	String	Yes					255

**Spatial coverage « Study Zone »**  
to delineate the area of interest and properties of each project



**Table-type coverage « Data »**  
containing each specific parameter and associated values

Table  
Donnees

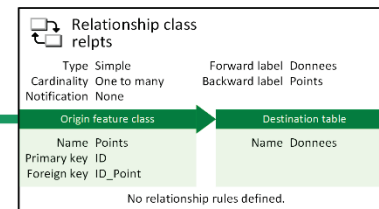
Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
ID_Projet	Long integer	Yes			0		
ID_Point	Long integer	Yes			0		
Date_	Date	Yes			0	0	8
Remarques	String	Yes					255
Tracage	Short integer	Yes	0	Tracage	0		
K1	Double	Yes			0	0	
K2	Double	Yes			0	0	
K_ref	Double	Yes			0	0	
ne1	Double	Yes			0	0	
ne2	Double	Yes			0	0	
ne_ref	Double	Yes			0	0	
disp_long1	Double	Yes			0	0	
disp_long2	Double	Yes			0	0	
disp_long_ref	Double	Yes			0	0	
infiltration	Double	Yes			0	0	
Type_essai	Short integer	Yes	0	Type_essai	0		
dist_tracage	String	Yes					255
Gradient	String	Yes					255

**Spatial coverage « Point »**  
to indicate measurement locations and their properties

Simple feature class  
Points

Geometry Point  
Contains M values No  
Contains Z values No

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
Nom	String	Yes					20
Type	Short integer	Yes	0	Type_points	0		
X	Double	Yes			0	0	
Y	Double	Yes			0	0	
Z	Double	Yes			0	0	
ID	Long integer	Yes			0		
ID_RW	Double	Yes			0	0	
Remarque	String	Yes					200
Lithologie	String	Yes					100



# Structure and content of the SERAN geodatabase

Studies	ID	ID of the study
	Title	Title of the study
	Authors	Authors of the study
	Type	Type of report
	Year	Year of publication
	GW body	Concerned groundwater body
	Aquifer_GRER	Concerned GRER aquifer
	Aquifer_SPAQuE	Concerned SPAQuE aquifer
	Spatial covery	Spatial covery of the study
	Data density	Data density
	GW body note	Note abot groundwater body
	Aquifer_GRER note	Note about GRER aquifer
	Aquifer_SPAQuE note	Note about SPAQuE aquifer
Contact	Contact information	

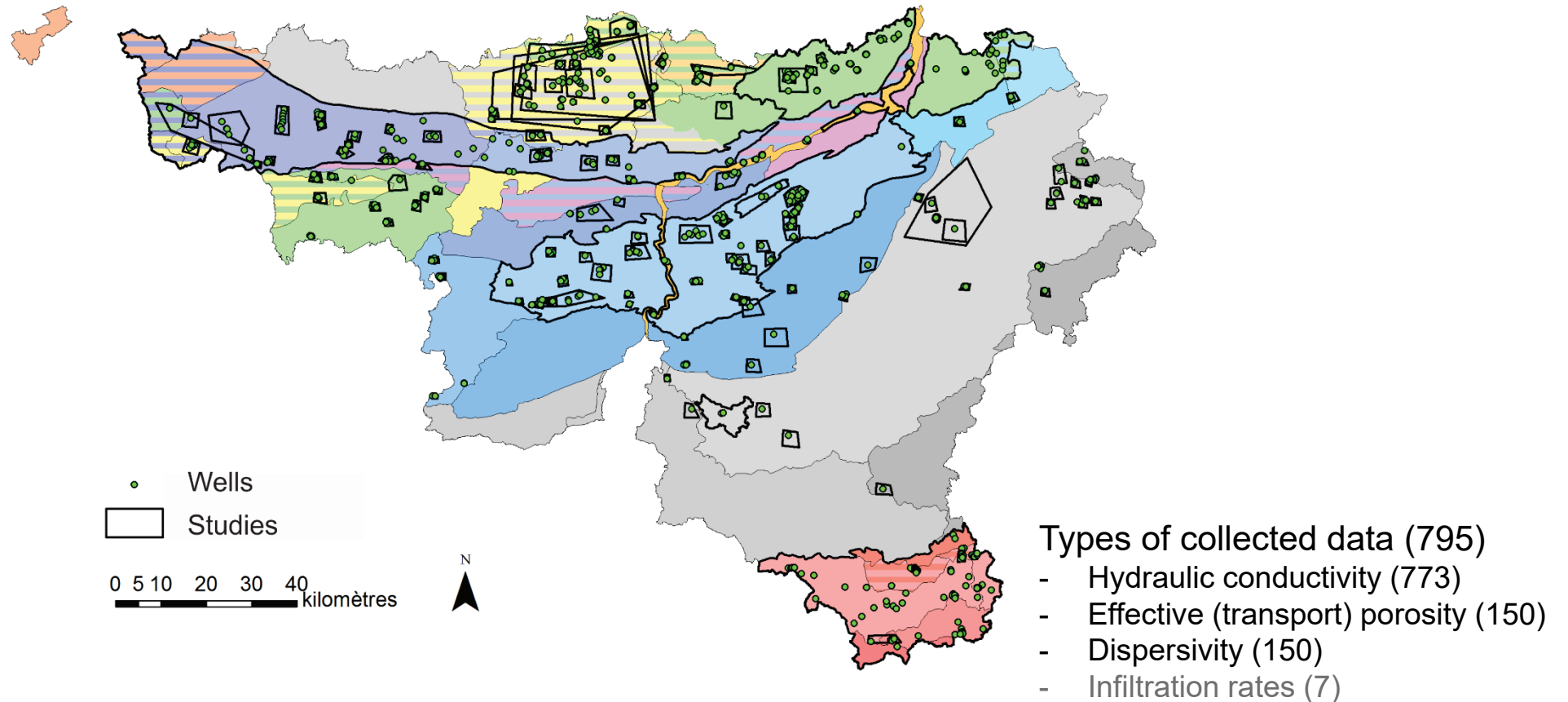
Point	ID	ID of tested well
	Name	Name of the well
	Type	Type of point
	X	X coordinates
	Y	Y coordinates
	Z	Z coordinates
	ID_RW	Walloon Region ID
	Lithology	Main lithology of the well

Data	ID_Projet	ID of concerned study
	ID_Point	ID of tested well
	Date	Date of the test
	Notes	Note about the test
	Tracer test	Existence of a tracer test
	Tracer test distance	Distance of the tracer test
	Type of test	Type of test
	K1	Minimum hydraulic conductivity value
	K2	Maximum hydraulic conductivity value
	K_ref	Representative hydraulic conductivity value (geometric mean)
	ne1	Minimum effective porosity value
	ne2	Maximum effective porosity value
	ne_ref	Representative effective porosity value
	disp_long1	Minimum longitudinal dispersivity value
	disp_long2	Maximal longitudinal dispersivity value
	disp_long_ref	Representative longitudinal dispersivity value
	Infiltration	Infiltration value

# Available sources of information

## Summary of data available in the database

172 sources of information, among which  
145 protection zones and 27 hydrogeological surveys



# Data availability by lithology / aquifer contexts

## Three main classifications available ...

### GRER: 7 units

GRER	Studies	Points
Alluvial	9	65
Cretaceous	29	173
Bruxellian	16	47
Limestone	79	330
Sinemurian	6	101
Schist and sandstone	32	76
Unexploitable	1	3
<b>Total</b>	<b>172</b>	<b>795</b>

### EuroWaterNet: 16 units

EuroWaterNet		Studies	Points
BE001	Calcaires du bord Nord du bassin de Namur	21	117
BE002	Calcaires carbonifères du bassin de Dinant	40	170
BE003	Craies du bassin de Mons	12	55
BE004	Craies de Hesbaye	11	63
BE005	Sables bruxelliens	15	47
BE006	Calcaires carbonifères du Tournaisis	3	9
BE007	Graviers de la Meuse	8	46
BE008	Craies captives du Brabant	5	36
BE009	Formations jurassiques du Sud-Luxembourg	6	101
BE010	Massif schisto-gréseux de l'Ardenne	31	76
BE011	Massif schisto-gréseux du bassin de Dinant	/	/
BE012	Calcaires dévoniens du bassin de Dinant	11	29
BE013	Socle cambro-silurien de l'Ardenne	/	/
BE014	Aquifère du massif de la Vesdre	2	6
BE015	Crétacé du pays de Herve	2	19
BE016	Socle cambro-silurien du Brabant	/	/
	Autre/Multiple	5	21
<b>Total</b>		<b>172</b>	<b>795</b>

### WFD GW bodies: 33 units

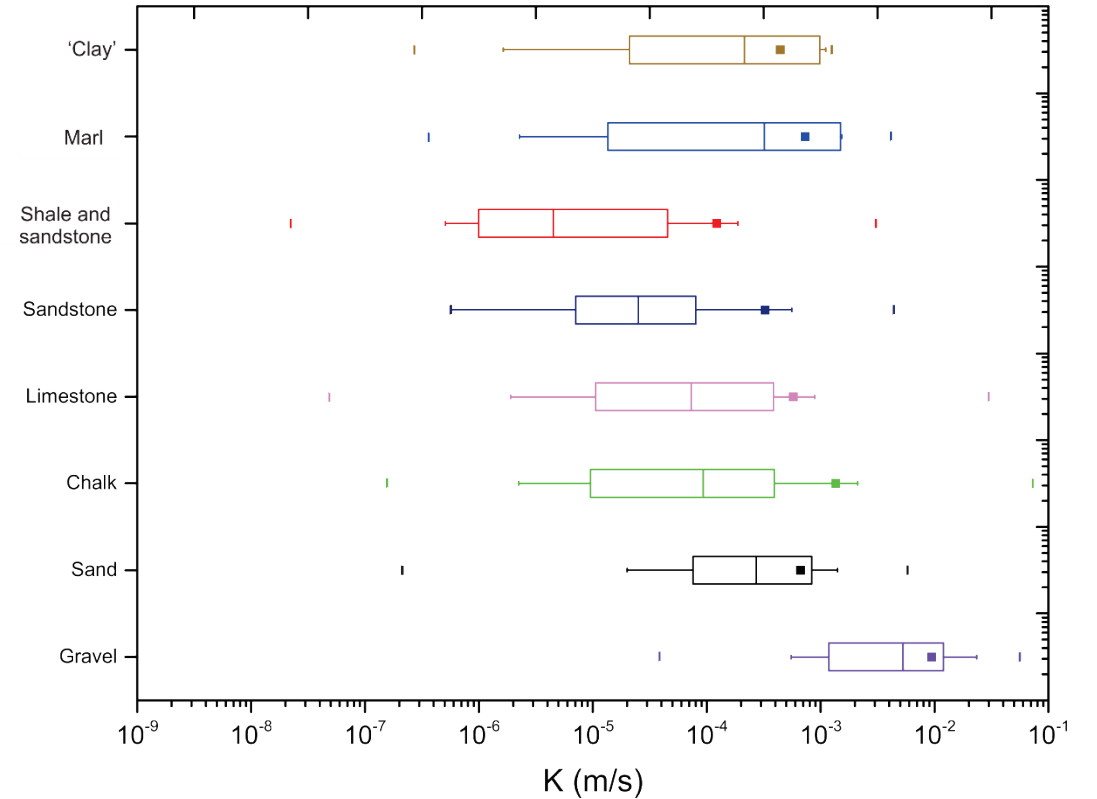
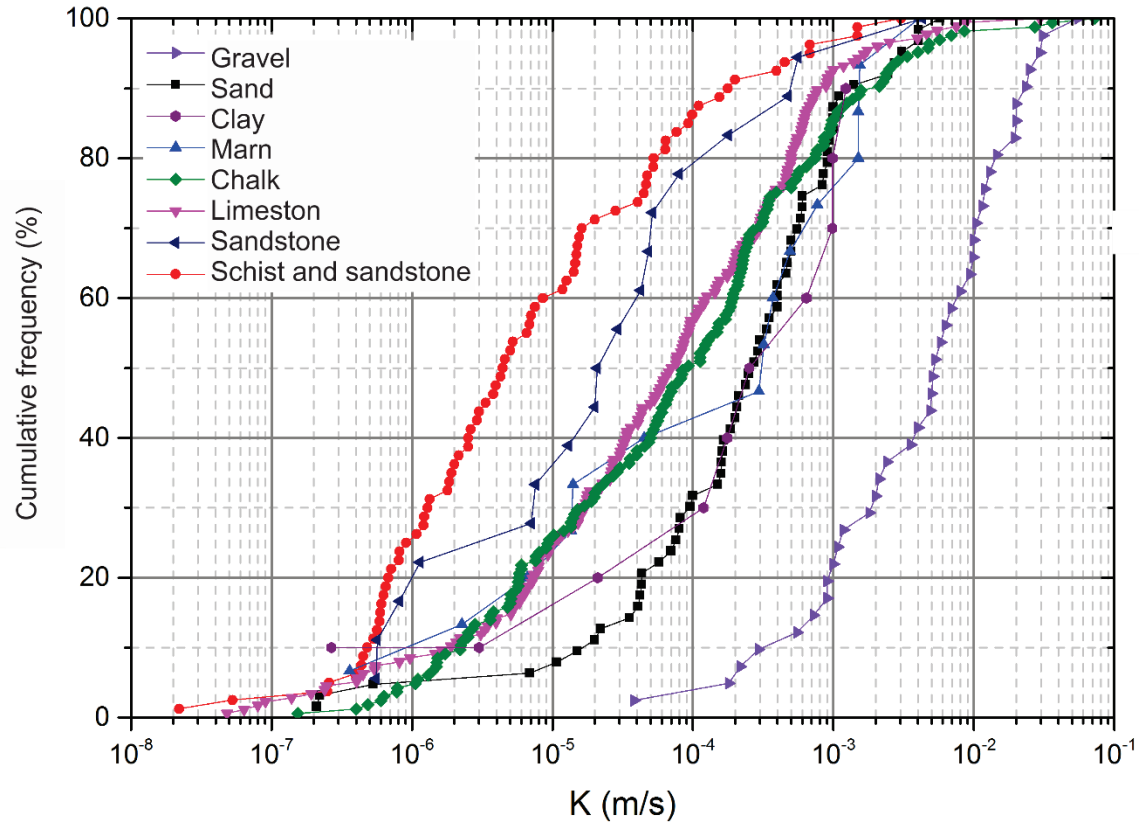
Masse d'eau souterraine (MESO)		Etudes	Points
RWE013	Calcaires de Peruwez-Ath-Soignies	16	77
RWE017	Houiller	1	3
RWE030	Craies du bassin de la Haine	11	49
RWE031	Sables de la vallée de la Haine	/	/
RWE032	Craies de la vallée de la Deûle	1	6
RWE051	Sables du Bruxellien	14	57
RWE053	Sables du Landénien (Est)	1	3
RWE060	Calcaires du Tournaisis	/	/
RWE061	Sables des Flandres	/	/
RWE080	Craies captives du Brabant	5	39
RWE160	Socle du Brabant	5	14
RWM011	Calcaires du bassin de la Meuse bord Nord	8	45
RWM012	Calcaires du bassin de la Meuse bord Sud	5	13
RWM021	Calcaires et Grès du Condroz	35	157
RWM022	Calcaires et Grès du bassin de la Sambre	4	15
RWM023	Calcaires et Grès de la Calestienne et de la Famenne	8	15
RWM040	Craies du bassin du Geer	10	62
RWM041	Sables et Craies de la Mehaigne	1	1
RWM052	Sables Bruxelliens Haine et Sambre	/	/
RWM071	Alluvions et Graviers de la Meuse (amont de Namur)	1	2
RWM072	Alluvions et Graviers de la Meuse (Namur - Lanaye)	5	37
RWM073	Alluvions et Graviers de la Meuse (Engis - Herstal)	2	7
RWM091	Conglomérats du Rhétien (Trias supérieur)	/	/
RWM092	Lias inférieur (Sinémurien)	2	14
RWM093	Lias supérieur (Domérien)	2	7
RWM094	Calcaires du Bajocien-Bathonien (Dogger)	/	/
RWM100	Grès et schistes du massif ardennais	21	50
RWM102	Grès et schistes du massif ardennais: bassin de la Roer	2	4
RWM103	Grès et schistes du massif ardennais: Semois, Chiers et Viroin	1	1
RWM141	Calcaires et grès du bassin de la Gueule	2	5
RWM142	Calcaires et grès du bassin de la Vesdre	1	3
RWM151	Craies du Pays de Herve	2	19
RWR092	Grès du Luxembourg (Sinémurien - Lias inférieur)	1	6
RWR101	Grès et Schistes du massif ardennais: bassin de la Moselle	2	7
	Multiple	3	77
<b>Total</b>		<b>172</b>	<b>795</b>

### ... and maybe a final compromise

Lithology	Studies	Points	K	ne	αL
Limestone	51	178	176	45	45
Sandstone	10	18	18	5	5
Sand	21	64	63	7	7
Clay	6	10	10	/	/
Chalk	30	168	165	49	47
Gravel	7	46	41	9	8
Marl	4	15	15	2	2
Schale and sandstone	29	80	80	16	10
Undetermined	14	216	205	21	19
<b>Total</b>	<b>172</b>	<b>795</b>	<b>773</b>	<b>154</b>	<b>143</b>

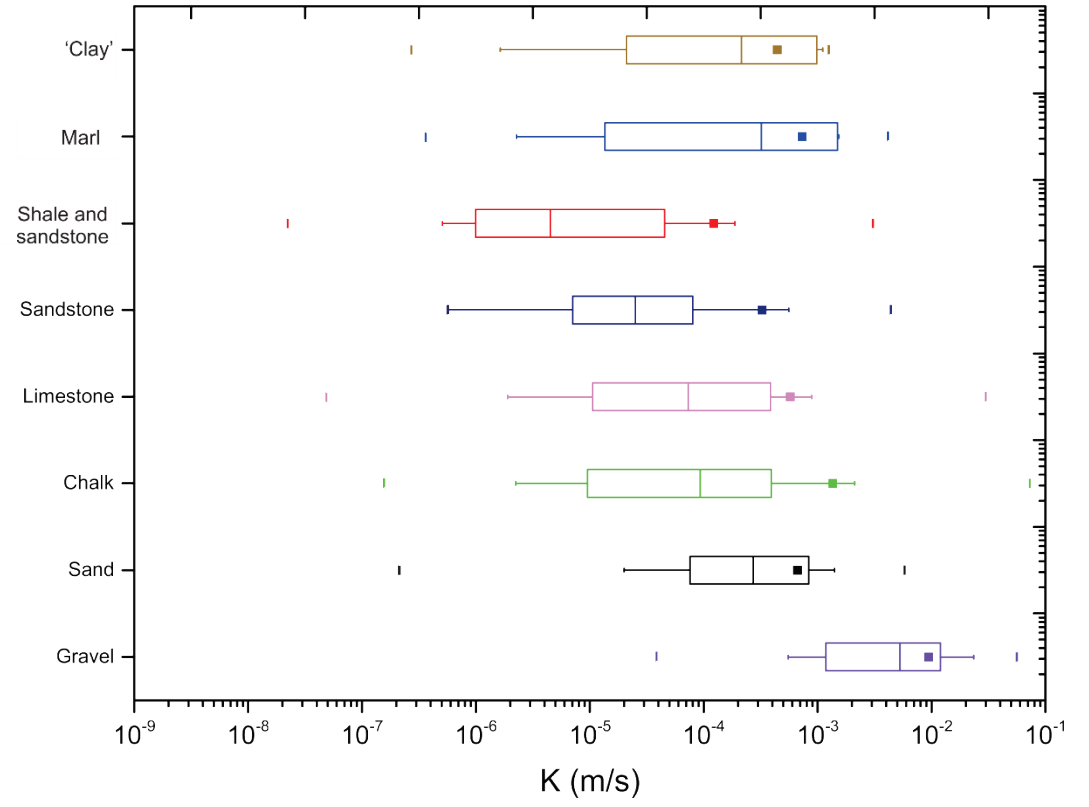
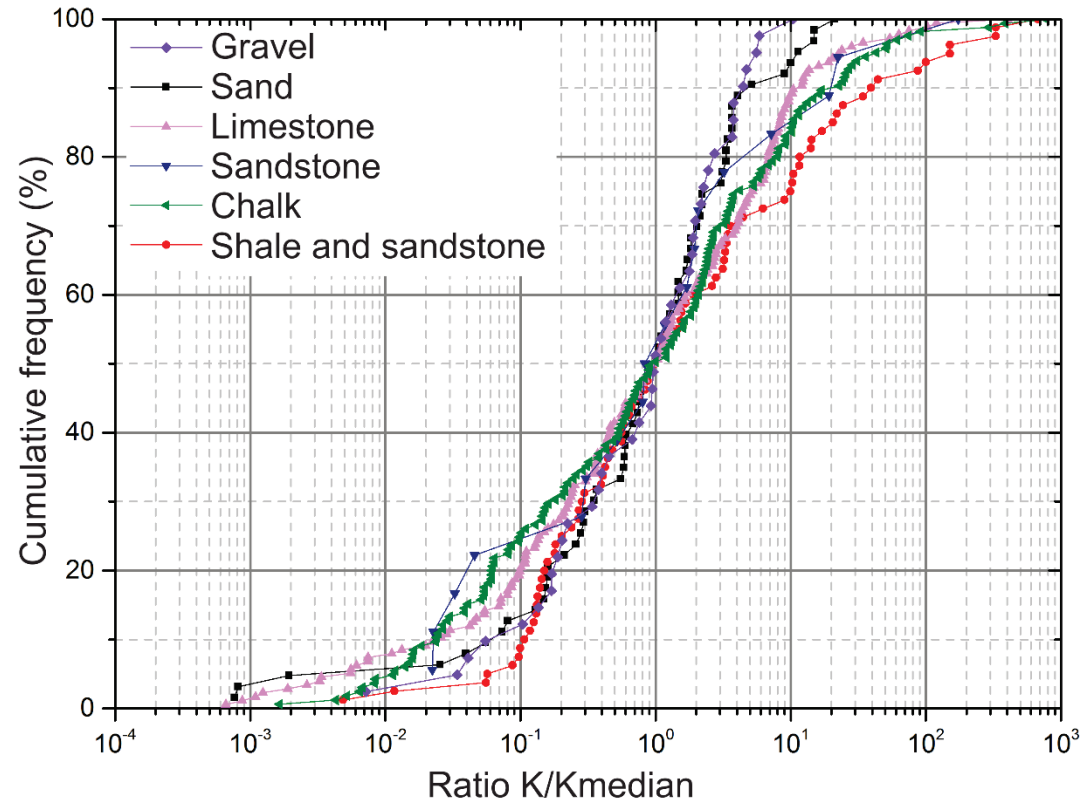
# Statistical description of collected data

## K values based on main lithological units



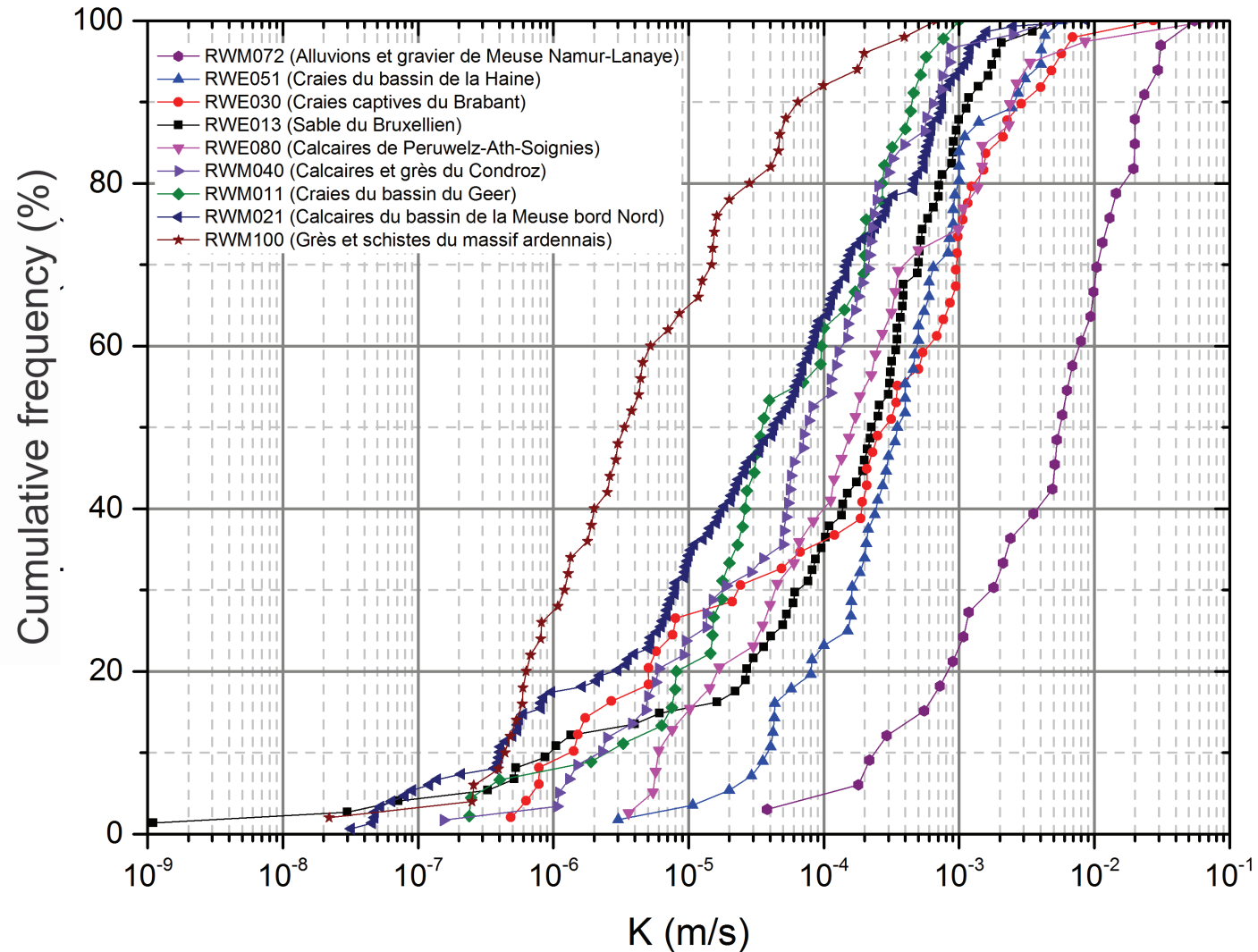
# Statistical description of collected data

## K values based on main lithological units



# Statistical description of collected data

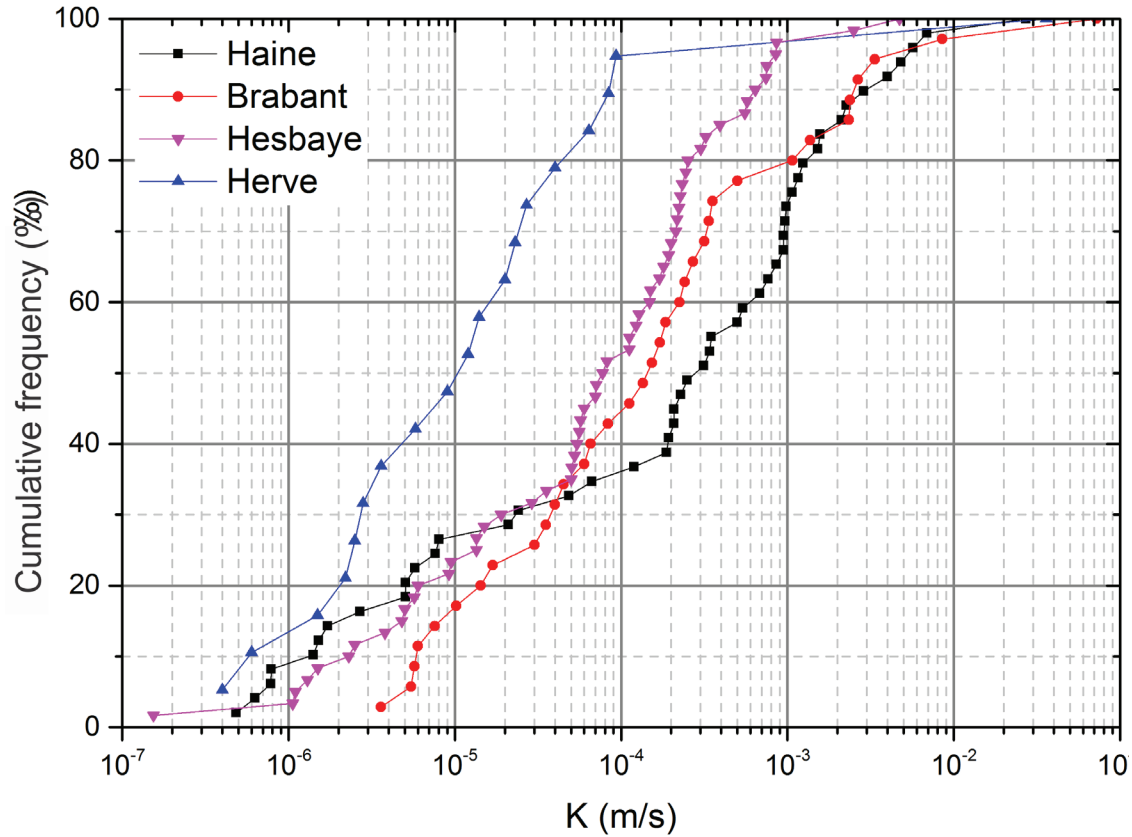
## K values based on EU WFD GW Body classification



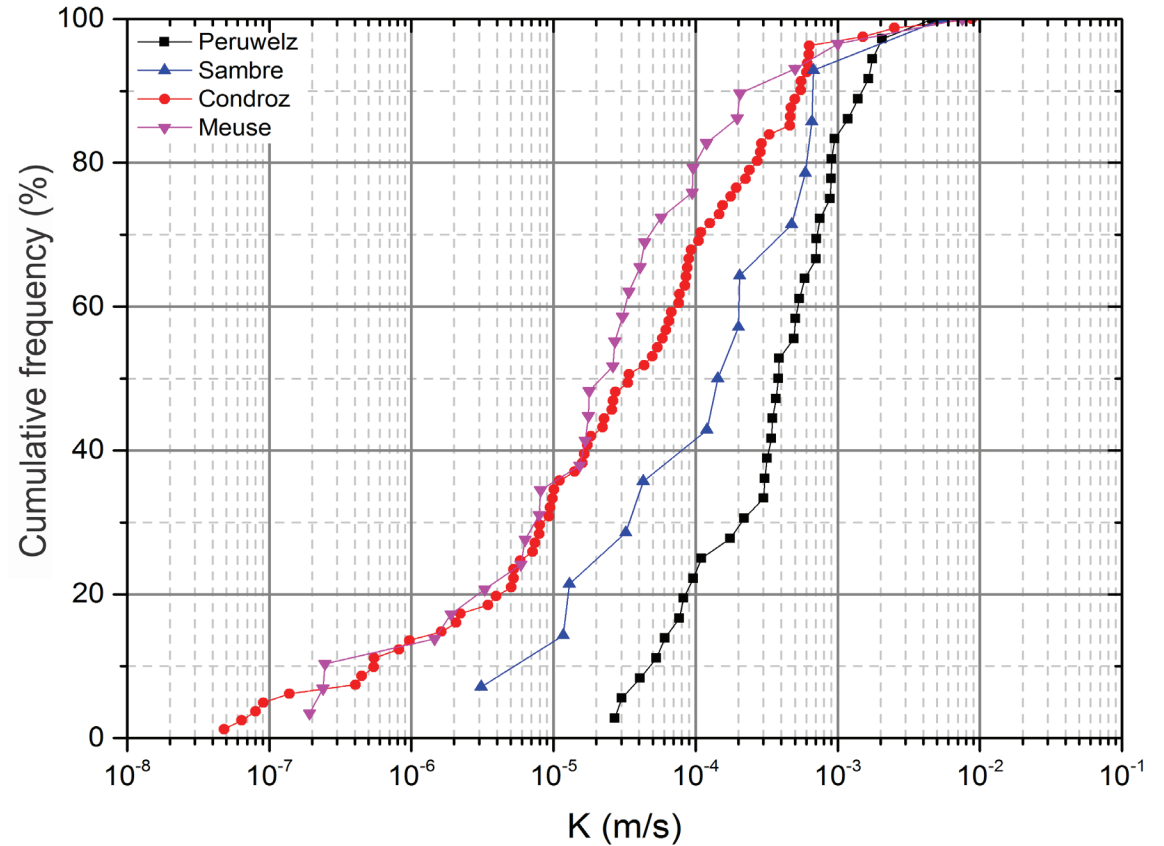
# Statistical description of collected data

## Same lithology in different geographical contexts ...

Cretaceous chalk



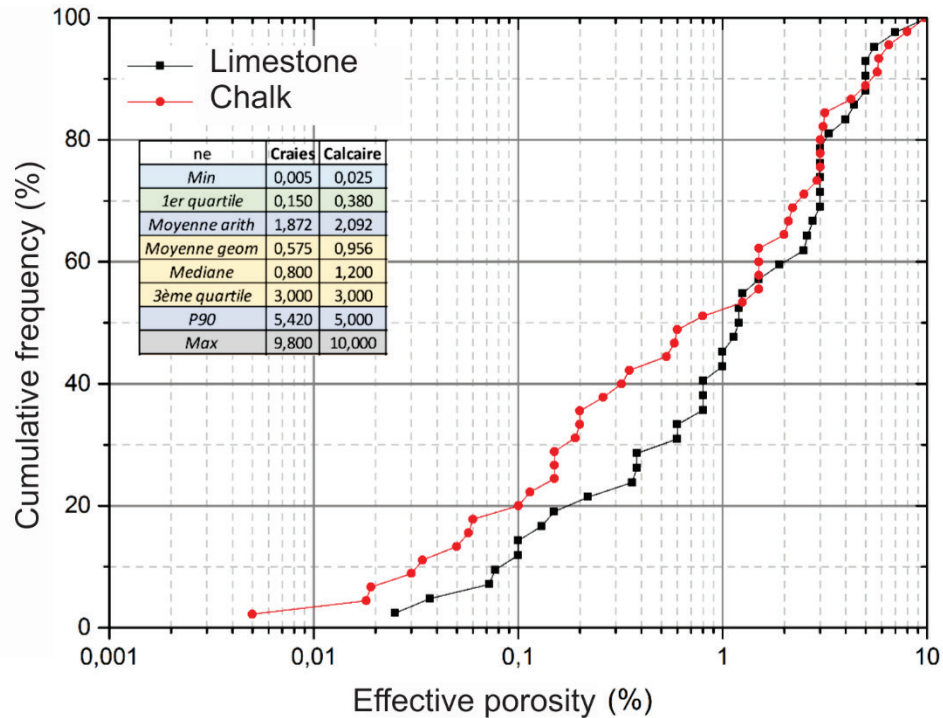
Devonian & carboniferous limestone



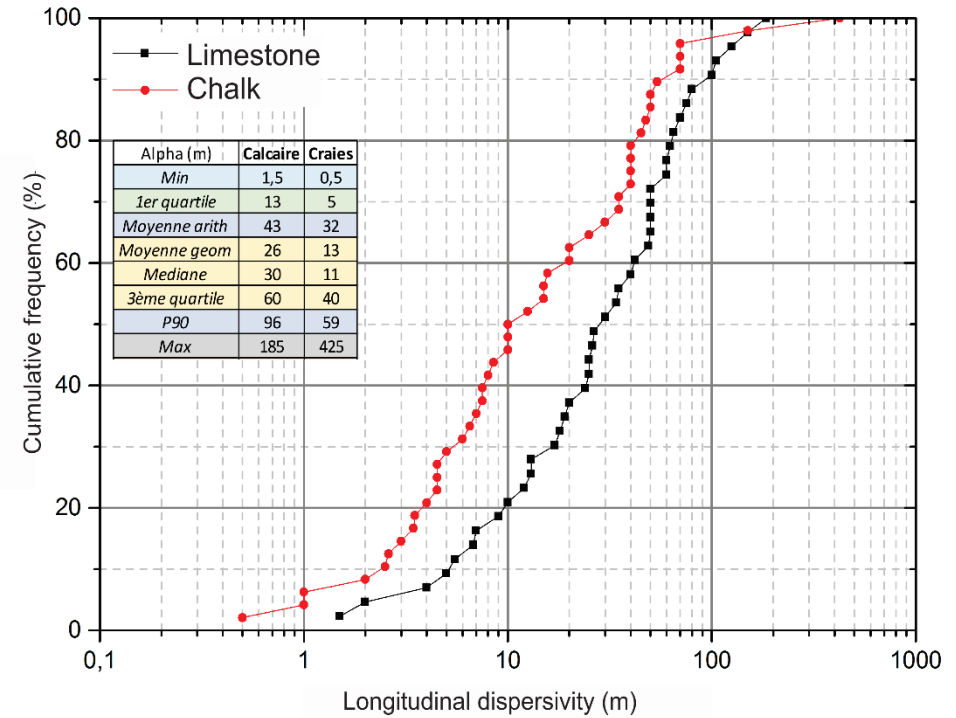
# Statistical description of collected data

## Transport parameters ...

### Effective (transport) porosity



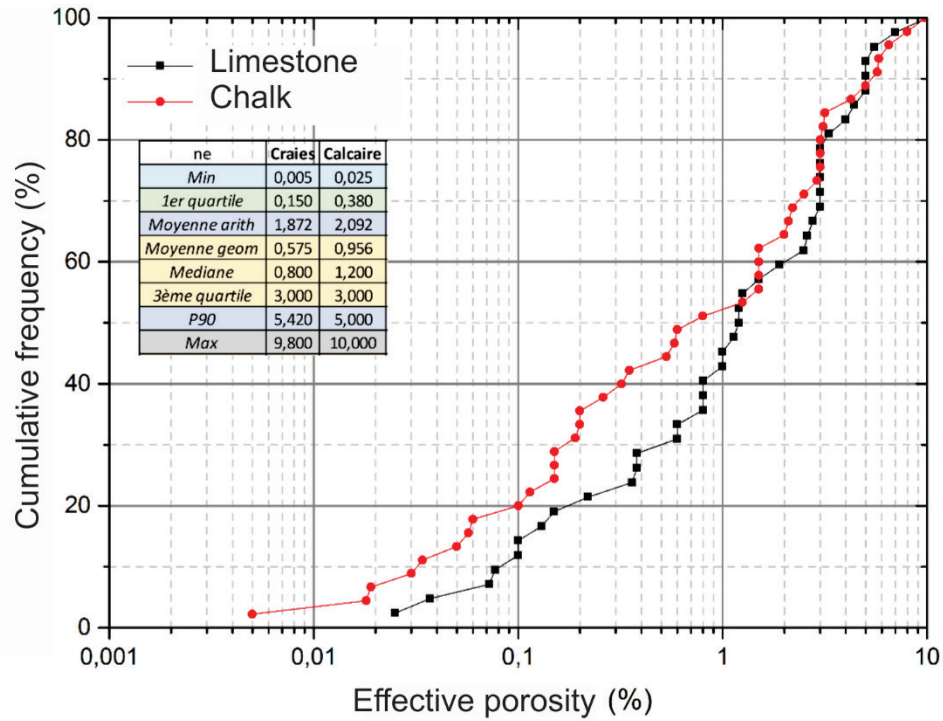
### Longitudinal dispersivity coefficient



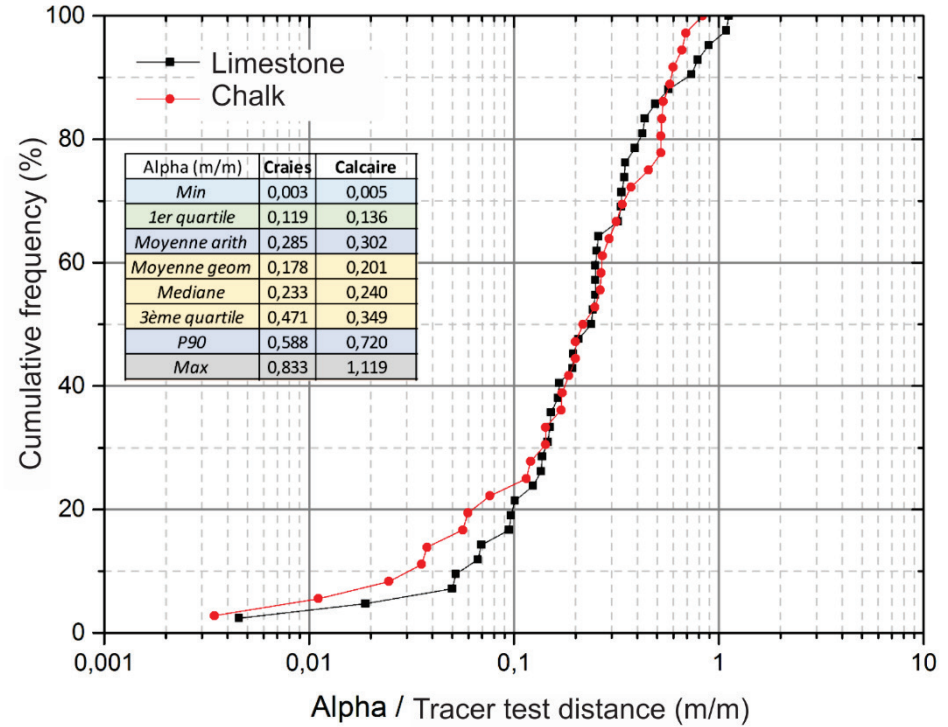
# Statistical description of collected data

## Transport parameters ...

### Effective (transport) porosity



### Longitudinal dispersivity coefficient





# Conclusions and perspectives

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- Despite the disparity and diversity of HG data sources, interesting parameter distributions obtained, with trends reflecting the various HG contexts of Wallonia, in particular
  - Porous (loose) aquifers with highest K values and narrow distributions
  - Consolidated (fractured) aquifer with lower K values but broader distributions
- Among similar geological contexts, significant differences from one region to another, related to different local geological histories / contexts?
- Even if clear differences from one geological context to another, strong variability in the ranges of HG parameters (3 to 5 orders of magnitude)  
→ *'a priori'* estimates of hydrogeological parameters will never replace *'in situ'* measurements, at least for more advanced and accurate calculations
- Reliability of transport parameters more questionable, in particular for dispersivity estimates which are most probably more site-dependent and strongly dependent of selected transport models and calibration procedures



# Conclusions and perspectives

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- Next steps
  - Make the database accessible and available for further data encoding and increased reliability of datasets (particularly for less documented aquifer / geological contexts)
  - Further examination on the variability of HG parameters (both at local and regional scales)
  - Other relevant HG data / information and generalization to other contexts / regions?
  - First use of these data : improved referential for the « Guide de Référence pour l'étude des risques (GRER) in the context of the Walloon Soil Decree

# Acknowledgements

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*“Etablissement des valeurs représentatives par type d'aquifère des paramètres hydrogéologiques intervenant dans l'Évaluation des risques pour les eaux souterraines en application du Décret du 5 décembre 2008 relatif à la Gestion des Sols »*



Results and conclusions presented in this talk have not yet been validated by the project follow-up committee