Managed Aquifer Recharge in Wallonia (Belgium)
The MARWAL Project

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Environmental Geology

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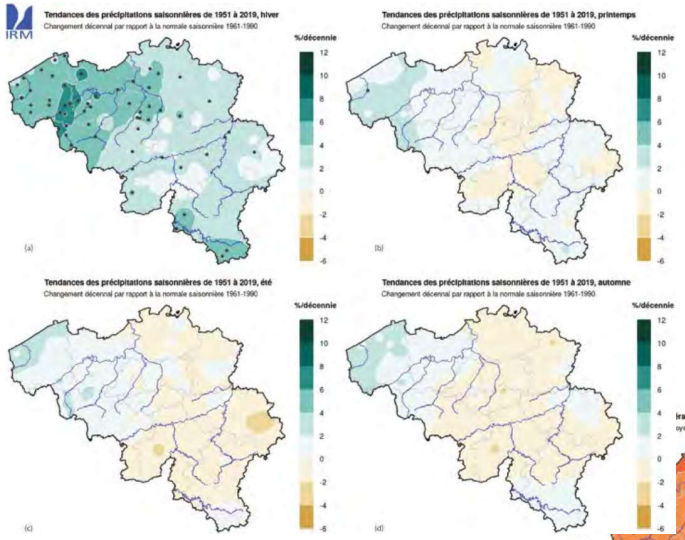
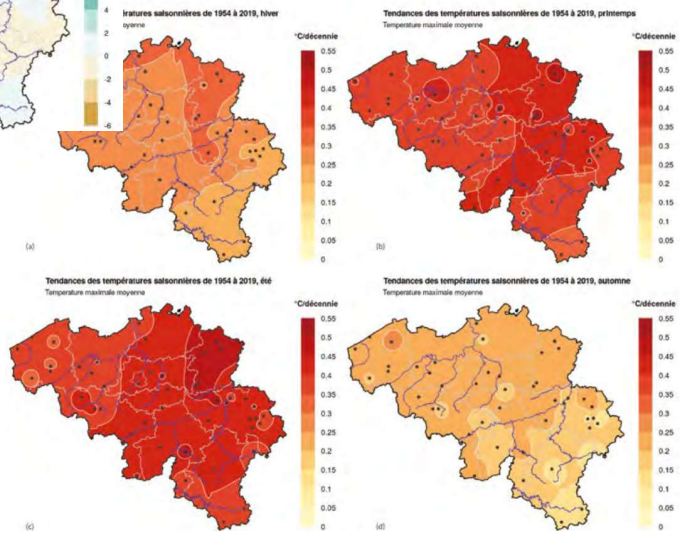
General context

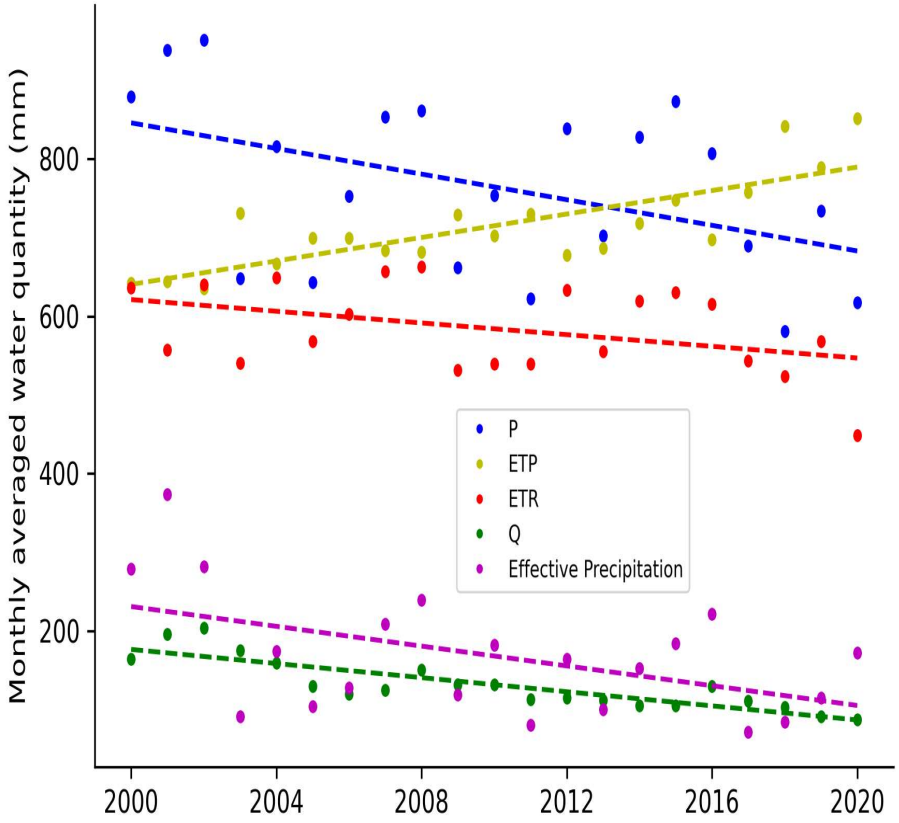
Over the last decades, initial impacts of climate change with repeated summer and winter droughts



Precipitations

Temperatures





Source : IRM-KMI climatic 2020, 92p.,
Ed. : Dr. D. Gellens | ISSN 2033-8562 |
Coordination : Rozemien De Troch |

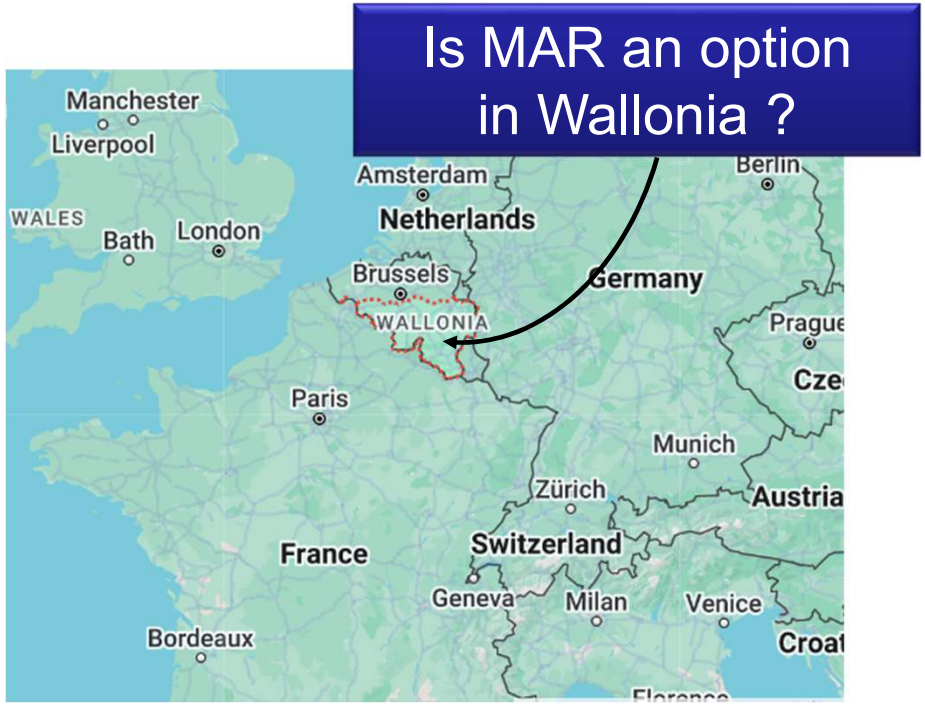
General context

The MARWAL Project

Feasibility study and pilot tests to evaluate if MAR is a possible response to secure groundwater resources in Wallonia

Aim of MAR in Wallonia:

- Storage of water for a delayed use
- Overcome droughts and support developing irrigation in agriculture

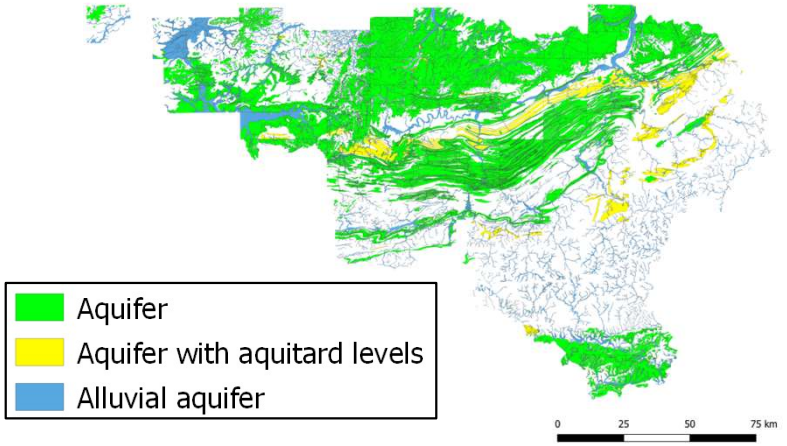


1. Regional-scale feasibility study (scale of Wallonia)
2. Local-scale feasibility study for the Hesbaye chalk aquifer in the region of Liège

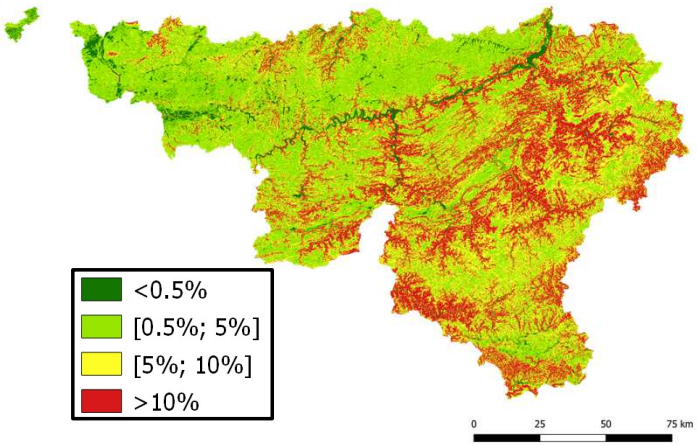
Regional-scale feasibility study

Considered factors for the elaboration of a MAR feasibility map

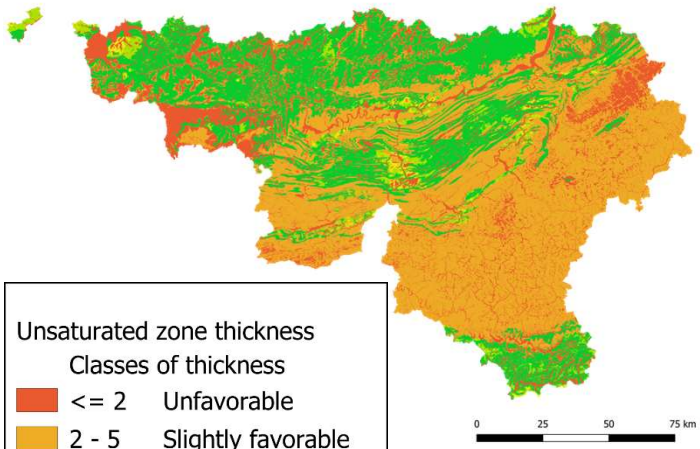
1) Hydrogeological contexts



2) Land slopes



3) Unsaturated Zone

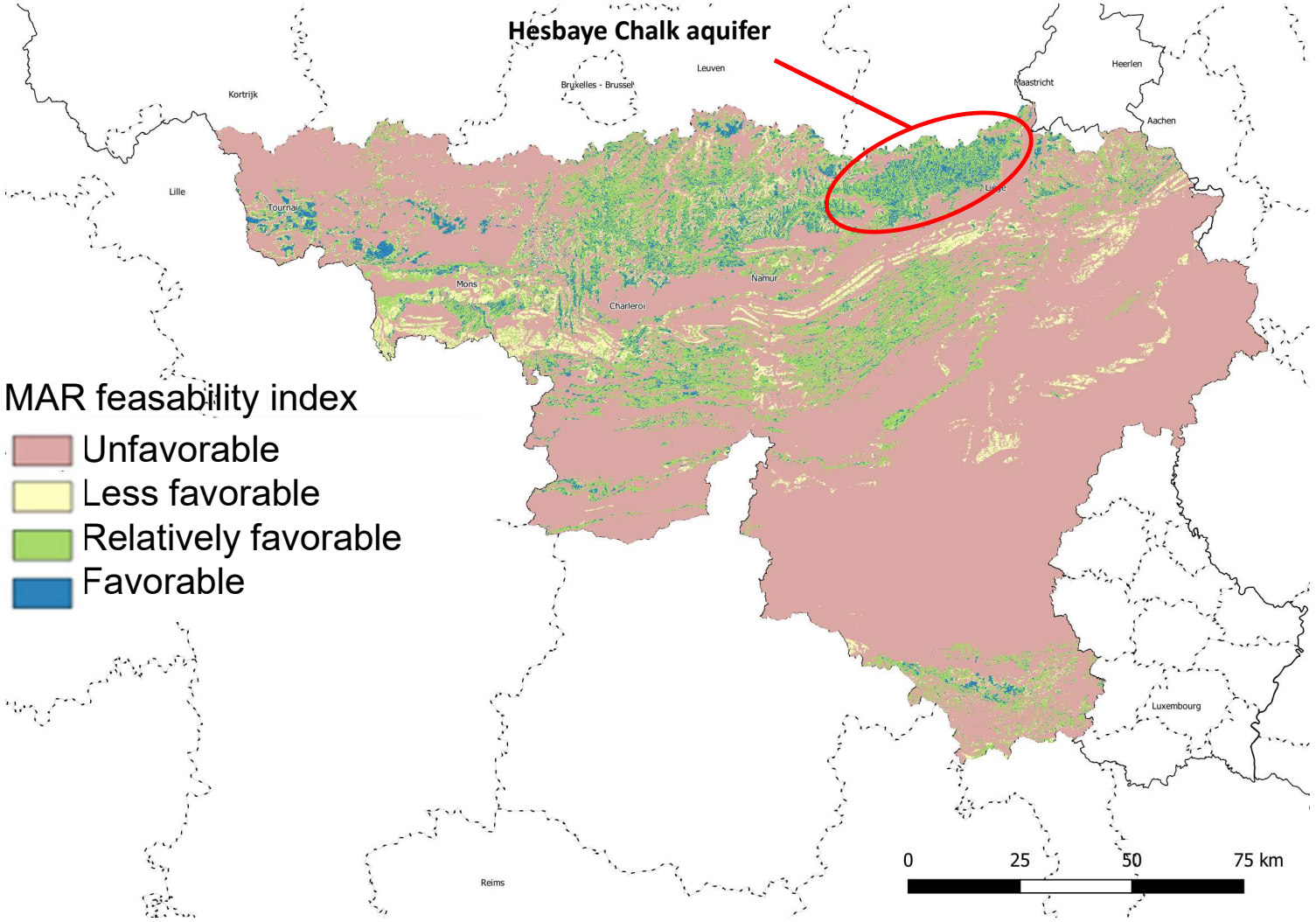


→ **Summary of the considered factors**

	1	0,5	0
HYDROGEOLOGICAL CONTEXTS	Aquifer	Aquifer with aquitard levels	Oher hydrogeological contexts
LAND SLOPES	[0; 2] %	]2; 10] %	> 10 %
THICKNESS OF THE UNSATURATED ZONE	]5; 70] m	]2; 5] &]70; 90] m	<=2 m & >90 m

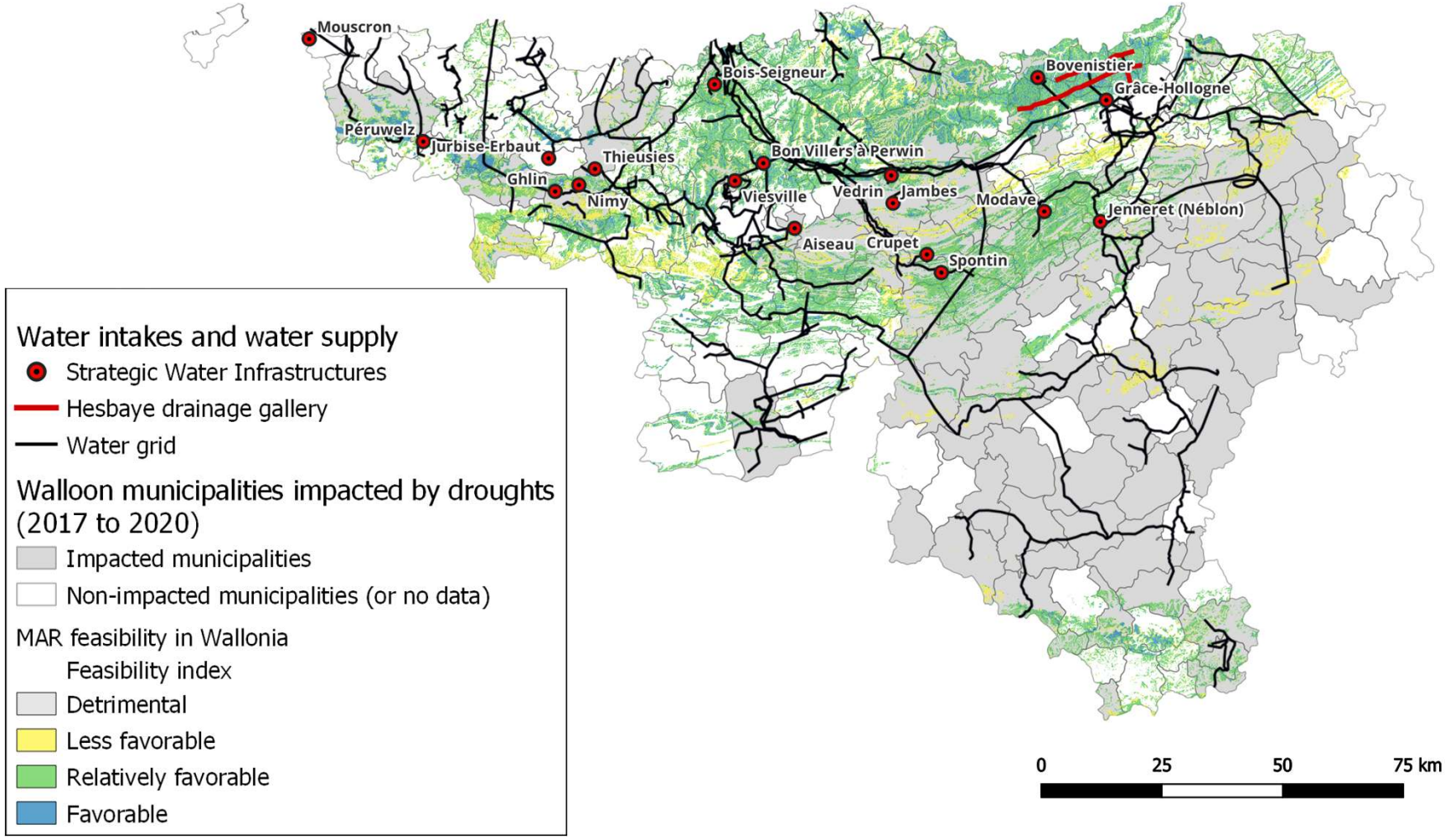
Regional-scale feasibility study

Final MAR feasibility map



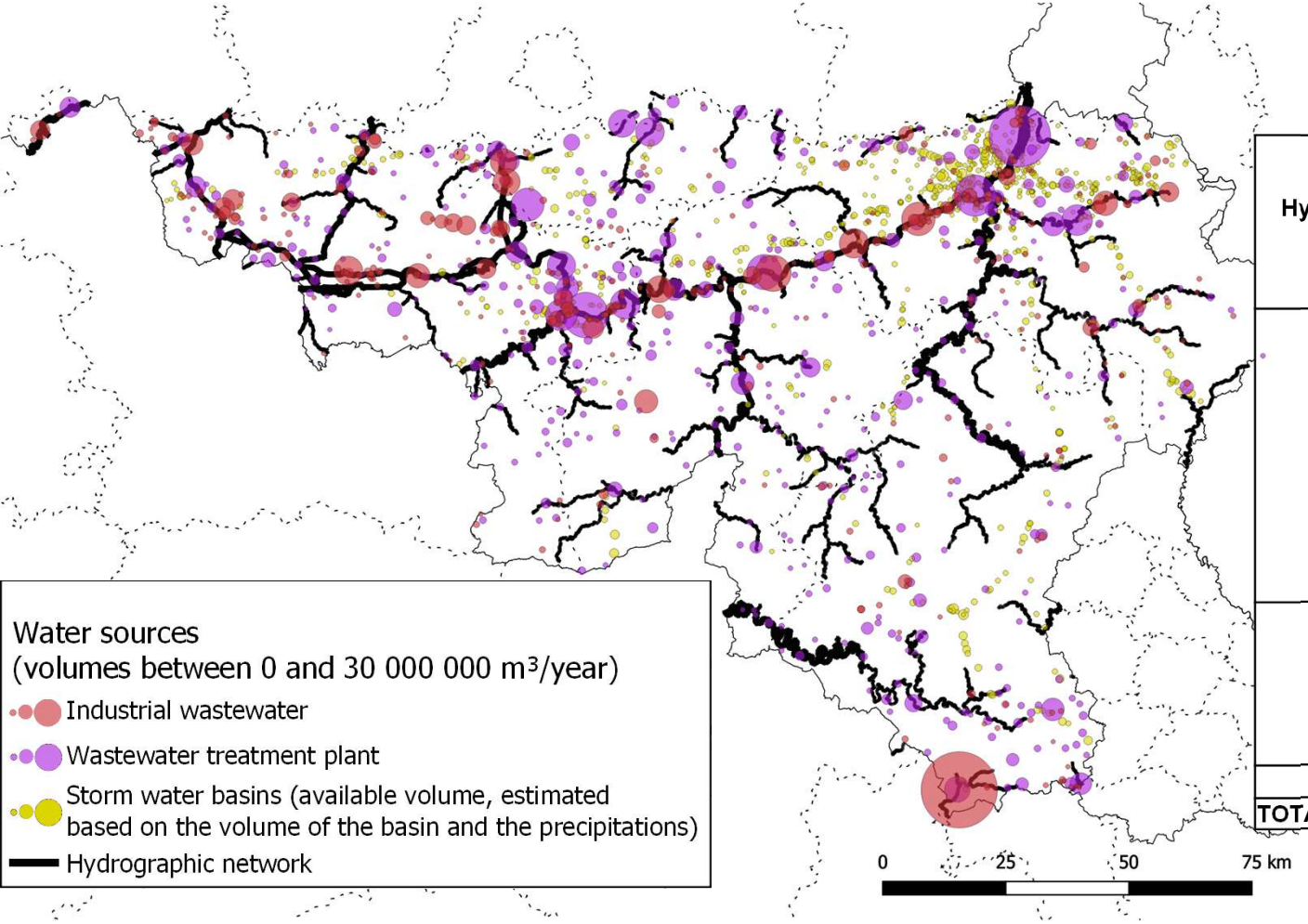
Regional-scale feasability study

Crossing information on strategic groundwater catchments and municipalites already been impacted by droughts



Regional-scale feasibility study

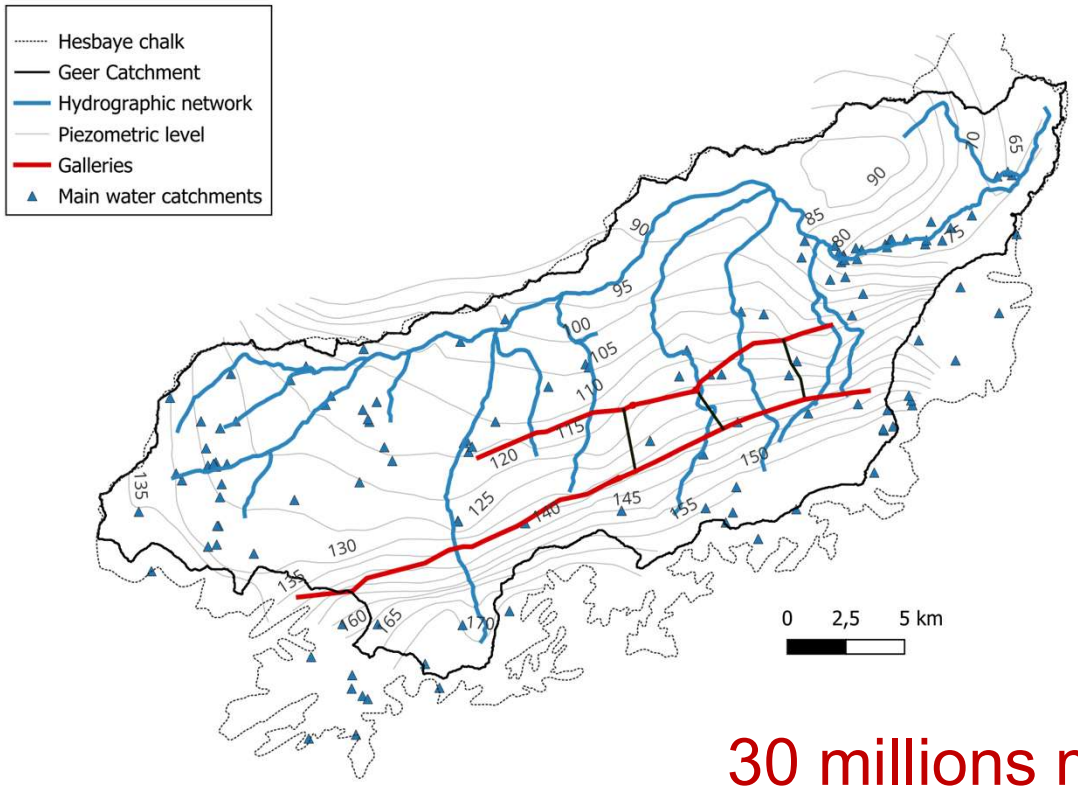
Identification of water sources

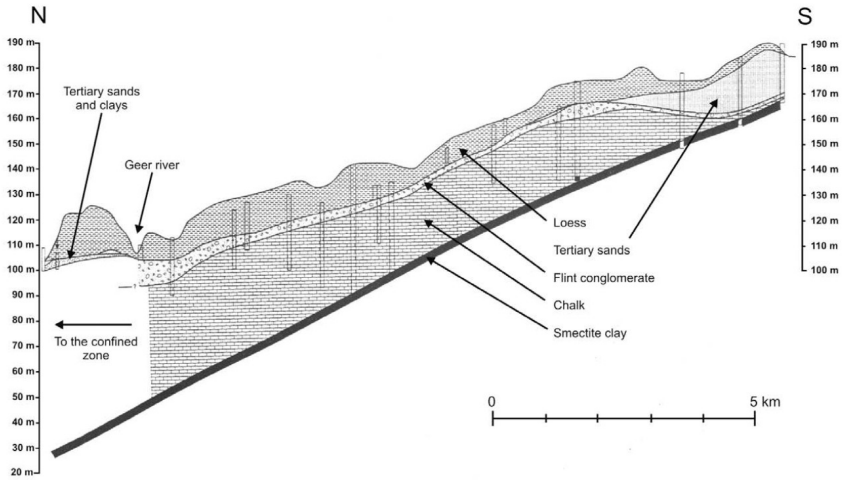


Hydrographic Basin	Sub-basin	Mean flow (between 1990 and 2021) [m³/s]	Potentially available volumes (6 month per year, 20h per day) [Mm³]
Meuse	Basse Meuse	123.5	320.0
	Haute Meuse	91.2	236.3
	Ourthe	33.9	87.8
	Sambre (outflow)	14.9	38.5
	Semois	12.9	33.5
	Lesse	9.6	25.0
	Amblève	12.2	31.6
	Chiers	9.5	24.7
	Vesdre	7.4	19.1
Escaut	Escaut (outflow)	24.4	63.3
	Haine	4.8	12.6
	Dendre	3.3	8.5
	Dyle	2.6	6.8
	Senne	1.7	4.3
Rhin	Our	3.2	8.2
TOTAL			920.3

Local-scale (aquifer) feasibility study

Hesbaye chalk aquifer in the region of Liège





30 millions m³/year for water distribution to 600,000 inhab.

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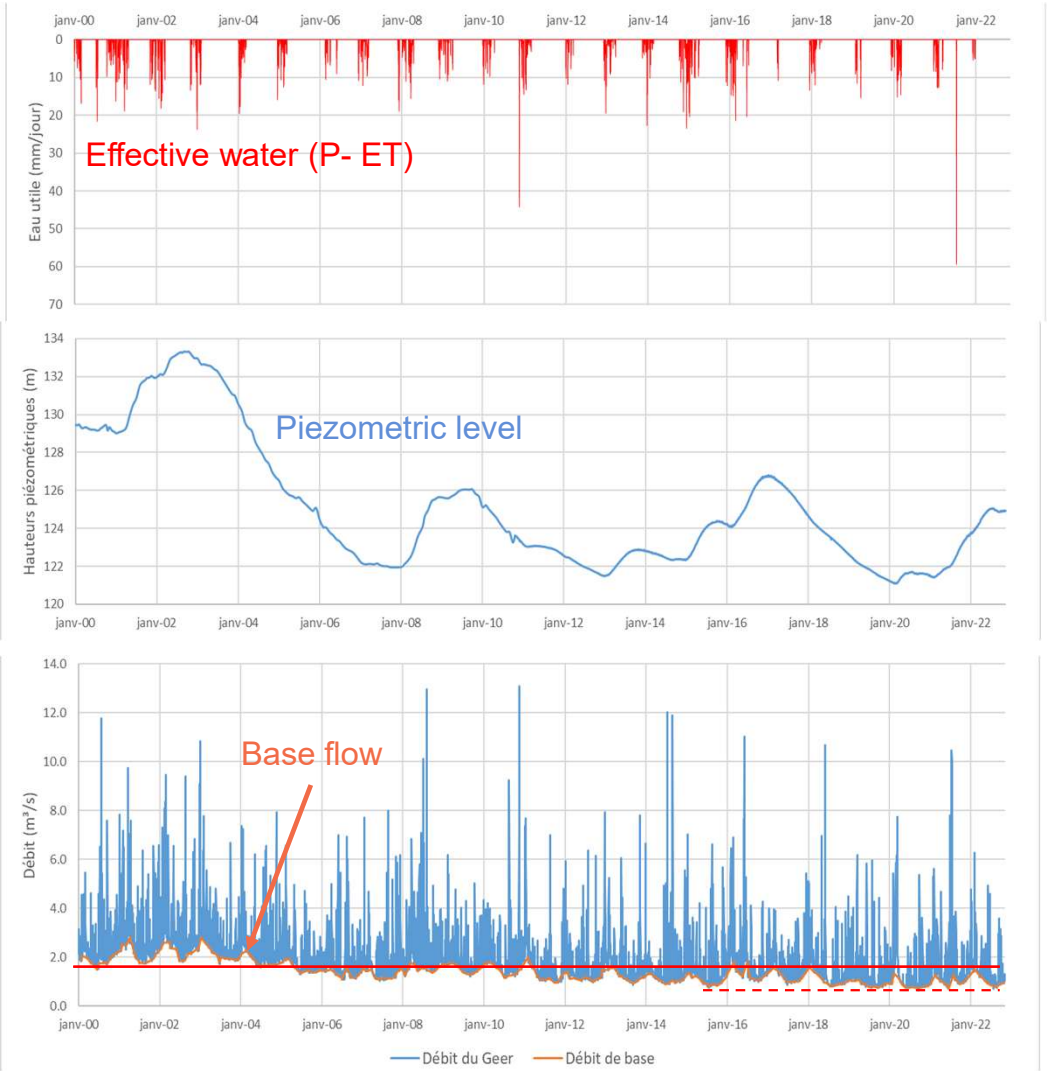
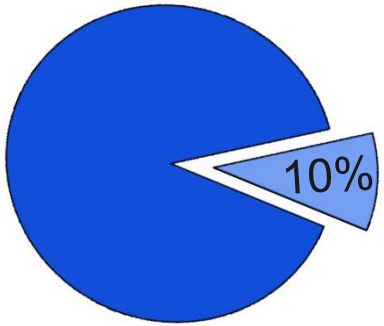


Estimated decline in GW reserves 2000 - 2020

Methods	Water table fluctuation	Hydrologic budget	Change in base flow
Deficit	**- 61 Mm³** (ω = 5%)	**- 74 Mm³**	**- 44 Mm³**

(source : MSc thesis Kanto ANDRIAMIALISOA 2024

→ 50 to 60 Mm³ over 20 years



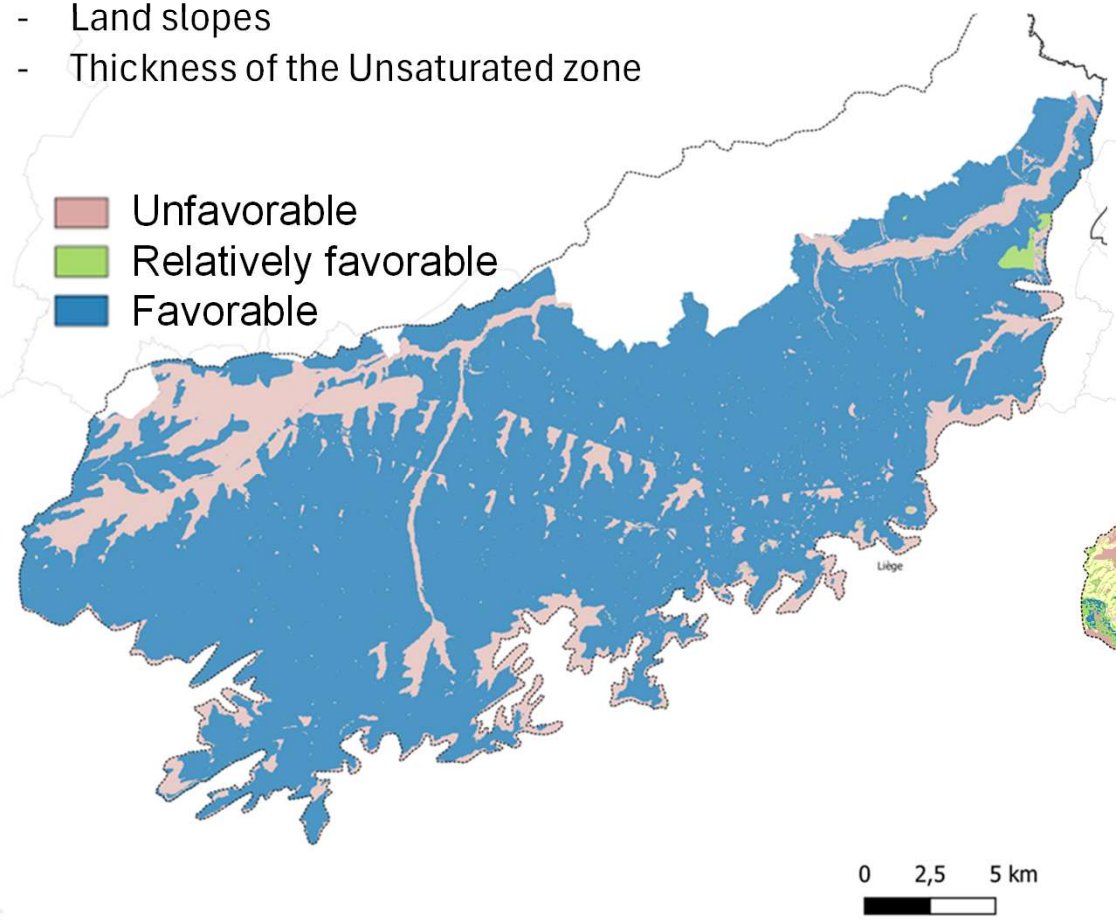
of annual GW abstraction

Local-scale (aquifer) feasibility study

Hesbaye chalk aquifer in the region of Liège

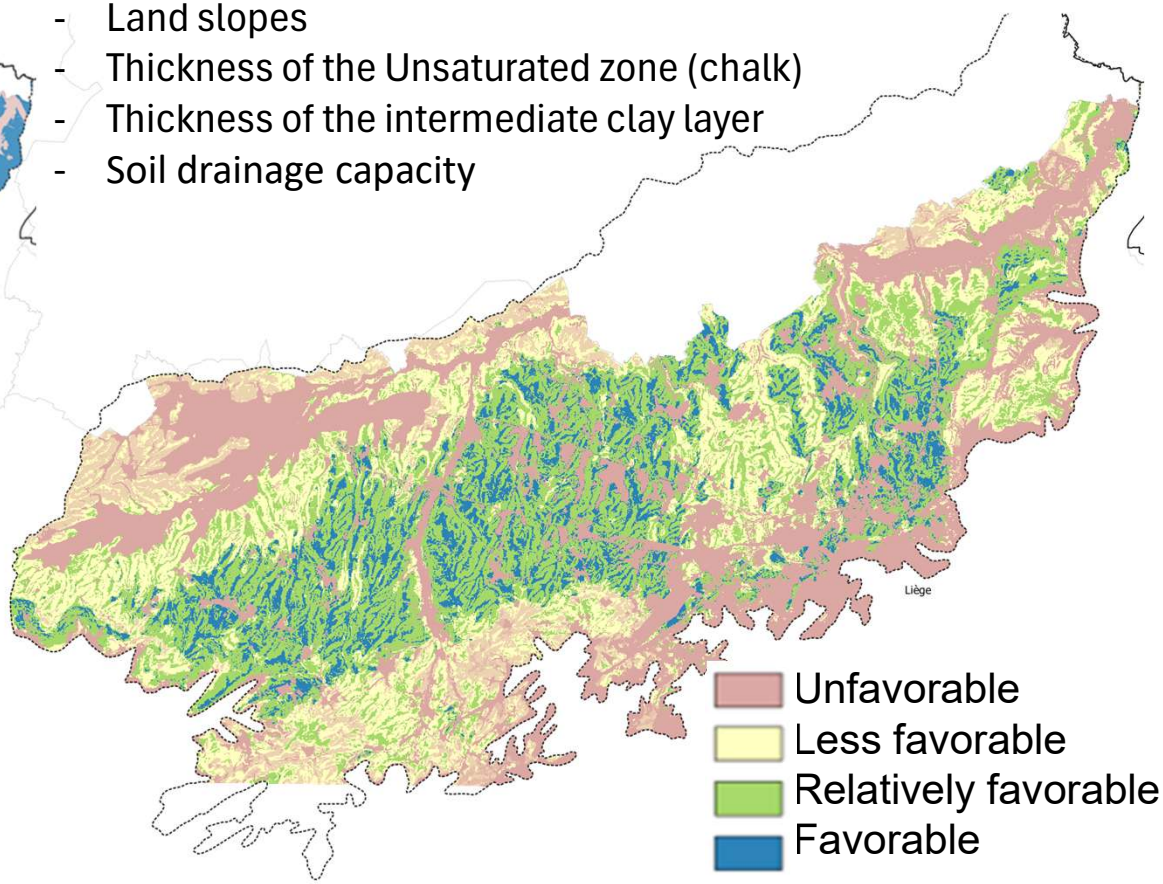
Factors considered for the **BOREHOLE RECHARGE** :

- Hydrogeological contexts
- Land slopes
- Thickness of the Unsaturated zone



Factors considered for the **INFILTRATION BASINS** :

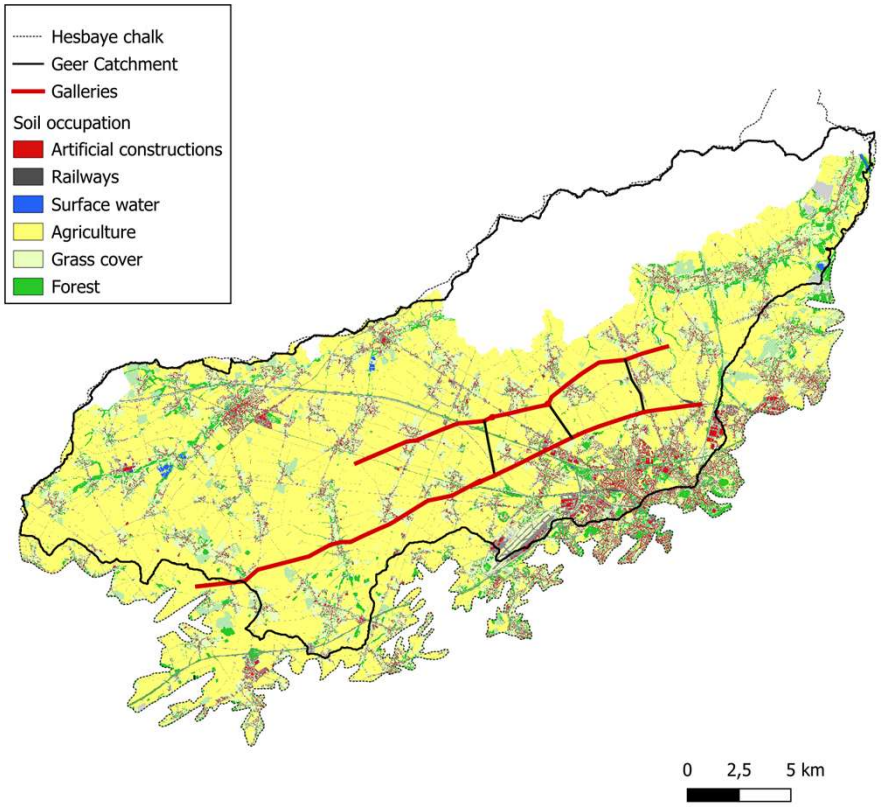
- Hydrogeological contexts
- Land slopes
- Thickness of the Unsaturated zone (chalk)
- Thickness of the intermediate clay layer
- Soil drainage capacity

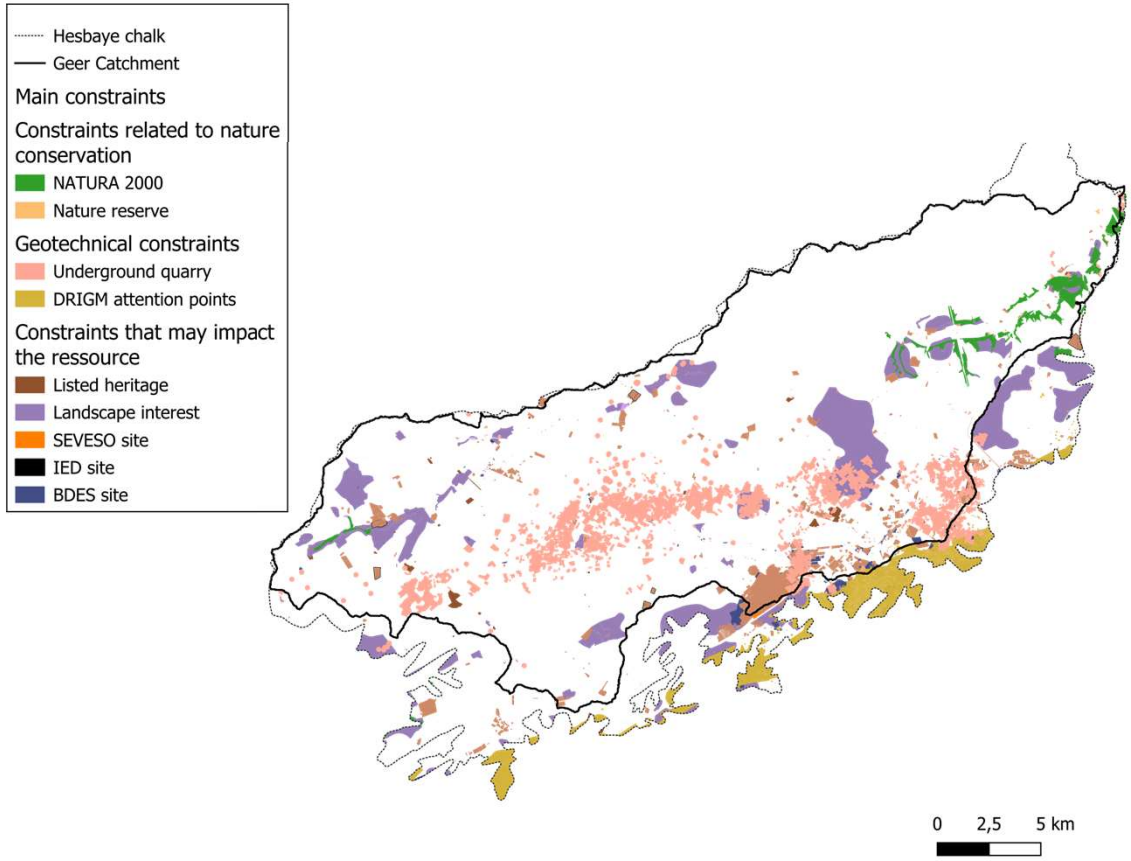


Local-scale (aquifer) feasibility study

Challenges : land use constraints

Relatively urbanized catchment + intensive agriculture
→ many land use restrictions ….

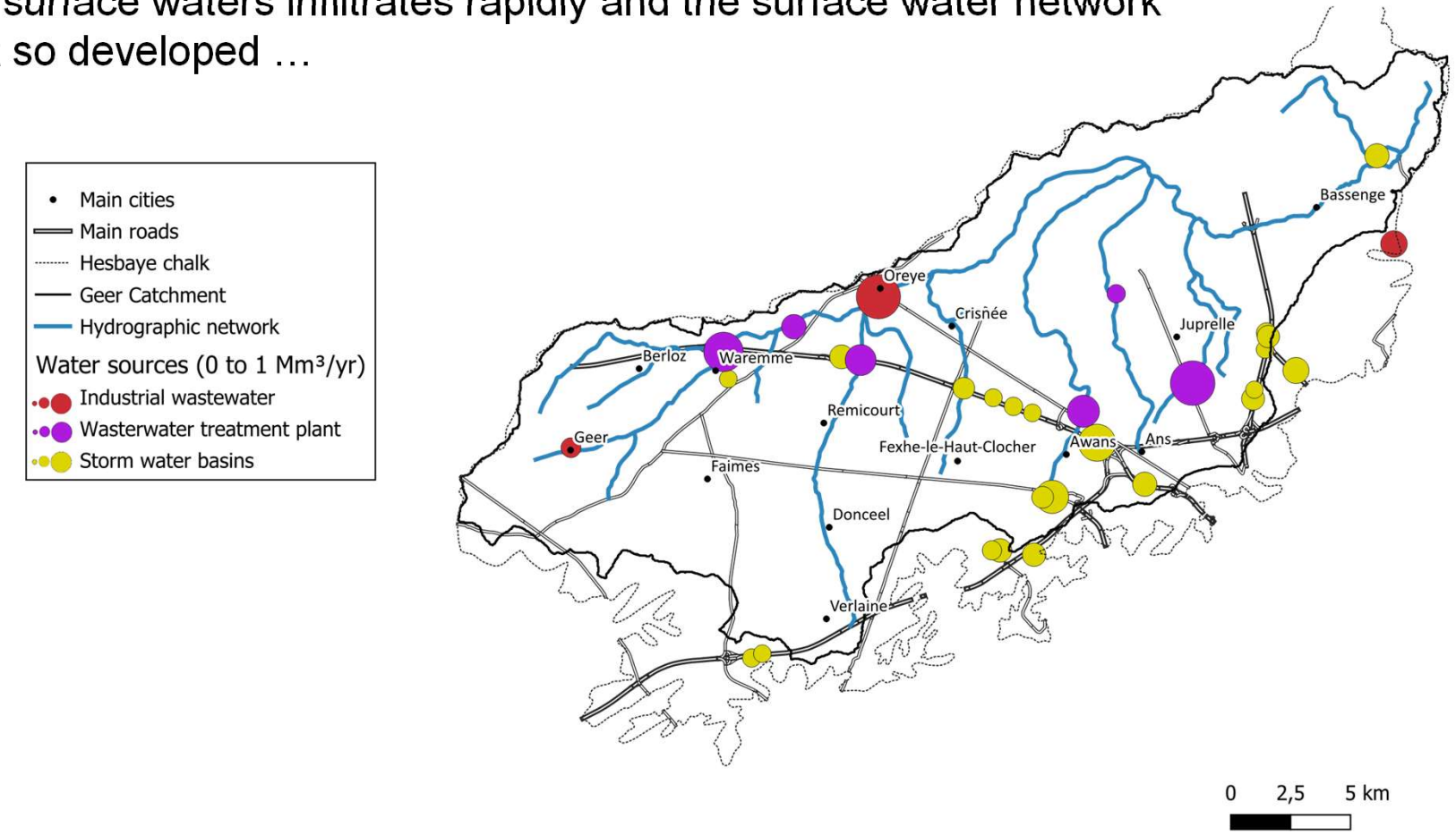




Local-scale (aquifer) feasibility study

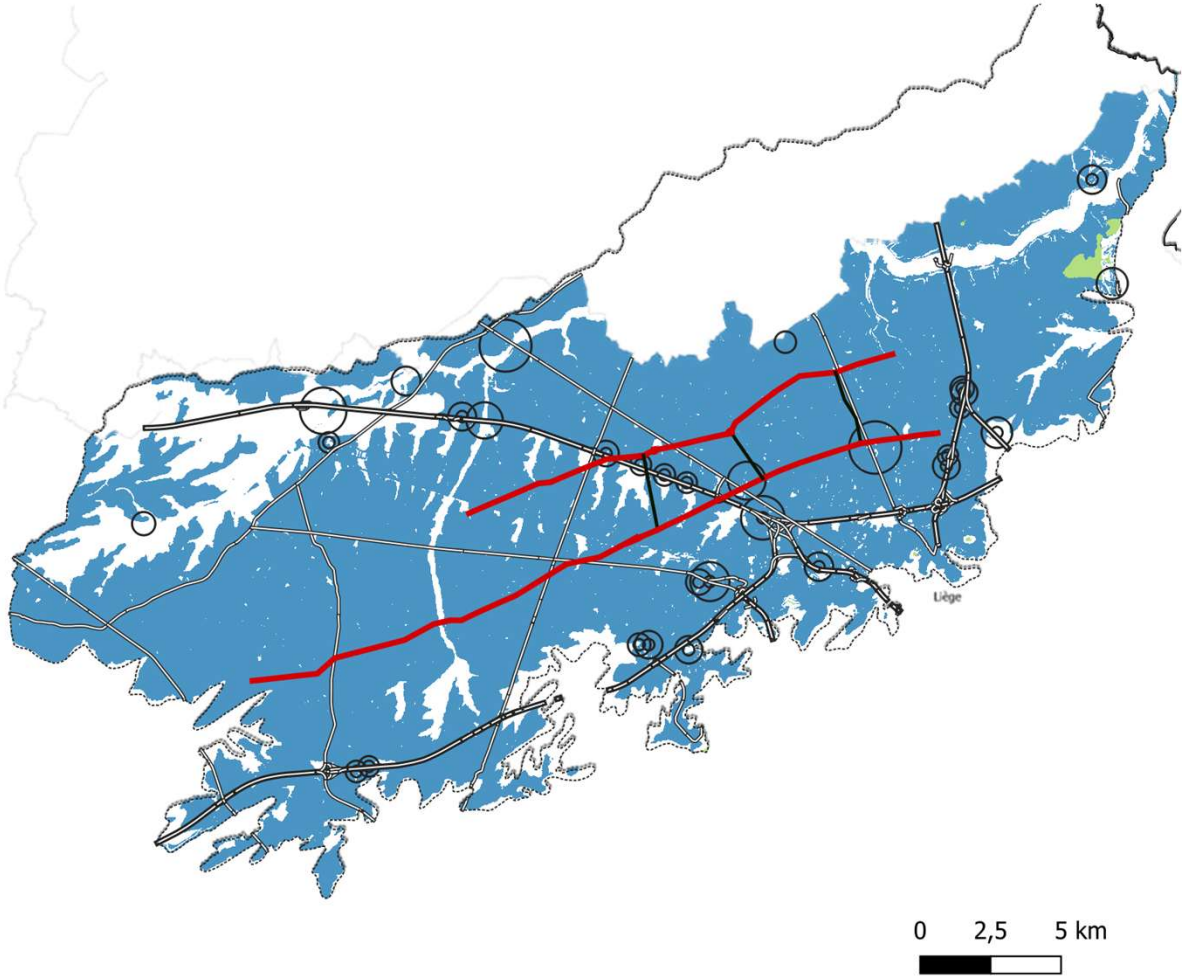
Challenges : the region is called the “Dry Hesbaye” (loamy soils)

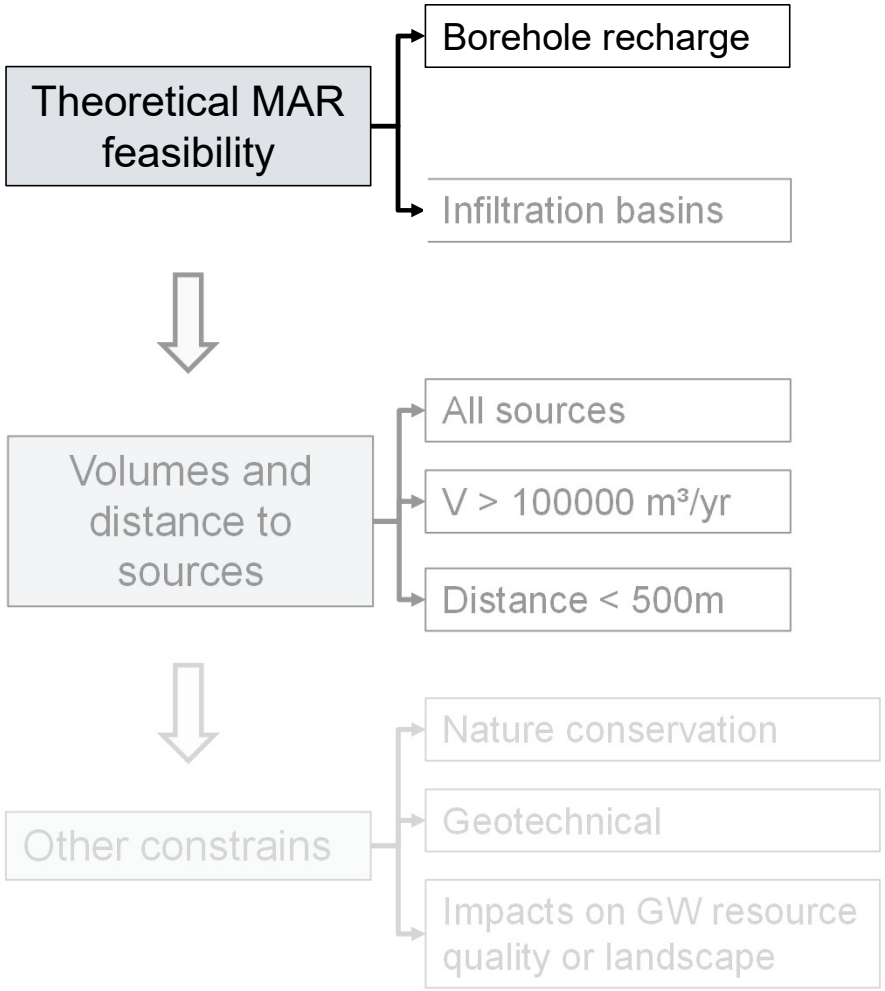
Most surface waters infiltrates rapidly and the surface water network is not so developed …



Local-scale (aquifer) feasibility study

Decision tree for site selection





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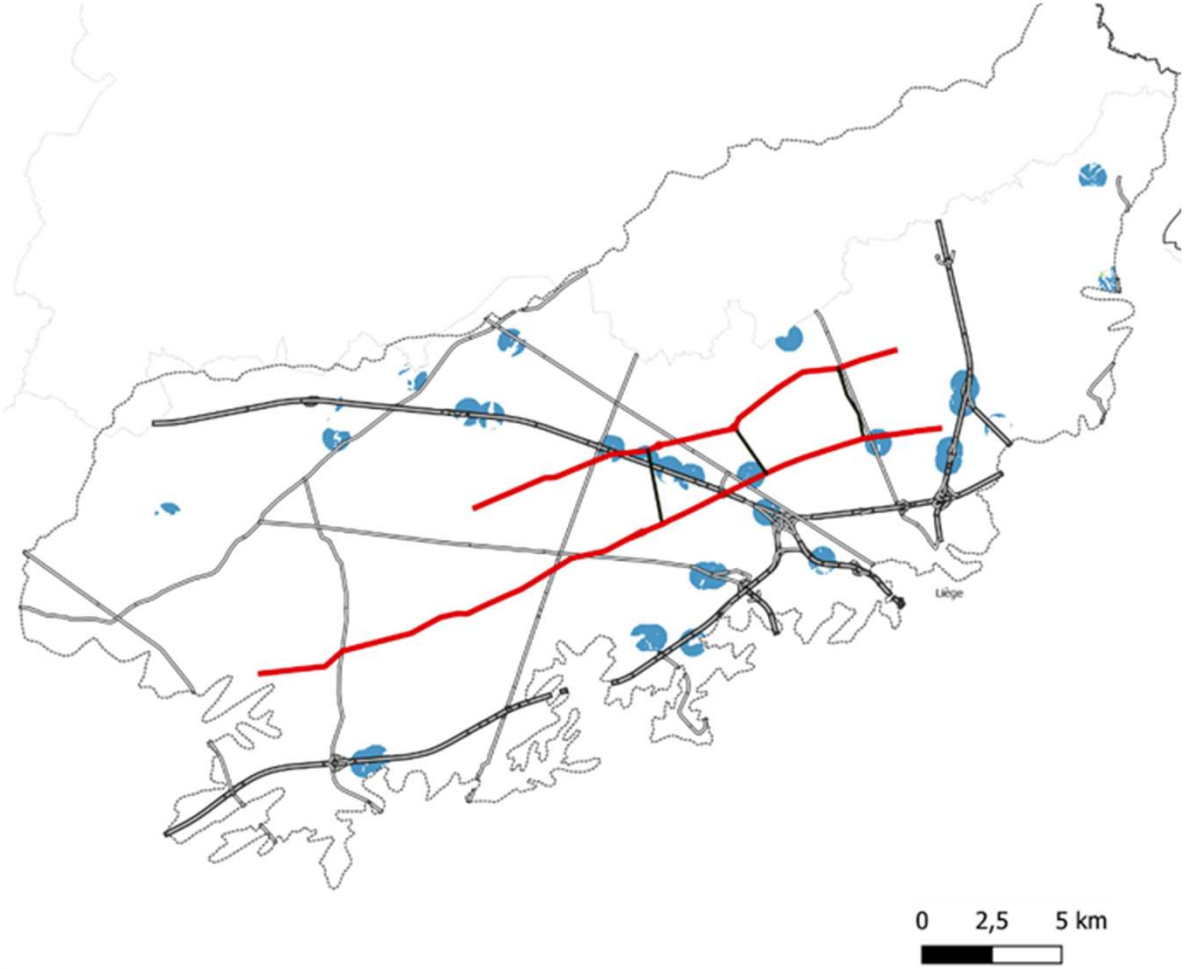

- **Theoretical MAR feasibility**
  - Borehole recharge
  - Infiltration basins
- ⇩
- **Volumes and distance to sources**
  - All sources
  - V > 100000 m³/yr
  - Distance < 500m
- ⇩
- **Other constrains**
  - Nature conservation
  - Geotechnical
  - Impacts on GW resource quality or landscape

Local-scale (aquifer) feasibility study

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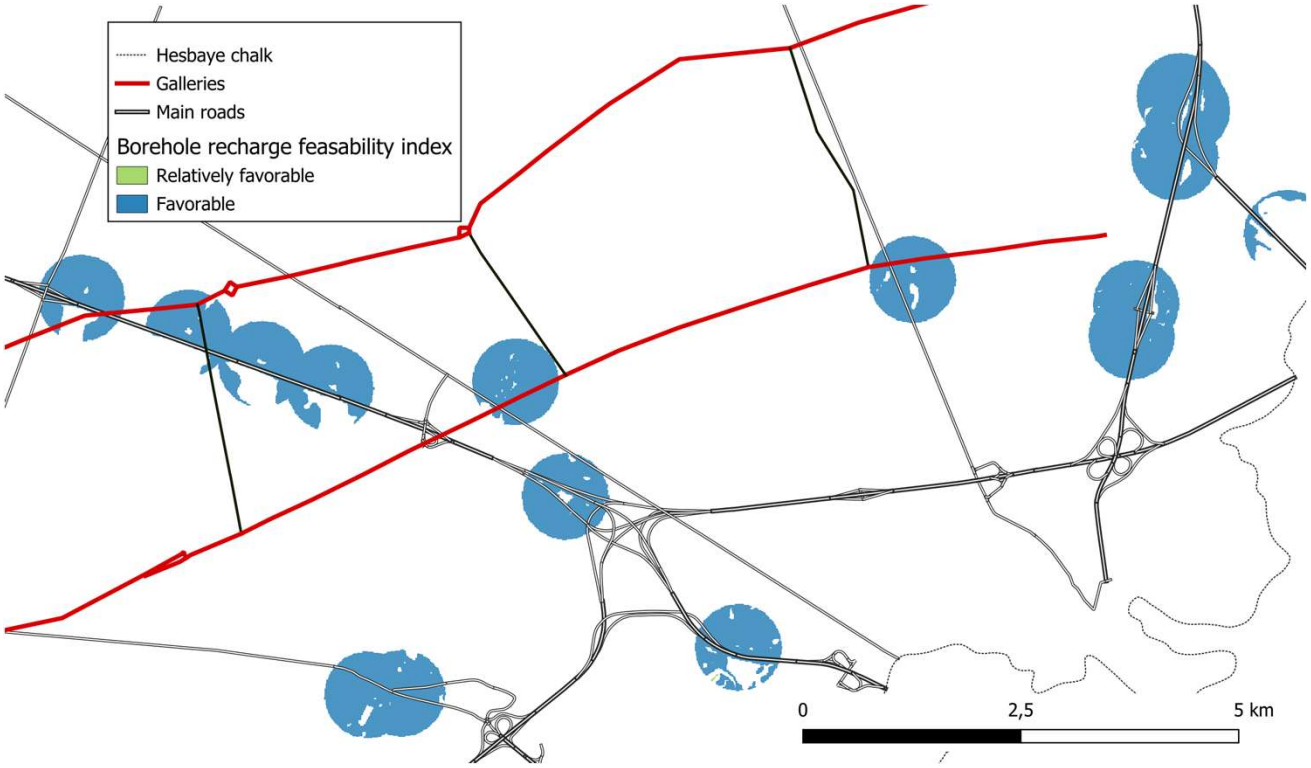

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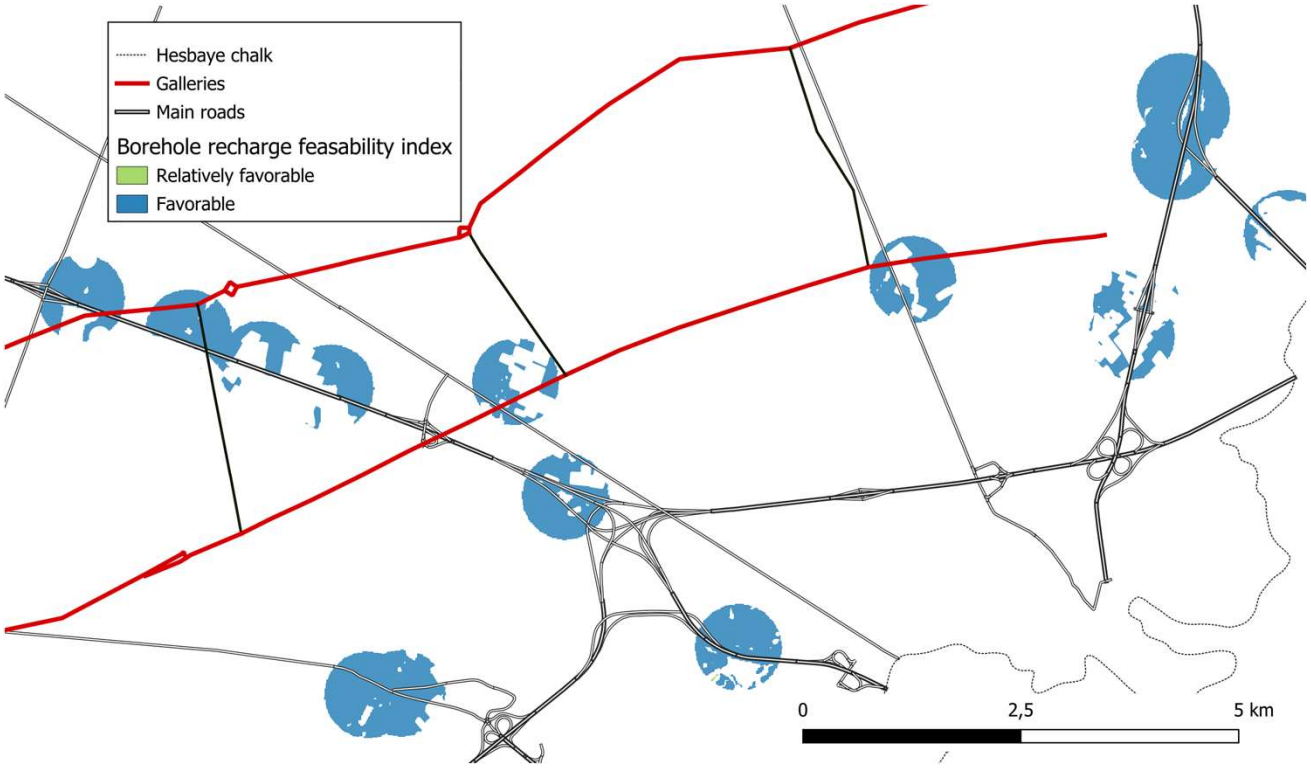

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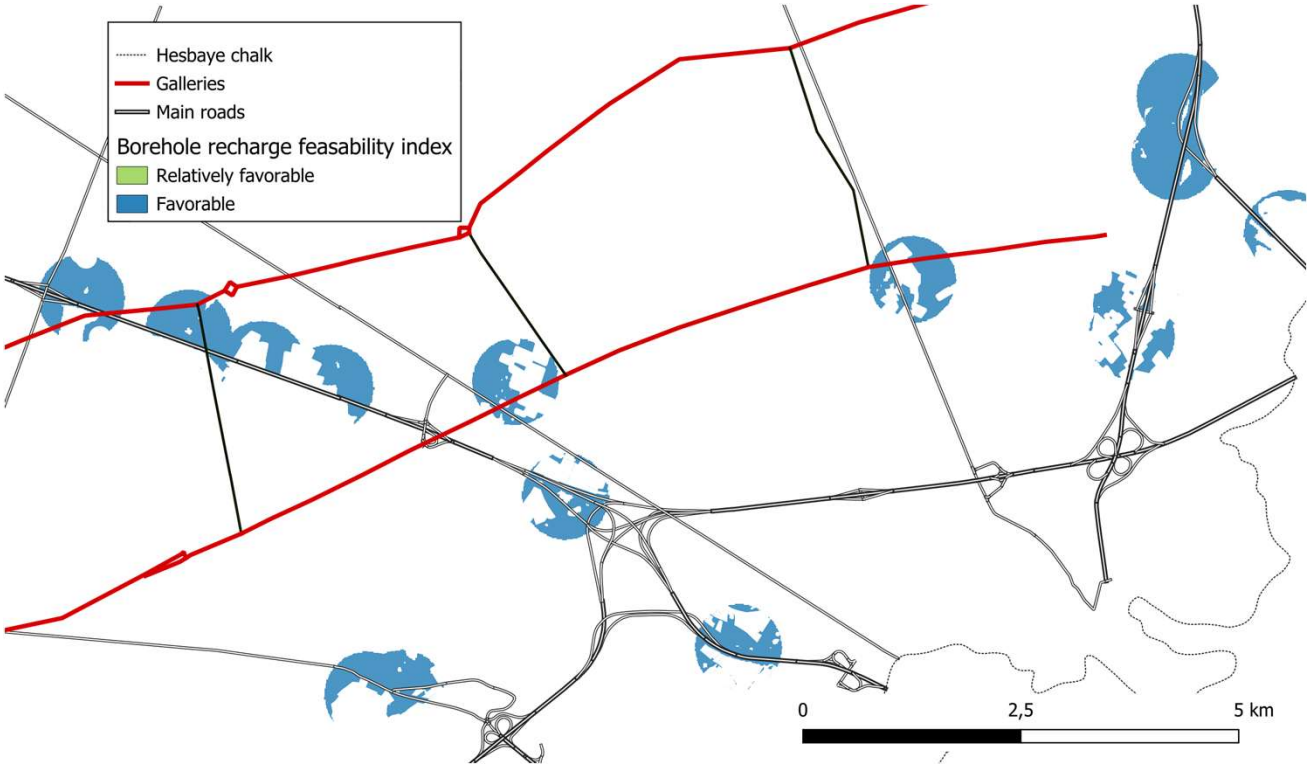

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Local-scale (aquifer) feasibility study

Series of investigations to implement a pilot site afterwards

Experimental infiltration pound on eolian loess materials (Fize-le-Marsal)

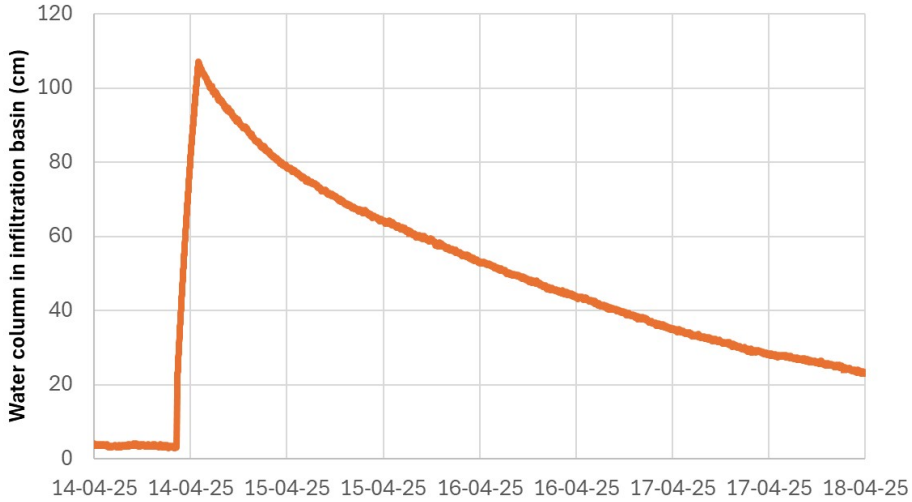
Dimensions :
5 x 10 m with 1:1 slopes

Infiltration volume : 65 m³

Local-scale (aquifer) feasibility study

Series of investigations to implement a pilot site afterwards

Experimental infiltration pound on loess materials (Fize-le-Marsal)



Recharge rate : 65 m³ / 50 m² in 5,43 day

→ 65/(50 x 5,43) = 0,24 m / day **= 240 mm/day**

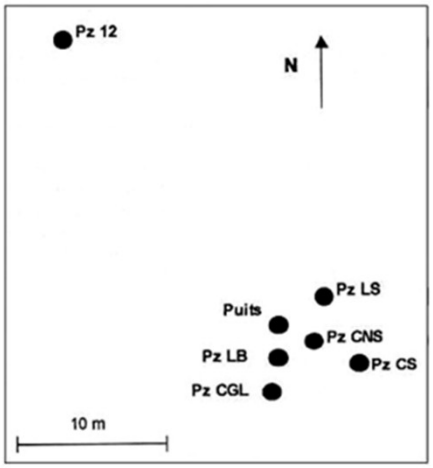
Daily recharge ~= annual natural recharge in the basin

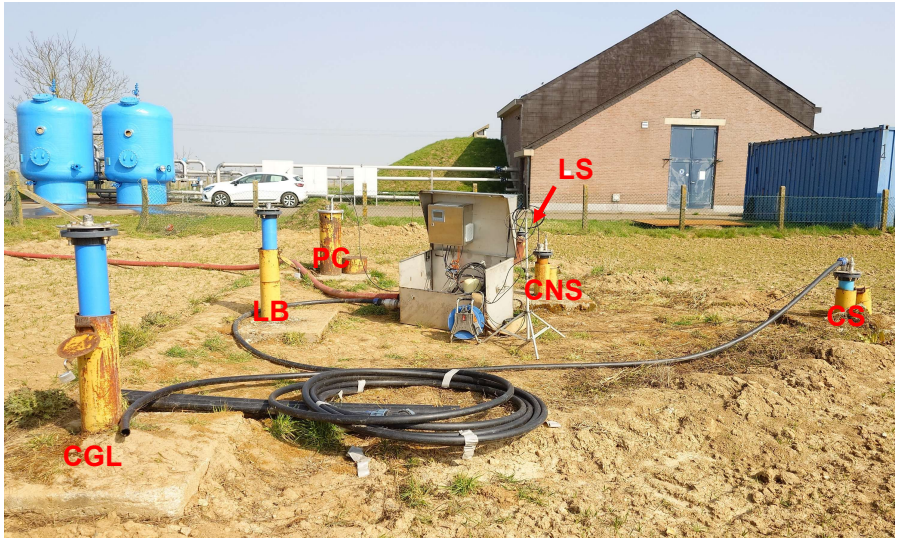
Recharge similar to experiment in Kemexhe (see R.Glaude presentations of yesterday)

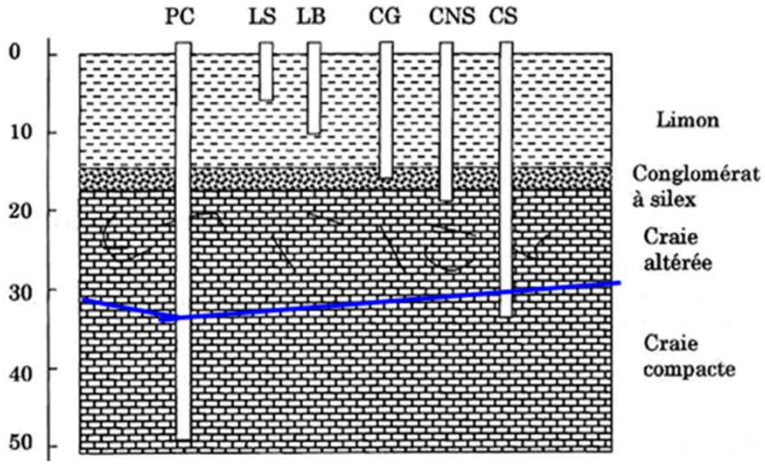
Local-scale (aquifer) feasibility study

Series of investigations to implement a pilot site afterwards

Direct well recharge experiments in Bovenistier







Multiple step water injections under constant rate or manometric pressure (max 2 bars)

Local-scale (aquifer) feasibility study

Series of investigations to implement a pilot site afterwards

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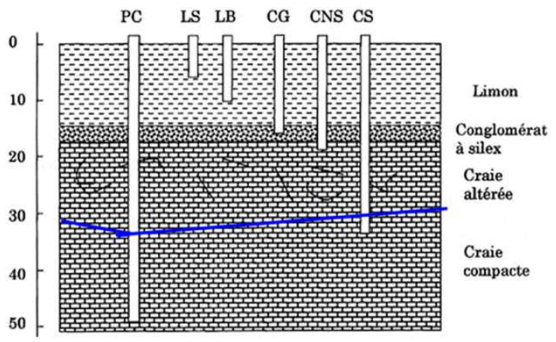

	Injections in the saturated zone of the aquifer		Injections in the unsaturated zone above the aquifer			
	PC (6” diam)	pz CS (4” diam)	pz CNS (4” diam)	pz CGL (4” diam)	pz LB (4” diam)	pz LS (4” diam)
Max injection [m³/h]	26.5	20	13	0.7	/	/

Boreholes recharge tests for a maximum pressure of 2 bar

Conclusions & Perspectives

Setup of a first MAR demonstration pilot site in the Hesbaye chalk aquifer

Key points :

- Direct well recharge
- 100000 m³/year
- No a priori on source water type
- Based on field experiments :

			Number of recharge boreholes required (to be rounded)	
equivalent case	Max Q rate (m³/h)	m³/year/ borehole	continuous recharge (24h/day, 365 j/year)	intermittent recharge (8h/day, 200 days/year)
PC (6")	**26**	**227760**	**0,44**	**2,4**
CS (4")	20	175200	0,57	3,13
CNS (4")	13	113880	0,88	4,81
CGL (4")	0,7	6132	16,31	89,29

By comparison, infiltration basins :

240 mm/m².day → 2,400 m³/ha

100000 m³/year → 0,115 ha (1150 m²)

Conclusions & Perspectives

Setup of a first MAR demonstration pilot site in the Hesbaye chalk aquifer

Thank you for your attention !

Any question ?