What is impacting transboundary aquifers? Climate or global changes?

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LIÈGE université Sciences Appliquées

POLYTECH MONS

UEE Urban & Environmental Engineering

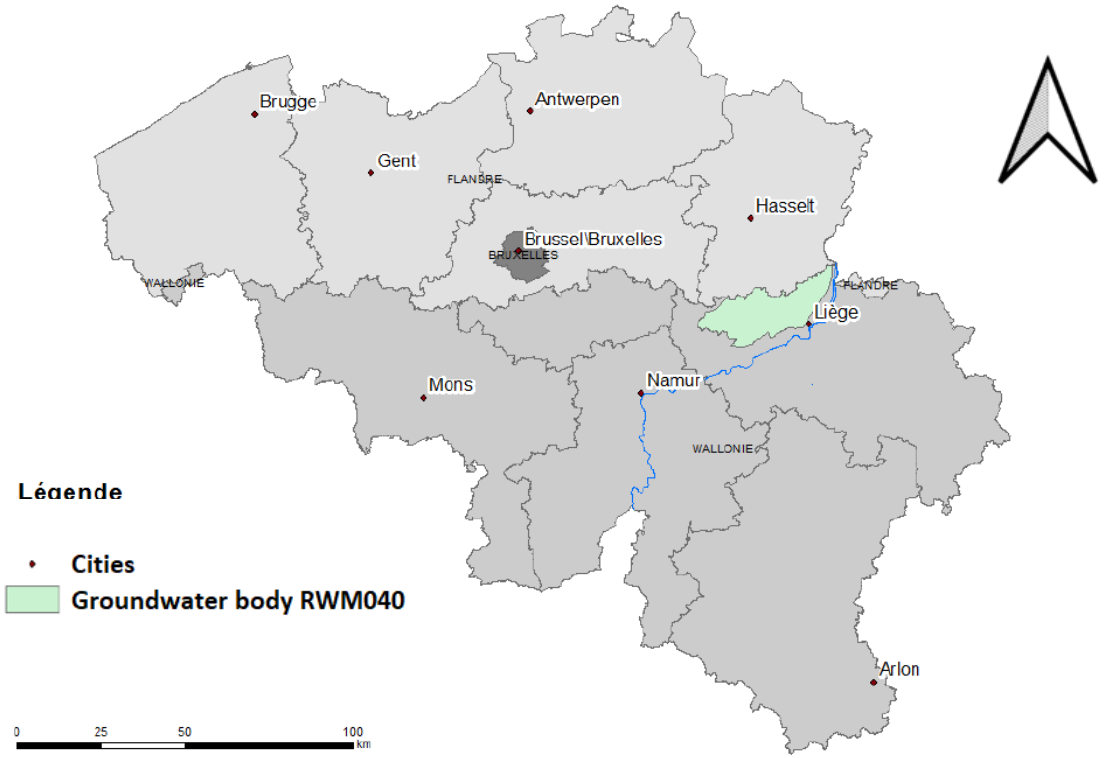
General Background

In South Belgium (Wallonia)

23% of abstracted groundwater are from chalk aquifers

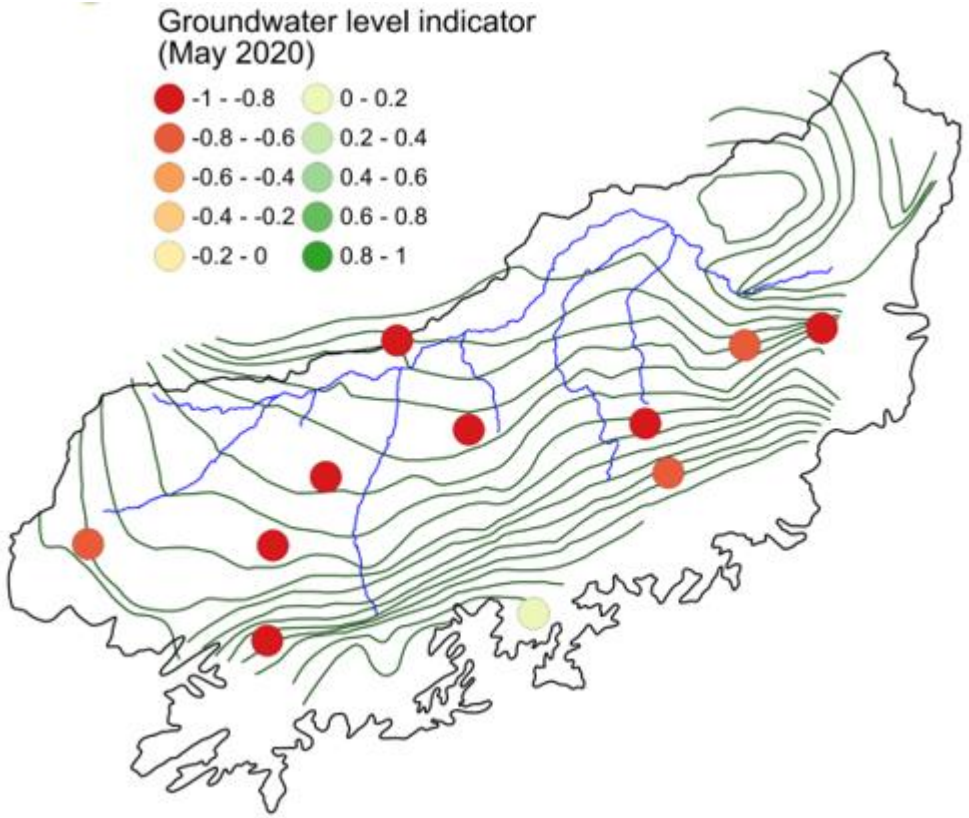
- **Strategic** resources
- However, **decreasing** trend in GW levels these last decades
- Climate and/or global changes?

Chalk aquifer in the Geer Basin

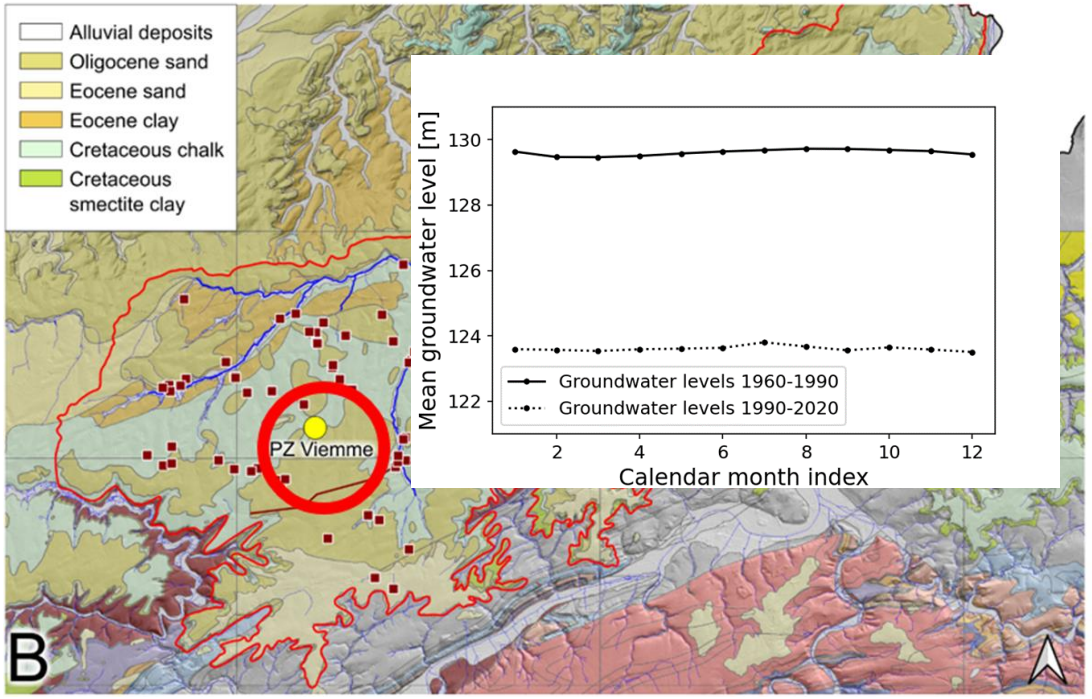


Orban et al., 2014

Groundwater level observations



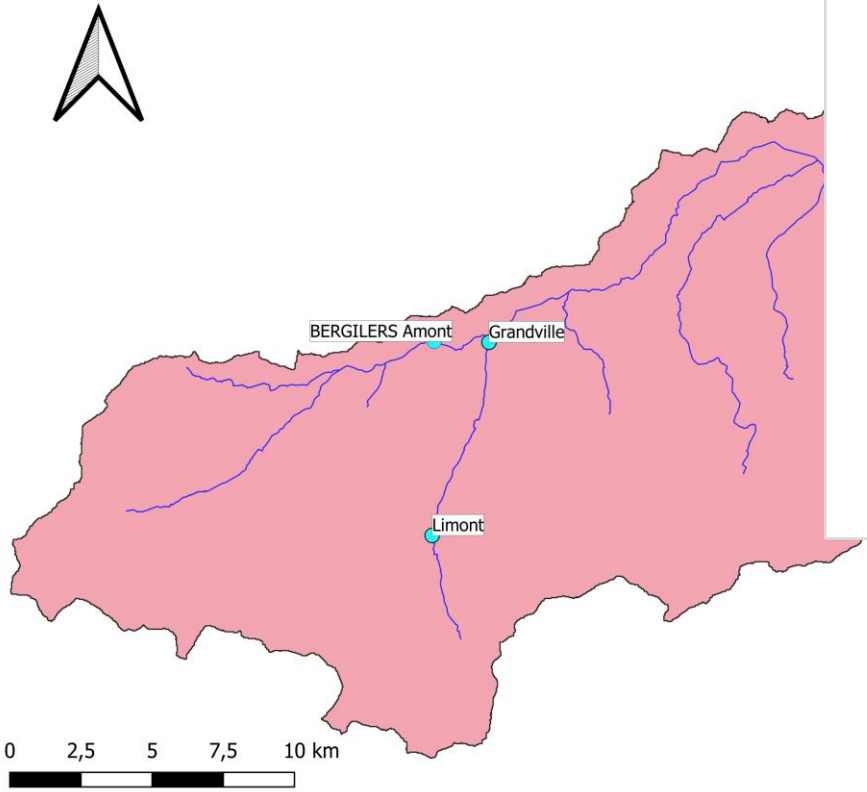
$$Indicator = \frac{H_{May\,2020} - \bar{H}_{May}\big|_{1990-2020}}{[Max(H_{May}) - Min(H_{May})]\big|_{1990-2020}}$$

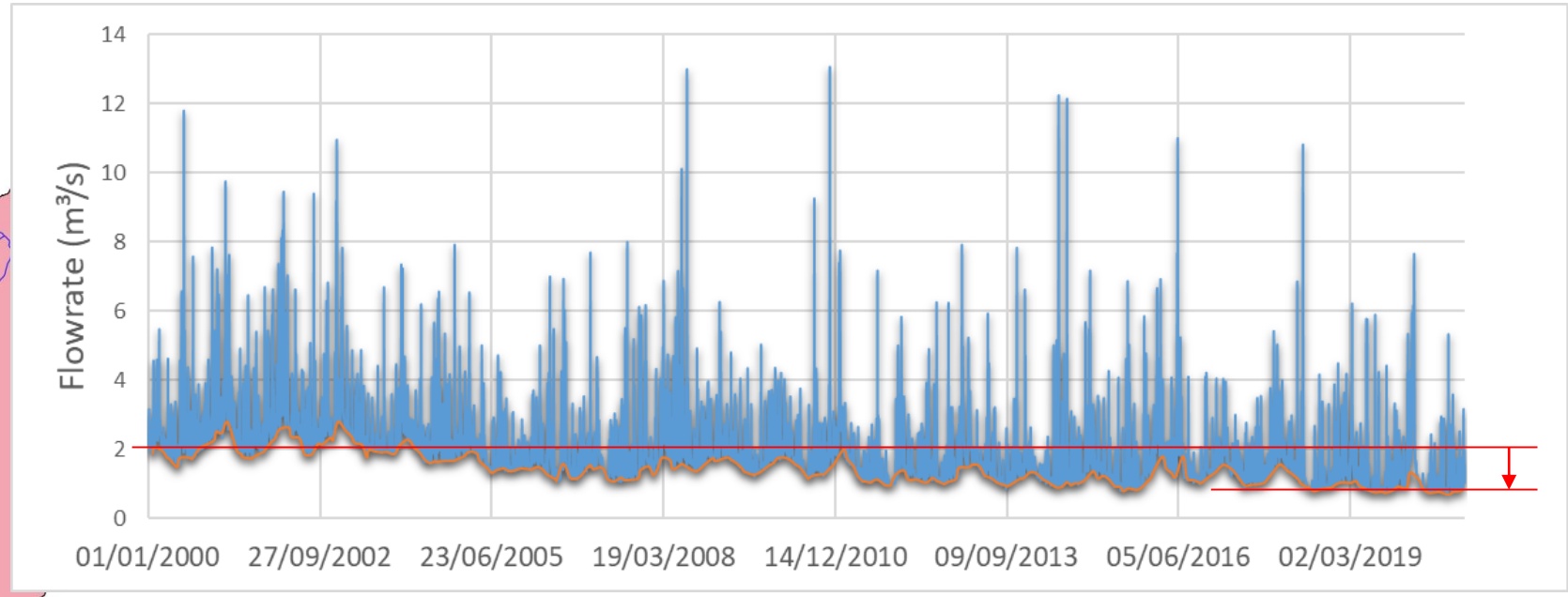


- In Viemme piezometer, **6 m** of monthly averaged **piezometric difference** between 1960-1990 & 1990-2020

Goderniaux et al., 2020

Flowrates observations





Measurement stations
River network
Geer basin

- Flowrate at the basin's outlet 2 times lower in 2020 than in 2000.

Studied area: Geer catchment basin

- Land use: dominated by **agricultural** activities (70%)

In large flat opened fields on loamy soils. More urbanised in the south.

- **Transboundary chalk aquifer** exploited in Geer basin:

In Wallonia (South of Belgium):

CILE → drainage galeries

SWDE → abstraction wells

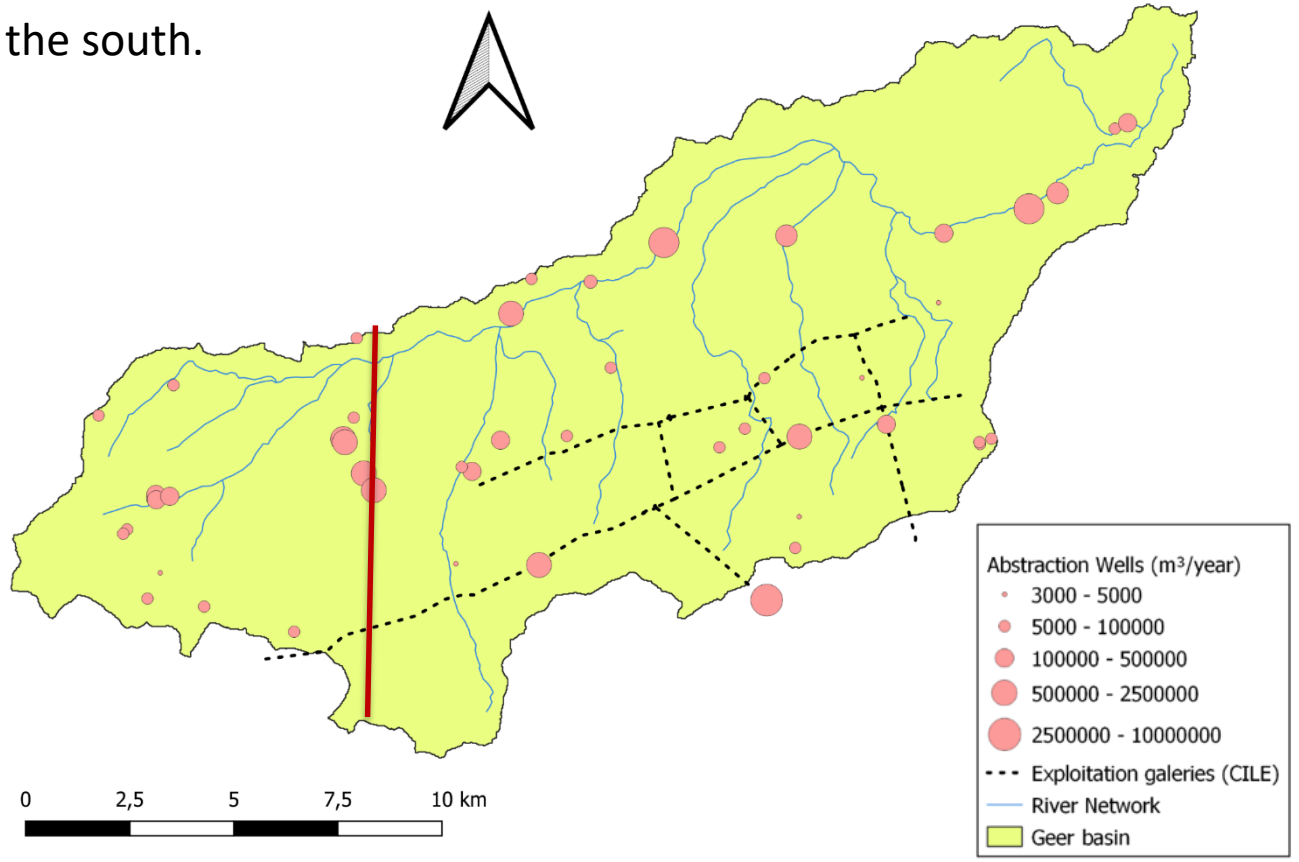
In 2018

25 millions of m³

In Flanders (North of Belgium):

De Watergroep → abstraction wells

Production in 2018



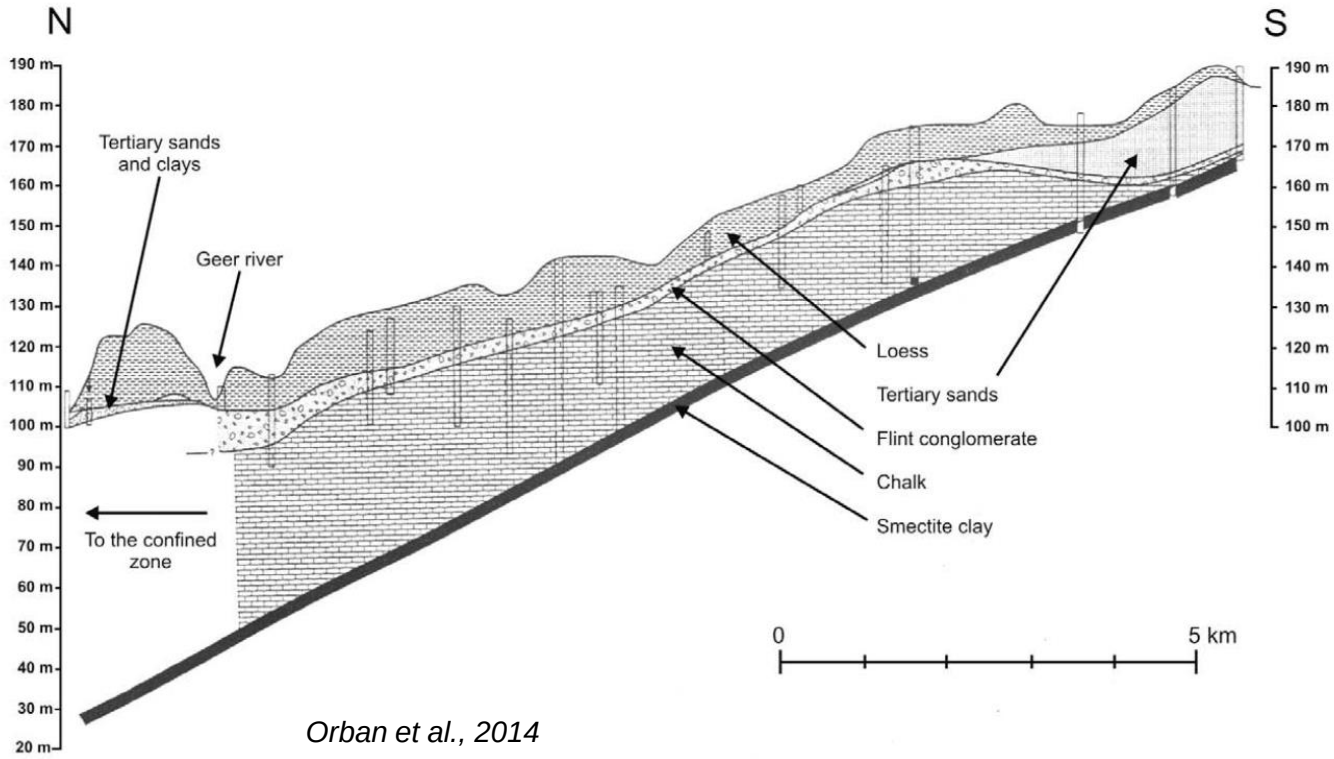
Geological background

From top to bottom:

- Quaternary Loess
- Flint Conglomerate
- Cretaceous **chalky formations** (Superior Campanian and Maastrichtian) that dip northward

→ **Hesbaye's aquifer**.
→ Mostly unconfined but becoming more confined gradually as it dips to the north
→ Continuity in Flanders (North of Belgium)

- Limited at their base by 10 m of **Smectite Clays** (Inferior Campanian) of very low hydraulic conductivity.



Orban et al., 2014

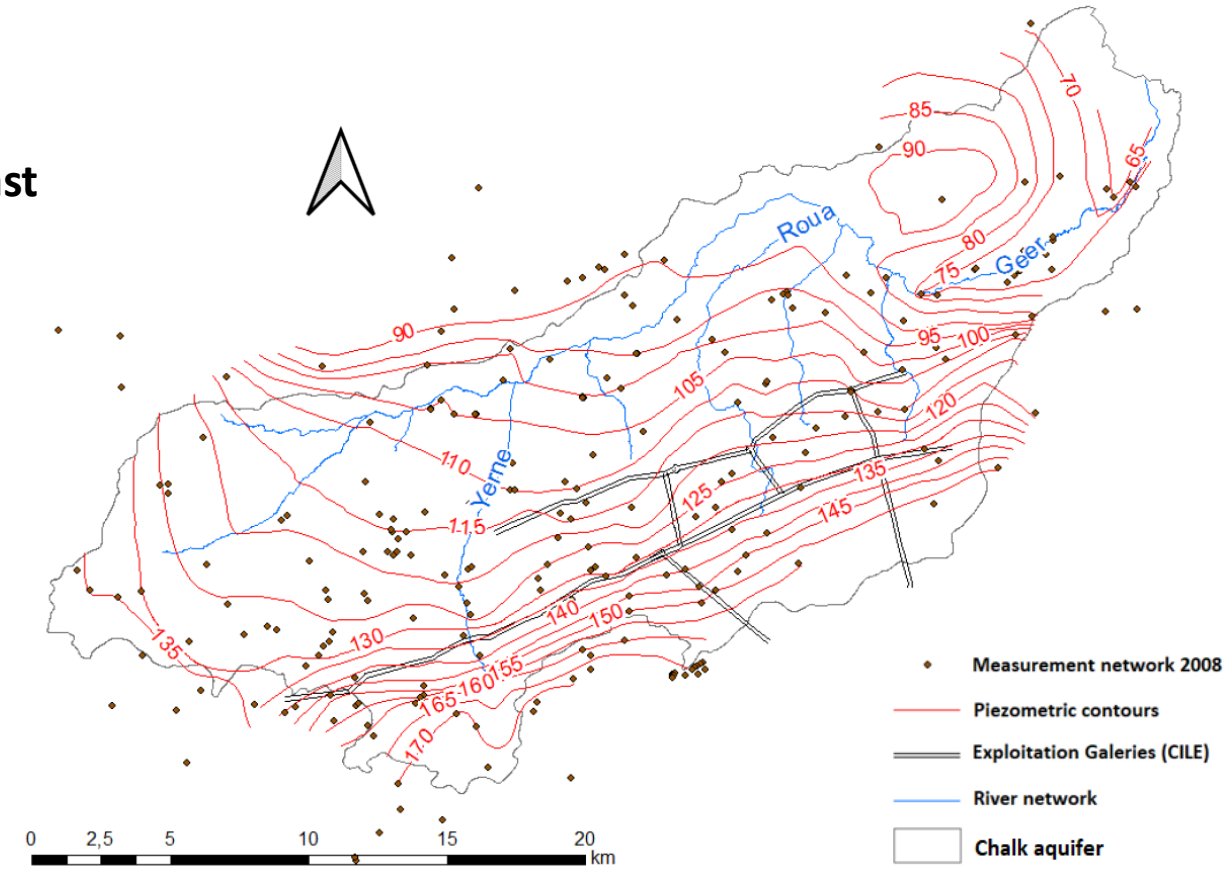
Hydrogeological background

- Chalk layer **dipping northward**

→ General groundwater **flow to the north/north-east**
→ Important groundwater fluxes leaving Geer Basin to the North boundary in Flanders

- Small developped river network. Main rivers are:

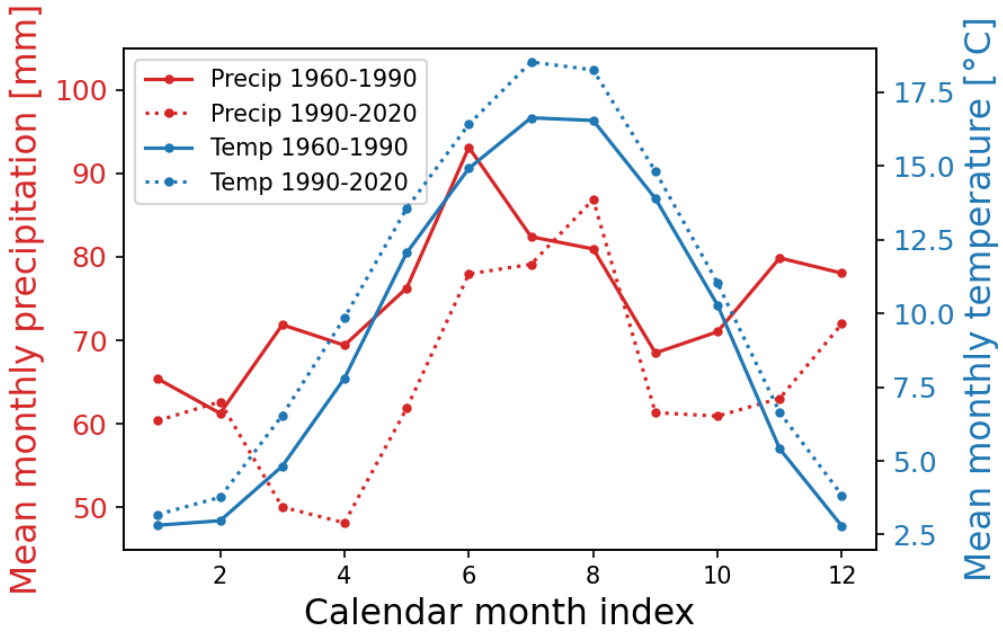
→ Geer, Yerne and La Roua
→ **Draining** behavior of the **Geer downstream**

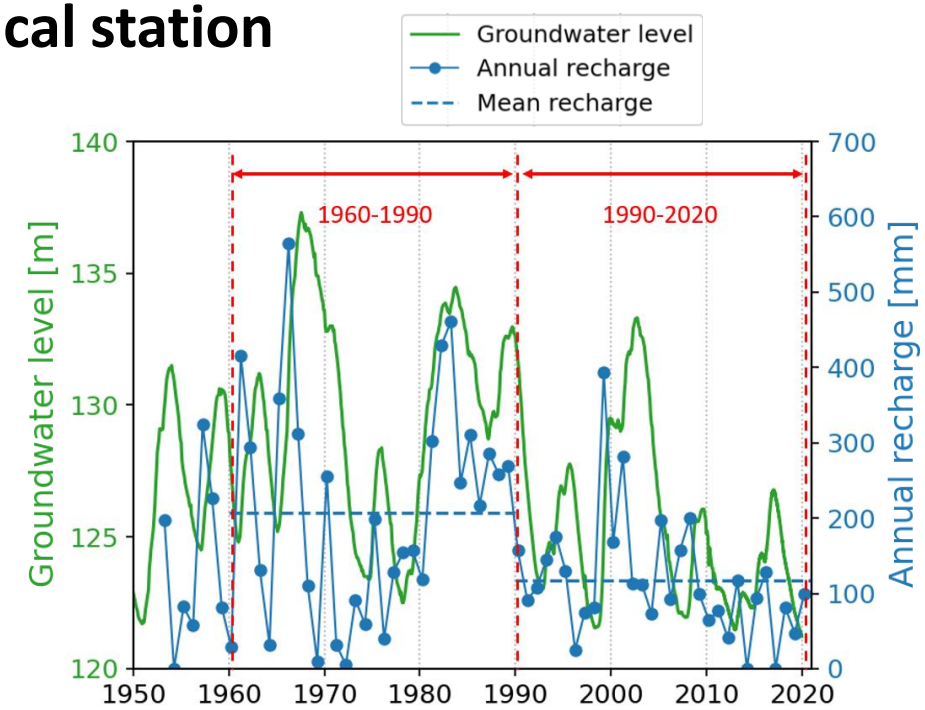


Orban et al., 2014

Climate change effect?

Bierset meteorological station





- Increase of monthly average temperature
- Decrease of monthly average precipitation

- Decreasing recharge

Goderniaux et al., 2020

Global change effect?

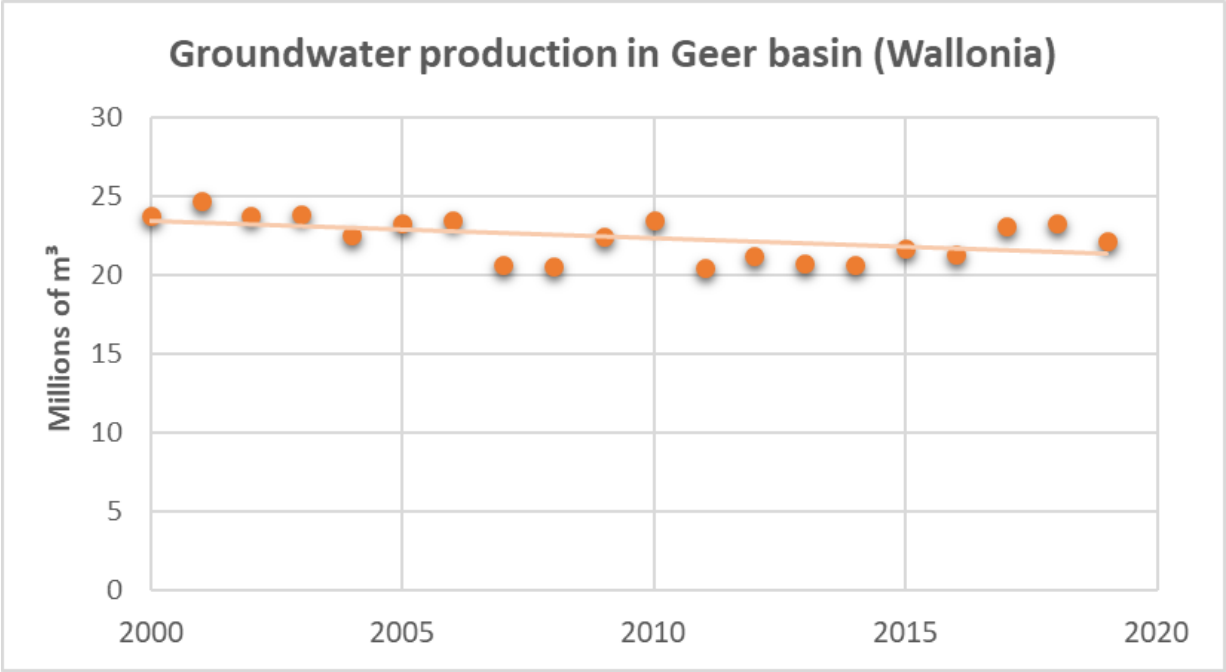
Global change

Refer to changes related to groundwater exploitation

Groundwater levels decrease

→ Expect higher abstracting rates

→ However decreasing trend in groundwater production (in Wallonia)



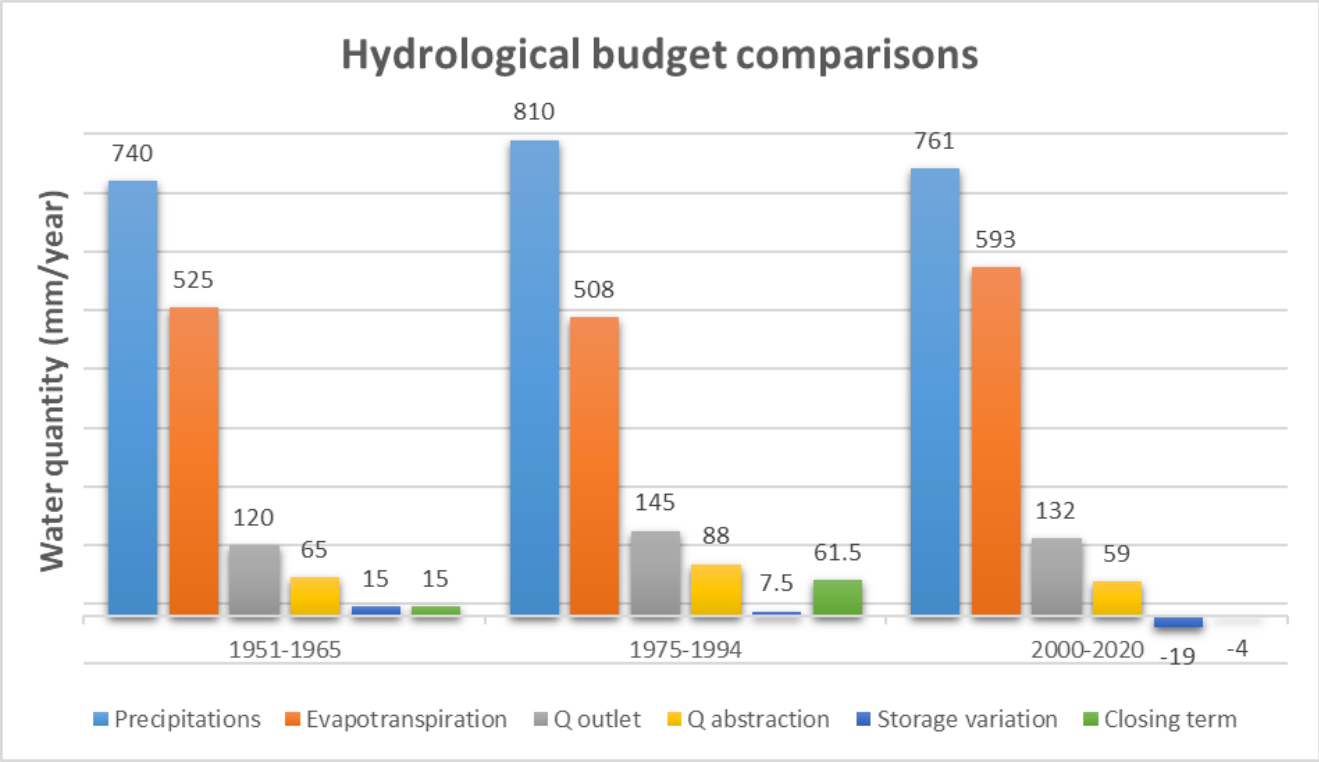
Nevertheless, uncertainties:

- Unknown evolution of groundwater production in the North (Flanders).
- Possibility of non-declared abstraction wells for agriculture?

Climate and Global change effect?

Hydrological budget

$$P = ETR + Q_{outlet} + Q_{abstraction} + \Delta \text{ Storage} + \varepsilon$$



- *1950-1965 & 1975-1994*

→ Positive closing term

→ **Expected water losses** in the North border of Geer basin

- *2000-2020*

1. **Increased** part of **evapotranspiration**

→ Less available water for infiltration

+

2. **Negative storage variation**

→ Translate decreasing trend in GW levels

+

3. **Negative**/Null **closing term**

→ Change of hydrogeological behavior at the border.

Conclusions

Decreasing trend of **GW levels** in the studied chalk aquifer and in surface water **flowrates**.

2 main assumptions

1. Climate change

Decrease of monthly average **precipitation**

+

Increase of monthly average **temperature**
→ Increase of evapotranspiration potential

→ **Less available water** for the « natural » **recharge** of the aquifer

2. Global change

Decreasing trend in groundwater **production in Wallonia**
BUT
Uncertainty about

- Production on the **other side of the border** (Flanders).
- Possibility of **non-declared wells**.
- Direction of groundwater fluxes at the border.

→ **Collaboration** between regions who share a common aquifer for:

- Better hydrogeological behavior understanding
- Better water management

Thank you !
Any questions?

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