E-TEST Einstein Telescope EMR Site & Technology

ET EMR: E-TEST general objectives, geological conditions and hydrogeophysical imaging

Einstein Telescope EMR Site & Technology

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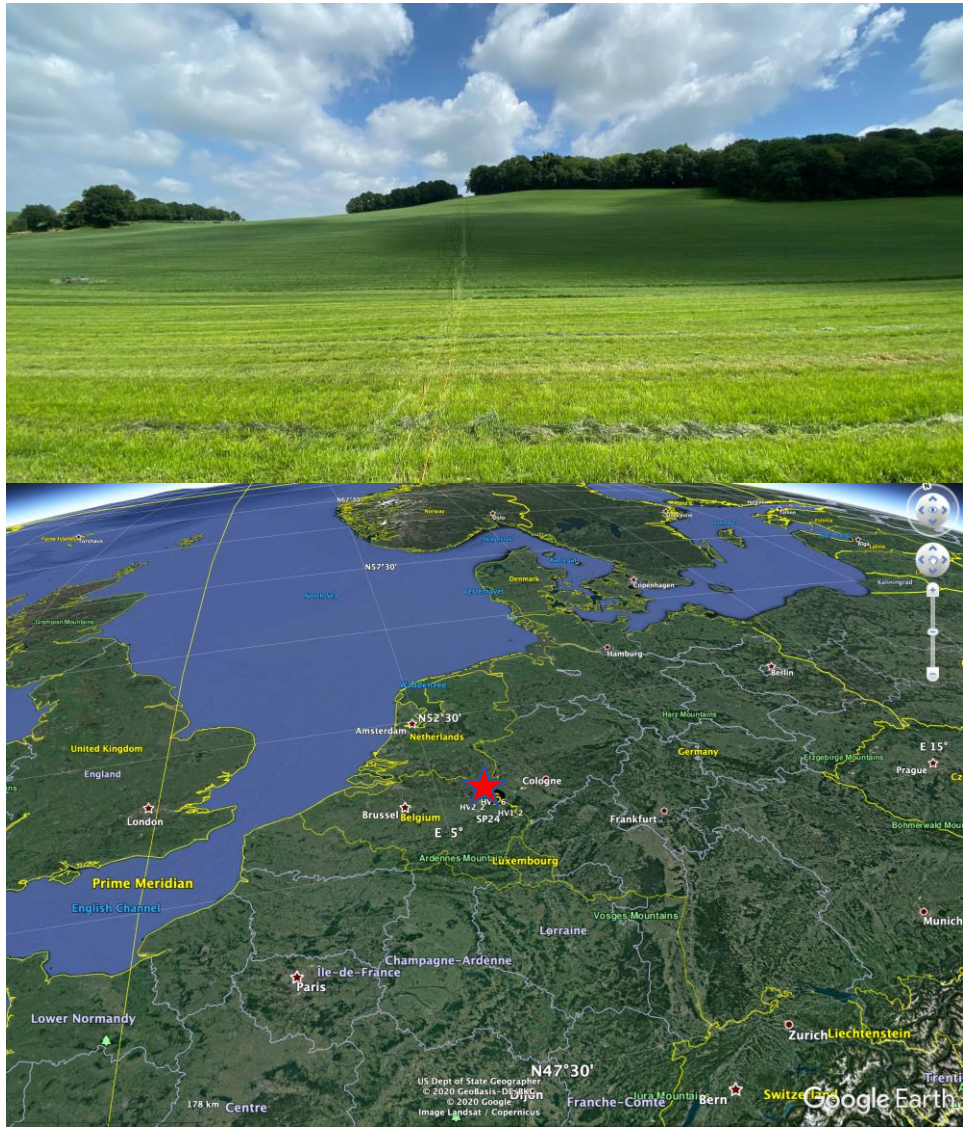
Outline

- **Overall project objectives**
- Site perimeter
- Key geological conditions
- Need for geophysical imaging
- Hydrogeophysical tests and groundwater model
- Future timeline



New data, database, models and design

Cross-border database

- Existing boreholes
- New structural data
- New boreholes
- New geophysics
- New geomechanical tests
- New hydraulic tests

New data

- 5 drillings including an observatory (2) for :
  - Geological exploration
  - Seismic vibrations monitoring
  - Hydrogeophysical tests

Underground models of the geology with different scopes:

- Engineering geology
- Groundwater
- Seismic noise

ET design in the EMR region

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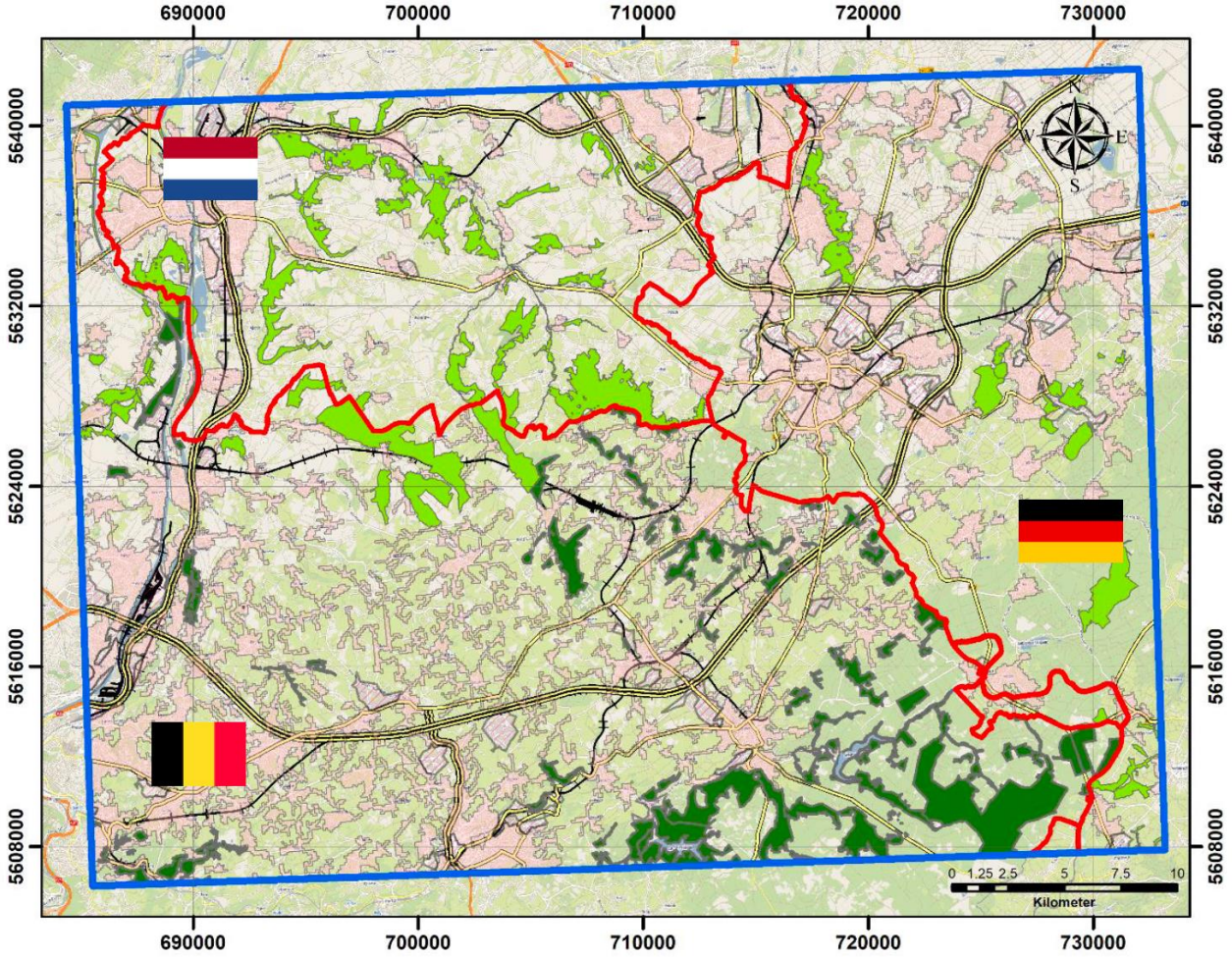
Perimeter of study



Legend

- ET mapping area
- Country borders
- Industrial districts
- Residental areas
- Major roads
- Motorways
- Railways

Natura 2000
SITETYPE
- B
- C

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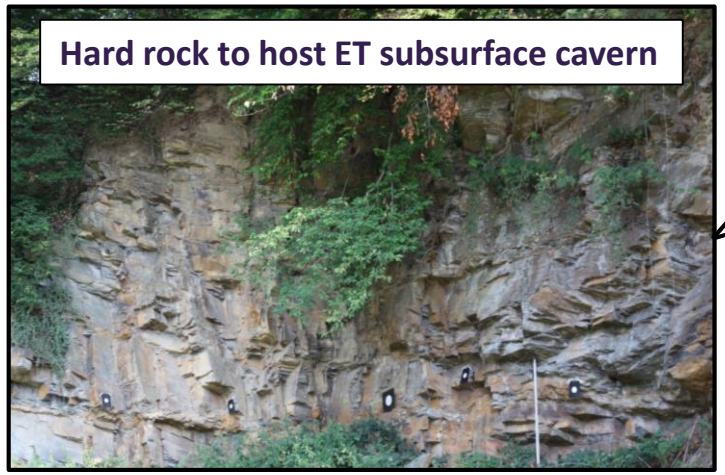
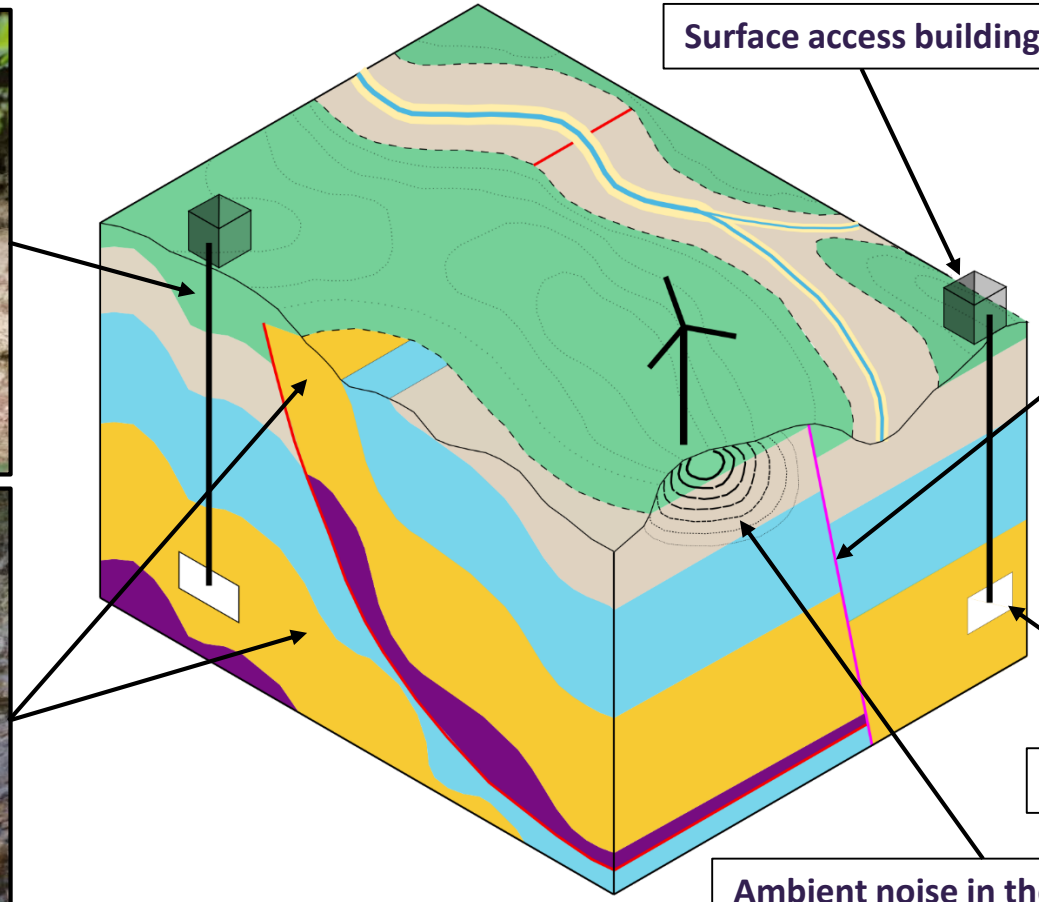
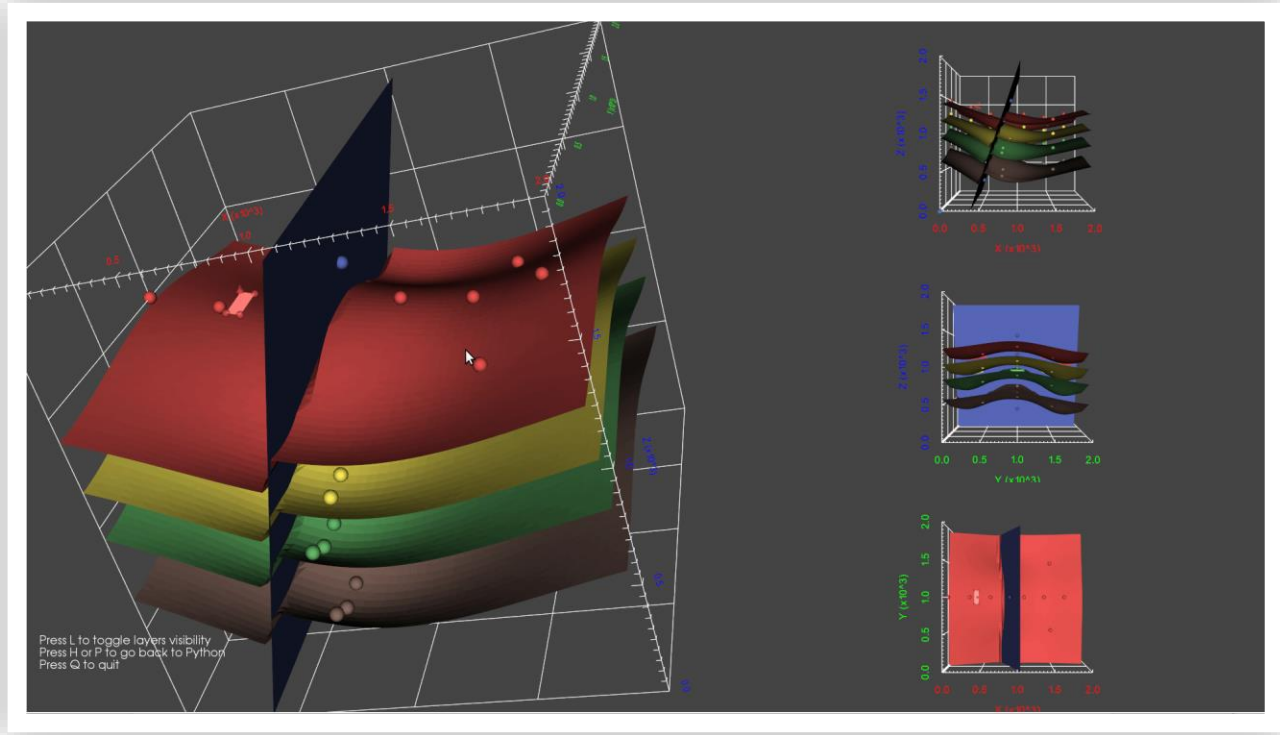
Geology dependent conditions



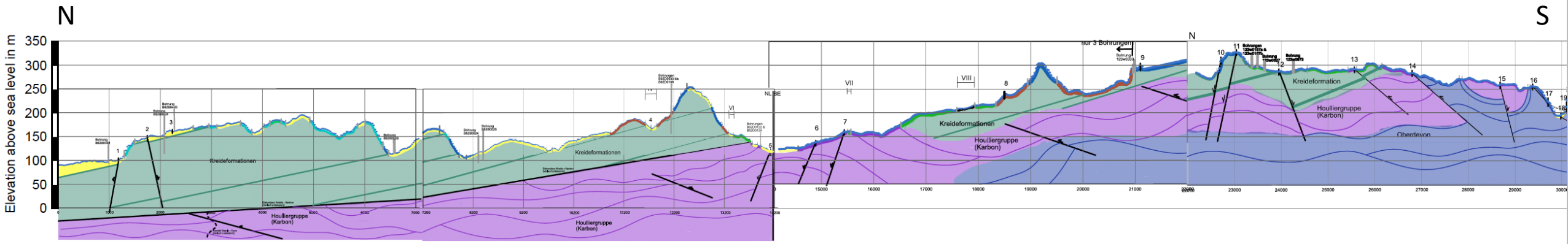


Structural geology

- Deeper and older rocks from Paleozoic are expected to be highly folded and faulted (ca. NE-SW-oriented Paleozoic folds and faults; ca. NW-SE-oriented Cenozoic faults).
- Those rocks are covered by 50-150m of younger soft sediment



Open-source geomodeling in Python gempy (www.gempy.org), developed at CGRE, RWTH Aachen University (de la Varga et al., 2019)

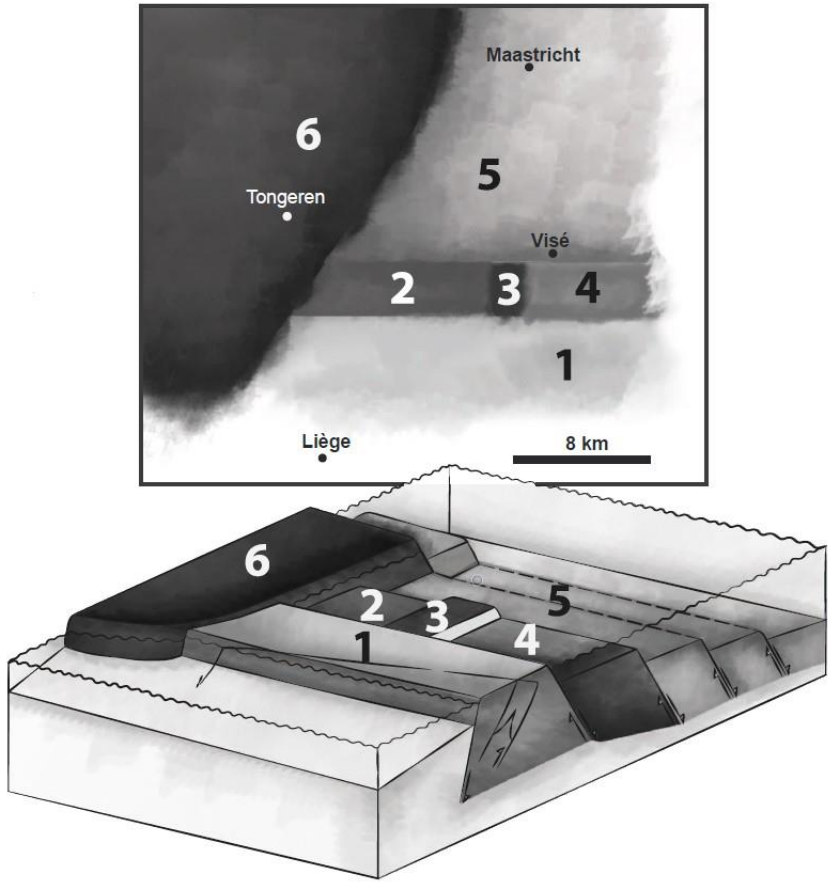


Lithology

Paleozoic

- Cretaceous to Quaternary sediment, claystones and **weakly lithified** sandstones (clastic Aachen and Vaals Formations); Cretaceous chalk with flint layers (calcareous Gulpen Formation, Cretaceous), and various Quaternary alluvium and loess > dampening rocks
- Upper Carboniferous (Westphalian) shales, siltstones, sandstones and conglomerates;
- Upper Carboniferous (Namurian) sandstones, shales and quartzites;
- Lower Carboniferous (Visean) **limestones**;
- Lower Carboniferous (Tournaisian) **limestones**, dolomites and shales
- **Upper Devonian (Famennian) shales, quartzitic sandstones, quartzites**;
- Upper Devonian (Frasnian) limestones and shales.

Due to paleogeography and/or erosion, some stratigraphic units may be missing in parts of the subsurface of the study area

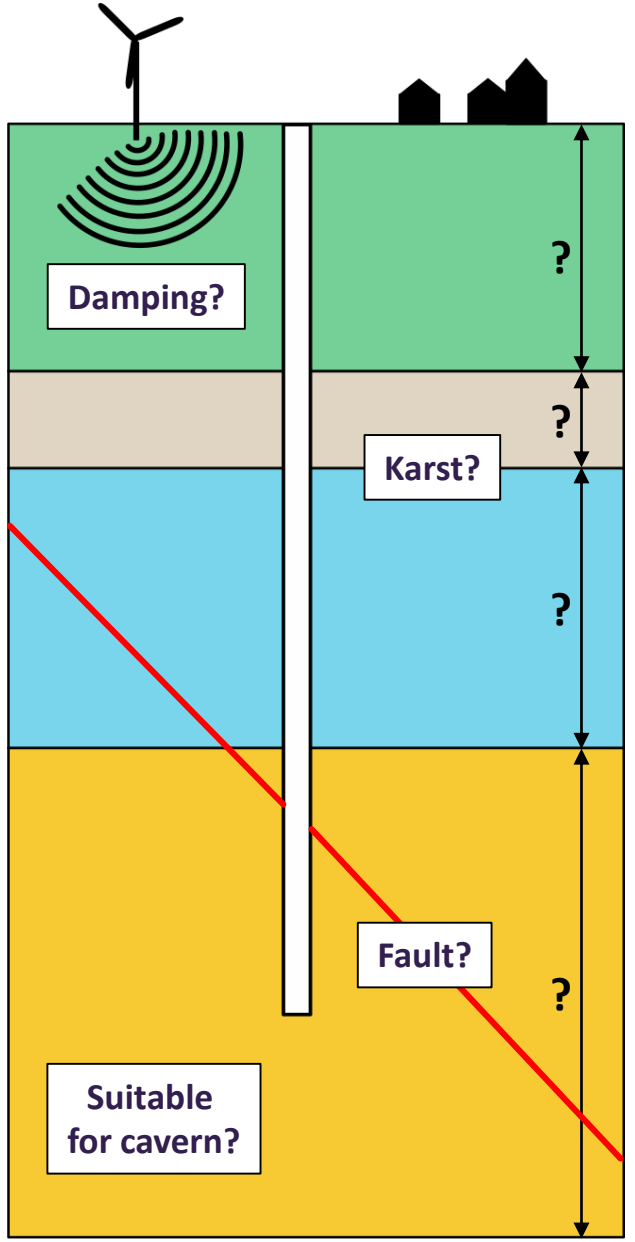


3D block view during the upper Visean age
Poty, 1991

Critical points

- Younger rocks important for later-stage access to corner points, groundwater issues, and drilling stability
- Limestones pose a karstification issue that need to be identified
- Find suitable rocks to hold the caverns

(see F. Amann talk later on)



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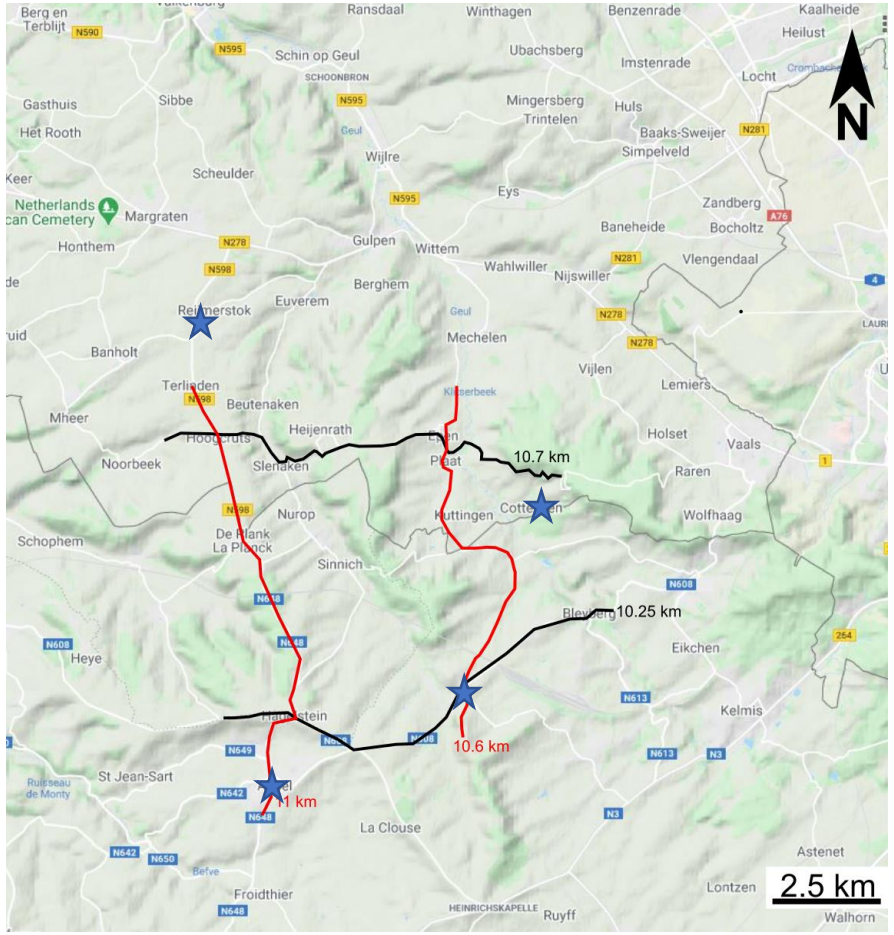
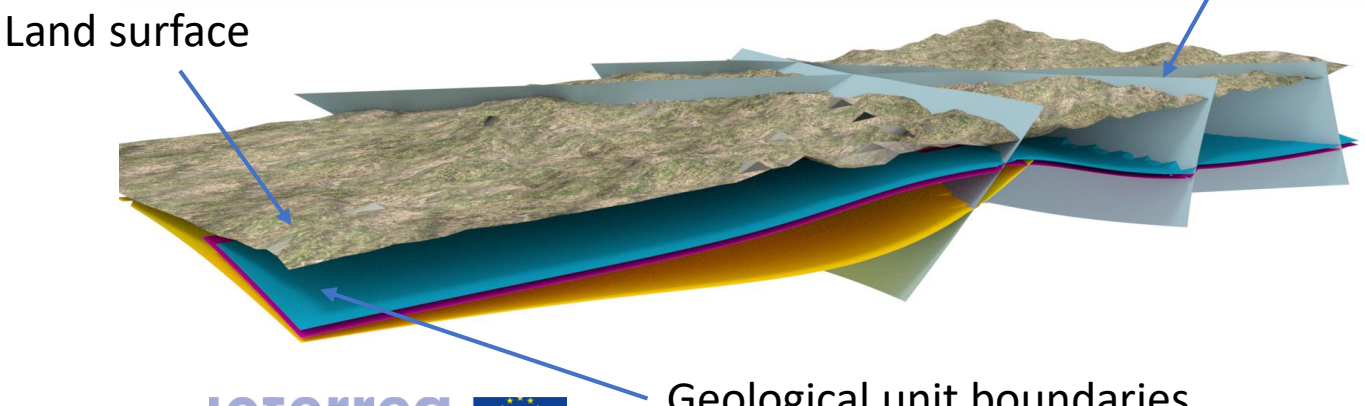
Multiscale surveys

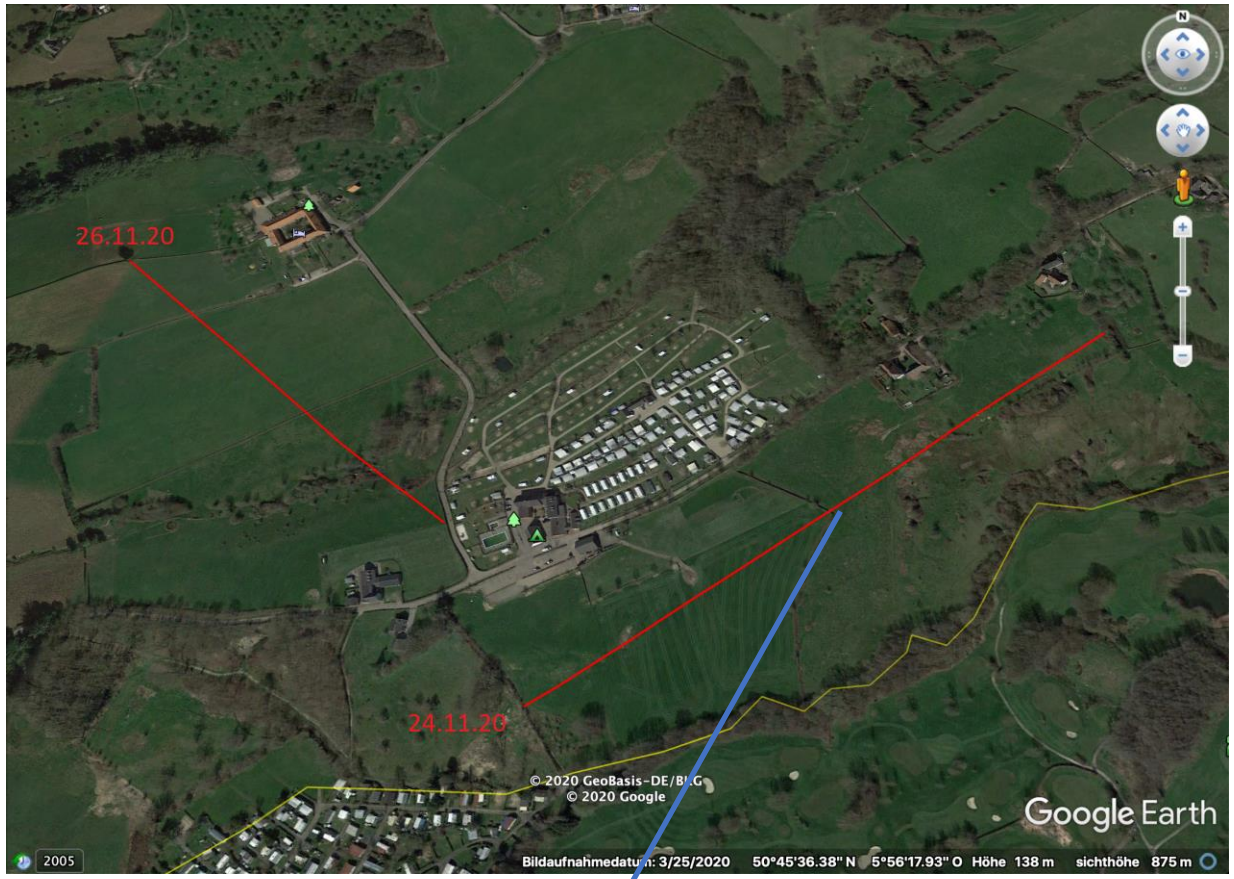
- Fault mapping, fold mapping,
- Stratigraphic interpretation
- Correlation of potentially (and most likely) highly inclined, bended and disrupted seismic reflections of variable lithology.
- Direct link with 3D geological model incl. uncertainty (e.g. Wellmann & Caumon, 2018)

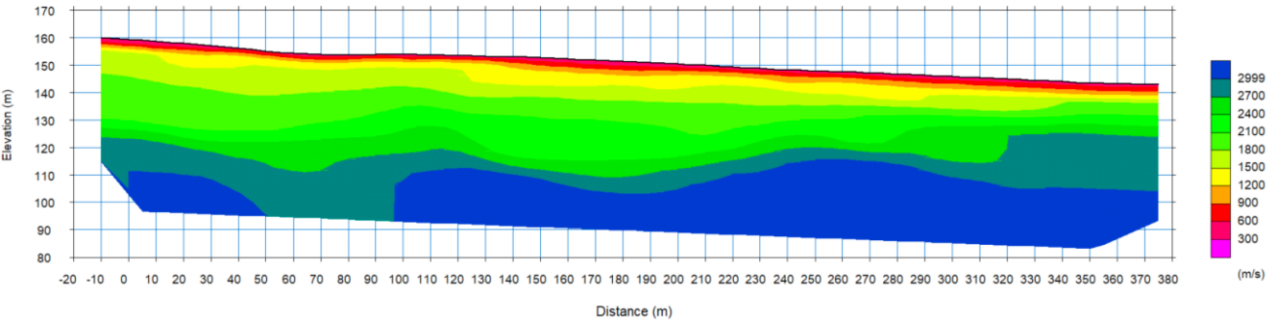


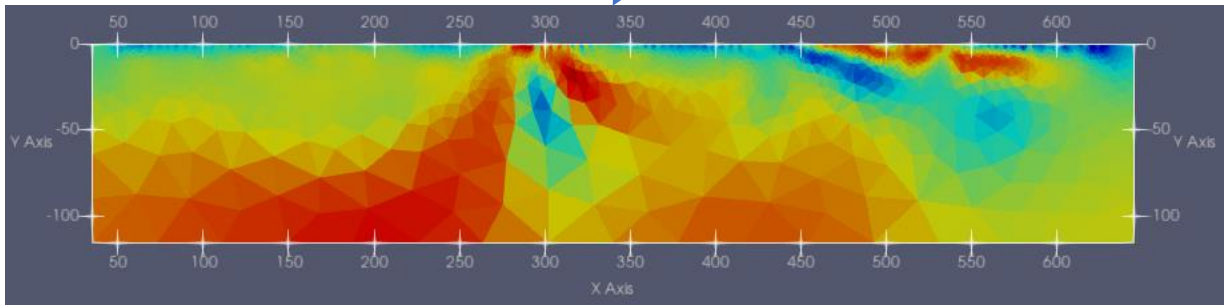


Multimethod survey

- Detailed imaging of ”shallow” layers
- Identify potential karstic areas at depth
- Map faults at shallow depths



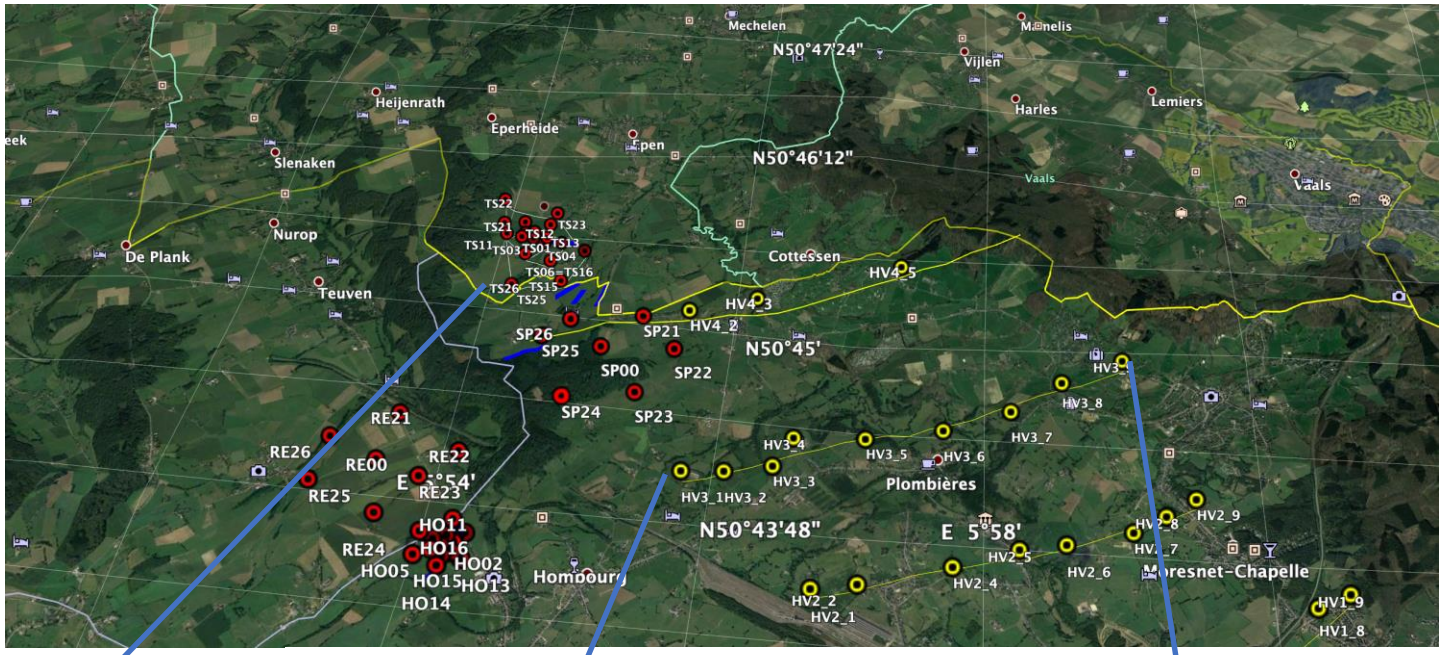


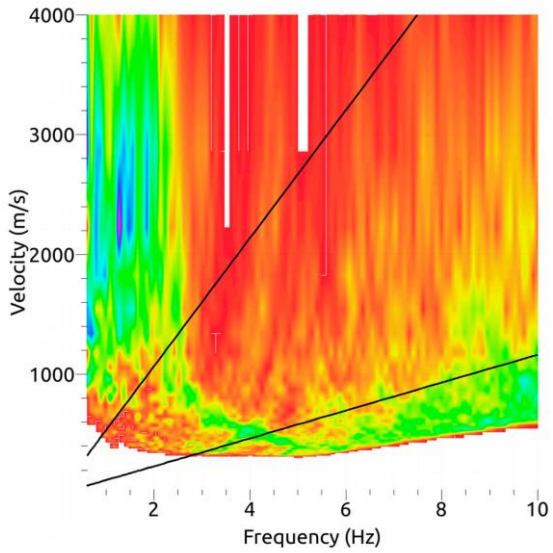


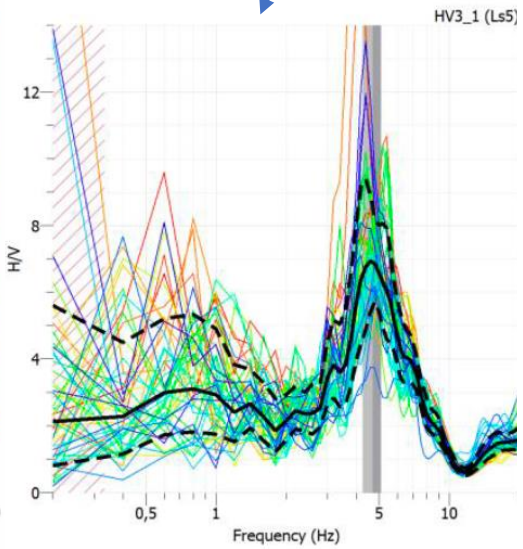
Seismic parameters quantification

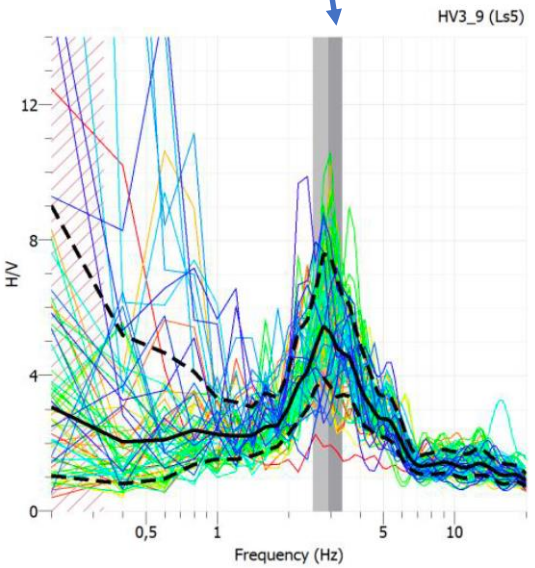
- Seismological measurements with single and multiple stations
- Estimates Vs-logs typically beyond 80 m. (and for very large arrays down to 400-500 m).
- Seismic noise at surface and depth

<u>See also S. Koley talk and F. Amann</u>









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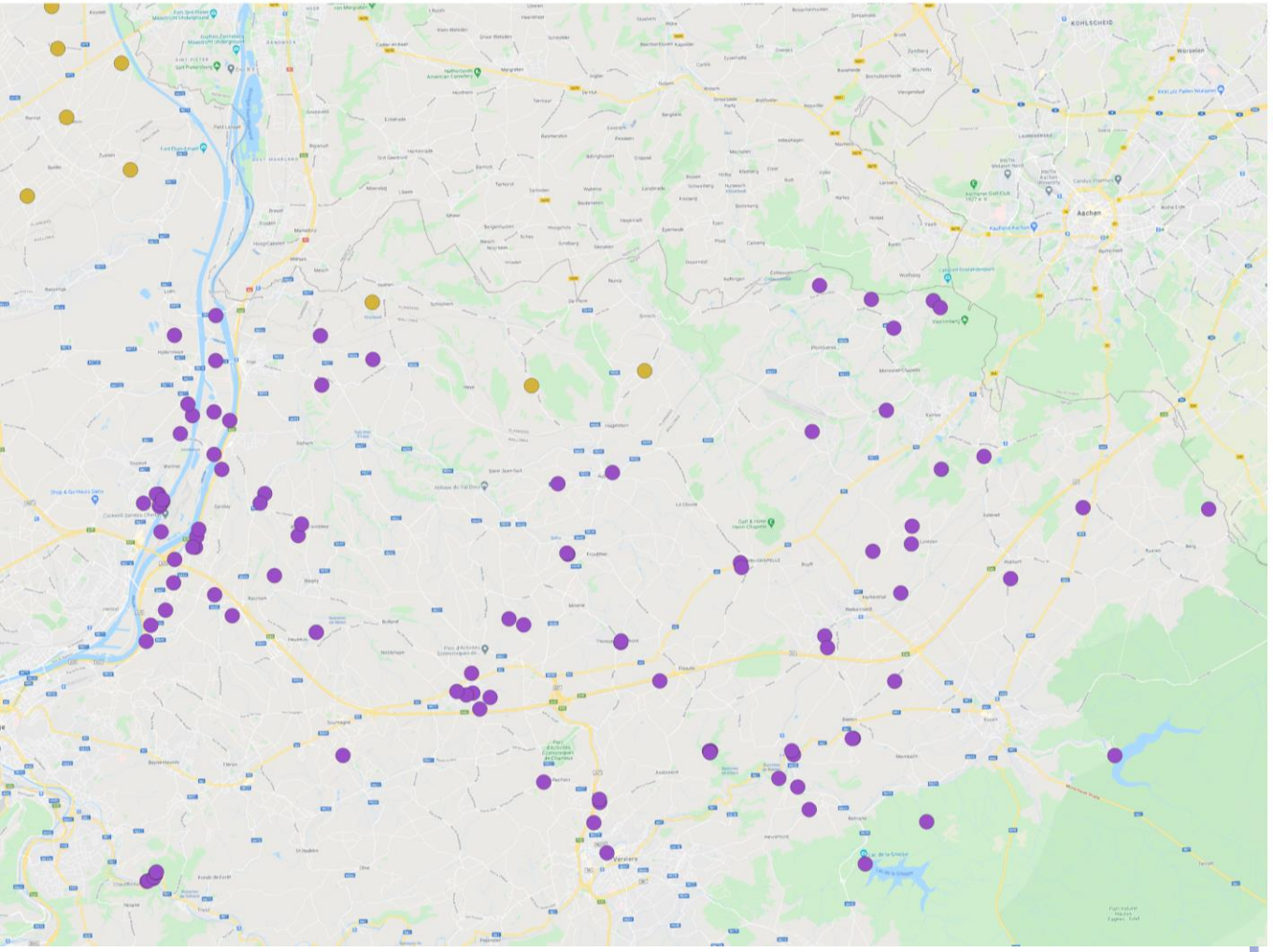
Outcrop near Kelmis @BjornVinck

Why studying hydrogeological conditions ?

- Groundwater is a key factor for any successful underground project.
- It is mainly controlled by strata discontinuities
- Controlling water inflow is critical for both the construction phase and the exploitation phase
- It is a critical input for the design of the Einstein Telescope

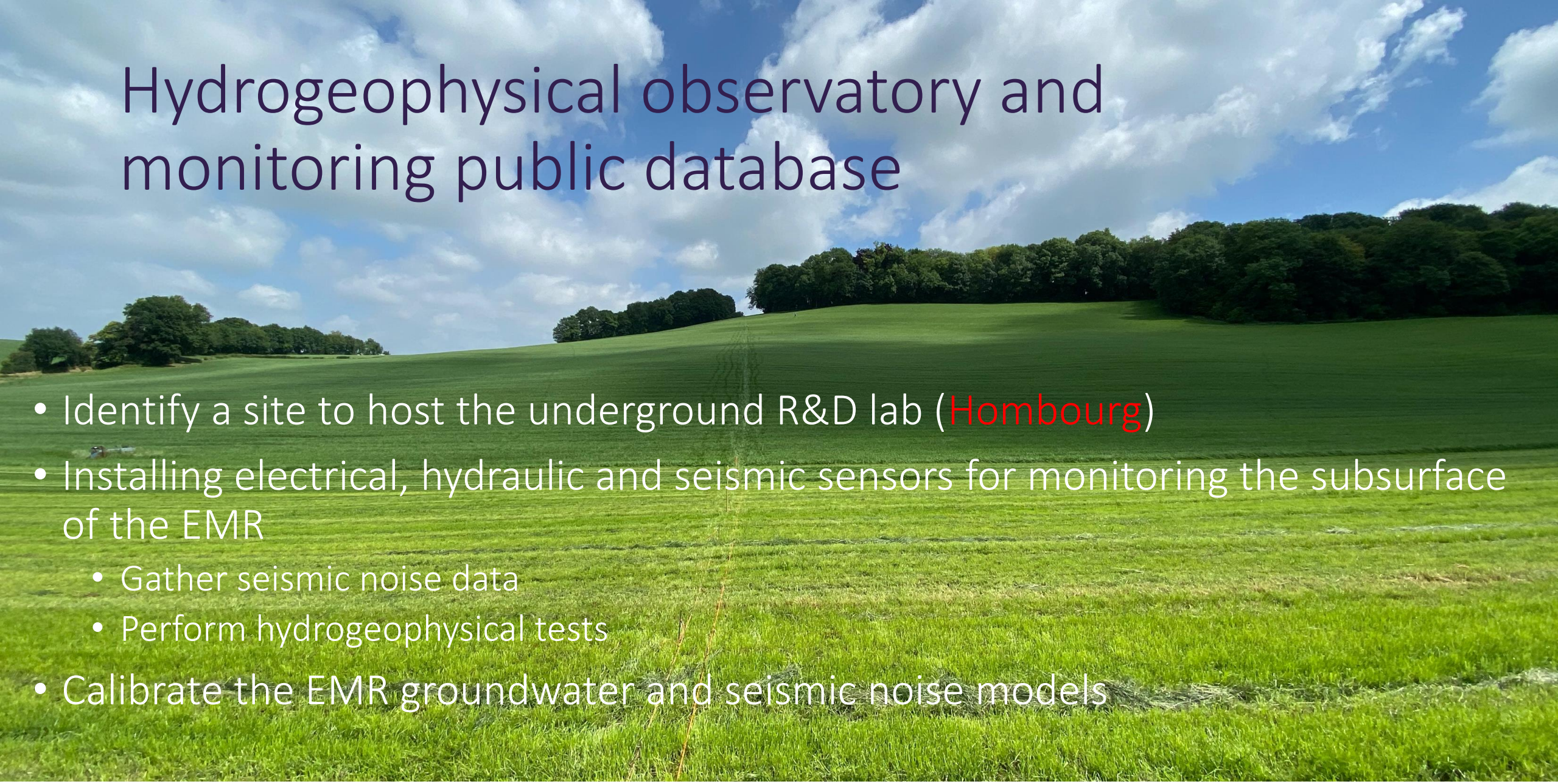
A cross-border EMR groundwater model enables



A sustainable management of ecosystem services:

- Water abstraction
- Shallow geothermy potential
- Environmental impact assessment

Hydrogeophysical observatory and monitoring public database



- Identify a site to host the underground R&D lab (Hombourg)
- Installing electrical, hydraulic and seismic sensors for monitoring the subsurface of the EMR
  - Gather seismic noise data
  - Perform hydrogeophysical tests
- Calibrate the EMR groundwater and seismic noise models

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To follow our activities: https://www.etest-emr.eu/

- Seismic vibrations campaign (windfarms and fault): works start in december 2020
- Drillings, testing, observatory installation : works start in february 2021
- Seismic lines: works start in 2021
- Deep ERT/IP : works start in spring 2021
- Deep SRT/Arrays : works start in 2021
- GIS
- 3D geological model (BIM)
- 3D hydrogeological conceptual model
- …

Thank you!

The E-TEST project is carried out under the Interreg V-A Euregio Meuse-Rhine Programme, with €7.5 million from the European Regional Development Fund (ERDF).

By investing EU funds in Interreg projects, the European Union invests directly in economic development, innovation, territorial development, social inclusion and education in the Euregio Meuse-Rhine.