



European and municipal scale drillability maps: a tool to identify the most suitable techniques to install Borehole Heat Exchange (BHE) probes

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INTRODUCTION



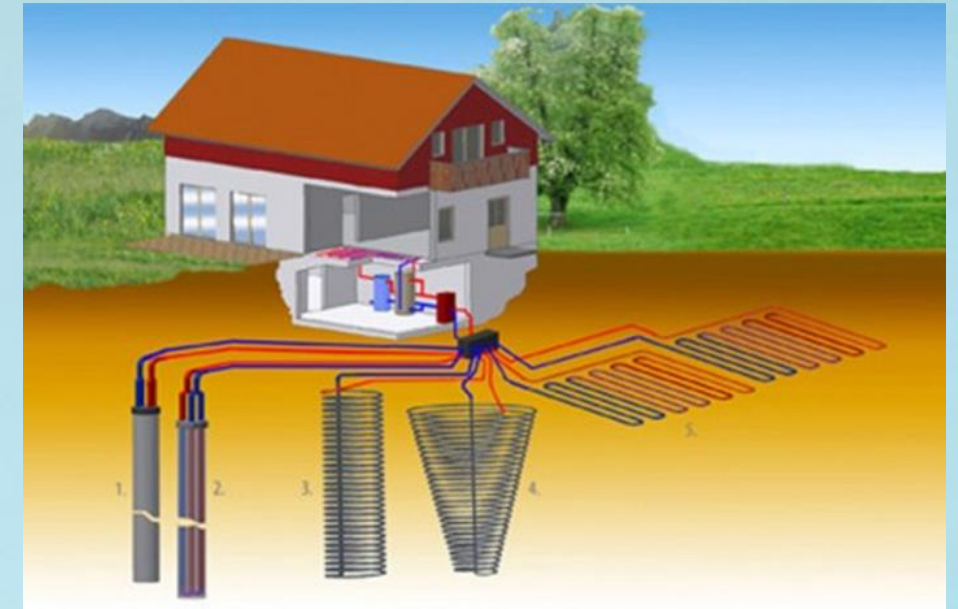
- ✓ to reduce CO₂ and gas emissions by 55% by 2030 (compared to 1990 levels)
- ✓ to reach climate neutrality by 2050



- ✓ **energy transition** also for the retrofitting of the building stock

shallow geothermal energy (SGE) plays a key role in building retrofitting because it provides:

- i. a further **shift in the energy mix** towards renewable
- ii. a substantial **reduction in energy demand** in the residential sector

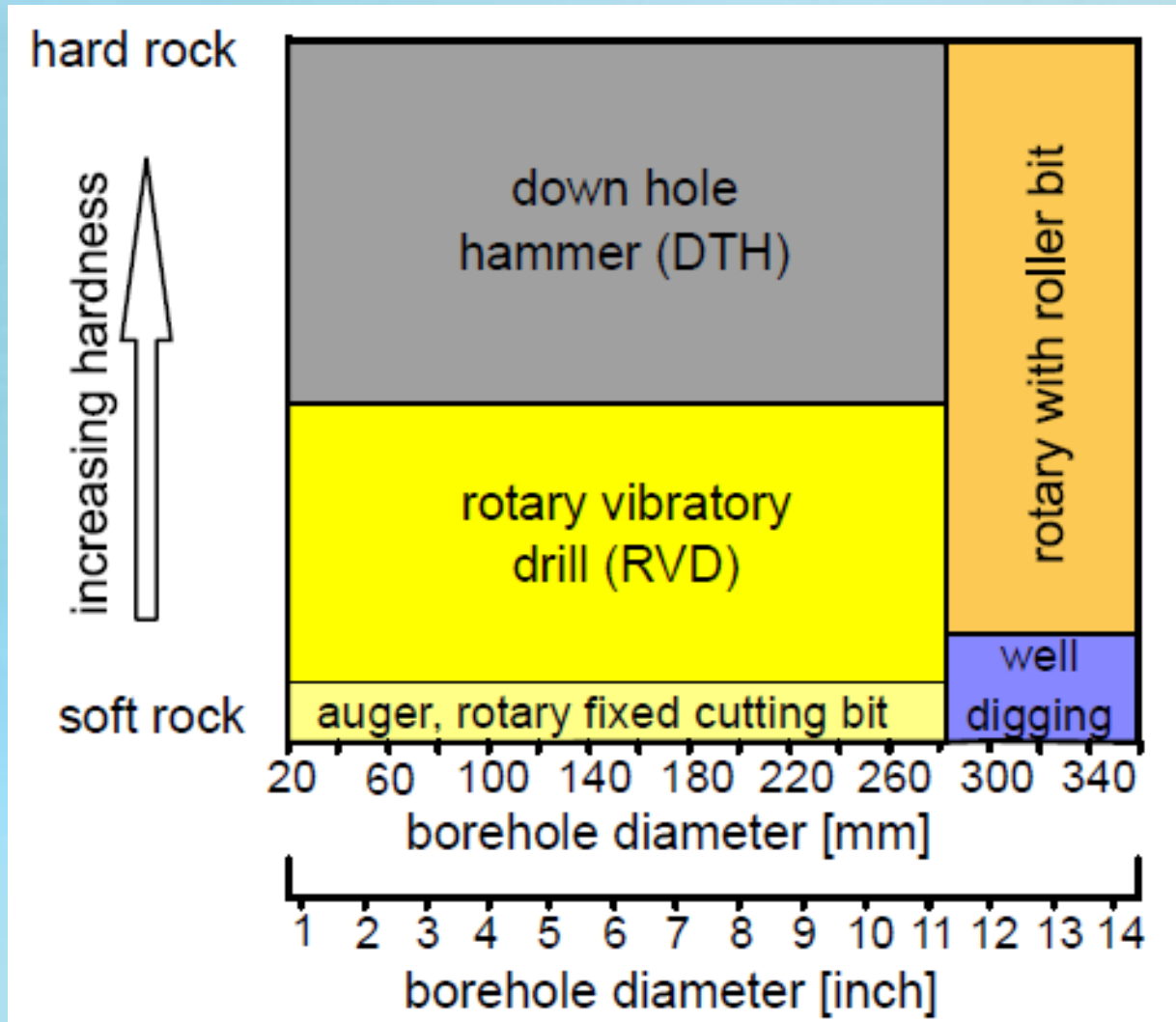


to be competitive the total investment cost of SGEs systems has to decrease

- **drilling cost** needs to be tackled down
- **a better understanding** of available drilling technology suitable for shallow geothermal installation is needed

the mapping approach is a good starting point for underground analysis and characterization

DRILLABILITY



modified by D2.1 GEO4CIVHIC

prediction of the most suitable drilling methods related to BHEs installation taking into account:

- ❑ the estimated installation time in function of the rig and drilling technology
- ❑ the local geological constrains

Mapping of ground eligibility for drilling methodologies and BHEs

1. European shallow geothermal map

- ✓ Thematic maps at **European scale (1:1.500.000)**
- ✓ **Target group:** policy makers, energy planning administrator
- ✓ Based on the **geological map released following the INSPIRE** (INfrastructure for Spatial InfoRmation in Europe) **Directive**
- ✓ considers the most used **drilling methods**

It provides:

- ✓ **first information** about the geological context
- ✓ **first estimation** of the best drilling techniques to be applied and time/costs

Mapping of ground eligibility for drilling methodologies and BHEs

2. Local shallow geothermal maps

- ✓ Thematic maps at **municipal scale (1:25.000)**
- ✓ **Target group:** geologists, engineers, local authorities, stakeholders, policy makers, administration ...
- ✓ Based on **local information:** geology / hydrogeological data/ local costs / local heat exchange capacity / TRT / ground temperature / building thermal needs etc...
- ✓ To be calibrated/compared with the **real data in the test sites**

It provides:

- ✓ Suggestions about the **best drilling technique** to be applied
- ✓ Estimation of **drilling time and costs**

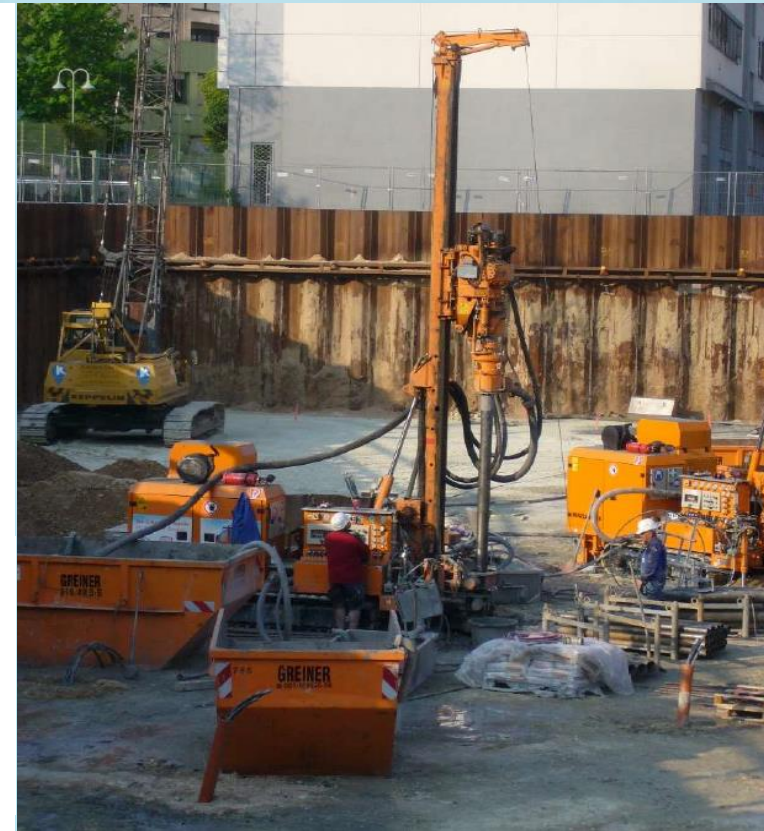
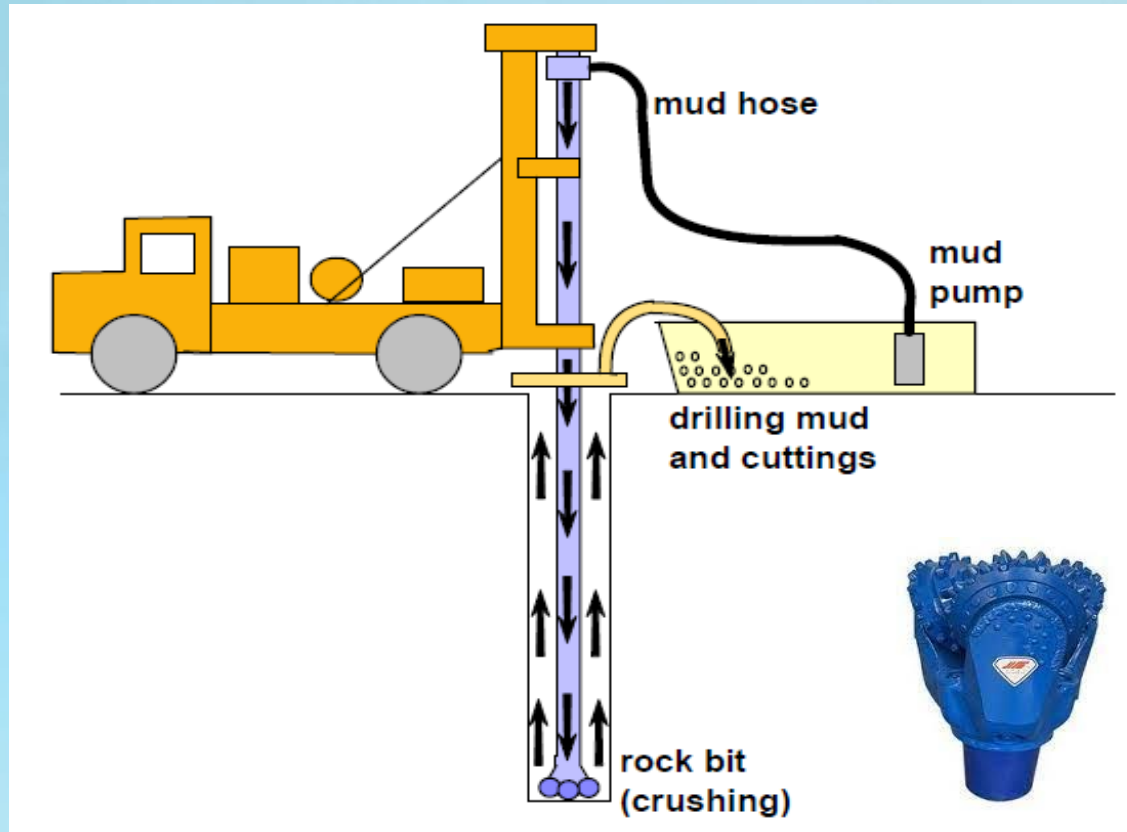
The **drilling methods** considered by questioning project partners expert in drilling operations (FAU, GEOSERV, GEOGREEN, UBeG, HYDRA, UNIPD-DG) are:

- 1) down-hole hammer WITH casing → **DTH + c**
- 2) traditional down-hole hammer WITHOUT casing → **DTH w/o c**



The **drilling methods** considered by questioning project partners expert in drilling operations (FAU, GEOSERV, GEOGREEN, UBeG, HYDRA, UNIPD-DG) are:

- 3) rotary drilling tricone WITH casing → **tricone + c**
- 4) rotary drilling tricone WITHOUT casing → **tricone w/o c**



The **drilling methods** considered by questioning project partners expert in drilling operations (FAU, GEOSERV, GEOGREEN, UBeG, HYDRA, UNIPD-DG) are:

- 5) chevron WITH casing → **chevron + c**
- 6) chevron WITHOUT casing → **chevron w/o c**



The **drilling methods** considered by questioning project partners expert in drilling operations (FAU, GEOSERV, GEOGREEN, UBeG, HYDRA, UNIPD-DG) are:

- 7) easy drill piling without casing (Cheap-GSHPs technology) → **ED w/o c**
- 8) easy drill with casing + grout+ probe inserted and extraction of the casing at the end (technology developed in the GEO4CIVHIC project) → **ED + c**



<https://cheap-gshp.eu/>



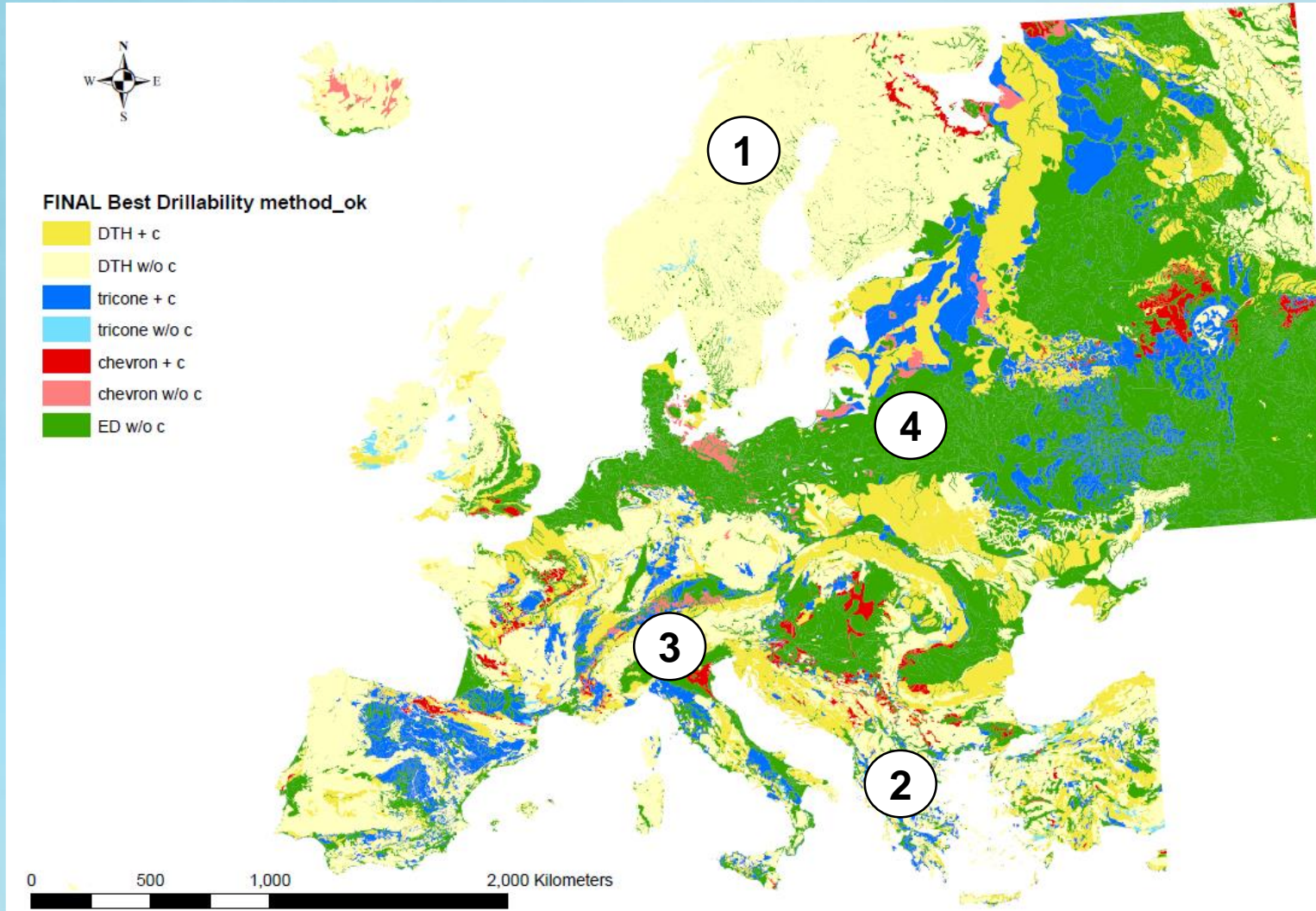
The **drilling methods** considered by questioning project partners expert in drilling operations (FAU, GEOSERV, GEOGREEN, UBeG, HYDRA, UNIPD-DG) are:

- 9) enlarged auger for helicoidal heat exchangers (with casing of about 30cm) (Cheap-GSHPs technology)
→ EA



1. European shallow geothermal map

- ✓ more than 200 geological settings identified
- ✓ according to the lithological distribution **4 main regions** were identified



1) Northern Europe

hard rocks →

percussion rotation methods

2) Central and Southern Europe

different rocks →

rotating or percussion rotation methods

3) European fold belts

folded and metamorphosed rocks →

mainly percussion rotation methods

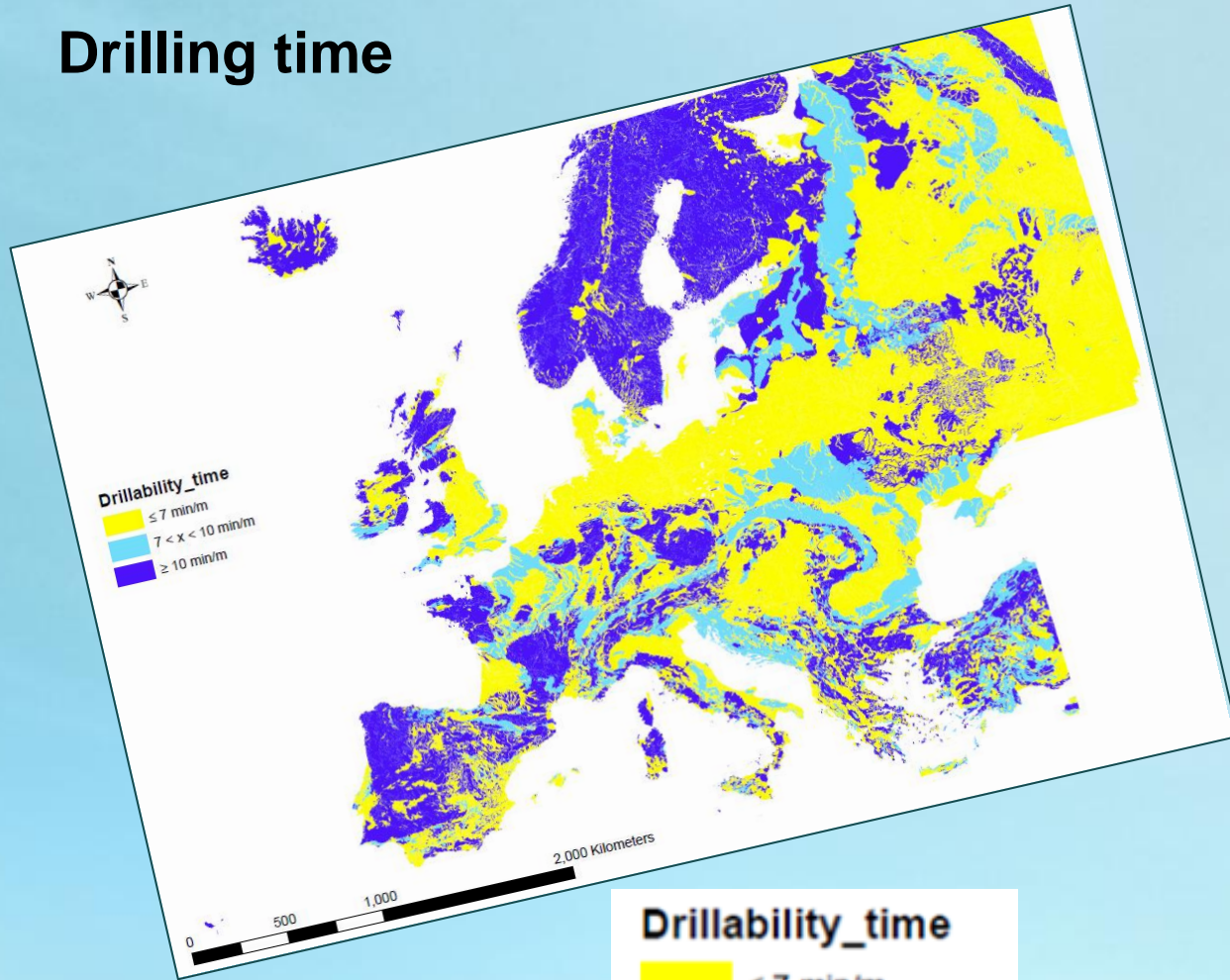
4) European sedimentary basin

unconsolidated sediments are prevalent →

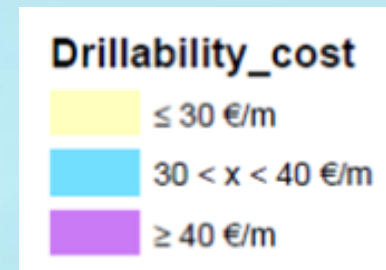
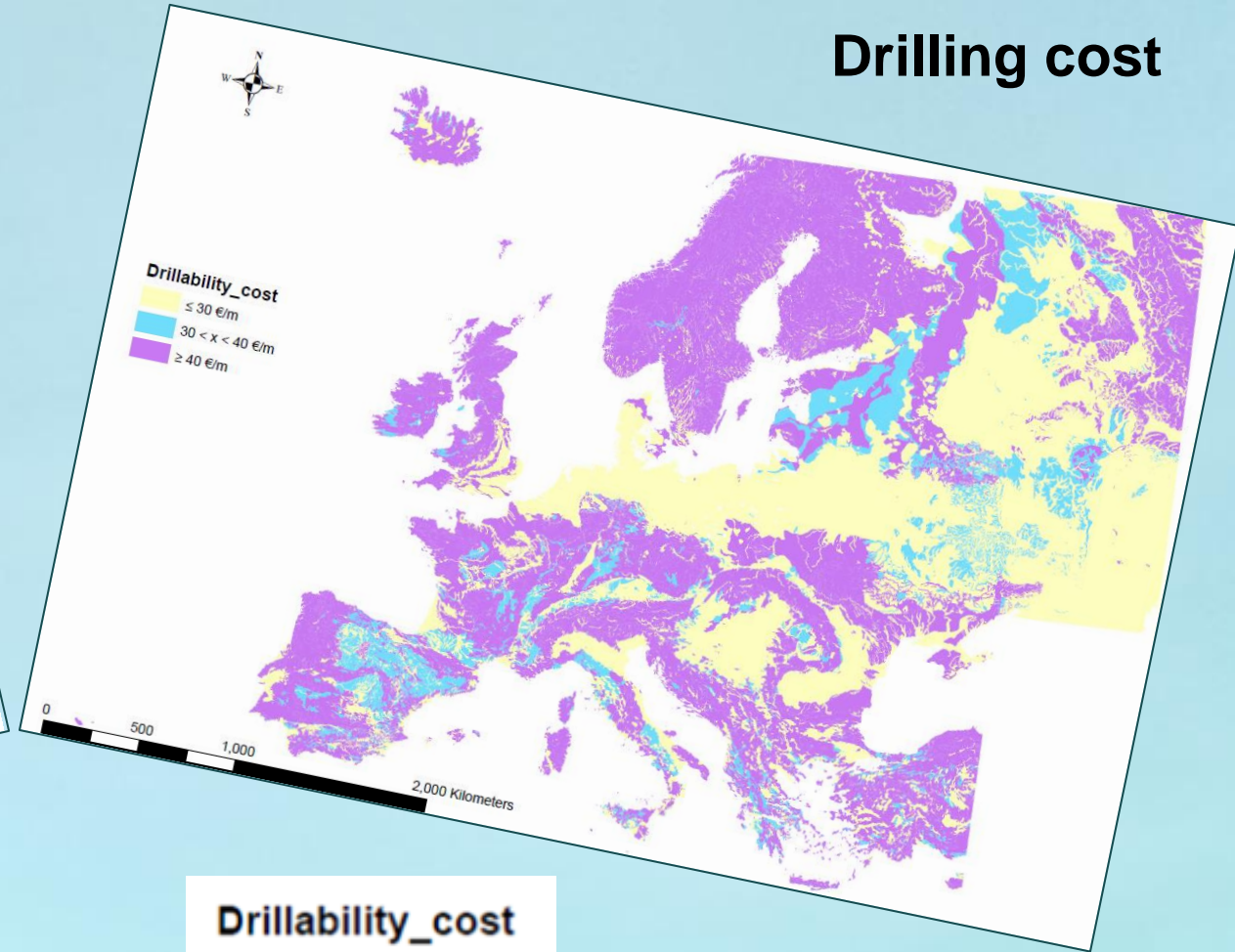
rotary rigs, often using temporary casing to stabilise the hole

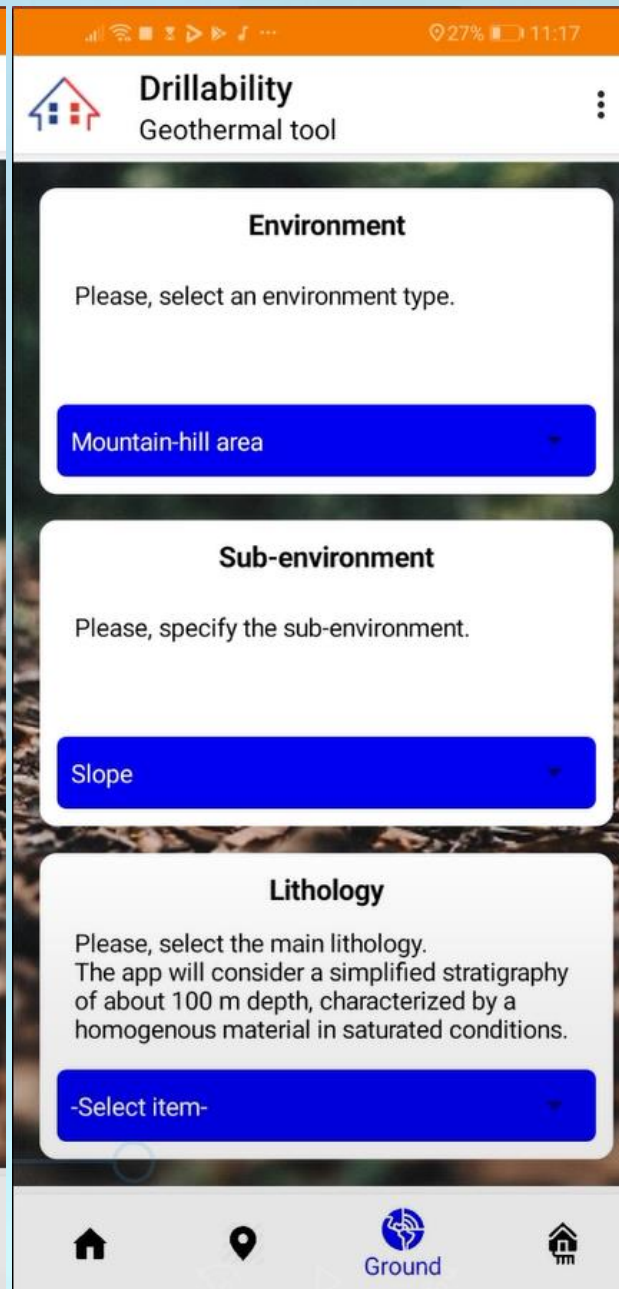
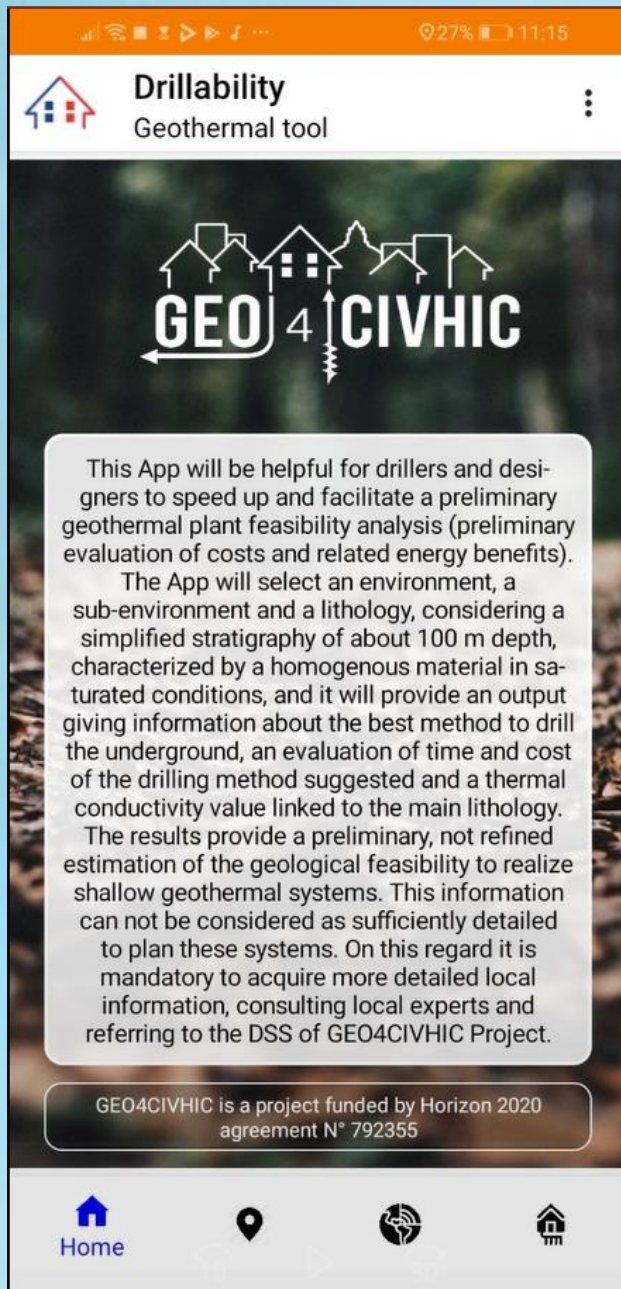
1. European shallow geothermal map

Drilling time



Drilling cost





2. Local shallow geothermal map

Dublin (Ireland)



La Valletta (Malta)



Ferrara (Italy)

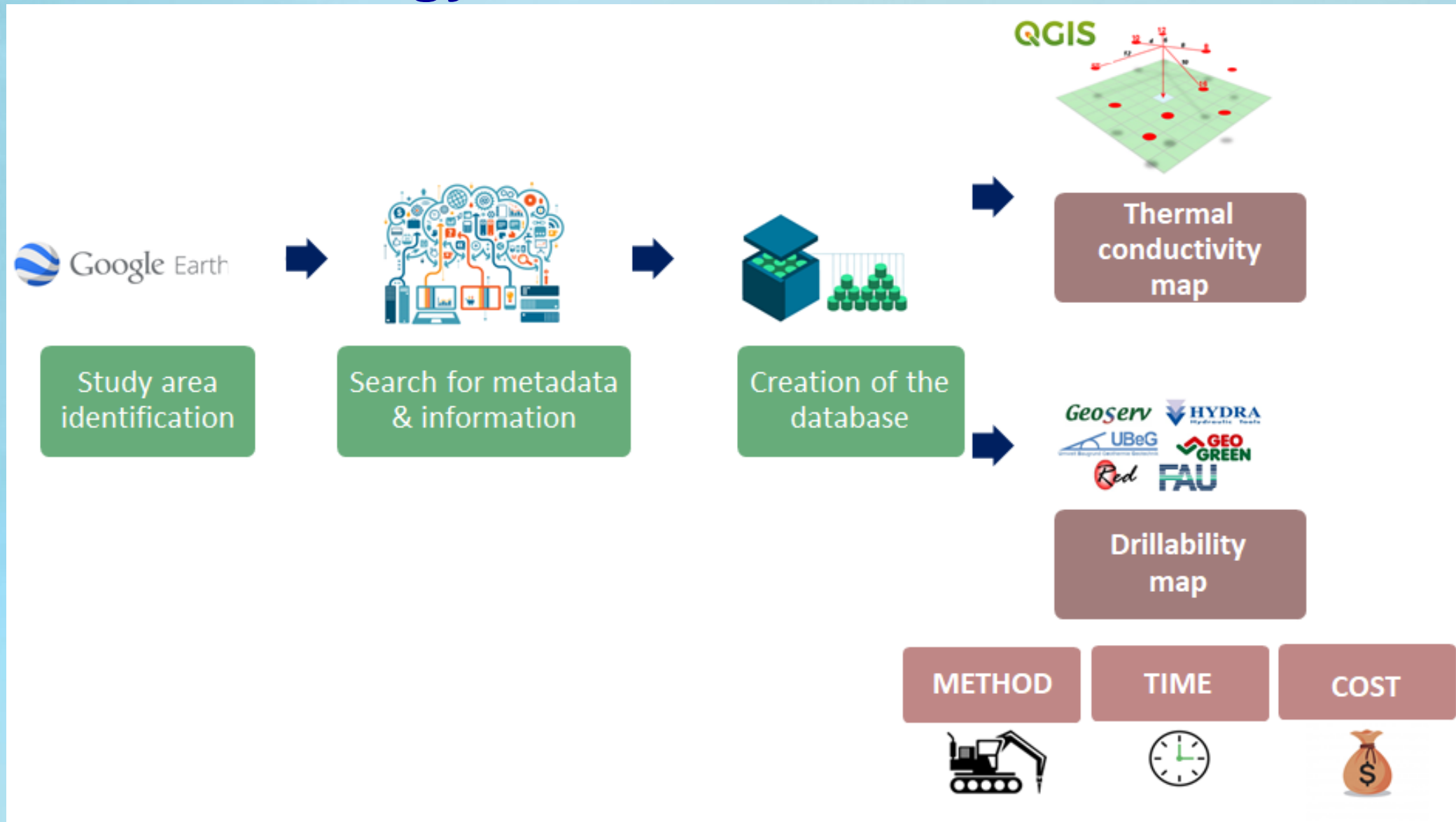


Mechelen (Belgium)

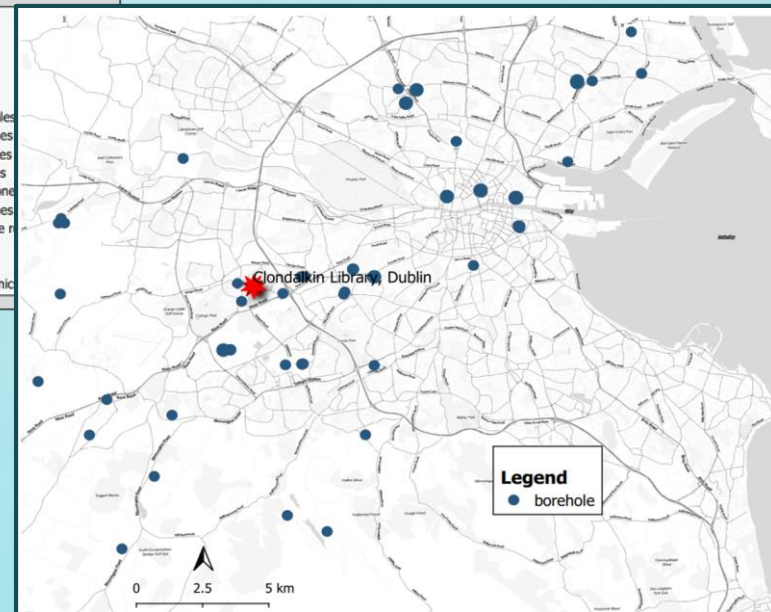
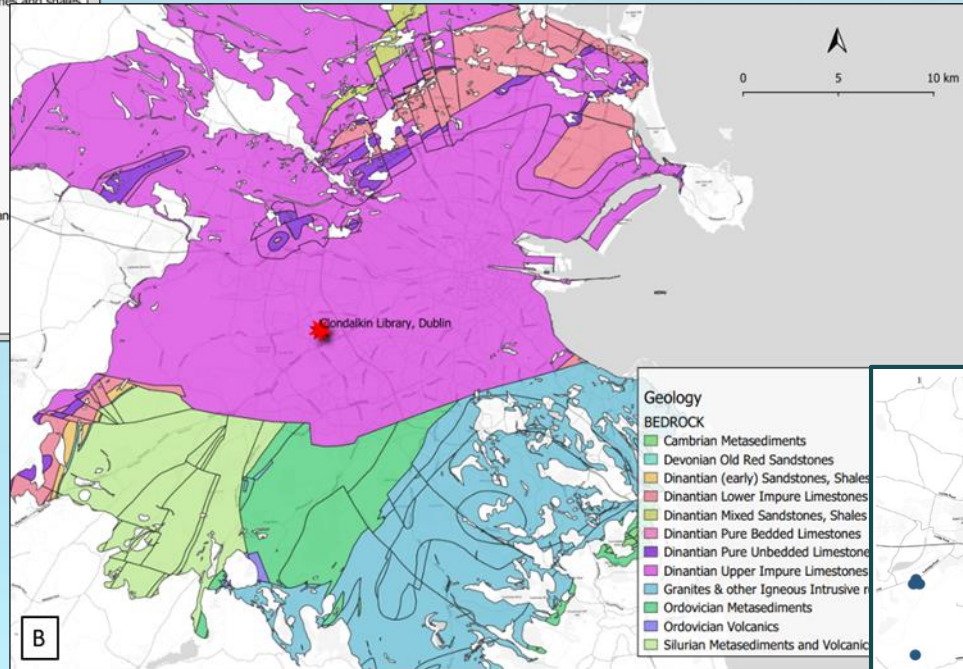
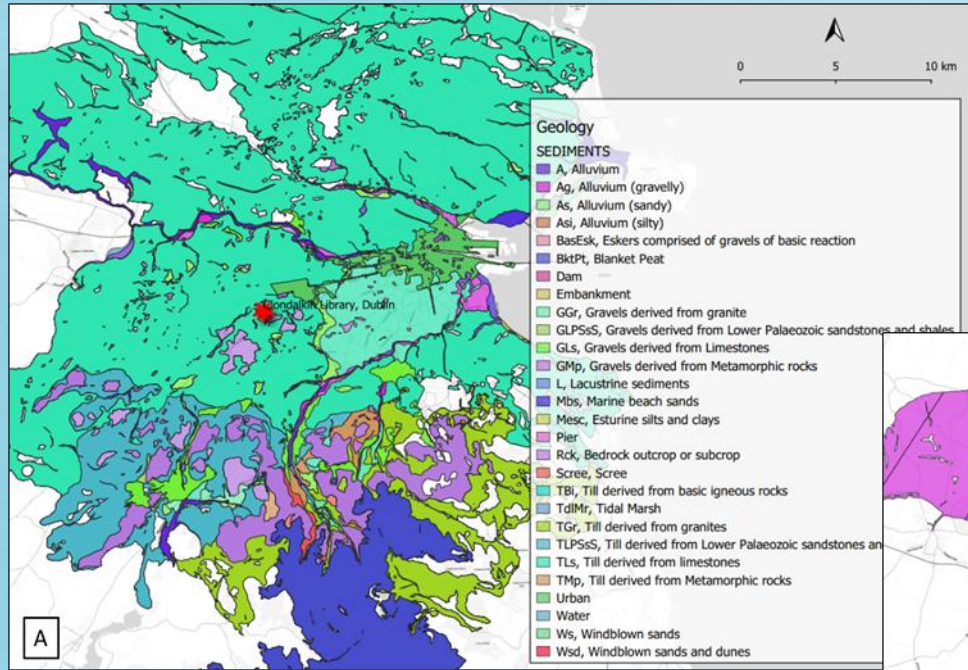


related GEO4CIVHIC demonstration sites, with different geological contexts, climates and data availability

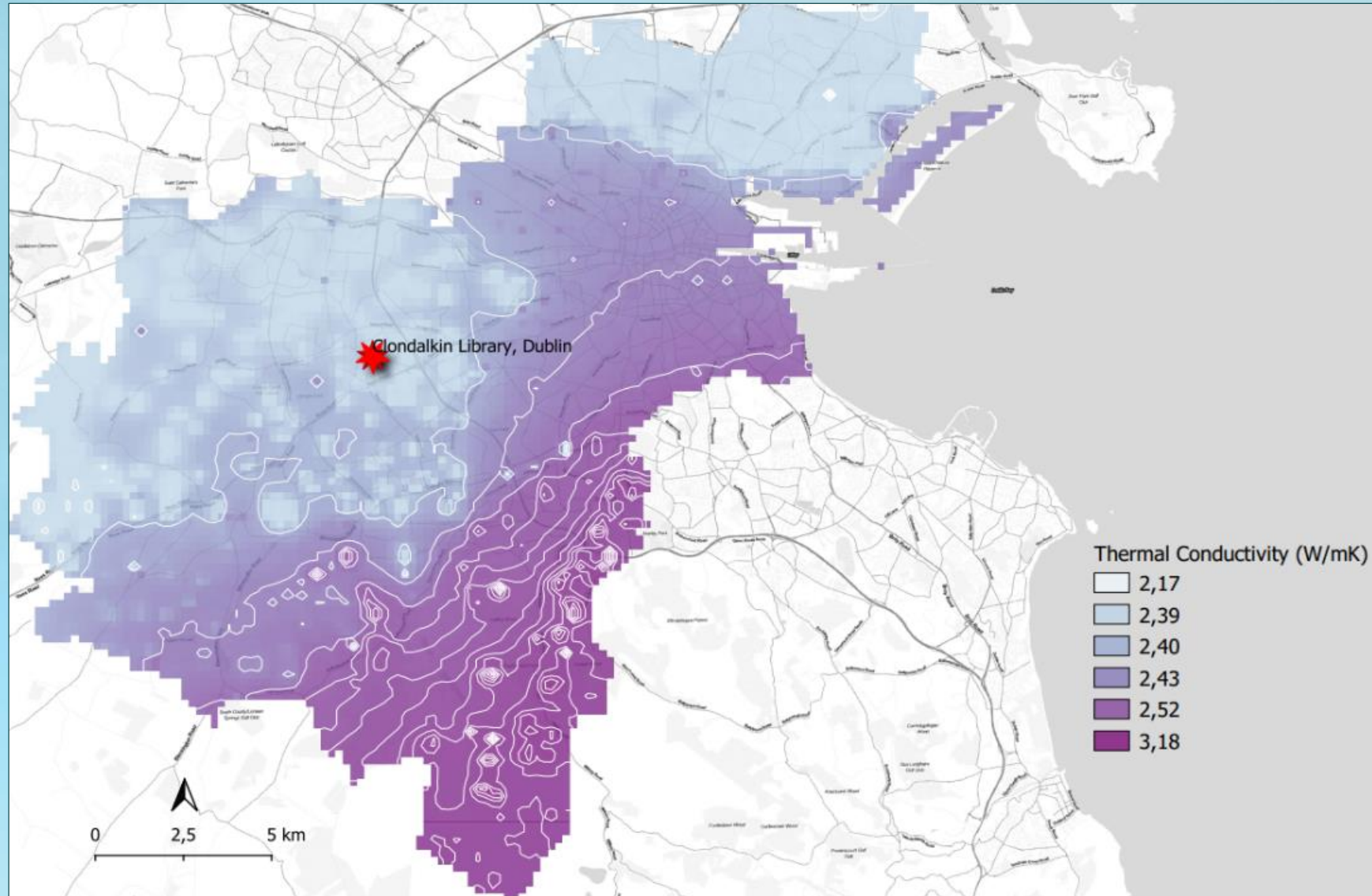
General Methodology



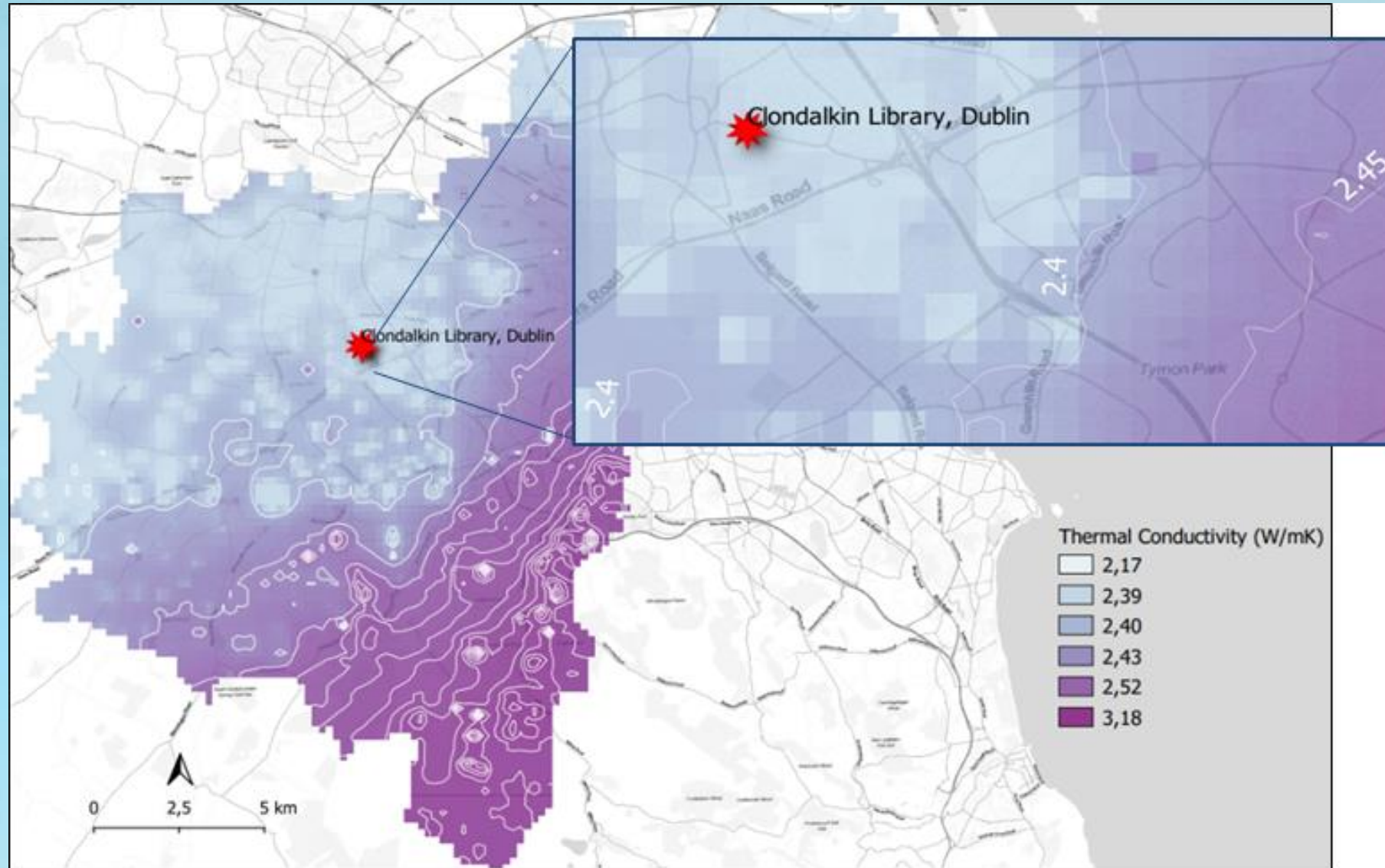
Dublin – Geology and borehole information



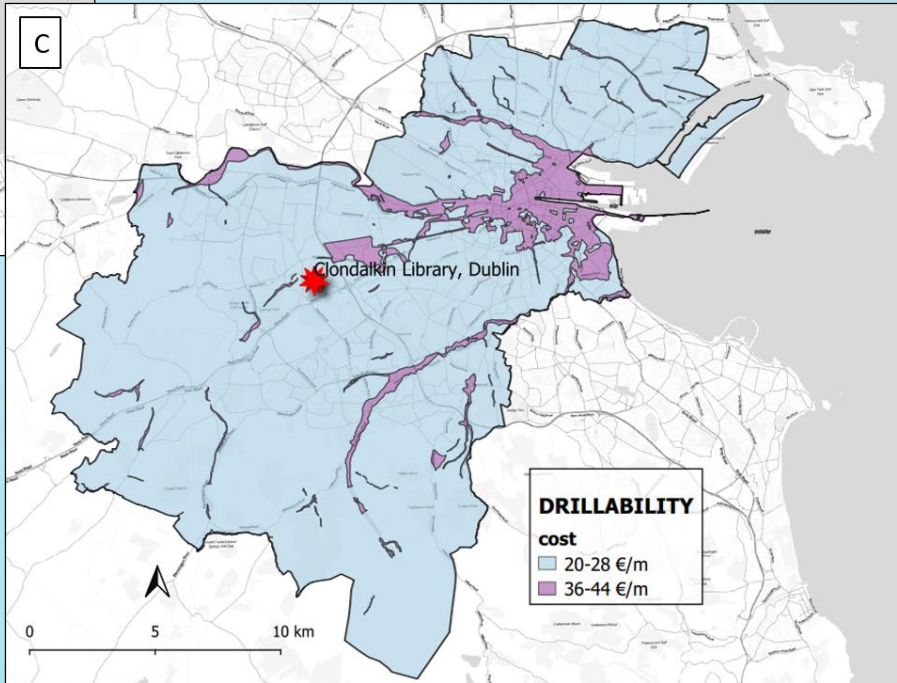
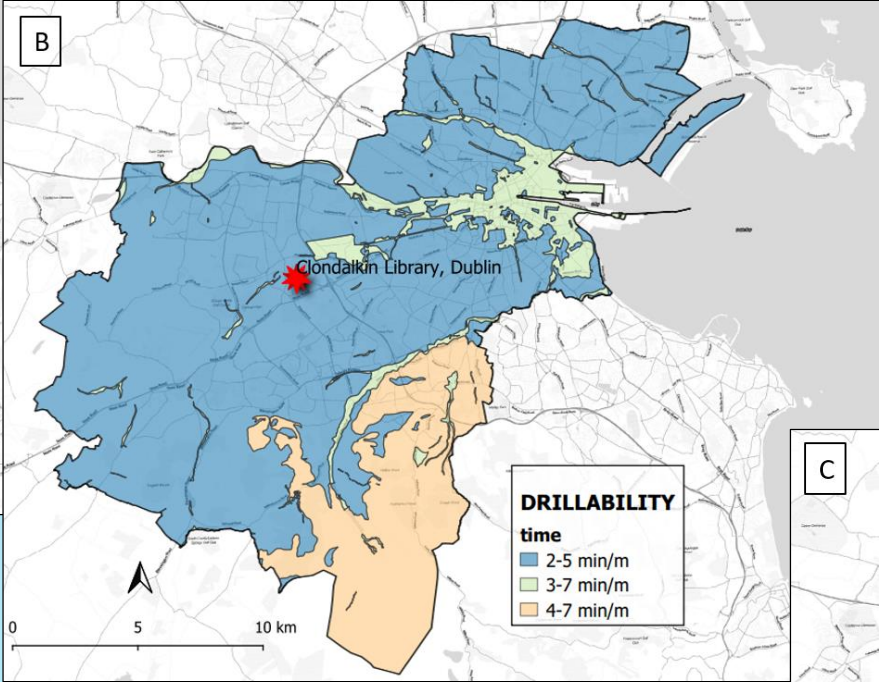
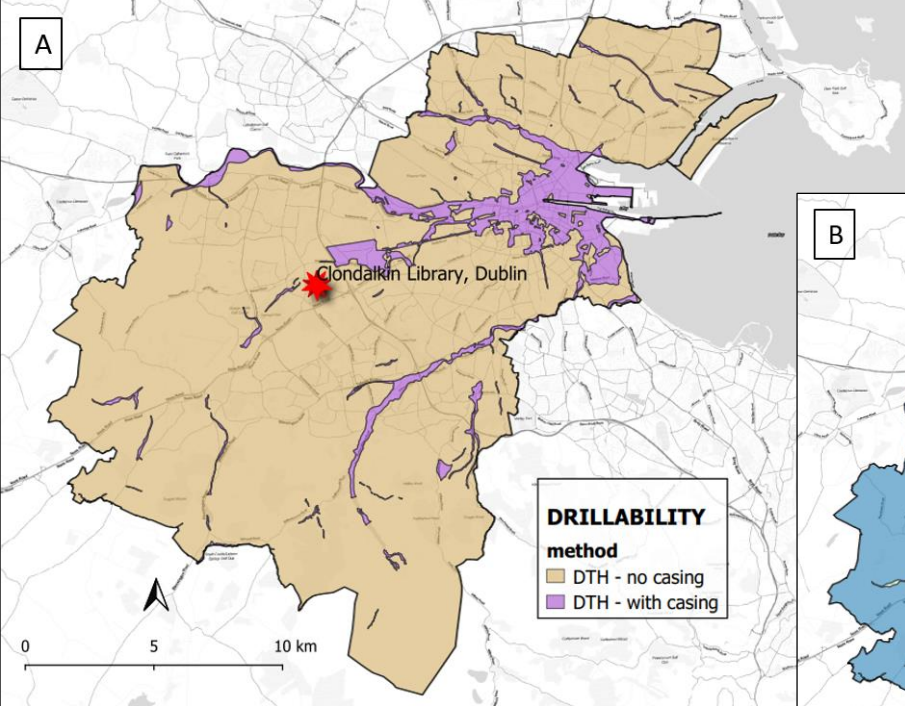
Dublin – weighted Thermal Conductivity (100m depth)



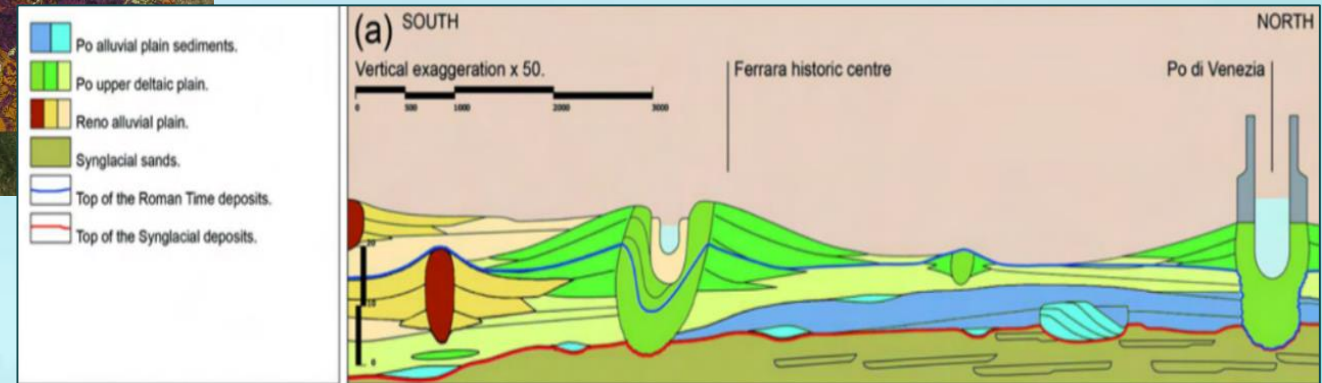
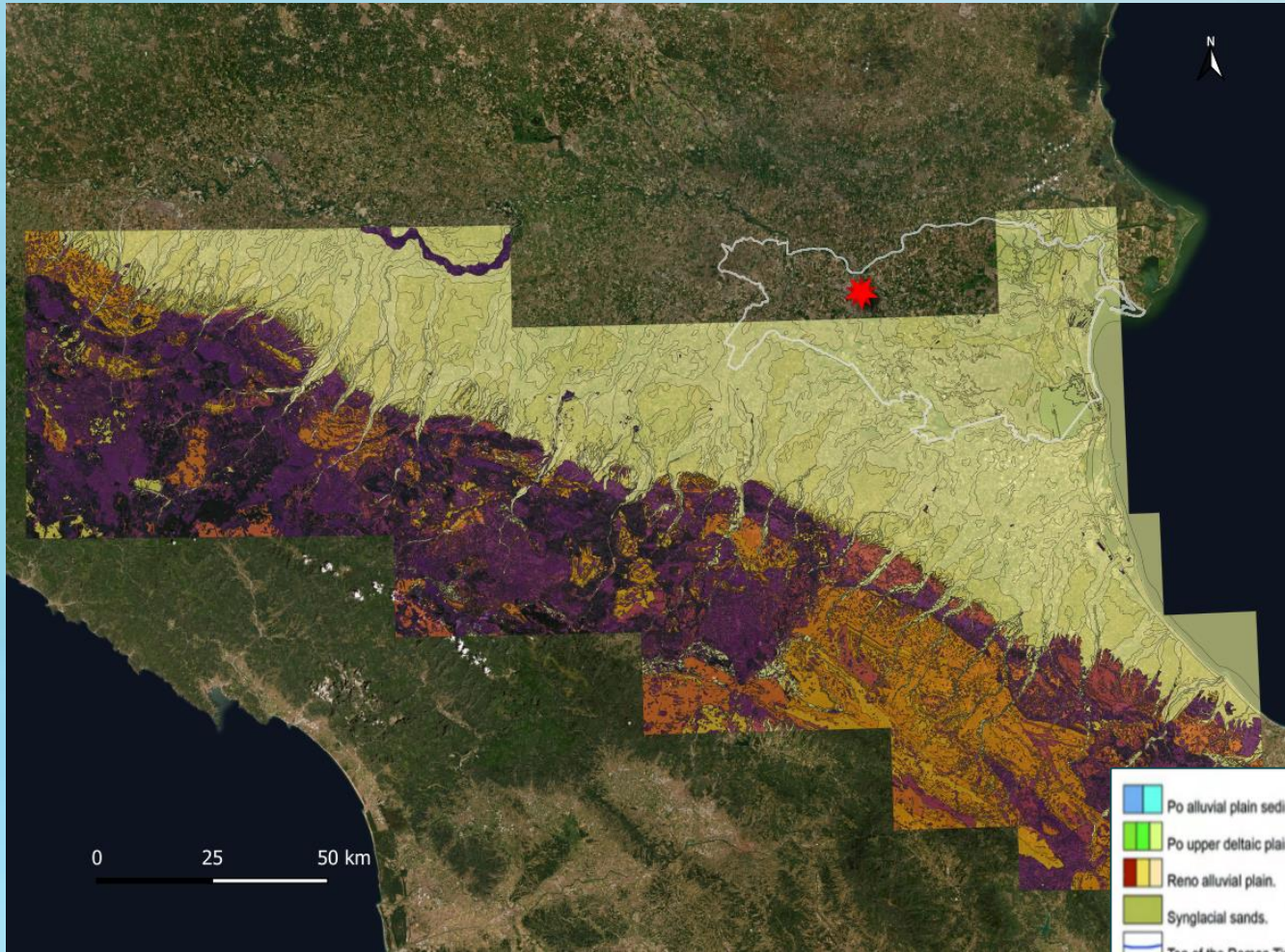
Dublin – weighted Thermal Conductivity (100m depth)



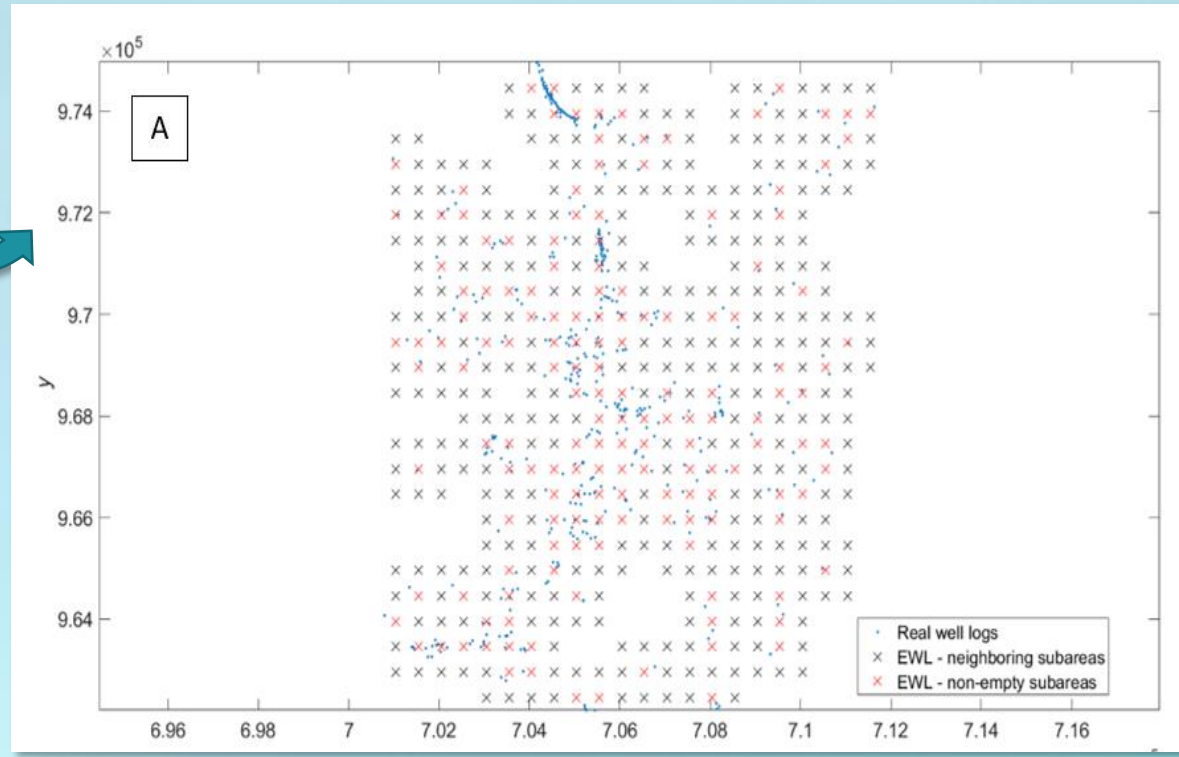
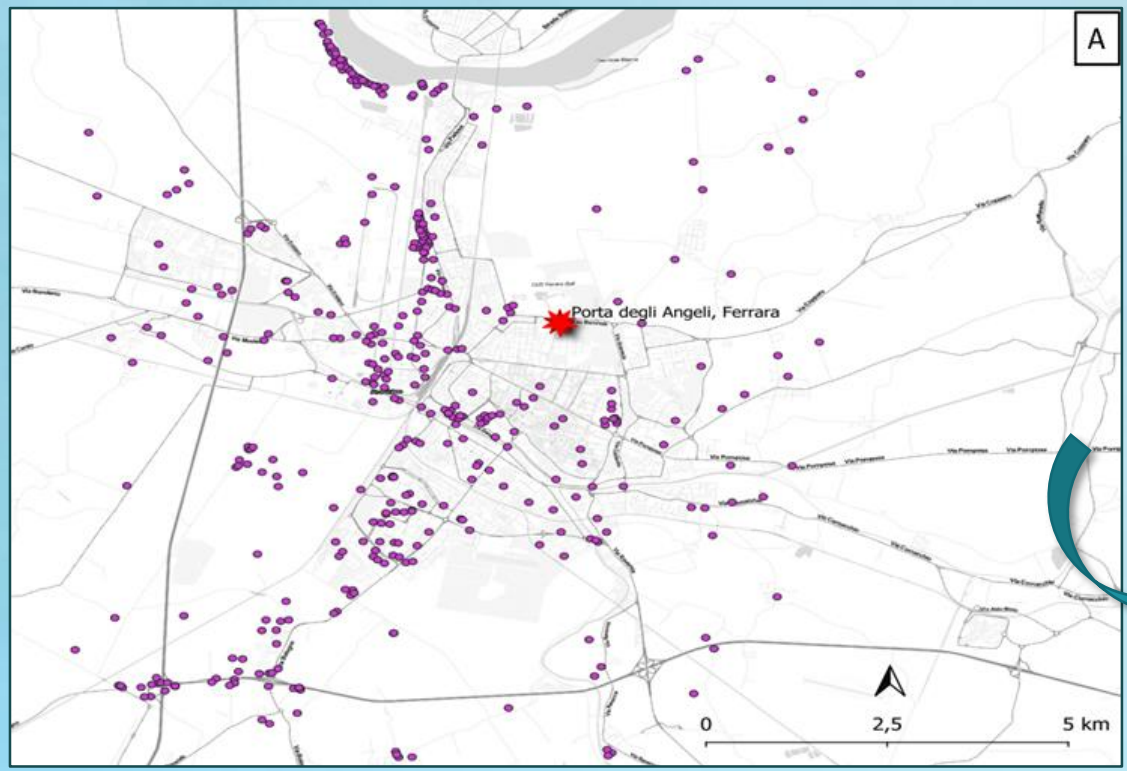
Dublin – Drillability maps: method, time and cost



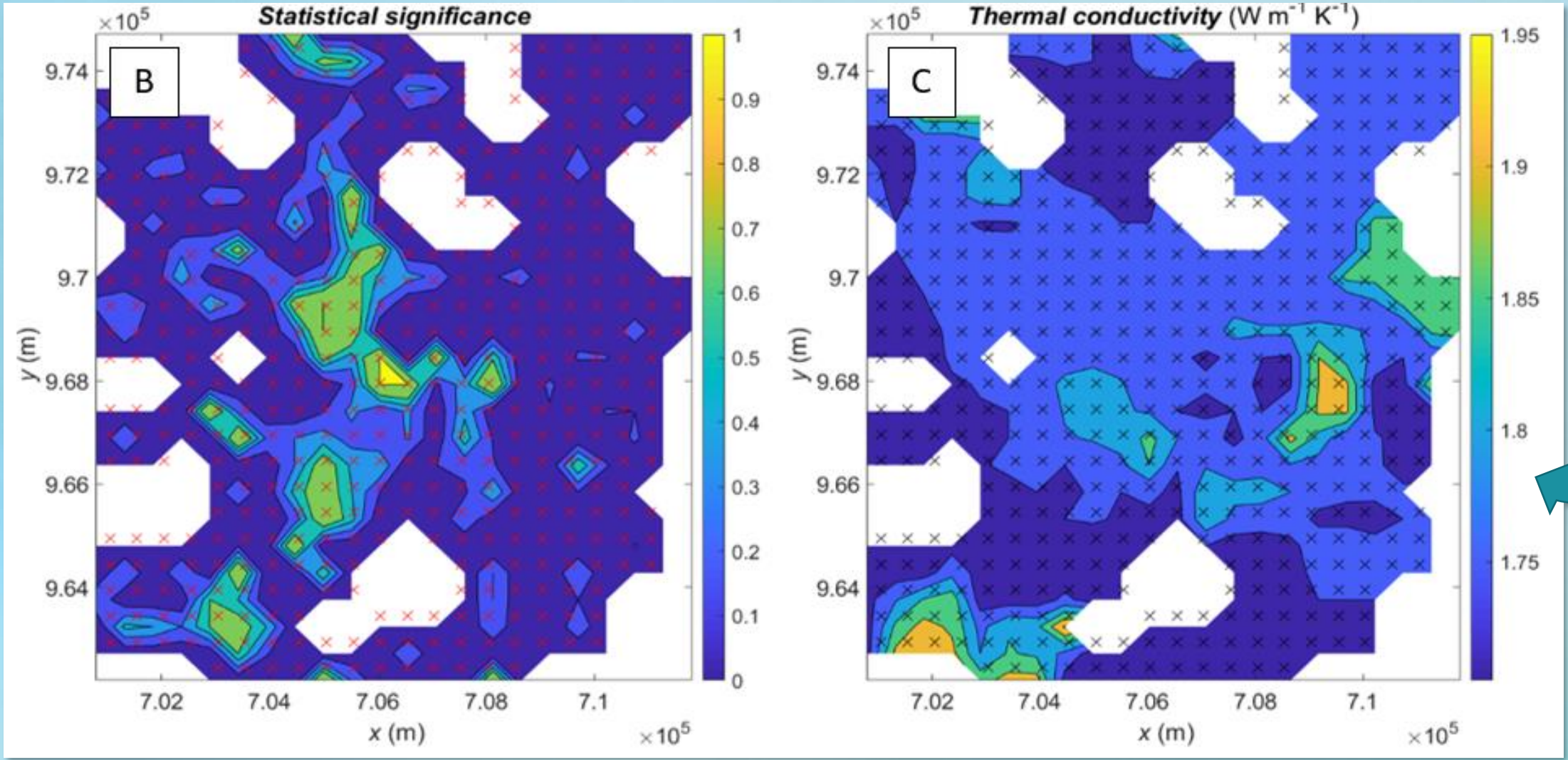
Ferrara – Geology and borehole information



Ferrara – weighted Thermal Conductivity (100m depth)



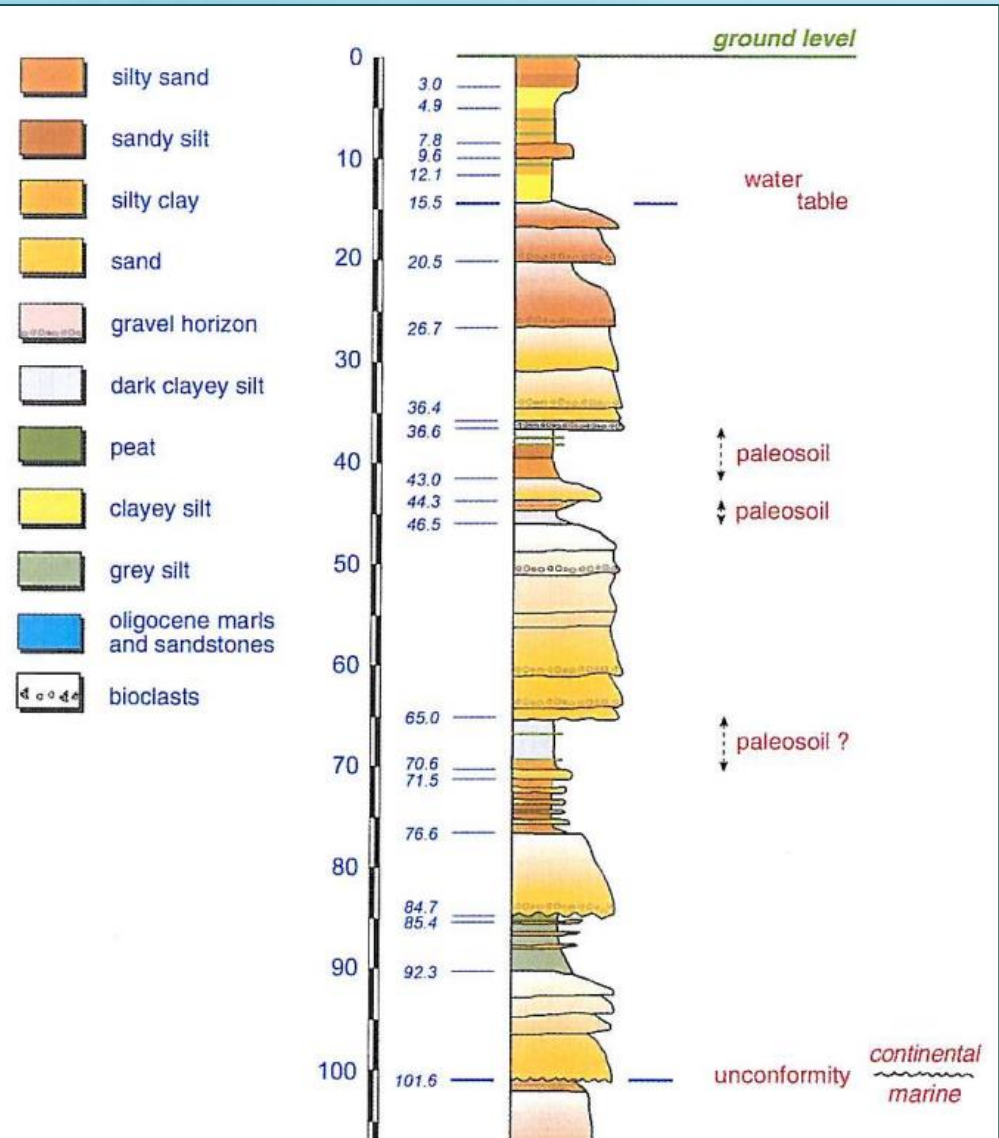
Ferrara – weighted Thermal Conductivity (100m depth)



Ferrara – Thermal Conductivity & Drillability map



Ferrara – Thermal Conductivity & Drillability map



Next step

- **map validation** with **information** from driller partners during the site development

Location:

Site Manager:

**GEOLOGY &
HYDROGEOLOGY**

**THERMAL
PROPERTIES**

DRILLING INFORMATIONS

1. Local stratigraphic description:

2. Groundwater table depth (m):

1. TRT method:

2. Ground T (°C):

3. Ground λ (W/mK):

1. Drilling method:

2. Machine movement and preparation (time):

3. Grouting (Yes/No) and preparation (time):

4. Overall length of works (time):

1222-2022
800
ANNI



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DIPARTIMENTO
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Thanks for your attention

<https://geo4civhic.eu/>

