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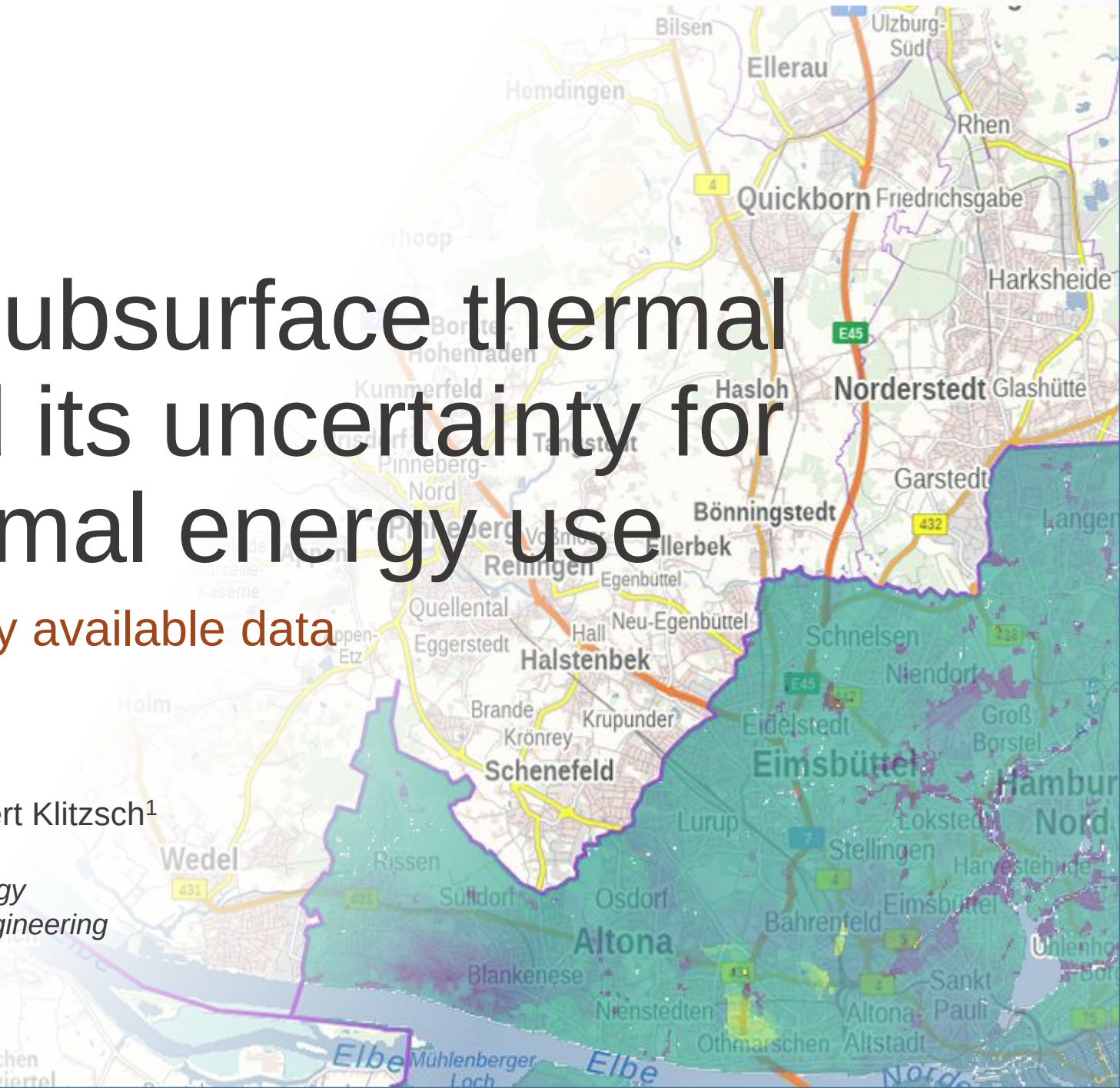
Estimating the subsurface thermal conductivity and its uncertainty for shallow geothermal energy use

a methodology based on publicly available data



26.05.2022

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[1]Institute for Applied Geophysics and Geothermal Energy
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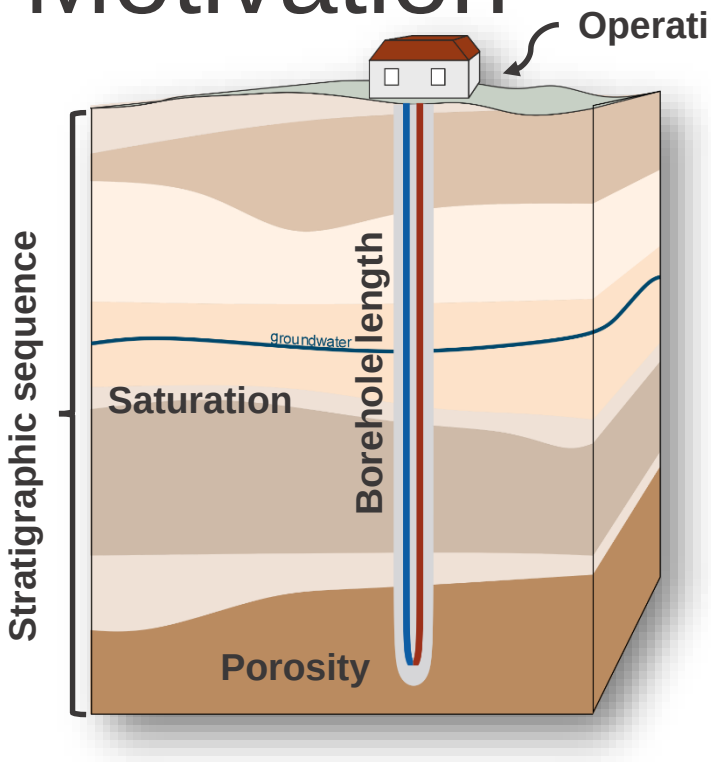
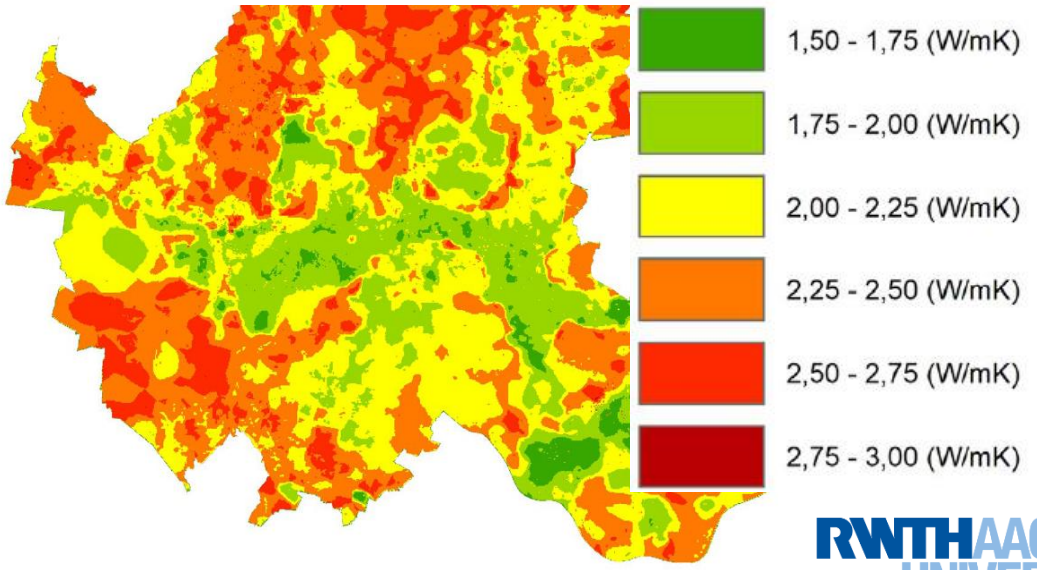
Motivation



Borehole heat exchangers (BHE):

- Efficient option to heat and cool buildings in a sustainable manner
- Design & performance depends on technical, operational and subsurface parameters
- most important subsurface parameter: **Thermal conductivity (TC)**

TC map of Hamburg (100m)



➡ Planning of BHE fields:
estimate subsurface properties using existing data

Geothermal potential maps

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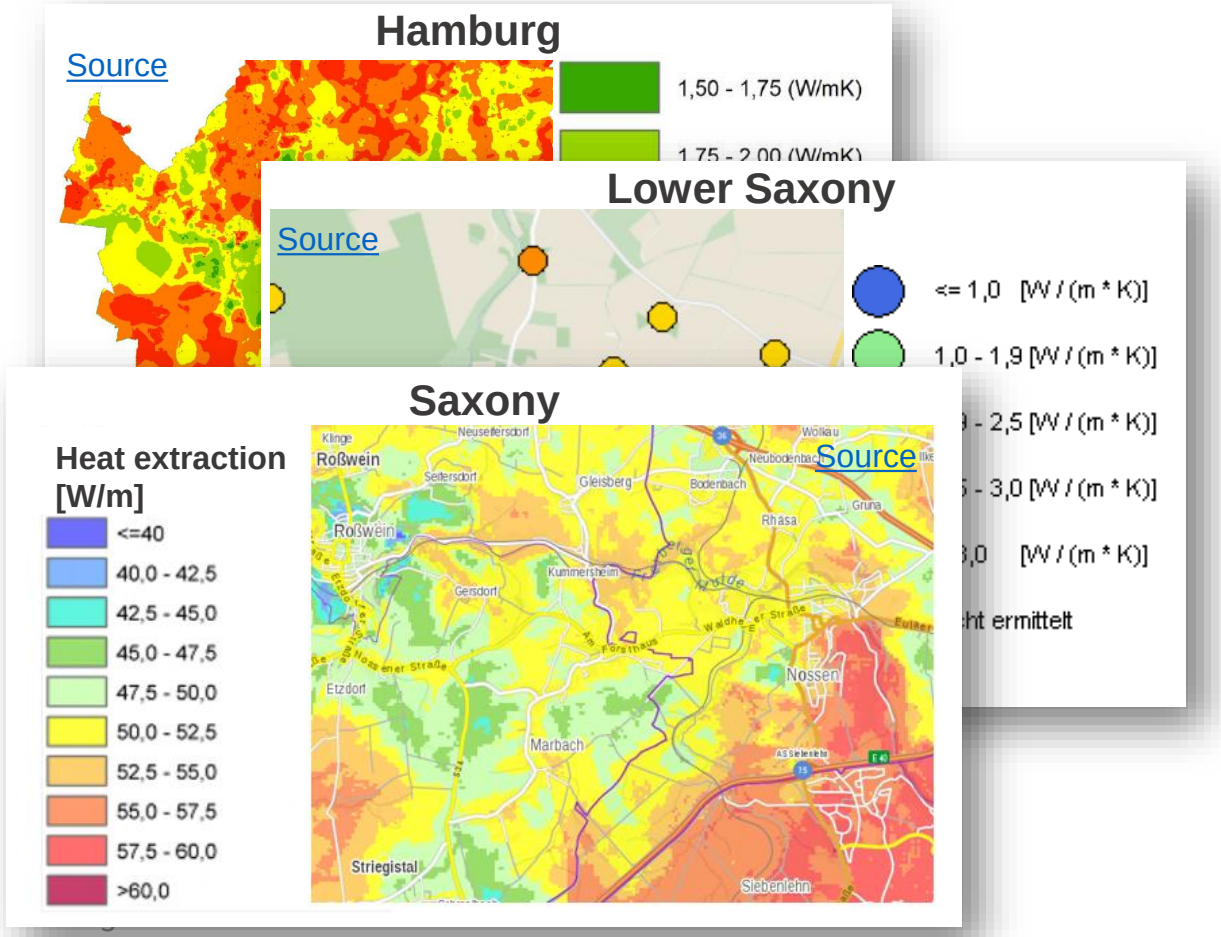
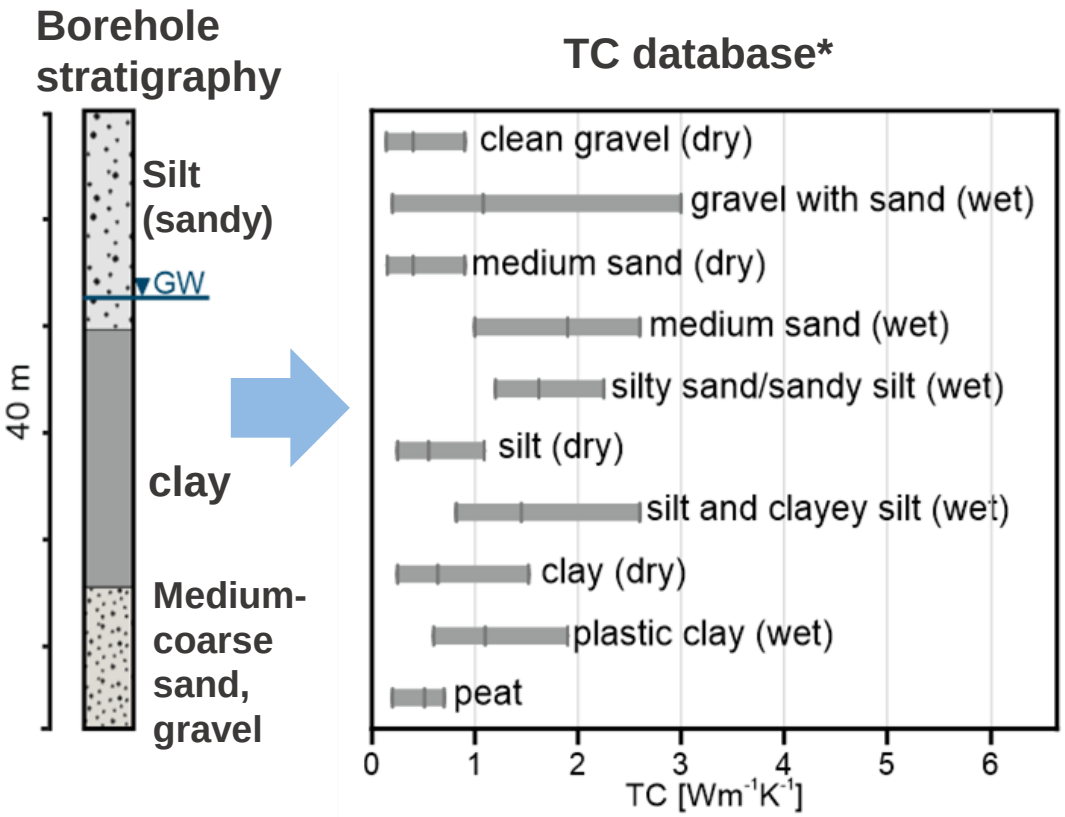
Existing thermal conductivity estimation workflows

1 Results are not comparable across states or countries



2 Uncertainty of TC estimate is high, but usually not communicated



*values from Dalla Santa et al., 2021

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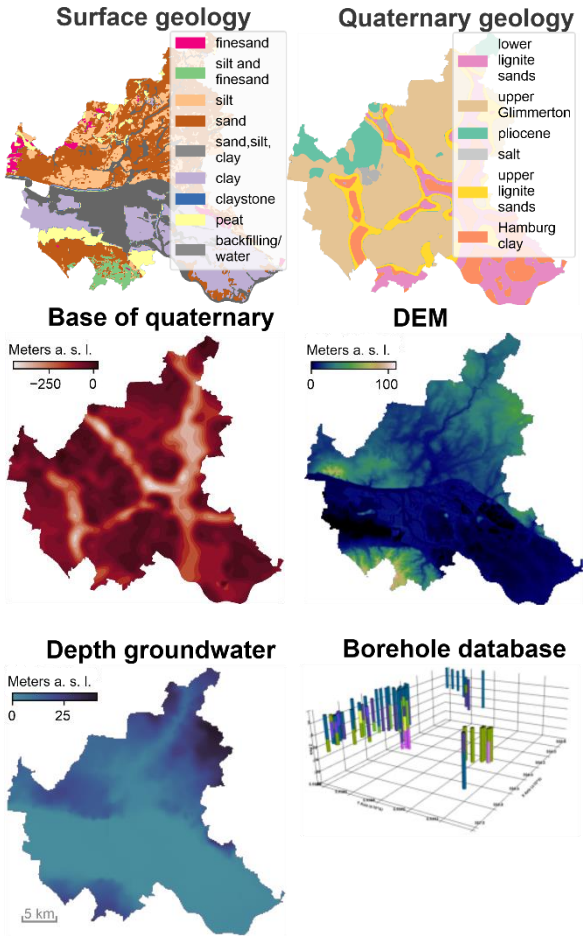
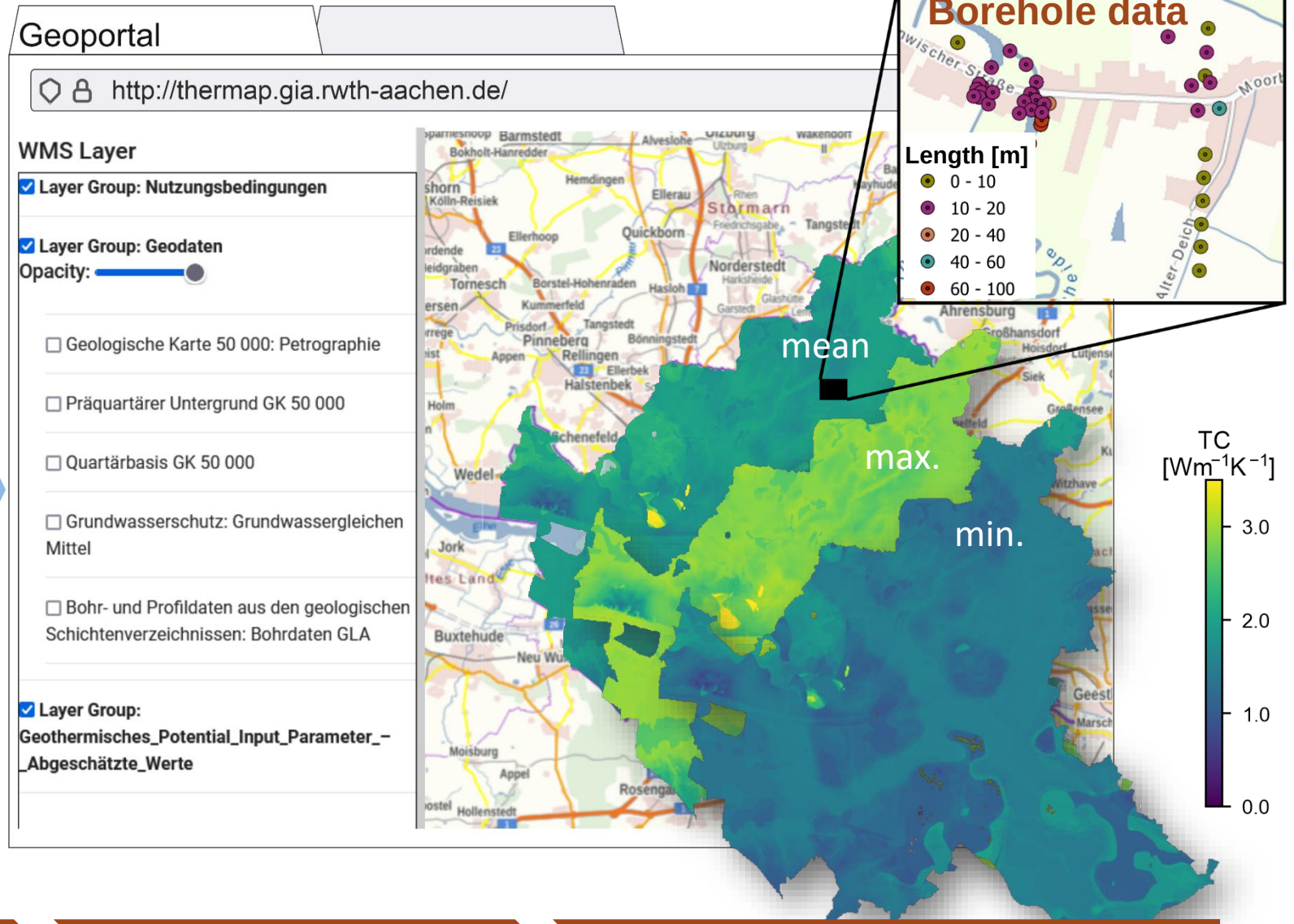
Our approach



Data connection via Open-Web-Services (OWS)



Publicly available, common input data types → **Always up to date** → **Geodata infrastructure** → **Considers uncertainty in assignment of thermal conductivity**

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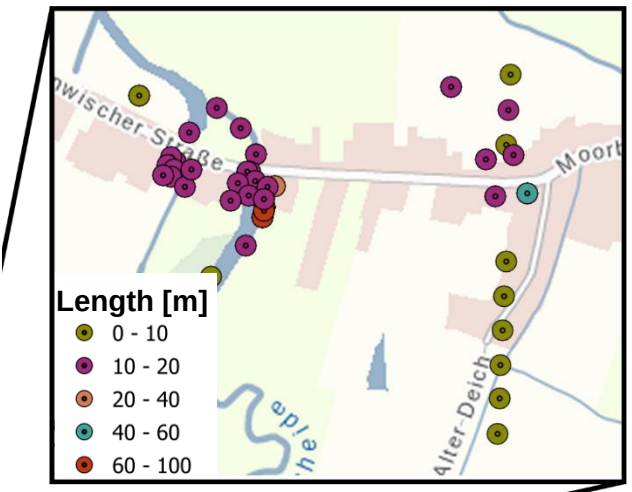
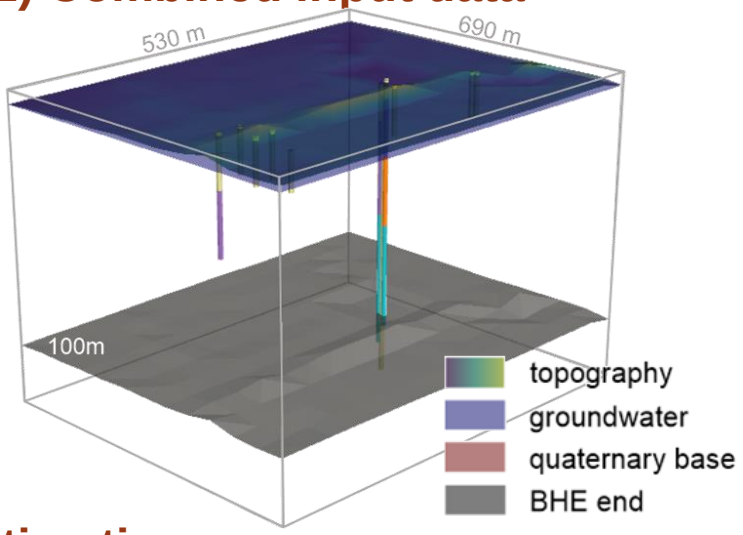
Application to example region

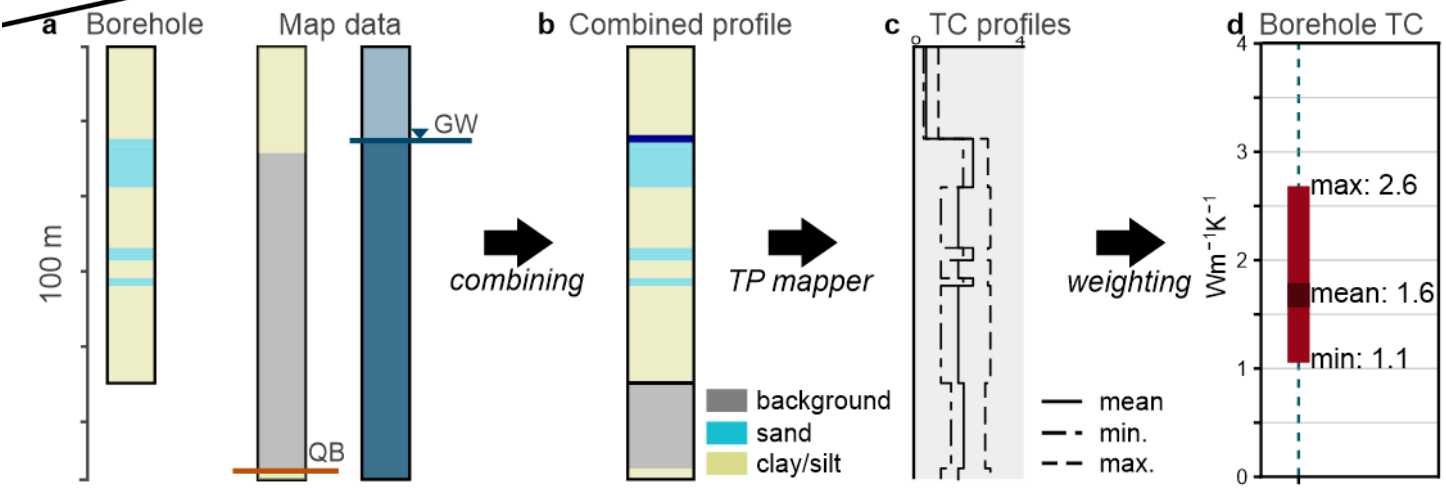
1) Request data



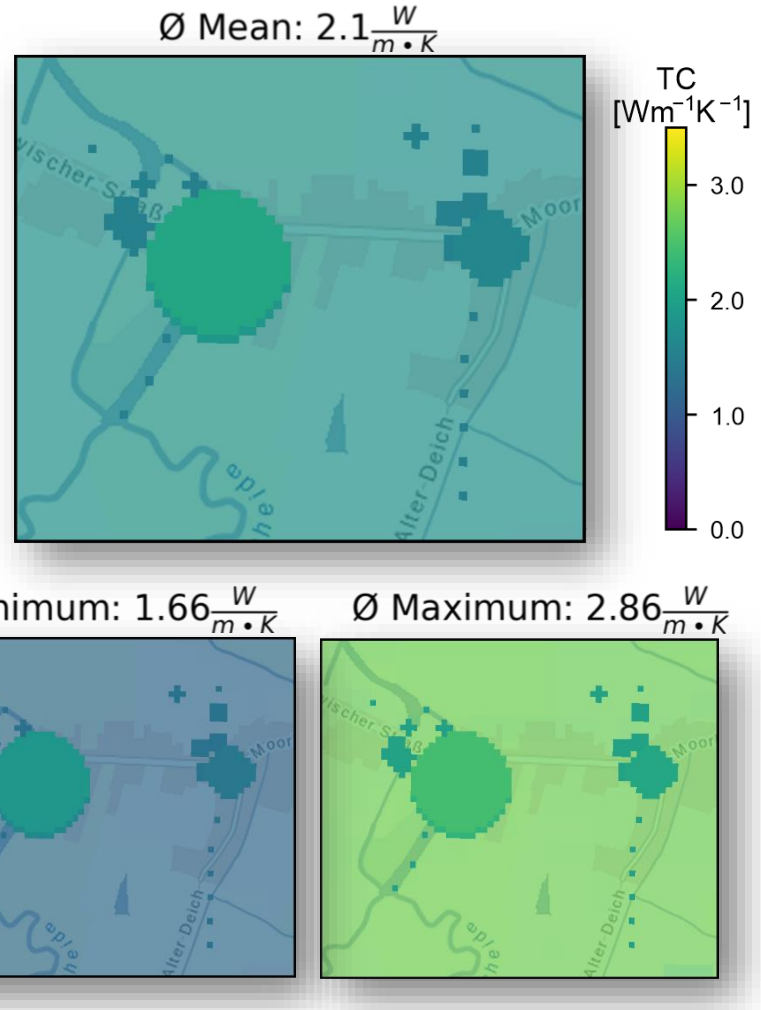
2) Combined input data



3) TC estimation



4) Result



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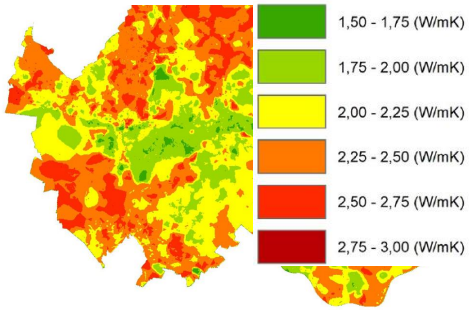
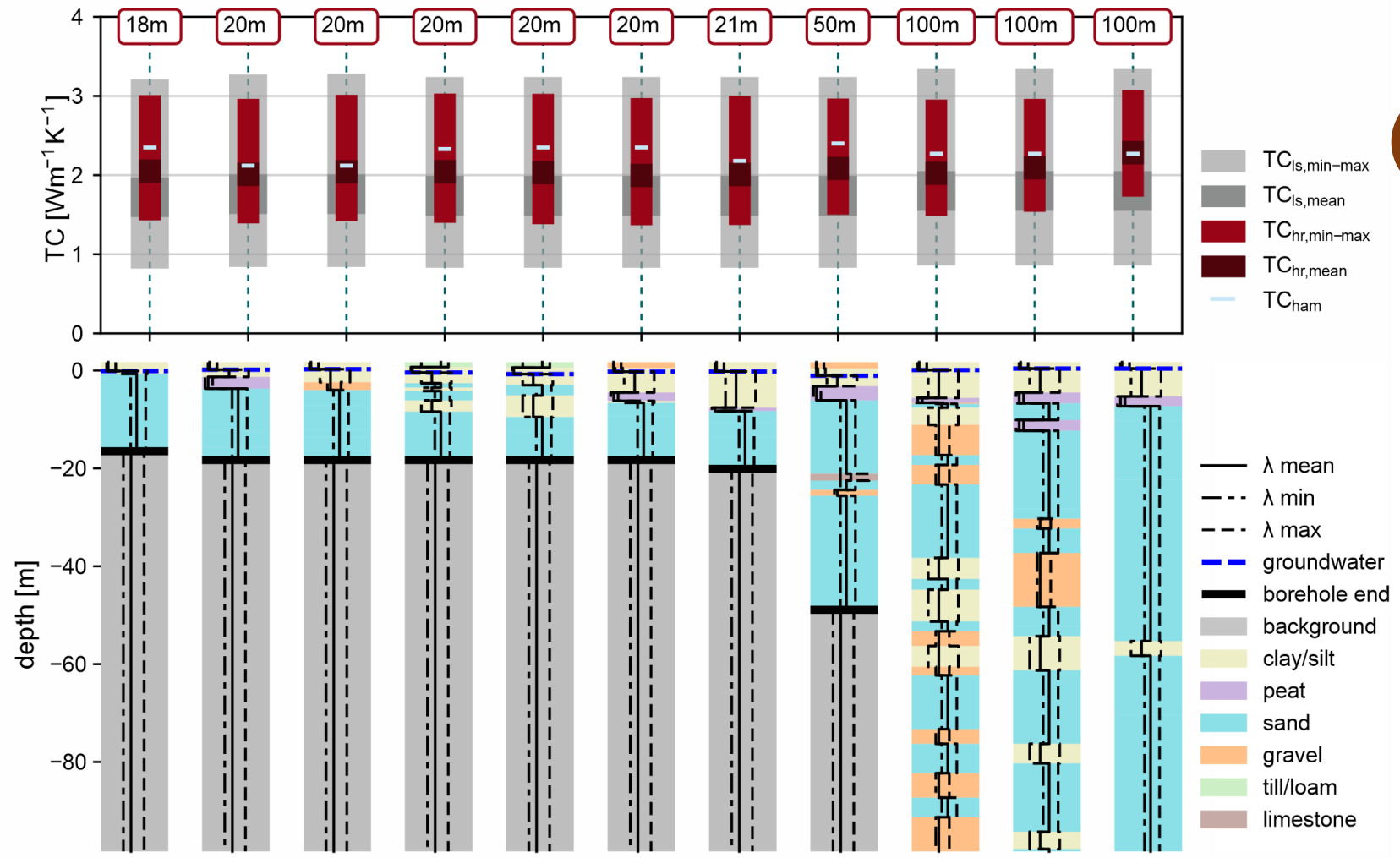
Comparison to TC estimate of Hamburg





! Differences between our prediction and TC Hamburg

- Selection of thermal property database
- Consideration of wet and dry rock

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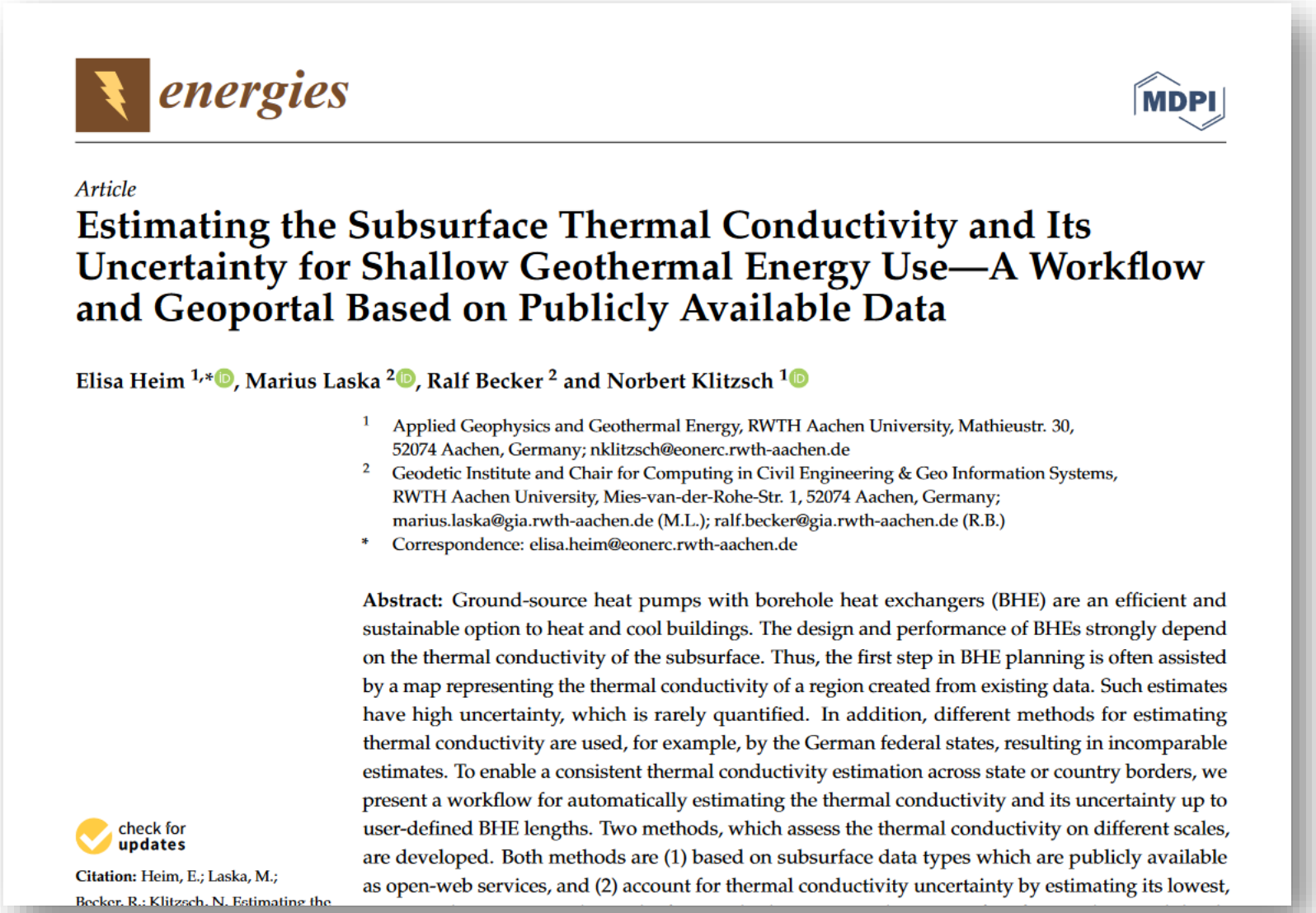
More information



energies

MDPI

Article

Estimating the Subsurface Thermal Conductivity and Its Uncertainty for Shallow Geothermal Energy Use—A Workflow and Geoportal Based on Publicly Available Data

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Abstract: Ground-source heat pumps with borehole heat exchangers (BHE) are an efficient and sustainable option to heat and cool buildings. The design and performance of BHEs strongly depend on the thermal conductivity of the subsurface. Thus, the first step in BHE planning is often assisted by a map representing the thermal conductivity of a region created from existing data. Such estimates have high uncertainty, which is rarely quantified. In addition, different methods for estimating thermal conductivity are used, for example, by the German federal states, resulting in incomparable estimates. To enable a consistent thermal conductivity estimation across state or country borders, we present a workflow for automatically estimating the thermal conductivity and its uncertainty up to user-defined BHE lengths. Two methods, which assess the thermal conductivity on different scales, are developed. Both methods are (1) based on subsurface data types which are publicly available as open-web services, and (2) account for thermal conductivity uncertainty by estimating its lowest,

check for updates

Citation: Heim, E.; Laska, M.; Becker, R.; Klitzsch, N. Estimating the

Publication available at https://www.mdpi.com/1996-1073/15/10/3687/htm

Contact:
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References

- Dalla Santa, G.; Galgaro, A.; Sassi, R.; Cultrera, M.; Scotton, P.; Mueller, J.; Bertermann, D.; Mendrinos, D.; Pasquali, R.; Perego, R.; et al. An Updated Ground Thermal Properties Database for GSHP Applications. Geothermics 2020, 85, 101758.
- data from Hamburg is obtained from *Freie und Hansestadt Hamburg, Behörde für Umwelt und Energie* under the Data licence Germany—attribution—Version 2.0 (licence text available at www.govdata.de/dl-de/by-2-0Data, accessed on 8 May 2022)
- Thermal conductivity map of Hamburg: published in „Behörde für Umwelt, Klima, Energie und Agrarwirtschaft Hamburg. Leitfaden Erdwärmenutzung; Behörde für Umwelt, Klima, Energie und Agrarwirtschaft Hamburg: Hamburg, Germany, 2021.“