

AN UNCERTAINTY-DRIVEN DECISION TREE APPROACH GUIDING FEASIBILITY DECISIONS OF SHALLOW GEOTHERMAL SYSTEMS IN COMPLEX SUBSURFACE SETTINGS

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Seasonal subsurface thermal energy storage is increasingly used to heat and cool buildings. Excess heat and cool is stored in the shallow groundwater and is recovered when needed.

Diverse subsurface settings are studied to assess the potential for storage systems. To make robust decisions about project feasibility, we propose a decision tree approach that takes into account subsurface and operational uncertainties.

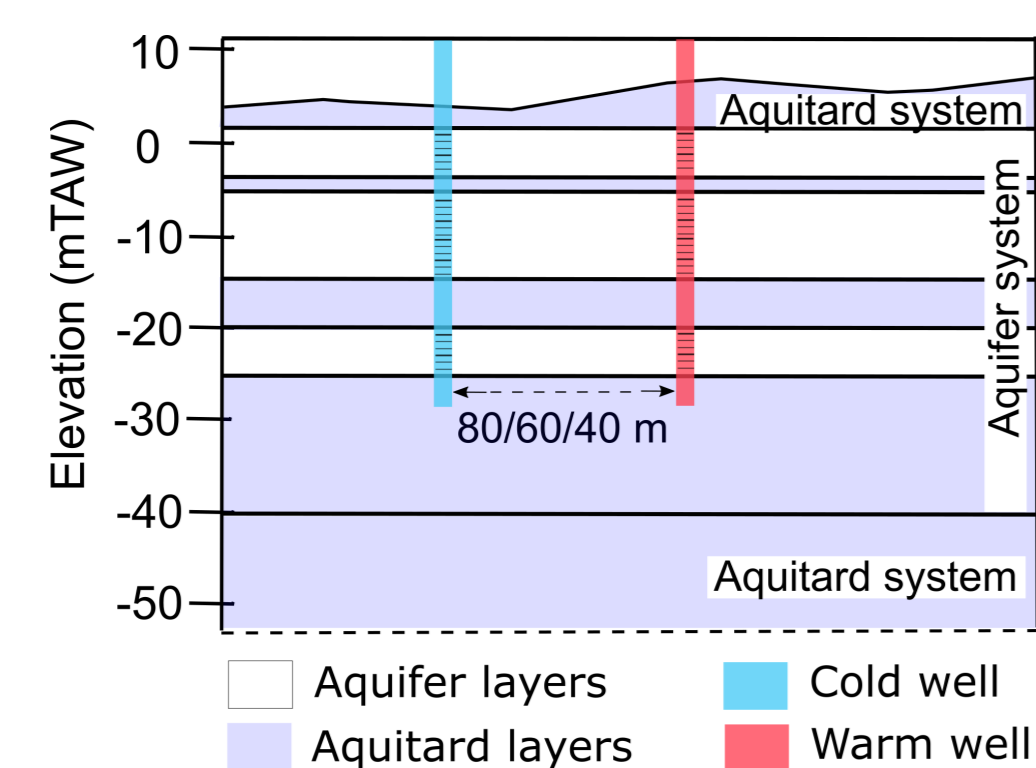


Problem Definition

Should we invest in a subsurface energy storage system?

challenge = high investment cost, uncertain return on investment

- Define the main prediction target. (What do we want to know? What should the investment decision be based on?)
- Are there other important prediction targets? → rank them



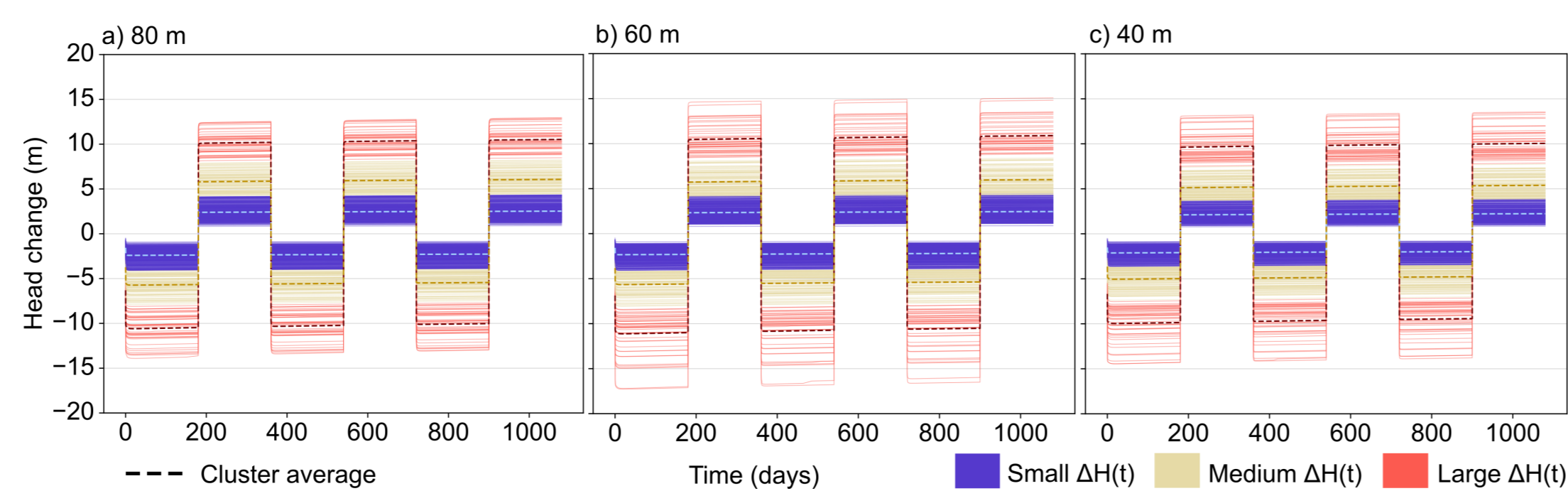
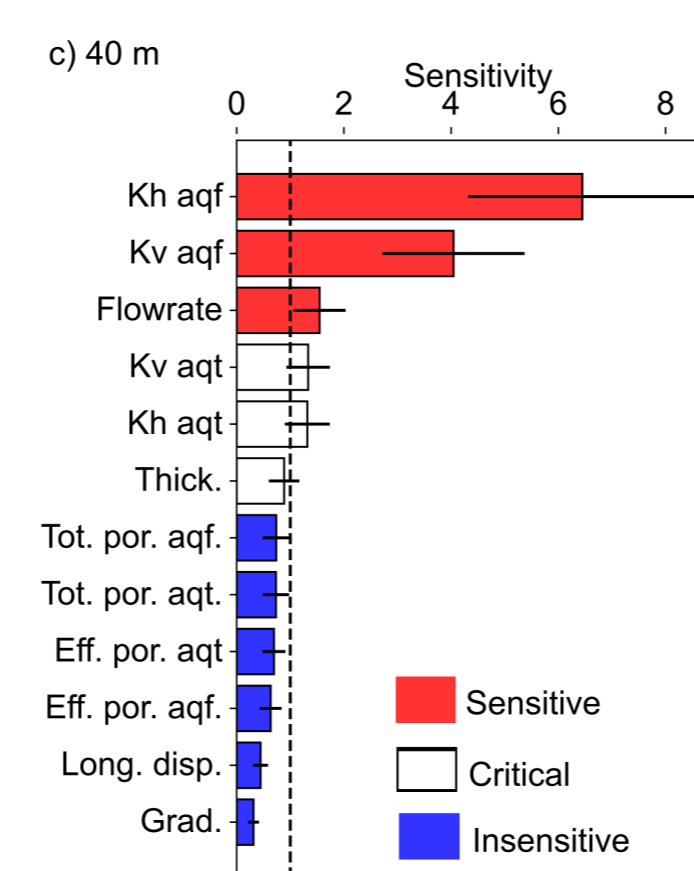
Acknowledge Uncertainty

We cannot directly look into the subsurface, so we cannot be 100% sure our model is correct

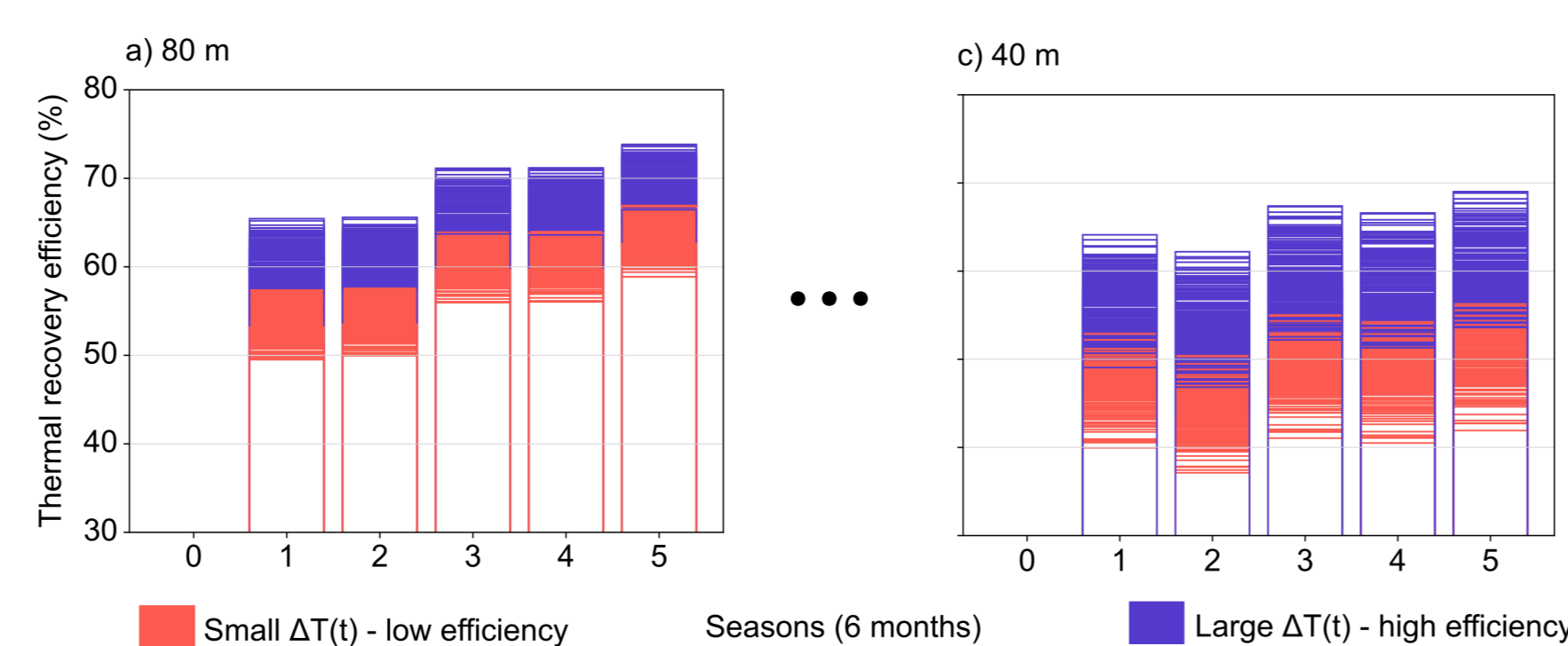
BUT

we can include uncertainty in our models

- Monte Carlo simulations with Latin Hypercube sampling
- Global sensitivity analysis
- Categorize results with clustering (feasibility - infeasibility - still uncertain)



(each line is one model output)

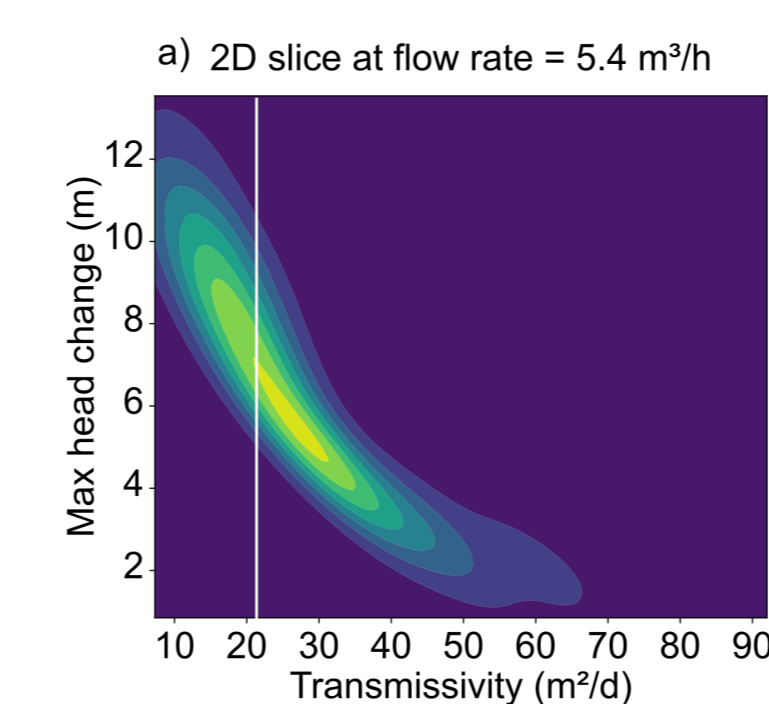


Depending on the prediction target, this could also be another prediction (energy density/contamination risk/...).

Communicate

In case of uncertain feasibility: instead of providing a single model output, we provide the probability of reaching the prediction target.

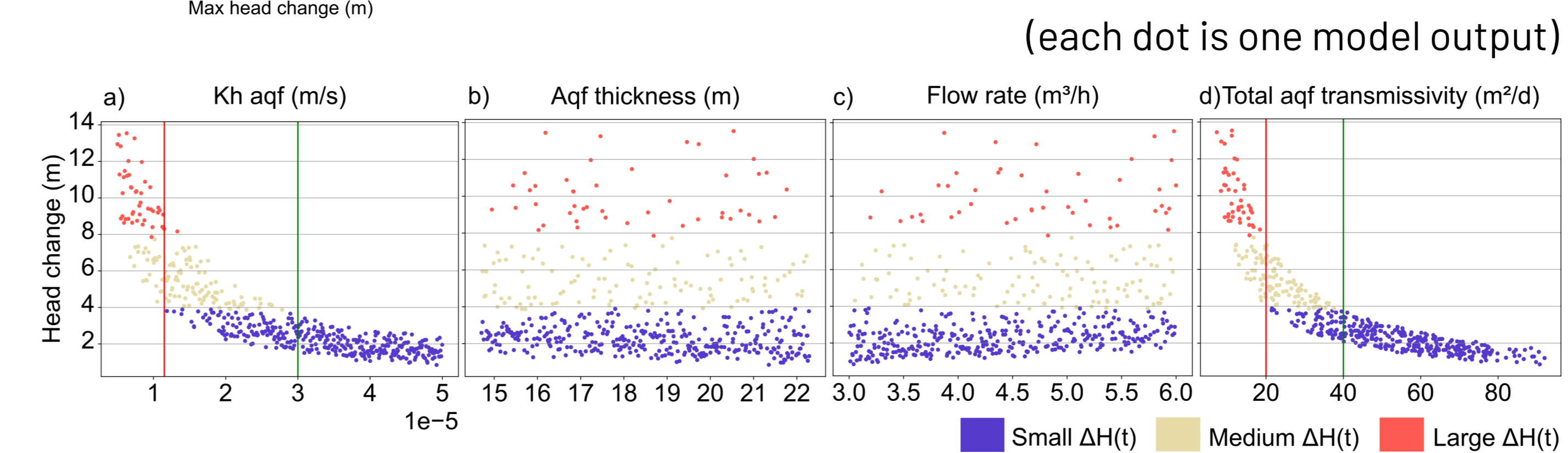
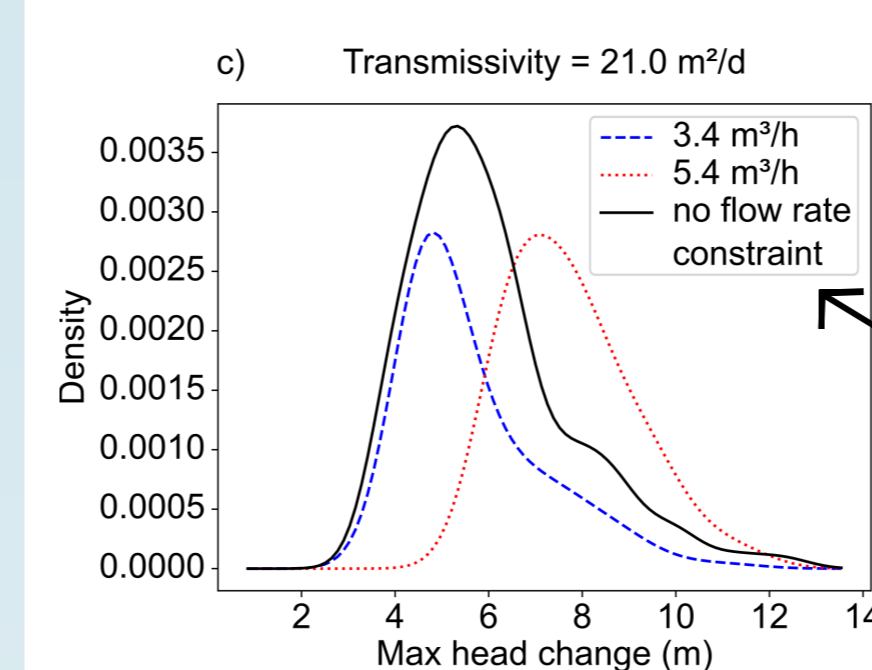
- joint probability distribution estimation
- kernel density estimation



In other words it gives you the information to communicate about the likelihood of project feasibility.

It also offers the opportunity to assess the impact of adapting engineering actions such as

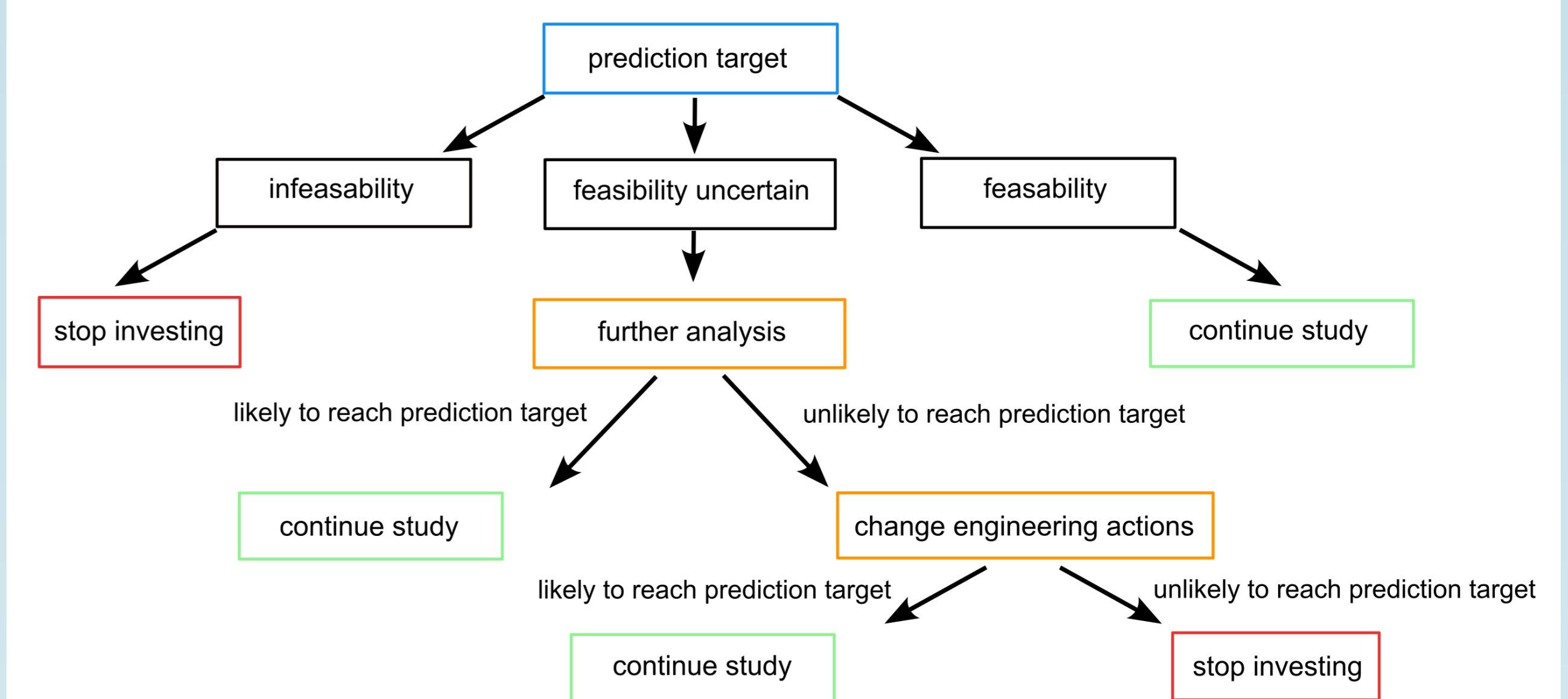
- well spacing
- stored temperature
- flow rate



(each dot is one model output)

Decision tree

Summarize the main findings in an easy to interpret decision tree.



UQ by joint probability distribution estimation and kernel density estimation, calculate probability of reaching prediction target

subsurface categories determined by distance-based global sensitivity

root node, depends on hydrogeological setting

Better feasibility studies to realize global untapped potential for local and sustainable heating and cooling



Write your ideas here :)