THE HEAT BENEATH OUR FEET

MINE WATER HEAT IN COUNTY DURHAM, UK

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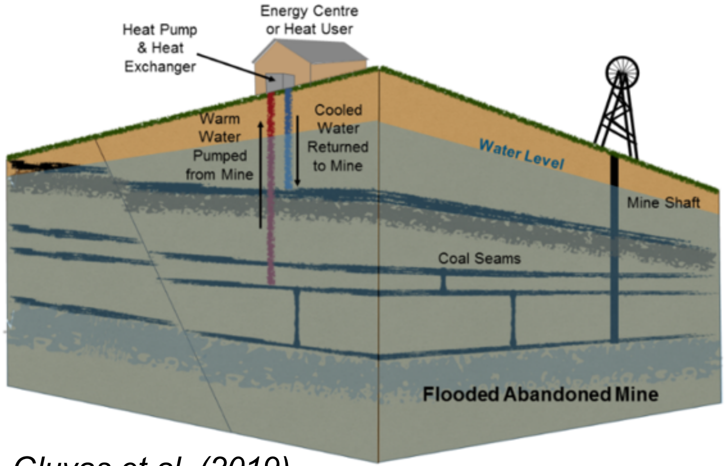
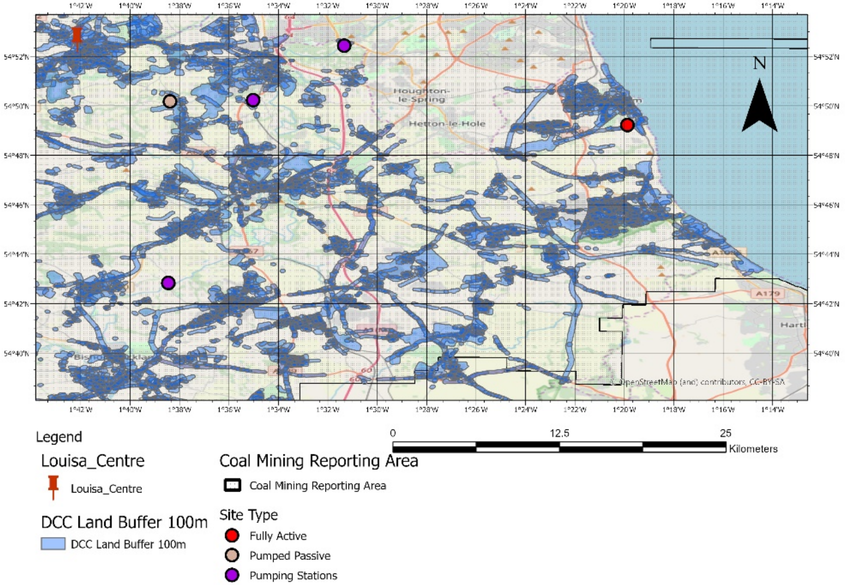
Summary

The viability and sustainability of geothermal heat extraction from mines is modelled numerically. Models are applied to the planned system at the Louisa Leisure Centre in Stanley, county Durham, UK. Long-term heat extraction is feasible if mine water is extracted from and re-injected into different seams and if boreholes are planned at suitable locations.

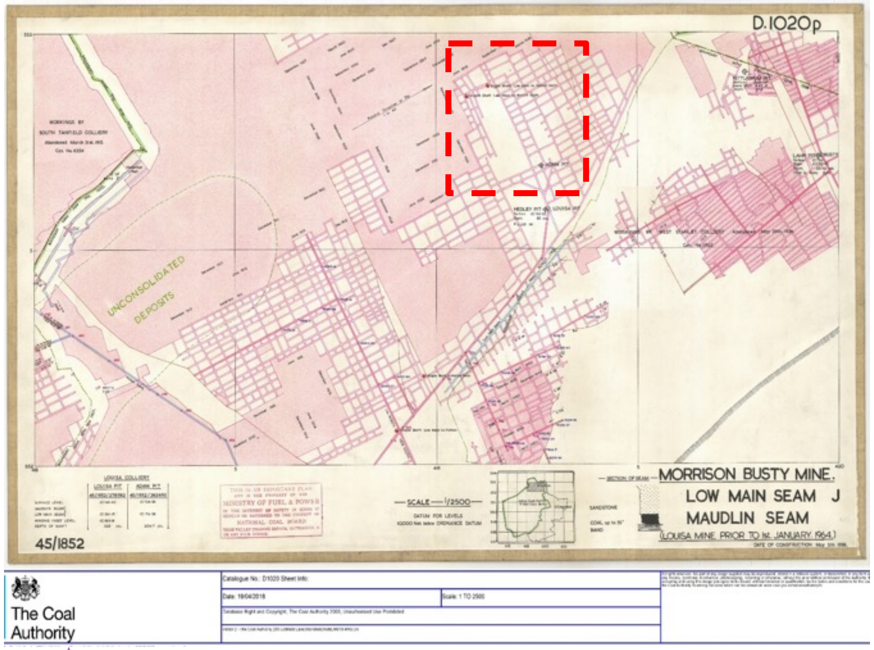


Gluyas et al. (2019)

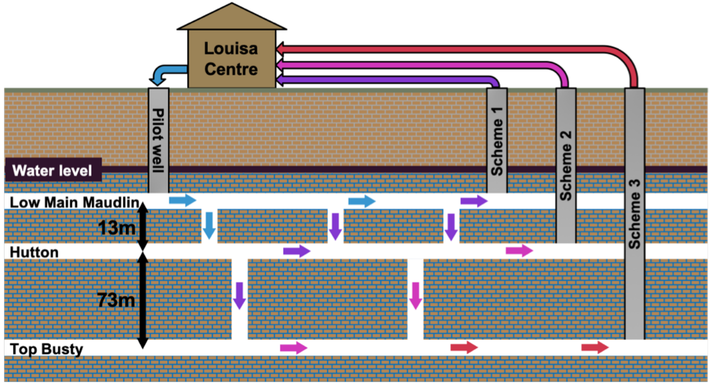
INTRODUCTION AND MOTIVATION



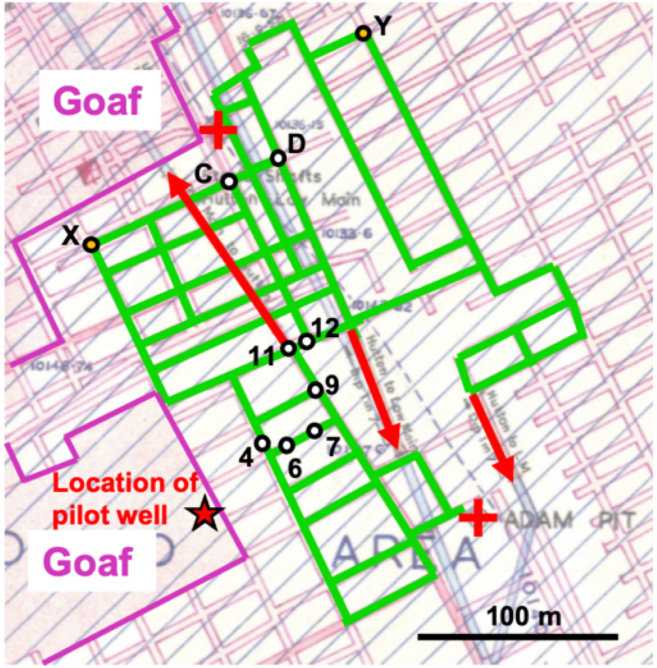
- ❑ 80% of domestic heat demand in the UK using gas
- ❑ Decarbonising heat → 2050 emissions targets
- ❑ Potential in NE England from many flooded mines



- ❑ Louisa Leisure Centre situated above a multiple-seam abandoned coal mine.

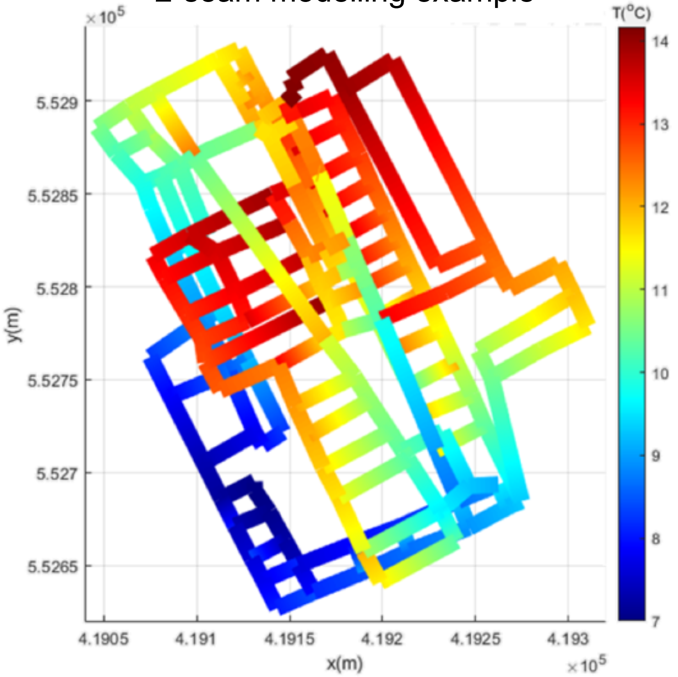


METHODOLOGY



- ❑ Low Main Moadlin & Hutton Seams (top seams)
- ❑ ★Pilot Well (for re-injection) already drilled
- ❑ 5 possible sides for extraction wells (in black)
- ❑ Green area = dominant mine water pathway

2-seam modelling example



<u>Mine data extraction</u>

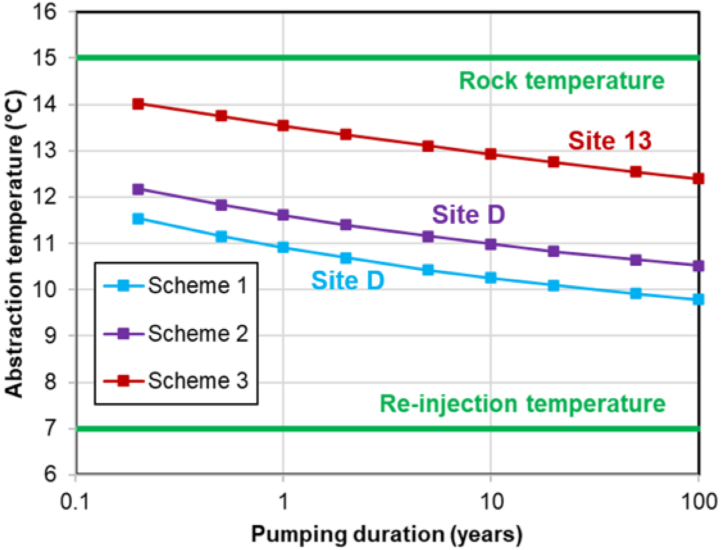
- ❑ Mine plans from UK Coal Authority
- ❑ Digitising seam location data for top 3 seams using GIS

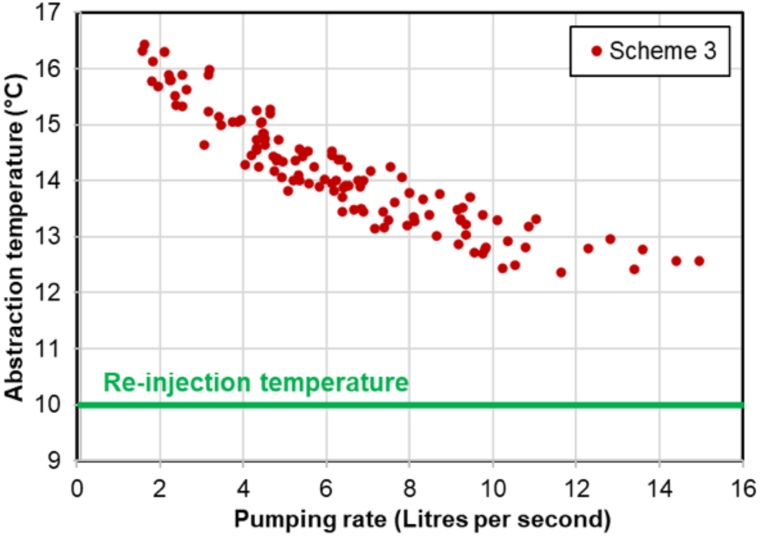
<u>Heat and fluid flow model</u>

- ❑ Model setup in Matlab
- ❑ Fluid flow with gradient method (Todini & Pilati, 1987)
- ❑ Methods as used for EPANET software (Rossman, 2000)
- ❑ Heat transfer using Rodríguez & Díaz (2009)

Parameter	Range	Default
Tunnel diameters (m)	1.7-2.7	2.2
Initial rock temperature, LMM & Hutton seams (°C)	14.5-15.5	15
Initial rock temperature, TB seam (°C)	17-18	17.5
Rock heat conductivity ($W\ m^{-1}\ K^{-1}$)	2.3-3.9	3.0
Rock specific heat capacity ($J\ kg^{-1}\ K^{-1}$)	740-920	800
Rock density ($kg\ m^{-3}$)	2100-2700	2400

SOME KEY RESULTS





<u>Long-term viability and sustainability</u>

- ❑ Fixed pumping rate (3.5 litres/s) and injection- & initial rock temperatures (7°C & 15°C).
- ❑ The impact of using different mine workings, for a single-seam (Scheme 1) to a 3-seam setup (Scheme 3).
- → Scheme 3 has the longest fluid pathways, and therefore is most effective.
- → All schemes have 1.5-2°C drop after 100 yrs.

<u>Effect of pumping rate, for Scheme 3 only</u>

- ❑ Varying different model parameters (in Table slide 3)
- ❑ Injection & initial rock temperatures: 10 & 17.5°C
- → Faster pumping reduces warm-up time and efficiency

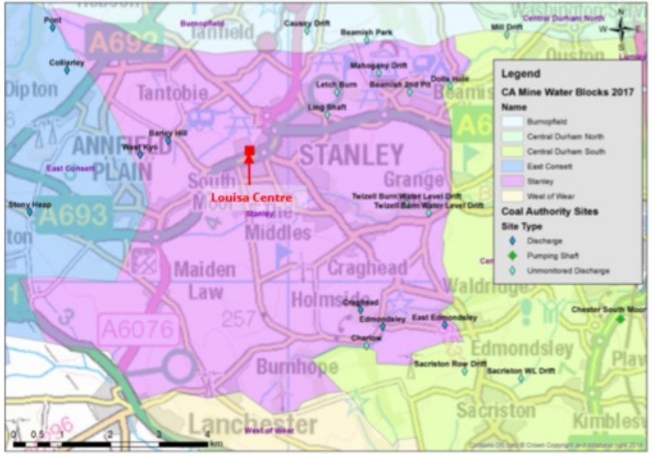
LIMITATIONS AND FUTURE DIRECTIONS

<u>Limitations</u>

- ❑Uncertainty in model parameters:
  - ❑collapsed tunnels
  - ❑imprecise tunnel locations
- ❑Processes unaccounted for:
  - ❑regional groundwater flow
  - ❑goaf
  - ❑interation between nearby tunnel walls

<u>Future directions</u>

- ❑Application to other sites
- ❑Further model customisation
- ❑Digitise geometry file creation
- ❑More model calibration
- ❑Incorporating regional regional flow



Other Coal Authority drilling plans (Coal Authority Report, 2018)

Drilling injection bore hole at Louisa Centre, Nov 2019