Project Title: **A Unified Approach to Multiple Timescale Climate, Sea-level, and Coastal Change Projections in the UK**

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Summary

A framework for assessing impacts of future environmental change on geological disposal facilities (GDFs) for nuclear waste has been set out through an International Atomic Energy Agency (IAEA) coordinated project (Lindborg et al, 2018). This is based on modelled estimates of climate variables such as sea level, temperature, and rainfall, which are produced by global-scale models and then downscaled to specific regions. For short-term (~100 year) projections, a standard approach is to use climate model outputs associated with the IPCC. On longer timescales (>~10,000 years), for which standard climate models are too computationally expensive to be applied, the utility of a statistical approach based on multiple "snapshot" climate model simulations has been demonstrated (Lord et al, 2019). However, there are several issues associated with this approach in the context of potential GDF sites in the UK, which will be addressed here. Firstly, short-term and long-term climate projections would be inconsistent, as they are produced by different modelling frameworks. Secondly, the framework does not extend to evaluating how the climate projections can be translated into coastal risk.

The PhD project will address these issues, providing a framework for projections of local sea level and coastal flooding risk, unified across multiple timescales.

Methods

We will develop a new methodology which unifies climate model and ice sheet model projections of sea level and climate, with long-term statistical-based (emulator) projections. This unification will be carried out by initialising the emulator projections for the next 1,000,000 years from the end of the climate projections (this timescale is relevant to evaluating post-closure safety for GDFs). This will be achieved by (i) using a range of CO_2 scenarios (taking account of long-term carbon cycles changes) in the emulator which seamlessly continue from those of CMIP6, and (ii) driving the emulator with global sea level data that are consistent with the end-state of the CMIP6 sea level projections. We will then carry out flood inundation modelling of the UK, driven by the local sea level, precipitation, and runoff from the new methods outlined above, and informed by glaciological modelling accounting for isostatic

changes. This will be carried out using the LisFlood-FP model (Shaw et al, 2021), which is a hydrodynamic model designed to simulate river networks and floodplain inundation in data-scarce environments. We will explore multiple scenarios of extreme rainfall, runoff, river morphology and storm surge distribution, to generate flood risk maps of the UK for specific return periods.

Background reading and references

- Lindborg, T., Thorne, M., Andersson, E., Becker, J., Brandefelt, J., Cabianca, T., Gunia, M., Ikonen, A.T.K., Johansson, E., Kangasniemi, V., Kautsky, U., Kirchner, G., Klos, R., Kowe, R., Kontula, A., Kupiainen, P., Lahdenperä, A.M., Lord, N.S., Lunt, D.J., Näslund, J.O., Nordén, M., Norris, S., Pérez-Sánchez, D., Proverbio, A., Riekki, K., Rübel, A., Sweeck, L., Walke, R., Xu, S., Smith, G. & Pröhl, G. : Climate change and landscape development in post-closure safety assessment of solid radioactive waste disposal: Results of an initiative of the IAEA, Journal of Environmental Radioactivity. 183, 41-53, 2018.

- Shaw, J., Kesserwani, G., Neal, J., Bates, P., and Sharifian, M. K.: LISFLOOD-FP 8.0: the new discontinuous Galerkin shallow-water solver for multi-core CPUs and GPUs, Geosci. Model Dev., 14, 3577–3602, https://doi.org/10.5194/gmd-14-3577-2021, 2021.

- Lord, N., Lunt, D., Thorne, M.: Modelling changes in climate over the next 1 million years, SKB Technical Report TR-19-09, 2019.

How to Apply

The deadline for this position is 8th January 2025. The studentship will begin in September 2025. Please apply to the “Geography- PhD” at https://www.bristol.ac.uk/study/postgraduate/apply/