PROJECT TITLE: Climate change impacts on coastal systems

University of Bristol Theme: Climate and Environment Research Challenge Area, Digital and Data Research Challenge Area
Research Group(s): Bristol Palaeobiology group, Met office academic partnership
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Project keywords: climate change, Sea level Rise, coastal socio-ecological systems, ecosystems
Funder: University of Bristol Scholarship

Diversity of a coastal ecosystem exemplified by a kelp sub-canopy in Orkney.

Tension between adaptation for human infrastructure and ecosystem space

Project Background

Climate change projections show substantial changes in the physical marine environment in the coming century and beyond (Fox-Kemper et al. 2021) including rising sea levels, increased stratification, and changes in ocean circulation. UK shelf waters have been warming by around 0.3–0.6 °C per decade over the last 30 years, with total global warming forecast to be in the range of 1.5–4 °C by 2100 (Tinker et al. 2024). Fundamental and far-reaching impacts include distribution shifts of species and communities, with range contraction, immigration establishment of non-native species, and local extinctions (Hoegh-Guldberg et al., 2018). Sea level rise (SLR) and coastal water level extremes are projected to increase (Howard et al., 2019) with large uncertainty in the timing, rate of change of impacts, and thus adaptation needs. SLR increases the risk of coastal flooding, affecting habitats above and below the water line by increasing water depth, and necessitating enhanced or new defence structures for citizens in the low elevation coastal zone (Vousdoukas et al., 2017). A future loss of marine and coastal ecosystems – including their biodiversity and ecosystem goods, functions and services – will impact coastal livelihoods including food, trade and sustainable energy production.

Project Aims and Methods

While adaptation is planned for coastal cities and settlements, less consideration is given to the impact on coastal ecosystems. The project will determine when thresholds for migration or vertical growth of species will be exceeded and whether SLR at a given location facilitates gradual adaption or if rapid changes provide thresholds to adaptation. The PhD will quantify these future environmental changes under a range of future climate change scenarios to establish what changes are “locked-in” versus those changes that can be avoided or reduced through greenhouse gas emission reductions (Muccione et al. 2024). The project will use a combination of computer modelling, habitat mapping and ecological analysis to assess threats to coastal ecosystem from climate change. You will (1) analyse a suite of high-resolution ocean model simulations performed at the Met Office to explore marine environmental changes and rates-of-change over the 21st century. You will (2) combine this information with sea-level projections for the UK coastline to assess the probable impacts on UK marine ecosystems, such as rate of inundation, and quantify the dependence on climate change scenario. You will (3) consider the potential ecosystem impacts of sea-level rise on multi-century time-horizons, including the possibility of accelerated sea-level rise associated with ice sheet instability processes. You will (4) combine this information with coastal

habitat distribution around the UK and the locations of protected areas. This assessment will then be widened by combining the SLR threat with changes in marine climate hazards such as warming, salinity and current speed. This information lends itself to dynamic niche modelling for coastal systems if the applicant is interested in this approach.

Candidate

The candidate will have a degree in Geology, Environmental Sciences, Physics, or a related subject. The candidate will be interested in acquiring new skills as no likely candidate will have all skills. You will be numerate, curious, organised and self-motived to take charge of the project. The candidate will be confident in handling large datasets and ideally have some background using a programming language, such as R, Python, etc.

Training

The student will join the world leading Bristol Palaeobiology group and the UK Met Office, and be a member of outstanding research environments at the host institutions. The student will get first-class in-house training in writing code, earth system modelling, ecology, and analysis of large data sets. Courses in R, Python, statistics etc are offered by the group and the university. All the training will be provided. The Cabot Institute for the Environment provides training in science communication and the applicant will be encouraged to participate in outreach activities.

Background reading and references

Bindoff, N. L., et al. (2019) Chapter 5: Changing ocean, marine ecosystems, and dependent communities, in Pörtner, H.-O., et al. (eds.) IPCC SROOC. https://www.ipcc.ch/srocc; Brodie, J., et al. 2014. The future of the northeast Atlantic benthic flora in a high CO_2 world. Ecology and Evolution 4, 2787--2798; Fox-Kemper, B., et al. (2021) Chapter 9, in Masson- Delmotte, V., et al. (eds.) IPCC AR6. https://www.ipcc.ch/report/ar6/wg1/; Howard, T., et al. 2019. Contributions to 21st century projections of extreme sea-level change around the UK, Env Res Comm, 1: 095002. Melbourne, L.A., et al. 2018. The importance of wave exposure on the structural integrity of rhodoliths. J of Ex Mar Biol and Ecoly, 503: 109-119.; Muccione, V., . . Schmidt, D. N. (2024). Adaptation pathways for effective responses to climate change risks. Wiley Interdisciplinary Reviews: Climate Change, e883. Tinker, J., Palmer, M. D., Harrison, B. J., O'Dea, E., Sexton, D. M. H., Yamazaki, K., & Rostron, J. W. (2024). Twenty-first century marine climate projections for the NW European shelf seas based on a perturbed parameter ensemble. Ocean Sci., 20(3), 835-885. doi:10.5194/os-20-835-2024; Vousdoukas, M.I., et al. 2017. Extreme sea levels on the rise along Europe's coasts. Earth's Future, 5(3): 304-323;

Useful links: **http://www.bristol.ac.uk/earthsciences/courses/postgraduate/**

Eligibility

UK and International students are eligible for a University of Bristol Scholarship. UoB Scholarships are fully funded for 4 years and cover university fees, living expenses at the UKRI standard rate, and an allowance of £2100 per year towards research expenses.