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ARC0010

Written evidence submitted by Dr Harold Lovell, Dr Clare Boston, Dr Mark Hardiman, Dr Nick Pepin Dr Heather Rumble

Introduction

Harold Lovell, **Nick Pepin**, **Clare Boston** and **Mark Hardiman** work in the **School of the Environment, Geography and Geosciences** at the **University of Portsmouth**. **Heather Rumble** is an ecologist at the **University of the West of England**. **Harold Lovell** and **Clare Boston** have expertise in glaciology and glacier change, and have undertaken research on glaciers in Svalbard, Greenland and Arctic Norway. **Nick Pepin** is a climate scientist, specialising in Arctic and mountain climate change, and is undertaking long-term climate monitoring in Arctic Finland. **Mark Hardiman** is studying historical and modern wildfire regime changes in the Arctic. **Heather Rumble** is studying the soil ecology of Arctic ecosystems. We are submitting evidence based on our varied research expertise in the Arctic as explained above.

1. The Arctic environment

What are the consequences for the UK of the observed climatic and environmental changes in the Arctic?

- Sea-level rise from increased melting of glaciers and ice sheet (Carrivick et al., 2019; Tepes et al., 2021; Edwards et al., 2021; Box et al., 2022)
- Dynamic glacier instabilities e.g. glacier collapse and increased iceberg risk for shipping (Bigg et al., 2018; Nuth et al., 2019; Dalton et al., 2019; Williams et al., 2021)
- Changing ocean currents, e.g. thermohaline circulation change and impact on UK agriculture (Ritchie et al., 2020)
- Changes to ocean-atmosphere systems and implications for UK weather, in particular possible changes to the jet stream and patterns of atmospheric blocking (extreme weather events) (Barnes & Screen 2015; Cohen et al. 2020)
- Creation of novel ecological communities (Hobbs et al., 2009), with unpredictable consequences for many areas including species conservation (Thomas, 2011), hydrology (Laize et al., 2017) and other areas relying upon biodiversity, e.g. nature based solutions and agriculture.
- Potential reduction in import wood supply due to less productive/harvestable Boreal forest (Brecka et al., 2018)

What are the observable realities of ice decline for biodiversity, air quality, sea level changes, permafrost melt and levels of methane?

- Sea-level rise due to glacier melting (Carrivick et al., 2019; Tepes et al., 2021; Edwards et al., 2021; Box et al., 2022)
- Nutrient release from Greenland Ice Sheet meltwater and buoyancy-driven upwelling of nutrient-rich subtropical water in fjords are predicted to increase as glacier meltwater discharge increases, with repercussions for marine ecosystems (Cape et al., 2019)
- Changes to marine and terrestrial species communities, including a reduction in zooplankton, the commercially important fish (Arctic cod) that feed on them, and predators of cod (e.g. seabirds and mammals) (Post et al., 2013)
- Changes in microclimate, e.g. cold air drainage patterns - with varied ecological consequences (e.g. survival of moths and birch defoliation)
- Changes in terrestrial snowpack (duration, extent, other properties), which leads to many of the terrestrial impacts listed below
- Loss of snowpack leading to more extreme soil temperature regimes, and possible frost damage for plants

- Permafrost melting can expose and dry out tundra (peat), increasing fuel availability for tundra fires (Hu et al., 2010). This leads to a possible increase in poor air quality associated with large tundra fires and deposition of soot on local glaciers/ice sheet, leading to reduced albedo/enhanced glacier melt (Keegan et al., 2014)
- Permafrost melt and release of methane (Schuur et al., 2022)
- Changes in phenology as a result of a reduced snow/ice season - e.g. earlier break up of ice on lakes
- Changes to infrastructure, e.g. road networks disrupted by permafrost melt (Teufel and Sushama, 2019) and changing avalanche patterns (Callaghan et al., 2011)
- Unpredictable future for hydropower industry (Wasti et al., 2022) - new basins may become available for hydropower as glaciers recede (Farinotti et al., 2019); initially meltwater discharge will increase, but then will reduce as glaciers continue to shrink (Huss and Hock, 2018)

2. The UK's Arctic interests

What use do UK businesses (oil, minerals, fisheries, tourism, shipping) make of the Arctic as a whole, and how may that use develop in coming years, especially as the ice recedes?

- Increased tourism activity expected in Greenland, e.g. Kangerlussuaq and Sisimiut (Arctic Circle Trail hiking route), with the development of new tourism infrastructure (https://www.nytimes.com/2023/02/21/travel/greenland-tourism.html)
- Potential increase in cruise travel across Greenland and Svalbard
- New shipping routes as sea ice declines (https://nsidc.org/arcticseaicenews/)
- Increased mineral extraction opportunities
- Fisheries (e.g. Arctic stock quota worth £2m; Defra & Spencer 2022); some species likely to decline as ice declines (Post et al., 2013)

What are the risks to the climate and the environment of current business trends, especially extractive industries, in the Arctic?

- Increased shipping (commercial and tourist) in new areas brings increased pollution risk
- Damage to environment and cultural heritage from tourism (New World cultural heritage sites established) - vegetation damage, erosion
- Potential unwanted interference of cruise ship populations in local communities, highly fluctuating tourism numbers (Greenland, Svalbard, Canada)
- Increased fire risk in Greenland (tourism trigger in fire-prone landscape): potential risks of wildfires due to human activity and underestimated landscape risk to fire (Gosden et al., 2022). The fires produce emissions that can impact local glacier surface albedo, increasing melt (Evangeliou et al., 2019)
- Impact on caribou/musk ox migration routes due to increased tourism presence on hiking trails (Greenland)
- Over-exploitation of natural resources, e.g. mineral extraction, fisheries
- Pollution related to extractive industries, e.g. spoil heaps
- Landscape degradation and vegetation reduction in areas of extractive industries

3. The UK's contribution to the Arctic through scientific research

What are the benefits for the UK of support for Arctic research activity?

- Quantifying glacier contribution to sea-level change and its potential impact on the UK
- Being leaders in Arctic science and contributing to global climate initiatives and reports e.g. IPCC, COP28 etc.
- Improving model predictions of UK climate and sea level changes e.g. IPCC
- Strengthening the UK's historical interests in the Arctic (exploration and science)
- Being part of Arctic-wide science cooperation and collaboration
- A strengthened contribution to Arctic governance e.g. Arctic Council

What more could the UK do to improve or increase its contribution to Arctic science?

- Establish new UK permanent research presence or joint international research base(s) across a range of countries
- Targeted funding schemes for increased collaboration with Arctic partners, e.g. UK-Greenland Arctic Bursary Scheme and Canada-Inuit Nunangat-United Kingdom Arctic Research Programme 2021 – 2025 (CINUK)
- Continued participation in Arctic field station access schemes such as LAPBIAT (https://www.sgo.fi/lapbiat/) and INTERACT (https://eu-interact.org/accessing-the-arctic/)
- Varying sizes of available funds in different schemes to increase accessibility for researchers at different career stages and at different institutions
- Funding schemes for long-term (decades) monitoring of environmental and climate change based on supporting/expanding existing infrastructure and networks

How do the findings of scientific research into the Arctic's climate and environment inform the UK's Arctic policy?

- Rapid changes in the Arctic as outlined above mean that the UK's Arctic policy will need to be agile and regularly updated to reflect the state of research

What are the implications for UK Arctic research of the UK Government's new Arctic policy framework?

- Importance of international collaboration and cooperation in all research initiatives
- New research opportunities related to emerging business interests, e.g. shipping, extractive industries, green fisheries

How can future Arctic research in UK institutions be supported so as to maintain and enhance the UK's leadership in Arctic science?

- Additional research bases or contribution to international research bases (e.g. like BAS office in Ny-Alesund, Svalbard). Maintain involvement in INTERACT Transnational Access scheme (https://eu-interact.org/accessing-the-arctic/)
- Targeted funding schemes for increased collaboration with Arctic partners, e.g. UK-Greenland Arctic Bursary Scheme and Canada-Inuit Nunangat-United Kingdom Arctic Research Programme 2021 – 2025 (CINUK)
- Varying sizes of available funds in different schemes to increase accessibility for researchers at different career stages and at different institutions
- Funding schemes for long-term monitoring of environmental and climate change (at least 20-30 years). It can be challenging to do the same thing for a long time - but essential for observing trends and changes

What factors govern the commissioning of Arctic research programmes in UK scientific institutions, and to what extent are the outputs of such programmes used in contributions to multilateral scientific assessments such as the IPCC?

- Pressing research questions relating to climate change, e.g. glacier change, sea level contribution, glacier stability, fires, impacts of climate change on communities
- UK research is a key contribution to the evidence body used in IPCC reports, with key chapters in recent reports led by, and contributed to, by UK authors (e.g. Fox-Kemper, Hewitt et al., 2021)

What research activities concerning the climate and environment ought to be eligible for UK support through the NERC?

- Greater availability of smaller pots of money for targeted research activities to combat 'diminishing returns' (Aagaard et al., 2020)
- Access to international research bases and facilities in the Arctic region

- Funding schemes for long-term monitoring of environmental and climate change

Has the UK's departure from the EU had an impact on UK research in the Arctic? Has there been any impact on agreements on international cooperation, joint research projects and access to funding streams such as Horizon Europe?

- Increased administrative burden in relation to transporting kit and specimens; In some cases unclear legislation in place of former, clear, EU legislation, particularly on movement of goods, kit and specimens

What impact has Russia's invasion of Ukraine had on Arctic scientific cooperation? Has the conflict had an impact on UK research capacity in the Arctic?

- Increased difficulty and apprehension regarding collaborations with Russian colleagues

What role is there for the UK to assist in Arctic scientific co-operation while the Arctic Council is in abeyance?

- Host/facilitate alternative means of cross-Arctic discussion forums

4. The UK's contribution to the Arctic through diplomacy and military support

What role could the UK play in reviving or replacing the Arctic Council?

- Host/facilitate alternative means of cross-Arctic discussion forums

How can the UK increase its visible presence and influence in the Arctic in support of activities which protect the Arctic environment?

- Additional research bases or contribution to international research bases (e.g. like BAS office in Ny-Alesund, Svalbard)