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Deposition of fallout radionuclides in the Isfallsglaciären catchment: a future problem for pristine Arctic Environments?

Caroline Clason (1), Will Blake (1), Nick Selmes (2), Geoff Millward (1), Alex Taylor (1), and Stephanie Mills (1)

(1) School of Geography, Earth and Environmental Sciences, University of Plymouth, Plymouth, United Kingdom (caroline.clason@plymouth.ac.uk), (2) Plymouth Marine Laboratory, Plymouth, United Kingdom

Glaciers act as stores for external products that fall onto their surface, ranging from snow, rocks and ash, to fallout radionuclides (FRNs) and other environmental pollutants. Falling snow has been shown to be a highly efficient scavenger of trace elements from the atmosphere, with snow and then glacial ice acting as a reservoir capable of storing and subsequently releasing pollutants into waterways or onto the land surface during glacial retreat. Increased temperatures are accelerating the melt of glaciers worldwide, introducing the risk of enhanced contaminant release. Snowmelt has been shown to increase contaminant release in alpine freshwater systems, indicating that similar processes can be anticipated due to ice melt. Fine-grained glacial sediments act as a sink for FRNs that are stored within ice then released through melting, with the high ice-to-particulate ratio resulting in enriched concentrations of potentially harmful contaminants within sediments. The subsequent transport of enriched sediments through glacial meltwater streams, or direct deposition onto the land surface, could have detrimental effects on the ecology and water quality of proglacial environments as well as the downstream reaches of glacier-fed rivers.

The presence of FRNs in glacial catchments has been little-studied, but recent geochemical analysis of cryoconite and glacial sediments from Isfallsglaciären in the Kebnekaise region of Arctic Sweden has revealed high activity concentrations of FRNs on the glacier surface, at levels substantially greater than the surrounding proglacial environment. Historical delivery of FRNs to the landscape from Chernobyl and 1960s weapons testing was reconstructed from the stratigraphic record of a core taken from a proglacial lake fed by meltwater from Isfallsglaciären. The concentration of fallout caesium-137 in a number of the cryoconite samples retrieved from this site exceeds 4000 Bq/kg, some two orders of magnitude greater than the surrounding landscape. This is well in excess of the legal level of caesium set by Sweden's Food Standards Agency (1500 Bq/kg), and may present a future issue for grazing animals and traditional Sami reindeer husbandry as the glaciers retreat and down-waste, depositing FRN-enriched cryoconite within the proglacial environment. Improved understanding of FRN accumulation, release and fate in glacial catchments is thus imperative to better predict future changes to environmental quality and assess the impact on pristine Arctic ecosystems.