

## EDITORIAL

## Tackling crises in cryospheric research

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## The cryosphere in crisis

The global cryosphere is in crisis. Snow and ice on land and at sea are shrinking in response to rising air and ocean temperatures, posing new challenges to those who depend on them for survival. Last year saw record-low sea ice extent in Antarctica [1], and an increasing body of research now indicates that parts of the West Antarctic Ice Sheet are unstable even at present day temperatures [2].

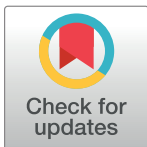
The Arctic is warming at nearly four times the global average rate [3], a rate so high that it is affecting the global average value, pushing us across the Paris agreement's 2C limit around eight years earlier [4]. Melt driven runoff from Greenland has grown by 20% [5], with the ice sheet contributing more than 1.2 cm to global sea level rise in that time [6]. Based on our emissions to date, we appear to have already committed to a further 25 cm [7].

Away from the polar regions, millions of people worldwide are now at risk from the changing cryosphere. Glaciers in High Mountain Asia faced an accelerated melting by 65% in recent years compared to the first decade of this century [8]. Similarly, snow cover days declined at a rate of five snow cover days per decade since 1950 [9]. Both the components comprise between 5% and 80% contribution to runoff, increasing from east to west in the region critical for ~1.9 billion people—a quarter of the world's population [10]. In Norway, where about 94% of the electricity generation is based on hydropower of which 15% from glaciated catchment areas, the majority of major glaciers will have disappeared by 2100 [11]. These rapid cryosphere changes are expected to cause more frequent and intense glacial lake outburst floods, water scarcity, increased landslide risks, and disruptions of communities.

## Scientific communication in crisis

Despite the importance of the above changes, the global research and policy communities are also struggling to keep up. A variety of barriers to science mean that advances in our technical understanding run the risk of becoming outdated before they percolate through to decision-makers. That percolation is more important than ever, but the process is often limited by digital access rights, a credibility crisis in scientific publishing, and a growing misinformation movement aimed at stalling policymakers. Furthermore, a “communication gap” exists between scientists and policymakers, where key processes, caveats and uncertainties are sometimes lost in translation. The scientific community—and publishers—must act to dismantle these barriers.

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landscape where predatory practices are making it harder than ever to know what science can be trusted. Furthermore, the journal is underpinned by PLOS's Global Equity financial model (<https://plos.org/resources/global-equity-model/>), which has been designed to offer more equitable participation in scientific publishing by authors from all parts of the world. Finally, the journal's editorial criteria focus squarely on scientific and ethical rigour, avoiding the biases that can stem from subjective assessments of novelty.

## Key topics for future research

Having made the case for *where* to publish, we now highlight a few cryosphere-related subject areas which we believe will be particularly exciting and consequential.

We are equally interested in interactions of the changing cryosphere with the rest of the climate system as well as their impact on societies. Notwithstanding the profound direct effect of melting ice on mountain communities and those living downstream, far field impacts mediated through the Earth system such as sea level rise and changes in weather patterns is how the majority of people will experience a shrinking cryosphere. As one pertinent example, we encourage research on the physical drivers and ecosystem impacts of recent declines in Antarctic sea ice; these declines have shocked the research community, and changes in the Southern Ocean sea ice system could impact fisheries, nearby ice-shelves and the marine carbon sink. This scientific puzzle would benefit from a synergy between modelling, in-situ and earth-observational approaches, and we welcome cross-cutting research of this kind.

Climate intervention and geoengineering are rapidly rising in prominence among the media, the public and policymakers. At first sight, these proposed climate solutions may seem at odds with nature-based approaches that recognize the self-adaptive and self-restoration capacity of landscapes, especially the socio-ecological systems associated with the mountain cryosphere. However, there is still a dearth of research on these topics, keeping many discussions relatively uninformed. We would therefore encourage submissions on the risks and potential benefits of climate intervention, geoengineering and nature-based solutions on the cryosphere, at global, regional and local scales. In particular, we would like to showcase high-quality research on the attitudes of Indigenous communities and local residents towards these approaches.

Furthermore, as mountain snow and ice changes can impact the communities that depend on them on very short timescales, providing accurate, fine-scale evidence of how the cryosphere is changing is urgent. A large number of people are dependent on glacial and snow melt in the Andes and high-mountain Asia. Hazards related to glacial and permafrost thaw impact mountain communities worldwide. We therefore welcome submissions on current trends and future projections of the mountain cryosphere with societal implications.

These topics are highly interrelated, highlighting the interdisciplinary challenges that remain to be tackled in the study of the cryosphere.

## Where now?

The cryospheric research community faces a variety of unprecedented challenges. These range from the dizzying pace of environmental change, to the credibility and reproducibility crises in the academic literature. Rather than just being at the mercy of these problems, as scientists we can make choices which improve the situation.

By working on the scientific problems of the greatest urgency and impact, we can make meaningful strides to understand and then address the environmental change around us. These problems are often interdisciplinary and international. By judiciously considering how

and where we publish, we can make our communications more transparent, credible and effective. This makes our profession more transparent, credible and effective too.

## Author Contributions

**Writing – original draft:** Robbie Mallett.

**Writing – review & editing:** Alfonso Fernández Rivera, Sher Muhammad, Andreas Born.

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