

Permafrost Climate Services

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Context: escalating costs and risks

The *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* revealed the benefits of ambitious mitigation and effective adaptation for sustainable development and, conversely, the escalating costs and risks of delayed action. These costs and risks include those arising from permafrost thaw, both projected and already observed in polar and high-mountain regions.

Living and working on permafrost has a long history of knowledge and practice. By contrast, permafrost thaw due to climate change is a new challenge. We can only partially rely on past experience to prepare for it.

A need for new information

What information do we need for adapting to permafrost thaw? Common sense and past experience will suffice in some situations, and in others, geotechnical and geomorphological knowledge or traditional knowledge will help to stay clear of areas susceptible to thaw-related hazards. And sometimes, quantitative information about the severity, timing, and location of permafrost thaw will be needed for informing adaptation. How do we make this knowledge useable for those who need it?

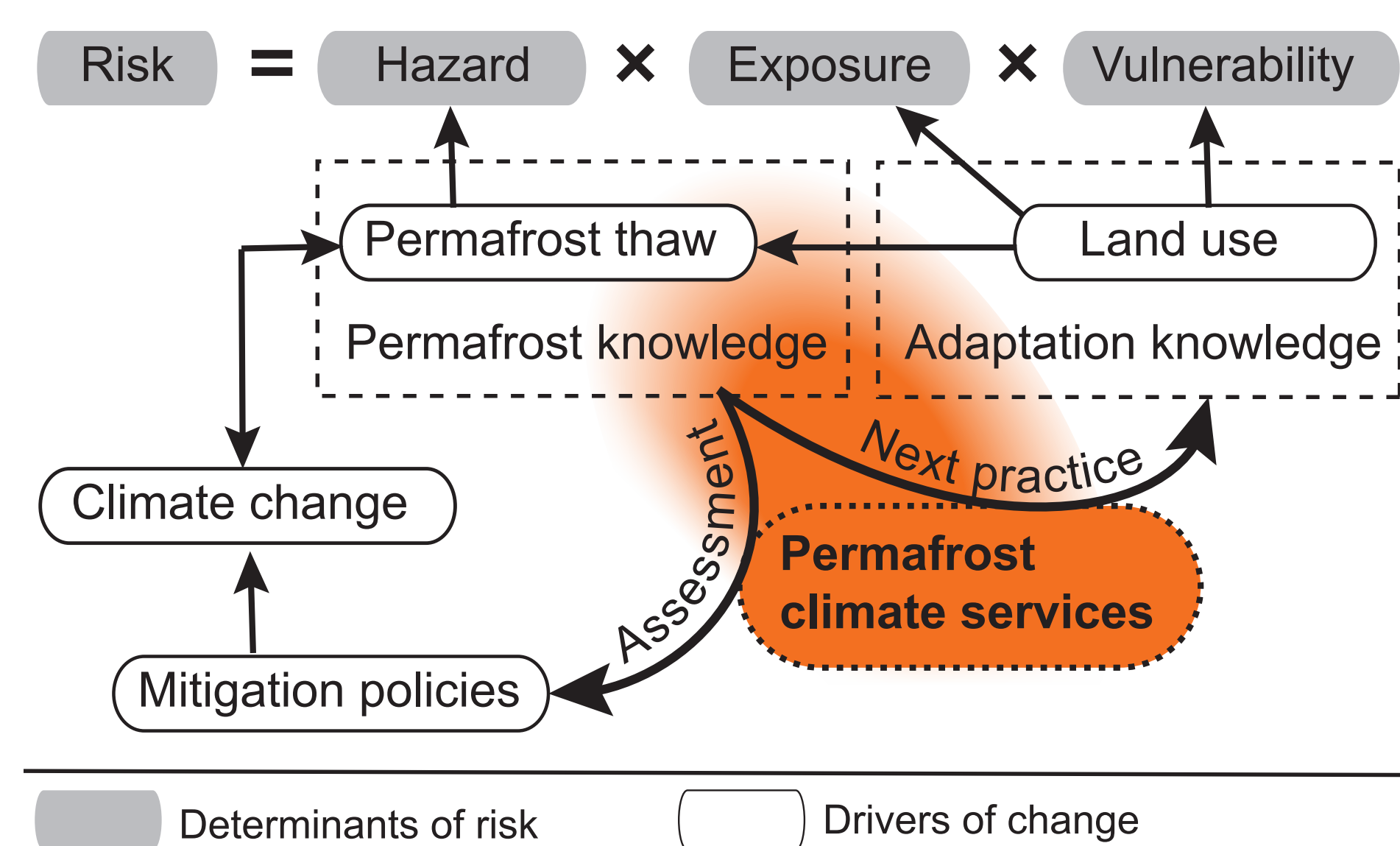


Figure 1. Permafrost climate services are an avenue to boost climate action by informing adaptation and mitigation with reliable and consistent evidence. Permafrost thaw can increase risk via multiple and often cascading hazards. Adaptation of land use can reduce risk by lowering exposure and vulnerability and by reducing disturbance to permafrost. Climate change is a pervasive and persistent new driver of permafrost thaw.

Consider weather and climate services: Weather prediction supports our everyday lives, from apps on smartphones to aviation weather forecasts. Climate services now make information about future climate available. Through such services, research in atmospheric science and related fields creates value for people, and operationalization enables new research within and across disciplinary boundaries. Imagine not having these services: this is the reality in the context of permafrost.

A lack of permafrost services: A gap exists between the need for forward-looking permafrost information and the ability to provide it. Services for permafrost information are rare, if they exist at all. The relevant knowledge and methods are found across differing academic disciplines, locations, and sectors. Creating services will accelerate how permafrost knowledge can be connected and delivered for action.

Permafrost climate services are a (missing) element of evidence-based support for decisions about adapting to permafrost thaw.

Permafrost Climate Services help connect distributed and networked capacity, research, and knowledge for action.



Figure 2. The circle of groups with an interest in permafrost is large and growing. The examples here show some of the many differing mandates, interests, and perspectives. Every individual or organization holds and seeks differing types of knowledge. When we connect this knowledge well, it can inform and drive action. Creating or strengthening the resources and initiatives shown inside the circle can help us make strong connections in the long term. (Figure doi 10.1139/as-2023-0016)

Envisioning permafrost climate services

Climate services are information and products that support individuals and organizations in forward-looking decision-making related to climate change and its consequences. Co-development – inclusive, collaborative, decisions driven, and iterative – with the intended users produces best results.

Permafrost climate services fit this framework but will be distinct because information from climate science and models alone cannot easily be interpreted to inform permafrost-related decision-making.

- They will need to integrate knowledge, data, and methods from fields such as geology, ecology, and atmospheric science.
- They will be built from scratch, as opposed to other climate services that grew from established institutions in numerical weather prediction and hydrology.
- They may not be perceived as urgent or important because permafrost areas are sparsely populated and remote.

The requirements for permafrost climate services will emerge from co-development and likely include:

- Observations, e.g., of ground temperature, active-layer thickness, ground-ice, and thermokarst.
- Predictions of historic and future permafrost conditions that can be related to local conditions in the built and natural environment.
- Careful contextualization and presentation.

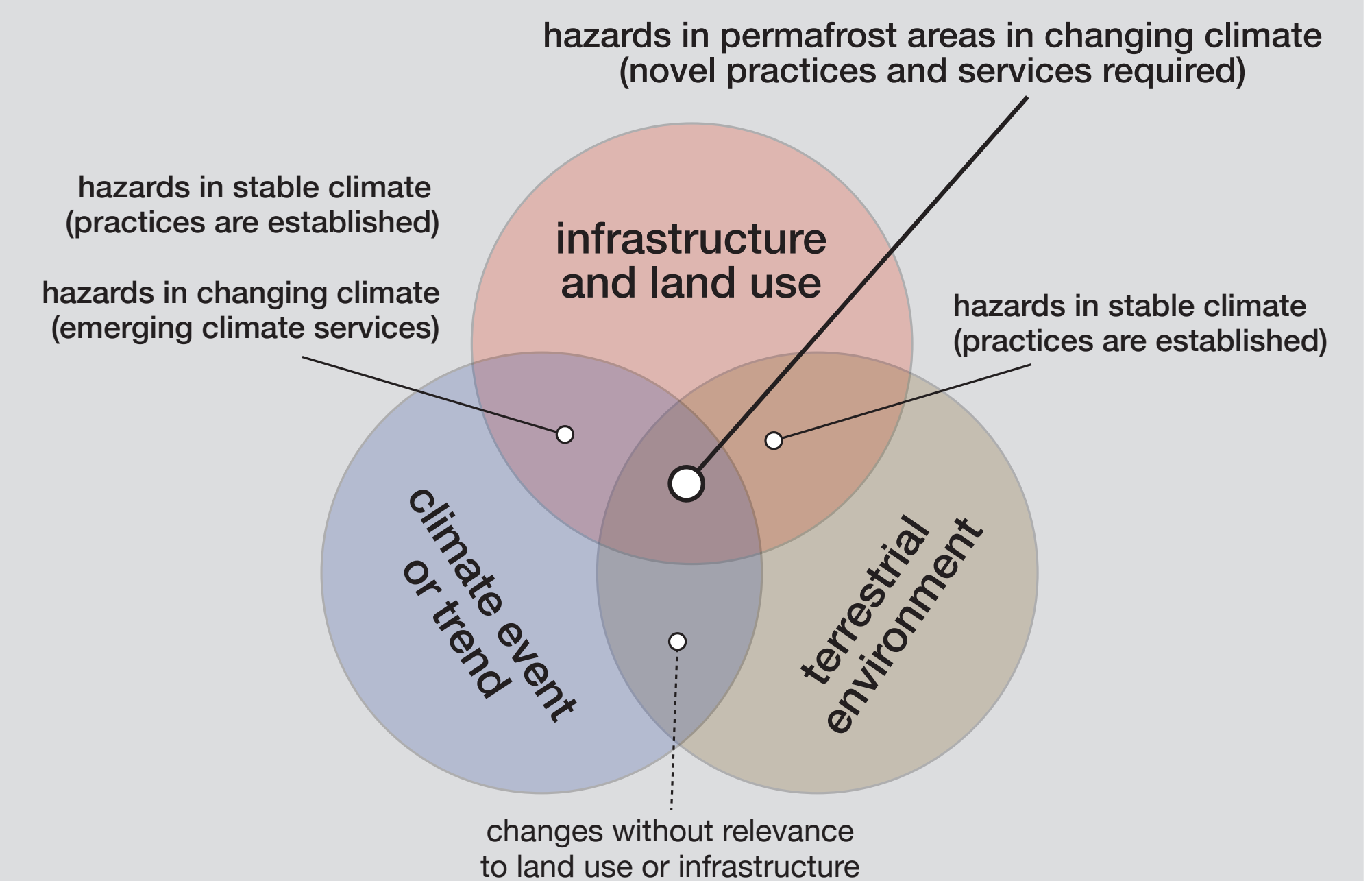


Figure 3. Permafrost climate services address challenges in a novel and expanding intersection of three domains. Permafrost affects most terrestrial systems in its environments. The reaction of permafrost to climate change often causes an unprecedented amplification of climate change into hazards.

Arctic nations like Canada have an opportunity to lead the way in building permafrost climate services.