First steps towards establishing an early warning system for natural hazards in Nunavik, Québec, Canada

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Background

In Nunavik, a strong climate variability is contributing to significant environmental changes. Frequent extreme meteorological events and associated natural hazards are commonly observed consequences and may threaten public safety and infrastructures in the northern villages. The communities are affected by the impacts of less predictable weather, shifting snow and ice regimes, and more frequent natural hazards, and must find ways to adapt to their changing and highly dynamic environment. Within CEN's project *Qaujikkaut* (meaning *warning*), efforts are underway to develop an early warning system for key natural hazards in Nunavik based on the monitoring of meteorological indicators. The envisaged threshold-based forecasting approach will be enabled by short-term weather forecasts and real-time access to observations from the SILA network of climate and environmental monitoring stations operated by the CEN and MELCC in Nunavik.

Extreme Weather Events as Root Causes for Natural Hazards

Because many of the natural hazards observed in Nunavik have meteorological components acting as triggering conditions (e.g., landslides releasing due to water saturation after prolonged or intense rainfall events, wet-snow avalanches following periods of rapid warming (Fig. 1), or storm surges during episodes of strong winds, high tides, and low atmospheric pressures), it is hypothesized that the prediction of these events is possible, to a certain extent, through the identification of meteorological indicators and their monitoring. With knowledge of their characteristic development and their thresholds, and with the use of meteorological forecasts and meteorological data accessible in real-time, warnings and possibly even robust forecasts of natural hazards in the making could become a reality through the monitoring of precursor signals.

Except for weather forecasts issued by Environment and Climate Change Canada for each of the communities, no system is yet in place to monitor extreme meteorological events and related natural hazards in Nunavik.

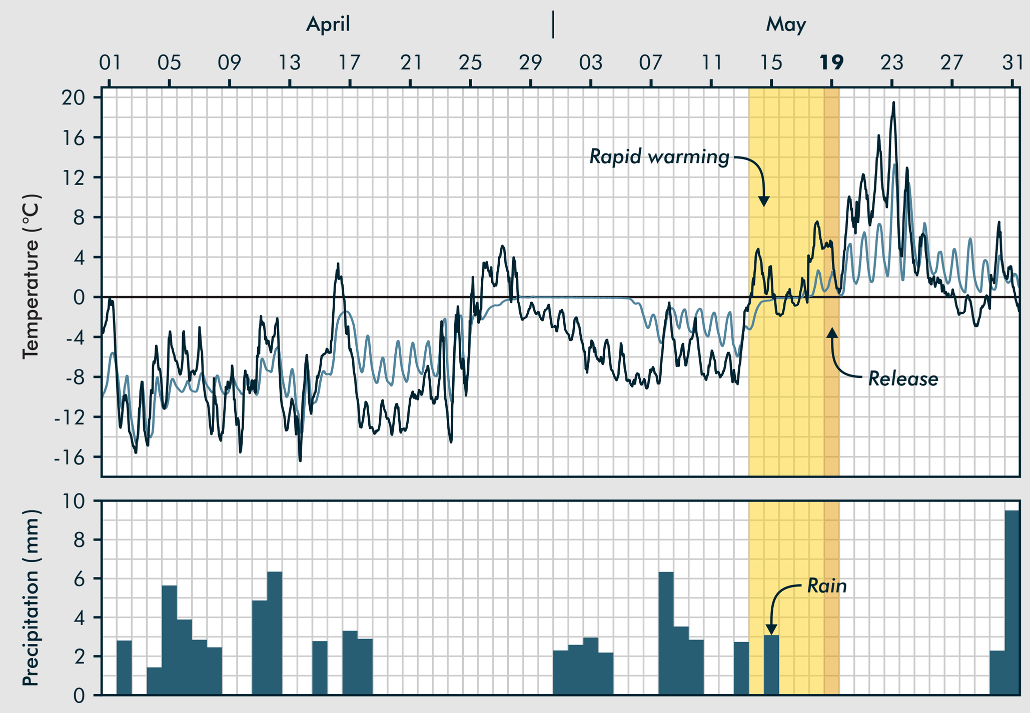
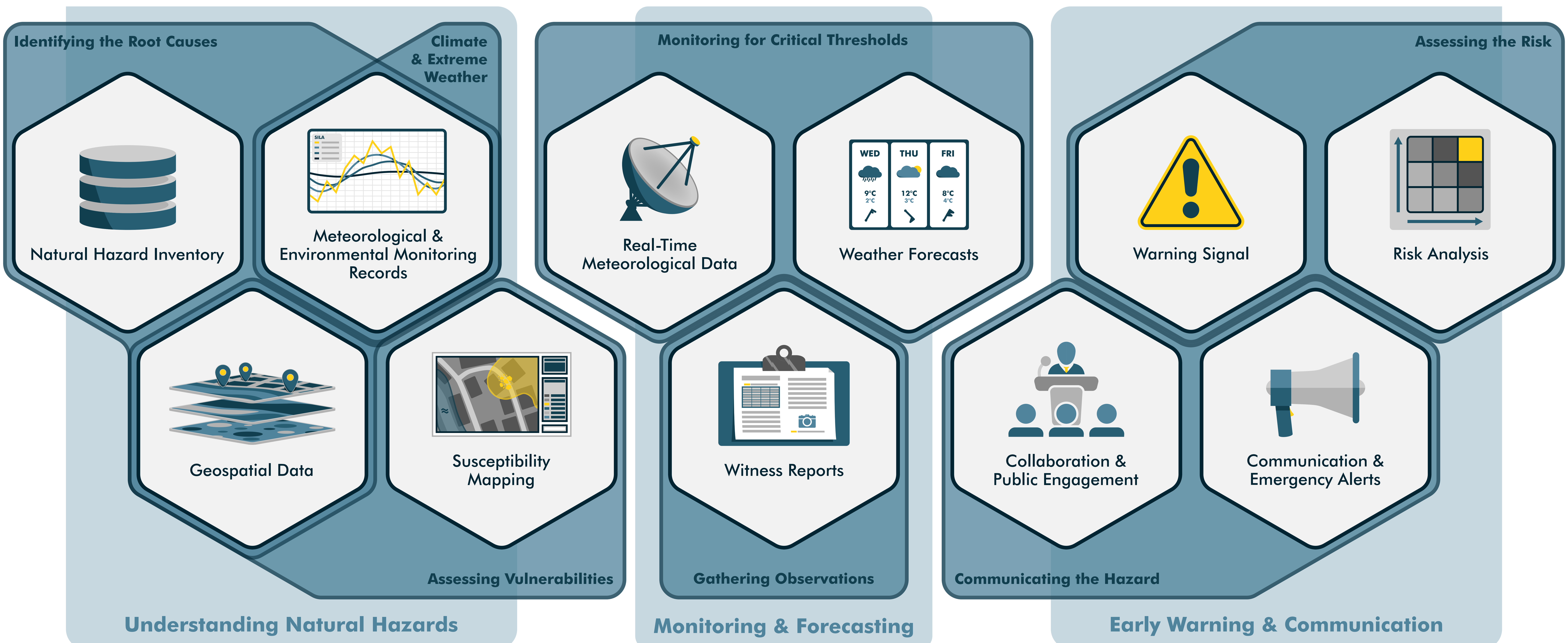


Figure 1: Historic wet-snow avalanche in Deception Bay (Raglan Mine) on 19 May 2005. A rapid increase in air temperature and possible liquid precipitation in the preceding days of the event (yellow band) led to rapid melting of accumulated snow over a short period of time, ultimately causing the release (orange band). Air and ground temperature records are taken from the SILA station in Salluit; daily precipitation estimates are taken from the Daymet dataset (Thornton et al 2020).

The *Qaujikkaut* Project – An Integrated Early Warning System for Nunavik



Data Availability Proves Challenging For Now

Precisely forecasting the broad range of natural hazards necessitates large and accurate data sets of past events that can be linked to recorded environmental variables. Because dated events in Nunavik are few and far between (n = 106, Fig. 2), however, a variety of methods must be explored to potentially expand the existing inventory of natural hazards, gain insight into long-term dynamics and spatial distributions, and ideally provide a robust basis for predictive modeling. A remote sensing approach will be employed to attempt dating of inventoried (geomorphological) evidence of past events (n = 2928, Fig. 3), while the implementation of witness reports will supplement the inventory in the years to come. In parallel, available meteorological data sets will be evaluated to understand regional and local climate variability and to extract information on short-duration meteorological extreme events, their evolution, and how they trigger natural hazards.

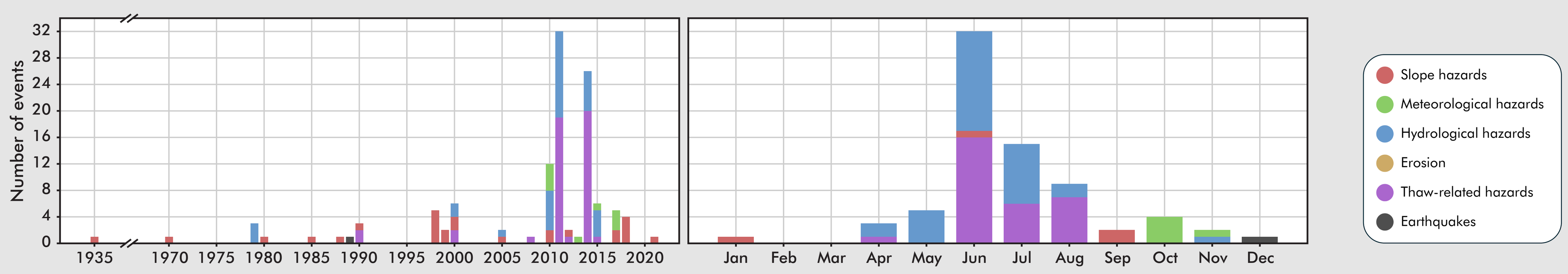


Figure 2: Inventory of dated natural hazard observations in Nunavik between 1935 and 2021. Data until 2015 from L'Hérault and Aubé-Michaud (2018).

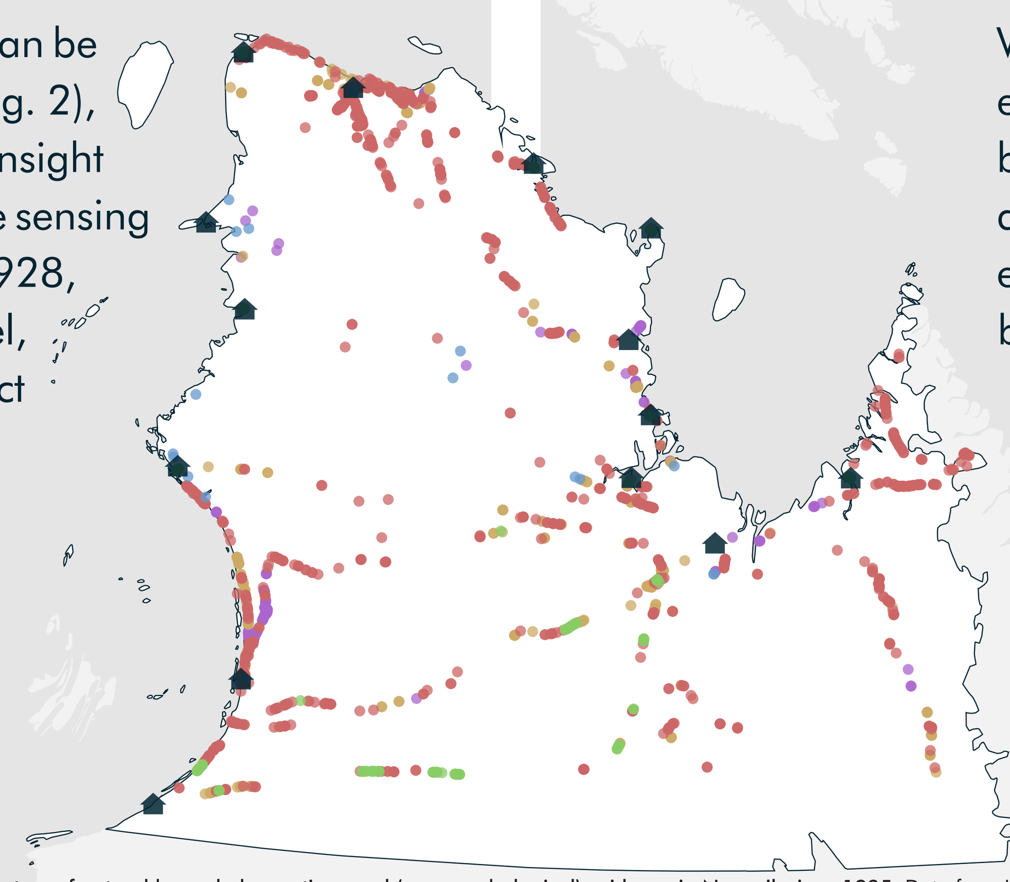


Figure 3: Inventory of natural hazard observations and (geomorphological) evidence in Nunavik since 1935. Data from L'Hérault and Aubé-Michaud (2018).

Collaboration

Whereas the feasibility and reliability of an early warning system will be limited mostly by data availability, its utility and benefits depend on local needs. These must be explicitly considered in this project and will be discussed in dialogue with the stakeholders and responsible authorities of the northern villages. The development process, data, and interim results will be shared in a transparent and accessible manner (e.g., through web portals, presentations, and reports) to raise awareness and to engage community members.

The Qaujikkaut project is a collaboration between the Centre d'études nordiques (CEN), the Research Centre for Geospatial Data and Intelligence (CRDIG), the Big Data Research Center (CRDM), the Kativik Regional Government (KRG), the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC), the Ministère de la Sécurité publique (MSP), Environment and Climate Change Canada (ECCC), Raglan Mine, and Ouranos.

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