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

Till Groh [1,2], Richard Fortier [1,2], Jean-Michel Lemieux [1,2], Daniel Nadeau [1,3], Thierry Badard [4,5], Jacynthe Pouliot [4,5], and Amir Vahdat [4,5]

[1] *Centre d'études nordiques, Université Laval;* [2] *Département de géologie et de génie géologique, Université Laval;* [3] *Département de génie civil et de génie des eaux, Université Laval;* [4] *Département de géomatique, Université Laval;* [5] *Centre de recherche en données et intelligence géospatiales, Université Laval*

Background

In Nunavik, a **strong climate variability and significant environmental changes are contributing to more frequent extreme weather events and associated natural hazards**, threatening public safety and infrastructures. The northern communities must find ways to adapt to the impacts of less predictable weather, shifting snow and ice regimes, and more frequent natural hazards.

Within CEN's project ***Qaujikkaut*** (≙ *warning* in Inuktitut), efforts are underway to **develop an early warning system for key natural hazards in Nunavik for use by decision-makers**. The envisaged forecasting approach will be based on the monitoring for meteorological indicators and **enabled by real-time access to climate and environmental monitoring stations from the SILA network** conjointly operated by the CEN and MELCC, and to short-term weather forecasts issued by ECCC.

Extreme Weather Events as Root Causes for Natural Hazards

Because **many of the observed natural hazards are triggered by meteorological extreme events** (e.g., landslide occurrences triggered by 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), **the prediction of these events is possible through the identification and monitoring of meteorological indicators**.

With knowledge of the characteristic development of the natural hazard processes and their associated meteorological thresholds, and with the use of weather forecasts and meteorological data accessible in real-time, **issuing warning signals and possibly even robust forecasts of natural hazards in the making** could become a reality through the monitoring of precursor signals.

Except for certain extreme weather forecasts published by ECCC for each of the communities in Nunavik, **no system is yet in place to monitor and warn for related natural hazards**.

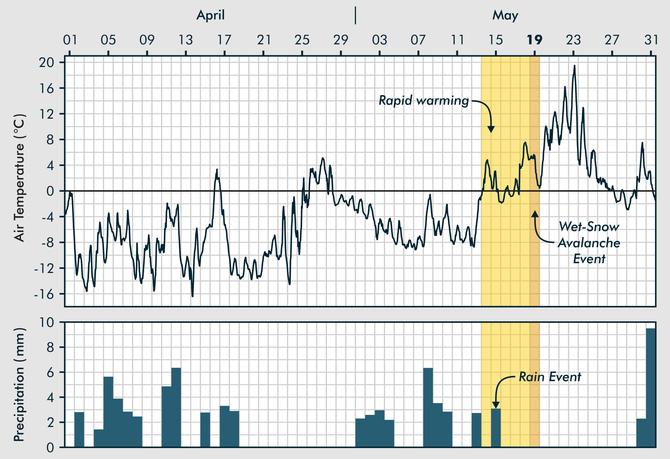
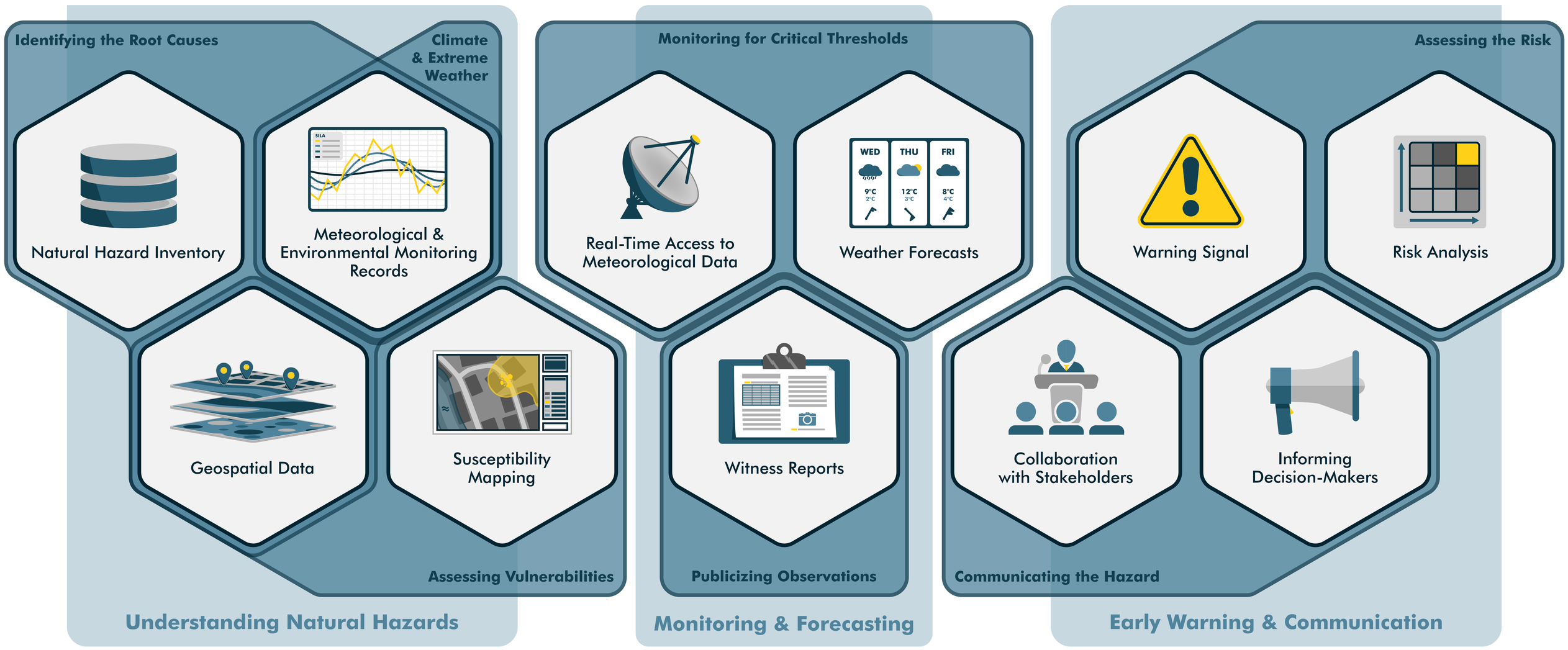


Figure 1: Historic wet-snow avalanche in Deception Bay (Nunavik) on 19 May 2005.
A rapid increase in air temperature and possible liquid precipitation in the preceding days of the event (yellow band) led to rapid melting of accumulated snow, ultimately triggering the wet-snow avalanche (orange band). Air temperature records are taken from the SILA station in Salluit (CEN 2020), daily precipitation estimates are derived from the Daymet data set of the overlying grid cell (Daymet 2020).

Qaujikkaut – An Integrated Early Warning System for Natural Hazards in Nunavik



Data Availability Proves Challenging

Precisely forecasting the broad range of natural hazards necessitates accurate data of past events that can be linked to recorded environmental variables. However, **dated events of natural hazards in Nunavik are rare** (Fig. 2), and a variety of methods must be explored to **expand the existing inventory**, gain insight into long-term dynamics and spatial distributions, and ideally provide a robust basis for predictive modeling. For this purpose, an approach is developed to **automatically identify pertinent geospatial data sets for the context of early warning** in Nunavik. Based on the identified and available data, remote sensing methods are used in an attempt to **date inventoried evidence of past events** (Fig. 3). In parallel, available climatological data sets will be evaluated to **understand regional and local climate variability** and to further **explain how short-duration meteorological extreme events trigger natural hazards**.

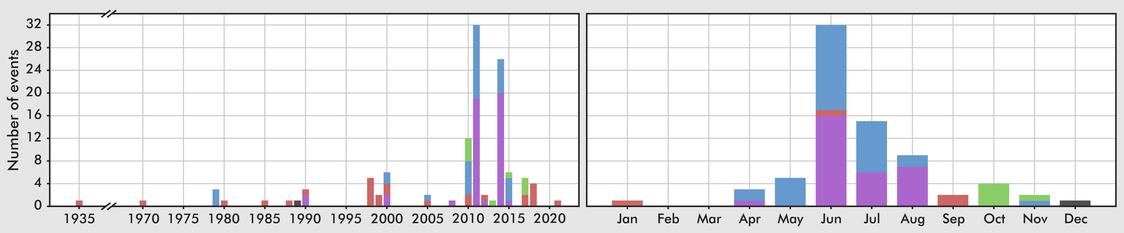


Figure 2: Inventory of dated natural hazard observations in Nunavik between 1935 and 2021 (n = 109). Data until 2015 from L'Hérault et al. (2017).

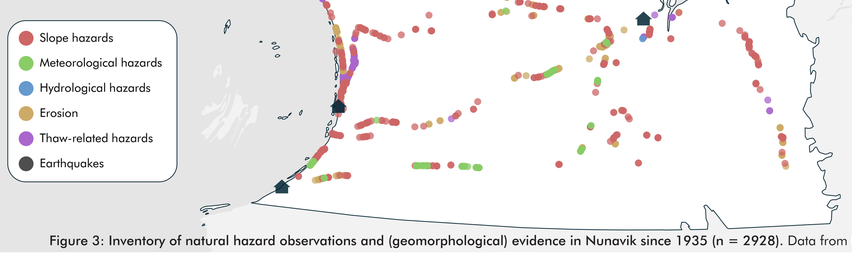


Figure 3: Inventory of natural hazard observations and (geomorphological) evidence in Nunavik since 1935 (n = 2928). Data from L'Hérault et al. (2017).

A Collaborative Approach

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 stake-holders and local authorities** of the communities in Nunavik.

The development process, **data and interim results will be shared in a transparent and accessible manner** (e.g., on web portals, in reports, and in presentations) 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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