Write a short article describing your research. Your target audience is scientists who are not specialists in your discipline. You are trying to tell the story of your work and engage and educate your reader, not write a technical paper. The tone can range between somewhat technical and more casual, but it must be something that technical readers would find interesting. Use your answers from step 1 to frame the story you write in this part of the exercise.

In high-latitude environments, cold climate causes rivers to freeze several months a year. As river-ice develops and changes with meteorological conditions, it influences hydraulic, bedload transport and erosion processes, which in turn affect channel morphology. In fact, the presence of river-ice changes the flow conditions, moving from free-surface to closed-surface flow. Cold temperatures alter the physical properties of flowing water, causing changes to sediment transport capacity (Beltaos and Burrell, 2000; Ettema, 2006; Lau and Krishnappan, 1985; Prowse, 2001a; Sayre and Song, 1979; Smith and Ettema, 1995). Furthermore, the presence of river-ice and snow affect water and sediment availability (e.g., Gatto, 1995), connectivity between the stream bed and banks, and streambank erosion (e.g., Chassiot et al., 2020). Thus, river-ice can influence key fluvial processes that drive fluvial morphological change.

In the current climate warming context, ongoing rapid changes are ongoing regarding rive-ice cover duration and seasonal precipitation patterns (Yang et al., 2020; Thellman et al., 2021; Lee et al., 2021, 2023; Riahi et al., 2022; Forster et al. 2023; IPCC, 2023). Climatic changes to freshwater ice are projected to produce a variety of effects on hydrologic, ecological and socio-economic systems, leading to increasing scientific concern about how future changes in climate might affect river-ice regimes (e.g. Anisimov and others, 2001; Walsh et al., 2005; Wrona et al., 2005; Prowse et al., 2008; Prowse et al., 2011).

However, insufficient information on the spatial and temporal variation of the processes under ice-covered conditions limits our understanding of ice-covered river dynamics, including estimation of stage-discharge relationships, sediment transport, ice-cover formation, and channel-thalweg alignment (Ettema, 2002; Lotsari et al., 2019; Turcotte et al., 2011; Polvi et al., 2020). For many reasons, collecting measurements from an ice-covered river is challenging. First of all, standing on river-ice can be dangerous, and river-ice thickness conditions are highly dependent on channel geometry, water depth, and hydrological and meteorological conditions (e.g., Prowse et al., 2007). Secondly, measuring flow velocities and bedload transport during the ice-covered season is difficult: holes can be drilled in the ice to access the water, but require a thick and stable ice-cover, and only provide spatially and temporally limited measurements (e.g., Lotsari et al., 2017, 2019; Polvi et al., 2020). Thirdly, these intrusive methods are not adapted for the study of certain processes that depend on a thick ice cover to operate, such as flow pressurization under ice, which hole-drilling through ice would interfere with. Furthermore, photographic data has been used to study river-ice and ice-affected river processes using satellite imagery and time-lapse cameras (McGinnis and Schneider, 1978; Cooley and Pavelsky, 2016; Beaton et al., 2019; Polvi et al., 2020) yet there is a lack of high-resolution continuous spatial and temporal information to enable high-precision monitoring.

To address these field measurement shortcomings, within the past decades, geomorphologists have started using seismic methods. Seismology covers the study of the generation and propagation of elastic waves through Earth, emitted by a source (Stein & Wyssesion, 2002). Seismometers record continuous and high-resolution seismic data, providing information about the source, its timing and location, as well as on the medium through which the wave travels. Earth surface dynamics can be detected and characterized by seismic signals described by specific waveforms, event durations, amplitudes and frequencies. This field of environmental seismology offers a promising opportunity for geomorphologists to collect continuous, temporally and spatially rich high-resolution data, otherwise not accessible using traditional measurement methods (Cook and Dietze, 2022).

In my PhD project, I am interested in using seismic methods to characterize bedload transport and streambank erosion due to ice in high-latitude rivers. I am interesting in investigating how ice seasonally interact with sediment, driving bedload transport and streambank erosion. We hypothesize that bedload transport increases during the ice break-up season, firstly from mechanical ice-bank and ice-bed interactions during the ice break-up process and secondly from increased discharge during the snowmelt flood.

We deployed seismic sensors on two rivers in the subarctic environment and collected data over one year. Results show that snowmelt and ice melt in the spring cause streambank erosion. When discharge increases before the ice pack loses strength, mechanical break-up plucks a large portion of the streambanks. When air temperature increases steadily, leading to river-ice gradual in-situ melting, streambank erosion is limited. Furthermore, we note differences caused by different river morphologies. In a meander bend, where river-ice thickness and shape are heterogeneously distributed over the reach, we identify more ice-cracking signals on seismic data originating from the meander bend compared to the straight reaches.

Overall, our results show that streambank erosion due to river-ice is mainly caused by mechanical action from river-ice on bank material, when discharge upstream from the ice pack increases. The meander bend is the location where most ice cracking activity occurs during this time, suggesting that bend curvature influences ice dynamics. Therefore, ice-bank interactions happen during the ice break-up period, and river-ice plays an important role in shaping river systems affected by ice.