

Fjord ice can have a great impact on local communities

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Location of ice in Beisfjord while avalanche debris covered the only road leading into the community (left). The dock was not accessible, so a military boat (right) could only land further way along a rocky coastline when the tide allowed. Credit: Vidar Løkeng/Fremover

Norwegian fjord and coastal ice represent a potential security threat, as it may cut off entire communities from the outside world.

After a significant avalanche closed the road to Beisfjord in Nordland, Norway in February 2022, the community of approximately 700 people could only be accessed by boat. A military boat was sent in to help, but due to the presence of ice extending over one km from the back of the

fjord, access to a dock placed the previous summer was impossible.

As a result, the boat was forced to land outside the town on a rocky coastline to provide supplies to residents.

Such events provide one reason why the behavior of ice in subarctic fjords needs more attention, according to researcher Megan O'Sadnick at SINTEF Narvik. In her Ph.D. thesis, she provides the first comprehensive look at Norwegian subarctic fjord and coastal ice to address an intriguing gap in scientific knowledge.

Little research so far

Due to the influence of warm Atlantic water, larger fjords along the Norwegian coast are ice free all year. However, sea ice can form in the inner parts of fjords and in smaller fjord branches.

While a wide breadth of work exists examining mainland Norwegian fjords, often focusing on water mass dynamics and their link to [biological processes](#), little research has been conducted on sea ice in these locations.

"With industry increasing in the North, a larger number of boats and people are being drawn to these areas. Understanding ice conditions including not only where it may be present but also the properties of that ice and the factors contributing to its formation, will better prepare northern communities for future development," O'Sadnick says.

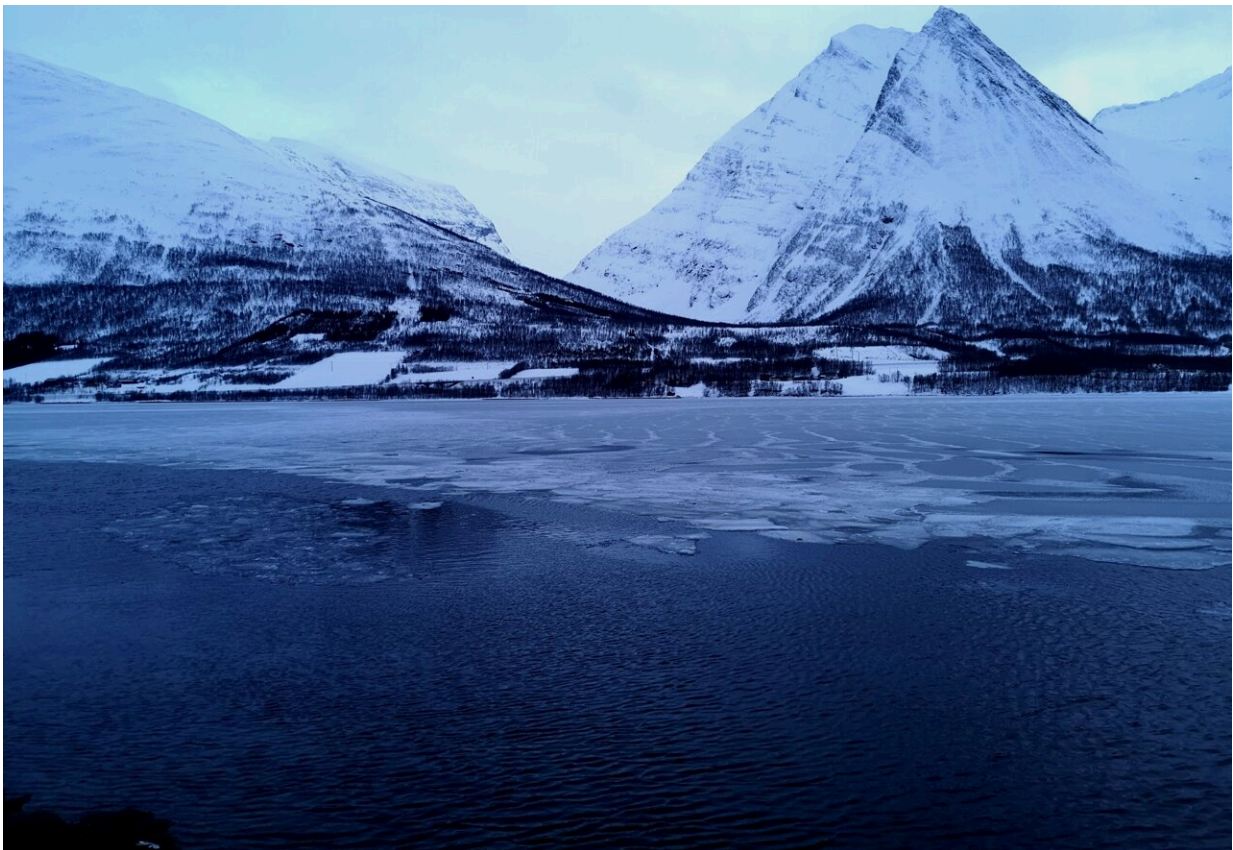
Analysis of satellite imagery

To fill the knowledge gap, an automated method was developed to estimate quantitatively ice extent from optical satellite imagery for 386

fjords and other coastal areas along the coast of mainland Norway from 2001 to 2019 between February and May.

The individual fjords were next grouped into regions to begin investigating the factors potentially driving ice formation including air temperature, snowfall, and rainfall plus snowmelt.

"While the first, [air temperature](#), was correlated to ice extent in some regions, this relationship as well as relationships to the two other weather variables examined were not consistent pointing to variations in the mechanisms driving ice formation," O'Sadnick explains.



The breakup of ice in Nordkjosbotn, March 2020. Credit: Megan O'Sadnick

To enhance understanding of the properties of fjord ice including its [crystal structure](#), bulk salinity and oxygen isotopic composition, ice samples were gathered at seven fjords located in northern Norway during three winter seasons between 2017 and 2020. Possible correlations to temperature and snowfall were revisited in addition to river runoff illuminating further variations not only in ice extent between seasons, but also ice properties and the factors driving ice formation.

In addition, using previously derived relationships linking the salinity and [isotopic composition](#) of the ice to that of the ocean and river water, the composition of water at the ice-ocean interface during ice growth was subsequently estimated.

Locals concerned about inaccessibility

The closure of the road leading into Beisfjord, provides a clear example of how communities located in fjords and along the coast of Norway can quickly become inaccessible. The presence of ice in Beisfjord was an additional obstacle, limiting the area where boats could travel and the amount of coastline available to gain access to the town.

Only a week later, after the avalanche debris had been cleared, ice extent increased filling nearly the entirety of the fjord. Travel by boats without icebreaking capabilities was no longer viable, leading to concern within the community. If the road was again closed, they would need to depend on helicopters or wait for an ice breaker to arrive.

"Conversations are ongoing on how to ensure continuous access to Beisfjord through the winter, yet one thing is for certain, the presence of fjord ice greatly complicates any options that depend on access by sea," O'Sadnick explains.

As a result, solutions to how to keep Beisfjord safely accessible through

winter are being explored, including more dependable but costly measures like the building of a tunnel.

Fjord ice should not go overlooked

Through this research examining ice conditions along the coast of Norway, it is reasonable to surmise that the town of Beisfjord is not entirely unique in how it is impacted by the occasional presence of ice.

Sandnessjøen provides another example, with fjord ice being noted to halt winter-time shipments of building materials for a factory as early as the 1940s. To this day, fjord ice is still defined as a transportation challenge, blocking the only alternative route if the single road into town is closed during winter.

"Thus, Norwegian fjord and coastal ice should not go overlooked, and perhaps given more focus, because of its potential influence on local communities, industry, and the fjord environment," says O'Sadnick.

Through her work, a gap in scientific knowledge has narrowed through the collection of data and completion of analysis focused specifically on Norwegian fjord and coastal ice.

"More work remains, however, to improve our understanding not only of Norwegian fjord ice, but also of other regions where similar ice exists," says O'Sadnick.

More information: Megan O'Sadnick, Ice in Norwegian subarctic fjords and coastal regions: An examination of ice formation, properties, and trends based on remote sensing and in situ data.

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Provided by SINTEF

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