

Tsunamigenic Landslides from Freshly Exposed Arctic Slopes – Preliminary Pan-Arctic Susceptibility Assessment

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Abstract

Accelerated climate warming has caused the majority of marine-terminating glaciers in the Northern Hemisphere to retreat significantly during the 21st century (Kochitzky and Copland 2022). Recently published digital inventory of new exposed coasts shows that a total of 2466 ± 0.8 km of new coastline was exposed in period 2000–2020, giving an average length of 123 km every year. Two-thirds of this coastline was exposed in Greenland with shorter sections in Canadian Arctic Archipelago, Russian Arctic, Svalbard, and south-western Alaska (Kavan et al. 2025).

Juvenile paraglacial slopes are hotspots in the Arctic in terms of geohazards. They are known to be unstable after releasing from glacier ice and therefore prone to landsliding (Baltantyne 2002). What is more, massive landslides entering water can trigger tsunami-like waves, which were already recorded in the fiords of Greenland and Alaska in 21st century (Dahl-Jensen et al. 2004; Buchwał et al. 2015; Higman et al. 2018; Paris et al. 2019; Bloom et al. 2020). The process calls for hazard assessment studies as it poses a real danger to local communities as well as tourists visiting such sites. For example, the wave recorded in Karrat Fjord (West Greenland) in 2017, caused substantial infrastructure damage and loss of life in the settlement of Nuugaatsiaq (Strzelecki and Jaskólski 2020). The highest recorded Arctic landslide tsunami (Lituya Bay, Alaska, in 1958) reached a runup height of over 500 m (Miller 1960)! Ongoing climate change may lead to increased frequency of extreme waves in the region.

The objective of this ongoing study is to deliver a preliminary tsunamigenic landslide susceptibility assessment for all coastlines that have recently emerged recently from glacier ice, in areas where infrastructure or tourist activity is present. Analysis involves the utilisation of remotely sensed, topographic, and environmental data that is available to the public, with the objective of identifying areas of heightened susceptibility to specific phenomena.

Key words: new coasts, landslides, tsunamis, susceptibility assessment.

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References

- Ballantyne, C.K. (2002), Paraglacial geomorphology, *Quater. Sci. Rev.* **21**, 18–19, 1935–2017, DOI: 10.1016/S0277-3791(02)00005-7.
- Bloom, C.K., B. MacInnes, B. Higman, D.H. Shugar, J.G. Venditti, B. Richmond, and E.L. Bilderback (2020), Catastrophic landscape modification from a massive landslide tsunami in Taan Fiord, Alaska, *Geomorphology* **353**, 107029, DOI: 10.1016/j.geomorph.2019.107029.
- Buchwał, A., W. Szczuciński, M.C. Strzelecki, and A.J. Long (2015), New insights into the 21 November 2000 tsunami in West Greenland from analyses of the tree-ring structure of *Salix glauca*, *Pol. Polar Res.* **36**, 1, 51–65, DOI: 10.1515/popore-2015-0005.
- Dahl-Jensen, T., L.M. Larsen, S.A.S. Pedersen, J. Pedersen, H.F. Jepsen, G. Pedersen, T. Nielsen, A.K. Pedersen, F. Von Platen-Hallermund, and W. Weng (2004), Landslide and tsunami 21 November 2000 in Paatuut, west Greenland, *Nat. Hazards* **31**, 277–287, DOI: 10.1023/B:NHAZ.0000020264.70048.95.
- Higman, B., D.H. Shugar, C.P. Stark, G. Ekström, M.N. Koppes, P. Lynett, A. Dufresne, P.J. Haeussler, M. Geertsema, S. Gulick, A. Mattox, J.G. Venditti, M.A.L. Walton, N. McCall, E. Mckittrick, B. MacInnes, E.L. Bilderback, H. Tang, M.J. Willis, B. Richmond, R.S. Reece, C. Larsen, B. Olson, J. Capra, A. Ayca, C. Bloom, H. Williams, D. Bonno, R. Weiss, A. Keen, V. Skanavis and M. Loso (2018), The 2015 landslide and tsunami in Taan Fiord, Alaska, *Sci. Rep.* **8**, 1, 12993, DOI: 10.1038/s41598-018-30475-w.
- Kavan, J., M. Szczypińska, W. Kochtitzky, L. Farquharson, M. Bendixen, and M.C. Strzelecki (2025), New coasts emerging from the retreat of Northern Hemisphere marine-terminating glaciers in the twenty-first century, *Nat. Clim. Change* **15**, 528–537, DOI: 10.1038/s41558-025-02282-5.
- Kochtitzky, W., and L. Copland (2022), Retreat of Northern Hemisphere marine-terminating glaciers, 2000–2020, *Geophys. Res. Lett.* **49**, 3, e2021GL096501, DOI: 10.1029/2021GL096501.
- Miller, D.J. (1960), The Alaska earthquake of July 10, 1958: giant wave in Lituya Bay, *Bull. Seismol. Soc. Am.* **50**, 2, 253–266, DOI: 10.1785/BSSA0500020253.
- Paris, A., E.A. Okal, C. Guérin, P. Heinrich, F. Schindelé, and H. Hébert (2019), Numerical modeling of the June 17, 2017 landslide and tsunami events in Karrat Fjord, west Greenland, *Pure Appl. Geophys.* **176**, 7, 3035–3057, DOI: 10.1007/s00024-019-02123-5.
- Strzelecki, M.C., and M.W. Jaskólski (2020), Arctic tsunamis threaten coastal landscapes and communities – survey of Karrat Isfjord 2017 tsunami effects in Nuugaatsiaq, western Greenland, *Nat. Hazards Earth Syst. Sci.* **20**, 9, 2521–2534, DOI: 10.5194/nhess-20-2521-2020.

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