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INTEGRATED SITE INVESTIGATIONS FOR INFRASTRUCTURE PLANNING IN GREENLAND

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This talk aims to provide an introduction to challenges and approaches to site investigations for infrastructure planning and development in Greenland. Much of the existing infrastructure in Greenland - including residential buildings, roads and airport runways - is poorly adapted to existing conditions and is subject to deterioration or damage (Ingeman-Nielsen et al., in press). Built infrastructure affects permafrost conditions and may itself induce permafrost degradation. Climate change acts as an amplifying factor and with current predictions, it is expected to play an increasing role.

Meanwhile in Greenland, demands on infrastructure are rising due to increasing tourism and migration of population into larger towns. In the last two years, expansion or building of five airports, together with supporting infrastructure, have been decided by the Greenlandic Home Rule (The Government of Greenland). Structures such as airports and roads are distributed over broad areas, and therefore cross variety of environments. With permafrost in all of its forms affecting virtually the entire ice-free area in Greenland, there is a need for better permafrost knowledge and more reliable permafrost projections to support infrastructure design choices and justify the high cost associated with new engineering solutions and adaptation measures. Better projections require more engineering monitoring surveys and in-situ experimentation, as well as more spatially distributed and longer-term permafrost monitoring time series.

At numerous sites in Greenland, the geological history has resulted in a complex ground profile consisting of an upper ice-rich part and a lower zone with high residual salinity in pore water, high unfrozen water content, low or no ice content and low bearing capacity (Foged, 1979; Ingeman-Nielsen, 2008). In such settings, inadequate site investigation methods may fail to document these anomalies and thereby lead to poor choices of foundation design.

Two case studies of ongoing site investigations for large infrastructure projects in Greenland (a new airport in Ilulissat and a general geotechnical characterisation of permafrost conditions in Qaanaaq (Thule)) will illustrate the complex approaches for a more reliable assessment of ground geotechnical properties. We apply a range of methods, from studies of archive data, geophysical surveys, geotechnical drilling and borehole temperature monitoring for an integrated description of permafrost conditions. Aiming for a more spatially-distributed, longer-term predictions of ground thermal state, we develop and test alternative monitoring approaches, combining geophysical and thermal observations in a numerical modelling scheme. We share our practical experiences from these applications.

References:

Foged, N., 1979: Engineering Geological Investigations of Quaternary Marine Clay Deposits on West Greenland. Ph. D. Thesis. The Institute for Applied Geology. Technical University of Denmark.

Ingeman-Nielsen, T., N.N. Foged, R. Butzbach and A.S. Jørgensen, 2008: Geophysical investigations of saline permafrost at Ilulissat, Greenland. In: Kane, D.L. and K.M. Hinkel (Eds.). Proceedings of the Ninth International Conference on Permafrost, Fairbanks, Alaska, 2008. Volume 1, pp. 773-78. Institute of Northern Engineering, University of Alaska Fairbanks.

Ingeman-Nielsen, T., Lemay, M., Allard, M., Barrette, C., Bjella, K., Brooks, H., Carbonneau, A.-S., Doré, G., Ducharme, M.-A., Foged, N., L'Hérrault, E., Lading, T. & Mathon-Duffour, V. (2017): Chapter 10 - Built Infrastructure. In: AMAP: Adaptation Actions for a Changing Arctic - Perspectives from the Baffin Bay/Davis Strait Region. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. In press.