Permafrost degradation in West Greenland

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Important aspects of civil engineering in West Greenland relate to the presence of permafrost and mapping of the annual and future changes in the active layer due to the ongoing climatically changes in the Arctic. The Arctic Technology Centre (ARTEK) has worked more than 10 years on this topic and the first author has been involved since 1970 in engineering geology, geotechnical engineering and permafrost related studies for foundation construction and infrastructures in towns and communities mainly in West Greenland. We have since 2006 together with the Danish Meteorological Institute, Greenland Survey (ASIAQ) and the University of Alaska Fairbanks carried out the US NSF funded project ARC-0612533: Recent and future permafrost variability, retreat and degradation in Greenland and Alaska: An integrated approach. This contribution will present data and observations from the towns Ilulissat, Kangerlussuaq, Sisimiut and Nuuk. They are situated in continuous, discontinuous and sporadic permafrost zones. We will show examples of detoriation of permafrost related to present local scale climate observations and large scale climate and permafrost simulations modeled numerically with the GIPL model driven by HIRHAM climate projections for Greenland up to 2075. The engineering modelling is based on a risk assessment methodology based on a flow diagram which classify the risk of permafrost degradation causing settlement and stability problems for buildings and infrastructures based on relatively simple parameters. It is planned as decision and planning tool for town planners and engineers in local municipality governments and to consulting engineers and contractors in Greenland, which also may be used in other arctic regions. Risk is classified in four categories: Low, Limited, Medium and High based on environmental properties as surface conditions (rock or sedimentary basins), soil grain size classification (gravel, sand, silt and clay) and ice content in the ground. The model uses ground thermal conditions quantified as the Permafrost Thaw Potential, which is defined as the potential active layer increase due to climate warming and surface alterations. Using this methodology it is expected that mapping of vulnerability in towns and construction areas together with proposed adaption and mitigation technologies will be of practical use to technical institutions and public as well as a general tool for the scientific community. The presentation will focus on the application of the Risk Evaluation diagram used in the selected towns in different permafrost zones and is illustrated with present observations of permafrost detoriation in West Greenland.

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