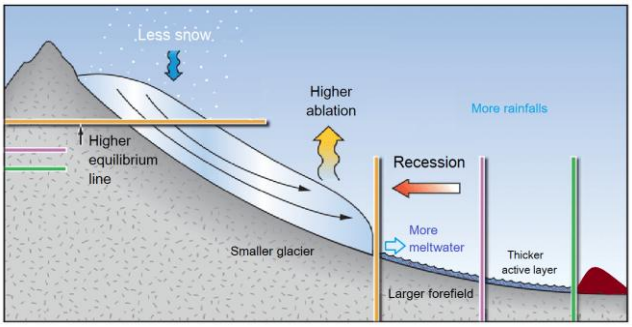
Hydrological modelling of drainage response to climate warming in the Arctic glacierised basins

As a consequence of climate change in the Arctic, we are observing reducing volume and retreat of the glaciers from the previously covered areas, resulting in the expansion of their ice-free surface zone – forefield, thereby increasing its role in the hydrology of glacier catchments. Furthermore, due to the permafrost loss (soil or rock in temp. < 0ºC) as a result of an increase of the ground temperature, wody Surface water infiltrates much deeper into the underground forefield zone.

We have at the same time two domains:
(1) **a glacier** as an object that supplies water from its body, and affecting changes in the catchment geomorphology by its progressing recession,
(2) **a forefield,** supplied by glacier ablation water and rainfalls, modifies drainage and discharge from the catchment within its surface (surface runoff, river runoff) and underground (groundwater flow and storage) parts.



Schematic presentation of changes in two domains in an Arctic glacierised basin affecting water drainage, storage and discharge (from Candas, 2017, modified; **https://doi.org/10.13140/RG.2.2.10834.40646)**

The increasing surface area and the soil active layer thickness in forefield sediments, is so far a poorly explored issue for glacierised catchments, which are the sources of water supply to inhabited areas for many mountainous and polar regions. Additional, estimation of the size of the runoff from the catchment area, which determines the inflow of fresh water to the ocean, transport of sediments and chemical components as well as biological material, is of great importance for ecosystems, with particular emphasis on the ecology of coastal zones.

This project aims to indicate how climate change is affecting the drainage system and water balance of glacierised catchments in the Arctic in a hydrological modelling approach for the surface zone of the forefield and the hydrologeological modelling for of its underground zone, supplied by waters from glacier melt and rainfall, which enabling both quantitative and spatial analyses, with particular emphasis on the role of increasing glacier forefield capacity in drainage and water storage.
Our specific aims are: I - identification of the role and quantitative importance of precipitation waters and ablative waters from recessional glaciers in the hydrological balance of the catchment in view of ongoing climate change, **II -** determination and estimation of the water capacity potential of the forefield area caused by glacier recession, geomorphological conditions, and how it affects the surface drainage in catchment.**, III -** determination and estimation of the water capacity potential in glacial sediments as well as hydrogeological conditions and active layer thickness changes, as a consequence of climate change, and how it affects the subsurface drainage in catchment, **IV** - evaluate the applicability and limitations of two modelling tools for hydrological and hydrogeological studies of drainage and water balance studies in the polar environment. The study area includes forefields of the southern Spitsbergen glaciers: Werenskioldbreen and Renardbreen. **The 1st step is** analysis, preparation and setup of a input datasets for planned modelling studies. These includes the implementation, collection and processing archival data and comparative meteorological and hydrological monitoring in glacierised catchment as model input and verification data. Then **in 2nd step**, three categories of project modelling work would be conducted:**[1] glacier** - quantification of ablative water supply - modelling glacier melt, **[2] forefield surface** - hydrological model 1D, hydrological balance **[3] forefield subsurface** - hydrogeological model 3D, hydrogeological balance. **The obtained results allow to** indicate the leading factors and trends in progressive changes in the glacier's forefield water cycle under the influence of climate warming, on the basis of reconstruction of previous meteorological, hydrological and glaciological conditions. The use of modeling methods will enable a quantitative and spatial analysis of changes in the drainage system and the contribution of components of the hydrological balance in two compared glaciated catchments, to achieve a broader context of analysis and conclusions than single case studies.