



Quantification of landscape changes in the foreland of polythermal glacier, Hørbyebreen, Svalbard – transition from glacial to paraglacial processes.

Marek Ewertowski (1), David Evans (2), David Roberts (2), Aleksandra Tomczyk (1), Wojciech Ewertowski (1), and Krzysztof Pleskot (1)

(1) Faculty of Geographical and Geological Sciences, Adam Mickiewicz University, Poznan, Poland (marek.ewertowski@gmail.com), (2) Department of Geography, Durham University, Durham, United Kingdom

Glacial forelands exposed due to the glacier recession are one of the most dynamically transformed landscapes in Polar and mountainous areas. Ice margins of most of the Svalbard's glaciers retreated since the end of the Little Ice Age, so the exposed forelands are common landscape component giving us a perfect opportunity to study transformations of landforms as a response to changes in climatic conditions and geomorphological processes. This study deals with landscape transformation in a decadal time-scale in the foreland of Hørbyebreen, Svalbard. The main aim of this study is to illustrate transition from glacial to proglacial (paraglacial) conditions by: (1) mapping and quantifying landforms development, and (2) evaluating the most important geomorphological processes responsible for landscape changes. Changes in landscape in front of Hørbyebreen were quantified using time-series of remote sensing data (aerial images, satellite images, digital elevation models [DEMs]) and field geomorphological mapping. Four sets of historical aerial photographs were obtained from the Norsk Polar Institute, and two sets of satellite images were purchased from Digital Globe and Apollo mapping companies.

The total decrease in the glacier extent in the period 1900 – 2013 was about 13.3 km² or almost 50% of its maximum extent. The presented values indicate only the change of the clean glacier cover (i.e. ice surface without debris) and there is still large amount of ice buried under the debris of the moraine complex. Shrinkage of the ice cover led to the detachment of two smaller ice units, which in the past were linked to the main trunks of ice. In total, since the LIA the percentage of the catchment area occupied by ice decreased from 62% to 34%, which demonstrate importance of switching from glacial to paraglacial geomorphological processes.

DEM of Differences of the foreland of Hørbyebreen during the periods 1960-1990, 1990-2009 as well for whole studied period (1960-2009) shown widespread lowering mostly related to the melting of the exposed ice surface. Only small areas indicated positive elevation changes. The total net volume of change over the 1961-2009 period from the glacier snout and foreland was about -215 million m³ (+/- 3%). Annual percentage changes in snout area and volume vary over the study period. Spatial variability was different for two main glacial units, which is indicated in the patterns of elevation changes. Percentage of the Area of Interest with detectable changes varied from 64% to 90%, and errors for volume loss was much smaller (from 3 to 8%) than for deposition (from 62 to 70%). Much larger uncertainty of measurements of volumes of deposition is related to the fact that increase in surface elevation was usually small (within the range of DEM errors). The area covered by clean glacial ice, ice-cored moraines, till plains, fluvio-glacial deposits, rivers and lakes were quantified for each available period (i.e. between Little Ice Age and 2013 glacier margin) for the proximal part of the glacial system.