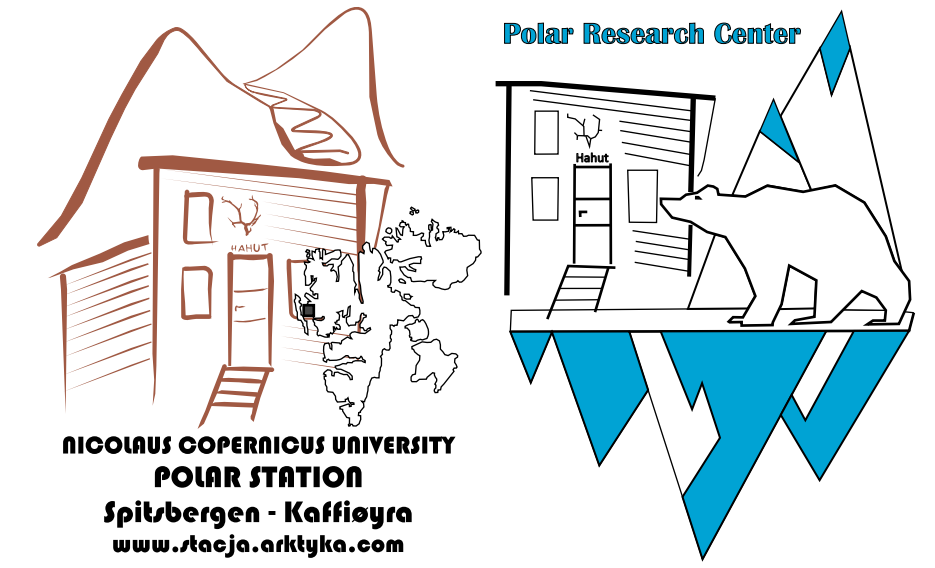


Research on contemporary changes in the coastline of Kaffiøyra (Svalbard) in the light of photogrammetry and remote sensing using UAV



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Introduction

The Arctic is a region where changes caused by climate warming are the most conspicuous. Between 2000 and 2019, the average mass balance of all glaciers, calculated on the basis of DEM models, was $-267 (\pm 16)$ Gt/year (Hugonnet 2021). The recession of the glaciers in the Kaffiøyra area during the period of analysis is a result of a negative trend in the mass balance and dynamics of the Svalbard glaciers. From the time of the maximum advance to 2020, the glaciers in this area decreased by about 48.0% on average (Sobota 2021). In many parts of the world, glaciers are the main source of water supply for hundreds of millions of people, a source of electricity generation or an element responsible for the local structure of flora and fauna. They involve all elements of the cryosphere, as well as contribute to landscape transformation. This is also evident in the contemporary reshaping of the coastline.



Research of Area

The changes in coastline were the subject of research conducted in the area of Kaffiøyra, which is a coastal plain situated in the north-western Spitsbergen (Oscar II Land) – the largest island of the Svalbard archipelago. The plain is the widest in the north, reaching more than 3.4 km. The research is a part of long-term observations and monitoring of changes in the cryosphere and landscape of that area. Kaffiøyra has a diverse coastline: in the north the coastal strip of the plain is low and aggradational, whereas its southern part is predominantly cliffy.

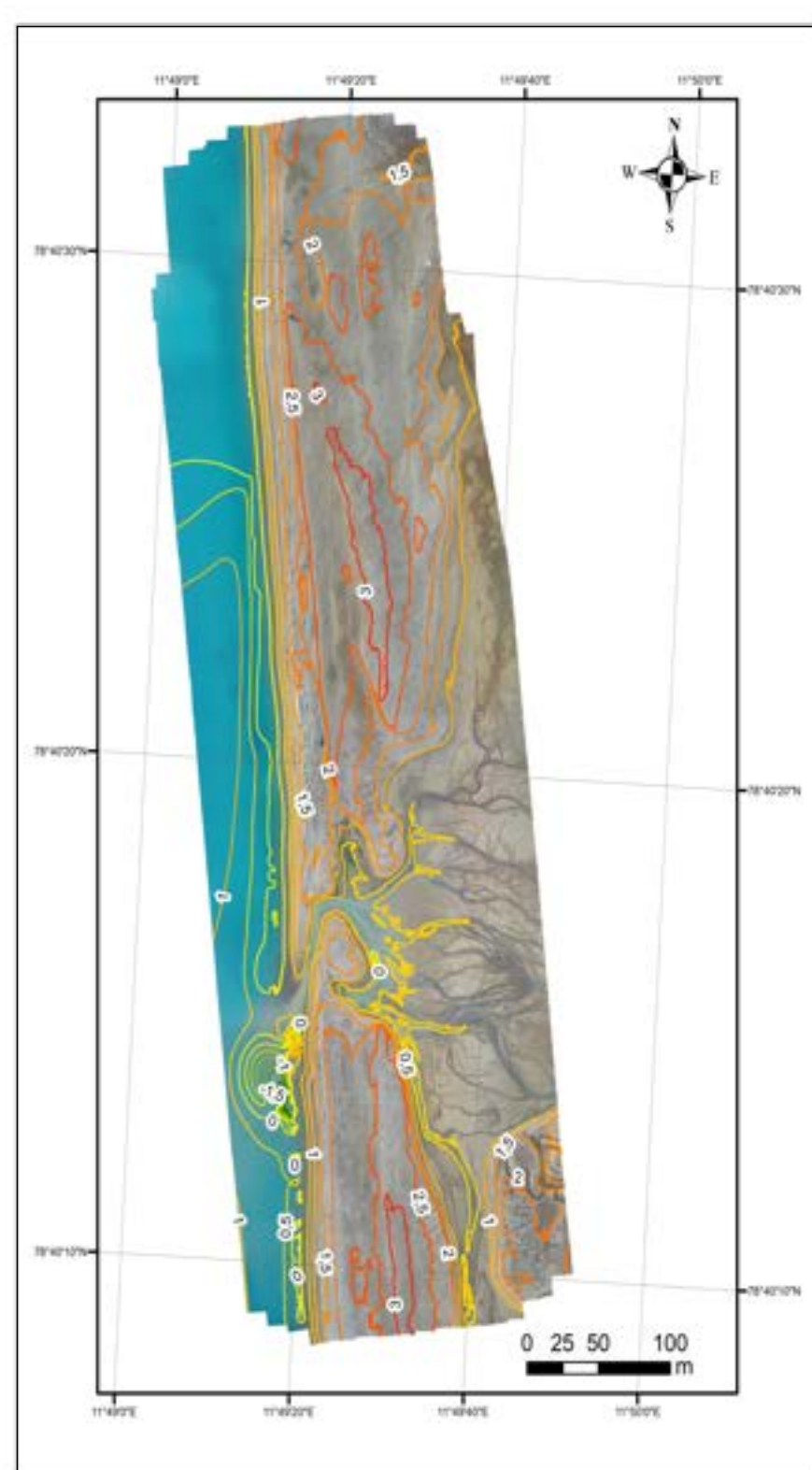
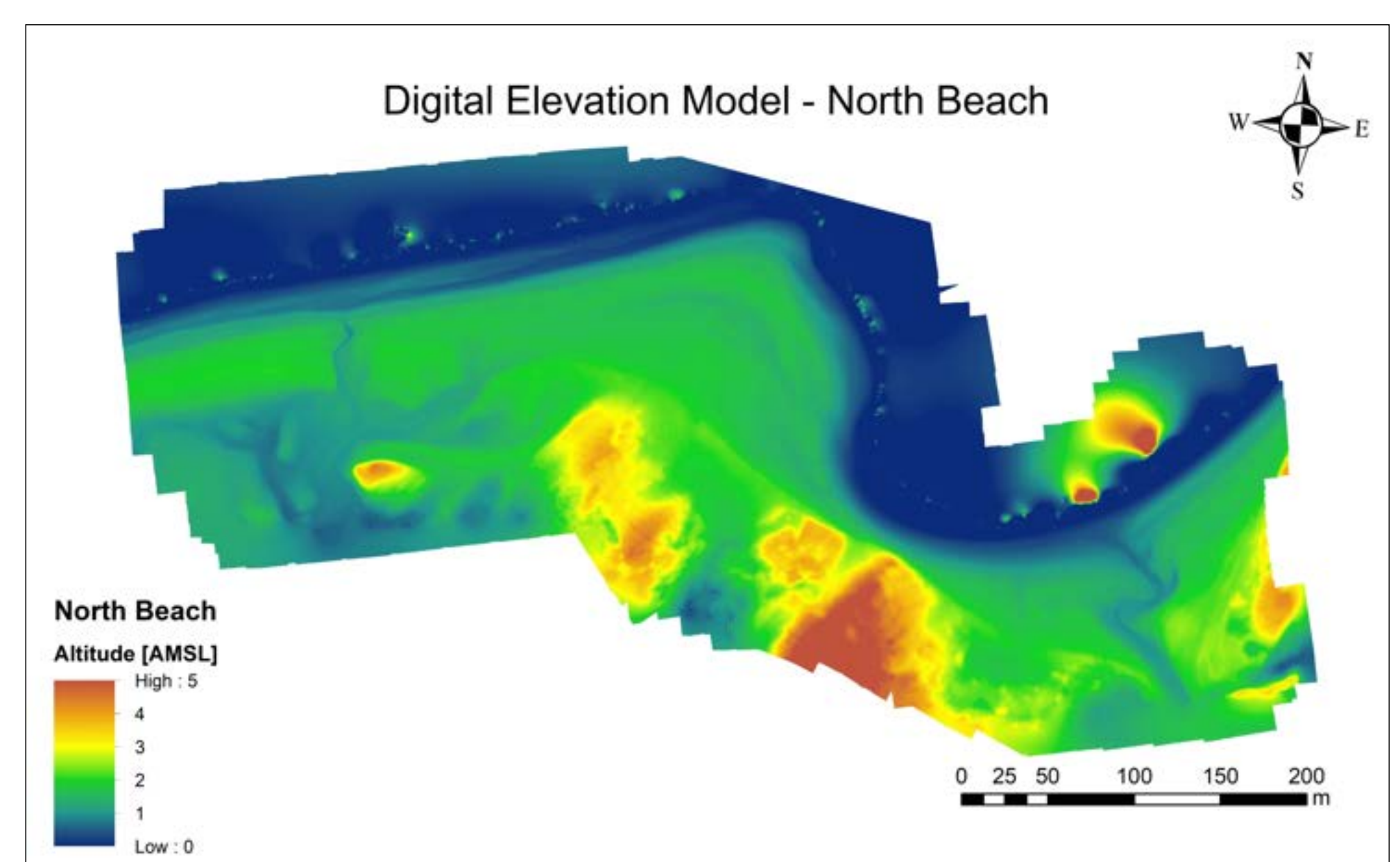
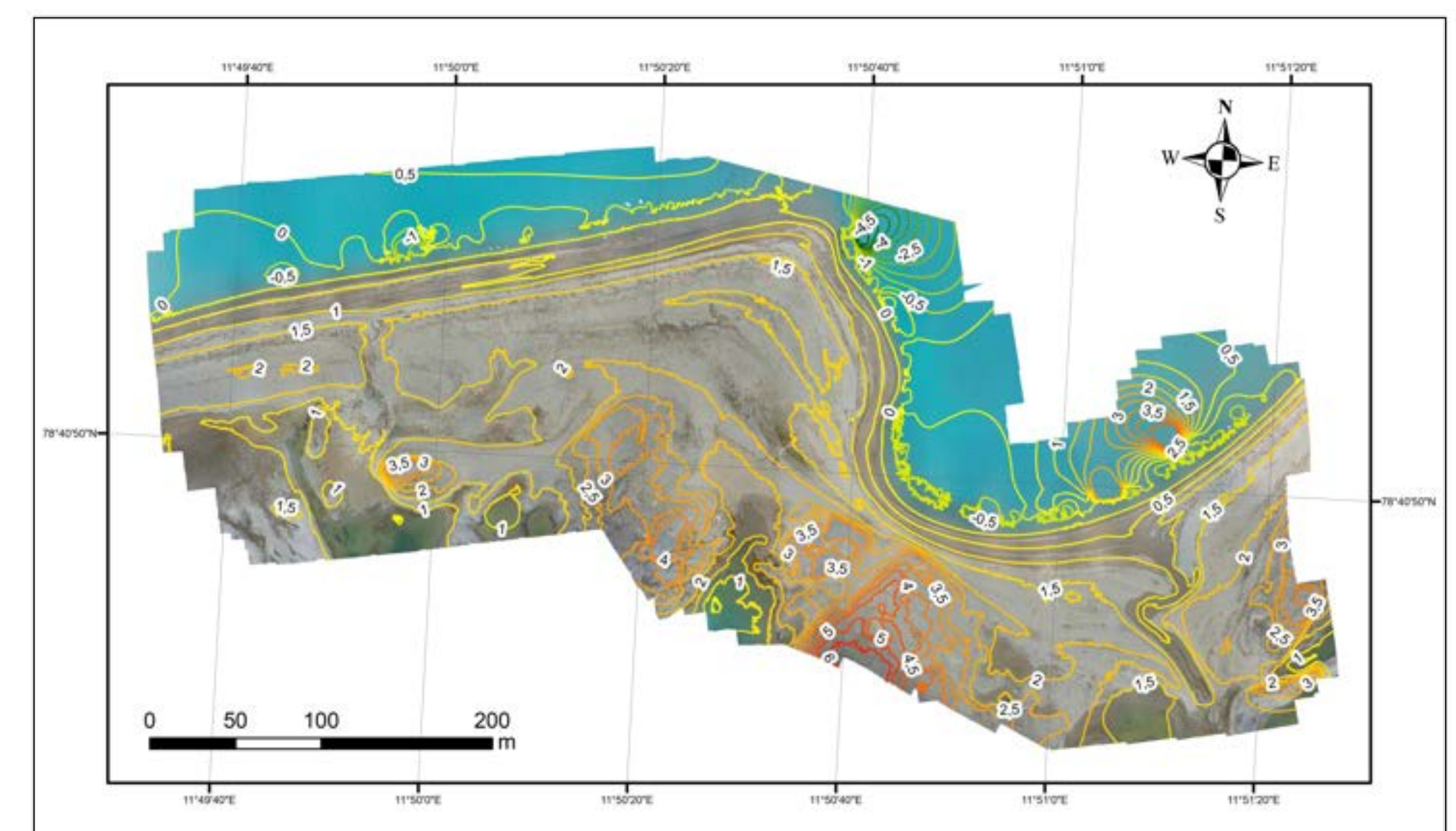
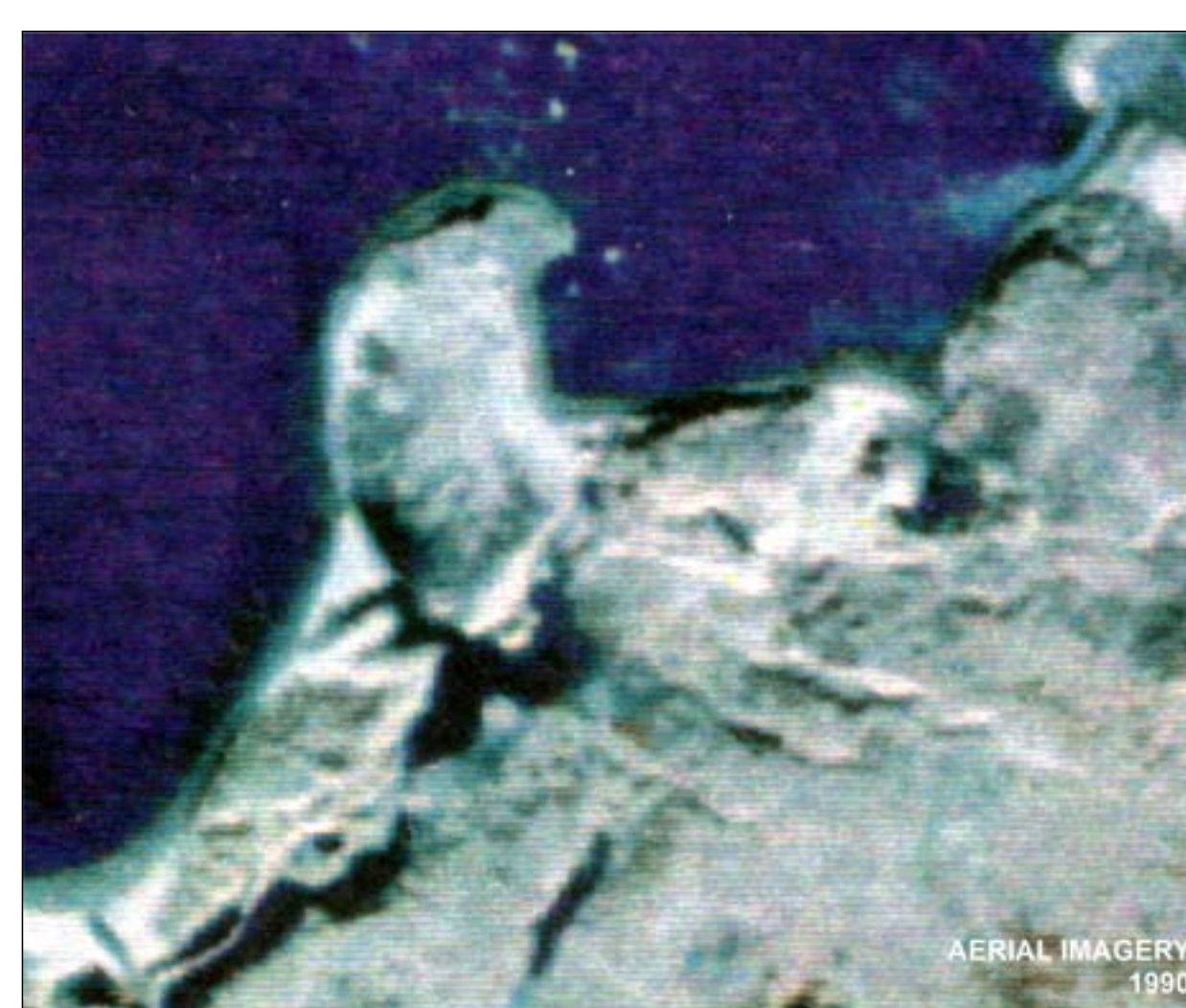
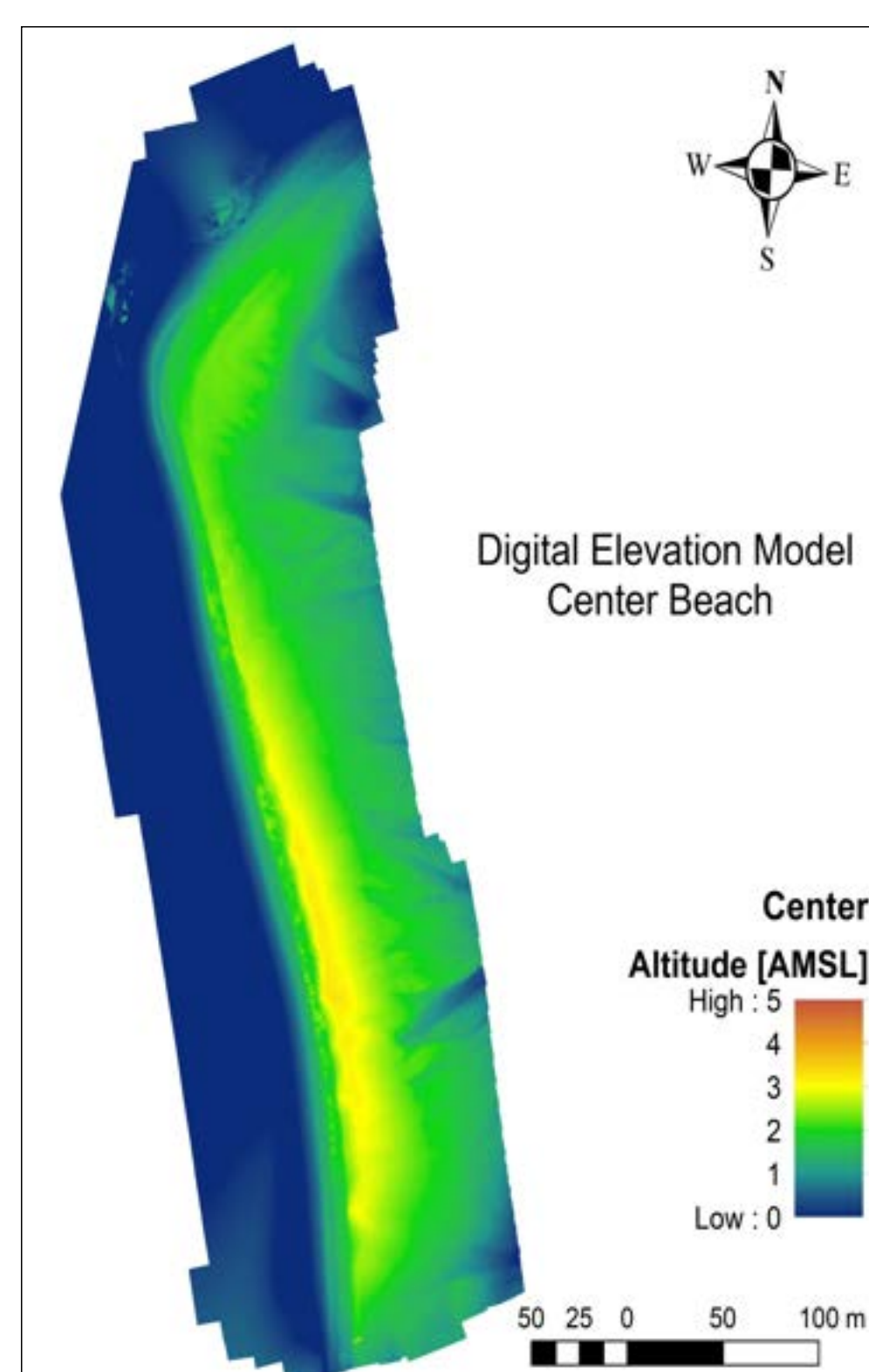
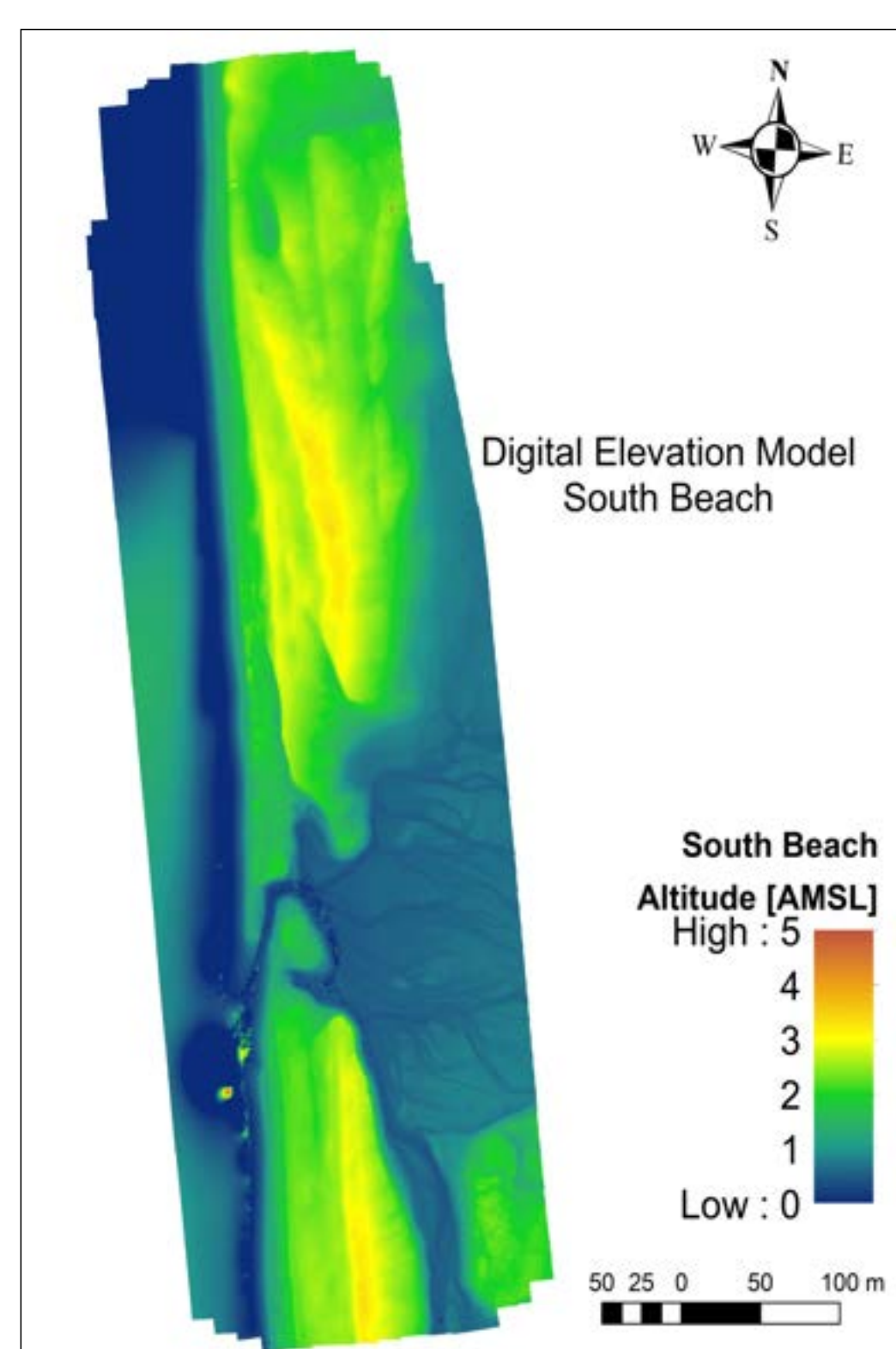


Methods

Satellite imaging and photogrammetric flights were used in the measurements. The analysis of Kaffiøyra coastline covered an area of 44 ha over which a number of UAV flights were carried out. Principal activities were conducted in the north part of the plain where the NCU Polar Station is located. In the south a preliminary reconnaissance was done without establishing measurement sites. The data was evaluated using UgCS PRO – the software designed to control flight missions, select UAV routes, set up imaging parameters etc. Agisoft Metashape Professional was used to transform raw images into the final product (dense point cloud – orthomosaic). In order to increase the accuracy of the model GNSS Geomax Zenith Pro 35 was used to measure the points on the ground. As a result, a digital elevation model (DEM) was generated and an orthophotomap was produced. In the above study, more than 100 measurements were made, which were then georeferenced in post-production. Thanks to the use of the highest quality equipment, the resolution of the presented images varies from 5.4 to 10.4 cm.

Results

In the presented analysis zones, a significant number of glacio-fluvial and glacial forms were noted. It can be distinguished, for example: in the northern beach the zone of former meltwater channels, the points of shallow (the altitude of which may indicate a measurement error in the bay zone) and the moraine zone; in the central part the sandy beach level; in the southern beach the backwater and outwash of drain water of the Waldemar Glacier River flowing through one stream, surrounded on the north and south by sandy embankments and areas of transport and accumulation of sediments deposited in sea zone. What's more, the research on the change of Kaffiøyra coastline has been enriched with satellite imagery and aerial images from the 60s of the twentieth century. The image from over 50 years allowed to clearly define the dynamics of changes, the formation of new sandy bank or sand spit.



Bibliography

Hugonnet R. i in. 2021: Accelerated global glacier mass loss in the early twenty-first century. *Nature*, 592, 726–731. doi:10.1038/s41586-021-03436-z
<https://www.nature.com/articles/s41586-021-03436-z>

Sobota I. 2021. *Glaciers of Kaffiøyra*. [in] Atlas of changes in the glaciers of Kaffiøyra (Svalbard, the Arctic). (ed.) I.Sobota. Wydawnictwo Naukowe UMK, 77-87

