Publications of the Institute of Geophysics, Polish Academy of Sciences
Geophysical Data Bases, Processing and Instrumentation
vol. 455 (P-5), 2025, pp. 33–34
DOI: 10.25171/InstGeoph_PAS_Publs-2025-075
40th International Polar Symposium – Arctic and Antarctic at the Tipping Point, 4–7 November 2025, Puławy, Poland

Long-term Transformation of the Polar Coast Environment in NW Spitsbergen based on Modern Photogrammetric Measurements and Remote Sensing Techniques

Kamil CZARNECKI✉ and Ireneusz SOBOTA

Nicolaus Copernicus University in Toruń, Faculty of Earth Sciences and Spatial Management, Department of Hydrology, Cryology and Water Management, Polar Research Center, Toruń, Poland

✉ kczarnecki@doktorant.umk.pl

A b s t r a c t

The polar zones, the Arctic and Antarctic, are considered to be areas where global warming is particularly pronounced and the rate of change is up to 4 times faster. In the global approach, an important aspect of scientific research is also the analysis of changes in the coastline in the High Arctic. The dynamics of changes in the polar areas, caused, for instance, by a longer period without ice phenomena, irregular outflows of meltwater rivers, the variable nature of coastal currents (a set of hydro-oceanic processes), or permafrost thawing, lead to cyclical, often short-term changes. On the other hand, the recession of the tidewater glaciers, and at the same time their frequent surge phenomenon (occurring in 13% in Svalbard, about 1% in the world), leads to the discovery and transformation of huge new areas of the coastline, islands, and straits. To assess the changes observed in the north-western part of Spitsbergen, a number of remote sensing and photogrammetric tools (UAVs, CoastSat modules, DSAS) and data on which they were based (archival NPI aerial imagery, Landsat 5-8, Sentinel 2 and Pleiades satellite images, Digital Terrain Models and Orthomosaics made with UAVs) were used. The main area of research was located near the Polar Station of the Nicolaus Copernicus University, in the northern part of the Kaffiøyra Plain (Fig. 1). Neighboring areas such as Sarsøyra Plain and Prins Karls Forland are also included. This research was carried out in this part of the Svalbard Archipelago for several main reasons: the Kafføyra lowland is a distinctive research material due to its low degree of human transformation, its specific location (along the Forland Strait, surrounded by the island of Prins Karls Forland and the Løvenskioldfonna mountain area, far from the permanent settlements of the Svalbard archipelago), as well as access to the polar station and its extensive database of materials concerning this environment (geomorphological, meteorological, hydrological or glaciological). The main objective of the analysis of shoreline changes was the use and evaluation of the usefulness of remote methods of shoreline extraction and the determination of the main zones of accumulation and erosion of the shores. In this study, the authors tried to explain the causes of changes

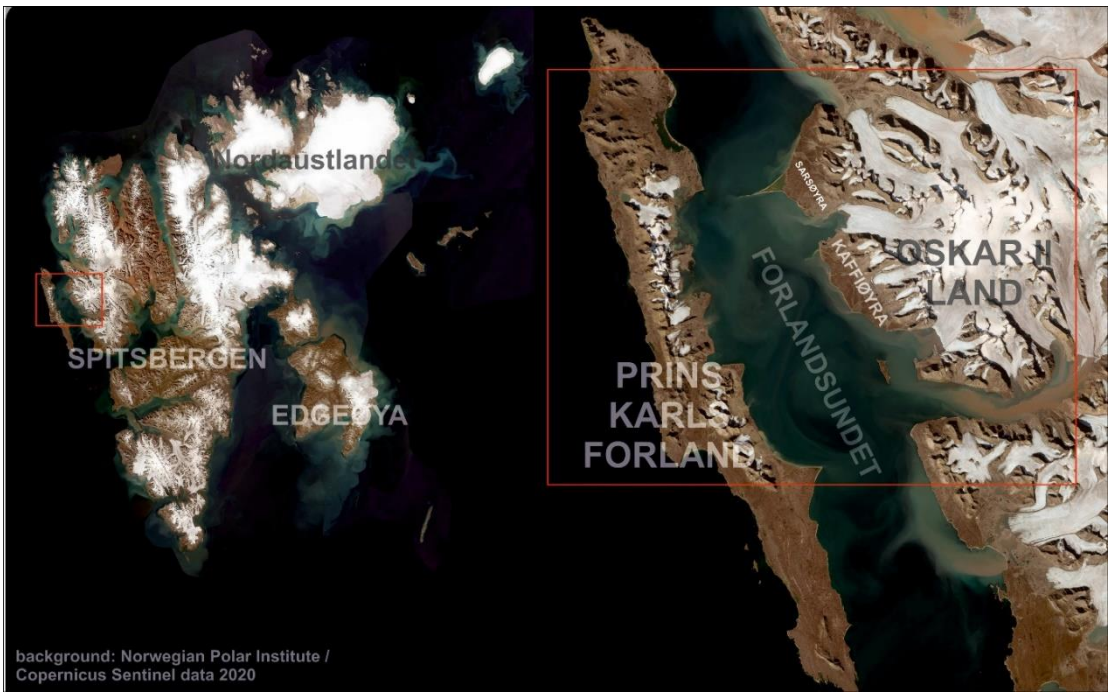

Fig. 1. Area of interest. NW Spitsbergen.

in the polar environment by analyzing topographic and oceanic aspects. The average rate of coastline retreat in the adopted AOI ranged from –0.24±0.16 m yr^{-1} to 0.70±0.16 m yr^{-1} (1966–2021) and from –0.03±0.39 m yr^{-1} to a maximum of 0.92±0.68 m yr^{-1} (approx. 1990–2024). The main directions of changes in the shoreline were determined, as well as the zones of dynamic changes over 50 years were determined: the variable nature of the estuary, the formation and transformation of new lakes, spits, and bays were traced. The seasonal rate of changes in the nature of the Waldemar estuary (change of the direction of the estuary, over-building), the dynamism of the Hornbæk zone in connection with the recession and the surge of the Aavatsmarkbreen, the build-up of spits, or the formation of coastal lakes were recorded.

Received 15 September 2025
Accepted 20 October 2025