1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title:
Characteristics of changes in the shoreline in the light of photogrammetric studies using UAVs in the High Arctic, on the example of the Kaffiøyra region, Svalbard

1.1. Project goals

The aim of the project is to analyze changes in the coastline in the polar zone, using the example of the Kaffiøyra region (Svalbard). The analysis will include

- Development of historical and contemporary sources presenting the variability of the Kaffiøyra coastline with particular use of aerial and satellite photos.
- Field studies in Spitsbergen, during which photogrammetric flights and GPS measurements will be conducted.
- Estimation of the causes and forecasts of changes in the Kaffiøyra coast and their presentation in the form of detailed maps of spatial variability.

1.2. Outline

Kaffiøyra is a coastal plain located in the northwestern part of Spitsbergen, the Svalbard archipelago. Since the establishment of the Nicolaus Copernicus University Polar Station in 1975, the plain has become an excellent scientific testing ground for many scientists, academic staff, doctoral candidates and students.

The Kaffiøyra coastline stretches for 24 km, annually undergoing transformation due to intermediate factors (glacier recession) and direct factors (hydrodynamic). Research conducted in the High Arctic, using Kaffiøyra as an example, is particularly important in times of global climate change and pertains to issues related to glaciology, hydrology, and geomorphology. In response to continuous technological development, remote methods for acquiring and processing environmental data are increasingly being used in polar research. These studies are a valuable element in illustrating short- and long-term climate changes and allow us to understand the mechanisms causing these transformations. The average coastal erosion in the Arctic varies from 0 to 2 m/year, while locally in eastern Siberia and the Beaufort Sea, it increases to as much as 20 m/year.

The project will be based on a series of photogrammetric missions during polar expeditions to Spitsbergen in geomorphologically active areas (e.g., the spit in Hornbækbukta bay, the mouth of the Waldemar River, cliff coasts in the southern plain). Due to the very specific conditions prevailing in the Arctic, the selection of specific areas and their analysis will be extensively discussed and chosen depending on the weather conditions. Further research will be based on the processing of available historical and contemporary resources and the analysis of the transformation scale. Resource processing will include, among other things, the merging of raw UAV images into the final product - DEM and orthophotomosaic with the support of specialist software such as Agisoft Metashape. Geointerpretation of available images will indicate the shape of the coastline, as well as highlight its main active zones. For this purpose, methods characteristic of this type of activity will certainly be used, such as DoD (Dem of Difference), DSAS (Digital

Shoreline Analysis System). Due to the very characteristic orography of the Kaffiøyra region, along the Forland Strait and protected from the open sea by the Prince Karls Land, this study will be a valuable complement to geomorphological-remote sensing studies in the polar zone, which have not yet been conducted in detail in the northwestern part of Spitsbergen.

1.3. Work plan

October 2023 - December 2023
Preliminary research on publicly available platforms with aerial and satellite resources. Selection of the area to be surveyed using photogrammetric flights
January 2024 - February 2024
Literature review on the subject under investigation
March 2024 - May 2024
Building a database on the shape of the coastline of the Kaffiøyra region
June 2024 - September 2024
Photogrammetric flights in designated AOI zones during the expedition to Spitsbergen
October 2024 - May 2025
Processing of the obtained data
June 2025 - September 2025
Photogrammetric flights in designated AOI zones during the expedition to Spitsbergen
October 2025 - May 2026
Processing of the obtained data
June 2026 - September 2026
Photogrammetric flights in designated AOI zones during the expedition to Spitsbergen
October 2026 - February 2027
Preparation of articles based on the obtained results

1.4. Literature *(max. 10 listed, as a suggestion for a PhD candidate)*

Sobota, I. Atlas of Changes in the Glaciers of Kaffiøyra (Svalbard, the Arctic), 1st ed.; Scientific Publishers of the Nicolaus Copernicus University: Toruń, Poland 2021, pp. 216.

Sobota I., 2013. Współczesne zmiany kriosfery północno-zachodniego Spitsbergenu na przykładzie region Kaffiøyry. Wydawnictwo Naukowe UMK. 449 pp.

Niewiarowski, W.; Myzyk, B. Kaffiøyra coast (Oscar II Land), its morphogenetic factors and processes. Acta Univ. N. Coperni-ci, Geografia 1983, 18, 17 43.

Ruszkowska, B. Formy rzeźby plaży spowodowane działalnością lodu na Ziemi Oskara II (Północno-zachodni Spitsbergen), Przegl. Geogr. 1985, 57, 693-701

Himmelstoss, E.A.; Henderson, R.E.; Kratzmann, M.G.; Farris, A.S. Digital Shoreline Analysis System (DSAS) version 5.1 user guide: U.S. Geological Survey Open-File Report 2021-1091 2021, pp. 104. https://doi.org/10.3133/ofr20211091

Irrgang, A.M.; Bendixen, M.; Farquharson, L.M.; Baranskaya A.V.; Erikson L.H.; Gibbs, A.E.; Ogorodov, S.A.; Overduin, P.P.; Lantuit, H.; Grigoriev, M.N.; Jones, B.M. Drivers, dynamics and impacts of changing Arctic coasts. Nat Rev Earth Envi-ron 2022, 3, 39-54. https://doi.org/10.1038/s43017-021-00232-1

Lantuit, H.; Overduin, P.P.; Couture, N.; Wetterich, S.; Are, F.; Atkinson, D.; Brown, J.; Cherkashov, G.; Drozdov, D.; Forbes, D.L.; Graves-Gaylord, A.; Grigoriev, M.; Hubberten, H.W.; Jordan, J.; Jorgenson, T.; Ødegård, R.S.; Ogorodov, S.; Pollard, W.; Rachold, V.; Sedenko, S.; Solomon, S.; Steenhuisen, F.; Streletskaya, I.; Vasiliev, A.; The Arctic Coastal Dynamics data-base. A new classification scheme and statistics on Arctic permafrost coastlines. Estuaries and Coasts 2012 35, 383-400. https://doi.org/10.1007/s12237-010-9362-6

Jones, B. M.; Irrgang, A.M.; Farquharson, L.M.; Lantuit, H.; Whalen, D.; Ogorodov, S.; Grigoriev, M.; Tweedie, C.; Gibbs, A.E.; Strzelecki, M.C.; Baranskaya, A.; Belova, N.; Sinitsyn, A.; Kroon, A.; Maslakov, A.; Vieira, G.; Grosse, G.; Overduin, P.; Nitze, I.; Maio, C.; Overbeck, J.; Bendixen, M.; Zagórski, P.; Romanovsky, V.E. Coastal Permafrost Erosion. Arctic Report Card 2020 https://doi.org/10.25923/e47w-dw52

Zagórski, P.; Jarosz, K.; Superson, J. Integrated Assessment of Shoreline Change along the Calypsostranda (Svalbard) from Remote Sensing, Field Survey and GIS. Marine Geodesy 2020, 43, 433-471. https://doi.org/10.1080/01490419.2020.1715516

1.5. Required initial knowledge and skills of the PhD candidate

- The candidate should be a graduate of environmental studies (geography, environmental geoinformation, spatial management)
- Ability to use GIS software (ArcMap, QGis, ArcGIS PRO) and photogrammetry (Agisoft Metashape)
- Be an active person, willing to go on a three-month field study in Spitsbergen
- Have a license or training course in the operation of UAVs

1.6. Expected development of the PhD candidate's knowledge and skills

- Broadening skills in the use of UAV software
- Development of high-resolution images, DEM and orthophotomosaics
- Proper interpretation of the obtained results in the context of changes in the coastline on Kaffiøyra

- Development of skills in creating maps, e.g. transformations of the Kaffiøyra coast. Proficient use of GIS and photogrammetric tools