MSc Thesis research plan

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Working title: A methodological comparison of bathymetric modelling in large sub-arctic rivers – case study in Tana river, Finland

Introduction

Efficient, accurate and cost-effective methods to model river bathymetry benefit the field of earth sciences (Kinzel et al., 2013). Detailed information of river bathymetry may assist with questions related to, for example, hydrology related management and decision-making issues, sustainable development, and predicting future conditions and how to prepare for them. To understand and gain knowledge of many essential hydrological and environmental factors on riverine environments, for example stream velocity, sediment transportation and littoral habitat mapping to name a few, it is beneficial to know every physical aspect of underwater morphology and topography (Flener et al., 2012). In the Arctic region, the climate change has warmed the area more than six time the global average in the last decade (Huang et al., 2017), which is affecting for example the local environments, landscapes, habitats, livelihoods, and species dramatically. Tana, being a large sub-arctic river, can provide essential information and future scenarios on river conditions in these changing temperatures.

In recent years shallow water monitoring techniques, especially in river environments, have developed greatly (Alho et al., 2011; Kinzel et al., 2007). Especially active remote sensing techniques, e.g. airborne laser, allows shallow water modelling with high spatial and temporal resolution, and gains access to remote or otherwise hard-to-reach places. Traditionally, bathymetric models have been implemented using field measurements and passive remote sensing methods, e.g. aerial imagery and echo-sounding. For an analysis to have an efficient workflow, it would be advisable to know which remote sensing methods fit the circumstances of the study area best, composing the most accurate model of river bathymetry. Things to consider include, for example, the fluvial conditions of the river, geomorphology and weather constraints (Flener et al., 2012; Kinzel et al., 2013).

Tana's morphology consists of fluvioglacial material and older fluviatile and glacio-marine sediments. At the lower course of the river, the sediment, consisting mostly of sand, silt and clay, is quite erodible (Collinson, 1970; Mansikkaniemi, 1970). The main factors controlling the erosion and other modifications in the river bed are wind, waves and changing currents. The magnitude of those impacts depends on local morphology, slope and the duration and strength of wind (Collinson, 1970). Amongst other things, these geophysical elements are to be taken into consideration when trying to give evidence of most suitable remote sensing technique.

For the models to be useful in future studies, a proper assessment is in place. So, the research questions for my thesis are: how accurately can different remote sensing methods model sub-arctic river bathymetry – what are their strengths and weaknesses, and how are they affected by the physical conditions of the river. Tana river is one of the sites being studied in research projects that aims to provide a dense, highly instrumented sites for freshwater monitoring. These research projects are Hydro-RDI Network, Hydro-RI Platform, and Green Digi-Basin that are project managed by Freshwater Competence Centre. This thesis is being done as a cooperation with FCC.

Aims and goals of the thesis

The aims in this thesis are to produce bathymetric models measured with different remote sensing system techniques and implement an error assessment and comparison of those different bathymetric models. The goal of this assessment is to clarify what is there to be taken into consideration when modelling the bathymetry of sub-arctic river bed for further research.

Study area

The study area takes place in the border line of northern Finland and Norway, at Tana river. The research group took measurements on site in September 2022 with helicopter and ASV (autonomous surface vehicle) from the upper reaches (Karigasniemi) to the lower reaches, almost to the Tanafjord, a bay in Barents Sea, Norway. All in all, eleven 50m x 50m sites were measured. In this thesis I will study two sites from those 11 study sites that represent two different parts of the large sub-arctic river by fluvial characteristics: upstream in Utsjoki, near Holiday village Valle, and downstream in Nuorgam, near Nuorgam elementary school.

Data and methods

For the analysis I'm going to use a point cloud data derived from helicopter laser scanning and echo depth sounding measurements from ASV. From those datasets I'm going to produce bathymetric models with interpolation method and form an accuracy assessment. If there is still time left, I will compare the accuracy results with satellite imagery depth rates from the study sites. I would use Sentinel-2 satellite images for the study from July 2022, because that was the only time period when there was clear weather data from both study sites and was close to the time the in situ measurements were acquired. GIS software that will be in use is QGIS, and maybe Google EarthEngine and LAStools. Additional analysis tools would possibly be programming languages R (for error analysis) and Python (PDAL for further point cloud analysis).

Schedule

Literature review end of 2022 – start of 2023

Data available 02/2023

Analysis and writing the whole spring term 2023

Finished by autumn 2023

References

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