NTNU

Norwegian University of Science and Technology

Sustainability in Hydropower 2023

Trondheim, Norway

Green LiDAR in Lakes

Lake Selbusjøen, Benna, & Krøderen

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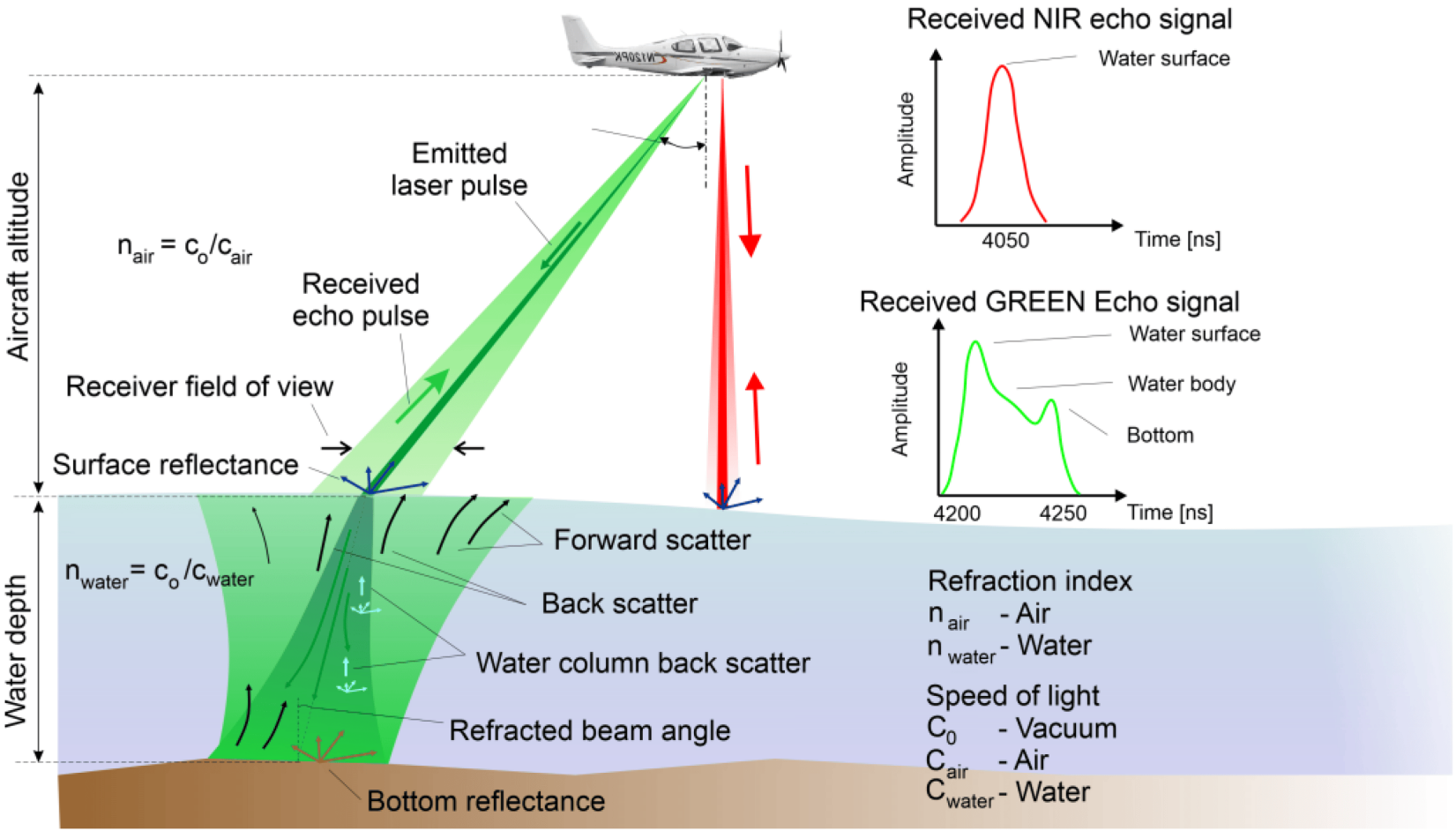
14.06.2023

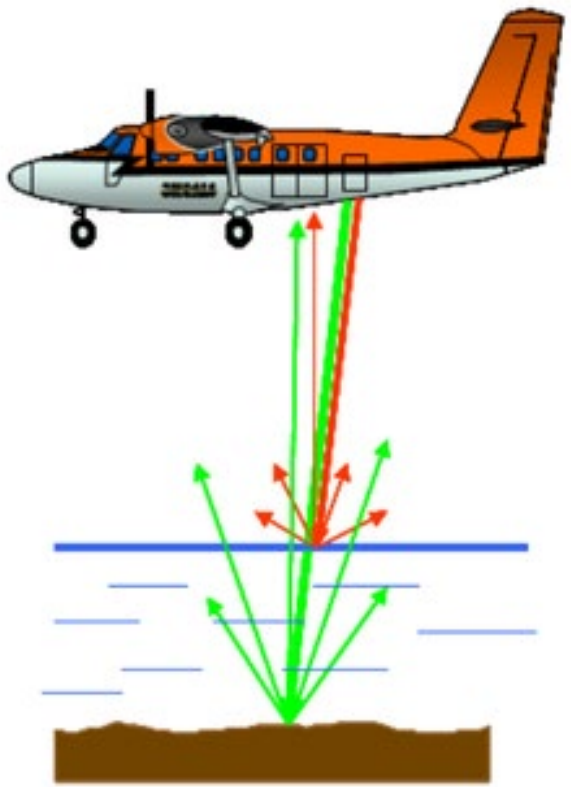
What is Green LiDAR?



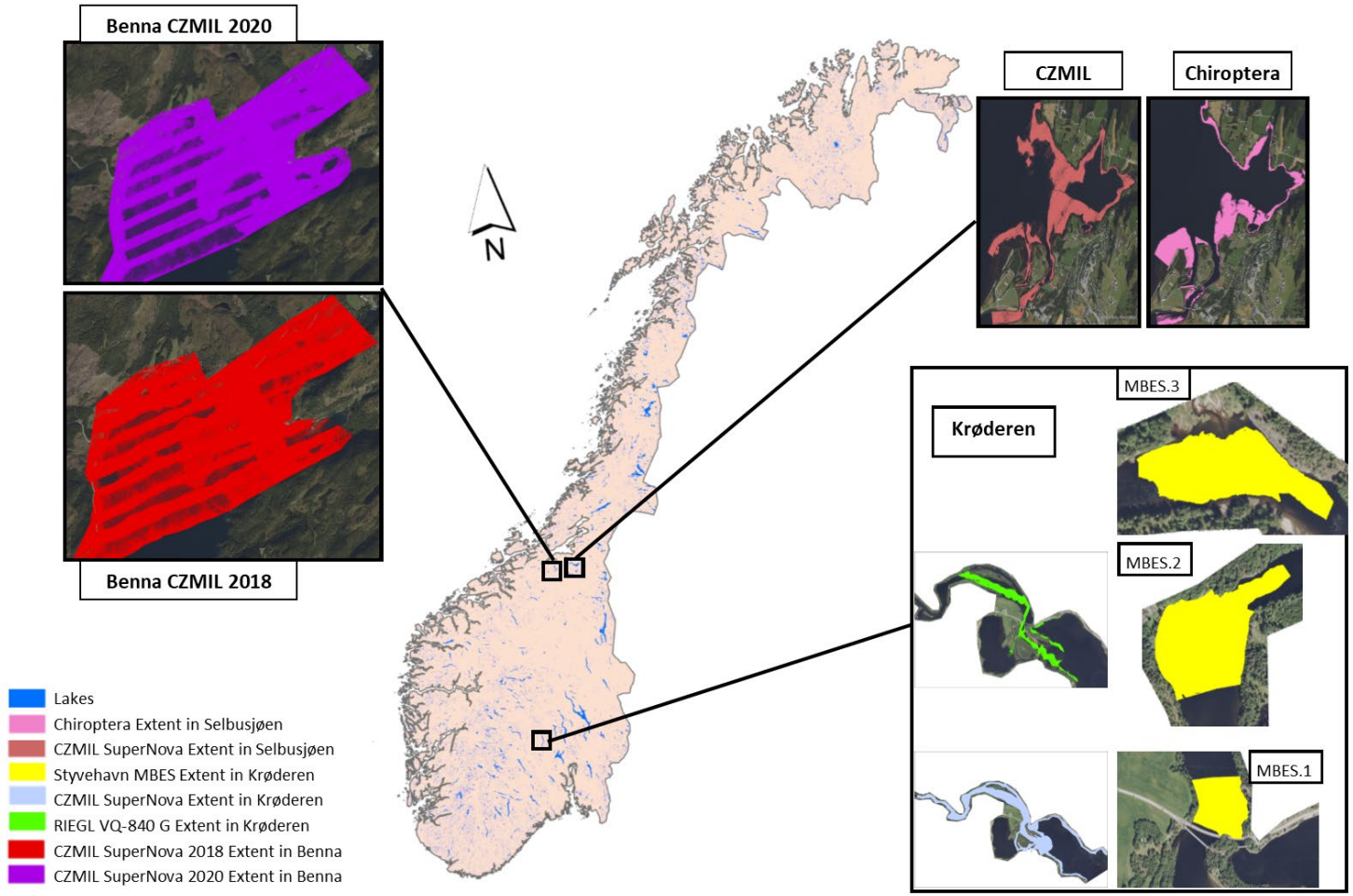
Szafarczyk, Anna, and Cezary Toś, 2022

Green Lidar Application Examples

- Flood risk assessment, high accuracy for flood inundation maps is a way to precise predictions for floods & damage cost
- Erosion and sedimentation
- Natural stream resotration
- hydrogeomorphic characterization and habitat
- Transport of rock material



Study Area


Benna CZMIL 2020
Benna CZMIL 2018
N
CZMIL
Chiroptera
Krøderen
MBES.3
MBES.2
MBES.1
Lakes
Chiroptera Extent in Selbusjøen
CZMIL SuperNova Extent in Selbusjøen
Styvehavn MBES Extent in Krøderen
CZMIL SuperNova Extent in Krøderen
RIEGL VQ-840 G Extent in Krøderen
CZMIL SuperNova 2018 Extent in Benna
CZMIL SuperNova 2020 Extent in Benna

The sensors used for surveying the specified lakes and the dates of mapping

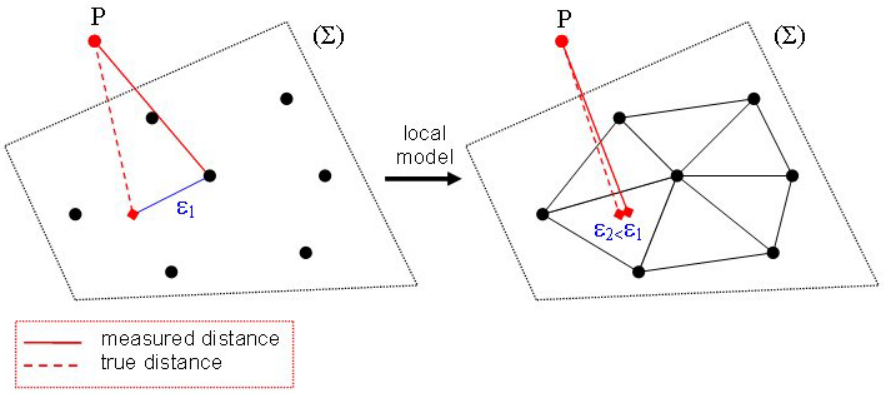
Lake	Sensor	Date
Benna	CZMIL SuperNova (2018 & 2020)	28/10/2018
		10/08/2020
Krøderen	CZMIL SuperNova	16/07/2021
	RIEGL VQ-840 G	24/08/2021
	RIEGL VQ-880 G	03/09/2021
	Norbit MBES	09/11/2021
Selbusjøen	CZMIL SuperNova	16/07/2021
	Chiroptera	14/09/2021
	Norbit MBES	02/12/2021

Nearest Distance Method

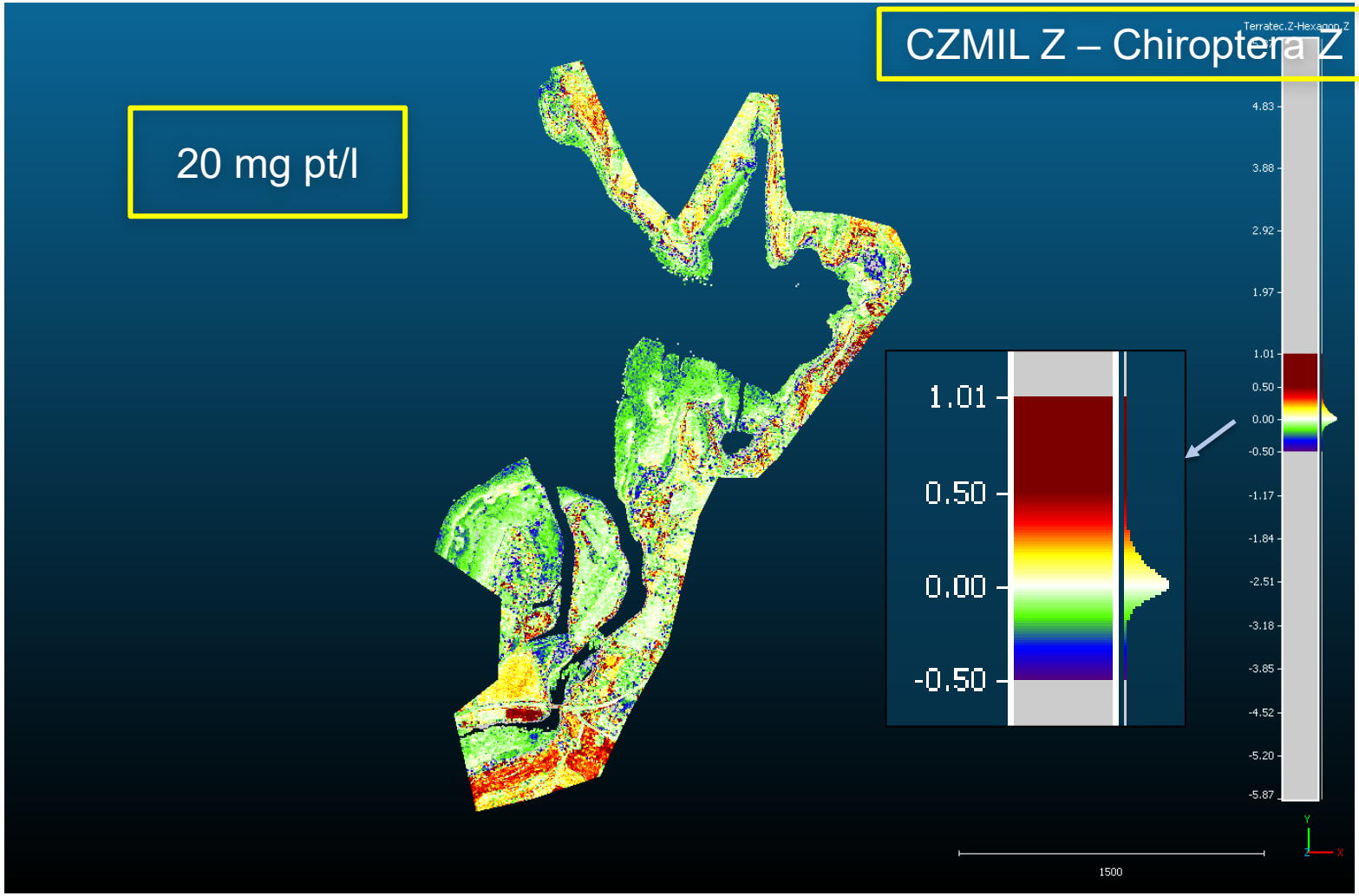
- Extracted elevation values to the point clouds
- Interpolate the elevations to the designated point clouds
- Filtering classes to 2 and 26/40
- Comparing the point clouds from the two sensors using scalar field arithmetics

Residual = Sensor i(Z) – Sensor j(Z)

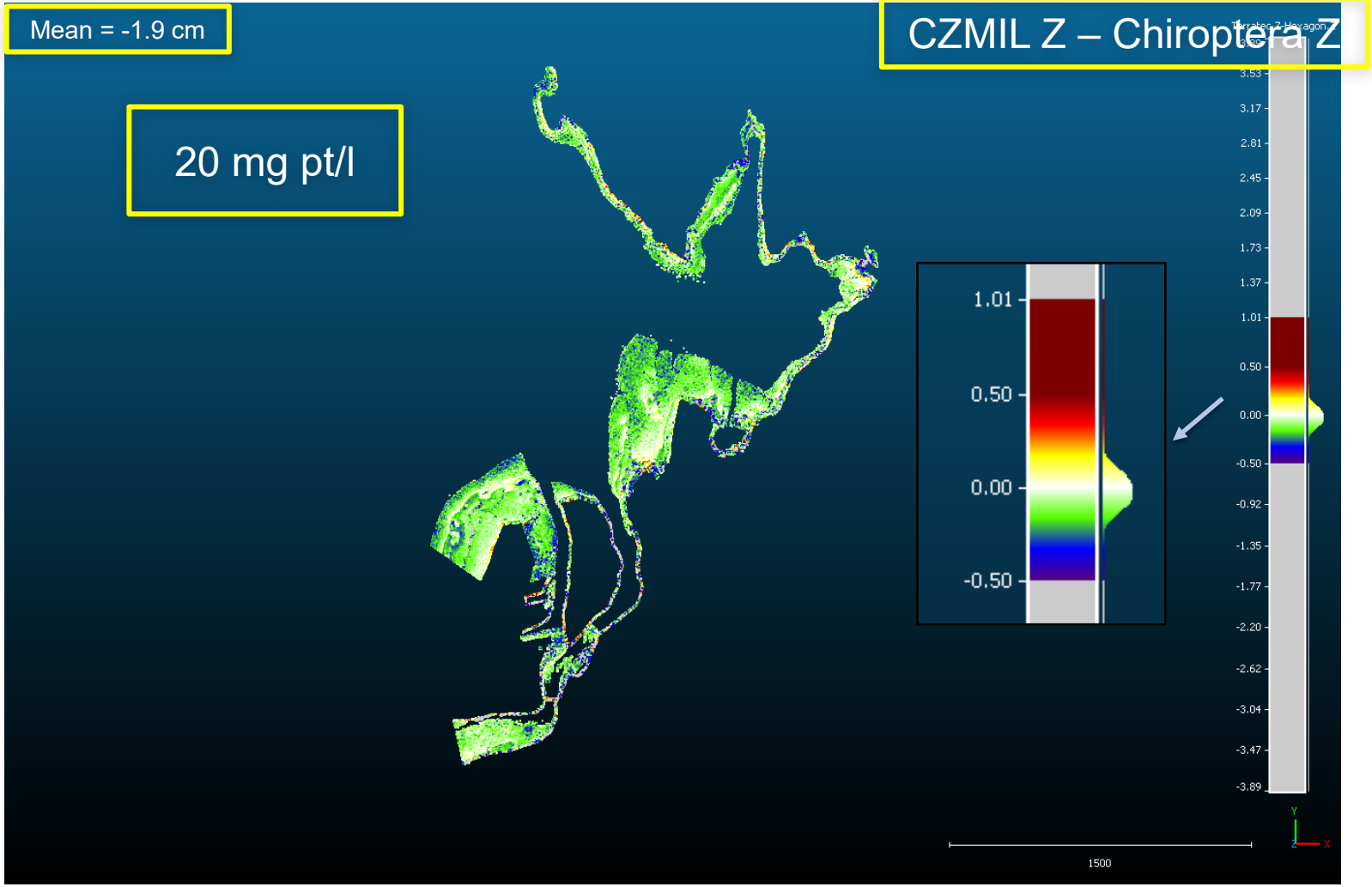
- Sampling the points for quantitaive analysis



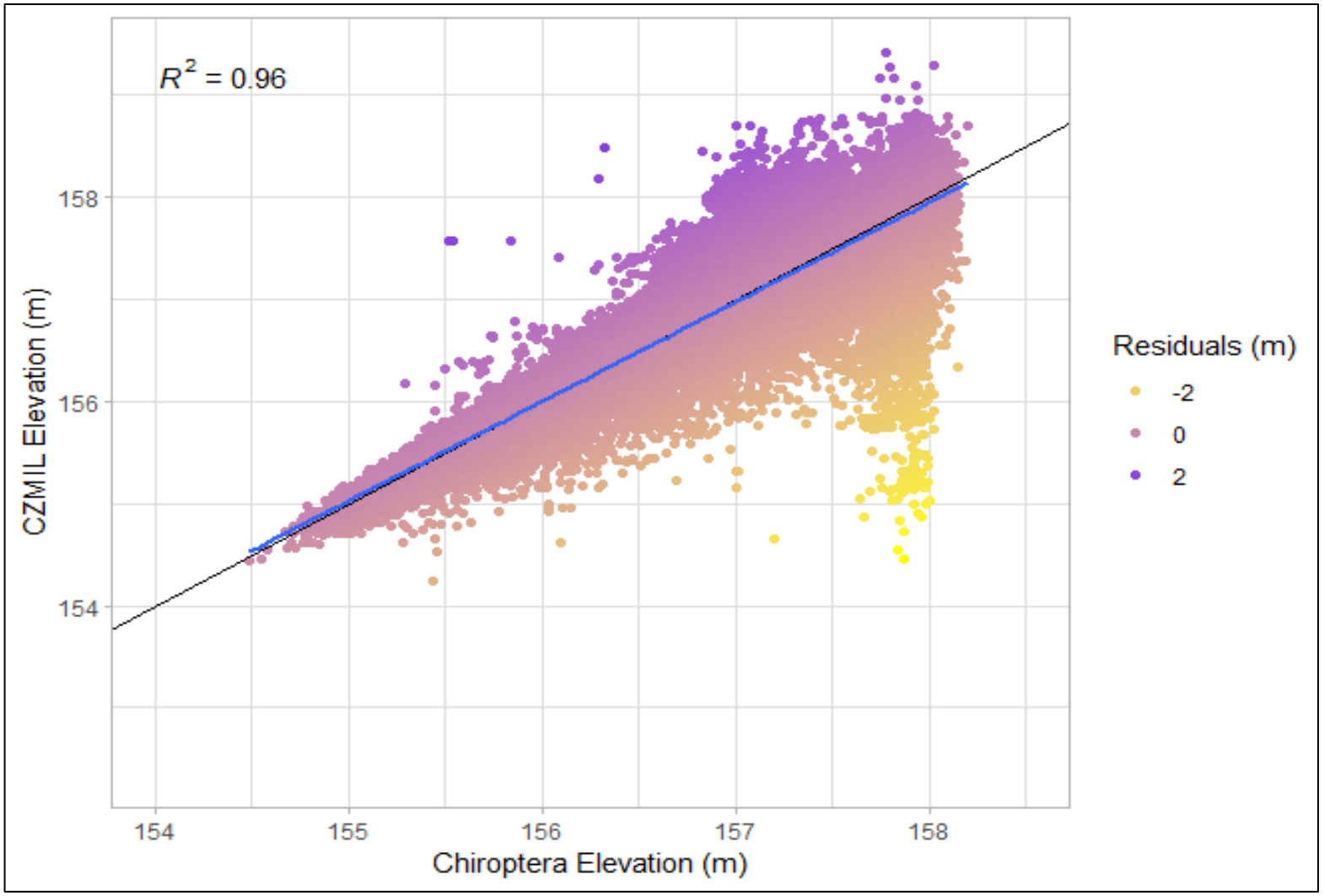
Selbusjøen Residual Map (class 2, 26)



Selbusjøen Residual Map (class 26)



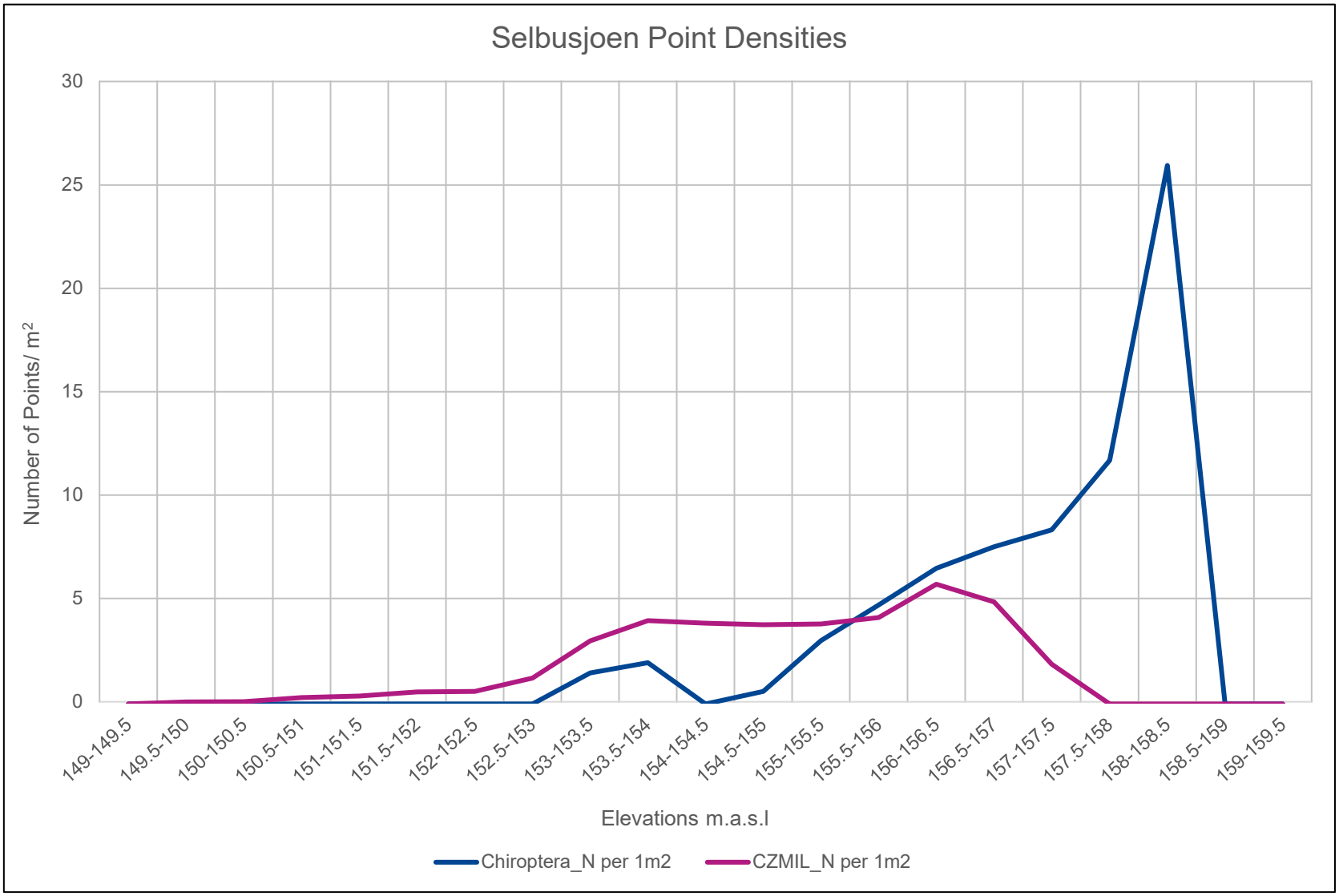
CZMIL & Chiroptera Bathymetry Residuals in Selbusjøen



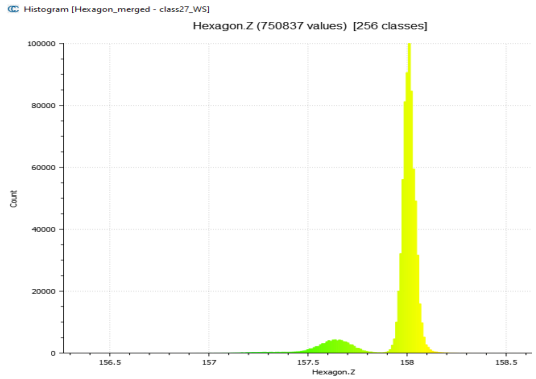
Results

Location	Sensor comparison	Mean (cm)	Standard Deviation (cm)	Median (cm)
Benna	CZMIL2018 and CZMIL2020	3.52	15.0	- 3.0
Krøderen	CZMIL and MBES	0.16	18.56	3.2
	CZMIL and VQ840	0.49	7.49	1.0
	MBES and VQ840	5.55	6.67	5.0
	VQ880 and MBES	-10.5	14.5	- 10.0
	VQ880 and CZMIL	- 8.0	15.0	- 9.0
	VQ880 and VQ840	- 7.8	10.1	- 8.8
Selbusjøen	CZMIL and Chiroptera	- 1.93	13.41	- 2.0

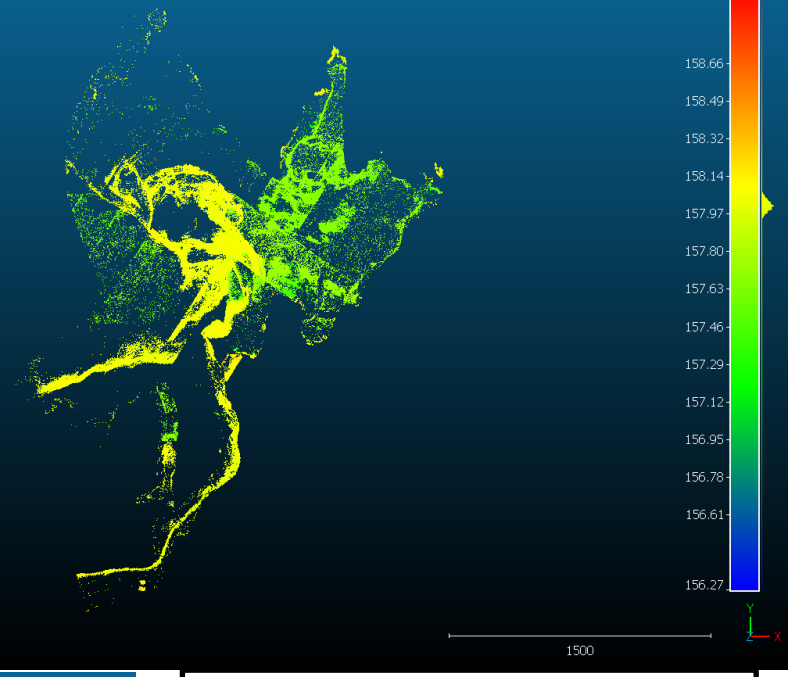
Point Density at Selbusjøen



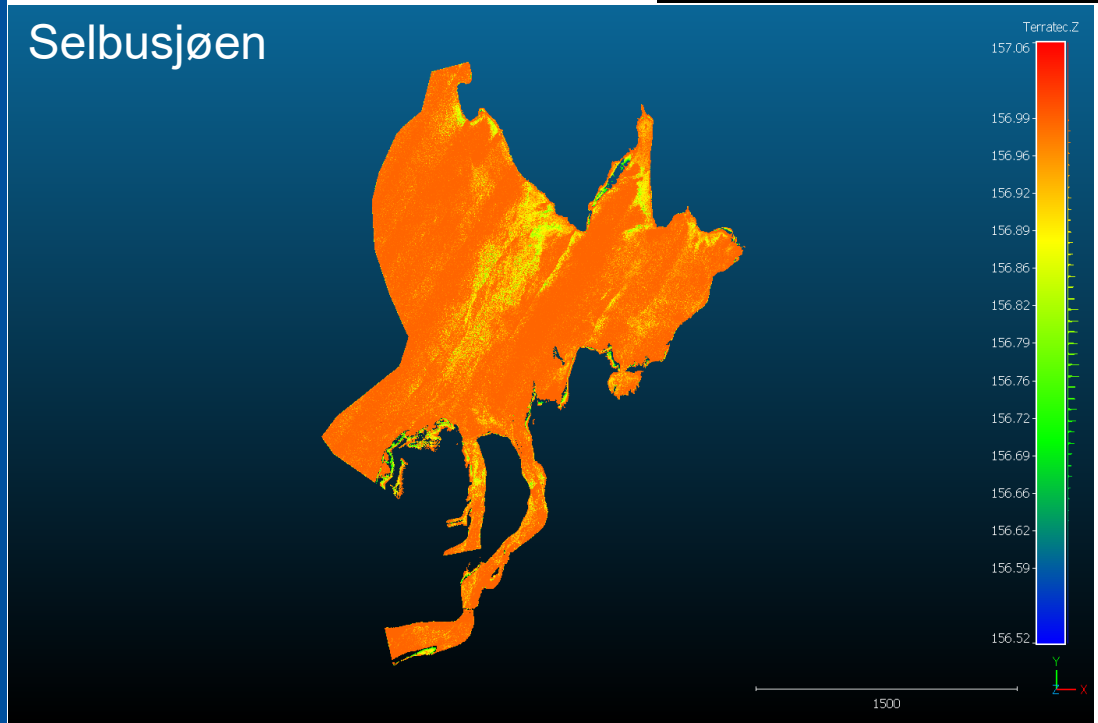
- Chiroptera Water Surface elev. (27class)
- Distributed (157-158.2)
- 158



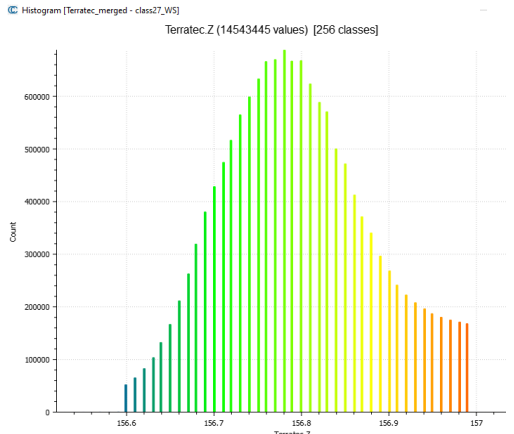
Selbusjøen



Selbusjøen



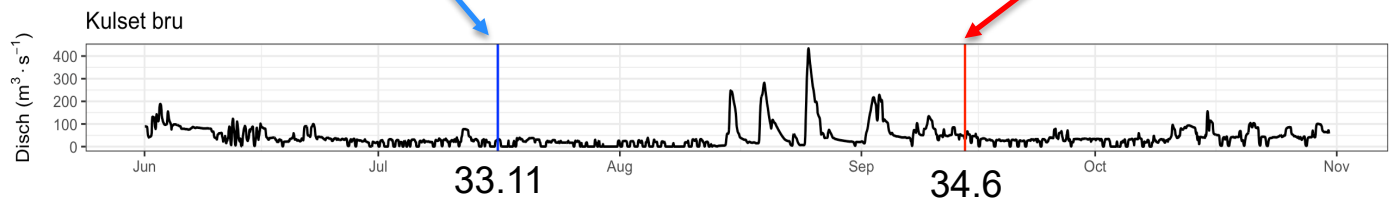
- CZMIL Water Surface elev. (27class)
- Distributed (156.6 – 157)
- 156.8



Hydrological Conditions During Flights in Selbusjøen

Terratec (CZMIL)
16.07.2021

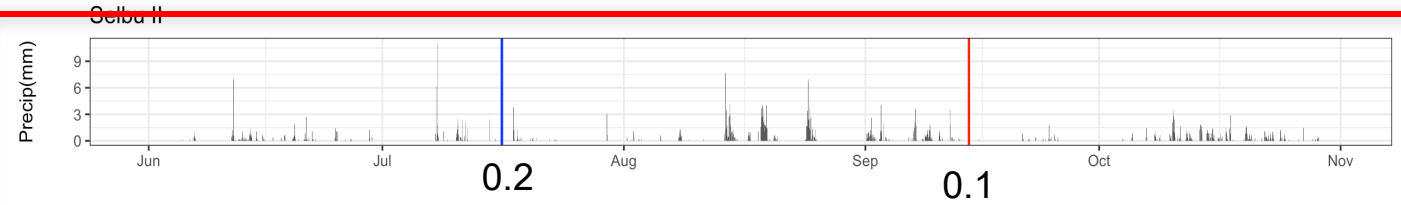
Hexagon (Chiroptera)
14.09.2021



33.11

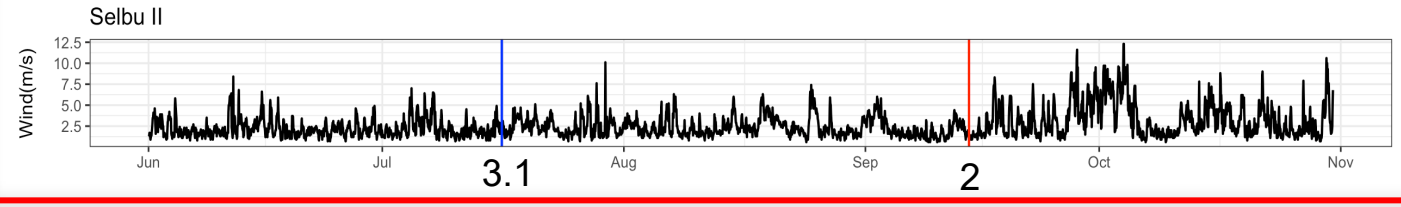
34.6

Climate Factors



0.2

0.1

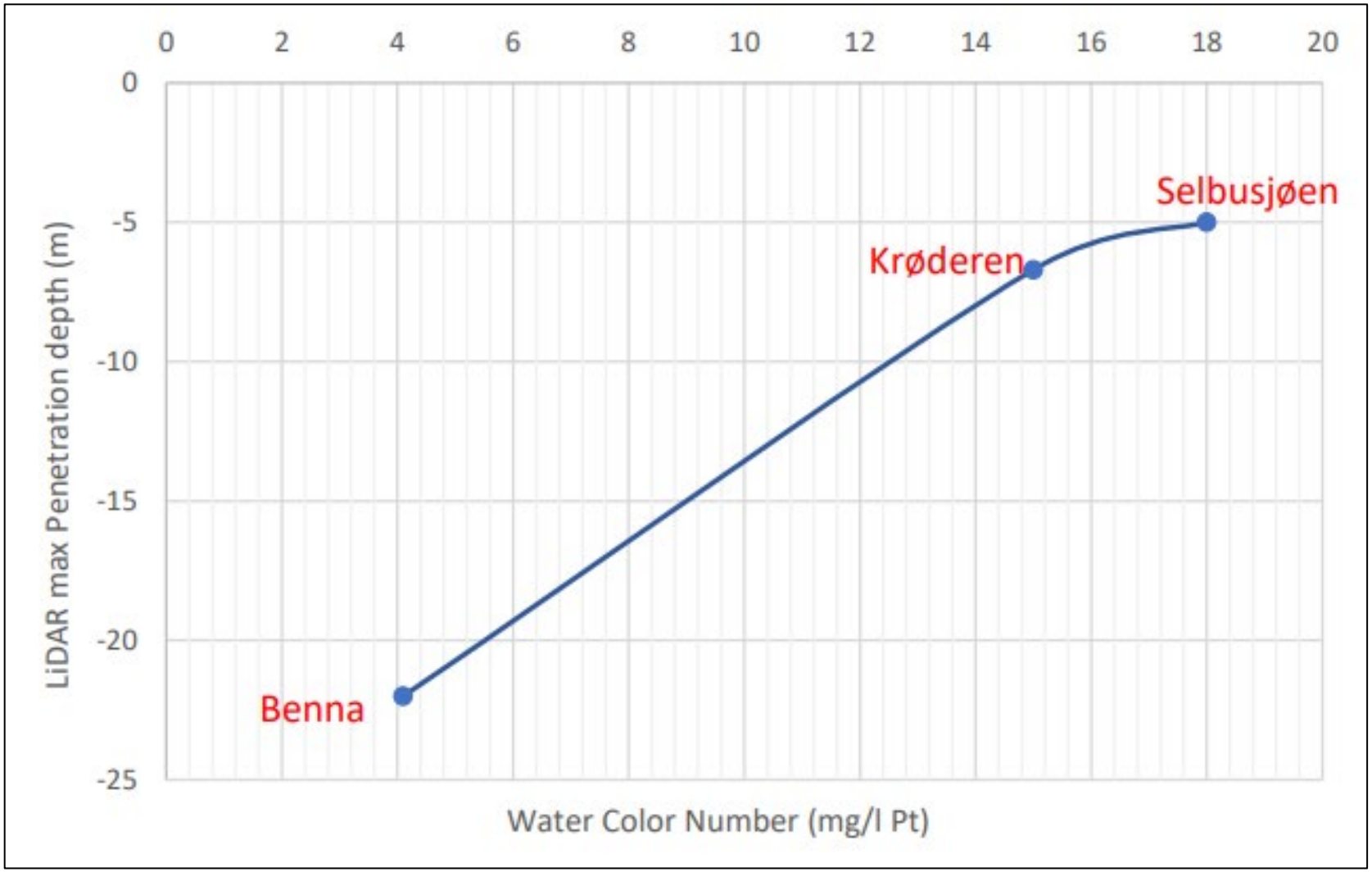


3.1

2

Water Level	156.8	158

Water Color and LiDAR Penetration Depth



Conclusion

- The precision when comparing Green LiDAR and MBES datasets are in general very high, when comparing mean and median residual values (1 to 9 cm)
- When comparing different Green LiDAR sensors, the residual values are generally normally distributed around 0 cm, indicating no systematic error
- Under certain conditions (perfect conditions), Green LiDAR seems capable of measuring down to more than 20 meters below the lake surface as in Lake Benna, while in most lakes probably less than 20 meters
- For the purpose of (micro) habitat mapping, Green LiDAR datasets might be useful in areas with high point densities, but less suitable closer to the penetration depth when the datasets are less rich (low point densities). This needs, however, be further investigated
- Our experiences find Green LiDAR suitable for mapping shallow to moderately deep parts of lakes, including areas normally covering the littoral zone.

Conclusion

- The water quality seems to affect the maximum penetration depth of Green LiDAR, and the correlation with water color gave some insight into how this relationship can be. For the purpose of supporting future studies with better datasets, water quality data should be collected at the time and the place of the LiDAR mapping
- Green LiDAR and MBES datasets can be complementary to each other to build a seamless and accurate representation of the lake bathymetry used for important applications such as generation of precise volume curves for power plants.
- The results of Green LiDAR scanning of lakes seem to be more than satisfactory for assessing flood levels in lakes and water bodies.

NTNU Report

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Assessment of the suitability of Green LiDAR in mapping lake bathymetry

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