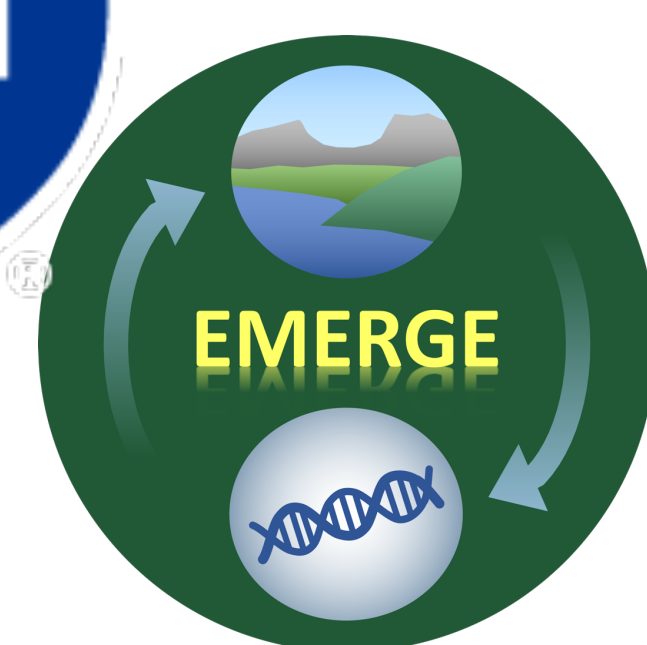




# Using UAS Imagery to Monitor Permafrost Thaw and Vegetation Dynamics in a Northern Peatland



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## Introduction

- Disproportionate Arctic warming is contributing to increased permafrost thaw which changes hydrology and vegetation composition.
- In-situ measurements are beneficial but need to be scaled. Remote sensing offers wide-scale and rapid data acquisition to address this.

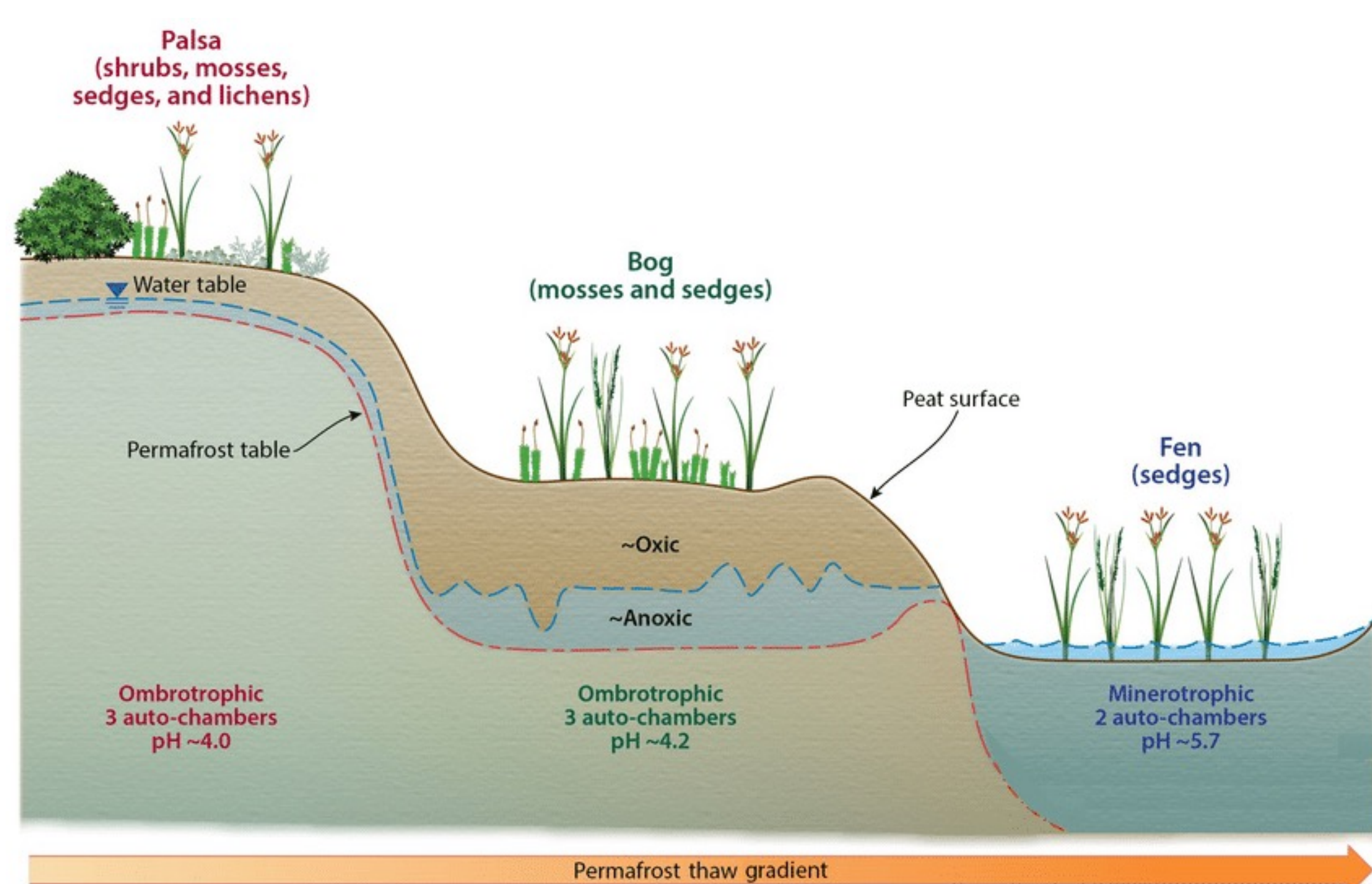


Fig 1: Diagram of palsa, bog, and fen habitats with permafrost thaw gradient<sup>1</sup>

**Our goal is to explore elevational change and vegetation composition at Stordalen Mire, Sweden.**

## Vegetation Methodology

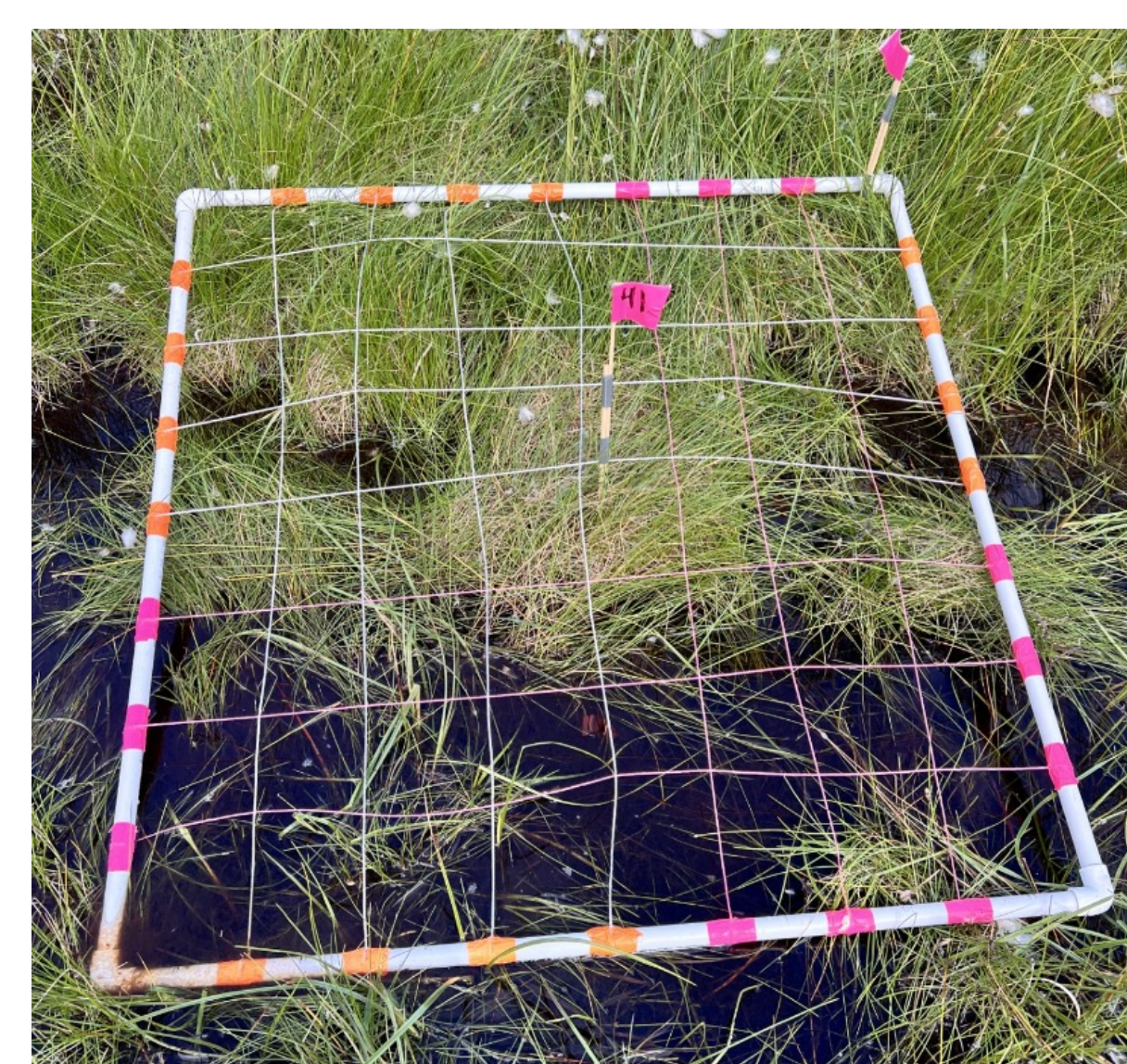
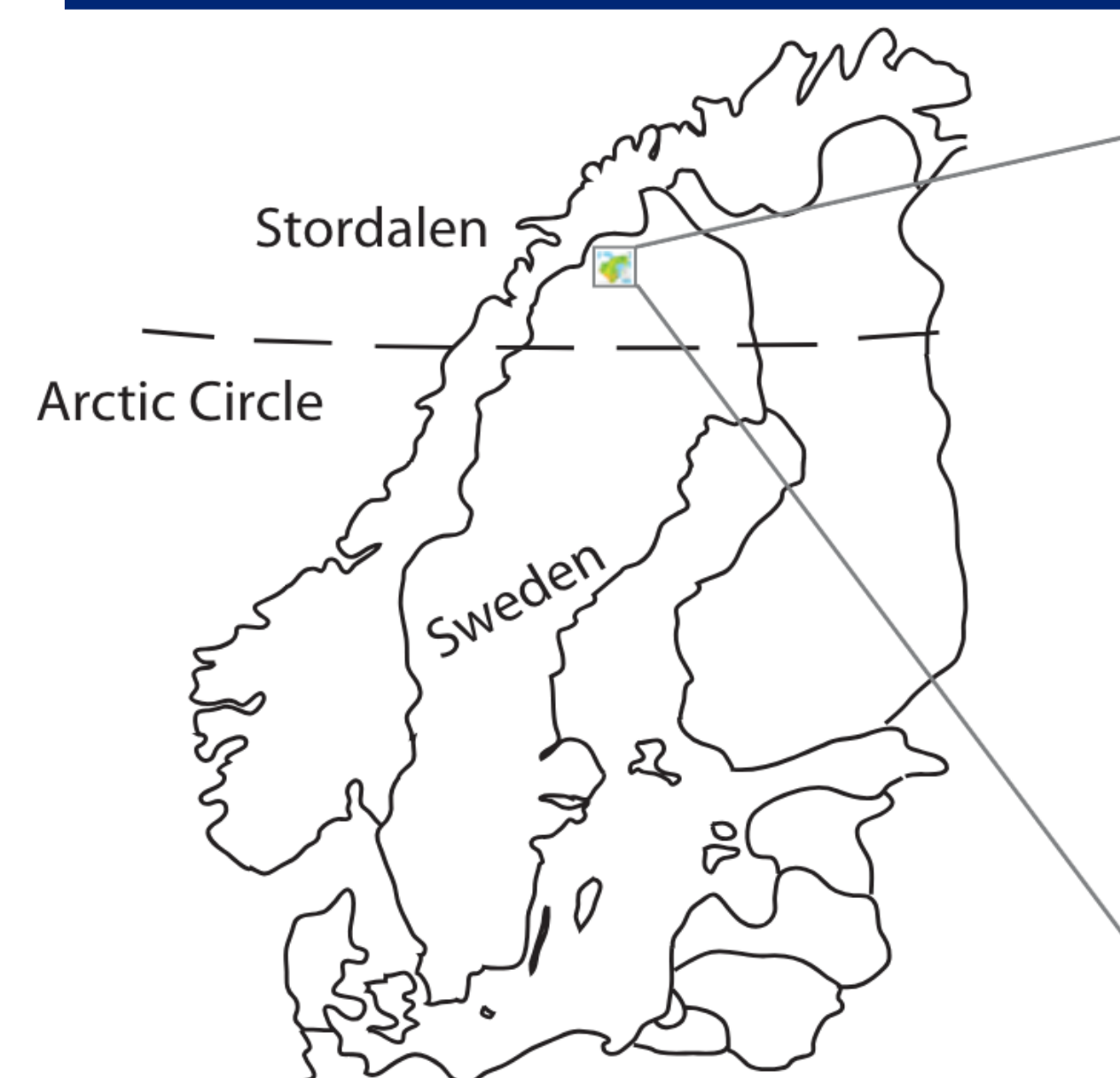


Fig 3: Vegetation survey quadrat - site 41. PC: P. Cobak

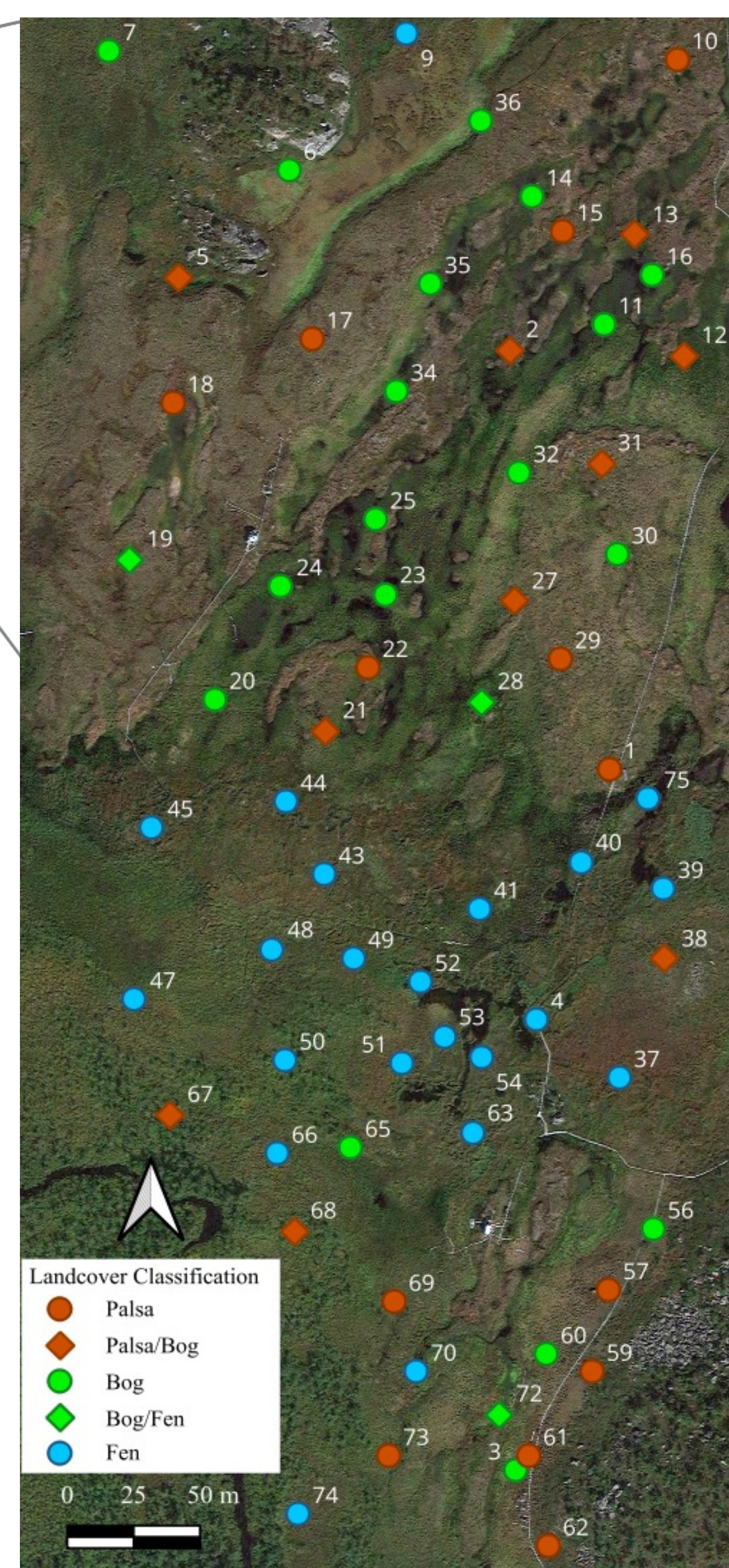


Fig 4: Map of survey sites with landcover classification<sup>3</sup>

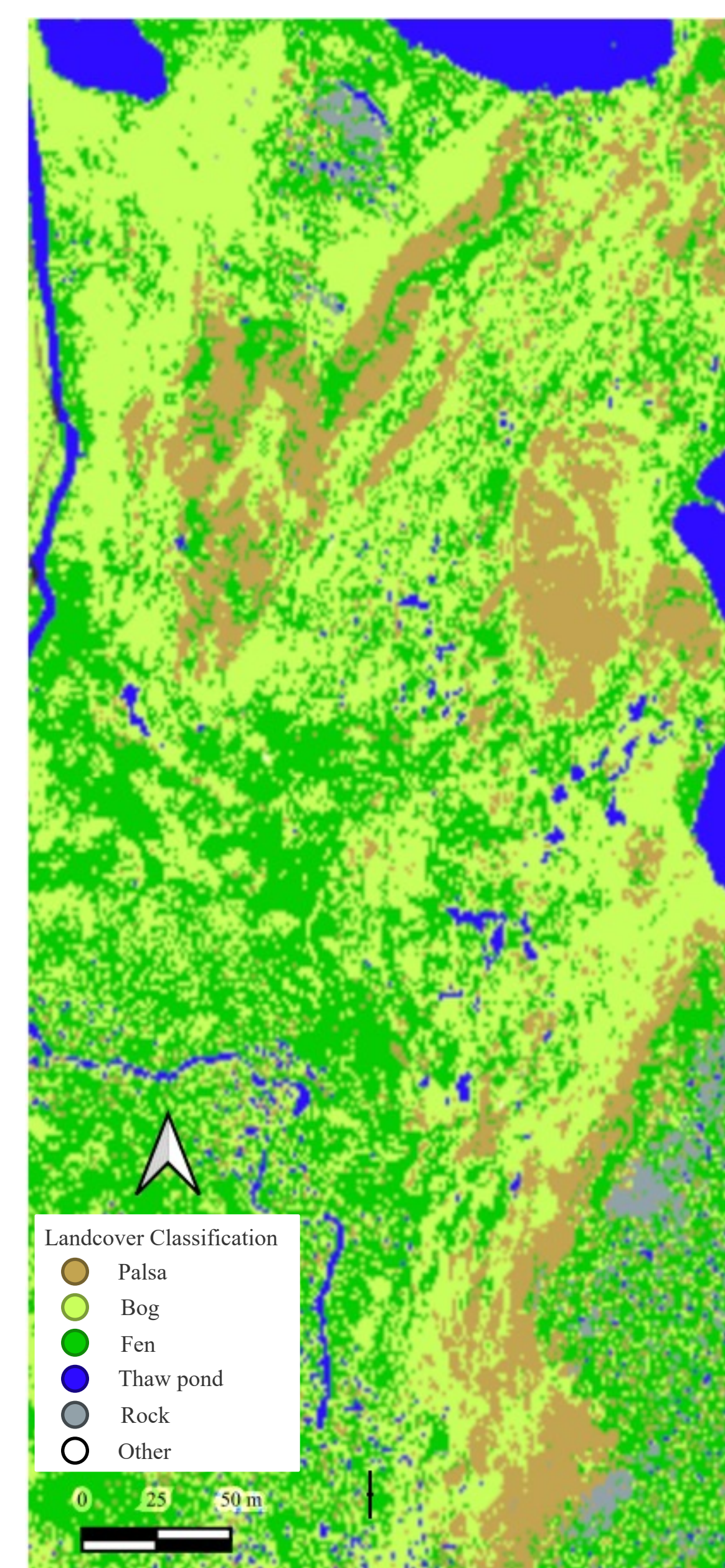


Fig 5: 2024 simple cover type map with landcover classification

	Palsa	Bog	Fen	Rock	Other	Thaw Pond
Palsa	18	0	0	0	0	0
Bog	0	47	1	0	0	0
Fen	0	2	45	0	0	0
Rock	0	0	0	6	0	0
Other	0	0	0	0	4	0
Thaw Pond	0	0	0	0	0	6

Fig 6: Confusion matrix with 6 classes using 2024 multispectral and 2023 LiDAR.

- Of 70 total sites, 62 were surveyed for vegetation so far in the 2024 field season (Fig 4).
- A 1m quadrat with 64 cells was used for each survey site, using the “bird’s eye view” method to count vegetation up to 100% (Fig 3).
- In google earth engine, maps were combined and a 0.5 by 0.5-meter buffer was created around the center GPS point of each site for training.
- A random forest classifier with 80 trees was used to generate a simple cover type map with classes of palsa, bog, fen, thaw pond, rock, and other (Fig 5).
- A confusion matrix and overall accuracy is reported. The 2024 overall accuracy was 0.98, with palsa being the most accurately classified landcover in the confusion matrix (Fig 6).

## UAS

- The first drone was the DJI M300 with an integrated Livox Avia LiDAR sensor.
- The second drone was the DJI Phantom 4 with a 6-channel multispectral camera.
- Flights were conducted around solar noon over Stordalen Mire in July 2024.
- LiDAR and multispectral imagery were captured for analysis.
- Preliminary analysis was conducted with 2023 LiDAR while 2024 imagery is finishing processing.

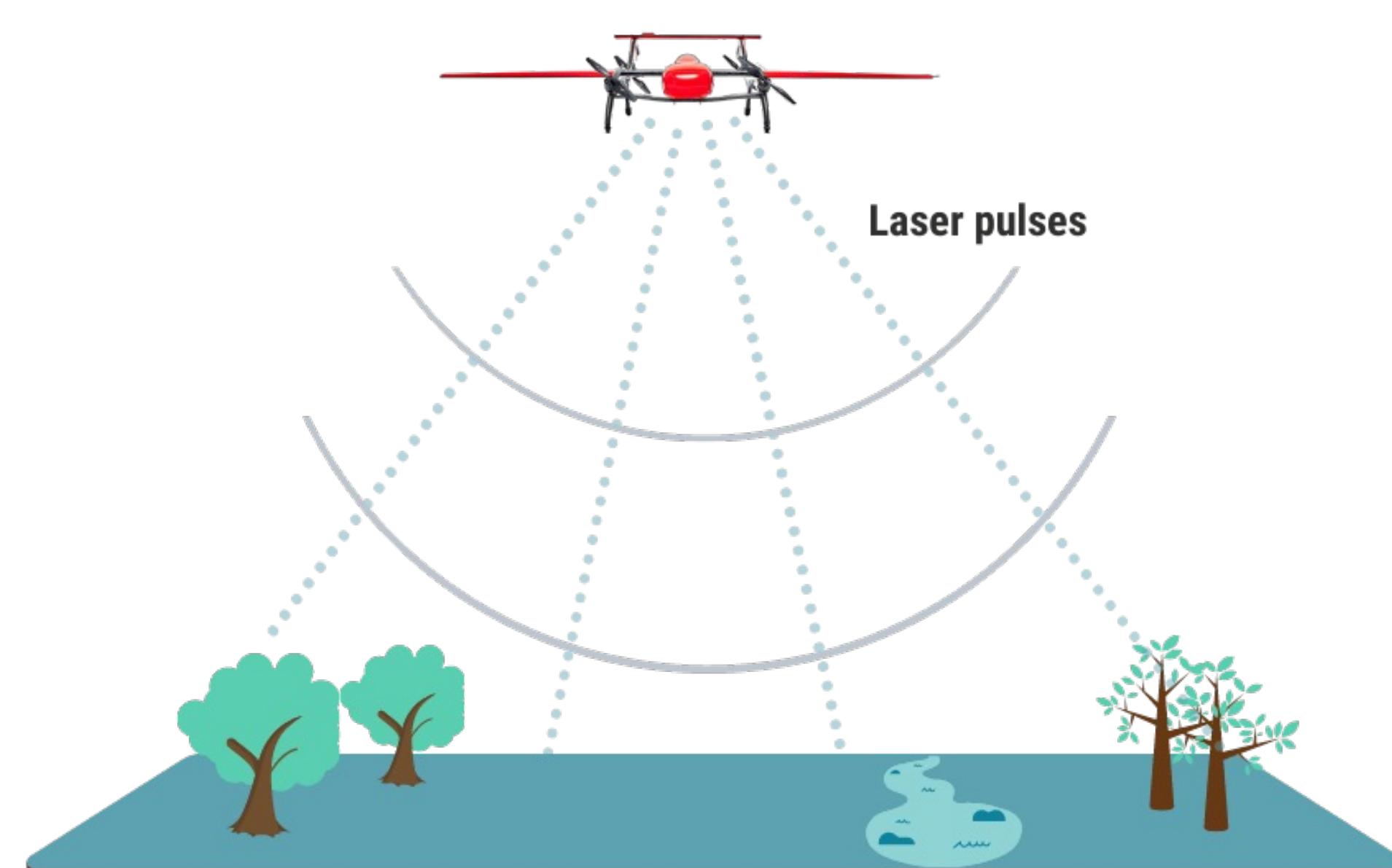


Fig 2: Diagram of LiDAR technology<sup>2</sup>

## Terrain Methodology

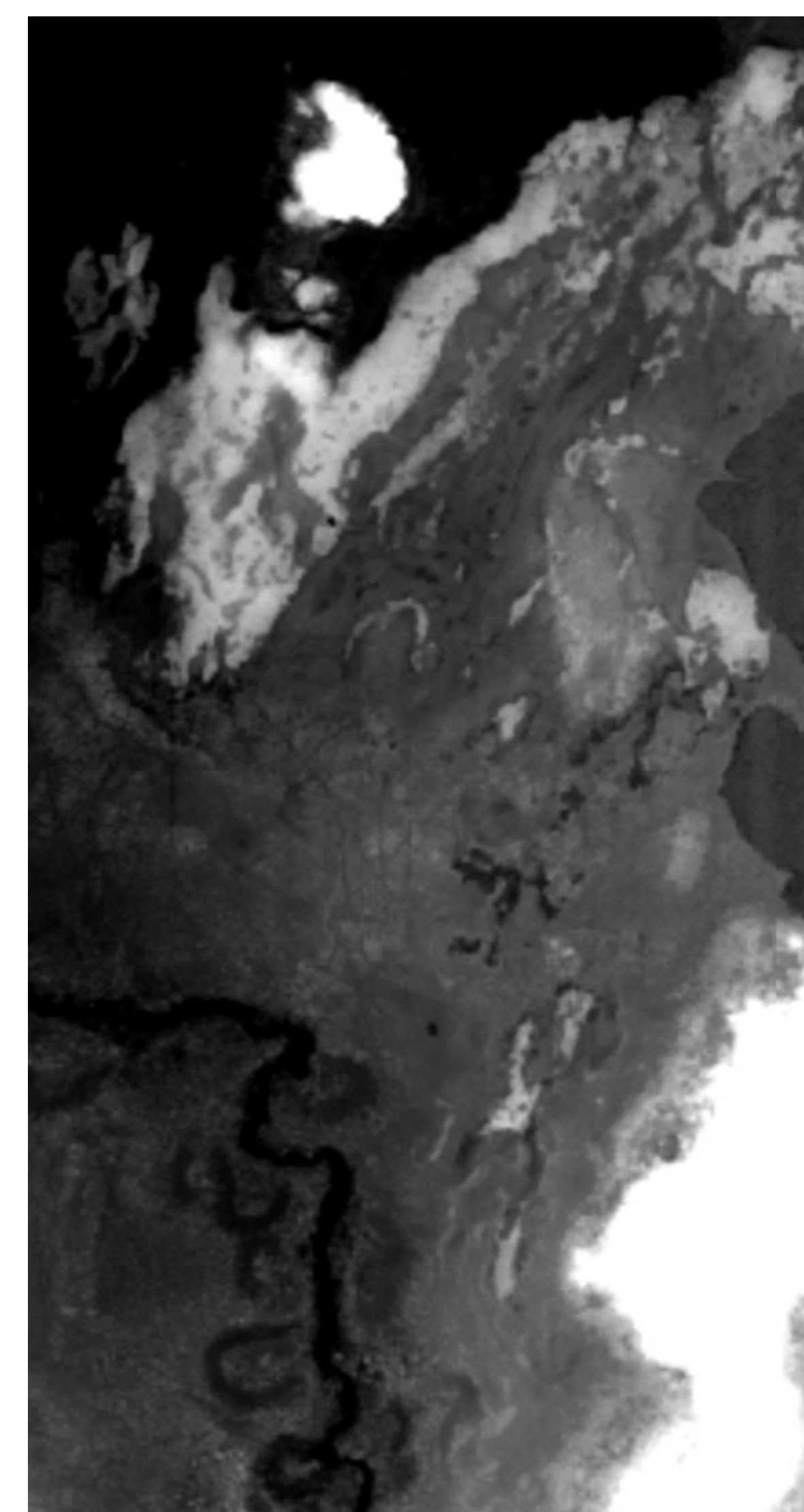


Fig 7: 2023 digital terrain model

- A digital terrain (DTM) and digital surface model (DSM) will be processed from the 2024 LiDAR.
- The 2024 DTM will be subtracted from the 2023 DTM for analysis of yearly elevation change.
- A canopy height model will be calculated by subtracting the 2024 DTM from the 2024 DSM.

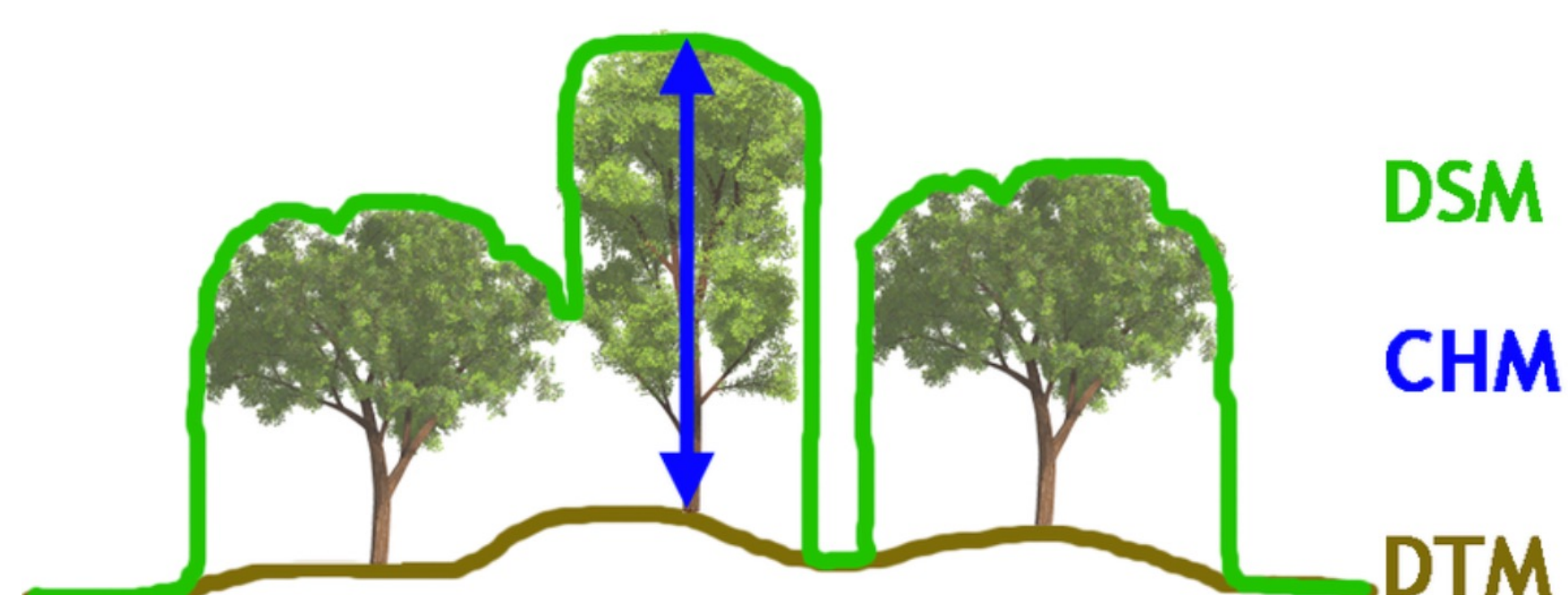


Fig 8: Diagram of digital surface model (DSM), canopy height model (CHM), and digital terrain model (DTM)<sup>4</sup>

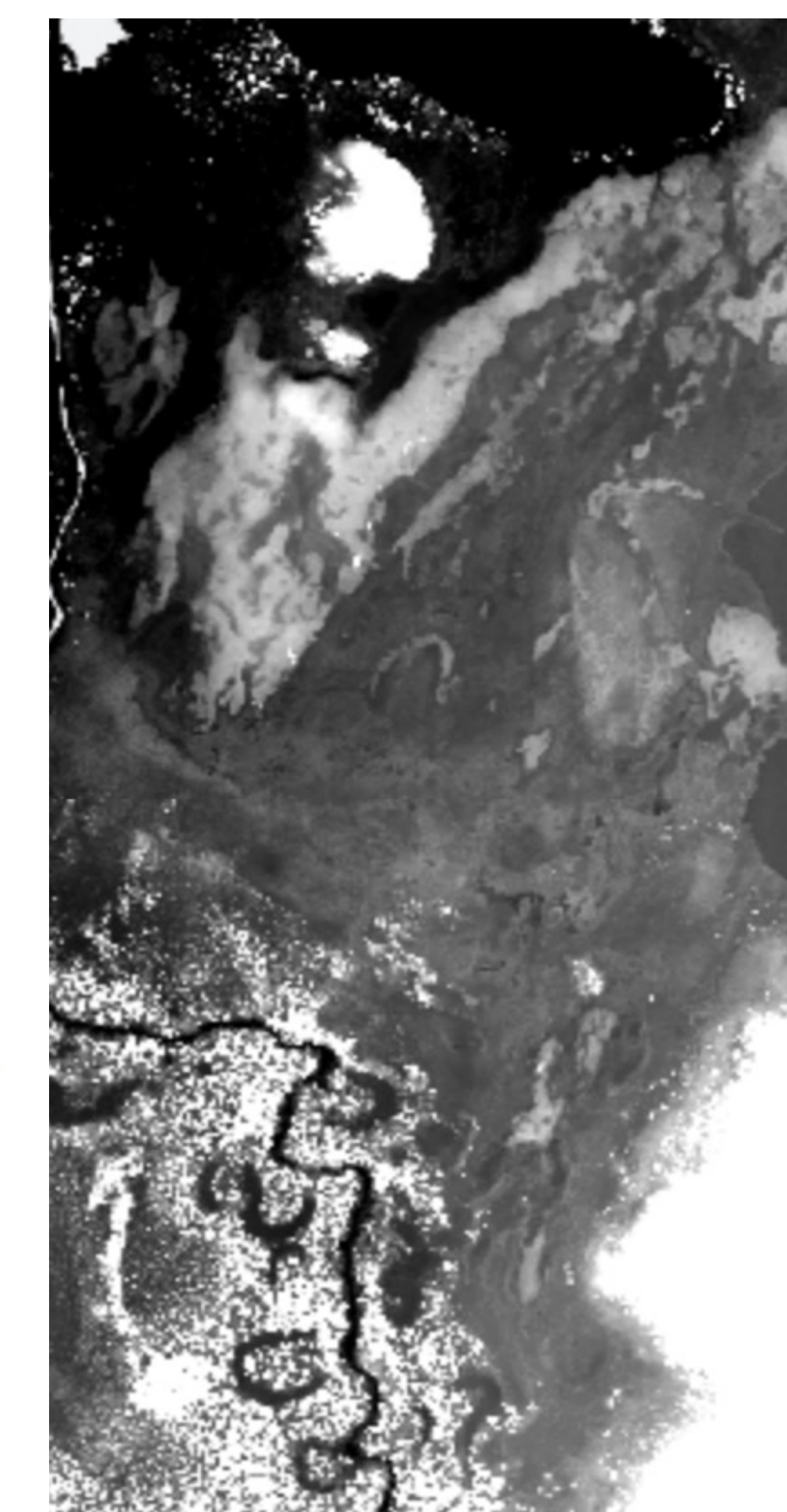


Fig 9: 2023 digital surface model

## Next Steps

- Repeat vegetation and terrain methodology steps with 2024 LiDAR data.
- Incorporate transition sites into a complex cover type map.
- Expand statistical tests on vegetation survey data to incorporate into cover type maps.
- Expand statistical tests on the 2024 cover type maps and elevational change map too see if there are further correlations.

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- This research took place on indigenous lands in Sápmi, where Sámi people have lived since time immemorial.
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