G05: Wetland vegetation mapping using UAV imagery and Sentinel-2

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Wetland ecosystems provide an optimum natural environment for the sequestration and long-term storage of atmospheric carbon, **representing about 30% of the global soil carbon** pool from carbon sequestration (Mitch et al., 2013). Their widespread degradation has motivated the **Intergovernmental Panel on Climate Change to include wetlands** in carbon emission accounting, while LULUCF reporting requires accurate **delineation of wetland** extent for GHGs estimation. **Remote sensing and GIS tools can accurately classify land cover** at high spatial resolution; however, large-scale wetland mapping relies on satellite observations with broad geographic coverage. **This study evaluates the combined use of both approaches across two wetland land-use**: natural peatlands and abandoned peatland areas for comparative assessment.

1. INTRODUCTION

1.1. Study Sites

- Two different sites were selected to be able to compare two different states of peatland in Estonia.
- Both Sites are located in Estonia close to Tartu.
- **Site 1, Parika:** Natural Peatland which has not been intentionally altered by human activity.
- **Site 2, Ilmatsalu:** Abandoned Peatland, previous land-use of peat-extraction site but is now left untouched for many years.

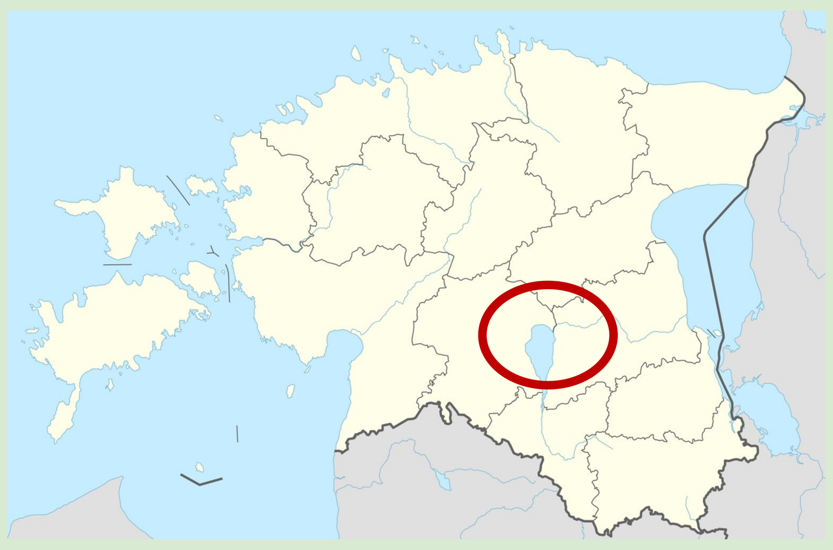


Figure 1: Map of Estonia & Study Area. Map: NordNordWest, Licence: Creative Commons by-sa-3.0 de.

1.2. Data acquisition

UAV Data:

- High-resolution data were collected on August 14, 2026 using a fixed-wing eBee X drone (AgEagle Aerial Systems Inc.) equipped with a multispectral camera
- Flights were conducted at an altitude of approx. 150 meter

Satellite Imagery:

- To assess the advantage of high-resolution drone data over satellite data, multispectral satellite imagery was acquired from Sentinel-2 for our case studies

Acquired bands: Green, Red, Red Edge, Near Infrared

High res. UAV imagery ⟷ Sentinel 2 scenes (10 – 20m resolution)

2. METHODOLOGY

Methodological Workflow

- **Vegetation indices** were calculated from the bands for both sites: CTVI, DATT4, GNDVI, IPVI, MCARI, MGRVI, MSAVI, NDVI, NDVIRE, NDWI, RTVI, SAVI, SR, VCI
- Clustering the UAV and Sentinel-2 images with **K-Means** clustering unsupervised algorithm and **silhouette** score for optimal number of clusters
- **Validation** by **photointerpretation** of clustered images with ground-truth data points.
- Interpretation of **clustered pixels**.

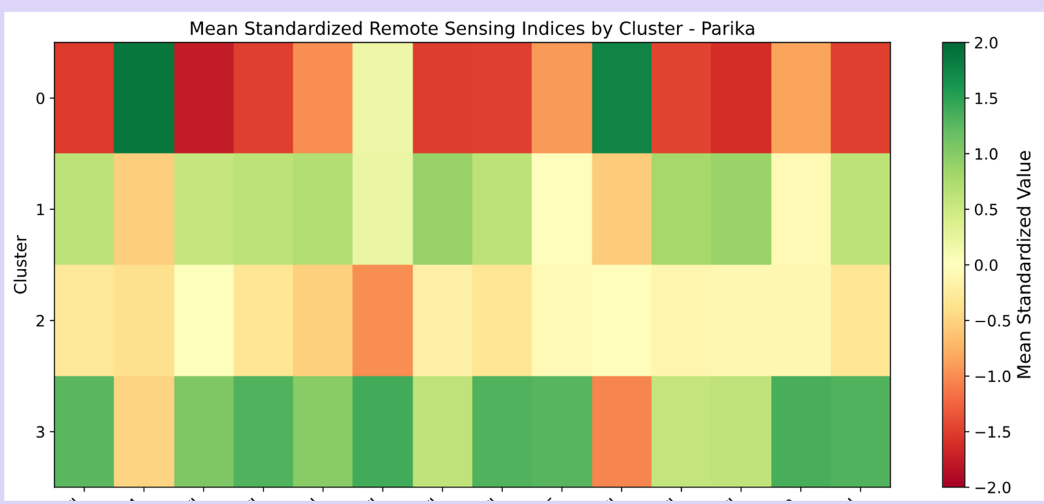
Unsupervised Classification:

Unsupervised clustering identifies groups of pixels with similar spectral and vegetation characteristics without predefining vegetation classes.

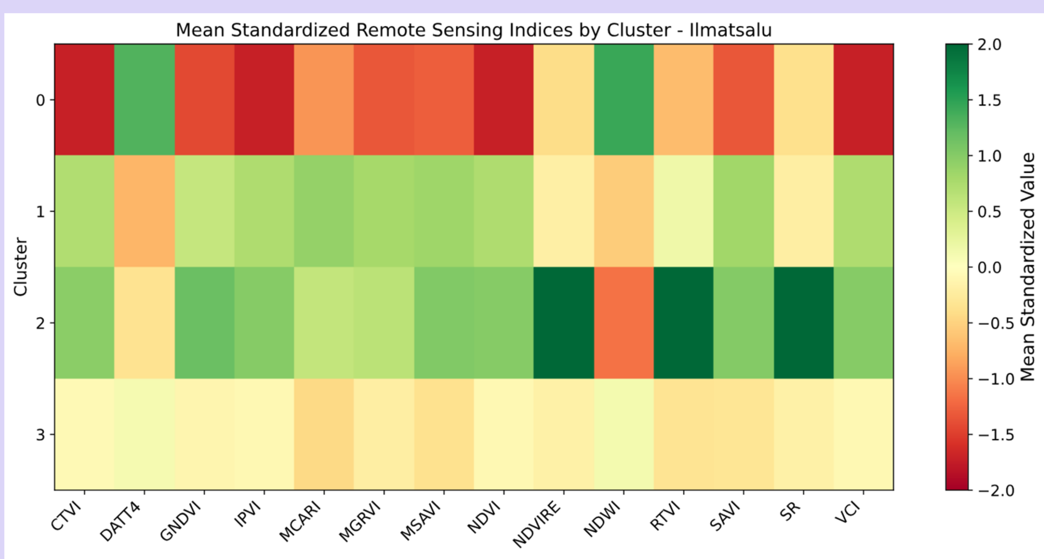
- It becomes visible, that a big share of the Ilmatsalu study site (abandoned peat-extraction area) is classified as bare soil
- The natural wetland on the other hand shows denser vegetation.
- It must be recognized, that the conditions for both areas vary (Parika is located directly by the water, Ilmatsalu is surrounded by trees).

3. RESULTS

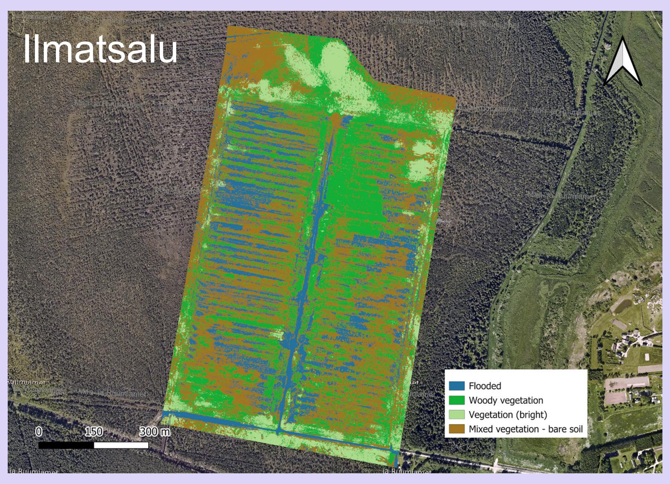
Parika

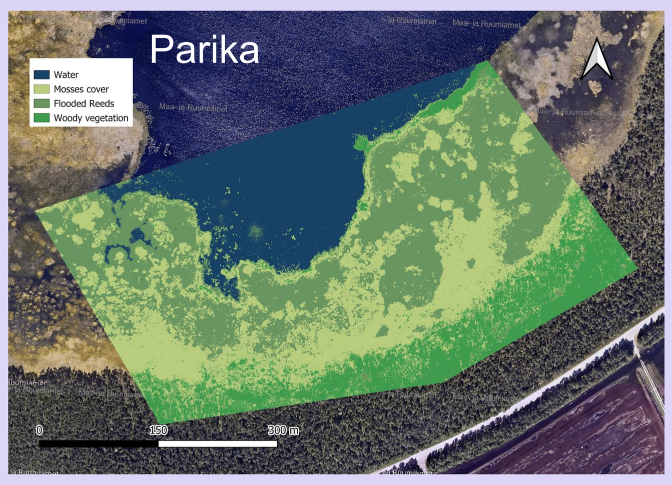


Ilmatsalu

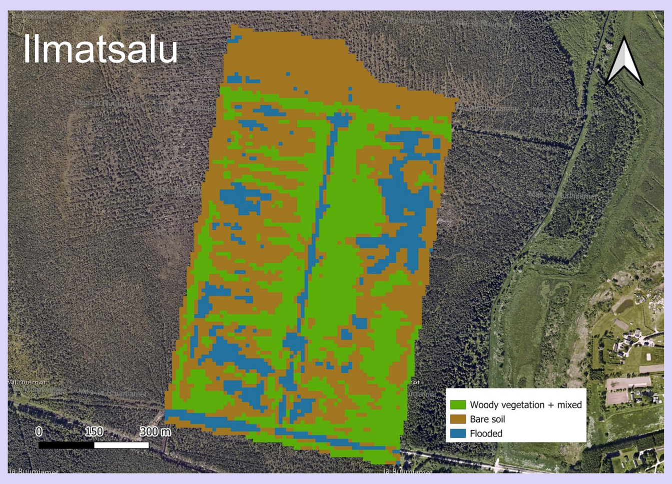


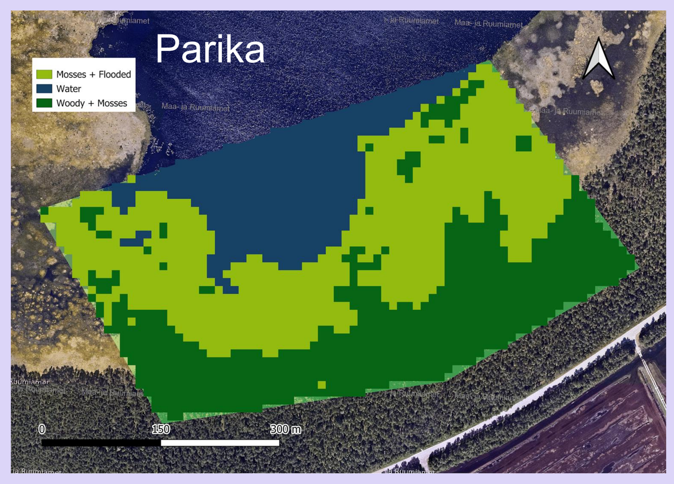
UAV classification:





Sentinel-2 classification:





4. CONCLUSIONS

- Land cover types show differences between land study areas.
- Reflectance images of the natural wetland (Parika) show better correlation, mostly due to a malfunction during the solar irradiance detection from drone.
- Centimeter-resolution of UAVs show high details and land cover clustering retrieves pure radiance from covers, specially the bareground, while Sentinel-2 mixes those with vegetation, mostly, although detects the common patterns (large clusters)
- Reliable clustering of UAV and Sentinel-2 images with unsupervised ML methods

Code & Resources - Github Repository

Scan the QR code to access the code, workflow, and results on GitHub.