Aspen detection in boreal forests: Capturing a key component of biodiversity using airborne hyperspectral, lidar, and UAV data

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Introduction

Biodiversity decline is one of the major concerns in nature protection. For land use planning and biodiversity conservation, tools to estimate the existing biodiversity are needed. Biodiversity indicators suitable for remote sensing have to be quantifiable, repeatable, spatially comparable and cover large land areas.

European aspen (*Populus tremula L*) is a keystone forest species and a potential biodiversity indicator, since hundreds of other species of various life forms are dependent on it as a source of nutrition or a living environment.

Research goals

The key goal is to provide decision-supporting tools on how to optimally manage valuable forests in a changing climate and how to secure their connectivity.

We aim to:

- collect multisource RS data at various spatial & temporal scales;
- develop and produce novel remotely sensed indicators of biodiversity variables;
- detect and classify European aspen in boreal forests using multisource RS data

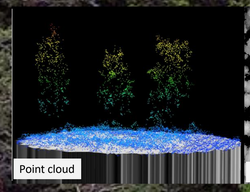
Data

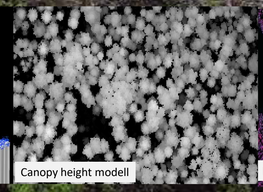
Airborne:
Hyperspectral
- HySpex sensor data 406-2552nm
- VNIR GSD 50 cm SWIR GSD 1 m.

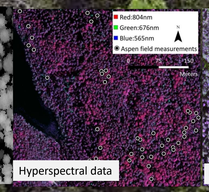
Lidar
- Leica ALS70-HP – SN7204
- 10.2p/m2

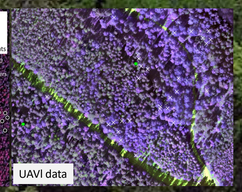
UAV data:
RGB, GSD = 4,5 cm, overlap 80/80
MS, GSD = 10 cm, overlap 80/80 (Micasense rededge 5 band)

Field data:
-1400 RTK-GPS locations of trees (Spruce, Pine, Birch and Aspen)
- 300 forest inventory field plots (9 m diameter)

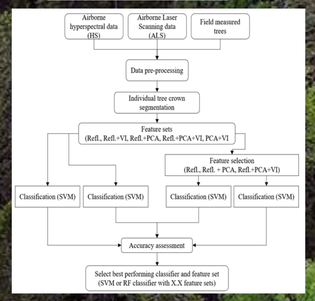


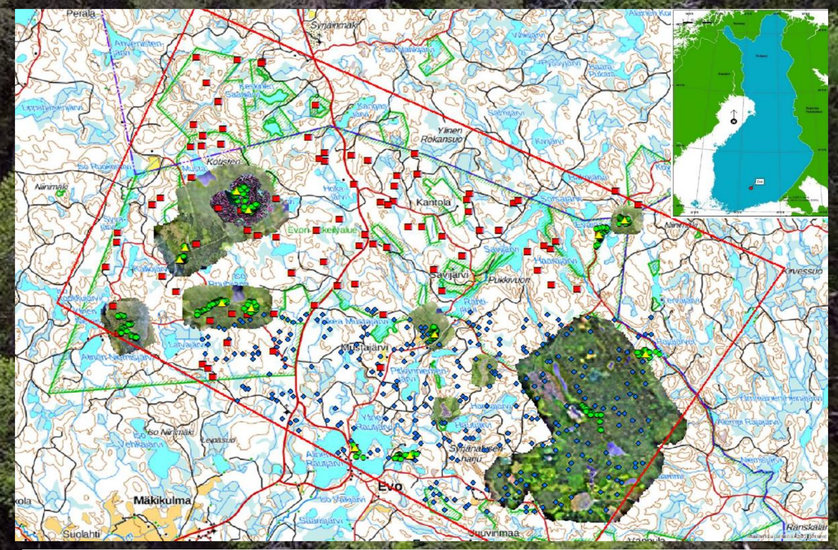






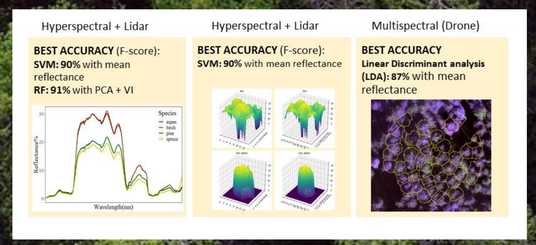
Methods

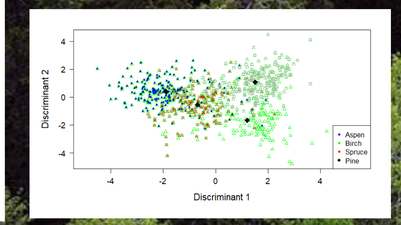




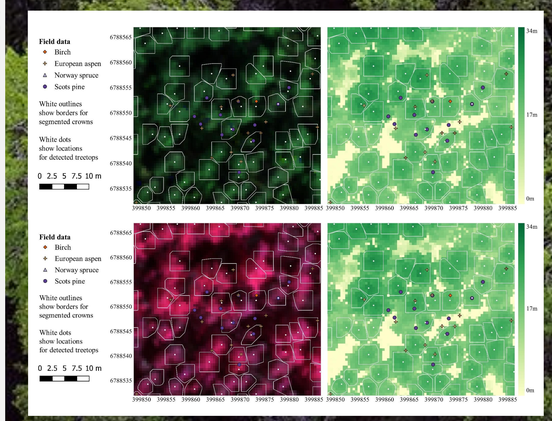
The study area of 83 km² at Evo (Hämeenlinna, southern Finland). Red retangle is the area of acquired airborne and hyperspectral data. UAV data coverage plotted as RGB images on top topographical map. Field data: circular forest inventory plots (red, blue), ashttps://www.ibccarbon.fi/en-USpen sampling for chemical analyses (green), vegetation plots (yellow).

Results

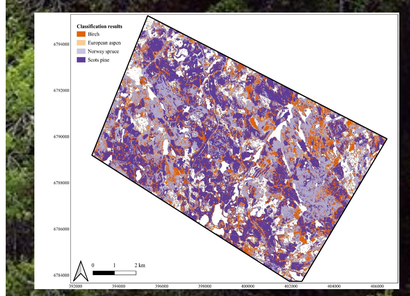




Linear Discriminant analysis of UAV data
Kappa = 0.74, User accuracy of Aspen classification 82%.



Example comparison of field plot data and segmentation results. Left: RGB composite from hyperspectral data, central wavelengths Red:664nm, Green: 560nm, Blue: 493nm. Right: LiDAR-derived canopy height model.



Wall-to-wall tree species map of trees with maximum height of 10 meters or more.

Discussion/conclusion

- In our results, SVM clearly outperformed RF when only spectral reflectance features were used for classification. However, PCA features clearly enhanced RF ability to discriminate tree species.
- At the species level, both SVM and RF could classify aspen and pine with higher accuracy compared to birch and spruce regardless of the feature set used.
- The results of the current study indicated that UAV-based automatic aspen detection approach provides a cost-efficient alternative for the rapid assessment of tree species composition in boreal forests.

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