Project information

Project title

Utilising multi--angular information from overlapping UAV images to enhance vegetation mapping in northern Norway (UAV Vegetation)

Year

2018

Project leader

Dr Corine Davids (PL), Norut, Tromsø

Geographical localization of the research project in decimal degrees (max 5 per project, ex. 70,662°N and 23,707°E)

In Tromsø at 18°65' – 18°90' E and 69°58'- 69°65'N, in Malangen 18.90° – 18.92°E and 68.45° – 68.46°N

Participants

Dr. Marit Jørgensen, NIBIO Holt, Tromsø

Flagship

Terrestrial

Funding Source

Funding from Fram Centre: 430 000 NOK for 2018

Summary of Results

a. Implementation of multi-angular information extraction method

Using UAV 15-band hyperspectral data collected over cultivated grasslands in Malangen in 2017, the individual single band images were orthorectified and a digital surface model (DSM) was created using Agisoft Photoscan. A Python script was developed to extract the sun-surface-sensor geometry for each pixel in each image, and to extract the information on the reflectance anisotropy for each spectral band at each of the 50 sample points (fig. 1). For example, figure 1 shows that the variation in reflectance is about 10% (for wavelength 865 nm) with view zenith angles up to 20°from nadir.

b. Collection of data at different viewing geometries

At the end of June, new data was collected from the experimental fields at NIBIO Holt, Tromsø. A Rikola hyperspectral camera was placed on a tripod and full hyperspectral images (between 500-900 nm) were collected at different view zenith angles and view azimuth angles (fig. 2a). A number of fields with different amounts of fertilisation, and therefore varying yields, were measured. The fields were harvested soon after collecting the hyperspectral images and the yield (wet and dry biomass) was measured per field. The images have been processed (calibrated and converted to reflectance), but not yet analysed against biomass. Analysis of the reflectance anisotropy shows up to 60% variation in reflectance relative to nadir (for 30° view zenith angles and wavelengths between 500-700 nm; up to 30% variation for wavelengths between 700-900 nm), with the highest variation in the back scattering direction (fig. 2b).

c. Implementation of the Rahman-Pinty-Verstraete (RPV) model

The RPV model is a semi-empirical model that describes the bidirectional reflectance distribution function (BRDF) as a function of the illumination and viewing geometry and four anisotropy parameters. The model has been implemented, but has not yet been run over the full image data set.

The work that remains to be done in November and December 2018 includes the mapping of the anisotropy parameters for the fields using the RPV model, and the regression analysis of the anisotropy parameters with the sample biomass data. A paper is planned for 2019.

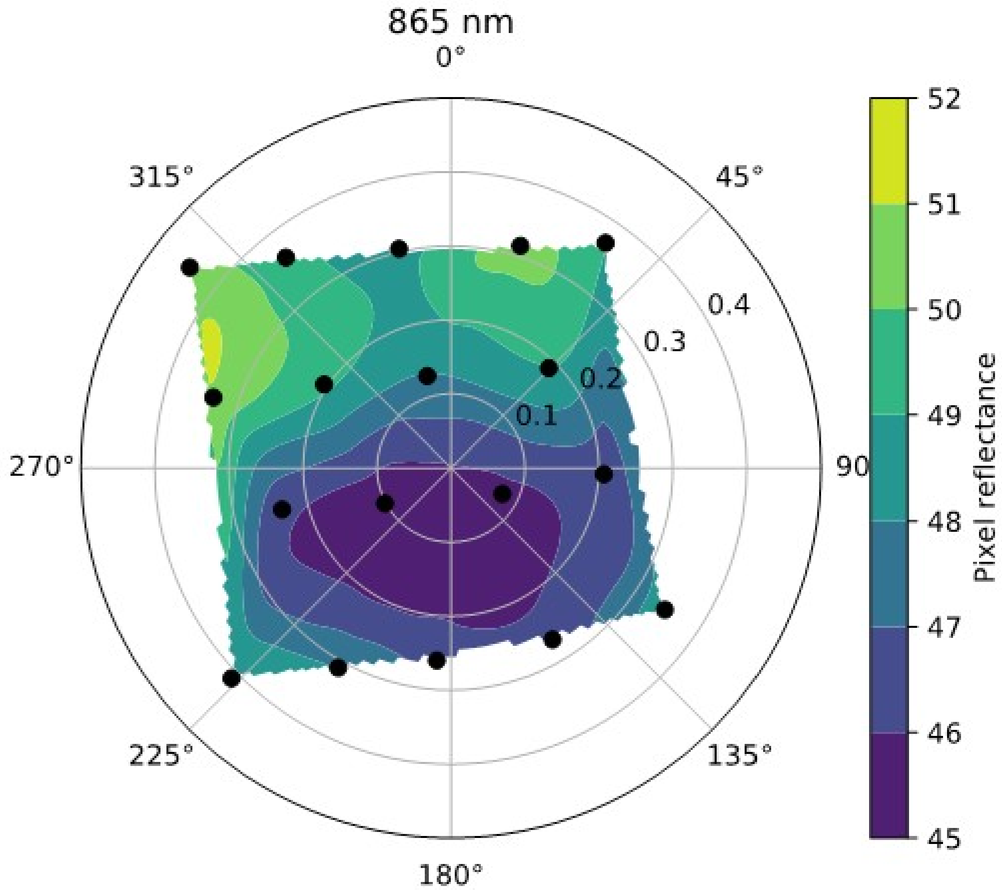

Figure 1a: Outlines of overlapping images, which cover sample point 10.

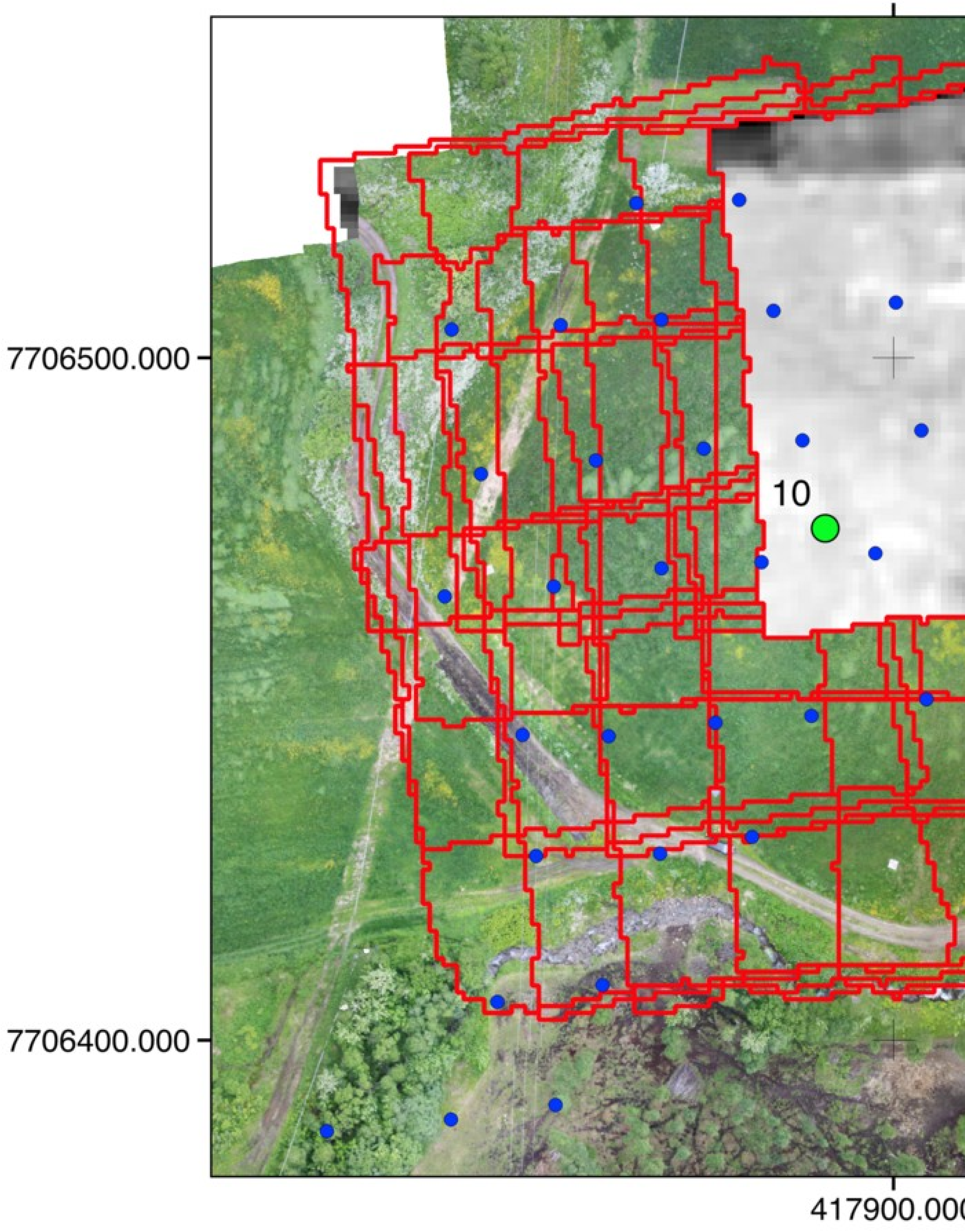

Figure 1b: Reflectance anisotropy for band 865 nm relative to viewing zenith angle. Sun is from the south at 187°.

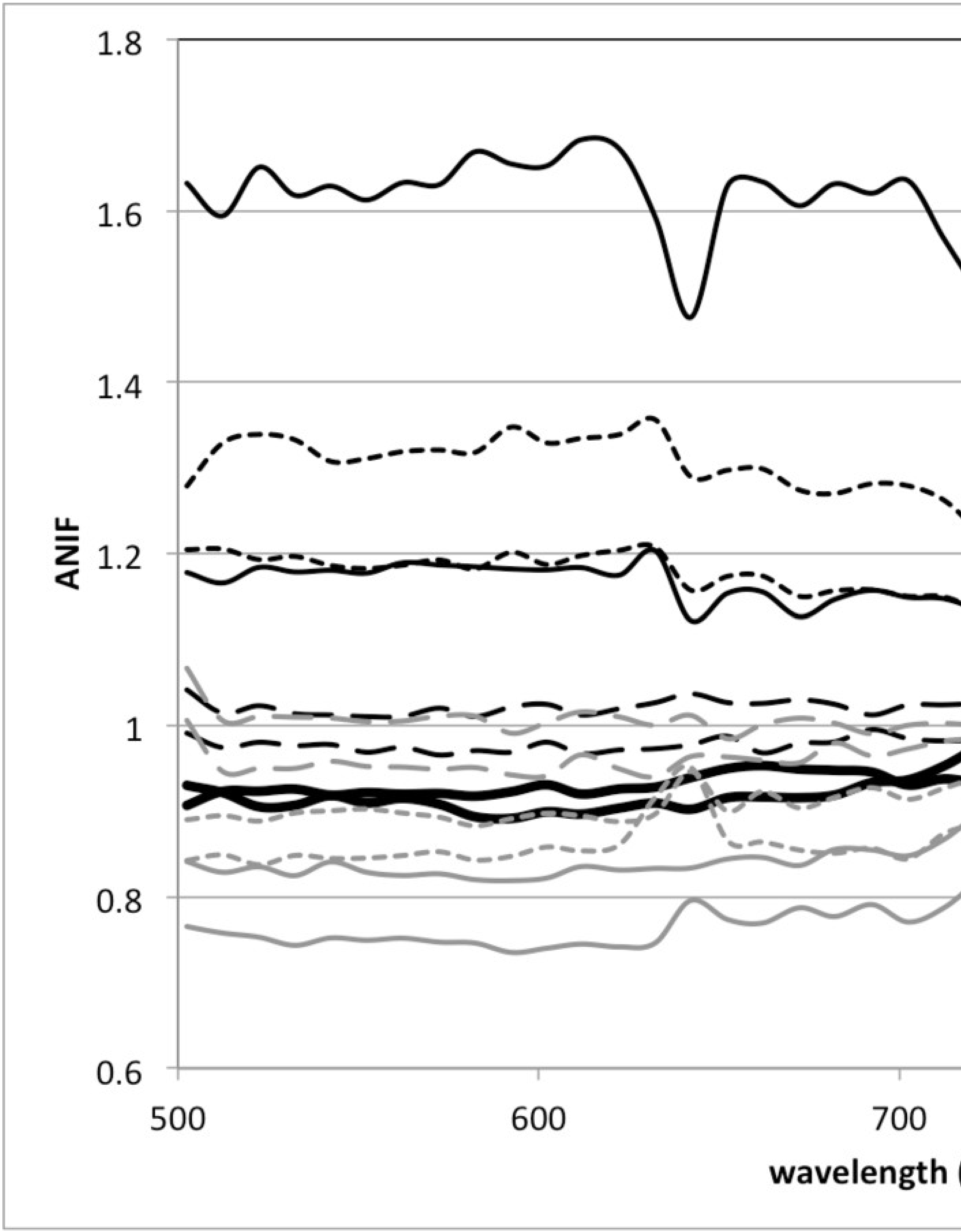

Figure 2. a. Top: measurement setup at NIBIO, Holt. b. Bottom: Anisotropy factors (ANIF) relative to nadir measurements for the 500-900 nm spectra. Measurements at 15° and 30° view zenith angles, at azimuths ca 0°, 45°, 90°, 135°, 180°, 225°, 270°, and 315°.

Highlights:

1. High reflectance anisotropy for cultivated grassland at wavelengths between 500-700 nm, lower at wavelengths between 700-900 nm.

2. Highest anisotropy in the back scattering direction.

For the Management

Forage is a key resource for ruminant meat and milk production. Information on yields and forage quality on the standing crop could help farmers make appropriate management decisions concerning i.e.: harvesting sequence of different fields according to yield and feed quality, sorting according to feed quality, purchasing the appropriate supplements, stocking rate etc. Cultivated grassland in northern Norway shows a diverse species composition as the age of the grasslands vary. This makes it more challenging to obtain a good correlation between spectral information and biomass than results obtained using experimental fields with a homogenous and well-known species composition. As the reflectance anisotropy is influenced by the structural properties of the surface, which is again influenced by the species composition, it is expected that including this information will improve biomass estimates.

Published Results/Planned Publications

Conferences

Davids C., Karlsen S-R., Murguzur F., and Jørgensen M. UAV based mapping of variation in grassland yield for forage production in Arctic environments. American Geophysical Union (AGU) Fall meeting, 11-15 December 2017, New Orleans, US.

Davids C., Karlsen S-R., Murguzur F., and Jørgensen M. **UAV based mapping of grassland yield for forage production in northern Europe.** European Grassland Federation (EGF) General Meeting, 17-21. June 2018, Cork, Ireland.

Planned publication:

Mapping reflectance anisotropy in cultivated grasslands in northern Norway to improve UAV-based biomass estimates.

Communicated Results

Dissemination for stakeholders

Davids, C., Karlsen, SRK., Haarpaintner, J., og Johansen, B., 2018. Bruk av satellittdata i landbruket? Trøndersk Landbrukskonferanse ’Trøndersk Landbruk - Hva nå?', 14-15 November 2018, Stjørdal. https://www.fylkesmannen.no/nb/Trondelag/Kurs-og-konferanser/landbrukskonferanse-2018/

Jørgensen, M., 2018. Bruk av fjernmåling til overvåking av engareal i Nord-Norge - kan det komme bonden til nytte? Hurtigruteseminaret 2018. 19-20 November 2018.

Interdisciplinary Cooperation

This project is a collaboration between scientists focused on agronomy (Jørgensen – studying grassland cultivation and effects of agronomy and climate changes on grassland productivity), and statistical modelling and remote sensing (Davids –modelling and remote sensing of vegetation).

Budget in accordance to results

This is a pilot project to implement a model and study if and how the retrieved model parameters can improve UAV-based biomass estimates. The idea was developed after work carried out in the project ‘Use of remote sensing for increased precision in forage production’ (PI Marit Jørgensen), which was funded by NRC (Matfondet) and Fram Centre 2015-2018. This pilot project could not have been carried out without Fram Centre funding. It also enhances the work done in the ‘Use of remote sensing for increased precision in forage production' project.

Could results from the project be subject for any commercial utilization

No

Conclusions

a. Initial results have shown that the overlapping UAV images include a significant amount of information on the reflectance anisotropy (BRDF). This can now be used to study different vegetation types and to investigate if this information can facilitate the classification of vegetation types and/or the mapping of vegetation biophysical parameters, such as biomass or leaf area index.

b. The project has helped to further develop a processing chain for the UAV-based multispectral Rikola camera, by utilizing the information from overlapping images to extract parameters describing the structural properties and bidirectional reflectance distribution functions (BRDF) of the surface. This is important to increase the usefulness of UAVs for vegetation monitoring and the ability to extract physical vegetation properties.