Ke Shao

Optimizing winter wheat leaf area index estimation across growth stages using UAV data

Winter wheat is a significant grain crop in Europe, with its production playing a crucial role in food security. As climate change threatens the stability of crop yields, it's more important than ever to monitor wheat growth accurately. One of the key ways to do this is by measuring the leaf area index, which tells us how much leaf area there is in a given area. This information helps farmers make informed decisions about irrigation, fertilization, and predicting crop yields.

The goal of the study was to optimize the accuracy of leaf area index estimation for winter wheat across different growth stages by using drones with professorial cameras. Cameras took images when flying in the study areas and provided image data after processing. The study focused on understanding which types of image data are most useful and how combining different types of data (like plant height and specific wavelengths of light) can improve leaf area index estimates.

The study was conducted in southern Sweden, over three winter wheat fields. Field data included leaf area index and plant height measured every two weeks. The drone took images and generated reflectance maps and digital surface models. Using these data, the study developed regression models to estimate the leaf area index. The study found that the Normalized Difference Red Edge index was the best single indicator for estimating the leaf area index. However, when plant height data were added to the models, the accuracy improved significantly. The most accurate model combined plant height with the Chlorophyll Index with Red Edge.

The study then discussed the challenges of radiometric calibration and the limitations of using the red edge band, which showed weak correlations with the leaf area index. Additionally, the study emphasized the impact of weather conditions on capturing drone images and estimating plant heights and listed some future study directions on solving model overfitting problems. The findings provide an approach for accurately estimating leaf area index in winter wheat using drone-derived data. The combination of spectral indices and plant height data enhances the precision of leaf area index estimation.

Keywords: Leaf area index, multispectral UAV, winter wheat, machine learning, random forest

Advisor: **Shangharsha Thapa, El Houssaine Bouras, Lars Eklundh**

Master degree project 30 credits in Physical Geography and Ecosystem Science, 2024
Department of Physical Geography and Ecosystem Science, Lund University. Student thesis series INES nr 663