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Estimating dry matter content in forage grasslands using Sentinel-2 satellite data

Leaf-level vegetation dry matter and water content as plant traits have been commonly studied, but few studies have investigated the capabilities of satellite remote sensing in estimating community-level dry matter content as percentage (DMCaP) in forage crops for agricultural applications. It is a crucial quality factor for maximizing nutrient yield and producing palatable forage.

In this thesis, we evaluated the capabilities of primarily Sentinel-2 data, and combined with environmental variables, in estimating DMCaP in forage grasslands in Southern Norway. Two types of models were developed, the interpretable model and the Random Forest Regression (RFR) model. The evaluation of the model performance showed that the RFR model outperformed the interpretable model, achieving an RMSE of 3.88%, and the use of environmental predictors further improved the estimation accuracy (RMSE = 2.90%). The interpretable model performed better when applied to individual fields respectively, indicating its better suitability for highly local-scaled data, and there was no significant difference in performance when using different combinations of water index and vegetation index. Although the performance evaluation suggested that DMCaP can be estimated with acceptable accuracy, model development was challenged by the inadequate temporal and spatial resolution of Sentinel-2 data, noise and uncertainties in the dataset, and the small data volume.

This thesis underscores the potential of satellite remote sensing for estimating the DMCaP quality factor in agricultural applications, providing valuable insights for the forage-harvesting process and pasture management. It addresses the gap in estimating vegetation dry matter content between the agricultural and academic communities, as well as the limitations observed in previous studies when matching satellite and in-situ data pairs.

Keywords*: dry matter content, machine learning, remote sensing, forage grasslands, vegetation index*

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