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Image-Based Vegetation Classification of Rewetted Peatlands; an Example on the FluxNet-Site Zarnekow

Drained peatlands have a high potential in mitigating anthropogenic climate change through the process rewetting. The Intergovernmental Panel on Climate Change (IPCC) provides a binary distinction of these biotopes: Peatlands remaining Peatlands and Land converted to Peatlands, and associates GHG emission factors to these classes. However, this distinction is not able to grasp the transition of these states, which is also characterized by highly dynamic GHG fluxes. Tracking the progress and impact of rewetting peatlands is needed to monitor the goal of policymaker decisions and further understand the peatland characteristics. Conventional methods such as chamber or eddy-covariance measurements are highly local and thus not suitable for upscaling. A key to that lies in the Greenhouse Gas Emission Site Type (GEST). This approach allows emission estimation based on dominant vegetation species and water table depth. The first part of this approach is the focus of this study: vegetation mapping. The combination of high resolution Uncrewed Aerial Vehicle (UAV) imagery and dominant vegetation species survey data, Machine Learning (ML) models are used to tackle the task. This case study uses data collected in the rewetted peatland of Zarnekow in Mecklenburg-Western Pomerania. The sites rewetting started in late 2004 and its developement is tracked by Eddy-Covariance measurements from 2007 to 2009 and from 2013 ongoing. The datasets consist of a RGB-orthomosaic which was used to plan and do a vegetation survey aiming at spatially dominant species, which can visually be delineated. The collected ground truth dataset was then expanded by visual interpretation of the orthomosaic. The two datasets (ground-truth and expanded) span 5.7ha and 0.75ha hectares and are used to train four different ML methods. Random Forests (RF) are explainable and frequently employed. Being dependent on precalculated features, this technique suffers from heterogeneous datasets, such as the one collected in the field. To boost model robustness, handcrafted features (Haralick-Features in different scales) are used to expand the datasets feature space. Neural Networks (NN) are able to calculate and find features automatically. While this decreases the models explainability, a high degree of specialization can be achieved leading to increased prediction accuracy. In this highly dynamic field of research new concepts are frequently proposed. In the computer vision domain, however two approaches gained popularity for their classification capabilities: Convolutional Neural Networks (CNN) and Vision Transformers (ViT). A model-architecture of each of these category as well as a vanilla RF and a RF with additional handcrafted features are trained with the dataset. While being quantitatively superior, the NN, when judged qualitatively, falls short of the traditional RF approaches performance.

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