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A UAV-based approach for biomass prediction and sward structure characterization in coastal meadows

Miguel Villoslada[1,2], Thaísa Bergamo[1], Raymond Ward[3,1], Chris Joyce[3], and Kalev Sepp[1]
[1]Estonian University of Life Sciences, Institute of Agricultural and Environmental Sciences, Department of of Landscape Management and Nature Protection, Tartu, Estonia (mpecina@emu.ee)
[2]Department of Geographical and Historical Studies, University of Eastern Finland, P.O. Box 111, 80101 Joensuu, Finland
[3]Centre for Aquatic Environments, University of Brighton, Cockcroft Building, Moulsecoomb, Brighton BN2 4GJ, United Kingdom

Coastal meadows provide a wide range of ecosystem services (ES) worldwide. Primary production in coastal meadows is a key ecosystem function that drives the supply of ES such as carbon (C) sequestration as well as food provision for livestock. Beyond their role as carbon sinks, high species diversity and complex structure of coastal meadow landscapes comprise an important habitat for populations of wildfowl, waders, amphibians, and arthropods. The quality of these habitats partly depends on sward structural heterogeneity, which is mostly determined by low intensity grazing.

In order to better target conservation efforts in these ecosystems, it is necessary to develop highly accurate models that account for the spatial nature of ecosystem structure, processes and functions. In this study, above-ground biomass was predicted at very high spatial resolution in nine study sites in Estonia. A combination of UAV-derived multispectral and rgb datasets were used to produce vegetation indices and micro topographic models. A Sensefly Ebee UAV equipped with a Parrot Sequoia 1.2 megapixel monochromatic multi-spectral sensor and a senseFly S.O.D.A camera was used to obtain images at 10 cm and 3.5 cm ground sampling distance. A random forest algorithm was used to generate above-ground biomass maps based on biomass samples collected at study sites. The contribution of each predictor variable to the models was subsequently assessed. The models successfully predicted above-ground biomass at very high accuracies.

In order to assess grassland structural heterogeneity, each above-ground biomass map was clustered into discrete sward units using a Large Mean-Shift segmentation algorithm. The clustered above-ground biomass maps were further analysed using a set of five landscape indices that characterize different components of landscape configuration, patch size and heterogeneity. Grassland structural heterogeneity was subsequently related to management history at each study site, showing that continuous, monospecific grazing management tends to simplify grassland structure, which could in turn reduce the supply of a key regulation and maintenance ecosystem services: nursery and reproduction habitat for waders. These results also indicate that UAV-based surveys can serve as reliable grassland monitoring tools and could aid in the

development of site-specific management strategies.