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Towards efficient and standardised large-scale monitoring of peatland habitats through fine-scale drone-derived vegetation mapping

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Northern peatlands provide key climate regulating services by sequestering and storing atmospheric carbon as peat, but they also harbour highly specialized plant and animal species. Yet, 50% of peatlands in the European Union are currently degraded. To understand the effect of recent restoration efforts on habitat suitability and peat accumulation rate, there is a need to develop and refine efficient and standardised methods that can effectively target the multiple ecosystem services that peatlands provide. Given the spatial characteristics of peatlands, as well as the direct link between vegetation structure and peatland functioning, vegetation mapping with unmanned aerial vehicles or drones is ideal for such tasks.

For this study, we collected very-high-resolution drone imagery (2.8cm) of five Irish peatlands (ranging between 35–124 ha) in September 2022. We then used Random Forest classifiers to map fine-scale vegetation patterns (microform and plant functional type) in all peatlands using the resulting remote sensing products. Hereafter we subdivided and labelled each peatland into 20x20m grid cells using polygon-shaped field-based ground truth maps of peatland, and classified large-scale peatland habitats (ecotopes, and status or Active versus Degraded Raised Bog) with Support Vector Classifiers while using the proportions of microforms and plant functional types and topography as input datasets. Lastly, we assessed model performance and mapping accuracy between models trained on a singular peatland to those trained using a pooled ground truth dataset from the four other peatlands to evaluate the spatial transferability of habitat mapping over multiple peatlands.

Our results highlight that model performance for fine-scale vegetation patterns were consistently high (>90%) for all peatlands. Subsequent classifications of peatland habitats were also relatively consistent for singular peatlands with overall model performances of 73.0% and 89.3% for ecotopes and status respectively. Nevertheless, we observed notable reductions in overall model performances of 11.0% and 6.2% using pooled ground truth datasets. Inconsistencies in classification models resulted largely from artificial landscape features created by restoration, sun and shading, variation in plant phenology, suboptimal elevation models, and development of a gridded ground truth dataset from an original polygon-shaped and field-based map.

Our findings highlight that fine-scale vegetation patterns and peatland habitats can be classified accurately and consistently on the scale of whole peatlands using drone-derived imagery products and machine learning classifications. Our study provides comprehensive and novel insights into the multiple requirements for accurate vegetation mapping on which future drone studies can build to further optimize and standardise monitoring of vegetation dynamics in a wide variety of peatlands and peatland types of contrasting eco-hydrological integrity.