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Habitat mapping in coastal dunes using Random Forest classification of UAV images

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The EU Habitats Directive (HD) requires that natural habitats are monitored every six years to assess habitat condition, extent and range. In Ireland, reporting for the HD is based on ecological field surveys. This field-based mapping and assessment methodology, while desirable, can be time-consuming, difficult, and expensive. It also only covers a sub-sample of sites due to cost. Thus, more efficient mapping approaches, such as remote sensing, should be considered to supplement these monitoring techniques.

Here we present some preliminary results from the iHabiMap Project. The overall aim of iHabiMap is to develop and assess analytical approaches that use machine learning techniques to derive habitat maps from imagery acquired by Unmanned Aerial Vehicle (UAV). The project started in 2019 and to date twelve UAV surveys have been conducted acquiring very high-resolution (6 cm) multispectral imagery for five selected study sites. Ecological data were collected concurrently with each UAV survey to obtain the actual state of the recorded vegetation. The project focuses on assessing imagery from three habitat types: upland blanket bog, coastal dunes, and grassland in Ireland. In this abstract we focus on the coastal dunes.

The Random Forest (RF) machine learning algorithm using the python Scikit-learn library was utilized to identify and map the habitats. The pixel-based RF model was calibrated using a combination of ground truth data and several colour, band ratios, and topographic variables derived from the UAV data. Six separate models were generated to compare how classification accuracies change based on combinations of input variables. The methodology was initially implemented to classify four sand dune Annex I habitats: 2120 - Marram dunes; 2130 - Fixed dunes; 2170 – Dunes with creeping willow; 2190 – Dune slacks, in the Maharees site in Ireland. The results were analyzed using the standard confusion matrix to calculate overall and class-specific accuracies. Preliminary results suggest that RF can classify sand dune Annex I habitats 2120, 2130, 2170, and 2190, with overall accuracies ranging from 0.80 to 0.93, depending on the input variables. The highest accuracy was achieved using the combined spectral and topographic information. Feature importance metrics calculated from RF showed that the surface elevation

and Green Normalized Vegetation Index (GNDVI) were the key input variables in the classification. The results obtained from the presented workflow demonstrate the potential of using UAV, machine learning techniques, and field data in characterizing coastal dune environments. The classification will be further expanded to explore phenological differences of the vegetation by including the temporal dimension of the data and will be tested on the upland and grassland habitats. Moreover, an upscaling methodology will be implemented to assess UAV data usability on a broader scale mapping.