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Classification of Ombrotrophic Peatland Condition using Structural Signatures from Remote Sensing Data

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BACKGROUND: Lowland raised bogs contain distinctive assemblages of species, and play a key role in the global cycling of carbon. Monitoring peatland condition is important in the context of carbon cycling, because projections of future climate indicate that some bogs may turn from net carbon sinks to carbon sources through increased oxidation of peat in lower water table conditions, which can be brought about through processes of land degradation. Ombrotrophic (rain fed) peatlands contain structural "microtopes" (e.g., hummocks and hollows) which are linked to hydrology, biodiversity and carbon sequestration, and information on surface structure is thus a useful proxy for peatland condition. Despite this, many previous approaches using remote sensing data have relied on spectral approaches for mapping peatland condition, and these often result in poor discrimination of cover types because of the lack of unique spectral endmembers for key species assemblages. There is a clearly defined need for an approach which can utilize the potential structural information content of remote sensing data and apply this to a physically-based mapping tool for peatland eco-hydrology. This was the focus of the research we propose to present in this paper.

APPROACH: Wedholme Flow, Cumbria, UK was used as the primary study site for this work because it contained a range of surface condition types ranging from intact primary peat to drained and degraded areas with little Sphagnum cover. Two remote sensing datasets were used (airborne LiDAR and spaceborne IKONOS multispectral 4 m imagery) in a combined multispectral-structural approach for mapping peatland condition classes. Firstly, LiDAR data were pre-processed to extract spatial estimates describing peatland surface topography. These products included minimum and maximum land surface height, surface variance and semi-variance (derived from semi-variogram analysis). LiDAR products were then assimilated with optical IKONOS data into a maximum likelihood classification procedure, and thematic outputs were compared. Ecological survey data were used for validation. Our presentation will demonstrate the application of these methods to the thematic separation of peatland condition classes, linked to eco-hydrological condition and land degradation.

RESULTS: Improvements in mapping products were achieved when spatially-distributed measurements of LiDAR variance or semi-variance were included in the classification. Quantitatively, the classification accuracy improved from 71.8% (IKONOS data only) to 88.0% when a LiDAR semi-variance product was used. Of note was the improved delineation of management classes (including Eriophorum bog, active raised bog and degraded raised bog). The work shows that the application of a combined textural-optical approach can improve land cover mapping in areas where reliance on purely spectral discrimination approaches would otherwise result in considerable thematic uncertainty. The approach enabled us to draw out the differences in surface pattern across the peatland and resulted in an improved mapping product which is useful for scientists, peatland managers, statutory conservation agencies and for policy makers.