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Characterizing Alpine peatlands from drones: a case study

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Alpine peatlands occur in alpine, sub-alpine and mountain regions of the world and can be frequently found on the Alps as well as on the Andes, on the Tibetan Plateau, on the Australian Alps and in other regions of the world. Italian Alps host a large number of relatively small bogs and fens that can be found on gently sloping surfaces or in small valleys created by past glaciers. The high precipitation-low temperature climatic regime ensures large water availability to these ecosystems. The uniqueness and importance of peatlands in the Alpine territory is strongly linked to the countless ecosystem services that they provide, including their ability of sequestering and stocking carbon, providing habitat for flora and fauna including endangered species, supporting important biological diversity, being reservoir of high-quality freshwater during warm and dry seasons, and having the role of paleo-climate archives.

Despite their importance, the peatlands of the Alps are still poorly studied and incompletely mapped, probably because they are relatively small and difficult to access. The use of remote sensing techniques provides a possible solution, allowing extending local measurements to wider areas in a fast and cost-effective way. Our hypothesis is that the spatial distribution of different plant associations as well as the spatial variability of vegetation biomass may provide important information for mapping the spatial distribution of peat properties, thus making remote sensing an effective method for peatland studies.

In this work, we present the results obtained by using data collected by Unmanned Aerial Vehicles (UAVs) on the Val di Ciampo alpine peatland (Province of Belluno, northeast Italy) in July 2021. LiDAR data, hyperspectral data and aerial digital photos were simultaneously collected on an area of 88.000 m^2. Field observations and measurements were performed in the same period, providing georeferenced ground information on vegetation and peat characteristics. Peat and vegetation samples were collected and analyzed in the lab. For each vegetation association we measured the height of plants and determined their above- and below-ground biomass based on 20 above-ground and 15 below-ground samples. As for the peat, we measured the peat thickness and determined the bulk density and the organic carbon content of 46 samples.

Our results show that some of the correlations found between the parameters that characterize different vegetation associations can be used to calibrate the data collected by UAVs and extend the results from point locations to the entire peatland. For example, we found that the aboveground biomass is significantly correlated ($r = 0.81$, $p < 0.001$) to the local average vegetation height, therefore both LiDAR data and the Digital Surface Model (DSM) extracted from the photos can be used to estimate and map the vegetation aboveground biomass. The correlation between the surface microtopography and the aboveground biomass will also be presented, as well as other correlations between vegetation patterns and peat depth and properties. The significance of combining UAVs multi-sensor data with field observations for the characterization of Alpine peatlands will be discussed.