Submitted Abstract

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Abstract

Alpine treeline ecotones are facing an exceptional change due to both climatic and land use changes. Elevational treelines of Southern Alps are mostly constrained by regional-scale climate, landscape-scale human legacy and fine-scale microsite conditions.

10 treeline ecotones of the Italian Alps were randomly selected along the uppermost forestline extracted from a tree cover density Copernicus dataset (year 2018), spanning from west to east of the mountain range. In these treeline ecotones, we integrated proximal and UAV-based remote sensing data to obtain a stem-mapped dataset of seedlings within 9 ha plots. In particular, proximal data included the position of all seedlings taller than 50 cm and their height. Regarding remote sensing data, we employed UAV photogrammetry to derive a 4 cm digital elevation model (DEM) and a canopy height model (CHM). Moreover, we coupled object-based image analysis (OBIA) and random forest (RF) to classify RGB very-high resolution orthomosaics into land cover classes, including tree species. We adopted multivariate statistical analysis to assess site-scale environmental and anthropogenic drivers. At a singletree scale, we used first- and second-order point pattern analysis (PPA) to assess species distribution and facilitation mechanisms and statistical modeling to assess micro-topographic drivers on tree encroachment.

Coupling proximal and remote sensing techniques allowed us to map accurately (average RMSE = 30 cm) 90 ha of alpine treeline ecotone. Results highlighted common patterns and some peculiarities. Larix decidua was the dominant species at the treeline, but Pinus cembra, Picea abies, Pinus sylvestris and Pinus uncinata were locally abundant. All the measured treeline ecotones showed a common legacy of human impact, but with locally different intensities and patterns. Pure larch treelines of western Alps were at lower elevations and mostly associated with intense pastoral historical use.

Our fine-scale approach is a powerful and low-cost tool to efficiently obtaining precise and spatially explicit data on forest dynamics occurring at treeline ecotones. The comprehensive dataset that we obtained for relatively large study areas allowed us to explore the role of biotic and abiotic drivers of tree establishment and growth at the treeline. An integration of landscape-scale diachronic analysis is planned to disentangle the role of land use legacy on treeline ecotone dynamics.