ASSESSING BIODIVERSITE RELATED VARIABLES BY UNMANNED AERIAL VEHICLE (UAV) REMOTE SENSING

EXTENDED ABSTRACT

The continuous collection of forest data is crucial for a sustainable forest management. However, forest inventory data collection is time consuming and expensive. Remotely sensed data appear as an alternative to the field inventory. Despite the general knowledge of advantages satellite and airborne remote sensed data present, they present a limitation in the application of forest management inventories and small-scale forest monitoring where a number of forest stand structural (e.g. tree density, basal area, stand height, volume), compositional (e.g. dominant species, species proportions) or health status (e.g. crown condition) variables must be assessed at extremely fine spatial scales. In fact, these variables are usually collected on ground sample plots as large as 400-500 m^2. The unmanned aerial vehicles (UAV) imagery could be used to overcome the limitation the satellite/airborne remote sensing presents.

This research explored the capability of a UAV, namely the eBee drone, imagery to map forest canopy gaps and derive some forest parameters such as, biodiversity indices, habitat trees, basal area, canopy height, deadwood, etc. using handy techniques in a test area of 240 ha of natural reserve of Lago di Vico in Central Italy. We used correlation and linear regression techniques to explore relationships between gaps patch metrics on one side and forest features on the other.

To achieve those objectives, we firstly mapped forest canopy gaps using the contrast split algorithm based on the red band of the RGB orthomosaic. Secondly, we calculated for each gap the extent and shape metrics. Thirdly, we aggregated the data on plots' level by only assigning to each plot gaps that completely lie inside the plot or have over 50% of their area within the plot. Fourthly, for each plot, we calculated the mean, the standard deviation, the sum, the coefficient of variation associated with the patch metrics considering minimum area thresholds of 1 m^2 and 2 m^2, separetly. Sixthly, we performed statistical analyses on the collinearity among patch metrics and exploratory analysis for the field parameters which were grouped in three different datasets, namely, the understorey, the living trees and the deadwood. Seventhly, we performed the correlation and regression analyses on gap patch metrics and field parameters. Finally, for field parameters that led to an $R^2 > 0.5$ we produced the forest map of the parameter and using the cross-validation method, we produced the RMSE associated to each map.

The results showed that contrast split algorithm is effective in mapping forest canopy gaps, particularly the shaded gaps. The 95 patch metrics calculated for each plot (for each threshold) were highly collinear. In the study area, the three forest types (*Fagus*, *Quercus* and Mixed forests) do not have the same understorey, and the same characteristics of living trees but the deadwood distribution is roughly the same.

As a whole, the total deadwood volume presented a poor correlation with patch metrics. A similar result is obtained when the deadwood is separated either in decay class or in type of deadwood (eg. Standing deadwood, living deadwood, etc). For the understorey, the field parameters were strongly correlated with gap patch metrics. For instance, Shannon index and mean DBH in the Quercus forest yielded an $R^2 > 0.5$ while in Mixed forest, number of plants, mean HTOT and mean DBH exceeded that threshold (Fig1). Results were relatively lower in Fagus forest, with only Pielou index R^2 close to 0.5.

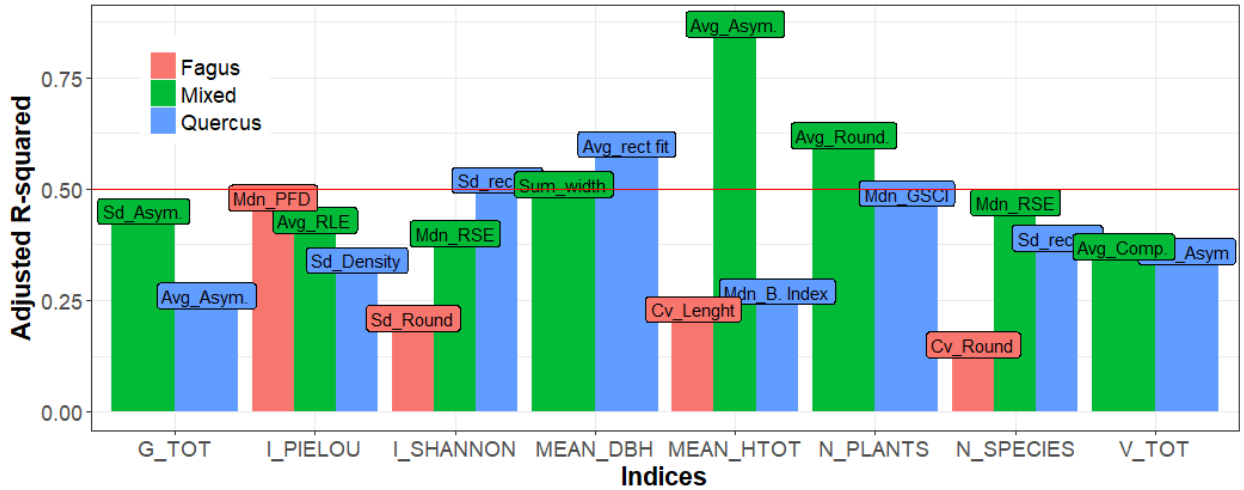

Fig1. Summary bar chart of adjusted R^2 from linear regression with understorey data in all the three forest types. On top of each bar, the gap patch metric used for linear regression

Results for the living trees (Fig2) were similar to the ones in the understorey. We found strong correlations between gap patch metrics and living trees parameters. In addition to the DBH and HTOT, Pretzsch index, which is an indicator of vertical structure complexity and habitat trees, which is a functional diversity indicator, depicted all R^2> 0.5.

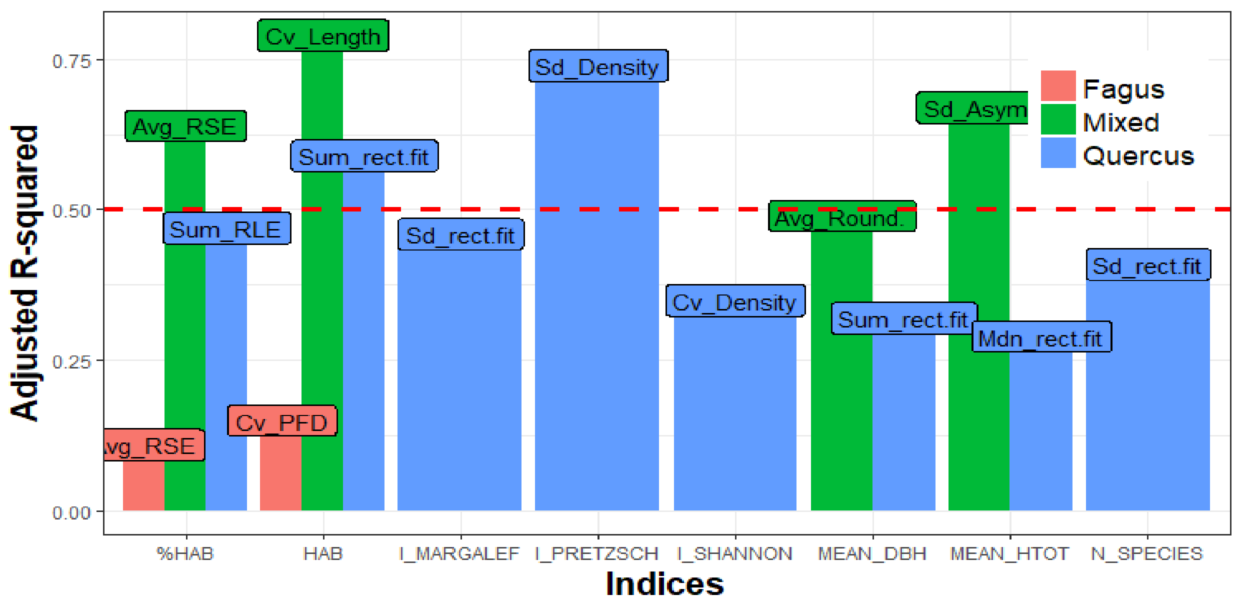

Fig2. Summary bar chart of adjusted R^2 from linear regression with living trees data in all the three forest types. On top of each bar the gap patch metric used for the linear regression

The study showed that in the examined forest types, all characterized by a stand exclusion development stage, horizontal structure, vertical structure and functional diversity of the forest can be assessed through forest canopy gaps. Of the many gap patch metrics, the shape metrics yielded best results compared to the extent ones such as the area of the gap. Therefore, the study suggests that a particular attention should be given to gap shapes as much as to gap sizes, when creating new gaps by silvicultural interventions.