EGU24-5476, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-5476
EGU General Assembly 2024

Mapping evergreen broad-leaved species spatial cover in Italian forests from Sentinel-2 time series using Deep Learning

Benedikt Hiebl[1], Gianmaria Bonari[2], Nicola Alessi[3], Alessandro Bricca[4], Giacomo Calvia[4], Georg Wohlfahrt[5], Clemens Geitner[1], and Martin Rutzinger[1]

[1]Department of Geography, University of Innsbruck, Italy, Austria (benedikt.hiebl@uibk.ac.at)
[2]Department of Life Sciences, Unicversity of Siena, Siena, Italy
[3]Institute for Environmental Protection adn Research, Rome, Italy
[4]Faculty for Environmental, Agricultural and Food Sciences, University of Bolzano, Bolzano, Italy
[5]Department of Ecology, University of Innsbruck, Innsbruck, Austria

Climate change-induced shifts, such as prolonged growing seasons and milder winters, coupled with land-use alterations like forest management abandonment, are reshaping species composition across European forests. A significant spread of evergreen broad-leaved species (EVEs) was observed in southern European forests, driven by global change dynamics. However, large-scale spatio-temporal analysis of these changes are lacking and emphasizes the necessity of mapping these dynamics. The TRACEVE projects ("Tracing the evergreen broad-leaved species and their spread") primary goal is therefore tracking EVEs' cover, spread and diversity on a national-scale in Italy. As part of the project, this study focuses on satellite remote sensing, Deep Learning, and forest mapping, aiming at creating seamless maps quantifying the current degree of EVEs cover within forests in Italy.

Challenges arise in the transitional zones between evergreen and deciduous forests, where EVEs initially spread in the understory of a deciduous canopy. Tracking EVEs at the edge of their range, where abundance is rare and in mixed forests is therefore difficult. Leveraging Sentinel-2 remote sensing time series covering the full annual phenological cycle addresses this challenge, utilizing leaf-on and leaf-off canopy conditions. Values of species cover derived from ad-hoc forest plot observations in Italian protected areas across a latitudinal gradient serve as initial training data, although the small sampling size (~1000 plots) poses challenges for the generalizability of time series extrinsic regression models, particularly when employing state-of-the-art Deep Learning architectures.

The main aim of the study is therefore the development of a robust, Sentinel-2 based mapping procedure to track EVEs within Italian forests on a national-scale. A remote sensing time series extrinsic regression model based on a Deep Learning architecture for cover degree mapping will be developed. Sentinel-2 annual time series, along with derived indices serve as predictors for the models, while target cover will be derived from the plot observations. The study is built around exploring selected strategies to address the issue of large-scale model generalizability, given a

small training sample size, that is recorded within small representative areas scattered across Italy. This entails assessing the efficacy of self-supervised pretraining methodologies applied to remote sensing time series within forested regions, pretraining on a more extensive forest database, and evaluating the viability of training data augmentation techniques.

To validate and evaluate results on a national scale, an independent forest vegetation database containing around 17,000 forest plots sampled across Italy is employed. This extensive dataset enhances the understanding of EVEs' distribution within Italy's diverse forest ecosystems and can further enhance understanding of complex model results.

In conclusion, the study combines advanced satellite remote sensing technologies, Deep Learning methodologies coupled with vegetation plot datasets to map current distribution of EVEs in Italian forests. The findings contribute to the TRACEVE project's future objectives but also offer insights into the challenges and opportunities of Deep Learning models in large-scale forest mapping applications.

Acknowledgements

This research has been conducted within the project “TRACEVE - Tracing the evergreen broad-leaved species and their spread” (I 6452-B) funded by the Austrian Science Fund (FWF).