Exploring climate, soil, and land-use effects on plant communities: a large-scale study in Europe

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Abstract

Understanding how environmental factors shape species distributions and community composition is a key challenge for ecologists, especially in the face of climate change and land-use intensification. Studying not only the species themselves but also their functional traits is crucial, as these traits determine how plants interact with their environment and influence key ecological processes.

Here, we present a large-scale study focusing on tracheophyte plants across Europe to elucidate the impacts of climate, soil, and land-use on plant communities. Leveraging plant community data from the European Vegetation Archive (European Vegetation Archive, Chytrý et al., 2016) and GBIF observations from across Europe as well as adjacent areas (Northern Africa and Western Asia) to capture the whole ecological niche, we compiled a comprehensive dataset covering over 12,000 plant species observed between 1990 and 2022. We thus computed several community functional indices related to plant structure and leaf composition using data from the TRY database.

Using ensemble machine learning models and variance partitioning analyses, we assess the relative importance of climatic, soil, and land-use predictors on species distributions and community functional traits. Our findings reveal complex interactions, highlighting the important role of climatic variables while also acknowledging significant impacts from soil and land-use drivers. Notably, the effects of climatic factors vary across European biogeographic regions and within different functional groups, with the intensity of land-use subtly influencing community responses to other environmental variables.

Ultimately, our findings contribute to a better understanding of how environmental factors drive plant presences and community dynamics, facilitating the development of effective conservation strategies tailored to future scenarios of climate and land-use change.

Keywords: plant community, climat, soil, land use, functional traits, models

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