



## From satellites to smartphones: harnessing citizen science and Earth observation to unlock global perspectives on plant functional diversity

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Understanding global patterns of functional diversity is essential for exploring ecosystem functioning, yet our current knowledge is limited to specific regions and geographically restricted datasets.. Meanwhile, rapidly growing citizen science initiatives, such as iNaturalist or Pl@ntNet, have generated millions of ground-level species observations across the globe. Despite citizen science species observations being noisy and opportunistically sampled, previous studies have shown that integrating them with large functional trait databases enables the creation of global trait maps with promising accuracy. However, aggregating citizen science data only allows for the generation of relatively sparse and coarse trait maps, e.g. at 0.2 to 2.0 degree spatial resolution.

Here, by using such citizen science data in concert with vegetation surveys and high-resolution Earth observation data, we extend this approach to model the relationships between functional traits and their structural and environmental determinants, providing global trait maps with globally continuous coverage and high spatial resolution (up to 1km). This fusion of ground-based citizen science and continuous satellite data allows us not only to map more than 30 ecologically relevant traits but also to derive crucial functional diversity metrics at a global scale. These metrics—such as functional richness and evenness—provide new opportunities to explore the role of functional diversity in ecosystem processes, particularly in areas previously lacking in data availability.

Our approach presents a scalable framework to advance understanding of plant functional traits and diversity, opening the door to new insights on how ecosystems may respond to an increasingly variable and extreme climate.