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Modeling the spatial impact of an invasive N_2-fixing Acacia by means of isotopic and optical measurements

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Invasions by exotic plant species are known to seriously alter biogeochemical cycles and ecosystem functioning of the systems they invade, with nitrogen fixing species being among the most problematic invaders. However, explicitly quantifying such alterations remains challenging, as methods are lacking to capture the spatial scale of impact.

Here, we present a spatially explicit approach allowing to quantify the impact of an N_2-fixing invasive species, *Acacia longifolia*, on a native Portuguese dune system by means of stable isotope analyses. ^{15}N isotopic signatures (δ^{15}N) differed strongly between the native system (δ^{15}N c. -10 ‰) and atmospherically derived N in *A. longifolia* (δ^{15}N c. 0 ‰). Thus, N sources for a native, non-fixing plant, *Corema album*, could be readily distinguished. Using georeferenced δ^{15}N values of *C. album*, we could accurately map N introduced by *A. longifolia* on a spatial scale. N input exceeded the canopy of the N_2 fixer by far and reached up to 8 m into the uninvaded vegetation. The area altered by invasion was c. 3.5 fold larger than the area covered by the invader's canopy.

Our results highlight that spatially explicit measurements of sensitive ecological tracers like stable isotopic signatures, i.e. isoscapes, provide a valuable means to quantify alterations of biogeochemical cycles within plant communities.

Moreover, linking stable isotopes with optical measurements and remote sensing can be a powerful tool to upscale such information from leaf- to larger spatial scales. Here we show that foliar δ^{15}N signatures can be accurately modeled using leaf reflectance spectra. This approach opens promising future perspectives in ecosystem monitoring based on the potential use of hyperspectral aerial and satellite imagery.