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Soil microbial co-occurrence networks and functioning along an aridity gradient in Atlantic coastal dunes

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Atlantic coastal dunes are priority conservation areas highly sensitive to climate change. In the Iberian Peninsula, a large part of the coastal dunes are drylands where the chronic shortage of water acts as a major driver of the ecosystem structure and functioning. The predicted increase in aridity by the end of this century may compromise key ecosystems aspects in drylands, such as biotic cover, vegetation productivity and soil fertility. We know little about how changes in aridity and biotic cover may affect the abundance and diversity of soil microbial communities in coastal dunes, and as such their assembly and ecological interaction networks.

We investigated whether the exposure to different aridity regimes can induce differences in microbial co-occurrence networks as well as alter their spatial heterogeneity. Specifically, we aim to (1) assess whether soil fungal and bacterial networks respond differently and (2) test the role of the biotic cover driving the bacterial and fungal network relationships, the soil attributes and functions. To that end, we used a climosequence of dune systems with minimal variation in the soil type that covered a wide range of aridity conditions including humid, dry-subhumid and drylands in the coastline of Portugal and Spain (~1500 km).

Our results show that aridity decreased the biotic cover, favoured the formation of shrub vegetation patches and negatively affected microbial diversity, organic matter content and potential nitrogen mineralisation in soils. We also observed that the biotic cover exerts a strong control on soil attributes whose effects depend on the degree of aridity (e.g. formation of fertile islands in arid areas and different control of soil inorganic nitrogen forms in wetter areas). At an ecosystem level, increases in aridity resulted in a strong increase in the coupling of the soil microbial network until a specific threshold (values of aridity index (P/ETP)= 0.5-0.6) beyond which it remained constant. Soil bacterial networks showed lower stability against changes in aridity than fungal networks. Surface microsites strongly drove the interactions among soil bacterial groups, but much less so for fungal groups. Our results suggest that climate change, through increased aridity and associated loss of the biotic cover, will have important implications for microbial

communities and soil functioning in these coastal dune systems.