Impacts of increased N availability on the structure and functioning of a Mediterranean Basin ecosystem

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Increased nitrogen (N) availability, resulting from agro-industrial activities, affects ecosystems’ health and stability. Mediterranean Basin ecosystems are biodiversity hotspots threatened by N deposition, however, little or no information is available on their responses to increased N. We develop an integrated system-level approach to study the responses of an N limited Mediterranean Basin maquis to increased N availability. Since 2007, the form and dose of N available at the experimental site (ambient N deposition 5.2 kg ha⁻¹ yr⁻¹ and soil N 0.1%) was modified by the addition of 40 kg NH₄⁺-N ha⁻¹ yr⁻¹, 40 and 80 kg NH₄NO₃-N ha⁻¹ yr⁻¹. Control plots were not fertilized. Over the following years, the effects on plant and soil microbial diversity and ecosystem services were assessed: soil N retention, below and aboveground C sequestration, and soil protection.

Over the first year, the added N was retained by the system and detected in the autumn as soil inorganic N. The increased N promoted plant and soil microbial diversity. On the fifth spring of N additions, plant richness increased with enhanced N and was more related to the cumulative ammonium than with the cumulative nitrate. Exposure to 40 kg NH₄⁺-N ha⁻¹ yr⁻¹ (either alone or with nitrate) enhanced plant richness, but did not increase aboveground C sequestration or soil protection; soil N retention even decreased under 80 kg N ha⁻¹ yr⁻¹. The treatment containing less ammonium, 40 kg NH₄NO₃-N ha⁻¹ yr⁻¹, did not enhance plant diversity but promoted aboveground C sequestration and soil protection. The dataset permitted the first estimation of an N critical load for this European habitat (20-30 kg N ha⁻¹ yr⁻¹).

Data suggest that agriculture, the main source of NH₃, may affect the structure of the neighboring maquis, promoting soil erosion and N leakage. In contrast, industrial and urban activities that increase N availability as NOx may increase fire risk. This is of significant importance for land-use management in biodiverse and fragmented ecosystems such as the Mediterranean ones.

Keywords: ammonium; biodiversity; impacts; nitrate; N cycling; N retention; plants; soil protection

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