Climate controls on the fate of anthropogenic nitrogen additions in hot desert ecosystems

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Abstract: Rapid urbanization in dryland regions is increasing nitrogen (N) emissions and deposition yet the fate of this N is poorly constrained. Long-term experimental N additions have shown no significant aboveground shrub response whereas herbaceous cover has responded positively when accompanied by average or above average winter rains. Retention of N in surface soils receiving long-term N additions has not been able to explain the fate of N additions. Here we show significant storage of anthropogenic N in deep soils (average 84% of applied N) and strong climate controls on retention of N. Under-plant storage of applied ammonium declined with small increase in precipitation (r^2=0.99, *P*=0.08) whereas retention of nitrate increased dramatically across the same gradient (r^2= 0.99, *P*=0.03). A simple model coupling ammonium oxidation kinetics to soil water potential in Hydrus 1-D explained much of the excess residual nitrate found in N plots; wind or water redistribution from inter-plant spaces to under-shrubs may also be responsible. Soil N storage in inter-plant spaces showed no correlation with precipitation or temperature. Our findings suggest subtle changes in precipitation predicted over the next several decades may have important consequences for the fate of anthropogenic N in desert ecosystems. This work highlights the critical nature of understanding N retention processes in dryland systems and the need for future research efforts.

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