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Carbon cycling in a biological hotspot within the hyper-arid core of the Atacama Desert

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The Aguas Blancas basin represents a biological hotspot within the hyper-arid core of the Atacama Desert, Chile. Despite the extreme climate and edaphic conditions, it is capable of supporting an unusual quantity of plant-life. It is likely that these plants directly impact on a range of factors including soil formation, soil biodiversity and elemental cycling. Higher levels of organic matter (OM) are generally found in vegetated compared to barren soil, and the presence of plants apparently have important effects on the size and composition of fast-turnover OM pools. Further knowledge on how under such extreme conditions and the presence of plants influences OM and microorganisms dynamics would help in efforts to mitigate and understand desertification processes occurring in analogous landscapes.

In this paper, we report on the content of OM in samples of vegetated and non-vegetated soil in the same area. Analyses for plant and soil C, ^{13}C, N and ^{15}N content were performed along with the record of temperature and relative humidity of air and bare inter-spaces in surface and subsurface (10 cm depth) soils. The dominant plant species measured (*Distichlis spicata*, *Atriplex atacamensis*, *Adesmia atacamensis* and *Prosopis tamarugo*) included both C_4 and C_3 plants and N_2 fixers.

The results showed roughly 1.5, 5-6 and 5-7 times higher Total C content in topsoil, phyllosphere and subsoil of the vegetated compared to the bare soils. The differences in N content between vegetated and bare soil were generally small. Measurements of microbial biomass (by phospholipid fatty acid analysis) showed a concentration 20 times higher in the planted soil. The soil ^{13}C values suggested that ca. 50% was C_4-C thus derived from the current plant vegetation. The presence of plant fixed N was not evident from the soil ^{15}N value which ranged from 3 to 11 (average $7^0/_{00}$).

The temperature record shows a diurnal trend, which become less with depth in the soil. This diurnal variation greater than 30°C indicates that the plants are constantly adapting to the prevailing conditions, moving from one stress to another. Regarding relative humidity of air and topsoils, it follows an inversely proportional trend to temperature varying diurnally as well. Discordantly, the humidity is more constant in subsoil. In particular, humidity in the soil at the surface peaks after the maximum air relative humidity - as moisture is absorbed into the soil.

Since the absence of precipitation during the study, it is concluded that fog coming from the ocean causes the variation of the relative humidity of the air and soil. Fletcher et al (2012) suggested that the OM variability and peaks in Atacama Desert are both controlled by fog. A portion of this ingoing water to the system could be trapped by plants and also penetrate under the salt crust in topsoils, reaching plant roots and supporting soil biological communities, the production of organic material as a by-product of their own biological processes and mycorrhizas. Finally, plants are considered as an important key controller on the soil status in these extreme arid systems.