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Post-fire drought effects and their legacy on soil functionality and microbial community structure in a Mediterranean shrubland

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Climate change in subtropical areas, like the Mediterranean, is projected to decrease precipitation and to lengthen the seasonal drought period. Fire danger is also projected to increase under the most severe conditions. Little is known about the effects of increasing drought and, particularly, its legacy when precipitation resumes to normal, on the recovery of burned ecosystems. Here we studied the effects of post-fire drought and its legacy two years after it stopped on soil microbial community structure and functionality of a Cistus-Erica shrubland. To do this, a manipulative experiment was setup in which rainfall total patterns were modified by means of a rain-out shelters and irrigation system in a fully replicated set of previously burned plots. The treatments were: environmental control (natural rainfall), historical control (average rainfall, 2 months drought), moderate drought (25% reduction of historical control, 5 months drought) and severe drought (45% reduction, 7 months drought). One set of unburned plots under natural rainfall served as an additional control. Availability of the main soil nutrients and microbial community composition and functionality were monitored over 4 years under these rainfall manipulation treatments. Thereafter, treatments were discontinued and plots were subjected to ambient rainfall for two additional years. Post-fire drought had not effect on total C or N. Fire increased soil P and N availability. However, post-fire drought reduced available soil P and increased nitrate in the short term. Post- fire reduction of available K was accentuated by continued drought. Fire significantly reduced soil organic matter, enzyme activities and carbon mineralization, mainly in drought treated soils. Fire also decreased soil microbial biomass and the proportion of fungi, while that of actinomycetes increased in the short term. Post-fire drought accentuated the decrease of soil total microbial biomass and fungi, with bacteria becoming more abundant. After discontinuing the drought treatments, the effect of the previous drought was significant for available P and enzyme activities. Although the microbial biomass did not show a drought legacy effect of the previous drought period, the proportion of fungi was still lower in post-fire drought treatments and the proportion of bacteria (mainly Gram+) higher. Our results show that post-fire drought had an effect on soil functionality and microbial community structure, and that once the drought ceased its effects on some biogeochemical constituents and microbial groups were still visible two years thereafter. The fact that in a lapse of two years some variables had resume to normal while others still differed among drought treatment signifies that the legacies will last for some additional years, impairing during this time the normal functioning of the soil. However, these legacy was related to the magnitude of drought and, although not tested in our study, on the time since the occurrence of the phenomenon, and the sensitivity of the ecological system.