# Appraisal of Biogeochemical Markers for the Assessment of Damage Levels in Soils Affected by Wildfires

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Forest fires, a frequent and recurrent severe perturbation in Mediterranean ecosystems, exert both immediate and lasting ecological and environmental impacts in part caused by depth transformation on soil physical and chemical characteristics as well as on qualitative and quantitative changes in the organic matter (OM) composition, properties and dynamics which are reflected in the structure of the whole trophic system especially on microbial populations. This negatively affects soil health and quality favouring the occurrence of erosive processes lading to irreversible lost of a non-renewable natural resource such is the soil.. On the other hand, fire also leads to newly-formed C forms and to severe thermal modifications of the previously existing C forms, leading in general terms to the formation of substances with weak colloidal properties and enhanced resistance to chemical and biological degradation. Apart from this, fire also exerts a significant effect in soil biota, in their trophic structure, and consequently on OM decomposition pathways, which in some cases may lead to structural collapse and a loss of soil physical properties. However, the effects of fire on soil colloidal properties and on the microbial community are reversible. After the passage of the fire soil properties may naturally revert to a situation close to that before fire; erodibility is reduced and soil functionality is again achieved. This is especially evident in the so-called cold fires including controlled burnings and fires in open forest at semiarid environments with pyrophytic vegetation. Therefore, an early detection of the impact of fire just in soil, and the possibilities soil recovery in the next few years is important for the decision making and planning of environmental restoration actions that have to be taken after forest fire events. The starting hypothesis is

that if reversible effects do occur in fire affected soils, then we may be able to find out biogeochemical surrogated indicators informing on the loss of soil quality (health) that should be compensated through suitable remediation actions. The main objective of this work is therefore the identification of biogeochemical markers surrogated to the recovery potential of soils affected by forest fires. This was approached by a transdisciplinary study of fire affected soils at different time scale (cronosequences) that enable to obtain precise information about the processes involved in the lost of soil aggregate stability and increasing erodibility as well as about the changes driving to functionality recovery of fire affected soils. To achieve this, a variety of scenarios from Andalusia (Southern Spain) were chosen that included different soil types affected by fires during the past 10 years under contrasted vegetation, and located close to control soils with no recent history of forest fires. Changes in soil physical and chemical properties involved in soil erodibility and in the different forms of OM (water soluble and free lipid fractions, fulvic acids and humic acids, as well as ) and other highly resilient forms of C that may be incorporated like charred biomass), were studied in all chosen soils by different physical and chemical techniques including molecular-level analytical techniques (chromatographic, spectroscopic and degradation methods). The effect of fire on soil microbiota was approached using standard techniques for biodiversity estimation (viable counts in adequate culture media), microbial activity (evaluation of soil respiration, total N mineralization and nitrification rates by incubation experiments) and the estimation of viable microbial biomass (lipid biomarker assemblages), as well as through the use of specific molecular techniques including the analysis of the microbial genetic material extracted from soil (DNA, rRNA) and by establishing physiological profiles (biochemical analyses, isoenzymes, etc.). The information obtained was analyzed by multivariate statistical models that will help to the detection of the most informative chemical indicators for soil recovery.