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Fire effects on soil aggregate stability: a review and synthesis

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Fire can affect soil properties depending on a number of factors including fire severity and soil type. Aggregate stability (AS) refers to soil structure resilience in response to external mechanical forces. Many authors consider soil aggregation to be a parameter reflecting soil health, as it depends on chemical, physical and biological factors. The response of AS to forest fires is complex, since it depends on how fire has affected other related properties such as organic matter content, soil microbiology, water repellency and soil mineralogy. Opinions differ concerning the effect of fire on AS. Some authors have observed a decrease in AS in soils affected by intense wildfire or severe laboratory heating. However, others have reported increases. We provide an up to date review of the research on this topic and an analysis of the causes for the different effects observed. The implications for soil system functioning and for the hydrology of the affected areas are also discussed. Generally, low severity fires do not produce notable changes in AS, although in some cases an increase has been observed and attributed to increased water repellency. In contrast, high severity fires can induce important changes in this property, but with different effects depending on the type of soil affected. The patterns observed can vary from a disaggregation as a consequence of the organic matter destruction, to a strong aggregation if a recrystallization of some minerals such as Fe and Al oxyhydroxides occurs when they are present in sufficient quantities in the soil, after exposure to high temperatures. Because of the complexity of the different possible effects and reasons for the potential changes in the fire-affected soil aggregates, the inclusion of other parameters in the studies is necessary to understand the results. The suggested parameters to include in the examination of AS are: soil organic matter, microbial biomass, water repellency, texture, aggregate size distribution, together with accurate ways of estimating fire severity. More research is needed on what implications have for soil system functioning the changes suffered by aggregates after fire. Studies including measurements at very different scales: from AS measurements in the laboratory to erosion rates measured at pedon, slope and catchment scales are also necessary.

Keywords: burnt soil, structural stability, aggregate stability, aggregation, soil erodibility, wildfire, forest fires.

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