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Post-fire CO_2 efflux – the effect of soil water repellency on CO_2 pulse after rewetting in a burnt pine stand in central Portugal

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Forest fires are known to induce changes in soil water-repellency (SWR), often increasing its severity and persistence. SWR restricts infiltration into soils affecting water distribution patterns. This may result in increased overland flow and runoff after the fire, maintaining soil water content low even after substantial rainfall.
Rewetting of dry soil typically results in a short-term pulse of CO_2 from soil to the atmosphere. This response has been extensively reported under wettable conditions, however previous lab observations showed that CO_2 pulse after rewetting was substantially reduced by soil water repellency. Despite this, the effect of SWR on short-term CO_2 effluxes after rewetting has never been tested under natural conditions and remains poorly understood.
The aim of this research was to test the hypothesis that post-fire SWR suppresses CO_2 pulse after rewetting under field conditions. The study was conducted in a burnt pine forest in Portugal before the first natural rainfall event in two sites with similar characteristics but differing topography. The presence/absence of surface ash layer was also considered a variable. The study plots were rewetted with water and with water mixed with the wetting agent (Revoltution®, Aquatrols) to simulate inhibited and non-inhibited infiltration, respectively. CO_2 flux in response to wetting was monitored before and several times after the rewetting event using the LI-COR Li-8100A Soil Gas Flux system along with changes in soil moisture, infiltration and runoff.
The main conclusion from the study is that fire-induced SWR not only affects hydrological relationships but also has an impact on CO_2 effluxes. Hence SWR becomes an important parameter to consider in monitoring and modelling of gas fluxes during the recovery of burnt forests.

Keywords: wildfires, forest fires, soil water repellency, SWR, hydrophobicity, CO_2 flux, CO_2 pulse, GHG.