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Effects of fire regimes on soil C in fire prone forests of SE Australia: consequences for future management and climate change

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Fires mediate the dynamics of terrestrial carbon pools via combustion of biomass and redistribution of resultant by-products into the atmosphere, waterways and soil. Notably, landscape fires produce pyrogenic C (PyC) compounds which may have long residence times in the soil. The long-term consequences of differing fire regimes (frequency, intensity and season of fire) for soil C, and particularly PyC, are poorly understood. Such an understanding is required to predict how terrestrial carbon stocks will respond to changes in fire regimes that result from management interventions (e.g. use of prescribed fire) and climate change.

This study examined responses of soil C (total % C, % RPC - recalcitrant PyC) to time since fire (TSF), fire frequency and fire intensity in dry sclerophyll forests dominated by Eucalyptus spp. across the Sydney region of south eastern Australia. Specifically, the responses of soil C to the frequency (TSF held constant) across three different climatic regions (warm wet, cool wet, intermediate dry). Effects of intensity of pairs of successive fires were also explored in one region.

Post-fire response of total % C declined in sites of < 10 years TSF. At longer TSF (up to 30 years), total % C in sites burnt at high intensity (wildfires) increased whereas it remained relatively constant in sites burnt at low intensity (prescribed fires). Climate had a stronger effect on total % C than either fire frequency or intensity combinations of successive fires, with higher total % C evident under cool and/or wet conditions. Relatively small fire frequency effects were climate region dependent. Total % C was higher after successive fires of low then high intensity compared with other intensity combinations. % RPC was effectively a constant fraction of the total % C, irrespective of TSF, fire frequency and fire intensity.

We concluded that soil C (either total or recalcitrant fractions) was unlikely to be strongly affected by wide variations in fire regimes in these forests. Soil C may therefore be robust to differing management strategies and future changes to fire regimes driven by climate change. By contrast, there is potential for climate change to strongly affect soil C, with a decline likely under future warmer and drier conditions, though the latter is uncertain.