CONTROLS ON THE MAGNITUDE AND SOURCE OF SOIL ORGANIC CARBON RESPIRED AFTER SIMULATED RAINFALL IN THE KALAHARI

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Soil respiration resulting from microbial catabolism of organic C is the largest contributor of CO_2 to the atmosphere. Predicted temperature rises due to climate change could enhance respiration rates and soil organic C (SOC) loss, compromising soil fertility and agricultural productivity and further elevating atmospheric CO_2. In African drylands such as the Kalahari these consequences could be particularly marked for rural livelihoods dependent upon farming where SOC limits fertility. Current understanding of dryland SOC respiration is, however, insufficient to enable prediction of the consequences of climatic change upon CO_2 fluxes or soil fertility. Data are needed on the controls on CO_2 flux and the source of C respired to inform agricultural management plans that can improve adaptability to dryland environmental change.

We present findings from the Kalahari where the aim was to determine the magnitude and controls on soil CO_2 fluxes and the provenance of the respired C. Five locations along the Kalahari Transect in Botswana were selected on a common substrate but with differing annual rainfall and temperature regimes. Five purpose-built automated respiration chambers were used at each site over a period of 3 days to quantify hourly CO_2 fluxes under natural (dry) conditions and after simulated rainfall events of 2mm and 50mm. Solar radiation (PAR), air and soil temperatures were continuously recorded. The effect of disturbance on flux was investigated by disaggregating the surface biological crust. Subsoil pore space gases were also periodically sampled at 4 depths before and after the simulated rainfall events. The isotopic signature ($\delta^{13}C$) of the respired gas was used to deduce the substrates utilized in respiration.

Average peak C flux from dry soils was *c.* 2 mg C m^2 hr^{-1}, increasing to *c.* 6 mg C m^2 hr^{-1} after 2mm of rainfall. Large (up to 170 mg C m^2 hr^{-1}) but short-lived fluxes were observed after 50mm of rain. Temporal variability in flux was substantial. Night-time fluxes were positively correlated with air and soil temperatures. Day-time fluxes at all sites fluctuated as optimal conditions for CO_2 uptake via cyanobacterial photosynthesis and respiration varied with light, temperature and moisture. During dry conditions the $\delta^{13}C$ signal of the respired gas suggests respiration of vascular plant litter is the dominant C source. After heavy rainfall, however, there is a pronounced shift in the isotopic signal as microbial C become available as a result of hydration shock. Most SOC loss occurs when this glut of microbial C is respired upon wetting, resulting in large pulses of CO_2 from the soil. Our data contribute to the improved process understanding necessary in order to assess likely impacts of climatically-induced changes in temperature and moisture on Kalahari Sand soils.