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A multi-scale assessment of soil carbon dynamics at the hillslope and catchment scale

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The soil carbon pool is a key element within the global carbon cycle. Aside from the many biological, chemical and physical benefits of soil carbon, the significance of the soil carbon pool as a storage sink for CO_2 has received increased attention due to concerns over rising atmospheric CO_2 concentrations. Vegetation dynamics play a significant role within the terrestrial carbon cycle, in particular the uptake and storage of soil carbon within the soil matrix. Recent results in Australian study catchments have shown that in landscapes undisturbed by Europeans there is little change in soil carbon concentration over a four year study period suggesting the soil carbon pool is static. Soil carbon concentration also appears to be related to landscape position with high resolution spatial data needed, as poor resolution digital elevation models can mask any relationships with hillslope and catchment geomorphology. Results from agricultural catchments demonstrate that there are differences in the soil erosion and soil carbon distribution in land that has been grazed as opposed to land that has been cultivated suggesting different pathways of soil carbon movement. For both undisturbed and agricultural catchments above ground biomass is significantly related to soil carbon concentrations, however quantifying vegetation spatial and temporal dynamics at the catchment scale using ground-based methods is problematical. This is largely due to the limited spatial coverage afforded by traditional field based methods (e.g. quadrats and survey transects) which usually take place at point to plot scales of $<$1m. Remote sensing is an alternative method by which spatial and temporal vegetation dynamics can be captured over larger areas. Results indicate the higher resolution sensors have a much greater capacity to provide a better representation of conditions at ground-level, as good correlations were found between satellite-derived spectral vegetation indices and ground-based biomass, soil carbon and nitrogen data. Relationships were found to be strongest within cropped sites as opposed to native grass and grazing sites. This is thought to be a result of the nature (e.g. structure and colour) of the vegetation in the grazing areas studied. The results of this study emphasize the importance of spatial resolution when using remotely sensed data. In addition these findings suggest remotely sensed data, in combination with ground-based field data, can potentially be used to quantify vegetation dynamics and extrapolate point scale soil carbon and nitrogen data over larger catchment and regional scales. However further work is required, particularly within native grass and grazed landscapes to further investigate this potential.

Keywords: soil carbon; hillslope; soil erosion; catchment modelling, remote sensing