Scrublands and carbon fluxes: an unexpected result?

"For starters, checking for rattlesnakes before collecting samples is a must!" laughs Andrew Cunliffe from the University of Exeter in the UK, a young scientist member of the EGU who has just presented in the session on dynamic soil landscapes at the 2014 General Assembly. His talk was on redistribution of soil organic carbon (SOC) in semi-arid rangelands (grazing land with shrubby vegetation). He used the Chihuahuan desert in New Mexico, USA as a case study for understanding SOC dynamics in this relatively understudied area of soil science.

Semi-arid rangelands tend not to get the bulk of attention from soil scientists studying SOC because there is little growth of plants in scrublands, and there is little SOC available to begin with. Coupled with this is the fact that human activities have less impact on how soil carbon is distributed in semi-arid lands compared to intensively managed agricultural landscapes, so dryland SOC dynamics tends to be rather static and uninteresting to soil scientists. And yet, this type of land makes up around 40% of the world's land surfaces, representing an important part of the global terrestrial carbon sink. Further, it helps sustain a sixth of the global population, often in marginal environments. Recognising this, Cunliffe and his colleagues set out to investigate particulate SOC distribution and redistribution over the constantly changing interface between grasslands and semi-arid scrublands.

The study of SOC is important because of its key link to climate change: how is carbon transported and stored within Earth's biogeochemical systems? Not only that, but understanding SOC dynamics helps us understand the impact that changes in land cover have on different soils and wider ecosystems. It is especially important when considering the long term soil quality and fertility for supporting crops and livestock. Understanding what land management practices can keep SOC in the soils for the longest can help us work with farmers to ensure they have the best land for growing crops. Combining an understanding of SOC dynamics with climate and land use change can also help us prepare farmers for climate change and the subsequent changes in soils and land management they will need to endure and practice.

In Cunliffe's study, he collected 50 samples from four plots with different types of vegetation and examined the concentrations of particulate SOC in various particle-size fractions obtained from these samples, leading to some interesting results.

Soil components can roughly be separated into three parts: coarse, medium and fine. Generally, it's thought that there's no organic carbon to be found in big soil particles (those greater than 2 mm), and little in medium-sized ones (0.25–2 mm). However, Cunliffe's findings have shed new light on the distribution of organic carbon across soil aggregates. While fine soil particles (those under 0.25 mm) have relatively high concentrations of organic carbon, a finding in line with soil other science research, the medium-sized particles were surprisingly rich. The biggest particles were the biggest surprise, containing a similar concentration of organic carbon as the smaller (sub 2 mm) aggregates. The amount of carbon stored in scrubland soils could be severely underestimated if these size fractions are ignored.

View across the Sevilleta National Wildlife Reserve, in the Chihuahuan desert in New Mexico, USA. Inset: rattlesnake beneath a creosote bush where Cunliffe had wanted to collect a soil sample. (Credit: Andrew Cunliffe)

Surface runoff is a major erosive process in semi-arid rangelands. Here, rainstorm intensities exceed the soil's infiltration capacity and excess water flows over the land surface, carrying with it some of the soil. This process leads to wide redistribution of soil particulates and, in addition, SOC.

Eroded sediments are commonly enriched in SOC relative to the eroding topsoil. This is widely attributed to the fact that water erosion tends to favour the smaller particle sizes, which usually have relatively high SOC concentrations. However, Cunliffe's work has shown that this size selectivity explains less than 15% of the SOC enrichment they've monitored and he is working to find out why. Furthermore, they've found large changes in SOC enrichment when vegetation changes from grasslands to shrublands, which are currently very poorly understood.

Cunliffe's study helps to show that common practices of understanding of SOC distribution (and redistribution) are not always directly applicable for semi-arid rangelands. As these landscapes hold one of the largest carbon sinks in the world, it may even be that we are underestimating the amount of SOC these environments contain by excluding coarse soil fractions in SOC studies. For Cunliffe, this was an exciting and unexpected result.

So where will Cunliffe go next with these exciting results? He's now deploying remote sensing technologies to survey these landscapes and examine fine-scale controls on the distribution of SOC. He hopes this will help understand catchment-scale SOC dynamics in semi-arid rangelands and help scientists better understand how carbon is collected, redistributed and locked up in Earth processes.

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References

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