Biogeosciences Discuss., 8, C4125–C4128, 2011
www.biogeosciences-discuss.net/8/C4125/2011/

Biogeosciences Discussions

Interactive comment on "Aeolian nutrient fluxes following wildfire in sagebrush steppe: implications for soil carbon storage" *by* N. J. Hasselquist et al.

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Received and published: 4 November 2011

We thank the reviewer for their helpful comments, and we respond to only the critical points or questions below.

What fraction of the observed nutrient flux actually leaves the burned site compared to local redistribution? Were any measurements of aeolian deposition made in the burned and unburned areas? Is there a prevailing wind direction at the study site?

This is a question that cannot be addressed by sediment collectors alone. In the discussion, we therefore used LiDAR and erosion-bridge assessments of soil surface elevation change done on our study sites (see Sankey et al. 2010) to determine how

much sediment is actually lost from the burned area compared to being locally redistributed within the burned area. That study reported 2.63 x 104 kg of soil ha-1 was lost at a rate of -2.1 mm yr-1 over the entire burned area in the first year following the fire, based on mean surface changes at fine spatial scale (1-m length) ranging from 5 mm of deposition to 15 mm erosion within the burned area. Although there was some indication of local redistribution of sediment within the burned area, the burned area as a whole exhibited net deflation and thus soil loss. This finding is in contrast to what was observed in the unburned area, which had a mean surface change of 1.5 mm y-1, indicating net inflation.

In the current study, we did not make direct measurements of aeolian deposition using sediment traps (e.g., pans on ground). However, Sankey et al. (2010) reported that background atmospheric deposition ranged from 0.0004-0.02 mm y-1 (in units of thickness), which is considerable less than the 1.5 mm y-1 net inflation rate observed in the unburned area.

Prevailing winds are from the southwest at our sites. A large portion of the burned area and most (but not all) of our sampling efforts in the burned area were southwest/west and thus upwind of the unburned sampling locations.

As the authors point out in the manuscript, horizontal nutrient fluxes do not directly quantify the amount of nutrient lost per unit ground area. Estimates of C and N lost from the burned area based on soil erosion bridges may overestimate losses due to aeolian transport, as fluvial transport likely accounts for a considerable fraction of the mean rate of surface deflation (2.1 mm yr-1). Were any large rainfall events observed during the first few months following the fire?

It is quite unlikely that water-driven transport contributed to the net change in soil elevation on our study site, based on 1) our previous research showing the extent of wind erosion at this site and similar, flat sites on the ESRP (Sankey et al. 2009a,b), 2) our direct observations in the field that sediment transport was wind-driven, 3) Wilcox et al. (2011) showed that runoff and water erosion in sagebrush steppe require much steeper slopes than the flat sites we evaluated, and 4) rainfall intensity did not appear conducive to generating the type of runoff needed to generate water erosion.

According to four local weather stations (on the Idaho National Lab) the study area received 0.05 cm of rain over 30 minutes from August 23rd to 31st, 2.09 cm/1095 min in September, 3.50 cm/190 min in October, 0.36 cm/225 min in November, and 0.00 cm of rain from December 1st through December 10th (Sankey et al. 2009b). Generally speaking, wind erosion is more prevalent than water erosion for soil loss from semiarid rangelands (Field et al. 2011), owing to the dominance of vertical compared to horizontal water transport in these flat, dry, and windy regions. How are nutrients lost from the burned area at a greater rate than from the adjacent unburned area if no significant differences were detected in horizontal C and N fluxes in the suspension class?

Several points can be added to the manuscript to clarify this important point raised by the reviewer. First, although our study clearly shows nutrient depletion from the burned and eroded area, there is a practical limit to our ability to ascribe the changes to suspension compared to saltation processes. The BSNE traps we used have 200 um mesh openings in the air-exit screen, and so it is not surprising that their capture efficiency of suspension sized particles (e.g., PM10) is < 25% according to testing by B. Sharrot and others. Secondly, since we now have data from the ESRP to compared horizontal fluxes in the saltation zone to vertical suspension fluxes, we could provide some crude estimates of the range of suspension transport possible from our data. Thirdly, we can add text that considers the extent to which saltation could actually have contributed appreciably to removal of sediment from the site (rather than saltation merely redistributing soil within the burned area). Towards this, we have texture data for the soil surfaces, which shows a net reduction in the proportion of soil that was saltation-sized particles: from 12% in burned area compared to 18% in unburned area. Our aeolian sediments (i.e., captured in BSNEs) had a relatively high

abundance of organic matter (OM), which are low-density relative to mineral soil, and thus more buoyant and potentially capable of transport over longer distances. OM particles are also nutrient-rich compared to mineral soil. This was particularly true of the larger particle sizes (52.8% OM in the >500 um class; 19.7% OM in the saltation-sized class of 106-500 um; compared to only 4% OM in the <106 um class). These OM contents help explain why the larger particles had the greater values of C and N that we reported. In addition to the probable influence of OM on transportability of saltation particles, there was an appreciable amount of time for iterative saltation movements off the burn area, in a landscape nearly complete void of roughness elements (the burn site was vegetation-less for months). Dunes of saltation-sized particles were observed downwind of the burn.

The organic component of our study is interesting and unique – as we suggested in the paper the burned area is “newly eroding”, and thus had a considerable amount of organics accumulated prior to the erosion event. It is thus not surprising that organics could influence the nutrient fluxes on our site, in terms of influencing nutrient exchange in the saltation stream. These types of patterns might also hold for other sites that normally do not have much or any wind erosion, but then are suddenly subjected to it following disturbance.

References

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Interactive comment on Biogeosciences Discuss., 8, 8323, 2011.