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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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We thank the reviewer for their helpful comments, and we respond to each of them below. We will make the identified changes if the manuscript is accepted with revisions.

1) Calculations assume that sediment has left the site (this comment is a general theme in the reviewer's comments).

Our research questions focused on determining how much transport was occurring in the saltation zone and how the different particle classes contribute to horizontal fluxes. There were practical limitations to our ability to account for the soil budget of the site, but we are fortunate to have a detailed LiDAR and erosion bridge assessment

of soil elevations to use in extrapolating our horizontal flux findings to site budgets, as we describe below. Please note that we were careful to not exceed the limits of our data in discussing the fluxes specifically compared to net gain or loss from the whole ecosystem.

2) It would be important to document what proportion of the decrease in soil C and N is a direct function of the fire and not wind erosion.

We do not have soil samples taken before and immediately after the wildfire, as it is not feasible to predict and pre-sample wildland fire and prescribed fires are not large enough to have erosion. However, we can address this comment by examining differences in C and N concentrations in the aeolian sediment captured above the burned and unburned surfaces from immediately after the fire occurred (in fall 2007) to 1 year later (summer-fall 2008). Differences in concentrations between burned and unburned in fall 2007 are more likely to serve as a relatively better indicator of direct effects of fire on C and N concentrations, whereas differences 1 year post-fire should be a relatively better indication of the combined effects of fire and 1-year of post-fire wind erosion.

3) How much sediment is actually rearranged within the burn treatment vs. lost through long-distant transport.

This is a question that cannot be addressed by sediment collectors alone. In the Discussion, therefore we used LiDAR and erosion bridge data from Sankey et al.'s (2010) assessment of the same site to address the question of how much sediment is actually lost from the burned site. That study reported 2.63 x 104 kg of soil ha-1 was lost at a rate of -2.1 mm y-1 from the site in the first year following fire, based on mean surface changes at fine spatial scale (1-m length) ranging from 5 mm of deposition to 15 mm of erosion within the burned area.

As described in the Discussion, to calculate the amount of sediment lost from the burned site (2.63 x 104 kg of soil ha-1 yr-1) we multiplied the mean surface change (-2.1 mm yr-1) by the bulk density of the soil (1.29 g cm-3) as reported at a nearby site by McGonigle et al. (2005) and corroborated by Hoover (2009). A recently study also illustrates that fine-scale variability in aeolian emissions exists at the scale of individual sagebrush and interspace microsites (Sankey et al., 2011). Emissions on previous shrub microsites can be several orders of magnitude more prevalent than from shrub-interspaces, suggesting that fine scale patterns of soil loss after fire can vary with the spatial distribution of shrub vegetation (Sankey et al., 2011)

4) How frequently do fires occur in this system? You mention climate change and increasing fire frequency, but how will fire frequency differ in the future? Sediment loss occurred for a surprisingly short timer period. If all losses are correct as calculated, are they more than made up for during intervals between fires?

There is considerable uncertainty on pre-European colonization fire occurrence due to a lack of charcoal, burned wood, or other records of fire for sagebrush steppe, but the consensus is clearly that fire frequency is increasing. The best estimate of frequency of wildfires in our system is a return interval of 32-70 years or longer (Baker 2006; Keane et al. 2008; Miller and Heyerdahl 2008). The return interval of wildfires has drastically shortened during the last 15 years and can now be as short as 5 years in some places on the ESRP (Whisenant 1990; Keane et la. 2008). Fire size has also increased. The underlying causes are thought to be increased fuel loads and fuel continuity, resulting from increases in invasive annual grasses and climate shifts. More frequent fire is likely to result in more frequent large magnitude pulses of erosion, which in turn will produce a greater prevalence for the aeolian transport of nutrients such as C and N in this ecosystem. Based on our calculations (see comment below) we estimated that the loss of soil C immediately following the fire is roughly equivalent to 19 years of soil accumulation via litter input in this semi-arid ecosystem. Thus, wildfires and subsequently aeolian transport of nutrient-rich sediment following fires can be an important mechanism leading to the depletion of soil C on the ESRP.

5) Wouldn't the difference between pre- and post-fire levels of soil C and N be better calculations of C and N losses than doing so from wind-borne sampling given that not

all sediment leaves the site?

Our responses above address this comment – we have offered the best estimate possible given the available data, which is novel relative to the existing literature.

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