Geophysical Research Abstracts
Vol. 19, EGU2017-17577, 2017
EGU General Assembly 2017

The influence of wildfire severity on soil char composition and nitrogen dynamics

Charles Rhoades (1), Timothy Fegel (1), Alex Chow (2), Kuo-Pei Tsai (2), John Norman III (3), and Eugene Kelly (4)

(1) US Forest Service, Rocky Mountain Research Station, Fort Collins, USA, (2) Department of Forestry and Environmental Conservation, Clemson University, Georgetown, USA , (3) US Department of Agriculture, Natural Resources Conservation Service, Fort Collins, USA, (4) Department of Soil and Crop Sciences, Colorado State University, Fort Collins, USA

Forest fires cause lasting ecological changes and alter the biogeochemical processes that control stream water quality. Decreased plant nutrient uptake is the mechanism often held responsible for lasting post-fire shifts in nutrient supply and demand, though other upland and in-stream factors also likely contribute to elevated stream nutrient losses. Soil heating, for example, creates pyrogenic carbon (C) and char layers that influence C and nitrogen (N) cycling. Char layer composition and persistence vary across burned landscapes and are influenced first by fire behavior through the temperature and duration of combustion and then by post-fire erosion. To evaluate the link between soil char and stream C and N export we studied areas burned by the 2002 Hayman Fire, the largest wildfire in Colorado, USA history. We compared soil C and N pools and processes across ecotones that included 1) unburned forests, 2) areas with moderate and 3) high wildfire severity. We analyzed 1-2 cm thick charred organic layers that remain visible 15 years after the fire, underlying mineral soils, and soluble leachate from both layers.

Unburned soils released more dissolved organic C and N (DOC and DON) from organic and mineral soil layers than burned soils. The composition of DOC leachate characterized by UV-fluorescence, emission-excitation matrices (EEMs) and Fluorescence Regional Integration (FRI) found similarity between burned and unburned soils, underscoring a common organic matter source. Humic and fulvic acid-like fractions, contained in regions V and III of the FRI model, comprised the majority of the fluorescing DOM in both unburned and char layers. Similarity between two EEMs indices (Fluorescence and Freshness), further denote that unburned soils and char layers originate from the same source and are consistent with visual evidence char layers contain significant amounts of unaltered OM. However, the EEMs humification index (HIX) and compositional analysis with pyrolysis GCMS both indicate that C contained or leached from severely-burned char layers has higher aromaticity and thus chemical stability compared to C in unburned soils. Mineral soil (0-5 cm depth) beneath char layers in high severity portions of the Hayman Fire had significantly more soil N and C and lower pH. Potential net mineralization – an index of the supply of plant-available nitrogen – differed between the severely-burned areas and both unburned and moderately-burn areas. Negative net mineralization in unburned and moderately burned soils indicates immobilization or retention of inorganic N by soil microbes. In contrast, soils burned at high severity produced inorganic N sources available to plants, leaching and gas losses. Water soluble nitrate comprised a larger proportion of inorganic N leached from the char layer of high severity burns. Mineral soil in those areas had both higher water soluble nitrate and total inorganic N in leachate. Char layers that have persisted for fifteen years influence soil N turnover within the Hayman Fire affected area and may contribute to elevated N losses in streams burned at high severity. The chemical stability of soil char layers perpetuates their importance for C sequestration and N dynamics in burned landscapes.