Introduction

Wildfires are leaving bigger and deeper scars as the climate trends toward drier spring months and hotter summer months. Along with the ecological, societal, and economic costs of wildfires, hydrological impacts must also be considered. Heavy sediment loads, flooding, and pyrogenic black carbon (PyC) impact watersheds and water quality. Although wildfires are a natural part of forest ecology, increased magnitude and frequency of wildfires threaten forested watersheds and the public water that they provide.

Field Site

The Jemez Mountains in northwest New Mexico present an appropriate site for this study due to the recent history of forest fires. We are investigating the impact of the 2013 Thompson Ridge wildfire that burned over 23,695 acres of land including hill slopes, river banks, flood plains, and alluvial fans. We sampled the area in September 2009 and we resampled it in September 2014, 15 months after the Thompson Ridge fire was extinguished. The 2009 samples provide background concentrations of PyC and the 2014 samples show PyC concentrations 1 year post wildfire.

Methods

The first step to understanding PyC impacts on watersheds and water quality is to quantify PyC and to map its distribution after a fire. We are particularly interested in short time scales (months to years) after a wildfire, so we sampled to quantify PyC and to map its distribution after a fire. We are particularly interested in short time scales (months to years) after a wildfire, so we sampled to quantify PyC and to map its distribution after a fire. We are particularly interested in short time scales (months to years) after a wildfire, so we sampled to quantify PyC and to map its distribution after a fire. We are particularly interested in short time scales (months to years) after a wildfire, so we sampled to quantify PyC and to map its distribution after a fire. We are particularly interested in short time scales (months to years) after a wildfire, so we sampled to quantify PyC and to map its distribution after a fire. 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Fig. 1. Left: Fire derived debris filled San Antonio River after the 2011 Las Conchas burn (photo credit, NMED 2011) Right: Runoff showing evidence of fire influence, summer 2013

Fig. 2. Valles Caldera crater with streams, sampling locations, and burn severity map from the 2013 Thompson Ridge fire. Watersheds: (1) Redondo, (2) Lower Jaramillo, (3) Upper Jaramillo

Fig. 3. Soil pit showing the ‘O’ horizon (darker top layer) and the ‘A’ horizon (lighter lower layer)

Fig. 4 (a) PyC to TOC (Total Organic Carbon) ratios of 2009 and 2014 samples. A horizons are plotted in turquoise diamonds, O horizons in blue squares, and a 1:1 line is shown as a reference for change over time. (b) PyC to TOC ratios from 2009 and 2014. O and A horizons are not distinguished.

Results & Impact

All of the data plotted together above does not provide a full picture of transport processes. Figure 4a plots the 2009 data versus the 2014 data and a 1:1 line. Data above this line corresponds to samples that increased in PyC/TOC concentration over time and data below the line corresponds to samples that decreased in PyC/TOC concentration. We do not see a clear trend in the data as a whole, or between O and A horizons. With both the 2009 and 2014 data plotted independently (4b), we see that the 2014 samples are much more variable, with wider ranges than the 2009 samples. The 2009 samples are more uniformly distributed. By separating the data into different watersheds, we can tell a clearer story.

Fig. 5. (a, b) Both plots show PyC to TOC ratios of the 3rd watershed (see fig. 2). Both x-axes are PyC/TOC ratios from 0.00 to 0.18 and both x-axes correspond to movement from higher topography to lower topography. 2009 samples are shown as turquoise diamonds and 2014 samples are shown as blue squares. (a) ‘O’ horizon (roughly the top 6 cm) (b) ‘A’ horizon (roughly 6-30 cm)

The Upper Jaramillo watersheds shows clear trends over time. One year after the wildfire, the relationship between PyC/TOC concentration and topography reverses from what it was before the fire. Also, we see that the O horizon behavior is the opposite of the A horizon behavior. We will continue to analyze the soil samples and group the results together as well as distinguish between watersheds to illuminate trends and patterns.

An interesting impact of wildfires is the capability of PyC to sequester and store contaminants. Due to its high surface area and chemical properties, PyC can store contaminants including arsenic, lead, polycyclic aromatic hydrocarbons (produced by fossil fuel burning) as well as other pollutants. Since PyC can act like a filter, contaminant concentrations may be high in soils and lower in surface water. Therefore, knowing where PyC accumulates (whether it is deeper in soils, on the surface, on hillslopes, river banks, or in reservoirs downstream) is important for public water supply and for organisms that depend on surface and groundwater for their livelihood.

Conclusions

Assessing the distribution of PyC after a fire is important for our communities, water supply, public infrastructure, and for ecosystems. Many people in New Mexico suffer from the impacts of catastrophic wildfires and affected ecosystems will be recovering for many years to come. Agricultural fields, public and private property, city and rural infrastructure are at risk. Studying the complex and dynamic impacts of wildfire is the best way to prepare for these risks.

Fig. 6. Photograph of an apple orchard in Dixon, New Mexico that was impacted by post wildfire runoff in 2011.

References & Acknowledgements


Thank you!!! Center for Graduate Studies of New Mexico Tech, VCNP, Bob Pannenter, Kathleen Lohse, Fred Phillips, Michael Pullin, John Wilson, Phoebe Nichols, Erin Mavis, Emily Matthews, Yaika E. Roman