forWater Research Snapshot

AUTHORS: Mia Tullio (M.Sc. Graduate), Mike Stone (UW), Monica Emelko (UW)

SUBJECT: **Impact of the Kenow wildfire on the form and mobility of particulate phosphorus in gravel-bed rivers at large basin scales: Implications for downstream propagation**

Research Summary

Landscape disturbance by wildfire in forested source water regions can significantly accelerate fine sediment transport from hillslopes to receiving streams. The mobilization of fine sediment and associated nutrients, such as phosphorus (P) into high quality surface waters can substantially increase primary productivity, which can severely degrade water quality, threaten aquatic ecosystem health, and challenge drinking water treatability to the point of service disruptions. In the present study, abiotic controls (e.g., adsorption, precipitation) on the form and mobility of particulate phosphorus (PP) in fine suspended and ingressed river sediment were examined in several oligotrophic gravel-bed rivers in Alberta, Canada, following the 2017 Kenow wildfire. A sequential extraction scheme and batch equilibrium experiments were conducted to assess the immediate influence of severe wildfire on the form (non-apatite inorganic P, apatite P, organic P) and mobility (equilibrium phosphorus concentration, EPC_0) of PP in these systems, respectively.

Research Results

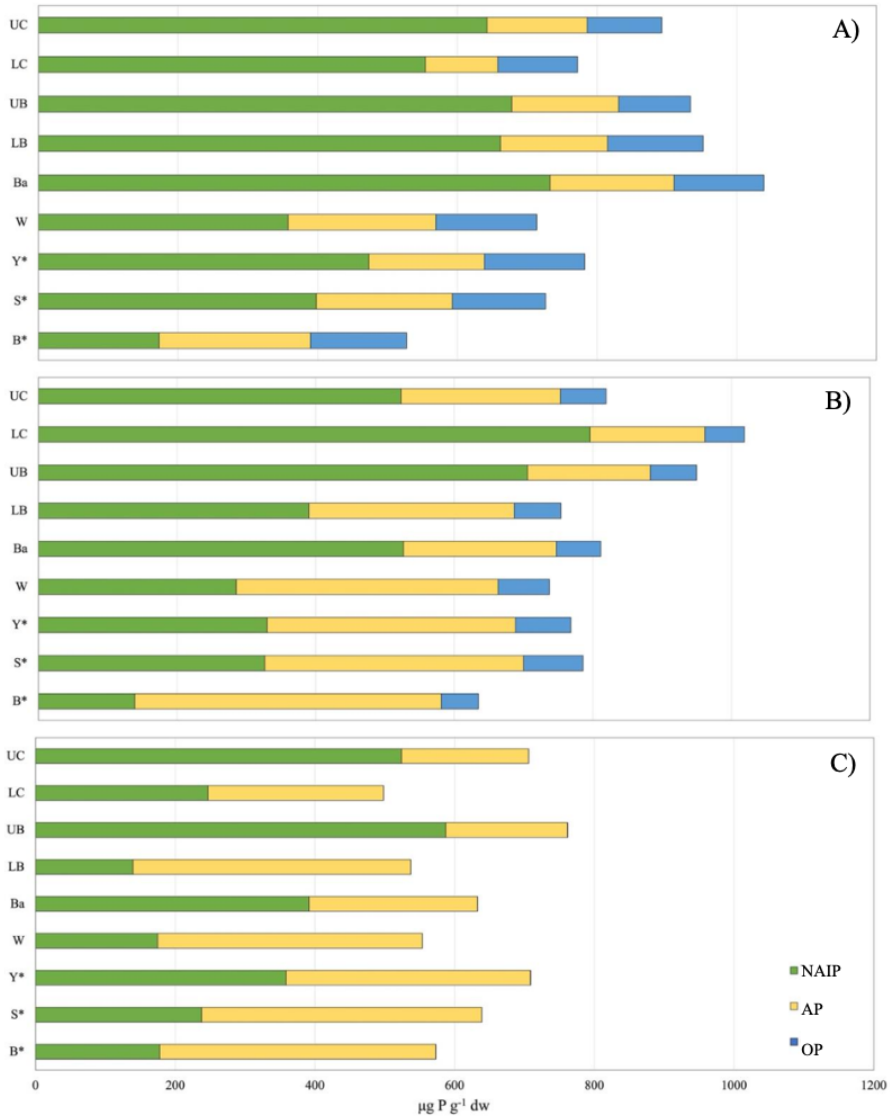
- Mean total particulate phosphorus (TPP) and non-apatite inorganic phosphorus (NAIP; the most bioavailable form of particulate P [PP]) concentrations were significantly elevated in sediment from rivers draining burned areas, underscoring that wildfire can severely degrade source water quality and result in conditions that promote primary productivity.
- NAIP concentration in PP was highly correlated with Al and Mn concentrations, which typically increase in soils after wildfire and contribute to long-term transfer of P to receiving streams via fine sediment erosion during runoff.
- Post-fire concentrations of organic phosphorus (OP) declined significantly after two years, likely due to reduction of the organic soil nutrient pool, increases in soil nutrient turnover rates, and redistribution of nutrients within soil profiles.
- The equilibrium phosphate concentration (EPC_0), which indicates the potential for P release from sediment to the water column, was not significantly different for sediments from burned and unburned reference watersheds—this was likely due to wet and dry post-fire deposition of pyrogenic materials on both burned and unburned landscapes as a result of the wildfire and prescribed fires that had been historically used for wildfire risk management in the region.

Key Messages

- Wildfire alters the composition of fine sediments, typically enriching them in bioavailable P.
- All of the wildfire-impacted sediments examined in the study demonstrated the ability to act as a source of soluble reactive phosphorus (SRP) to the overlying water column, especially at low flow conditions during which dilution from unimpacted upstream areas is reduced.

- Ingressed sediment in particular may act as a legacy source of bioavailable P in highly dynamic, oligotrophic gravel-bed rivers.
- Although not currently a common management focus, the development of strategies for managing fine sediment is critical to maintaining source water quality and treatability in systems with source water reservoirs, especially in wildfire-prone regions.

Figure 1



Comparison of sediment-associated PP forms in river sediment from several burned and unburned reference (indicated with *) watersheds in (A) 2018, (B) 2019, and (C) 2020. Data are composite mean values that include all sampling periods during each year for both suspended and ingressed sediment fractions.

Contact Information

For more information on this research please contact:
Mike Stone – mstone@uwaterloo.ca; Monica Emelko – mbemelko@uwaterloo.ca