forWater Research Snapshot

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SUBJECT: **Legacy of phosphorus bioavailability from cumulative watershed disturbance pressures, especially wildfire**

Research Summary

Recent continental-scale increases in total phosphorus (TP) have been reported in thousands of rivers and lakes across North America, rendering systems once oligotrophic no longer so—this is alarming because of the ecosystem and treatability impacts those shifts in phosphorus can cause. This study examined changes in major element chemistry and particulate phosphorus (PP) forms in riverbed sediments along 50 km of the oligotrophic Crowsnest River at low flow. This section of river represents a gradient of increasing cumulative landscape disturbance (harvesting, wildfire, municipal wastewater discharge) pressures on water quality. Sediment samples were collected and major elements, loss on ignition, and PP fractions were evaluated. Remobilization of enriched PP levels resulting from landscape disturbances and stored in riverbeds (legacy P) can be a critical source of bioavailable P that can promote algal blooms, water treatment challenges, and degrade ecosystem health for decades. This study highlights the longitudinal water quality impacts of increasing landscape disturbance on bioavailable PP in fine riverbed sediments.

Research results

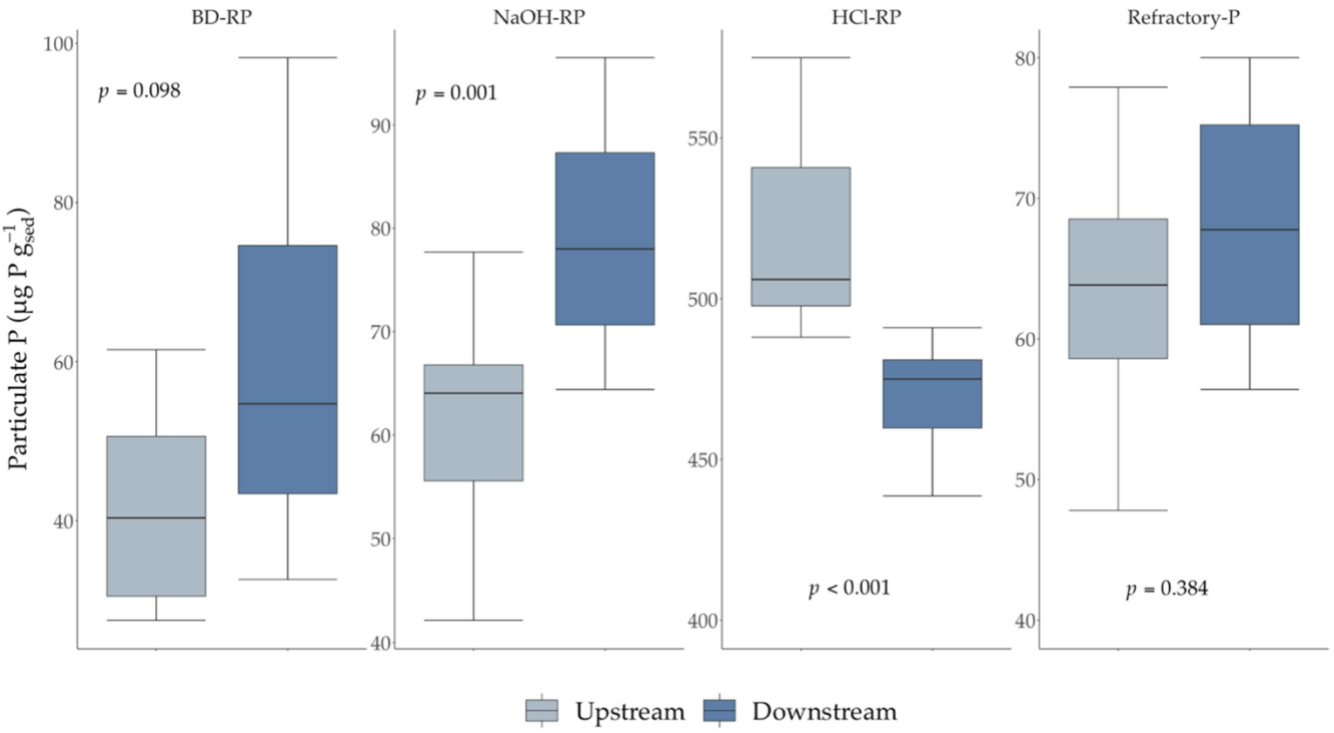
- Bioavailable PP fractions increased downstream with increased levels of landscape disturbance
- Total PP concentrations were similar across all sites; however, bioavailable PP fractions were especially elevated in bed sediments with elemental composition relatively high in Al_2O_3 and MnO that can be attributed to wildfire
- Despite the effects of multiple landscape disturbance pressures on sediment erosion and delivery to streams within each contributing sub-watershed of the Crowsnest River, downstream patterns of major element composition remained remarkably consistent over the two-year study period
- This is the first study to demonstrate the legacy of wildfire-associated increases in bioavailable PP forms in riverbed sediments and that they persist over a decade post-fire and may serve as an internal source of P

Key messages

- Climate-exacerbated (wildfire) and human (discharges from municipal wastewater treatment, forest harvesting, agriculture) landscape disturbances can combine (cumulative watershed effects) to alter the storage of fine sediment and associated phosphorus in forested source water regions, potentially resulting in cascading effects on water quality for decades
- Increased bioavailable PP fractions due to cumulative effects of landscape disturbances promote increased potential for eutrophication, algal blooms, and challenges for water treatment
- The use of targeted watershed monitoring programs to evaluate both water *and* sediment quality in river reaches upstream of reservoirs can help utilities assess potential risks to water quality and treatment
- Geochemical tracing approaches can be used to distinguish the contributions of various nutrient sources

- Future work should consider the role of biofilms in trapping and transforming P and scaling those processes to larger basin scales

Figure



Concentrations of PP fractions of fine sediment stored in gravel-beds at upstream (S2, S3; n = 8) and downstream (S4, S5, S6; n = 12) sites. The *p*-values from the Wilcoxon signed-rank test are provided. Horizontal lines indicate the median, boxes indicate lower/upper quartiles, error bars indicate 1.5 times the inter-quartile range or the minimum/maximum value observed, whichever is smaller.

Reference, featured publication: Watt C, Emelko MB, Silins U, Collins AL, Stone M. Anthropogenic and Climate-Exacerbated Landscape Disturbances Converge to Alter Phosphorus Bioavailability in an Oligotrophic River. *Water*. 2021; 13(22):3151. https://doi.org/10.3390/w13223151

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