Geochemical fingerprints of flood dynamics from an artificial extreme event on the Allegheny River

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Extreme events are important components of natural river flow regimes as they maintain the health of river ecosystems. For example, extreme high flows are necessary for maintaining aquatic habitats by flushing fine sediments from mussel beds. Moreover, flood inundation of riparian ecosystems is essential for the exchange of water, sediment, nutrients, and biota between the aquatic and terrestrial environments during floods. These floods are also essential to the health of riparian ecosystems which rely on frequent disturbance to prevent the over-growth of woody plants and maintain riverscour habitats. However, human alteration of rivers for flood control, including the installation of dams, homogenizes downstream flow regimes by preventing extreme high and low flows.

In this study, we evaluate the biogeochemical fluxes stemming from the first experimental spring flood conducted by the U.S. Army Corps of Engineers on the Allegheny River (Pennsylvania, USA). Flooding was initiated on March 30, 2023 by sustained releases of 450 cms for 17 hours from the Kinzua Dam and the Allegheny Reservoir. We hypothesized that the spring pulse would initially release organic rich sediment and nutrients stored behind the Kinzua Dam, and that the "geochemical fingerprint" of water will change as the flow eventually scours the channel and riparian areas. To quantify the impact of the pulse event on downstream biogeochemistry, we collected hourly grab samples from a site 5 km downriver of the Kinzua dam over a 48 period that spanned pre- and post-pulse. Grab sample chemistry including fluxes of dissolved, organic and total nutrients, as well as total suspended sediments and nitrate isotopes, are evaluated here. Our results are put in the context of flood events and material fluxes reported for extreme events in other river systems.