Assessment of change in the Upper Ohio River Basin: impacts of river regulation and climate change on streamflow and nutrient cycling

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There is a long history of human modifications to streamflow regimes in the Upper Ohio River Basin resulting from the region's industrialization, particularly related to the use of the Allegheny, Monongahela, and Ohio Rivers for river transportation. Recent downscaled climate model projections predict a 5-15% and 15-25% increases in streamflow from 2011- 2040 and 2041-2071, respectively, in parts of the upper Ohio River basin (USACE, 2017). Importantly, the Allegheny River watershed was identified as one of several most at-risk watersheds due to the severity of projected changes and resulting impacts to human communities and sensitive aquatic organisms. Despite these projections and evidence of widespread change in neighboring basins, there has been no comprehensive evaluation of changes in streamflow and associated nutrient export across the Upper Ohio River Basin. Given the tight dissolved nutrient export and watershed runoff, increased streamflow may alter nutrient concentrations and fluxes, and exacerbate nutrient pollution.

In this study, we evaluated long-term trends in streamflow and nutrient export from 35 United States Geological Survey (USGS) gages located on rivers and streams within the Upper Ohio River Basin, ranging in size, river regulation, and land use properties. Streamflow statistics and change from these 35 sites represent 31 tributary inputs to the mainstem Allegheny, Monongahela, and Ohio Rivers and analyses include recent changes (1990-2022) and long-term changes (starting at gage initiation to 2022). Of these sites, 10 had Total Nitrogen (TN) data available and were analyzed using the Weighted Regressions on Time, Discharge, and Season model developed by the USGS. Our preliminary analyses indicate that flows below the 50^{th} percentile are increasing across the region, where 28 of the 35 sites showed up to 5 percent per year increases within this range of streamflow. Interestingly, streamflow above the 50^{th} percentile showed low rates of change and even decreasing streamflow. These increases in streamflow were accompanied by increases in total nitrogen concentrations and fluxes at 5 of 10 sites.