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Geospatial Modeling for Watersheds Delineation: An Approach for Per- and Polyfluoroalkyl Substances (PFAS) Monitoring and Assessment in Alabama Surface Waters

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Among the emerging contaminants of concern (CECs), per- and poly-fluoroalkyl substances (PFAS) have been widely detected in surface water across the United States. In the present study, we completed a reanalysis of seventy-five (75) PFAS samples across ten (10) major river basins and four (4) minor rivers in Alabama. Among them, the total summed concentrations of sixty-six (66) detected PFAS contaminants were analyzed using spatial autocorrelation model (Global and Local Moran's Index) to identify spatial clusters and probable sources. Dendritic terrain watershed modeling was used to trace pollution points and potentially affected counties. The highest concentrations were observed along Alabama River and its tributary, the Coosa River, indicating a likely source area for PFAS within the Coosa River basin in southeastern Alabama. Spatial agglomeration analysis indicated elevated PFAS levels downstream of wastewater treatment plants (WWTPs), airports, and industrial landfills for both short-chain PFAS (PFBS, PFPeA, PFHxA, PFHpA) and long-chain PFAS (PFOS and PFOA). These locations likely serve as primary sources of PFAS pollution in the area. The Tombigbee and Black Warrior Rivers, both tributaries to the Mobile River exhibited notable coldspots, along with the Conecuh, and Yellow Rivers. Negative autocorrelation (a pattern of high PFAS concentration near low concentrations) along the Choctawhatchee and Mobile Rivers in south Alabama implied spatial heterogeneity, suggesting potential PFAS sources in tributary watersheds. This modeling approach accurately identified contamination hotspots linked to potential sources and these findings establish a framework for watershed-scale monitoring of emerging contaminants using spatial agglomeration techniques.

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