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Anthropogenic phosphorus (P) inputs to a river basin and their impacts on P fluxes along its upstream-downstream continuum

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Phosphorus (P) originating from anthropogenic sources as a pollutant of surface waters has been an environmental issue for decades because of the well-known role of P in eutrophication. Human activities, such as food production and rapid urbanization, have been linked to increased P inputs which are often accompanied by corresponding increases in riverine P export. However, uneven distributions of anthropogenic P inputs along watersheds from the headwaters to downstream reaches can result in significantly different contributions to the riverine P fluxes of a receiving water body. So far, there is still very little scientific understanding of anthropogenic P inputs and their impacts on riverine flux in river reaches along the upstream to downstream continuum. Here, we investigated P budgets in a series of nested watersheds draining into Hongze Lake of China, and developed a simple empirical function to describe the relationship between anthropogenic inputs and riverine TP fluxes. The results indicated that an average of 1.1% of anthropogenic P inputs are exported into rivers, with most of the remainder retained in the watershed landscape over the period studied. Fertilizer application was the main contributor of P loading to the lake (55% of total loads), followed by legacy P stock (30%), food and feed P inputs (12%) and non-food P inputs (4%). From 60% to 89% of the riverine TP loads generated from various locations within this basin were ultimately transported into the receiving lake of the downstream, with an average rate of 1.86 tons P km-1 retaining in the main stem of the inflowing river annually. Our results highlight that in-stream processes can significantly buffer the riverine P loading to the downstream receiving lake. An integrated P management strategy considering the influence of anthropogenic inputs and hydrological interactions is required to assess and optimize P management for protecting fresh waters.