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Modification of exploration of long□term nutrient trajectories for phosphorus (ELEMeNT-P) model to quantify legacy phosphorus dynamics in a typical watershed of eastern China

Wu Hao and Chen Dingjiang
Zhejiang university, College of Environmental & Resource Sciences, China (wuhao0916@zju.edu.cn)

In response to gradually expanding populations and the demand for food, excess anthropogenic phosphorus (P) input to watersheds leads to accumulating large P reservoirs in land systems, which becomes a persistent source of P pollution to aquatic systems, hindering the effectiveness of implementing water quality management. Therefore, clarifying the cycling process of P in watersheds, quantifying the legacy effects of P and identifying the spatial distribution of legacy P are key scientific issues for effectively developing watershed P management. We applied a modification Exploration of Long-tErM Nutrient Trajectories-Phosphorus model in a typical agricultural watershed in eastern China, which can well quantify the dynamics of legacy P over 40 years along the land-aquatic continuum. Modification of P erosion loss module improved the efficiency metrics of the model. The model indicated that the lag time for legacy P effects in the watershed was up to 10 years. P inputs increased by 40% (5.1 kg P ha^{-1} yr^{-1}-9.8 kg P ha^{-1} yr^{-1}) between 1980 and 2000 and decreased by 55% (9.8 kg P ha^{-1} yr^{-1}-3.4 kg P ha^{-1} yr^{-1}) between 2000 and 2020. Riverine P export fluxes increased from 0.11 kg P ha^{-1} $yr^{-1}$to 1.49 kg P ha^{-1} yr^{-1} (13-fold increase) from 1980 to 2012, and then decreased to 0.96 kg P $ha^{-1}yr^{-1}$from 2012-2020 years to 0.96 kg P ha^{-1} yr^{-1} (35% decrease). The modification model was effective in clarifying the spatial and temporal distribution of legacy P and proposed an effective method to guide watershed P management.