Intensification of phosphorus cycling in China

Phosphorus (P) is a critical and irreplaceable nutrient for life on earth. It plays an important role in the growth of cells, bones and teeth, and is a key component of molecules essential to metabolism. In old times, the biogeochemical cycle of P mainly involves natural activities, such as atmospheric transport, weathering and runoff. Human interference in the P cycle occurs when P minerals are extracted from the lithosphere every year and utilized in multiple anthropogenic activities, especially in agriculture. Excess P from these processes is discharged back into the environment, of which the most significant impact is causing eutrophication in surface waters, killing fish and other aquatic life. As one of the world's populous and most rapidly developing economies, China is facing more and more pressure of long-term P supplies and as well as massive eutrophication of freshwaters. Our recent study presents a four-century change of P cycling in China and provides essential information needed to develop long-term P sustainability strategies.

The results show that intensification of P cycling in China has been driven by strong human perturbations in the recent several decades, because of continuously increasing population and prevalence of protein-based diets. In 2012, about 24% of P consumed by Chinese residents, while only 2% in the 1950s, came from animal products. The growing demand for this kind of diet could worsen China's pressing P sustainability challenges, although plant-based P is still the main nutrition source. It is because that, to produce the same amount of P contained in food, animal husbandry requires much more P input than crop cultivation. Continuous accumulations of P have happened on China's land and water, primarily contributed by anthropogenic activities and creating temporary P storage sinks. Because of the geographical variation of excess freshwater P that has the potential to cause eutrophication and ecosystem damage, we further identify downstream Yangzi River Basin, where relatively wealthy regions with large population are located, as the high-risk area due to its large anthropogenic P emission and dense water network connected with sensitive freshwater ecosystems. These findings will help achieve the co-benefits of P resource conservation and eutrophication mitigation, which will sustain future food production and restore and maintain healthy aquatic ecosystems.

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