EPA water quality standards and their influence on water quality

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Excessive phosphorus in water is a critical water-quality concern globally and in the United States, leading to harmful algal blooms that impact aquatic life and human health. The 2017 US Environmental Protection Agency's (EPA) National Lakes Assessment identified phosphorus as the primary stressor in 45% of lakes, and in 2014, the Oklahoma Department of Environmental Quality reported phosphorus impairing 204 miles of streams. Fertilizer and manure runoff from agriculture contributes 38% to global phosphorus pollution. Despite known negative effects, managing non-point source emissions, historically addressed by USDA through financial and technical assistance, remains challenging (Liu et al., 2018). Since 1998, the EPA has been directing states to set numerical standards for phosphorus through the Clean Water Act, which has been crucial for U.S. water protection. However, the uptake of these standards has been staggered and incomplete. This paper seeks to assess the impact of states adopting numerical standards on U.S. phosphorus levels.

Water quality standards play a pivotal role in pollutant control. These standards embody state or tribal goals for individual water bodies, facilitating effective monitoring and the development of Total Daily Maximum Load criteria. The criteria provide the legal foundation for making control decisions, urging states, territories, and authorized tribes to adopt policies aimed at preserving and enhancing water quality. As per the Code of Federal Regulations, states, territories, and tribes are mandated to regularly submit, review, and update their water quality standards regularly. Despite this regulatory framework, not all states have introduced numeric standards. As of 2023, only 24 states and five major territories have implemented numeric water quality standards.

Since the inception of the Clean Water Act, research on water quality standards has covered diverse aspects such as the legal legitimacy of criteria use (Gaba, 1983), predicting the frequency of standards violations (Borsuk et al., 2002), and assessing the effects of water quality guidelines for recreational waters (Wade et al., 2003). However, few studies delve into the impact of numeric criteria specifically for nitrogen and phosphorus in surface water quality. Griffiths et al. (2012) scrutinize the estimated benefits of enhancing surface water quality by the EPA. They highlight shortcomings in the EPA's Regulatory Impact Analysis, particularly in water quality modeling and benefit estimation methods. Yet, this research is limited to the review of the literature and does not advance to an empirical analysis. Our study contributes to the literature by quantitatively assessing the benefits of implementing water quality standards for phosphorus. We compare nutrient levels in U.S. rivers and streams before and after the introduction of these standards.

Our primary dataset comprises water nutrient data obtained from the Water Quality Portal, integrating public water-quality data from the United States Geological Survey, the Environmental Protection Agency, and the United States Department of Agriculture. Focusing on 24 states with numeric water quality criteria, we selected seven states (Arizona, Florida, Montana, Nevada, Oklahoma, Utah, and Wisconsin) with criteria that apply to certain classes of rivers and streams to form more comparable control groups. The dataset encompasses 7,764 surface-water river and stream sites spanning from 1980 to 2022, providing information on total phosphorus. To address climate variables including temperature and precipitation, we incorporate PRISM data into our analysis.

Our baseline estimation employs a fixed effect model, given the varied adoption periods of numeric standards by states. The outcome variable is the yearly level of total phosphorus within distinct segments of individual water bodies. The treatment effect variable takes a value of 1 if a monitoring station is in a river or stream regulated by numerical phosphorus standards. We control for the previous period's phosphorus levels, year and state fixed effects, temperature, and precipitation. This approach informs an event study framework, allowing us to track changes in nutrient pollution over time relative to nutrient standards adoption. We run additional analysis allowing the intensity of the treatment to vary based on numerical standards magnitude. Recognizing that underlying differences between states in nutrient management are likely to reach beyond the adoption of numerical standards, we also use a synthetic control approach, matching treated rivers and streams with a combination of control units that exhibit similar pre-period nutrient trends and other characteristics. Our analysis will extend to total nitrogen using a similar approach.

Our descriptive statistics indicate that treated monitoring stations in our sample, on average, reduced total phosphorus levels by 20% post-adoption, with an average phosphorus level of 0.178 mg/L compared to untreated counterparts at 0.245 mg/L. Based on these results, we hypothesize that the adoption of numerical nutrient standards result in improvements in phosphorus levels, but that they are of a smaller magnitude than that of current downward trends occurring nationally. We believe that this research has significant potential to generate discussion at the AAEA meetings. Phosphorus runoff in US waterways has important implications for agricultural management, environmental amenity value, and human and ecosystem health. Additionally, this large-scale analysis allows for much broader implications than single-basin models, which currently dominate the existing literature related to nutrient pollution of waterways. Finally, studying the EPA's policy on this measure has valuable implications for water quality standards in the United States and beyond.

References

Borsuk, M. E., C. A. Stow, and K. H. Reckhow (2002). Predicting the frequency of water quality standard violations: A probabilistic approach for tmdl development.

Gaba, J. M. (1983). Federal supervision of state water quality standards under the clean water act. *Vand. L. Rev. 36*, 1167.

Griffiths, C., H. Klemick, M. Massey, C. Moore, S. Newbold, D. Simpson, P. Walsh, and W. Wheeler (2012). Us environmental protection agency valuation of surface water quality improvements. *Review of Environmental Economics and Policy*.

Liu, T., R. J. Bruins, and M. T. Heberling (2018). Factors influencing farmers' adoption of best management practices: A review and synthesis. *Sustainability 10*(2), 432.

Wade, T. J., N. Pai, J. N. Eisenberg, and J. M. Colford Jr (2003). Do us environmental protection agency water quality guidelines for recreational waters prevent gastrointestinal illness? a systematic review and meta-analysis. *Environmental health perspectives 111*(8), 1102–1109.