Commentary

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Journal of Water Pollution and Control

2018
Vol.1 No.1:1

Addressing Key Questions for Water Pollution Control: The Case of Nutrient Controls

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Received: November 01, 2017; **Accepted:** January 02, 2018; **Published:** January 10, 2018

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Citation: Hoornbeek J (2018) Addressing Key Questions for Water Pollution Control: The Case of Nutrient Controls. J Water Pollut Control. Vol.1 No.1:1

Introduction

I am pleased to have an opportunity to contribute to this first issue of the *Journal of Water Pollution and Control*. After having spent much of my professional career working on issues relating to public health, the environment, and water policy, I support the journal's aim to provide quality water-related research and open access to it. In this commentary, I call attention to the magnitude and importance of water pollution problems, and focus particularly on the example of excess nutrient enrichment and the policy tools used to address it. Excess nutrient enrichment is one among many areas where this new journal may contribute to dialogues about water quality problems and the ways in which they can be addressed technically and through public policies.

A recent study by the Lancet Commission on Pollution and Health estimates that 9 million people worldwide experienced premature death as a result of pollution in 2015 [1]. Phillip Landrigan et al. further estimate that 1.8 million of these premature deaths resulted from water pollution and many of these deaths occurred among children in low and middle income countries [1]. The Lancet Commission report attributes these deaths to unsafe water supplies and inadequate sanitation, and it also points out that water pollution negatively affects planetary health and ecosystems across the globe, as well as human health.

While water pollution often affects nations and people who are lacking in financial resources, it also has impacts on countries and people with higher incomes. Landrigan et al. point out that water pollution related deaths are most prevalent in Sub-Saharan Africa and Southeast Asia and that most deaths from pollution (92%) occur in low income and middle income countries [1]. However, wealthier countries also experience deleterious effects from water pollution. These problems are wide ranging, and include inadequate sanitation, pollution from chemical and industrial sources, agricultural runoff, naturally occurring pollution from minerals and soils, and legacy and other sources.

The United Nations (UN) calls attention to eutrophication stemming from excess nutrient enrichment, and calls it the most prevalent water pollution problem on the globe [2]. Concerns about excess nutrient enrichment are compounded by global climate change, which appears to be contributing to rising lake temperatures and the prospect of more prevalent Harmful Algal Blooms (HABs) in lakes across the globe in the future [3]. These concerns are further exacerbated by previous work highlighting the global and cultural dimensions of modern day nutrient enrichment problems [4-6]. In the United States (US), recent aquatic resource surveys suggest that more than 35% of lakes face problems associated with nutrient enrichment [7]. The nutrient-related problems identified include oxygen depletion and the development of HABs, which can impact ecological systems and human health.

While there is growing evidence of nutrient enrichment problems across the globe, research on appropriate public policy responses to these problems is not yet well developed [but see 8-10]. Recently, I have worked with colleagues to identify policy tools to address HABs and nutrient enrichment in Lake Erie (in the Great Lakes region) and in locations elsewhere in the US [11,12], where there are growing concerns about excess nutrient flows and HABs.

The policy tools for addressing nutrient flows that we have identified in the US are numerous and wide-ranging. They include limitations on phosphorus and nitrogen discharges and required best management practices in regulatory permits, funding support for water and wastewater infrastructure, targeted and collaborative research and information dissemination relating to nutrient flows and how to minimize them, and the development of organizational capacities to address nutrient related concerns [11-13]. However, as recent HAB problems in the Lake Erie basin and other water bodies in the US demonstrate [14], these tools are not yet accomplishing their objectives.

The widespread prevalence of HAB problems raises key questions about how best to minimize nutrient flows in an era of "cultural eutrophication" [5]. Can we build on our current menu of policy tools for nutrient control and increase their prevalence and their aggressiveness to more fully address problems of excess nutrient enrichment? Or, do we have to rethink our approaches more fundamentally and seek new policy tools altogether? In the Lake Erie region, some have argued that it may be necessary to restore ecological capacities of bygone eras by rebuilding vast wetlands, similar in some ways to those which were prevalent before the western portion of the Lake Erie drainage basin was developed for agricultural production [15]. Is this kind of ecological restoration feasible and an appropriate part of the response to the challenges faced in the Lake Erie region? If this kind of approach is appropriate for the Lake Erie region, to what extent is it feasible and appropriate in other regions and countries of the world? These kinds of questions are difficult ones, but they are the kinds of questions that we need to address if we are to combat the ill effects of excess nutrient flows on regional, national, and global scales.

While inventorying US nutrient control policies is a useful beginning, there is need to document nutrient control related policy tools used in other nations and in varying situations. There is also a need to connect these policy tools to technical approaches for reducing nutrient flows and to assess their effectiveness in reducing nutrient flows and improving water quality. Designing and implementing policy solutions to excess nutrient problems is inherently difficult due to the multiplicity of potential nutrient sources and cultural foundations associated with at least some of these sources. However, this kind of work is important if we are going to address growing concerns confronting the world's water bodies and the human beings who depend on them.

Finally, while excess nutrient flows are certainly important, they are just one of many kinds of water quality problems facing us across the globe. Many of these problems (including the control of excess nutrients) remind us of the fundamental connections between water, our physical world, and societal and cultural patterns that affect these relationships and the quality of our waters. My hope is that the *Journal of Water Pollution and Control* can take an interdisciplinary, multi-national, and comparative approach to addressing excess nutrient flows and other water pollution problems in the months and years to come.

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