Writing for the Sciences

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Abstract

Eutrophication is a process in which phosphorus (P) and nitrogen (N) contaminate the water that empties into coastal waters. Overtime eutrophication happens naturally but human activities have accelerated the rate thereof. When farmers use synthetic fertilizer, and detergent manufacturers put P in their detergent, the rate of eutrophication increases. This causes the deprivation of oxygen which results in “dead zones”. Solutions to this problem include having farmers use organic and/or long release fertilizers and try crop rotation, and demanding detergent manufacturers to stop using P.

Keywords: eutrophication, synthetic fertilizer, farmers, phosphate detergents

Eutrophication of water bodies occurs due to over-enrichment by nutrients, principally phosphorus (Schindler 1977), followed by uncontrolled growth of primary producers and episodes of oxygen depletion owing to decomposition of algal organic matter. In other words, eutrophication is a process in which water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that stimulate the growth of algae and nuisance plants (weeds).

Excess phosphorus inputs to water bodies usually come from two types of nutrient sources, point sources such as sewage, industrial discharges, and nonpoint sources such as runoff from agriculture, construction sites, and urban areas (Carpenter et al. 1998). Nutrients are chemical elements and compounds found in the environment that plants need to grow and survive. The main nutrients of interest in water quality are nitrogen (N) and phosphorus (P). Nitrogen can be added in the form of nitrate, nitrite, ammonium or organic nitrogen, and phosphorus in the form of orthophosphate (Iverson et al., 1998). Nonpoint sources of nutrients have replaced point sources as the driver of eutrophication in many regions (Carpenter et al., 1998). An important driver of nonpoint nutrient input is the excessive application of fertilizer or manure, which causes phosphorus to accumulate in soils (Bennett et al., 2001). Phosphorus-rich soils are washed into lakes, where some of the phosphorus dissolves and stimulates the growth of phytoplankton and aquatic plants.

Some consequences of eutrophication are reduced sunlight penetration, decreased the amount of oxygen in the water, and loss of habitat for aquatic animals and plants. Hypoxic ecosystems have low oxygen levels. When estuaries, lakes, and coastal waters have less than two parts per million of oxygen, they are hypoxic. Anoxic ecosystems are completely depleted of dissolved oxygen. In many cases, these waters do not have enough oxygen to support fish and other aquatic animals. The decrease in dissolved oxygen is caused by the decomposition of dead plant material (algal), which consumes available oxygen (Iverson et al., 1998).

Prevailing eutrophication by anthropogenic nutrient inputs is a relatively recent environmental problem. Intensive fertilization of agricultural soils and associated nonpoint inputs of phosphorus increased through the middle of the twentieth century (Carpenter et al. 1998; Bennett et al. 2001). It could take 1,000 years or more to recover from eutrophication caused by agricultural over-enrichment of soils (Carpenter, 2005). The main objective to remediate this issue is to reduce the N and P load to the fresh-water systems. Some solutions come from changing agricultural practices, for example, restricting the use of fertilizers, optimizing nutrient use to crop requirements, planning the use of fertilizers, and establishment of more sustainable agriculture farms (Khan and Ansari 2005). In order to control eutrophication and restore water quality, it is necessary to check and restrict phosphorus inputs, reduce soil erosion, and develop new technologies to limit phosphorus content of over-enriched soils (Carpenter and Lathrop 2008). Methods to control eutrophication include enforcing wastewater treatment and eliminating the importation of chemical phosphorus to watersheds via fertilizers (Schindler 2006).

The technical solutions to the eutrophication problem relate primarily to farming practices. This is because poor farming practices often lead to excess nutrient runoff. One farming practice that targets the excess nitrogen and phosphorus runoff caused by eutrophication is crop rotation. Crop rotation is a process by which farmers change the crops they grow every season, increasing crop yield and soil fertility while reducing soil erosion. The process requires the use of different crops and because different crops require different fertilizers the process should decrease eutrophication. The problem is that most farms in the U.S use some form of crop rotation while eutrophication remains problematic. Crop rotation is primarily responsible for subduing the effects of erosion, subsequently diminishing the runoff that causes eutrophication.

Another proposed solution to the issue of Agricultural based eutrophication is slow-release fertilizers. These fertilizers work by releasing nutrients over a period of time, making sure that plants do not receive too much of it at once. The release of these fertilizers is determined by the solubility of the soil, the condition of the soil and the weather. Unlike crop rotations, slow-release fertilizers are not commonly used by the agricultural community because of their high price relative to their low financial benefit. Slow release fertilizers consist of urea coated in water-insoluble sulfur or polymer (Gammon, 2017). Gehen Amaratunga gave slow release fertilizers a promising future when he and his colleagues attached urea molecules to nanoparticles of hydroxyapatite. This increased the crop yield by ten percent while only using half of the urea. Slow release fertilizers give fertilizers hope for the future

Policies must be targeted as well in order to mend the eutrophication problem. Farmers tend to use vast amounts of fertilizers which end up contaminating the waters. A policy that can be implemented is having farmers go in for mandatory classes on how to use long release fertilizers, learn which fertilizers cause less harm, and how to not misuse fertilizers. Outdated regulations should also be changed when it comes to the reduction of phosphorus in detergents.

Using synthetic fertilizers causes eutrophic bodies of water. Unlike its organic counterpart, synthetic fertilizers immediately replenish soil minerals like N, P, and Potassium (K), and may overload the soil with these nutrients. As such, “excess nitrogen runs off into streams, and rivers causing an increase in the growth of algae in estuaries, lakes, and oceans," (Fertilizer, synthetic, 2009). Once these algae multiply and occupy the top layer of these bodies of water, more sunlight is reflected off the air-water interface, preventing sea plants from growing, and releasing oxygen, O_2, into the aquatic environment. Consequently, the aquatic ecosystem becomes oxygen deficient. Considering this, while the use of synthetic fertilizer may be expedient for farmers, it has cascading negative effects on the environment. In fact, when a National Research Council member along with other scientists analyzed anthropogenic N input to water-resource units, synthetic fertilizer was identified as the largest source thereof (Sobota et al, 2013, p. 82). This insinuates that farmers, especially those using synthetic fertilizer, are crucial in determining the degree of degradation that water-resource units experience. In light of this, if farmers could change their practice of using synthetic fertilizers to more sustainable and environment-friendly ones, the damage incurred by the former could be reduced, and a nutrient surplus of soil could be halted.

To accomplish this, farmers could be mandated to take annual classes that inform them of the dangers of using synthetic fertilizer and teach them about eco-friendly alternatives. Recently, Pivot Bio released a technology that restores the ability for bacteria in the soil to take atmospheric N and fix it into the soil for corn crops (Pivot Bio Closes $70 Million, 2018). Farmers would apply this product after plowing and would avoid eutrophication and its effects (ibid). Additionally, farmers can be encouraged to use crop rotation techniques and use long release fertilizers that gradually fortify plants with nutrients. Thus, mandatory educational classes coupled with these technical practices, farmers could more efficiently and conscientiously produce crops.

Now, another means by which water is adulterated with excess nutrients is via detergents containing phosphorus. This mineral also feeds algae and leads to eutrophication. To combat this, the Environmental Protection Agency can institute a law that will halt the production of such detergents, and encourage detergent manufacturers to make phosphorus-free products. Water should not be a commercial product but rather a heritage that should be protected at all cost. Unsafe and polluted water is rapidly growing making it difficult for aquatic life and human life to sustain. Given the extent water quality degradation associated with nutrient enrichment, eutrophication has and continues to pose a serious threat to potable drinking water sources, fisheries, and recreational water bodies. Thus, mandatory educational classes coupled with these technical practices could help farmers more efficiently produce crops, manufacturers more conscientious, the average consumer more intentional about patronizing eco-friendly brands.

Eutrophication continues to be one the leading cause of water pollution for many freshwaters and coastal marine ecosystems not only in the U.S but also on a global scale. In India, half of their groundwater is contaminated with nitrates, a form of nitrogens found in fertilizers (Across India, high levels of toxins in groundwater by Vishwa Mohan). Consumption of nitrates could result in health impairments such as methemoglobinemia, a deadly condition that starves blood of oxygen. In addition, in the U.S Florida experienced the effects of excess nutrients. Witnesses recalled seeing red tides and blue-green algal blooms. Meanwhile, in Australia, Nutrients in the coastal waters trigger harmful algal blooms that feed the reef-eating crown-of-thorns starfish. We need a mix of effective strategies that include developing policies, innovative programs and ways for reducing excess nutrients such as Nitrogen and phosphorus which are the main excesses found in eutrophication. We need better ways of treating wastewater, controlling agricultural runoff and employing smart sustainable development practices. The U.S could learn from other countries such as New Zealand. the New Zealand government set up a trust to protect the pristine Lake Taupo from increased nitrogen loads. Funded by taxpayers, the trust purchases land where nitrogen pollution is high and converts it to forests. The trust also provides financial incentives to farmers and other landowners employing nitrogen-reduction technologies and conducts research on innovative pollution-control practices. After more than 10 years of the trust's activities, Lake Taupo continues to experience low nutrient loads and high water quality.

The effects of eutrophication can be quite devastating. Lakes with lower nutrients are considered high water quality due to lower concentrations of algae. However, the management of these resources requires a complex set of interactions. Therefore, in order to control the effects of eutrophication, need the cooperation of not just policy makers and scientists are needed, but the ongoing cooperation of citizens.

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