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Agricultural Activities and Their Environmental Impact on Surface Waters: A Review

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Abstract: Freshwater bodies have been significantly impacted by changing land use and land cover patterns, as well as changing environmental and climatic factors. Both point and nonpoint sources contribute significantly to water contamination. Point sources can be controlled, but managing and keeping an eye on non-point sources is far more difficult. Pollution in the current situation makes access to potable water practically difficult as water resources become more limited. To feed a rising population, intensive agricultural practices increase the use of pesticides and fertilizers, which causes runoff and eutrophication of freshwater systems. This assessment focuses on how agricultural practices affect water bodies, the environment, and people's health as non-point sources of pollution. It looks at the intricate relationships between local water quality and land use.

Keywords: Water pollution; Surface water quality; Agricultural activities; Freshwater ecosystems; Herbicides; Pesticides; Eutrophication; Sediment pollution.

1. Introduction

Agriculture is one of the major forces behind environmental changes worldwide, yet it is also the sector most susceptible to climatic changes [1]. Despite negative environmental consequences and agricultural production practises are the main routes to achieving food security, giving roughly 7.7 billion people access to food and fibre [2]. The world's land area is used for agriculture to the tune of about 37%. The usage of fertilisers and pesticides must be increased in agricultural practises in countries with less arable land [3]. More fertilisers and insecticides are often used in enhanced agricultural systems, but sadly they are not always fully utilised. The leftovers of These pesticides and fertilisers have the potential to be transferred as NPS (Non-Point Sources) during storm and runoff events, either in dissolved or particulate form. Due to the growth of hypoxic zones, this sort of pollution has attracted a lot of attention recently. For instance, the hypoxic zone for 2019 was the eighth-largest ever, at 18,005 Km2.Additionally, Van Metre et al. 2018 stated that the greatest hypoxic zone, measuring 22, 720 km2, occurred in the Gulf of Mexico during August 2017.

Extreme nitrogen and phosphorus fertiliser inputs cause eutrophication of surface waterways, increase toxicity, and have negative effects on vegetation and animal communities. Nitrogen and phosphorus are the most frequent chemical pollutants from agricultural NPS pollution, and they have been discovered in the majority of the world's aquifers [5].According to statistics from throughout the world, agricultural NPS is putting strain on 38% of water bodies in the European Union, whereas in the USA.A large cause of pollution for rivers and streams, second for wetlands, and third for lakes is agricultural NPS [6]. However, agricultural NPS pollution is responsible for the majority of the nitrogen pollution of surface water and groundwater in China [7] and is being made worse in developing nations by increased sediment runoff, which is a major concern [8].substances produced from different agrochemicals, such as nitrate, phosphate, potassium, dieldrin, aldrin, endrin, chlordane, arsenic, cadmium, and related poisons eventually make it to bodies of water [9–10]. Studies show that, in contrast to other sources like residential and industrial areas, the loss of N and P (nitrogen and phosphorus) from croplands to nearby rivers and streams has dramatically increased recently.[11–12]. Since then, several studies have worked to assess these compounds' amounts in the receiving waters and the impact of adopting the proper management action.

Lake Taihu recognised with blue green algae in 1987.since then, it has been seen that the lake's quality has deteriorated rather than improved [13]. Due to this situation, drinking has been stopped.individuals who depend on it, disturbing them [14]. water from the lake. concentrations of nitrate and phosphate that exceed the WHO-permitted limits.In Mysore, standards in groundwaters close to agricultural fields were recorded by Divya and Belagali in 2012 [15]. Khanna and Gupta studied the ecological impacts of the loop of water pollution from agricultural NPS and the same water used for irrigation in 2018.[16]. Persistent organochlorine residues were found in the waters of numerous Indian rivers, according to Mohapatra et al. (1995) [17]. Also, they stated that it was found that the levels of DDT, aldrin, and heptachlor were higher that authorized. As a result, the current review lessens the current state of global agricultural pollution, defines the key elements of agrarian practices that cause water pollution, covers the implications or impacts of such pollution, and gives alternatives or control methods that can be utilized to mitigate it, thereby promoting sustainable agricultural practices.

Pollutants

When used in the environment, it depletes resources or has adverse impacts. Pollution may have immediate or long-term negative effects. Pollutants that degrade quickly only have a short-term detrimental effect. Some pollutants, like DDT, break down and produce new ones like DDD and DDE. There are many different types and features of pollutants, including pollutants in the stock, including those with low or no capacity for absorption, including heavy metals, synthetic compounds.Over time, these toxins accumulate in the environment. Their devastation increases as their number does. Future generations are already being taxed by atmospheric pollution. Environmental pollutants have similar characteristics for absorption. only when their quantity outpaces the ecosystem's capacity to accept them.

Agricultural Runoff

Due to the negative impacts of nutrient run-offs, it is now essential to quantify and understand how cropping practises affect the ecosystem [18].In places where inorganic fertilisers are accessible with significant subsidies, an excess of these fertilisers is one of the primary sources of water pollution from agricultural NPS [19]. Nitrogen and phosphorus are the two ingredients that significantly contribute. Nitrogen and phosphorus pollution is caused by the overuse of synthetic fertilisers, which increases the unintentional loading of water bodies.

Given that ongoing agricultural practises reduce the availability of nitrogen to plants, the development of an automated technique for fixing nitrogen from its components is encouraged. As a result, agriculture has been intensified globally. Although nitrogen use in excess was thought to be a crucial development for feeding the expanding population, It also has a number of adverse effects on the environment, including soil acidification, eutrophication, emissions to the air, and greenhouse gas emissions. As a result, the agricultural sector is the primary contributor to nitrate-related water pollution.[20]. According to reports, the majority of the nitrogen from fertilisers and manures applied to agricultural areas is lost to the environment [21].

Additionally, anthropogenic nitrogen intake to the biosphere has the potential to significantly change the earth's system, resulting in beyond planetary bounds [22]. Nitrate-contaminated water has been shown to have long-term negative effects on the environment, endangering both ecosystem health and economic prosperity [23]. After being added to the soil as fertiliser in a reactive state or through microbial fixation, nitrogen acts as a substrate for a variety of microbial activities, making it available for absorption by plants. Plants' capacity to successfully absorb nitrogen is influenced by conditions such as moisture, temperature, aeration, and the presence of other substrates like carbon. As a result, these environmental factors significantly influence how nitrogen is used for purposes other than plant growth [24].

It is believed that denitrification and denitrification are the two main mechanisms involved in converting nitrogen species in soil to hazardous compounds [25]. When When applied in excess, wasted nitrogen causes increased nitrous oxide and ammonia emissions into the air as well as nitrate and ammonium runoff into surface and groundwater. Specifically, nitrous oxide from agriculture makes up 56 to 81% of all anthropogenic emissions, and by 2050, that percentage is expected to increase.Numerous research have been conducted on this issue in an effort to influence the relevant authorities to develop effective control measures. or instance, Rabalais et al. (2002) [26] and Turner et al. (2006) [27] claim that one of the primary causes of summer hypoxia in the Gulf of Mexico is nitrogen load from the Mississippi River, which has increased greatly over the past 100 years. Nitrate, the primary type of nitrogen, has been rising in surface water since 1970[28].

Inorganic fertilisers

Croplands receive phosphorus additions from inorganic fertilisers, imported manures, concentrates, slurries, and other sources. preserving ideal phosphorus levels or balancing.In order to evaluate possible chances for arable spread lands, phosphorus in farming is crucial [29]. It is known that phosphorus entering surface water bodies through catchment zones dominated by agricultural land is a crucial source for eutrophication. Because phosphorus is a limiting nutrient, it must be transported less from agriculture to prevent negative impacts. Legacy soil phosphorus is what Kleinman et al. (2015) [30] refer to as a residual store of accumulated phosphorus in the soil beyond the agronomic needs [31–32].Some soils have a high potential for retaining phosphorus, which is released gradually to natural runoff in modest amounts[33].It have devastating effects on receiving waterways. Therefore, controlling this phosphorus continues to be difficult for watershed mitigation measures and water quality, both of which have an economic impact [34]. As a dynamic interlacing stage from the source to mobilisation and discharge to receiving waters, the transfer of phosphorus to surface water may be described as contaminating those [35]. Through procedures including biological solubilization and geochemical desorption, phosphorus molecules are removed from the source during the mobilisation stage. With certain soil conditions, such as high organic matter, moisture, and management practises, the rate and amplitude of these processes tend to increase[36].

The phosphorus that has been mobilised travels via both surface and subterranean channels before being released into surface waters, where it turns into a contaminant [37]. Gurung et al. (2013) evaluations of nitrogen and phosphorus loading in two watersheds of Mulberry and Catoma using a pollutant loading model[38]. are the most recent studies to be cited.. This research has been conducted by several scholars across the world who are interested in understanding phosphorus loads in receiving streams.For lakes, the levels of nitrogen and total phosphorus were hypertrophic, whereas in rivers, they were eutrophic. Additionally, Darch et al. (2014)concluded from their study The danger of eutrophication is significantly increased by the greater mobility of bioavailable organic phosphorus compared to its refractory forms[39]. The approaches for removing phosphorus from water using adsorption and recovering it afterwards using desorption were reviewed by Bacelo et al. in 2020 [40]. As previously noted, there are several causes of nitrogen and phosphorus pollution, with agriculture accounting for a sizeable share of them[41].

Agriculture-related problems

Fertilisers, pesticides, and damaged soil are more common there since there are fewer people living there, and these toxins eventually enter water sources through flooding and runoff. Agricultural runoff contributes to the eutrophication of freshwater bodies. Phosphorus has a major part in eutrophication because it fosters the growth of cyanobacteria and algae, which reduces the level of dissolved oxygen in the water. Blooms of cyanobacteria emit poisonous substances that accumulate in the food chain. Nitrogen-rich fertiliser chemicals cause dissolved oxygen shortages in rivers, lakes, and coastal regions, which have disastrous consequences for aquatic life. Groundwater is contaminated by nitrogen fertilisers due to its high water solubility, increased runoff, and leaching rate. Chemicals drain into the earth, causing groundwater contamination, much as how pesticides are used to control pests.Water soluble pesticides tend to leak more.

Atmospheric Pollutant

The entry of small airborne particles into water bodies through rain is to blame. Sulphuric acid is made when sulphur dioxide, which is produced by burning fossil fuels, reacts with water molecules. It contains carbon dioxide. Sulfuric acid forms when sulphur dioxide from volcanoes and factories mixes with water molecules. Sulphur dioxide also forms when coal and petroleum products burn. Nitric acid is produced in a similar manner when nitrogen dioxide and water combine. Due to the fact that rain brings them, particles also play a big part in polluting water supplies.

Pathogens

Pathogens are the germs that cause illness. There aren't many harmful microorganisms in nature; most of them are benign or non-pathogenic. Additionally, these harmful bacteria taint drinking water.To identify water contamination, coliform bacteria are used as an indicator species of bacteria. The bacteria that cause illness include Salmonella, Norovirus, Giardia lamblia, Burkholderia pseudomallei, Cryptosporidium parvum, and parasitic worms like Schistosoma.

Insecticides and herbicides

To control weeds and pests, herbicides and insecticides are utilized. Both of these are a part of the polluting of the water. Also, leaching pollutes groundwater. The composition of pesticides, soil texture, irrigation, and rainfall all have an impact on leaching. In sandy soil, leaching will be worse if the herbicide is water soluble.

Runoff is how they enter natural bodies of water in a manner similar to how pesticides and herbicides do. Once in natural water bodies, these chemical remnants have an impact on the vegetation and wildlife there. Longer-lasting or more slowly decaying pesticides give a greater risk.

Remedial measures

The typical classification of all land uses and agricultural practises as agrarian NPS contamination, which depends on hydrological situations that directly interfere with measurement and control. But because of the characteristics of NPS pollution management that rely on spatial-temporal simulation modelling, this is the main approach to calculate NPS pollution associated with spatial uncertainty. Accurate calculations of the pollutant loads from various land uses may be made using methods like watershed-scale modelling and small-scale spatial experimentation [42].

2. Conclusion

Most ecological research, restoration initiatives, and water quality control still place a high importance on water quality monitoring. Water is presented in the current review says that quality decline brought on by agricultural NPS, with nitrogen and phosphorus being the main culprits. It also concentrated on the methods by which they entered the water bodies and the effects they had on the surrounding ecosystem. We also discussed some of the most recent technologies that may be used to lessen the amount of toxic pollutants that are transported to water bodies. It is possible to regulate nitrogen and phosphorus concentrations using process control technologies such integrated buffer zones, which appear to offer superior retention capacities, with the use of monitoring and testing techniques. Additionally, employing integrated approaches is always seen to be efficient.

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