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A Review on Characterization of Nitrogen and Phosphorus in Aquatic Flora and Fauna

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Abstract: ***Sources of water surface water, ground water and rainwater. Drying of water sources is majorly due to climatechange, the extreme hot summers, insufficient rainwater and the improper use of freshwater. Rivers has been polluting very rapidly in this era, mostly due to domestic and industrial waste direct discharge into water, even now seas are also getting polluted due to mainly domestic, variousscientific practices and some economic reasons. Shortage of ground water is mainly due to over extraction of it and insufficient rainwater infiltration process. Theambition of this review is to aware the future aspectstowards the pollution of aquatic ecosystem. There are mainly anthropogenic sources, whichdisturbed the whole aquatic environment at the global level. The use of chemical fertilizers in agricultural practices, industrial growth and many more causes.***

Keywords: Aquatic flora and fauna, Nitrogen, Phosphorus, Eutrophication.

I. INTRODUCTION

Water is an important like nectar in the planet. We all living things need water to survive. Pollution, infrastructuredevelopment and resource extraction pose additional challenges. Restoration, protection and management of fresh water ecosystem hasbecomes serious concern. Freshwaterecosystem consists inland water bodies for instance,lakes,rivers and groundwater aquifers. Water has chemical element hydrogen and oxygen existing in liquid gaseous and solid states.

Nitrate and phosphorous containing compounds create serious problem when released in water bodies without treatment P and N are major nutrients needed by living microorganisms for their physiological processes.

However they are considered as pollutants if their concentrationis more than recommended limits. Heavy nutrients load N and P containing water bodies favor the growth of aquatic plants and create negative effect on water quality by accelerating the growth of algal clumps, badodors and discoloration(Asha Lata Singh,BHU, 2016).

eutrophication is a condition occurred in water bodies due to excess addition of N and P in organic form from the various pollutant source, in which there huge growth of algal blooms and water hyacinth. This algal bloom as well as water hyacinth spread on the surface of water bodies and due to this film of algal bloom sunlight cannot penetrate in the water and creates ananxiouscondition.

The formation of algal blooms in fresh water and marine ecosystem can result in the production of toxins depending on the species of algal present (Glendon,R.Shaw, et al.,2022).

Oxygen deficiency leads to the death of aerobic plants and microbes and are replaced by the growth of anaerobes and algal blooms under anaerobic condition (Alm, 2003).

Eutrophication arises from the oversupply of nutrients which leads to overgrowth of plants and algae. After such organisms die the bacterial degradation of their biomass consumes the water there by containing hypoxia (Baranawal et al.,2022).

Several reports are available on removal of N and P from waste water with the help of physiochemical methods(Metcalf and Eddy, 2003).theoccurrence of nitrates and nitrites in drinking water has been reported to induce methemoglobinemia that affects children less than one age-old with about a 100% reduction of nitrates to nitrites in infants compared to a 10% reduction in adults(Akinnawo,2023).

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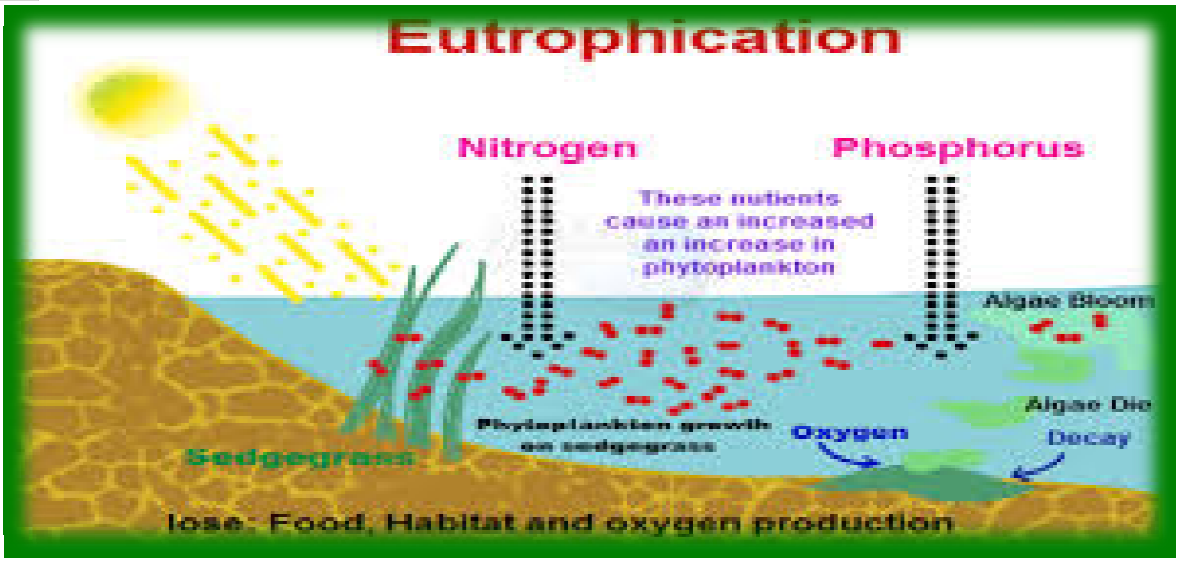


Fig: pictorial Eutrophication Process.

The use of water is increasing rapidly with our growing population. Pollution and contamination of the streams, lakes, wells, and rivershas greatly effects the quality of available water. This is because the disposal of waste from domestic and industrial sources.

II. TYPES OF EUROPHICATION

CULTURAL EUTROPHIATION: It is simply caused by anthropogenic activities. Cultural eutrophication has become a global issue, in particular due to interferencewith the local and regional nutrient and water cycles. Substantial amounts of nutrients are discharged into rivers, lakes and estuaries(Wassmann, 1998).Cultural eutrophication has had dramatic consequences on freshwater resources, fisheries, and recreational bodies of water and is one of the leading causes of aquaticecosystem degradation (Britannica, 2025).

NATURAL EUTROPHICATION: Natural eutrophication occurs due to natural process like weathering of rocks, accumulation of organic matter and decaying of plants. Accumulation of transported large quantities of solid materials in the sediments of water bodies by flooding and run-off, the consequent ability of these sediments to absorb large quantities of nitrogen and phosphorous as well as filling up the basin(Akinnawo,2023).Natural eutrophication has been going on for millennia and is acknowledge as the buildup ,flow, as well as addition of nutrient to water bodies thus resulting in primary compositional changes in the production and community species(Knight,2021).

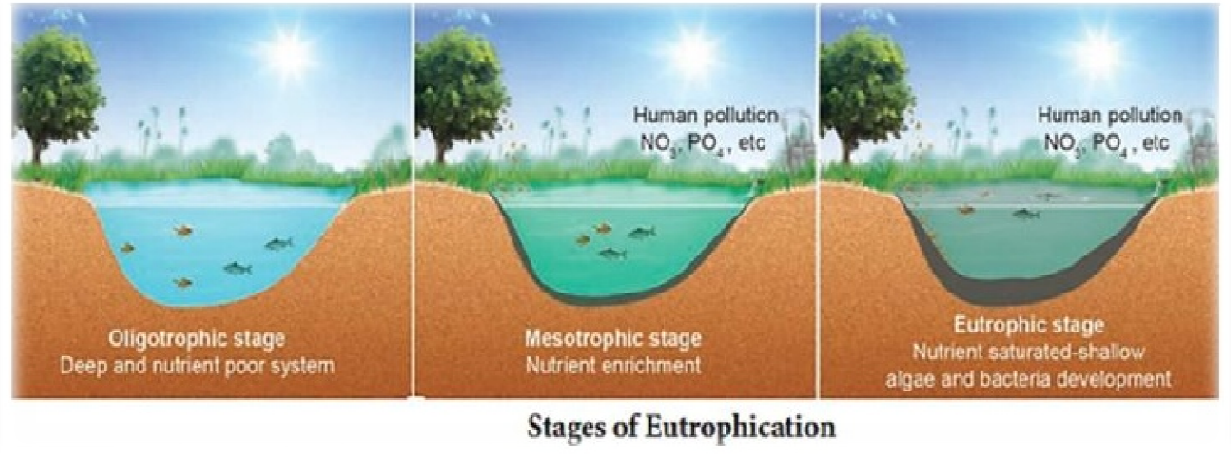


Fig: Progression from oligotrophic to eutrophic(Prasana, 2023).

Phosphate adheres tightly to soil and it is mainly transported by erosionprocess, but when human activities adds excess phosphorous by using of detergent, agriculturalactivities, domestic wastes and industrial waste it increases its concentration rapidly.

III. CHANGES IN PHYSICOCHEMICAL PROPERTIES OF WATER BODIES

Temperature and dissolve oxygen levels are correlated in freshwater ecosystem. With the increase in temperature and dissolve oxygen concentration decreases because of its solubility and this affects the aquatic organisms(Siddiqui et al., 2025).Fish species growth and feeding efficiency, like tilapia were maximized when temperature remain within 25-30 C (Vicencio et al.,2025).

Transparency and light indicates waterfreshness and clarity and light plays a vital role in photosynthesis process by aquatic plants like phytoplankton, supporting the entire food web.Lightattenuation from different wavelengths is related to interactions among water column constituents as the result of absorption and scattering by inorganic and organic particles and dissolved matter (Gordon et al.,1998; Devin et al., 2008).

pH is another important factor that effects microbial dynamics. The unbalance of pH effluent may disrupt pH buffer system and also disorder the ecological system (Verma et al., 2025).The majority of aquatic creatures prefer a pH range of 6.5-9.0, though some can live in water with pH levels outside of this range. A slight change in the pH of water can increase the solubility of phosphorus and other nutrientsmaking them more accessible for plant growth (Fondriest, Environmentallearning Centre).

Biological oxygen demand (B.O.D) inn which bacteria needs oxygen to degrade organic waste in water but when oxygen is low in water body the bacteria are unable to degrade wastes and water body turns into heavy sediment load.BOD of eutrophic water is generally considered high.As eutrophicationoccursthedecomposition of the excessive organic matter (from dead algae and plants) leads to an increase in the BOD of the water body. This is because more organic material is available for bacteria to break down, which consumes oxygen in the process (doubtnut.com).

IV. NITROGEN ROLE AND SOURCE

Nitrogen is a vital nutrient in water ecosystem, but when its concentration becomes high lead to damage the water quality. Nitrogen can reach freshwaters through a number of pathways; by atmospheric deposition on the catchment or directly on the water body; byleaching from diffuse sources within the catchment, suchas those resulting from fertilizers and manure application; bysediment erosion of nitrogen rich soil and surface application of manure in catchment; and by direct input from point source such as sewage treatment works(Durand et al.,2025).It plays role in decaying, nitrogen fixation, nitrification and denitrification processes. Blue green algae for instance nostoc,anabaena and azolla works on the nitrogen related process. Plant consume nitrogen in nitrate form.

Inorganic nitrogen pollution occurs in surface water and ground water can also induce adverse impact on human health and economy. Cyanobacteria,dinoflagellates and diatoms appear to be major responsible that may be stimulated by inorganic nitrogen pollution. Among the different inorganic nitrogenouscompounds(NH4+,NH3,NO2-,HNO2,NO3-) that aquatic animals can take up directly from the ambient water, unionizedammonia is the most toxic, while ammonium and nitrate ions are the least toxic(Camargo et al.,2006).

CONTRIBUTION BY GLOBAL REGION TO THE CONSUMPTION OF THE WORLD'S ANNUAL CURRENT USE OF 85 MILLION TONNES OF NITROGEN

ESTIMATION OF THE INCREASE IN NITROGEN FERTILIZER CONSUMPTIONTHROUGH THE YEAR 2030.

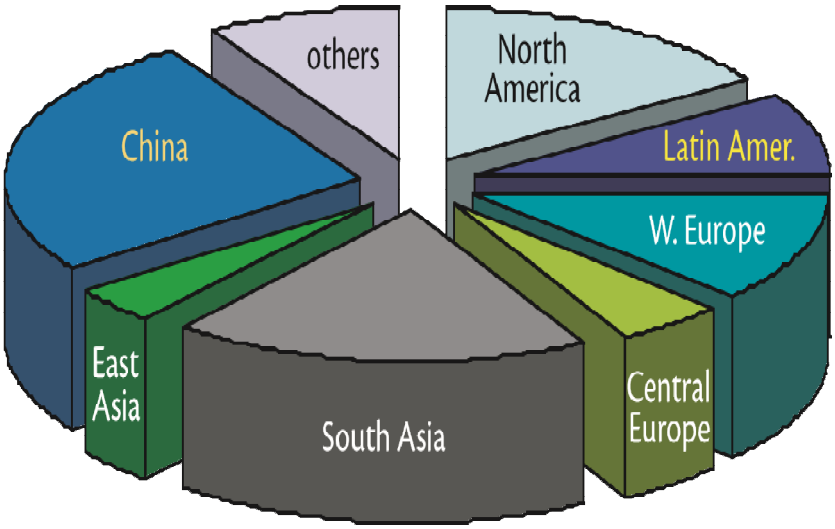


Figure 1. The use of nitrogen fertilizer varies considerably around the globe. Of the

85 million tons of nitrogen consumed annually, Asia uses about half. The greatest
Projected increases in global nitrogen fertilizer are also expected to be in Asia over
The next 25 years. Data from the International Fertilizer Industry(Gilbert. et. al., 2005).

V. PHOSPHOROUS ROLE AND SOURCE

Phosphorus has a complicated story. Pure, "elemental" phosphorus (P) is rare. In nature, phosphorus usually exists as part of a phosphate molecule (PO_4). Phosphorus in aquatic systems occurs as organic phosphate and inorganic phosphate. Organic phosphate consists of a phosphate molecule associated with a carbon-based molecule, as in plant or animal tissue. Phosphate that is not associated with organic material is inorganic. Inorganic phosphorus is the form required by plants. Animals can use either organic or inorganic phosphate (USEPA).It is a building block of DNA,RNA and energy carrying molecules like ATP.Aquatic plants, includingphytoplankton and macrophytes, depends on phosphorous for growth and reproduction (Hooda et al., 2024).Sediments generally act as sink for phosphorous and play an important role in overall phosphorusmetabolism of water bodies. The major source of sediment phosphorus is settled particulate inorganic phosphorus of allochthonous and autochthonous origin consisting of settling material of dead or live planktonicorganisms, excretionproducts, and organicdetritus, precipitate humus substances and calcium carbonates acting as vehicle for phosphorus(Jana et al., 2002).

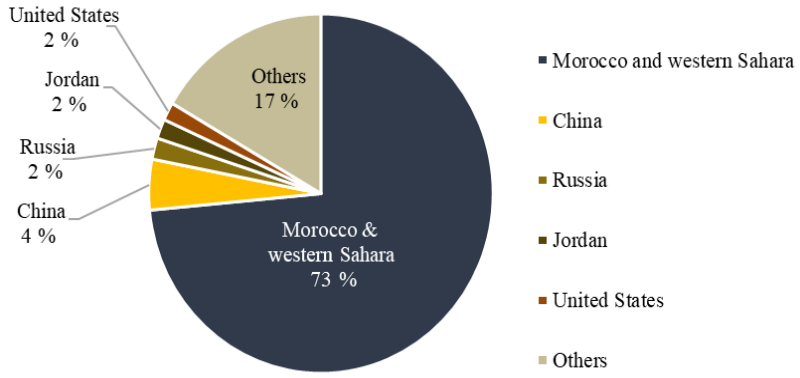
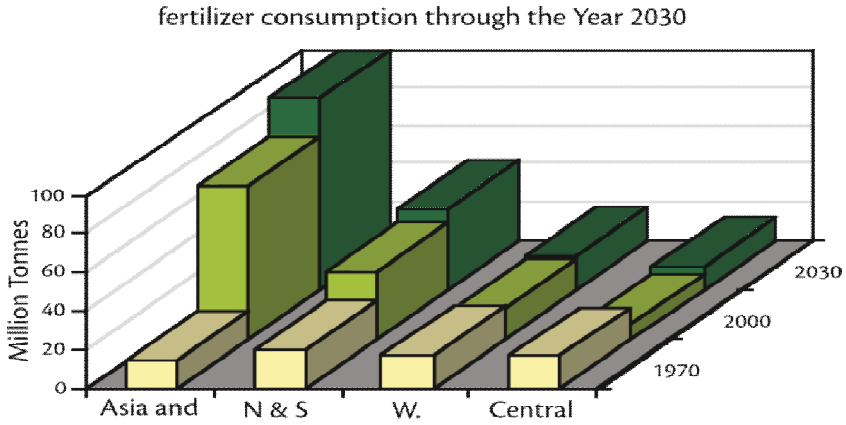


Figure:Estimated global phosphorus reserve disribution(JanKok et al.,2018).

VI. CONCLUSION

Due to excessive nutrient inputs and climate warming ,cyanibacteria dominated harmful algal bloom frequently occur in lakes and spread globally with increased levels of native algae derived dissolve organic matter(Hao et al.,2025).the fifth global environment outlook (GEO-5) alarmingly reports that over 40% of global water bodies are eutrophic ,which poses a series and escalating threat to their ecosystem (UNEP,2012).This situation has raised specific concern on europhication ,highlighting the urgent need for effective mitigation measures to protect lakes,which contain 87%of the earth's liquid surface freshwater (Mozafariet al.,2025).



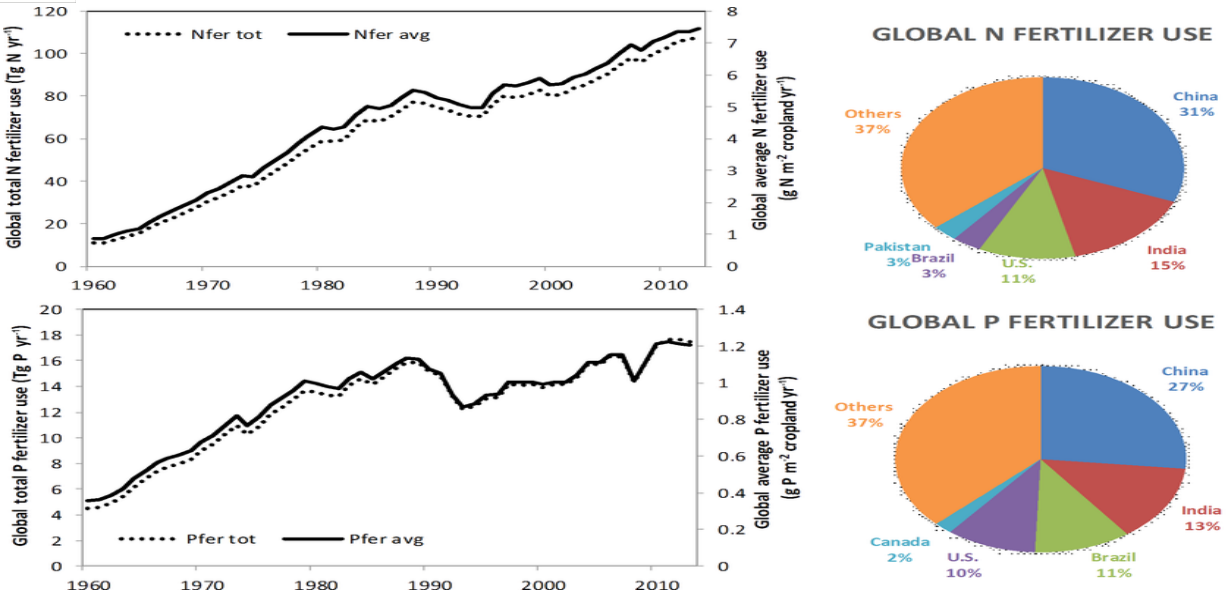


Fig: Temporal pattern of global nitrogen and phosphorus fertilizer use (Lu etal.,2017).

The rapid control of eutrophication by reducing point sources of phophorus is one of the clerarest cases.But conrolling detergent phosphates and point sources of sewage did not end the eutrophication problem(Schindler 2006).The aoolication of fertlizers in different ratios between N,P and K is a balanced fertlization method. Balanced fertlization refers to the application technology of reasonable fertilizer dosage and ratio based on the fertilizer demand characteristics of crops,soil fertlizer supply performance and fertilizer dosage to maintain nutrient balance between the proposed fertlizer dosage and ratio(Liu et al.,2024).

Due to the lack of effective control on agricultural non-point pollution, N and P pollution has become a global problem. In case of USA, over-enrichment issues of N and P were observed from about 50% of impaired lakeareas and 60% of impairedriver reaches(Xia et al.,2020).

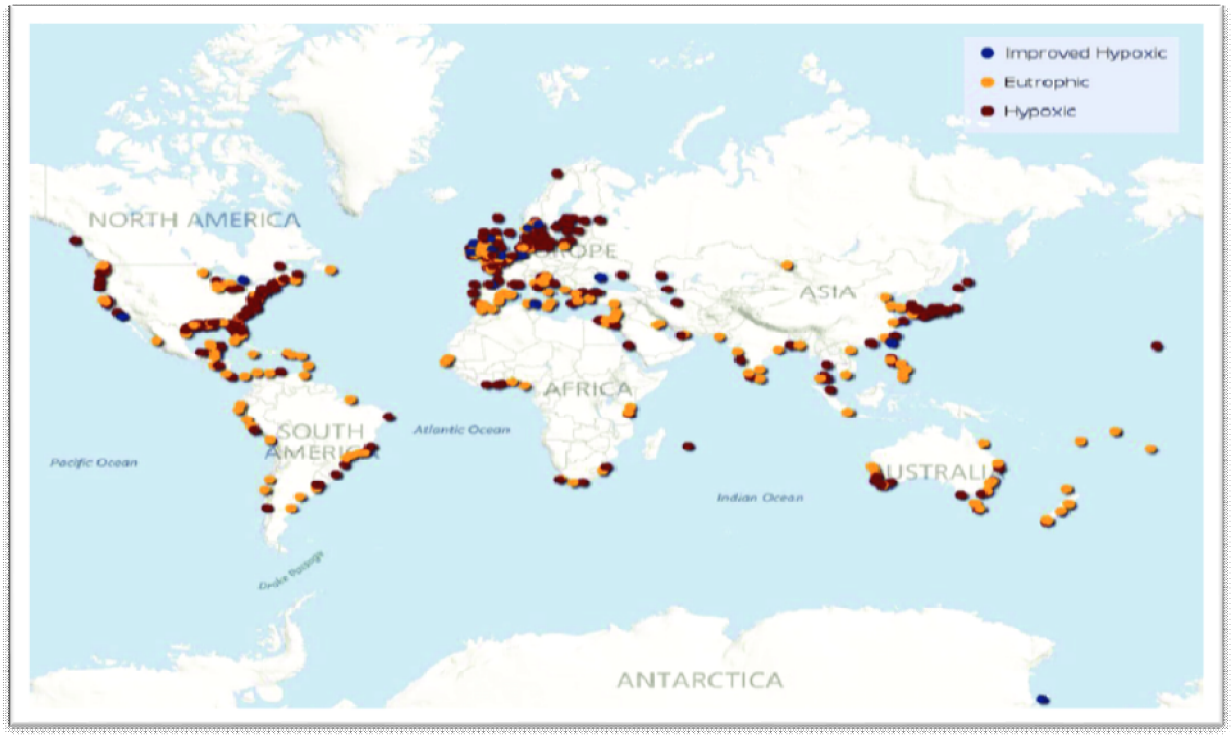


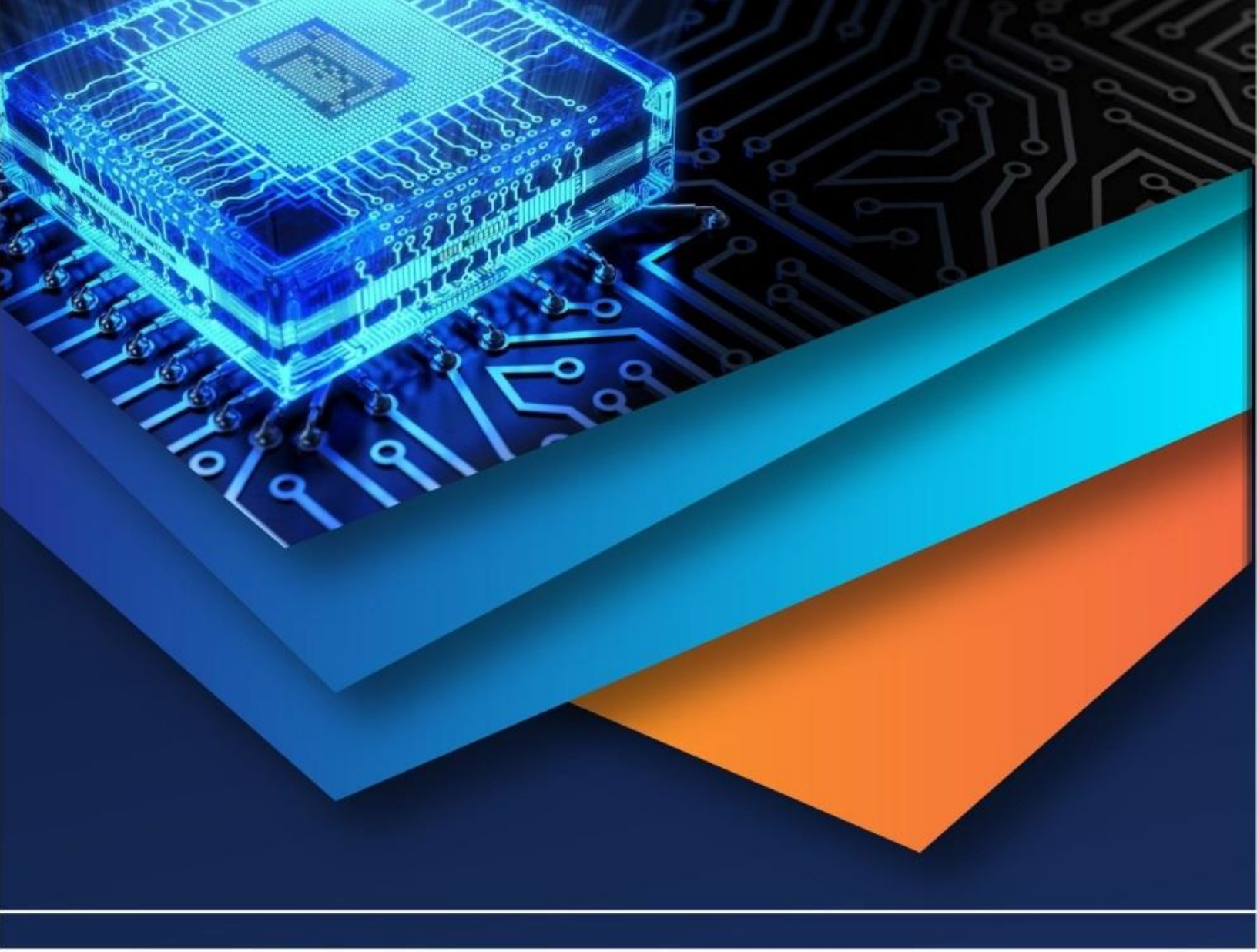
Figure: Global map showing eutrophication worldwide (Christian Jessen, 2013).

In India, it has been assessed that more than 80 per cent of the total pollution load arises from domestic sources, such as domestic wastewater, which is reported to contain P between 6 and 10 mg l-1 (Horan 1990).High quality of detergentcomprise around 35% sodium tripolyphosphate (STPP).In India majority of detergents are triphosphate based. Eutrophication and the associated loss of ecosystem services now rank among the most serious global environmental problems (UNEnvironment, 2019b).Agriculture, human sewage and aquaculture are becoming increasingly dominant, globally up to 80% of nutrient delivery.

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