

# CHAPTER:15

## EFFECT OF INDUSTRIALIZATION AND FERTILIZERS ON WATER QUALITY

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### Introduction

Industries help nations to achieve economic development and urbanization. On one hand, they transform nations become prosperous and their people to attain a high standard of living while on the other hand, they have turned out to be the leading cause of environmental pollution, particularly water pollution. As developing countries like India are still in the process of industrialization, water pollution has become a serious challenge to deal with while achieving growth and development (Rahman et al., 2021)<sup>22</sup>. It's hazardous for human life and aquatic ecosystems, and that only gets worsened with climate change and rapid increase in population.

Depletion of water resources is on a much higher scale. Out of different natural resources, water is one of the most vital resources that has suffered pollution on a large scale and to a much higher level. With limited water resources, the problem of a continuous influx of pollutants is severe. It is estimated that 70% of all available water in India is polluted (Agarwal et al., 2010)<sup>1</sup>. If not controlled this pollution will render water unusual for many human and non-human needs (Kriebel et al., 2001)<sup>16</sup>. Since South Asian countries are surrounded with huge river systems that flow from the great Himalayas and by huge Indo-Gangetic basin aquifers. Large canals and irrigation systems have run on these rivers for millions of years, thereby helping human civilizations develop and flourish alongside these rivers. Lately, surface water due to its less reliability has been replaced as the primary source of rural, urban and industrial water supply for alluvial and hard-rock groundwater aquifers.

Recently, many studies have noted the implications of various anthropogenic activities on the water quality and its accessibility, indispensability cannot be stressed enough. When nutrients and other pollutants are discharged directly into the water without any proper management, there is an adverse impact on both plant and animal life. Algal blooms are a major problem due to excess nutrient concentration in water resources which cause a reduction of oxygen levels and the release of odors and gases into the atmosphere. As lakes and streams receive nutrients from manure and fertilizers through runoff and soil erosion, it increases the chances of river and wetland contamination. Due to erosion, fine soil particles are carried away and accumulate as sediment in freshwater resources thus serving as a nutrient source over a period of time.

Degradation of water quality has serious implications for humans and the ecosystem. There are many sources that contribute to water quality degradation, for example. Ganga River Basin in India is highly polluted with N, P, and sediments that flow from sewage treatment plants. This has resulted in serious consequences like hypoxia, harmful algal blooms, and cancerous gallbladders in humans (Kamboj & Kamboj, 2019)<sup>13</sup>. Coordinated efforts are needed by researchers and policymakers that aim to reduce pollution and help in improving water quality.

It's important to explore different prevention techniques to mitigate water pollution if sustainable development is to be attained. "Wastewater treatment methods" can be employed to reduce the number of pollutants getting discharged into water bodies. Some other mitigation measures to prevent water pollution can also be considered to stop further environmental damage.

### **Water Pollution, A Side Effect of Industrialization**

Water degradation has many causes, natural and man-made. Natural causes include climate change and other geological factors while man-made causes are degradation, industrialization, and urbanization (Akhtar et al., 2021)<sup>3</sup>. Moreover, natural water cycles are affected by the interaction of soil and water which can have bad consequences on the health of living organisms (Akhtar & Rai, 2019)<sup>2</sup>. As water resources are non-uniform in nature in terms of quality and quantity, their characteristics get influenced by natural and anthropogenic processes (Khatri & Tyagi, 2015)<sup>15</sup>. The following figure shows the types of pollutants and sources and how they intermix with ground and surface waters, thereby contaminating water and degrading its quality.

Some metal ions are important for plants and animal development like Zn, Fe and Cu but when their concentration increases beyond susceptible levels, they become dangerous to living organisms (Vardhan et al., 2019)<sup>28</sup>. Similarly, other toxic metals like Pb and Hg reach surface water through industrial discharge and household waste, when discharged either directly or indirectly into water (Shahabuddin & Musa, 2018)<sup>24</sup>.

The dangers of groundwater aquifers getting polluted due to human activities become greater due to changes in land surface and how it interacts with hydrological system (Li et al., 2018)<sup>18</sup>. Groundwater system become more exposed to further damage due to land surface configurations, construction activities, watercourses and large-scale use of synthetic fertilizers (Lyon et al., 2011)<sup>19</sup>. Fertilizers are known to help in getting maximum crop yield but many such compounds are now considered harmful for life systems due to their ability to persist and move in groundwater aquifers (Shwetank et al., 2020)<sup>26</sup>. Following figure shows two categories of sources of pollution and their origins and locations.

Surface water and groundwater serve as two major natural resources that support plant and animal life (Boateng et al., 2019)<sup>4</sup>. Being a valuable resource, the demand for freshwater resources in a cause of concern. Water scarcity is turning out to be a major global problem, compounded by the continuous increase in population. Groundwater supplies potable water to many urban and rural areas but the growing risk of pollution in aquifers due to industries and urbanization will only lead to water crisis in the world. In order to protect the groundwater quality, extensive studies are needed to generate action on part of all the stakeholders involved in this process.

Groundwater as compared to surface water is pure and free of pollution that makes it an important resource for countries to achieve economic development and ecological stability. With increase in population along with industrial and agricultural growth, demand for groundwater has increased manifold (Kaviarason et al., 2016)<sup>14</sup>. Numerous natural and anthropogenic events affect quality of water (Varol & Davraz, 2015)<sup>29</sup>, with many 'point and non-point sources of pollution' containing it and making it unfit for use (Nalbantcilar &

Pinarkara, 2015)<sup>21</sup>. So, the need arises for systematic monitoring of different water quality parameters responsible for hydrochemistry of groundwater. It contamination poses a serious challenge worldwide. At it remains the single available source of drinking water. In India, presence of organic, inorganic & biological pollutants had resulted in the contamination of surface water up to 70%. In India, presence of organic, inorganic & biological pollutants had resulted in the contamination of surface water up to 70%.

### **Role of Agriculture**

It's difficult to assess the exact role of agriculture in eutrophication of lakes and rivers and their contamination. Different countries have reported how agriculture contributes to surface water pollution (Zhao et al., 2019)<sup>32</sup>. In 1960s Lake Erie was declared a 'dead lake' due to eutrophication and pollution from non-point sources. Higher P concentration has not only resulted in hypoxia but also a considerable decline in recreational and fishing activities (Watson et al., 2016)<sup>30</sup>. What led to eutrophication in the lake is double the amount of P nutrient than before that helps algae and cyanobacteria grow quickly (Scavia et al., 2014)<sup>23</sup>. This increase in P concentration is because of large scale use of commercial fertilizers in agriculture (Culbertson et al., 2016)<sup>6</sup>. A new report has classified the quality of water of Lake Erie's western part as poor because of the presence of higher amounts of nitrogen and phosphorous (LER, 2020)<sup>17</sup>.

The demand for agricultural production is consistently increasing due to massive growth in population and change in diet habits. During previous two decades, there has been a considerable increase in irrigated land, livestock and aquaculture (FAO, 2017)<sup>7</sup>. As a result, large scale use of machinery, fertilizers and chemicals like pesticides and herbicides to achieve maximum crop yield has only led to contamination of water resources. Excess fertilizers like N and P, chemicals and other waste products travel to nearest water bodies due to overflow and cause eutrophication and HABs (Zia et al., 2013)<sup>33</sup>

In agricultural fields cutting trees and plants aids in the process of soil erosion, due to which a lot of sediment flows with runoff water. Sedimentation is a major problem of rivers, lakes and other water bodies, which fills them up and increases the potential for flooding while as the soil loses its water retention capacity (Giri, 2021)<sup>9</sup>. Phosphorous and nitrogen are two major nutrients that when present in water bodies in excessive proportions, create hypoxia zones in which survival of plant and animal life is difficult and hinder recreational activities like swimming and fishing. These nutrients have also been associated with blue baby syndrome (Giri, 2016)<sup>10</sup>. Pesticides are used everywhere that when released into the environment pollute surface water and groundwater. Upon Accumulation in water bodies, they kill off zooplankton which is a major source for some aquatic animals. Also, human life is at a greater risk of infections from pathogens like *Escherichia coli* and *Salmonella* sps. That are produced from livestock waste material. Such waste products act as manure for agricultural lands that is carried to waterways through leaching or runoff (FAO, 2017)<sup>7</sup>.

In U.K., farming practices contribute to sedimentation, nutrient enrichment and phosphorous concentration in water bodies (GFS, 2019)<sup>8</sup>. FAO reported that agriculture is the main reason for pollution of rivers and streams in US and European Nations (FAO, 2017)<sup>7</sup>. To stem this kind of pollution from non-point sources such as agriculture, some European countries have

framed a number of legislations like 'Clean Water Act' and 'European Union Water Framework Directive'. Additionally, the farmers in these countries have been persuaded to adopt less polluting measures by offering them different kinds of incentives.

### **Effect of Fertilizers**

Fertilizer is simply food for plants that helps to grow and thrive. When a plant doesn't get all the nutrients from the soil due to unavailability or being present in an unusual form, then fertilizers are added to the soil to provide plants with nutrients- mostly N, P and K. Fertilizer is useful for plant growth but excessive fertilization proves harmful for both plants and the environment. Excess fertilizer tends to run off into streams and lakes leading to eutrophication. Toxic algal blooms degrade the water quality and harm aquatic life by consuming oxygen from the water. High nitrate levels in water can also harm animals and humans. Nitrate form of Nitrogen is a common pollutant in surface and groundwater. It can easily penetrate deep inside the agricultural solids until it reaches the groundwater, which can lead to a disorder called 'methemoglobinemia' or 'blue baby syndrome'.

Fertilizers such as nitrogen and phosphorous even when present in small concentration pose a serious threat to surface water (Sharpley et al., 2011)<sup>25</sup>. They also have the tendency to make the groundwater unfit for drinking. Algal bloom and eutrophication are caused as a result of very low phosphorous, and nitrate-N concentration in surface water, leading to hypoxia and anoxia and biodiversity loss. In some areas, coastal eutrophication increases with the increase in N flows. This issue worsens further with the widespread use of urea fertilizer with high solubility and mobility. As many countries witnessed huge developments in industrialization and agriculture, major water bodies have suffered widespread pollution and contamination due to the application of large quantities of fertilizers (Zadeh, 2018)<sup>31</sup>.

Excessive nutrient concentrations in water gives rise to algal blooms, however, these algae die off as soon as they reach a certain threshold. Killing algae is no long-term solution to control HABs as the nutrient return to the water, and the same cycle continues, however, some studies suggest that if the biogeochemical cycle of macronutrients is expedited by having more plants in the water body ecosystem (Cuellar- Bermudez et al., 2017)<sup>5</sup>. Eucalyptus is one such plant that is considered to control algal blooms because of its greater capacity to absorb nutrients while at the same time it restricts other plants growing around (Sillet et al., 2015)<sup>27</sup>.

### **Conclusion**

It's important to have data of water quality spanning last several years before a new initiative is taken to upgrade water quality because it can be used as a reference against new data and to effectively track progress of water quality. But the problem death of such data on global scale which makes it difficult to monitor the enhancement in water quality in drainage basins (Metcalf et al., 2017)<sup>20</sup>. To model a framework that could actually reflect the problem at global scale, there is no real social, economic and political data that could be consolidated and made productive. To improve water quality, its recommended that untreated wastewater is not discharged directly into water and to control it strong environmental laws need to be framed and implemented. Awareness should be raised about the dangers of water pollution and all the

stakeholders like farmers, local group and NGOs should be encouraged to use cutting edge technology that is less polluting and affordable.

Since water is vital for the sustenance of life, its conservation and sustainable availability is of prime importance. Various anthropogenic activities have proved detrimental for water quality, of which pollution is the main problem that disturbs the whole ecosystem. Despite recent technological developments in India and the world that aim to mitigate the effects of pollution, some industries still discharge their toxic effluents directly into water bodies without any treatment. Thus, effective environmental policies with high degree of implementation in collaboration with multiple stakeholders can serve as a major step in the direction of water pollution control and restoration of its quality.

Toxic chemicals and other harmful compounds need to be prevented from moving into food chains and other systems of biodiversity. Antibodies, personal care products and other toxic pollutants in water bodies cannot be ignored. Different anthropogenic sources that are involved in water pollution must be identified and steps taken to safeguard water resources from pollution. Industrial effluents should be treated properly before they are disposed-off into different water bodies. Different remediation methods that are eco-friendly cost effective and sustainable in the long run need to be explored. Moreover, biological wastewater treatment system, a low cost and environmentally sustainable technology, can alternatively be used to mitigate the problem of water pollution. Bioremediation is another process that is economically viable and eco-friendly solution to environmental problems in which microorganisms like bacteria, yeast and algae are exposed for remediation of harmful contaminants. To conclude, extensive research for alternative technologies, continuous monitoring of water bodies and their pollution level and regulations are immediately needed to control water pollution.

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