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Implications of industrial effluents on surface water and ground water

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Abstract

The industrial discharge carries significant level of contaminants to the surface water and ground water. Whereas the quality of freshwater is very vital because is highly use by human for drinking, bathing, agriculture and other needs. The presence of contaminants from industries within the water may reduce the yield of crops and the growth of plants; it is also harmful to the aquatic living organisms, it alters the surface water and ground water quality. Industrial pollution is one of the major factors causing degradation of the environment, affecting the water we use, the air we breathe and the soil we live on. Hence, the pollution of water is arguably the most serious threat to current human welfare. This paper review elucidates reasons of contamination of surface water by the industrial effluents, highlights major causes of ground water pollution; the work also indicates some industrial discharges and their contaminants.

Keywords: Industrial effluents; Ecosystems; Pollution; Environment; Contaminants

1. Introduction

Effluents coming from different industrial and commercial establishments have being posing serious threats to the environment, particularly in urban and semi urban areas [1]. Meanwhile, it was estimated that approximately one-third (1/3) of the world's population are using groundwater for drinking purposes [2].

The discharge of effluents from pharmaceutical industries into the environment could easily lead to the contamination of surface water and ground water with diverse drug active ingredients, the long effect of which may be harmful to the health of those that use the water [3].

Due to recent industrialisation and ever increasing urbanisation, the quality of surface water and ground water has become a matter of major concern because of heavy metal contamination. Metals remain in contaminated sediments may accumulate in microorganisms which in return enter into the food chain and eventually affect human well being [4].

Contamination of water by trace metals is a serious health issue. Studies have shown that heavy metal toxicity leads to cardiovascular, neurological and renal problems; the main health hazards caused by chemical pollution of water are due to presence of nitrates fluorides, arsenic, cadmium, lead and other toxic metals [5].

2. Why always Surface water is the Victim of the Industrial Effluents

One of the major reasons as specified by Bassi *et al.* [6] is limited financial and technical support from the government that led to poor maintenance of few lakes while many lakes are completely neglected. Yet another important factor is

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the poor understanding about the link between water and ecological health, ecosystem services and human well-being [7]. As an outcome, many urban and rural lake catchments are encroached, ground water is over exploited and surface and ground water are polluted due to household and industrial discharges. Changing water quality has implication on livelihoods and well-being of lake dependent communities [8]. Untreated waste from industries has a number of reasons of not safely treated; One of the reasons is mainly due to the lacking of highly efficient and economic treatment technology [2]. Water pollution is a major problem in the global context, and it has been reported that it is the leading worldwide cause of deaths and diseases [9].

2.1. Ground Water and Surface Water Pollution

Groundwater pollution can be caused by three major sources according to TWAS [10] which are:

- Weathering of soil and rock minerals,
- Decomposition of organic materials and
- Industrial effluents, sewerage and municipal waste water.

Surface water is a vital source of irrigation, household usages. However, the discharges of untreated industrial wastes have been deteriorating the quality of the surface water.

Ground water is the most important source of drinking water. At present almost all depends on ground water for drinking purpose. According to Hossain, *et al.* [1] in a research titled; Impact of Industrial Effluents Discharges on Degradation of Natural Resources and Threat to Food Security found that the presence of insignificant proportion (4%) of untreated industrial effluent decreases the quality of ground water.

Copacui *et al.* [11] asserted in his study titled; Assessment of Industrial Effluents Quality and their Possible Impact on Surface Water indicated a seasonal variation for several parameters, dictated by the manufacturer' production schedule. Reported the quality of the studied effluents was below the limits set by UE and Romanian legislation. The total dissolved solids (TDS), sulphate, chloride and detergents content of the effluents were within the permissible limits for surface water discharge, while the other parameters exceeded the limits set by the legislation. The most significant permissible limit excesses were recorded in the printing effluents and the second textile proving that their discharge into some rivers or the sewage systems can seriously affect the aquatic ecosystems.

Various parameters of industrial effluents such as temperature, pH, total dissolved solids (TDS), electrical conductivity (EC) and heavy metal contents (i.e., Cr, Fe, Cd, , Cu, Mn, Pb, Ni and Zn) have been found higher than normal at the discharge point of the industries [12].

Muhammad *et al.* [13] asserted in the study which focused on analyzing industrial effluents originating from industrial estate of Islamabad (the capital city of Pakistan); where dominant tree-species of Islamabad such as *Grevillea robusta, Bauhinia variegate, Acacia modesta, Cassia fistula, Syzygium cumini* (Skeels), *Terminalia arjuna* (Roxburgh)*, Albizia lebbeck* (Benth), *Melia azedarach* and *Pongamia pinnata* were selected to examine the tolerance of these tree-species against industrial effluents; One year old uniform saplings of nine (9) selected species were transplanted into soil filled polythene tubes for the experiment. The collected samples of effluents were analyzed for water quality parameters such as pH, total dissolved solids, electrical conductivity and heavy metals concentration. The pH of effluent sample was low (acidic) whereas total dissolved solids and electrical conductivity were higher than described FAO standards for irrigation water. The results also indicated higher concentration of heavy metals (Pb, Mn, Cr, Cd, Zn, Mg and Ni) in the industrial effluents. Saplings were irrigated with assorted water treatments and their effects on shoot and leaf growth was observed; the analysis of the data showed decline in growth of all tree species irrigated with effluent based treatments. However, *Syzygium cumini, Acacia modesta, Melia azedarach*, *Albizia lebbeck* and *Terminalia arjuna* relatively performed better and indicated tolerance against industrial effluents. Therefore, Muhammad et *al.* [13] recommended that these species Dharek, Arjun, Jaman, Siris and Phulai, may be planted along industrial drains.

3. Industrial discharge and contaminants

The table below presents a summary of the some types of contaminants discharged from the industries in different parts of the world through random case studies by Ho *et al.* [2].

Table 1 Contaminants Discharge from Different Types of Industry and Location.

Location	Contaminant	Type of industry
Bangladesh, to Lagoon [14]	**Metalloid** As **Metal** Zn, Cu, Strontium (Sr), Pb, Nickel (Ni), Cr, Lithium (Li), Vandadium (V), Silver (Ag), Cobalt (Co), Selenium (Se) **Organic/inorganic matter and parameter** Biochemical oxygen demand (BOD), chemical oxygen demand (COD), electrical conductivity, pH, total alkalinity, total hardness, total organic carbon (TOC), Turbidity (Cl^-), total suspended solids (TSS) and total dissolved solids (TDS).	300 industries included textile, dyeing to plastics, metal fabrications, semiconductor goods, lather tanning etc.
Japan, to Nishitakase River [15]	2-[2-(acetylamino)-4-[bis(2-methoxyethyl) amino -5-methoxyphenyl]-5-amino-7- bromo-4-chloro-2-H-benzotriazole (PBTA-1)	Textile industry
Germany, to three rivers of North Rhine- Westphalia [16]	**Organic/ inorganic matter and parameter** (i) Chemical process site 1 Dichloroaniline Tetramethylbutanedinitrile Tributylphosphate Triethylphosphate Diisopropylnaphthalenes Benzoic acid 2,2,4-Trimethyl-1,3 pentanedioldiisobutyrat (TXIB) (ii) Meat production site and chemical site N, N-dibenzylamine 1-methyl-2-indolinone N,N-Dibenzylamine Triethyl phosphate (TEP) Trimethyl- and 4-tertbutylbenzoic 2-(Chloromethyl)-1,3-dioxolan 1-Methyl-2-indolinon, Trimethylbenzoic acid, Tris(chloro-propyl) phosphat (TCPP) (iii) Oil production sites and chemical complex Tributylamine, Dimethylpyridine,	Petrochemical site, paper production, meat production

	Dimethylpyrazine, Indole Methylindole 1-Ethylpyrrolidone Thioanisole Methylphenyl sulfone, TCPP, Isomer 1 TCPP, Isomer 2 C1 Benzoic acid C2 Benzoic acid 2,4,6-Trimethylbenzoic acid	
Kingdom of Saudi Arabia, to Red Sea [17]	**Metal** Cd, Cr, Cu, Iron (Fe), Ni, Pb, Zn, Aluminium (Al), Barium (Ba), Molybdenum (Mo), Strontium (Sr) **Organic/ inorganic matter and parameter** Benzene, styrene, toluene, indene, Naphthalene, 1, 4-dioxane, Ethyl Benzene, Xylene	Two petrochemicals, three Refineries
India, to agriculture field [18]	**Metal** Cd, Cu, Fe, Ni, Pb, Zn **Organic/ inorganic matter and parameter** BOD, COD, TDS, dissolved solids (DS) Chloride, sulphate, phosphate	Paper Industry
India, to Uppanar river [19]	**Metal** Fe, Mn, Pb, Zn, Cu, Ni, Cr, Cd , Co **Organic/inorganic matter and parameter** DO, COD	Chemicals, beverage manufacturing, tanneries, oil, soap, paint production, paper, and metal processing plants
Croatia, to Sava River [20]	**Metal** Fe, Zn, Cu, Ni, Pb, Cr	Pharmaceutical and food Industries
India, to Bandi River [21]	**Metal** Cu, Fe, Zn and Mn **Organic/inorganic matter and parameter** TDS, TSS, COD, BOD, chlorides, sulphates, carbonates and sodium, calcium and magnesium	Dyeing and printing industries
Malaysia, to Juru River [22]	**Metalloid** Arsenic (As) **Metal** Chromium (Cr), Cadmium (Cd), Zinc (Zn), Copper (Cu), Lead (Pb), Mercury (Hg)	Chemical products Papers and printings Batteries Electroplating Textile and leathers Fertilizers, pesticides, insecticides

	Organic/ inorganic matter and parameter Phosphate (PO_4^{3-}) Ammonia (NH_3) Nitrate (NO^{3-}) Sulphates (SO_4^{2-}) Chloride (Cl^-) Aluminium (Al)	Plastic-based products Rubber-based products Wood based products Electric and electronic industries Cosmetics Fungicides Fluorescent lights Dental amalgams Art supplies Mining and siltation Cement and cement products Iron, steel and tin workshops Welding fumes Medical equipment Smelting plants Metal fabrications Oil refineries Quarries Beverages and food
India, to unlined lagoon [23]	**Organic/ inorganic matter and parameter** Sodium, chloride, calcium, COD, BOD	Cystine production industry
Bompai-Jakara drainage basin Kano [24]	**Metals** Zn, Pb, Cr, Fe, Cu	Industrial effluents, wastewater from tributaries, domestic wastewater

The study shows that most of the industrial discharge carries toxic substances. Due to the presence of high amount of toxic, carcinogen, and teratogen of heavy metals, researchers are highly concerned with its effect on the environment and health of mankind.

4. Conclusion

A clean and healthy environment is important for the survival and well-being of living organisms. Ecosystem is degrading gradually due to heavy industrialisation; contaminants from various industries have damaging effects on both flora and fauna.

Therefore, industrial effluents need to be treated properly before their discharge into sewerage network or the surface water in order to minimise their effect on the terrestrial and aquatic ecosystems.

Compliance with ethical standards

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Disclosure of conflict of interest

All authors declare that they have no conflict of interest.

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