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Short Note

Impacts of Industrial and Agricultural Chemical Wastes on Freshwater Resources

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Abstract

Freshwater is essential for the survival of man, and other living organisms but it is being impacted by human activities such as industrialization and chemical agriculture. This article discusses the potential impacts of the discharge of industrial wastes and the excessive use of agricultural chemicals for the cultivation of plants and crops on freshwater resources. Surface and ground waters get heavily polluted. Also, it briefly reviews a few cases of contamination of water bodies and the serious threats they pose. Probable recommendations that could alleviate the problem of the industrial and agrochemicals water pollution and the threat they pose to the environment are also proffered.

INTRODUCTION

Unlike saltwater, freshwater has a better potential of being used for man's consumption and supporting life. It provides a wealth of aquatic resources, such as animals that serve as food for man. Freshwater is also used for agricultural purposes, particularly for irrigation and feeding livestock. Meanwhile, from the hydrosphere that occupies about 70% of the Earth, less than 3% is freshwater and most of which are not even accessible. Over 68% of it is found in icecaps and glaciers; about 30% is found in the ground, and just about 0.3% found in the form of lakes, ponds, rivers and swamps. This little fraction is at man's disposal and supposed to be for our consumption and usage [1]. But it is very disheartening that it is being polluted due to anthropogenic activities. The worse of it is that even the groundwater that is more abundant and supposed to serve as a reserve source of freshwater is not excluded from the pollution [2].

Industrial activities and the practice of agriculture (which involves but not limited to the cultivation of crops) have been proven to be the significant causes of the severe environmental degradation [3,4]. They cause the pollution of ground and surface waters. Growing industries at the present times (with the use of wide range of industrial chemicals) and the metamorphosis of agriculture to its present stage (of massive use of agrochemicals for the sake of protecting plants and increasing crops yield) have caused direct and indirect contamination of freshwater resources. Industrial effluents discharged directly to surface water bodies, and agricultural soils being exposed to contamination by the agrochemicals wastes [5]. The agrochemicals, be it pesticide or fertilizer become wastes when after serving their purposes, are left as residues in the soil, constituting means of polluting water bodies.

FRESHWATER POLLUTION CASES

The Impacts of Industrial Wastes

Despite the fact that industrialization has brought some kinds of comfort and technology to mankind, it still has some negative sides, water pollution being one of them and having significant impacts on the health of the environment, particularly water resources.

Wright et al., examined the impact of the industrial effluent discharge on Coxs River [6], a freshwater source and part of the water catchment for Sydney's drinking water supply. Multivariate analysis of the resident macro-invertebrates in terms of their several species, families and orders were used as the measure of the degree of the water quality. It was found that, compared to the reference sites which were used for the study; the taxonomic richness of the sampled macro-invertebrates from the river was significantly low. This served as an indication of severe water contamination and serious ecological impairment that had possibly created a toxic environment for the inhabitants. Such water when consumed without quality treatment could result to serious health hazards, though may not be immediate.

Shah et al., assessed the level of heavy metals (lead, chromium, zinc, nickel, copper, cadmium and cobalt) contamination in Tapti estuary situated in an area of growing industrial activities in Surat, India [4]. Tapti River has been serving as a major source of domestic, irrigation and industrial water supply to the surrounding communities. Four sediment sites S1, S2, S3 and S4 from the river were analysed, and the assessment of the level of contamination was based upon Enrichment Factor (EF). The EF evaluates the relative abundance of the toxic metals introduced into the sediments compared to the background and gives the insight into the measure of the pollutants introduced into the sediments anthropogenically, especially via industrial pollution. Results (Table 1) shows that all the investigated sediment sites had been enriched with each of the pollutants investigated [4].

Cd is with minor enrichment while Pb, Zn, Ni and Cu, Cr and Co are all severely enriched. The enrichments are attributed to wastes inputs; particularly of industrial origin. The impact of these accumulated pollutants could be devastating. They would make the water toxic for consumption causing different ailments and deaths [7,8]. And the cost of the water treatment for township supply may be high.

Wang et al., showed that industrial water pollution and exposure to polluted water have a direct influence on the health of human being [9]. They examined the effect of industrial water pollution on the residents of diverse cities of China over a period of three years by studying the general mental and physical health status of their subjects. They found that industrial water pollution deteriorated both the mental and physical health of their subjects. Also, they found that the mental and physical health of their subjects deteriorated proportionately with the intensity of water pollution.

The Impacts of Agricultural Chemical Wastes: Fertilizers and Pesticides

Accumulation of chemical pollutants in water bodies could also be caused by agrochemical wastes discharge. Water pollution in this case basically aided by rainfall or snowmelt. Water in this situation becomes the carrier of the agrochemical wastes constituting nutrients, pesticides and toxic metals [10], moving them over and through the ground, and finally depositing them into lakes, rivers, wetlands, coastal waters and groundwater systems [11].

It is a well-known fact that inorganic fertilizers contain traces of toxic metals. Although the concentration of the toxic metals may be insignificant at each time of transport, with time accumulation can occur which could cause the serious contamination of the surrounding water bodies and constitute a huge environmental threat.

Tang et al., studied the sediments of estuaries very close to an agricultural region of Cholhu Lake Valley in China and found that Cd, Pb and Zn had accumulated dramatically in those sediments due to long-term intensified agricultural cultivation that involved the intensive application of fertilizers [12]. They also detected that the risk associated with the metals, which is a measure of their exchangeable and carbonate bound forms of metals that had been increased. The metals were significantly bioavailable and pose a very serious threat to the inhabitant organisms and even mankind.

Eutrophication is another potential environmental problem that could be caused by indiscriminate use of fertilizers, especially close to freshwater catchment areas. It is usually caused by nutrients enriched runoffs finding their ways into surface waters. The nutrients could cause algal blooms which could be harmful to the aquatic environment in two ways: produce harmful metabolites that can directly kill wildlife or poison seafood; accumulate biomass such that it affects co-occurring organisms and alter food web dynamics [13]. The biomass could shade sea grasses that provide nesting and foraging areas for a variety of aquatic animals, depriving them of light needed for their survival. The combined harms could cause the massive death of sea grasses, fishes, shellfishes, corals, seabirds and some other aquatic animals. They could decompose using the available oxygen in the water and causing hypoxia. Hypoxia could further aggravate the devastating condition in the water. Usually, waters affected by algal blooms become poisonous, develop foul taste and odour making it unpleasant for recreation and toxic for human and farm/domesticated animals' consumption.

Bulut and Aksoy gave an instance of Lake Uluabat in Turkey [14]. The lake that was considered a potential potable water source became deteriorated after some years. There was a manifestation of fish deaths because of dissolved oxygen deficiency. The deterioration was attributed to drainage from agricultural lands. Overall, the impact declined the population of aquatic organisms and caused diminished biodiversity in the aquatic environment.

A similar scenario applies to pesticide. Their availability in soils as residues is a big deal as far as water quality is concerned.

Komrek et al., presented a case of viticulture in Europe that involved the application of inorganic copper pesticides [15]. On the long run, there were concerns about the presence of the pesticide residues in water meant for human consumption and even the wine products. The consistent and long-term application of the pesticides had caused extensive copper accumulation in the plantation soils and got washed away to nearby water bodies via several hydrological cycles.

Groundwater was the principal source of drinking water of the local inhabitants of Akker in northern Lebanon due to the absence of public networks for water distribution. Meanwhile, Akker was known to be one of the largest agricultural regions in Lebanon. Chaza et al., analysed the groundwater in the region and found it highly contaminated with organochlorine, organophosphate and organonitrogen pesticides [16]. The groundwater contamination

Table 1: Enrichment Factor values for the toxic metals in the sediments from Tapti River estuary.

	EF						
	Pb	**Cr**	**Zn**	**Ni**	**Cu**	**Cd**	**Co**
S1	5.49	39.87	12.54	20.73	13.81	1.93	35.73
S2	5.09	64.50	19.50	24.17	14.97	2.28	40.49
S3	5.21	51.71	17.92	24.44	13.98	2.31	33.30
S4	4.49	41.46	13.41	24.53	12.30	2.80	34.31

in the area was attributed to the crops cultivation (characterized bythe huge application of pesticides) and the susceptible nature of the land to groundwater contamination. As reported, by Chaza et al., the land is karst with little or no soil cover which led to poor pre-purification of the groundwater and rapid downward movement of the pesticides up to the aquifer.

Panuwet et al., reported Thailand's application of pesticides for crops cultivation from 2000 to 2010 [17]. The application within the stipulated time range was almost always on the increase on yearly basis. Pests resurgence and the pressure to meet up with market demands even at off season-periods are mentioned as reasons for the yearly pesticide increase. When pests' resurgence against a pesticide occurs, a larger dose of the same pesticide may be required to again put the pests back to check. Resurgence could, however, be continuous; meaning more quantities of pesticides would always be required after each resurgence. May be Thailand's situation applies to some other developing countries. But does it really make sense if the resurgence of pests forces us to increase the application of pesticides to the detriment of the health of mankind and the environment as a whole?

PROBABLE PROBLEM SOURCES

Developing countries are the main sufferers of industrial water pollution. This is because there is lack of strict pollution control policies or weak institutional frameworks to properly implement the available policies [18,19]. Also, many of the industries in these countries lack modern and efficient technologies for the treatment of their effluents [20]. On the part of agricultural chemicals pollution, illiteracy of farmers has long been a problem of agriculture. So, they may have little knowledge about the probable consequences of the indiscriminate application of agrochemicals. This could be a contributing reason for agrochemical water pollution. Even households are guilty of the unthoughtful application of pesticides for weeds control, having little knowledge of how best to apply and the possible risk involved. Unregulated farming activities and open market for agrochemicals might have also contributed. With anyone having unrestricted access to these chemicals and with weak or no regulations guiding the usage, the application may become wild and probably lead to pollution of the surrounding freshwaters.

Meanwhile, some countries had experienced familiar problems at the earlier times. Kathuria reported the success stories of Malaysia, Colombia and Poland from their respective histories of freshwater pollution caused by growing industrialization [18]. They were able to surmount or significantly alleviate the water pollution problems through the employment and proper enforcement of some helpful command and control based policies. They established industrial effluent guidelines for meeting water quality goals, issued out marketable pollution licenses and limits, and fined guidelines violators. The active enforcement of the policies was key to the overall improvement of water pollution issues in these countries, as industries were indirectly compelled to upgrade their effluents treatment equipment to more efficient ones. Developed countries such as United States of America and European Union countries use a similar approach known as Polluter Pays Principle [21,22] where by defaulters of effluent standards [23] are taxed and charged for pollution behaviours in order to checkmate different kinds of industrial pollution.

Another success case in Aalborg was reported by LIFE-Environment [24]. Similar to the groundwater pollution problem experienced in Akker [16], the groundwater catchment areas in Aalborg were deteriorating due to contamination with pesticides and nitrates. The groundwater pollution might have resulted due to the soil's inadequate attenuation capacity against the subsurface contaminants or long-term accumulation of the attenuated contaminants [25]. However, it took regular monitoring of the groundwater quality in the area to detect the deterioration. Plans were put in place for the immediate implementation of sustainable land use in the areas which involved the discontinuation of conventional agriculture (involving the use of agrochemicals) in those areas. This in order to arrest the upward trend in the nitrate and pesticide levels in the groundwater, and protect permanently from further and future contamination.

CONCLUSION AND RECOMMENDATIONS

As maintaining the good quality of freshwater is important, so are industrial activities and crops cultivation. But in the process of the industrial activities and crops cultivation, there is need to take the safety of the environment into consideration, because that also directly or indirectly determines the health of the growing population of mankind.

To minimize the impact of industrial water pollution especially in developing countries it may be necessary for the concerned government authorities to ensure the availability of related working and highly motivated institutional frameworks to properly enforce the available regulations or policies guiding industrial wastes or effluents disposal into water bodies. Evaluation of the policies that are already in place from time to time may also be of help, in case they may need some adjustments or optimization for better results. Also, developing countries may learn from success stories of some other countries and import some of the policies, ideas and methods that may be applicable to their respective situations.

Professionalizing agricultural practices and placing under the supervision of the government may help solve some problems. The more organized farmers can be trained via regular seminars and workshops on the safe and lenient application of agrochemicals such that the environmental risks involved can be minimized. Work ethics be can be clearly defined, monitored and geared towards safe guarding the environment for this generation and the generation to come. Furthermore, restricting the access to agrochemicals to the trained farmers should checkmate wild application and further minimizethe associated environmental risk.

Also, government sponsored research may be intensified in the areas of both integrated pests' management (IPM) and cultural practices associated with crops cultivation, as substitutes for massive and continuous application of synthetic pesticides and fertilizers, and the knowledge should be communicated to the body of farmers.

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