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A Review on the Pollution and Phytoremediation of Romi Stream

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Abstract: *Romi stream receives effluent from Kaduna refinery which is believed to endanger the lives of the fauna and flora of the stream and even the inhabitants of Rido community, Researchers have make series of researches on the possible remediation of this pollution with phytoremediation being at the fore. This Review gives information on Pollution cases in Romi stream and bioremediation studies of Romi Stream.*
Keywords: *Effluent, Flora, Fauna, Rido Hausa, Heavy metals*.

I. Introduction

Since the beginning of the industrial revolution, water pollution by toxic metals have accelerated dramatically. According to Nriagu (1996) about 90% of the anthropogenic emissions of heavy metals have occurred since 1900 AD; it is now well recognized that human activities lead to a substantial accumulation of heavy metals in water on a global scale. Man's exposure to heavy metals comes from industrial activities like mining, smelting, refining and manufacturing sprocesses (Nriagu, 1996). A number of chemicals, heavy metals and other industries in the coastal areas have resulted in significant discharge of industrial effluents into the coastal water bodies. These toxic substances are released into the environment and contribute to a variety of toxic effects on living organisms in food chain (Dembitsky, 2003) by bioaccumulation and bio-magnification (Manoharet al., 2006).

Refinery effluents can seep into aquifers and pollutes the underground water or where it is discharged without proper treatment into water bodies, the pollutants cannot be confined within specific boundries (Asamudoet al., 2005; Nayyef and Amal, 2012). They can therefore affect aquatic lifes in enormous ways.

Since the commissioning of Kaduna Refinery in 1980, there have been notable changes in the physical and chemical qualities of the stream, which have been suspected to cause corresponding decline in fishery and agricultural potential of the area. Hence the need the need to assess the changes cause as a result of this effluents and the possible ways of further remediating this effluents

1.1 Romi Stream

Romi Stream is one of the tributaries of River Kaduna; it is located in the southern part of Kaduna metropolis between latitude 10º to 11º North and longitude 7º to 8ºEast, River Romi follow a course of about 16.4 km. It is characterised for most part of the yearly high salt concentration, low current velocity and low water level particularly during the later part of dry season.

The stream is usually used for both domestic and agricultural purposes. It is a major source of drinking water for both the in habitant of Romi, Ridochuduku and Rido Hausa settlement. In addition, this settlement depends on the stream for small scale fishing, dry season irrigation and a sources of drinking water for their animals.

Beside the possible danger of enriching the stream with excessive nutrient from agricultural activities that takes places along its banks, Romi stream receive effluent from Kaduna Refinery and Petrochemical Company.

II. Pollution Cases In Romi Stream

According to the Refinery construction engineers (Chioda Japan), the complex was designed with environmental safety in mind. It was therefore deliberate to minimize pipe-length to facilitate quick delivery of products from one process section or unit to another; as it is not advisable to transport highly viscous fluid over a long distance of time. To achieve this, intermediate tanks were placed close to various process units; thus using minimum length of pipe, which to a large extent reduces the risks of broken pipes and probable spillage.

Despite the knowledge of the wastes to be generated by the Refinery as contained in the Chioda Engineering manuals, there had not been an Environmental Impact Assessment (EIA) of the Refinery operations prior to the construction of the Refinery in 1979. Similarly, the addition of a Lube Plant in 1988 was also not preceded by any EIA as required by law. The only environmental report traceable by our consultancy firm was an Environmental Audit of the Refinery carried out in 1982 by a British Firm called Oil-Mop Inc. The audit as expected indicated normalcy in the Refinery operations in regard to its surrounding ecosystem. It

Showed out that all the parameters it investigated were within the allowable limits of the WHO (1993). A review of the audit by our environmental firm suggested that the timing of the audit was inadequate, as it was

done pretty early for the ecosystem to start showing any sign of degradation, as it's proven by science that a minimum of five years is needed to over-stretch the pollution threshold capacity of a host ecosystem of an oil Refinery (Harvath *et al*., 1994).

A World Bank sponsored study of the pollution case of river Kaduna in 1988 was the first empirical evidence which suggested that the Refinery was polluting river romi; which is the medium of "treated" waste water discharge by the Refinery. The result indicated that out of the 37 sampling sites studied the point at which river Romi entered into the Kaduna River is the one having the highest pollution load, which was attributed to the effluents being discharged from the Refinery through the Romi River.

Since then, there had been several academic researches on the pollution incidence of the Refinery on its host Ecosystem. Almost all the researches have indicted the Refinery in one way or the other in polluting it's host ecosystem. A climax of these academic researches was a doctoral study carried out in Ahmadu Bello University between 2001 and 2003. The work studied soil, water, vegetation and human health around the Refinery and compared it with the waste products and operational practices of the Refinery using a scientific tool called Ecological Risk Assessment Method (ERAM) that was developed by American scientists in 1991.

The study indicated that the Diagnostic, Compliance and Warning Indicators were well above the acceptable limit and concluded that the Refinery was impacting negatively on the host ecosystem and communities especially those living adjacent to the Refinery (Alamin, 2013).

Lekwot *et al.* (2014) reported difference of pollutants concentration at the three sampling points used. These studies later concluded that the waste released into the river from the refinery contaminates the water due to the fact that most of the parameters measured were higher than the acceptable limit set by National Standard Nigeria and World Health Organization. Lekwotet al., (2014) also found that these pollutants present in the river reduce the effects of solar energy absorption, resulting in a lower rate of photosynthesis and slows down natural water purification processes and the long effect of this is environmental degradation, similar result was reported by Alkasinet al., (2013).

Chikogu *et al.* (2012) reported high levels of heavy metals such as lead, mercury, cadmium, copper and chromium emanating from the effluents discharged by the Kaduna refinery.

2.1 Effect of Refinery Effluents on Aquatic Organisms

Most people are familiar with the devastating environmental impacts of industrial waste, one of the major effects of which is to pollute water and cause harm to, or even the death of aquatic wildlife. Previous studies of these processes have tended to focus on species that spend their entire lives in the water--fish, for example. However, there are some aquatic organisms that only dwell in the water for a portion of their life cycle. Many invertebrates, for example, spend their larval stage in streams and rivers, but, once they emerge, move onto land or the air just above it. There, they are an important source of food for species such as birds, bats, and other arthropods--including spiders (Laverock *et al*., 2014) .

Recent work by collaborators from the University of Sheffield has investigated the possibility that, by diminishing numbers of aquatic insects available for consumption, aquatic pollution can negatively impact predatory spiders. Although this possibility has been investigated in short-term experiments performed in a laboratory setting, the current study is the first to look at the effects of long-term pollution on entire populations of these animals (Laverock *et al*., 2014).

The researchers performed their study in England's Yorkshire coalfield region, where many streams are polluted by iron-rich runoff that discharges from abandoned coal mines. The iron forms compounds with other elements in the water, yielding a sludge known as ochre; this smothers the stream bed and reduces both the abundance and productivity of the aquatic insects that make up a vital component of riparian spiders' diets (Laverock *et al*., 2013).

The scientists focused on 15 polluted streams that had received coalfield runoff for at least 10 years and were anywhere from 100-1000 m long. Each of these polluted aquatic sites was paired with a nearby "healthy" partner located in similar habitat. Within each of these pairs, the researchers compared the density and biomass of aquatic insect larvae, emerged aquatic insects, other terrestrial invertebrates that might be an alternative food source for spiders, and the spiders themselves. They also measured a variety of habitat variables just to make sure that their results weren't impacted by habitat-specific differences in things like canopy cover and dominant plant species (Laverock *et al*., 2013)

On average, aquatic insect larvae were 88% less abundant, and had 80% less biomass, in polluted streams. Ugya. (2012) also reported the absence of macro fauna in a sampling point which is about 500 meters away from Kaduna refinery effluent point.

2.2 Impacts of Water Pollution

The extent of anthropogenic environmental pollution in the developing world is well documented (Mattina*et al*., 2003). Among overall environmental pollution, water pollution is one of the major threat to public health especially in developing and under developed countries as drinking water quality in these countries

is poorly managed and monitored (Mwegoha, 2008; Azizullah *et al*., 2011). Both surface and ground drinking water get contaminated with coli forms, toxic metals and pesticides. About 2.3 billion peoples are suffering from water related diseases worldwide (UNESCO, 2003). The presence of heavy metals (elements with an atomic density greater than 6 g/cm) is one of the most persistent pollutants present in water. Unlike other pollutants, they are difficult to degrade, but can accumulate throughout the food chain, producing potential human health risks and ecological disturbances (Akpor and Muchie, 2010). In developing countries, more than 2.2 million people die every year due to drinking of contaminated water and inadequate sanitation (WHO and UNISEF, 2000). In general, water pollution has served impacts on the quality of fresh water and aquatic system. Water pollution also has negative impacts on food production, heath and social development and economic activities. Poor quality of surface and groundwater has become a threat to supplies of drinking water throughout the world (World Bank, 1998). In general, the decreasing availability of safe and healthy drinking water due to pollution, in terms of quality and quantity has been a major health concern in South Asia.

Chikogu *et al.* (2012) reported high levels of heavy metals such as lead, mercury, cadmium, copper and chromium, this heavy metal get into man by either eaten or drinking (Sabine and Wendy, 2009). Below is the health effect of some selected heavy metals:

2.2.1 Cadmium

Cadmium and cadmium compounds are known human carcinogens. Smokers get exposed to significantly higher cadmium levels than non-smokers. Severe damage to the lungs may occur through breathing high levels of cadmium.

- Ingesting very high levels severely irritates the stomach, leading to vomiting and diarrhea.
- Long-term exposure to lower levels leads to a buildup in the kidneys and possible kidney disease, lung damage, and fragile bones. (Sabine and Wendy, 2009)

2.2.2 Mercury

The EPA has determined that mercuric chloride and methylmercury are possible human carcinogens.

- The nervous system is very sensitive to all forms of mercury.
- Exposure to high levels can permanently damage the brain, kidneys, and developing fetuses. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems.
- Short-term exposure to high levels of metallic mercury vapors may cause lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

(Sabine and Wendy, 2009).

2.2.3 Chromium

Chromium (VI) compounds are toxins and known human carcinogens, whereas Chromium (III) is an essential nutrient.

- Breathing high levels can cause irritation to the lining of the nose; nose ulcers; runny nose; and breathing problems, such as asthma, cough, shortness of breath, or wheezing.
- Skin contact can cause skin ulcers. Allergic reactions consisting of severe redness and swelling of the skin have been noted.
- Long term exposure can cause damage to liver, kidney circulatory and nerve tissues, as well as skin irritation (Sabine and Wendy, 2009).

2.2.4 Lead

EPA has determined that lead is a probable human carcinogen. Lead can affect every organ and system in the body. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system; weakness in fingers, wrists, or ankles; small increases in blood pressure; and anemia.

- Exposure to high lead levels can severely damage the brain and kidneys and ultimately cause death.
- In pregnant women, high levels of exposure to lead may cause miscarriage.
- High level exposure in men can damage the organs responsible for sperm production (Singh, 2003).

2.3 Phytoremediation of Romi Stream

Several technologies are available to remediate water that is contaminated by heavy metals. However, many of these technologies are costly (e.g. excavation of contaminated material and chemical/physical treatment) or do not achieve a long-term nor aesthetic solution (Mulligan *et al*., 2001). Phytoremediation can provide a cost-effective, long-lasting and aesthetic solution for remediation of contaminated sites (Ma *et al*., 2001).

The principles of phytoremediation system are to clean up contaminated water, which include identification and implementation of efficient aquatic plant; uptake of dissolved nutrients and metals by the growing plants; and harvest and beneficial use of the plant biomass produced from the remediation system (Lu, 2009). The most important factor in implementing phytoremediation is the selection of an appropriate plant (Roonngtanakiat *et al*., 2007; Stefani *et al*., 2011), which should have high uptake of both organic and inorganic pollutants, grow well in polluted water and easily controlled in quantitatively propagated dispersion (Roonngtanakiat *et al*., 2007). The uptake and accumulation of pollutants vary from plant to plant and also from specie to specie within a genus (Singh *et al*., 2003). The economic success of phytoremediation largely depends on photosynthetic activity and growth rate of plants (Xia and Ma, 2006), and with low to moderate amount of pollution (Jamuna and Noorjahan, 2009). Research by Bako *et al*. (2008) shows strain of Pseudomonasaerugenosa and Penicilliumjanthinellum can effectively be use in the bioremediation of Refinery effluents.

Ugya *et al*. (2015a) and (2015b) shows the efficiency of *Pistia stratiotes* and *Eicchorniacrassipes* to remove heavy metal from Romi stream. Similarly, Ugya (2015) shows the efficiency of *Lemna minor* L. In the phytoremediation of Romi stream, Ugya and Imam, (2015) reported that Romi stream could be effectively remediated using *Eicchornia crassipes* this result is almost similar to the result obtain by Ugya *et al*. (2015c) who stated that *Pistia stratiotes* can effectively be use in the phytoremediation of Romi stream.

III. Concluding Remarks

Studies reveals the potential health threat cause by the presence of heavy metals in Romi stream and the danger it pose to man and animals, as their mean values are far and above the World Health Organization maximumpermissible limits.

Since it has been observed that phytoremediation of wastewater using the floating plant system is a predominant method which is economic to construct, requires little maintenance and increase the biodiversity. Many researchers have used different method of bioremediation and phytoremediation in Romi stream although treatment capabilities depend on different factors like climate, contaminants of different concentrations, temperature. The removal efficiency of contaminants like TSS, TDS, BOD, COD, EC, hardness, heavy metals, etc varies from organism to organism. It is therefore recommended that Kaduna refinery and petyrochemical company should be force to collaborate with universities, research institutes and other environmental protection agencies to create voluntary teams to address questions like agronomic and microbiological practice needed for successful establishment of flora; identification of locally available plant species for specific remediation requirements and expansion of these plant species at local and national level.

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