

Status of Heavy Metals and Pesticides in Yamuna River: A review

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Abstract: Water is essential for all forms of life and rivers are the main source of surface water. Mostly civilizations were developed on the bank of rivers but now days the conditions of rivers are very bad. Due to rapid increase in population, rapid industrialization and mismanaged agricultural practices are deteriorating the water quality of rivers. Most of the small rivers which are considered as tributaries of main rivers like the Ganga, Yamuna, Narmada etc are dried or converted as dumping site for the waste. This river is suffering from heavy pollution load and almost considered as a dead river in the Delhi NCR stretch. In present article attempts are made to review the condition of Yamuna river in Delhi NCR.

Index Terms- Water quality, Pollution, River, Waste

1. INTRODUCTION

The right to have safe water for drinking and for other domestic usage like bathing, cooking, washing, etc are right of human which is legally defined by the UN Committee on Social, Cultural and Economic right. *Article 21 of the Indian Constitution also guarantees the right to life; define by the Supreme Court of India to include the right to a pollution free environment and safe drinking water.* Out of 122 countries, India ranks 120th in terms of water quality. There is violation of human right, at least 20 Crore Indian citizens are devoid access to safe drinking water. About 90% of water resources in India are contaminated with pesticides, fertilizer, untreated industrial and domestic waste (*Source: FIAN International- Investigating some alleged violation of human right to water in India*).

Lotic ecosystems are of great environmental importance and harbours diverse type of species, biodiversity units that support social and economic functions. Crop irrigation, navigation, hydropower energy generation and industrial uses has imperative requirement of clean river system. The total fresh water available on the earth surface in flowing rivers, lakes, ponds and streams excluding polar ice caps account to 0.008% of the total water available on the earth surface. This limited water resource are getting scares everyday due to anthropogenic activity, discharge of sewage, industrial effluents, filth, muck and agricultural runoff. It is estimated that 1,900 billion cubic meter per annum water is available in India for various usage, off this 86% is from the surface runoff. According to scientist at the Nagpur based National Environmental Engineering and Research Institute (NEERI), about 70% of the water in India is polluted. Community wastes generated from the rural and urban settlement are four times the waste water from an Industrial effluent. Most of this waste water generated is discharged untreated in lotic water systems mainly the rivers. In our country we have 217 partial and 8 full sewage treatment facilities out of 3,119 towns and cities which is less than one third of the urban population. This accounts for 1/3 of all illness, which is water borne such as typhoid, jaundice, diarrhoea, cholera and dysentery. In Indian scenario, water pollution is reported all over India due to industrialization, urbanization and mismanaged agricultural practices. In industrialized and urbanized area the main source of water pollution are discharge of untreated effluents laden with heavy metals like Cr⁺, Ni, Ar, Hg, Zn, Fe, Mn etc in nearby water bodies (Rai et al 2016). In the urbanized area usage of pesticides like DDT, HCH, BHC, OC, OP etc were detected in drains and sewer coming from hospital and residential area due to application of pesticides for control of insect and vector borne diseases (Rai et al 2012). The other major heavy metals pollution in surface water is from agricultural runoff and leaching from the soil.

In India extensive and over usage of pesticides has resulted bioaccumulation and biomagnifications in higher vertebrates and flora. The presence of pesticides has been established in surface and ground water samples in Yamuna and Hindon River basin in Delhi and NCR region. With reference to human health both pesticides and heavy metals hampers hormonal production and functions and effect endocrine system. In young children symptoms like undergrowth and maturation impairment has been reported if feed with water containing heavy metals. These pesticides and heavy metals also act as carcinogens and causes cancers. Organo – chlorinate (OC) pesticides affects the Central Nervous System (CNS) by interfering with neuro-transmitters and causes neurological and behavioural disorder (Tilwankar et al 2016).

2. HEAVY METAL AND PESTICIDES IN WATER OF INDIA

As per the WHO, 1990 the pesticides are cosmopolitan in distribution worldwide and exposure to pesticides have potential health effect, which cannot be neglected. There are about 1 million death worldwide and chronic diseases due to pesticides poisoning annually (Environ Forum 1999). The bald eagle population in United State has declined due to DDT and its metabolites DDE

causes eggshell thinning (Liroff, 2001). Based on the survey conducted by WHO (2000) over 5 lakhs peoples died in southwest Asia and Western Pacific from self-harm caused by Pesticides. In Kerala state, 1958 about 100 people died after consuming wheat flour contaminated with parathion (Karunakaran, 1958). A study conducted by European Union in 1996 shows presence of seven pesticides and two groups pesticides (Benomyl group and Maneb Group) in strawberries, grapes, tomatoes and apple. During the survey for ground water contamination in Bhopal city samples were drawn from wells and hand pumps, which shows 58% contaminated with OC level above EPA standards (Kole and Bagchi, 1995).

Pesticides effects were also reported altering soil properties. It has been reported by (Kelly and South, 1978) pesticides like oryzalin and trifluralin inhibit growth of mycorrhizal fungi which fix nitrogen in soil. World Bank conducted study in 1992 established that in Indian Environment degradation and health cost amount to Rs 24,500 Crore annually, which was 4.5% of the Gross Domestic Product (GDP). It has been reported that the people in Delhi have highest DDT levels in their body fat (Rai et al 2016). Based on the study conducted by CSE, DDT and HCH residues are present in Delhi water, soil and fauna. In 1978 in Bombay 2000 people are affected by jaundice due to pollution of water in main supply. Bombay's Minamata reported in 1978 and 1979, occurs due to industrial effluents discharges in Kalu River carrying heavy metals like mercury, lead, copper, and cadmium, chloride, dyes, organic acids, etc. The mercury level reported at effluents discharge points in Kalu river has level of mercury equal the Minamata Bay, Japans (*Source: The First Citizen's Reports, 1982*). In 1950 and 1960's Minamata disease occurs in Japan due to ingestion of fishes having Methyl mercury (Tsubaki et al, 1978) reported that it resulted in 1000 cases of poisoning, 3300 suspected cases and 100 death.

There are various research work carried at the global levels, which are showing that the earth water resources are depleting at alarming rate, polluted and rendered un-portable for human consumption. By the year 2025 it is expected that two-third of the world's population will be face water crises. Based on UN surveyed reports, by 2025 India is expected to face water stresses and serious water shortages (UN Climate Report, 2014).

3. HEAVY METAL AND PESTICIDES IN YAMUNA WATER AND VEGETABLES IN AROUND DELHI

Yamuna river, the lifeline of Delhi, originated near Banderpoonch from Yamunotri glacier in the Mussouries range of the lower Himalayas enters Delhi near Palla village (Haryana – Delhi boundary) to it's exists point at Kalindi Kunj barrage (Delhi – Uttar Pradesh) after traversing a route of about 224 Km. In Delhi state, Yamuna River traverse through 22 km, which is 2% of the total Yamuna stretch and account for 80% of the pollution load. As per CWC, 2009 report, approximately 85% of the river pollution is contributed by domestic source. As per CSE, 2009 survey the river is devoid of water for virtually nine months. The main reasons for Yamuna Pollution are untreated sewage, dumping of garbage, carcass of dead body, industrial effluents, immersion of idols, and pollution added due to in stream usage of waste (CPCB, 2006). The dilution capacity of the river had further deterioration due to abstraction of water for various usages. (Jain, 2000) reported that out of the total river zone area that is 9700 Ha, approximately 1600 ha of land are irrigated and 8100 Ha is dry land which contributes as runoff pollution into the river.

In 1955-56, 40,000 cases of jaundice in Delhi were reported due to Yamuna River pollution. Yamuna the lifeline of Delhi is the main source of water for domestic usage, drinking, agriculture purposes, industrial area, and other anthropogenic activities. Due to untreated discharge of water from industrial SEZ, urbanized area, Power Plant and Agricultural practices. In Delhi it is estimated that about 3267 MLD of wastewater is generated, including 218 MLD from industrial sources (CPCB, 2004). These affluent are laden with high concentration of heavy metals like Cr, Pb, Hg, Cd, Zn, Ni, As, Cu, etc, which are many folds above tolerant limits for Industrial Effluence (IS:2490,Part-I-1981).

Pesticides like Organochloronate (OC), Carbamates, and Organophosphate (OP) far exceed the permissible limits level (WHO norms) due to indoor usage in hospitals, houses, agricultural area and industries in Yamuna catchment area. These pesticides enter the riverine ecosystem from various sources like drains, sewers and agricultural runoff. These have severe effects on physico-chemical parameters like pH, D.O, BOD, and COD in Delhi and NCR region. The dissolve oxygen in Yamuna River is always reported below the concentration required to sustain aquatic life except monsoon season. This means that the river is dead and ecosystem is unfit for survival of fishes, amphibians and aquatic mammals. Even the microscopic organism like zooplanktons and insects cannot survive in zero D.O levels.

The vegetables farming practices (irrigation) reported along the Yamuna Banks in Delhi and NCT regions shows high levels of pesticides, heavy metals and herbicides residues. Heavy metals cause damage to heart, liver, kidney, nervous system, endocrine system and bones. The rise in stomach cancer in Delhi NCR region has been reported due to continuous usage of food and vegetable infested with heavy metals. Bioaccumulation of heavy metals and pesticides in primary producers will be transfer to higher trophic levels if consumed resulting in biomagnifications in food chain (Tyagi et al 2015).

Ser et.al, (2011) conducted studies to determine the presence of heavy metals in fishes, the result shows that heavy metals in fish elucidation are in order of Ca, K, Mg, Na, P which were too high as compared with maximum permissible level set by World Health Organization (WHO). TERI had conducted research work which (Yamuna, the poisoned river, 2012) shows moderate level of toxic metal in the water at several locations. Sehgal et al., (2012) studied heavy metal contamination in water and soil (silt) in Yamuna Basin from Wazirabad barrage till Okhla barrage selecting 13 site. The average heavy metal concentration at different location varies in the order of Fe > Cr > Mn > Zn > Cr > Pb > Cu > Ni > Hg > As > Cd. The average heavy metal concentration at different location in soil varies in the order of Fe > Mn > Zn > Cr > Pb > Ni > Hg > Cu > As > Cd. The study revealed that variations in heavy metals concentration of the river in pre and post monsoon season at various locations. Some

heavy metals may consider as chemical time bomb as they accumulate in aquatic ecosystem and enter in food chain via primary producers like phytoplankton. These phytoplanktons are further consumed by amphibians, fishes and humans and hamper health. Bioaccumulation of heavy metals in *O.niloticus* and *C. Carpio* hardy exotic fishes are now commonly available in the Yamuna River (Singh and Lakra 2011).

Heavy metals in vegetables have also been reported and the same confirmed by government agencies monitoring cell like CPCB (Central Pollution Control Board and DPCC (Delhi Pollution Control Committee). There are numerous articles in newspaper and scientific publication like down to earth magazine not to use vegetable growing along the Yamuna Banks. It has been reported may time that the farmers after harvesting the crops washes their vegetable in Yamuna water, which results in absorption and adsorption of heavy metals in plant tissues. Among vegetable spinach and radish shows greater accumulation of heavy metals (P.K Khillare et al., 2012).

Athal Village, the entry point of Yamuna River in Delhi shows that all the physical, chemical and biological parameter within permissible limits. At the kalandi Kunj barrage, heavy metals are reported exceeding the Indian Standard for Irrigation usage, inland water bodies (CPCB). The sources of these heavy metals like Pb, Cd, Cr, Hg, As, Ni, Zn etc comes from various industrial units located in Delhi and NCR industrial Area. The sources of these heavy metal like Hg is electrolytic production of Chlorine and caustic soda, lamps, switches, thermometers, lab apparatus, fungicides, antiseptic, preservative Arc rectifiers, mercury cells, industries, , pharmaceutical, electrode and reagents. Lead are used in production of solder, alloy, cable, sheathing, pigments, rust inhibitors, lead acid batteries, ammunition, glazes and paint pigments, etc. Cadmium is sourced from anticorrosive, electroplated onto steel, electric batteries, electrical components, fertilizers, etc. Chromium are produced during manufacturing of paints, catalysts, pigments, the ceramic fungicides and glass industries and in photography and all for alloy and chromium based metal production, chromium plating and corrosion controls.

Sampling of vegetables in Okhla mandi, Wazaribad Mandi and small vegetable markets in Delhi and NCR had reported laden with organophosphate, carbamate organochlorine, fungicides, herbicides etc. in the vegetable shown along the Yamuna Banks. According to Food and Agricultural Organization (FAO), agricultural lands comprises of 50% all usable land worldwide (FAO 2011). In India 60% of the population are involved in agricultural practices directly or indirectly, which contributes to important part in Indian Economy (GDP). The usage of these pesticides has resulted in increase in agricultural output. Ejaz et al. (2004) reported that due to application of pesticides the agricultural output increases but there is increase in risk of human health and environment. These compounds due to wide spread usage had contaminated water, soil, vegetable and even contaminated ground due to percolation and leaching. In 2003 pesticides has been reported in soft drinks, juices, and various can food product at an alarming level. Centre for Science and Environment (CSE) tested brands of market leaders Coca-Cola and PepsiCo. It was reported that Coke contained 30 times and Pepsi 36 times pesticides levels in comparison to European Economic Commission level (EEC). The pesticides reported were lindane, DDT, malathion, chlorpyrifos. These have potential to cause acute and chronic health effect including cancer, neurological damage, reproduction effect, immune suppression, birth defects and are also suspected endocrine disruptors (Calvert et al., 2001, Wang at al 2008). Organochlorine pesticides have been reported to hamper central nervous system and sensitize the myccardial catecho lamines due to toxic behaviours. Aluminium phosphate inhibits Mitochondrial Cytochrome C Oxidase and leads to pulmonary and cardiac toxicity with mortality ranging from 37% to 100%.

The concentration of Organochlorine pesticides (OCP) reported during pre-monsoon season in Yamuna River ranges from 157.71 to 307.66 ng/g. These high levels are due to addition of pollution load added from the upstream area in Haryana State and sewer discharge in the river in Delhi. The OCP level reported in the monsoon season ranges between 577.74 ng/g (highest level) and lowest level is 195.86 ng/g. The reason behind higher OC level during monsoon seasons were organic pollution discharge from agricultural runoff form upstream area of Yamuna flood plain, waste discharge from industries (L Puneeta Pardey et al-2011).

Bhupander et al., (2011) analysed municipal drains to assess the level of organic pollutants e.g Organochlorine pesticides (OCPs), Organophosphate pesticides (OPPs) and herbicides in Delhi and NCR region. The average level of Σ OCPs, Σ OPPs and Σ herbicides were 27.26 ± 9.7 ng/g, 80.89 ± 22.4 ng/g (dry wt.) and 16.20 ± 4.45 ng/g (dry wt.). The mixture of HCH production and usages were barred from production in 1997 and for control of vector borne diseases, public health practices and for pest control in selected crops, lindane formulation are registered for usage under medical prescription to control skin disease (Gupta, 2004; CAPE 2005).

Stockholm Convection banned the usage of DDT in India for agricultural practices; relaxation of 10,000 Tonne per year has been permitted until an alternative has been invented to prevent the spread of vector borne diseases during monsoon season (Zang et al., 2008; Chakarborty et al., 2010). The DDT reported in the Delhi NCR region are due to municipal waste water inflow from the residential area in adjoining area. The Total endosulphane usage in India was 2600 tonne between 1995 to 2000 (Usha and HariKrishna, 2005) which is almost 10% of total insecticides usage. Sharma et.al, (2010) reported that endosulphane affects endocrine system and spermatogonia in goats. The endosulphane can hamper microbial respiration affecting bioremediation of some pesticides for environmental pollution control (Nare at. al, 2010; Adhikari, 2010).

CONCLUSION: Yamuna River supports all form of life ranging from terrestrial ecosystem, aquatic and transitional (riparian) in nature. This river is a reservoir which influences the ground water recharge, edaphic factors, faunal, floral distribution and landscape of its catchment area. The heavy metal and pesticide load in water of Yamuna River is a matter of concern as population of Delhi is dependent on the water of Yamuna. The farmers use the contaminated Yamuna water for the irrigation purpose which leads to accumulation of heavy metals and pesticides in food chain. The higher concentrations of these chemicals result in death of aquatic flora fauna and impact on humans. The prevalent dire condition of Yamuna River is serious problem

and an urgent initiative by the Delhi government is needed to prevent further deterioration. Government should take immediate preventive measure.

ACKNOWLEDGEMENT: Authors are grateful to authorities of Amity University Madhya Pradesh, Gwalior for encouragement and necessary support.

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