WATER POLLUTION - GLOBAL PERSPECTIVE WITH SPECIAL REFERENCE TO INDIA

[2]Pallavi M Vishwanath ., [3]Preeti Pandey *and*[1]Dr. *Akshey Bhargava*

1M.tech, Ph.D., LLB, Professor, Department of Civil Engineering,Global Institute of Engineering and Technology, Hyderabad, India
[2]Freelance Researcher, Bangalore, India
[3]Mtech, Environmental Engineering and Management

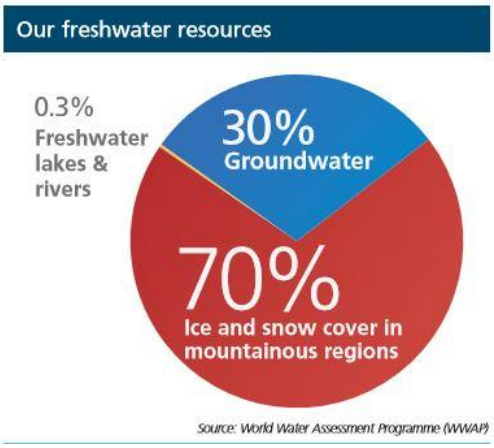
(Received on Date: 10th September 2017 Date of Acceptance: 11st October 2017)

ABSTRACT

The water pollution is a serious threat all over the world in the light of limited fresh water availability and increasing generation of waste of waste water being discharged either on land or into rivers, lakes, water bodies or sea thereby polluting the fresh water available in rivers, lakes, water bodies, and ground water. The water pollution scenario in India is equally critical posing great threat to human health, aquatic life, vegetation and ecological balance. Plethora of environmental legislations has been enacted all over the world to combat this alarming menace including India but the situation is continuously becoming worse on a time scale. The authors of the present paper have discussed and presented global perspective with special reference to India on water pollution with a view to partly provide overview of the seriousness and partly to address the decision makers to combat this menace of water pollution in an integrated and well defined approach.

No: of Tables: 1 **No: of References**: 13

Introduction:Water is a source of life and regarded as the most essential of natural resources. It covers our 98% of water ass seawater and is unusable for drinking because of the high concentration of salt. About 2% of the planet's water is fresh, but 1.6 % is locked up in polar ice caps and glaciers. Another 0.36 % is found underground in aquifers and wells. Therefore, only about 0.036% of the planet's total water supply is accessible in lakes and rivers. WHO/UNICEF survey states that in 45 developing countries, women and children bear the primary responsibility for water collection in the vast majority (76%) of households. This is time not spent working at an income-generating job, caring for family members, or attending school (D. Harikishore Kumar Reddy, 2012). Water pollution issues are a significant challenge for all the countries of the world.Water pollution occurs when undesirable effluents disperse in a water system and so water quality change. With the rapid unsustainable urban, industrial, agricultural and other infrastructural development, water pollution is fast increasing on a time scale causing health problems and limiting fresh water availability world over. Virtually all goods-producing activities generate pollutants as nwanted by-products. The most important water contaminants created by human activities are microbial pathogens, nutrients, oxygen-consuming materials, heavy metals and persistent organic matter, as well as suspended sediments, nutrients, pesticides and oxygen-consuming substances. Heat, which raises the temperature of the receiving water, can also be a pollutant causing stratification. Pollutants are typically the cause of major water quality degradation around the world. Globally, the most prevalent water quality problem is eutrophication, a result of high-nutrient loads (mainly phosphorus and nitrogen), which substantially impairs beneficial uses of water. More than 70% of sewage in developing countries is discharged untreated, polluting rivers, lakes and coastal areas. Many industries – some of them known to be heavily polluting (such as leather and chemicals) – are moving from high-income countries to emerging market economies. Water pollution is not only polluting the surface and ground water bodies but also adversely affecting the land, agriculture, aquatic life and human health to a greater extent

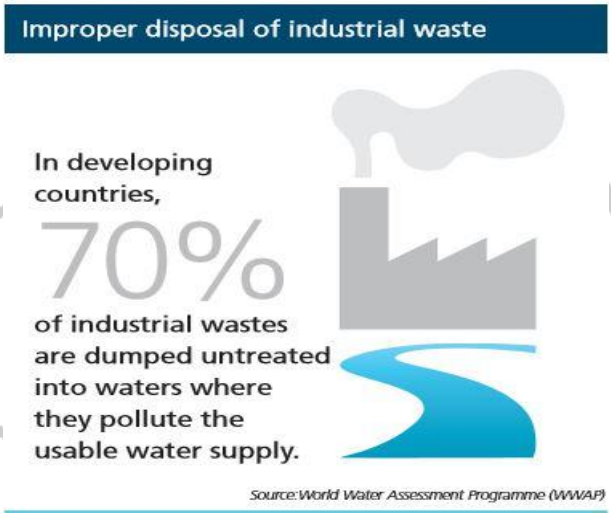


In rural and some suburban areas, domestic wastes are handled at the individual residence and enter the environment through the soil either in partially treated or untreated fashion. In urban areas, domestic wastes are collocated in sewage pipes and transmitted to control location either for treatment or discharge into a watercourse without treatment (This considered as the major potential source of water pollution). Urban sewage since they handled by established government agencies, they can usually be effectively controlled (*Boyd and Tucker, 2012*). Industrial wastes vary from industry to industry and from location to location. Some industries generate wastes high in organic matter, and these wastes can usually handled by methods similar to those used for domestic wastes, such industries include dairy and food-processing plants, meat-packing houses. Other industries, however, generate wastes that are low in organic matter but high in toxic chemicals such as metals, acids or alkalis. These include chemical plants, mining facilities, and textile mills (*Nesaratnam, 2014, Williams et al., 2015*). *(Sulaiman A. Alrumman, 2016)*. Theincreasing contamination of freshwater systems with thousands of industrial and natural chemical compounds is one of the key environmental problems facing humanity worldwide. The ever increasing world populations and rapidly advancing industrialization is causing more demand than ever for the dwindling supply of water, which makes it precious in more and more countries. In some parts of the world, water is a crucial commodity. Recently, a paper published in Nature indicated that 80% of the world's population is exposed to high levels of threat to water security. *(D. Harikishore Kumar Reddy, 2012)*.

2.0 Global water pollution:

Countries throughout the world are concerned with the effects of unclean drinking water because water-borne diseases are a major cause of morbidity and mortality (*c.f. Clasen et al. 2007; WHO 2010*). Clean drinking water is important for overall health and plays a substantial role in infant and child health and survival (*Anderson et al. 2002; Fewtrell et al. 2005;*

Ross et al. 1988; Vidyasagar 2007). The World Health Organization (2005) estimates that worldwide about 1.8 million people die from diarrheal diseases annually. Persons with compromised immune systems, such as those with AIDS, are especially vulnerable to water-borne infections, even those which are not typically threatening to healthy individuals (*Kgalushi, Smits and Eales 2004; Laurent 2005:* 6). The people most vulnerable to water-borne diseases are those who use an unclean drinking water source. Throughout the less developed world, the proportion of households that use an unclean drinking water source has declined, but it is extremely unlikely that all households will have a clean drinking water source in the foreseeable future (*c.f. Mintz et al. 2001*). UNICEF (2010: 7-9) reports that in 2010, 884 million people in the world use an unimproved drinking water source, and estimates that in 2015, 672 million people will still use an unimproved drinking water source. Thus it is important to understand what leads a household with an unclean water source to treat its drinking water.*(Barbara Anderson, 2005*).



Estimates suggest that nearly 1.5 billion people lack safe drinking water and that at least 5 million deaths per year can be attributed to waterborne diseases. With over 70 percent of the planet covered by oceans, people have long acted as if these very bodies of water could serve as a limitless dumping ground for wastes. Raw sewage, garbage, and oil spills have begun to overwhelm the diluting capabilities of the oceans, and most coastal waters are now polluted. Beaches around the world are closed regularly, often because of high amounts of bacteria from sewage disposal, and marine wildlife's beginning to suffer. Perhaps the biggest reason for developing a worldwide effort to monitor and restrict global pollution is the fact that most forms of pollution do not respect national boundaries. The first major international conference on environmental issues was held in Stockholm, Sweden, in 1972 and was sponsored by the United Nations (UN). This meeting, at which the United States took a leading role, was controversial

because many developing countries were fearful that a focus on environmental protection was a means for the developed world to keep the undeveloped world in an economically subservient position. The most important outcome of the conference was the creation of the United Nations Environmental Program (UNEP).

It is significant to note that 40% of America's rivers are too polluted for fishing, swimming, or aquatic life. Even worse are America's lakes—46% are too polluted for fishing, swimming, or aquatic life. Two-thirds of US estuaries and bays are either moderately or severely degraded from eutrophication (nitrogen and phosphorus pollution). The Mississippi River—which drains nearly 40% of the continental United States, including its central farm lands—carries an estimated 1.5 million metric tons of nitrogen pollution into the Gulf of Mexico each year. The resulting hypoxic coastal dead zone in the Gulf each summer is about the size of Massachusetts. 1.2 trillion gallons of untreated sewage, storm water, and industrial waste are discharged into US waters annually. The US EPA has warned that sewage levels in rivers could be back to the super-polluted levels of the 1970s by the year 2016.

Asian rivers are the most polluted in the world. They have three times as many bacteria from human waste as the global average and 20 times more lead than rivers in industrialized countries. In 2004, water from half of the tested sections of China's seven major rivers was found to be undrinkable because of pollution. The quality of water in Europe's rivers and lakes used for swimming and water sports worsened between 2004 and 2005, with 10% of sites not meeting standards. Slovakia has the lowest compliance with EU guidelines for freshwater areas, with only 22.4% of bathing sites meeting the standards. Thirty percent of Ireland's rivers are polluted with sewage or fertilizer. The Sarno is the most polluted river in Europe, featuring a nasty mix of sewage, untreated agricultural waste, industrial waste, and chemicals.Greece has the cleanest coastal waters, followed by Spain and Germany. Lithuania and Estonia have the dirtiest coastal waters.

The King River is Australia's most polluted river, suffering from a severe acidic condition related to mining operations. Pollution of freshwater (drinking water) is a problem for about half of the world's population. Each year there are about 250 million cases of water-related diseases, with roughly 5 to 10 million deaths. Diseases caused by the ingestion of water contaminated with pathogenic bacteria, viruses, or parasites include: cholera, typhoid, schistosomiasis, dysentery and other diarrheal diseases

Bangladesh has some of the most polluted groundwater in the world. In this case, the contaminant is arsenic, which occurs naturally in the sediments. Around 85% of the total area of the country has contaminated groundwater, with at least 1.2 million Bangladeshis exposed to arsenic poisoning and with millions more at risk. Each year, plastic waste in water and coastal areas kills up to: 100,000 marine

mammals, 1 million sea birds, and countless fish.

3.0 Sources of water pollution:

Water pollutants refer to the substances which are capable of making any physical, chemical or biological change in the water body. These have undesirable effect on living organisms. When pollutants enter a stream, river or lake these gives rise to water pollution. The water pollution has a number of sources. These can be categorized as:

- Point and Non-point Sources
- Natural and Anthropogenic Sources
-

3.1 Point and Non-point Sources:

The well-defined sources that emit pollutants or effluents directly into different water bodies of fresh water are called point sources like domestic and industrial waste waters and these point sources of pollution can be effectively monitored and controlled. On the other hand, the non-point sources of water pollution are scattered or spread over large areas. These types of sources deliver pollutants indirectly through environmental changes and account for majority of the contaminants in streams and lakes where the contaminated water that runs off from agriculture farms, construction sites, abandoned mines, solid waste disposal sites enters streams and lakes. It is quite difficult to control non-point sources.

3.2 Natural and Anthropogenic Sources:

An increase in the concentration of naturally occurring substances is also termed as pollution. The sources of such an increase are called natural sources. Siltation (which includes soil, sand and mineral particles) is one such natural source. It is a common natural phenomenon, which occurs in most water bodies. Indiscriminate deforestation makes soil loose and flood waters bring silt from mountains into streams, rivers and lakes. On the other hand, the human activities that result into the pollution of water are called Anthropogenic or manmade sources of water pollution. For example, domestic (sewage and wastewater), industrial and agricultural wastes that goes into the rivers, lakes, streams and seas are anthropogenic sources.

4.0 Water Pollutants:

Untreated wastes from industries, solid wastes from urban and commercial area, wastes water from sewerage in Municipality, feces of animals, pesticides, fertilizers, radioactive wastes, erosion of lands river banks etc., are the main sources of water pollution and main water pollutants are

- Liquid organic wastes
- Liquid inorganic wastes
- Micro-organisms/germs
- Nutrient substances
- Synthetic compounds
- Inorganic chemicals
- Silt and sediment
- Hot water
- Industrial, Municipal and urban waste

4.1 Liquid Organic Wastes:

Wastes when disposed of in water, bacteria and other micro-organisms

combine with oxygen dissolved in water to break them down, can be termed as "oxygen demanding" wastes. Liquid organic wastes include sewage, many wastes from industries and run-off from rains, floods and storms which picks up organic wastes from land, before flowing into streams, rivers, lakes or seas. As the concentration of dissolved oxygen decreases, so fish and aquatic plant life suffer or die.

4.2 Liquid Inorganic wastes:

Most of the inorganic liquid wastes come from industry, and their dilution in large river waters renders them harmless. Some inorganic toxic wastes can become concentrated up the food chain to fish. Many of the pollution incidents which have been resulted in largest number of deaths and serious injuries from water pollution have been arisen from human ingestion of fish, or crops contaminated with heavy metals or other inorganic compounds.

4.3 Micro-organisms/Germs:

With the feces of animals, wastes of sewerage, latrines etc. various kinds of bacteria, virus and other organisms spread out in the water bodies and pollute it. Poultry farms, tanneries and slaughter-houses always supply such kinds of micro-organisms to the water bodies.

4.4 Nutrient substances:

Domestic substances, excess use of fertilizers, minerals occurring nitrate are mixing with water. This nutrient substance causes fast growth of unwanted plants. After some days these plants gets rotten making water offensive in taste and odor. Such kind of abnormal growth of aquatic plants is called "eutrophication".

4.5 Synthetic compounds:

Various cleaning agents, soaps, detergents pesticides and other chemical substances belongs to this group. Industries also contribute to such kind of compounds.

4.6 Inorganic chemicals:

Many metals like lead, zinc, cadmium, mercury, arsenic and their compounds are inorganic pollutants.

4.7 Silt and sediment:

Soil erosion gives rise to silt and sediment in water bodies. Soil erosion has enhanced to 5 to 10 times as a result of agricultural and about 100 times due to construction activities.

4.8 Hot water:

Thermal industries use huge amount of cold water to cool their engines from overheating. This hot water is discharged to the nearby water bodies and causes depletion of DO.

5.0 Effects of Water Pollution:

Water pollution has a dual effect on nature. It has negative effects on the living and on environment. The effects of pollution on human beings and aquatic communities are many and varied. Definitely with all these, we can expect that there is going to be a reduction in productivity. Biomass and diversity of communities are to be expected when large amount of toxic materials are released into the streams, lakes and coastal waters in the ocean. Much of aquatic pollution involves sewage in which organic waste predominate. This waste can increase secondary productivity while altering the character of the aquatic

community. Most fishes especially the species desired as food by man are among the sensitive species that disappear with the least intense pollution.

Water pollution leads to damage to human health. Disease carrying agents such as bacteria and viruses are carried into the surface and groundwater. Drinking water is affected and results into health hazards. Direct damage to plants and animals nutrition also affects human health. Plants nutrients including nitrogen, phosphorus and other substances that support the growth of aquatic plant life could be in excess causing algal gloom and excessive weed growth. This makes water to have odor, taste and sometimes color. Ultimately, the ecological balance of a body of water is altered. Sulphur dioxide and nitrogen oxides cause acid rain which lowers the pH value of soil and emission of carbon dioxide can cause ocean acidification.

Sr. No.	Pollutant	Effects
1	Pathogens	Depletion of dissolved oxygen in water (foul odour) health effects (outbreaks of water borne diseases)
2	Organic pollutants (Oil and grease, Pesticides and Weedicides, Plastics, Detergents)	Disruption of marine life, and aesthetic damage, Toxic effects (harmful for aquatic life), possible genetic effects and cancer, kills fish, Eutrophication, aesthetics
3	Inorganic pollutants Fertilizers (Phosphate and Nitrate)	Algal bloom and eutrophication, nitrates cause methemoglobenemia
	Acids and alkalies	Kill fresh water organisms, unfit for drinking, irrigation and industrial use
4	Radioactive materials	Cancer and genetic defects
5	Heat	Decreases solubility of oxygen in water, disrupts aquatic ecosystems
6	Sediment	Affects water quality, reduces fish population

Table 1: Types of water pollutants and their effects

6.0 Indian scenario:

With rapid expansion of cities and domestic water supply, quantity of gray/wastewater is increasing in the same proportion. As per CPHEEO estimates about 70-80% of total water supplied for domestic use gets generated as wastewater. The per capita wastewater generation by the class-I cities and class-II towns, representing 72% of urban population in India, has been estimated to be around 98 lpcd while that from the National Capital Territory-Delhi alone (discharging 3,663 MLD of wastewaters, 61% of which is treated) is over 220 lpcd *(CPCB, 1999)*. As per CPCB estimates, the total wastewater generation from Class I

cities (498) and Class II (410) towns in the country is around 35,558 and 2,696 MLD respectively. While, the installed sewage treatment capacity is just 11,553 and 233 MLD, respectively (Figure 2) thereby leading to a gap of 26,468 MLD in sewage treatment capacity. Maharashtra, Delhi,

Uttar Pradesh, West Bengal and Gujarat are the major contributors of wastewater *(CPCB, 2007a)*. Further, as per the UNESCO and WWAP (2006) estimates (*Van-Rooijen et al., 2008*), the industrial water use productivity of India (IWP, in billion constant 1995 US$ per m3) is the lowest (i.e. just 3.42) and about 1/30th of that for Japan and Republic of Korea. It is projected that by 2050, about 48.2 BCM (132 billion litres per day) of wastewaters (with a potential to meet 4.5% of the total irrigation water demand) would be generated thereby further widening this gap (Bhardwaj, 2005). Thus, overall analysis of water resources indicates that in coming years, there will be a twin edged problem to deal with reduced fresh water availability and increased wastewater generation due to increased population and industrialization. In India, there are 234-Sewage Water Treatment plants (STPs). Most of these were developed under various river action plans (from 1978-79 onwards) and are located in (just 5% of) cities/ towns along the banks of major rivers (*CPCB, 2005a*). In class-I cities, oxidation pond or Activated sludge process is the most commonly employed technology, covering 59.5% of total installed capacity. This is followed by Up-flow Anaerobic Sludge Blanket technology, covering 26% of total installed capacity. Series of Waste Stabilization Ponds technology is also employed in 28% of the plants, though its combined capacity is only 5.6%. A recent World Bank Report (*Shuval et al. 1986*) came out strongly in favour of stabilization ponds as the most suitable wastewater treatment system in developing countries, where land is often available at reasonable opportunity cost and skilled labour is in short supply.

Apart from domestic sewage, about 13468 MLD of wastewater is generated by industries of which only 60% is treated. In case of small scale industries that may not afford cost of waste water treatment plant, Common Effluent Treatment Plants (CETP) has been set-up for cluster of small scale industries (*CPCB, 2005b*). The treatment methods adapted in these plants are dissolved air floatation, dual media filter, activated carbon filter, sand filtration and tank stabilization, flash mixer, clariflocculator, secondary clarifiers and Sludge drying beds, etc. Coarse material and settable solids are removed during primary treatments by screening, grit removal and sedimentation. Treated industrial waste water from CETPs mixed disposed in rivers. For example, 10 CETPs from Delhi with capacity of 133 MLD dispose their effluent in Yamuna River. The conventional wastewater treatment processes are expensive and require complex operations and maintenance. It is estimated that the total cost for establishing treatment system for the entire domestic wastewater is around Rs. 7,560 crores (*CPCB, 2005a*), which is about 10

times the amount which the Indian government plans to spend (*Kumar, 2003*). Table 1 illustrates the economics of different levels of treatments through conventional measures (*CPCB, 2007b*). The sludge removal, treatment and handling have been observed to be the most neglected areas in the operation of the sewage treatment plants (STPs) in India. Due to improper design, poor maintenance, frequent electricity break downs and lack of technical man power, the facilities constructed to treat wastewater do not function properly and remain closed most of the time (*CPCB, 2007b*). Utilization of biogas generated from UASB reactors or sludge digesters is also not adequate in most of the cases.

7.0 Water pollution laws in India

At the national level, Ministry of Environment and forests and Climate Change (MoEFCC) is the nodal agency to look after India's Environmental issues and policies and works under Central government. It main objective is to enact rules, acts and notifications to maintain the quality of water and control water pollution. Central pollution control board (CPCB) is a statutory organization under MoEF that has pollution control as its main disciplines. Central Ground Water Board (CGWA) is a statutory organization under Ministry of water resources and runs as apex organization in the field of groundwater in India.

Acts-

- The Water (Prevention and control of pollution) Act 1974, amended 1988
- The Water (Prevention and control of pollution) Cess (Amendment) Act, 2003

Rules-

- The Central Pollution Control Board (Amendment) Rules, 2012
- Wetland Rules, 2010

Policy-

- National Water Policy 2012 under Ministry of water resources
- State Water policy 2002

Conclusions:

Water pollution is an alarming issue world over and needs to be addressed in a sustained manner. Research and development framework is to be strengthened where new innovative technologies with financial feasibility should be worked out and established. The development activities in the form industries, urban development, agriculture, and other infrastructure should not be allowed to take place in river basins and catchment areas of water bodies to restrict rivers, lakes and other water bodies from getting polluted. Moreover, an integrated overall environmental planning should be done with legal backing through well-defined simulation models with main objective to maintain or restore the quality of waters.

REFERENCES

Owa, F.D. *Water Pollution: Sources, Effects, Control and Management. Mediterranean aterJournal of Social Sciences MCSER Publishing, Rome-Italy 4, (8), 65-68 (2013).*

Anonymous. 2004. NATP – MM project report on 'Use of Urban and Industrial Effluent in Agriculture' CSSRI, Karnal 132001, India.

***CGWB**. 2011. Ground Water Year Book - India 2010-11. Central Ground Water Board, Ministry of Water Resources. Government of India.*

http://www.cgwb.gov.in/documents/Ground%20Water%20Year%20Book-2010-11.pdf

***CPCB** (1999). Status of water supply and Wastewater Collection Treatment & Disposal in Class I Cities-1999, Control of Urban Pollution Series:CUPS/44/1999-2000.*

***CPCB**. 2005a. Parivesh Sewage Pollution – News Letter. Central Pollution Control Board, Ministry of Environment and Forests, Govt. of India, Parivesh Bhawan, East Arjun Nagar,delhi110032,*

***CPCB**. 2005b. Performance status of common effluent treatment plants in India. Central Pollution Control Board, India.*

***CPCB**. 2007a . Evaluation of Operation and Maintenance of Sewage Treatment Plants in India- 2007, Control of Urban Pollution Series: CUPS/68/2007. Central Pollution Control Board, India.*

***CPCB**. 2007b. Advance methods for treatment of textile industry effluents, Resource Recycling Series: RERES/&/2007. Central Pollution Control Board, India.*

***D. Harikishore Kumar Reddy, S. L.** (2012). Water pollution and Treatment Technologies. Environmental & Analytical Toxicology, 2(5).*

***Reddy, M. C**. (2004). Management of lakes in India. Retrieved September 3, 2015, from worldlakes.org: www.worldlakes.org/.../management_of_lakes_in_india_10mar04.pdf*

***Sulaiman A. Alrumman, A. F.-K**. (2016). Water pollution: Source & Treatment. American Journal Of Environmental Engineering , 88-98*

***Singh, R.** &. (2012). Urban lakes and wetlands: opportunities and challenges in Indian Cities- Case study of Delhi. Retrieved March 26, 2016, from HAL: https://hal.archives-ouvertes.fr/hal-00739984/document*