Freshwater Contamination: Sources and Hazards to Aquatic Biota

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Abstract Water is an essential compound for supporting the biota on earth. There are various sources of water to support the life in freshwater ecosystems. Freshwater ecosystems play magical role as they provide services to support life process in living creatures. But, growing population, urbanization, industrialization put drastic pressure on the freshwater ecosystems, with the result altered the quality scenario of freshwaters by adding huge quantities of contamination. Water contaminations not only degrade the quality of freshwater, but simultaneously pose harmful risks to the whole environment. The chemical substances in freshwater ecosystem can't be neutralized easily due to their complex structure and have great potential to remain intact in any kind of environments. These substances nowadays are continuously added into the freshwater ecosystem on daily basis by way of discharging untreated domestic, industrial and agricultural wastewater. Most of these substances get accumulated in the bottom sediments and very minute concentration in the form of organic and inorganic constituents remain either in suspended form or solution in liquid medium of freshwater ecosystem. Presences of these kinds of pollutants in freshwater ecosystem have long-term impacts on aquatic and associated biota. Therefore, need of an hour is to monitor the quality of freshwater ecosystem on regular basis and focus should be given to the treatment of effluents prior to its discharge into the freshwater ecosystem.

Keywords Aquatic ecosystem · Freshwater · Eutrophication · Toxic substances · Health hazard · Effluent

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1 Introduction

Water is considered as an essential natural resource and covers almost entire surface of earth and contributing 70% in the form of fresh waters and oceans and the availability varies being only 3% by fresh water bodies (Dikio 2010; Adesuyi et al. 2015). Worldwide, lakes and rivers in the form of fresh water embrace 10^5 Km^3 that counts 10^{-4} less than total water on earth (Jackson et al. 2001). Water bodies are important as they contribute major source of water for sustaining life on earth and its scarcity is likely to affect agricultural as well as domestic life. Rapid population growth during recent years has led to increased use of freshwaters by 10% from 2000 to 2010 (Vorosmarty et al. 2005; Rijsberman 2004) major portion of fresh waters goes to irrigation of fields (40%) globally with 20–40 L is used for consumption per day. Freshwater flora and fauna is prime source of valuable items and services for human use (Halder and Islam 2015), contributes 42% of total fish (Lundberg et al. 2008), 25% of fresh water molluscus Rijsberman and Moden (2001), some percentage of phytoplanktons and crabs Water bodies serve as an essential input for generating power and for disposal of sewage and industrial effluents (Eunice et al. 2017) but at the same time their regular disposal has generated environmental concerns as it has led to pollution problems and has become threat to aquatic flora and fauna and is considered unfit for human use (Ekubo and Abowei 2011; Dulo 2008). Water is contaminated mainly by chemical, physical, biotic factors coming from various sources (Richardson et al. 2007). There are many defining causes of water being getting polluted like discharge of field (Bhat et al. 2012) and industrial debris to waters, leakage of oil from oil tankers, use of excessive fertilizers and pesticides for crop protection, sewage sludge and much more (Aboyeji 2013; Bhat et al. 2017). Major pollution of water bodies is due to overcrowding in urban areas activities like polythene bags directly released to rivers and streams (Bhat et al. 2014, 2018), excessive use of chemicals, dirt, dust and debris (Master et al. 1998; Carpenter et al. 1998; Kalff 2002; Moss 2008). Water bodies have capacity to assimilate pollutants to the extent that may be hazardous to the life of biota in the form of number, variety or structure, the term known as assimilative capacity (Adekunle 2009; Adekunle and Eniola 2008).there exists a positive correlation between pollutants and health of organisms (Otukunefor and Obiukwu 2005). When excess pollutants are being discharged they compete for dissolved oxygen because there is conversion of organic substances to inorganic ones requiring oxygen for transformation creating a condition of biological oxygen demand, loss of biodiversity and eutrophication (Beeby 1993). Among aquatic biota, fishes are being severely affected as metal ions released from industries cause respiratory breakdown in them (Arimoro 2009), eg. Excessive release of iron cause iron clog in the gills of fishes and their consumption by humans affects human health (Ahmed et al. 2013). Pathogens are exuded from untreated sewage (Helmer and Hespanhol 1997) and many harmful substances from nuclear plants (Master et al. 1998). This has led to outbreak of numerous harmful diseases (APHA 1996) and has led to shortage of potable water therby affecting humam health (Eunice et al. 2017). Water pollution has given rise to health issues like discharge of faecal matter to water resources has

led to infectious fecal-oral route disorders (Nel and Markotter 2009), cancer, lung diseases, abdominal disorders, heart problems, low birth rates, etc. (Ullah et al. 2014). Recent survey has concluded that water pollution is affecting at a greater rate in rural areas than in urban regions due to lack of infrastructures for treating water before its use (Jabeen et al. 2011; Currie et al. 2013). More over poor quality water used for irrigating agricultural fields has affected our economy by producing poor quality produce (Khan and Ghouri 2011). Renewable fresh water is an indispensable resource for life and deserves special attention because it is very impaired and seriously threatened by human activities (Togue et al. 2017). In fact, population growth accompanied by rapid urbanization is major factor for causing disturbances (Fig. 3) in natural environments (Kinney 2002; Postel and Richter 2012).

2 Sources of Water Pollution

2.1 Sewage

Sewage consists of all waste material coming out from homes, industries, schools, farms, cities and towns and is mixture of degradable and non degradable substances with major portion consisting of human excreta (Cumberlidge et al. 2009; Chowdhury et al. 2015). Wastewaters are an assortment of likely organic and inorganic constituents associated with minute quantity of cultural substances (human excreta) and sewage from all point and non-point sources (Sulaiman et al. 2016). Large portion of industrial waste waters comes from big cites and in combination of domestic waste waters known as municipal waste waters (de Mora and Harrison 2013). Biodegradable wastes come from agriculture farm lands, pastures, cowsheds and dairy farms (Vikranthpridhvi and Musalaiah 2015). Almost all domestic sewage from cities and towns is discharged into rivers and streams sometimes untreated sewage are discharged into freshwater ecosystems (Banks et al. 1997; Barker and Stuckey 1999; Baron and Poff 2004; Burton and Pitt 2001) and cause freshwater pollution (Haseena et al. 2017) as shown in Fig. 1. Freshwater pollution are responsible for enhancing bacterial load in water bodies, which are directly and indirectly and trigger for serious health hazards (Desai and Vanitaben 2014). Most of water body pollution (70%) is due to domestic wastes (Sankhla et al. 2018) as it contains toxicants, solid and liquid wastes, polythene bags, (Haseena and Malik 2017) (Fig. 2).

2.2 Agricultural Waste

Widespread use of fertilizers and pesticides for increasing production of agricultural crops and improved livestock practices for doubling farmers income have adverse effect on quality of water used for drinking and irrigation purposes

(Mali et al. 2015) via flushing into lakes and rivers. This has also led to ground water contamination through seepage (Anonymous 2002). Pesticides pose major threat to aquatic biota because of their rapid fat solubility action and their accumulation in non target organisms (Dutta et al. 2009), thereby having harmful effect on their lives (Dapena-Mora et al. 2007; Das et al. 2010). Animal, human wastes and chemical pesticides used in agriculture or released directly into ponds constitute the major sources of pollutants of the water (Anonymous 2002).

2.3 Petroleum Slicks

Transportation of petroleum tanks may sometimes cause leakage of pipes and tapes and thus are ultimately discharged into water bodies which result in a condition known as anoxia as the living organisms in water bodies and they fail to take up dissolved oxygen due to the presence of oil film formed on the surface (Arora and Kakkar 2017).

2.4 Nuclear and Thermal Pollution

Thermal power plants contribute major sources power generation in India, but are also an important cause of environmental pollution, because it uses coal as fuel as it is the major fossil fuel resource in India for producing electricity (EEB 2000; Elhatip and Gullu 2005). Most of the coal based thermal power plants produce as

Fig. 1 Discharge of untreated domestic sewage into river ecosystem

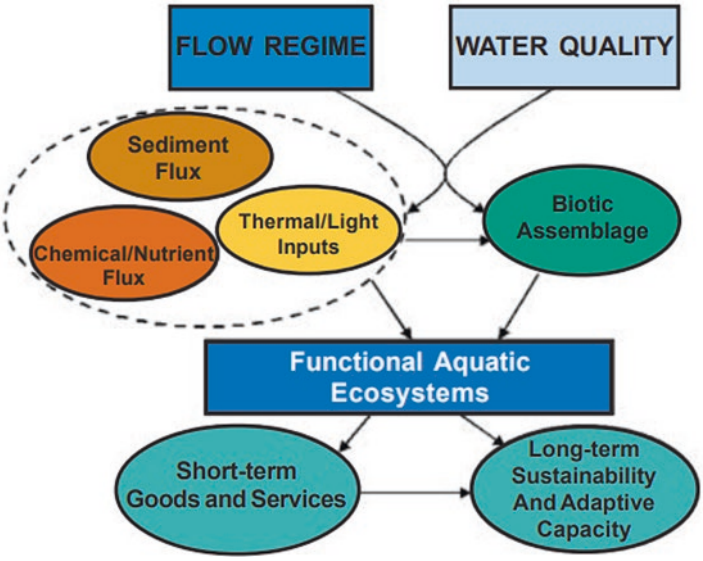

Fig. 2 Major forces that influence freshwater ecosystems. (Baron et al. 2003)

much as 70% of electricity in India (Dhadse and Bhagia 2008). Fly ash produced in such power plants is threatening aquatic life as well (Dart and Stretton 1980; Nair 1985) as it decreases dissolved content of oxygen in water and responsible for loss of ecological balance (Rao and Ravindhranath 2013; Arora and Kakkar 2017).

2.5 Pesticides and Fertilizers

The term pesticides include wide range of substances like insecticides, fungicides, growth regulators etc. and are now widely used for plant protection and their excessive usage has created havoc to the life forms on earth. These are directly or indirectly discharged to waters, polluting it and render it unsafe for use (Sankhla et al. 2018; Khurana and Sen 2008). Leached out chemicals after drained to water bodies lead to eutrophication (Sankhla et al. 2018) or get accumulated in fruits or vegetables that are consumed as such (Ebenstein 2008; Kamble 2014). Though pesticide usage cannot be completely controlled but can be managed efficiently to overcome its harmful effects (Yonglong et al. 2015; Khurana and Sen 2008). Pesticide exposure to the drinking water can be checked as given by NAS (National Academy of Sciences 1993) to prevent risks on biotic life.

2.6 Industrial Waste

With rise in population, there has been tremendous growth of industries and factories and produce large quantities of smoke as major pollutant and contributes 25% of overall pollution (Desai and Vanitaben 2014). Harmful substances discharged from industries are the main causes of water pollution (Haseena et al. 2017). Toxic metals released by different industries enter into water and reduced the quality of freshwater (Ho et al. 2012). The industrial mishaps have now become a matter of concern as these are rich in metal substances *viz.,* mercury, leads, chromium etc., that are very harmful to biota and sometimes make water unfit for drinking purposes (Owa 2013; Arora and Kakkar 2017; Haseena et al. 2017). Due to these reasons most of the population is facing problem of water shortage (EPA 2002; Farenzena et al. 2005; Garcia et al. 2014) .

2.7 Mining Industry

Large quantities of wastes are also produced by mining industry during the process of extraction and manufacturing (Das and Choudhury 2013). During the process of extraction waste substances pollute the water used in the process making it acidic which dissolves the metals from residue deposits (Musingafi and Tom 2014). The left out material results in both surface as well as ground water pollution leading to destruction of soil profile and soil quality (Adler and Rascher 2007). Mining of heavy metals pollute the surrounding environment and prove hazardous to human as well as animal life (Hetrick et al. 2000; Gong et al. 2008). Thus this uncontrollable discharge is a matter of concern and requires serious attention to prevent its ill effects on environment.

2.8 Population Growth and Urbanization

With increase in population there have been many issues with pollution to environment and is having negative influence on it (Ho et al. 2012). There is generation of large quantities of wastes, both solid and liquid wastes, by growing humans (Jabeen et al. 2011) and are being directly thrown to rivers, canals and streams. Contaminated waters are sources to emerging bacterial and other microbial diseases (Desai and Vanitaben 2014). Plastic bags containing large amount of wastes are also being discharged to fresh water sources and contribute major source of fresh water pollution (Desai and Vanitaben 2014; Sankhla et al. 2018). Population explosion, carrying capacity, in adequate management of waste and wastewater are major concerns to deplete fresh water qualities and create grave health issues, in urban localities (Kamble 2014).

3 Impact of Pollution on Water Physico-Chemical Characteristics

3.1 pH

It is an important factor to describe water health (Fakayode 2005) and play a crucial role in bio-chemical life cycles in aquatic environs (Chapman 1996; Lokhande et al. 2011; Smitha et al. 2013). Variation of pH from acidic to basic and vice versa could have deadly impact on aquatic biota. Aquatic organisms are sensitive to pH changes and biological treatment requires pH control or monitoring (Lokhande et al. 2011). Availability of heavy metals in water ecosystems are also affected by alteration of water pH. Thus, pH is having primary importance in deciding the quality of wastewater effluent (Lokhande et al. 2011). The high pH is probably due to the direct disposal of refuse into the water body and also to sea water intrusion (Ogbonna 2014). Water with a pH outside the normal range may cause a nutritional imbalance or may contain a toxic ion which can adversely affect the growth and development of aquatic life (Bolawa and Gbenle 2012). It is a known fact that variations in pH affect chemical and biological processes in water and low pH increases the availability of metals and other toxins for intake by aquatic life and high pH may be due to the presence of other pollutants introduced into the water (Ogbonna 2014).

3.2 Electrical Conductivity

It's value in aquatic environs depends on the concentration furnishing ions as well as the water temperature (Uqab et al. 2017). Electrical conductivity is increasing due to the influence of sewage water coming out from hotels coming out from kitchens, bathrooms and washrooms (Bhat and Pandit 2001). Increase in levels of electrical conductivity and cations and input of sewage water may be the result of decomposition and mineralisation of organic materials (Abida and Harikrishna 2008).

3.3 Temperature

It is a well known fact that the pace at which chemical reactions occur amplify with rise in temperature and the rate of biochemical processes usually double for every 10.0 °C rise in temperature (Ogbonna 2014). The temperature of untreated discharged from domestic sources sewage ranges between 8 and 12 °C in winter to 17–20 °C in summer (Sun et al. 2015). Increased temperature increases respiration leading to increased oxygen consumption and increased decomposition of organic matter (Pierce et al. 1998). Hence, population of bacteria and phytoplankton would

double in warm weather in a very short time (Chapman 1996). The temperature plays an important role in the metabolic activities of the organisms and is considered as a biologically most significant factor (Varunprasath and Daniel 2010).

3.4 Suspended and Total Dissolved Solids (TDS)

Suspended solids consist of materials originating from the surface of the catchment area, eroded from river banks or lake shores and suspended from the bed of the water body (Chapman 1996). It includes vey minute substances *viz.,* silts, clays, zooplankton, phytoplankton and dead particulate matter (Davis and Day 1998; Mahananda 2010). According to Lester and Birkett (1999), suspended solid values of less than 25 mg/l have no harmful effect on fisheries. High suspended solids might beo due to run off from many bathing Ghats, drain water discharge (Pawar and Vaidya 2012). Suspended solids generally cause damage to fish gills affecting their oxygen consumption and ultimately causing death at high concentrations (Ogbonna 2014). Total dissolved solid depends on various factors such as geological character of watershed, rainfall and amount of surface runoffs and gives an indication of the degree of dissolved substances (Smitha et al. 2013). Higher concentrations of total dissolved solids (TDS) in sewage water may be attributed to higher concentrations of carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, nitrogen and calcium (Kannan et al. 2004).

3.5 Dissolved Oxygen

High TDS, BOD and COD content cause decrease in DO of the water system creating stress condition to the aquatic living organisms (Kambole 2003). Dissolved organic contents consume a large amount of oxygen and increase BOD level which leads to anaerobic fermentation and produces organic acids and hydrolysis of these organic acids causes the decrease in pH values (Ahmed et al. 2011). According to Cunningham and Saigo (1999), the addition of certain organic materials due to discharge of sewage into water stimulates oxygen consumption by decomposers. Dissolved Oxygen thus indicates the ability of water body to support aquatic life and volume of oxygen present in the water (Sharma and John 2009; Shivayogimath et al. 2012; Smitha et al. 2013). Low oxygen in water can kill fish and other aquatic organisms (Smitha et al. 2013). Lower values of dissolved oxygen may be due to the organic matter in sewage which leads to the rapid decrease in this oxygen availability (Gray 2004). Ahipathy and Puttaiah (2006) reported that lower values of dissolved oxygen may be due bioaccumulation, biomagnifications and active utilization in bacterial decomposition of organic matter (Thilaga et al. 2005; Lone et al. 2017).

3.6 Biological Oxygen and Chemical Oxygen Demand

Biochemical Oxygen Demand (BOD) is used as an index for determining the amount of decomposing organic materials as well as the rate of biological activities in waste because oxygen is required for respiration by microorganisms involved in the decomposition of organic materials (Nartey et al. 2012). The slightly high BOD values may be attributed to the discharge of organic waste into water bodies resulting in the uptake of DO in the oxidative breakdown of these wastes (Akuffo 1998; Milovanovic 2007). High BOD values may be attributed to the percolation of waste water loaded with biodegradable compounds (Pitchammal et al. 2009), which might be the result of untreated sewage, solid and industrial waste discharge directly into water (Milovanovic 2007). Sources of BOD in aquatic environment include leaves and woody debris, dead plants and animals, animal manure, industrial effluents, wastewater treatment plants, feedlots, and food-processing plants, failing septic systems, and urban storm water runoff (Lokhande et al. 2011). In untreated effluent, high BOD may be due to fibre residues and suspended solids (Yusuff and Sonibare 2004; Pawar and Vaidya 2012).

Chemical Oxygen Demand (COD) is the quantity of O_2 needed for the oxidation of inorganic constituents in water environs (Eunice et al. 2017). The higher level of COD in the effluent discharged indicate that it contains high oxygen demanding materials, which causes depletion of dissolved oxygen in water thereby limiting its use for other purposes (Hogan 2014; Jeswani and Mukherji 2015; Kahiluoto et al. 2015; Kozai et al. 2014), such as irrigation and recreational purposes (Eunice et al. 2017). Thus, high BOD and COD levels in water indicated that the water is highly polluted (Eunice et al. 2017) (Fig. 3).

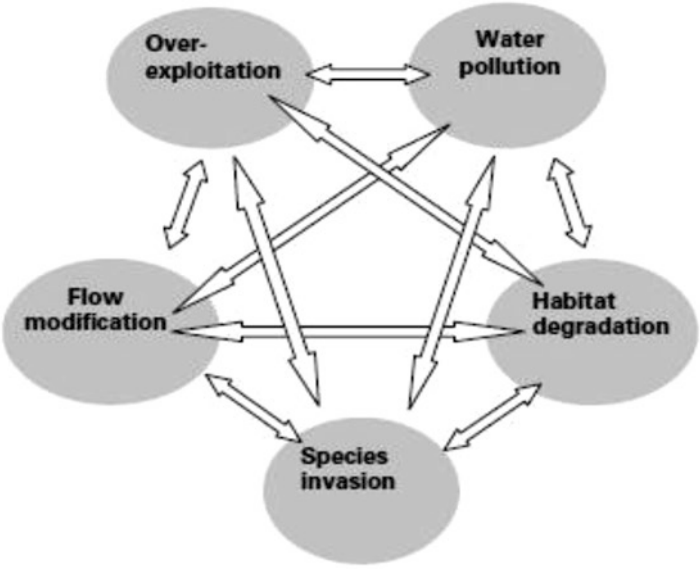

Fig. 3 Major threats to freshwater biodiversity. (Dudgeon et al. 2006)

3.7 Chloride

High amount of Cl^- due to discharge of untreated sewage into water reacts with Na^+ turns the water salty and also enhances dissolved solids (Little 1971; NRCC 1977; Malik et al. 2012; Smitha et al. 2013). Chloride is present in all types of water and its concentration shows the presence of sewage pollution (McConnell et al. 1993; Smitha et al. 2013). Higher concentration of chloride in water may result from the higher usage of washing agents like detergents, soaps and faecal matter (Sawhney 2008).

4 Impact of Increased Nitrogen Content on Freshwater

Nitrate in water is an important factor for water quality assessment (Jones and Burt 1993). The presence of nitrate in freshwater may be due to the result of waste being disposed off at the dumpsites or from agro- based industries (Ogbonna 2014). Excess amounts of nitrogen availability in water systems lead to eutrophication and algae blooms (Smitha et al. 2013). The natural background levels of nitrate may come from rocks, land drainage and plant and animal matter and extremely high concentration of nitrate in freshwater body is toxic (Ogbonna 2014). Invariably, nitrate is seldom abundant in natural surface water because it is incorporated into cells and chemically reduced by microbes and converted into atmospheric nitrogen (Chapman 1996). This phenomenon may account for the low concentration of nitrate in surface waters (Ogbonna 2014). Nitrate is highly oxidized form of nitrogen compound and is commonly present in surface and ground waters (Uqab et al. 2017), since it is final product of aerobic decomposition of organic nitrogenous matter (Bartram and Balance 1996). Nitrate concentration in surface and ground waters is usually low but can reach high levels as a result of leeching or runoff from the agricultural fields (Bhat et al. 2017) or contamination from human or animal wastes as a consequence of the oxidation of ammonia and similar sources (Uqab et al. 2017). Water nitrates result from the oxidation of ammoniacal nitrogen and nitrites and the mineralization of the river biomass (Togue et al. 2017). Major sources of nitrate pollution (Fig. 4) vary from agrochemicals, human and animal wastes, sewage leaks, landfills, application of wastewater for irrigation, industrial wastes (Adesuyi et al. 2015). Nitrates are generally found in nature they are the end product of the aerobic decomposition of organic nitrogenous matter as well as the decomposition of organic micro-organisms (Adesuyi et al. 2015) Contamination in drinking water has been implicated to be the causes of major health problems (Krishnan and Indu 2006; WHO 2007; Jagessar and Sooknundun 2011).

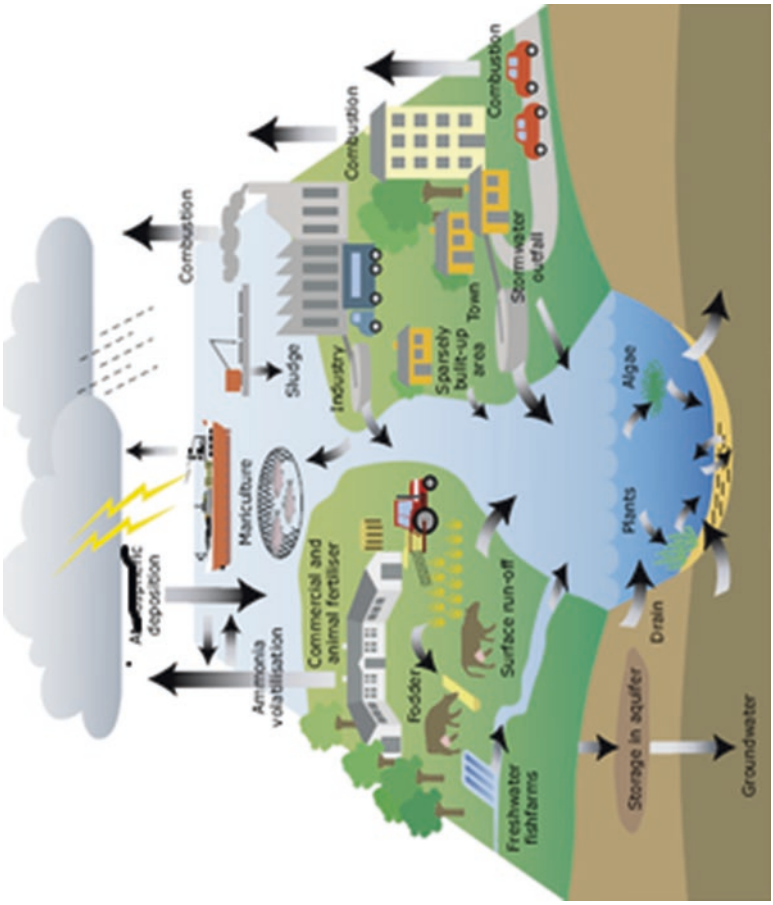

Fig. 4 Various sources of nitrogen pollution in water

5 Impact of Increased Phosphorus Content on Freshwater

Phosphorus is an essential nutrient and can exist in water in both dissolved and particulate forms (Ogbonna 2014). It gets into the water through various sources including leached or weathered soils from igneous rocks, phosphates from detergents in industrial effluents, run offs from fertilized farm lands and domestic sewage containing human excrement (Abowei et al. 2010; Bhat et al. 2017). Its compounds are used in detergent formulation as water softeners (Eunice et al. 2017). Elevated level of phosphates in surface water is one of the most serious environmental problems because of its contribution to the eutrophication process and impairment of water quality (Adesuyi et al. 2015). The elevated phosphate concentration in water have been linked to increasing rates of plant growth, changes in species composition and proliferation of planktonic and epiphytic and epibenthic algae, resulting in shading of higher plants (Chapman and Kimstach 1996). A plausible reason underlying the concentration differential is the unique behavior of phosphorus in shallow waters (Adesuyi et al. 2015) Phosphorus in its soluble state (phosphate) quickly adsorbs at the surface of mud and re-enters the water column (Onwugbuta-Enyi et al. 2008). The high concentration may be due to the effect of seepage from the dumpsites into the water bodies and may be attributed to domestic waste water and agricultural run-offs (Ogbonna 2014). High phosphate concentration is also responsible for the eutrophication of a water body as phosphorus is a limiting nutrient for algae growth (Eunice et al. 2017). All polyphosphates are eventually hydrolysed to produce the ortho form and the rate of hydrolysis is increased by temperature, decreased pH and bacterial enzyme action (WHO 2004). Phosphate, a plant nutrient which stimulates the growth of microbes, molds, aquatic weeds and algae (Eunice et al. 2017) and phosphates returned to the environment are mainly derived from industrial, agricultural (fertilizer) sources and excreta (Togue et al. 2017).

6 Heavy Metal Content

Atmospheric fallout is usually the most important source of lead in the freshwaters (Paar 1998). The higher concentration of cadmium and lead can be due to the potential tailing ponds and the consequences of mining and unregulated landfills in the catchment area (Georgieva et al. 2018). Acute toxicity of Pb in invertebrates is reported at concentration of 0.1–10 mg/L (Paar 1998). Iron is the fourth most abundant element in the earth's crust and is considered as a main factor determining the adsorption capacity (Wright and Welbourn 2002). The presence of high concentration of Fe may increase the hazard of pathogenic organisms; since most of these organisms need Fe for their growth (Centre for Ecological Sciences 2001). Copper is highly toxic to most fishes, invertebrates and aquatic plants than any other heavy metal except mercury by reducing growth and rate of reproduction in plants and animals (Lokhande et al. 2011). Aquatic plants absorb three times more Cu than

plants on dry lands (Moore and Ramamoorthy 1984). Excessive Cu content can cause damage to roots, by attacking the cell membrane and destroying the normal membrane structure; inhibited root growth and formation of numerous short, brownish secondary roots (Lokhande et al. 2011). Cr compounds are used as pigments, mordents and dyes in the textiles and as a tanning agent in the leather (Lokhande et al. 2011). Acute toxicity of Cr to invertebrates is highly variable, depending upon species (Paar 1998). Cr is generally more toxic at higher temperatures and its compounds are known to cause cancer in humans. The toxic effect of Cr on plants indicate that the roots remain small and the leaves narrow, exhibit reddish brown discoloration with small necrotic blotches (Moore and Ramamoorthy 1984). Cd is contributed to the surface waters through paints, pigments, glass enamel, deterioration of the galvanized pipes etc. (Lokhande et al. 2011). It is less toxic to plants than Cu similar in toxicity to Pb and Cr and is equally toxic to invertebrates and fishes (Paar 1998). Chromium is a potential pollutant and well known for its mutagenicity (Cheng and Dixon 1998) and carcinogenicity (Wang et al. 1999) effects in humans, animals and plants. Soil profile, surface water bodies (ponds and rivers), human health, fishes and other aquatic biodiversities are at risk of serious threat due to the extensive use of chromium in tanning industries and discharge of wastewater (Mohanta et al. 2010). Cu, Zn, and Pb are closely associated with crude oil and municipal wastes disposal (Chindah et al. 2004). These metals tend to increase in less saline and highly turbid media (Selvaraj et al. 2010; Wright and Welbourn 2002). The enrichments of heavy metals in water due to the discharge of waste are affecting the properties of the water (Shah et al. 2013; Singh et al. 2011). Discharge of pollutants directly in the water is deteriorating the water quality by decreasing the dissolved oxygen content of water thus making it unfit for aquatic life (Bulut and Aksoy 2008). The various potential sources of heavy metals pollution in any environment are presented in Table 1.

Among the pollutants, toxic metals are of serious concern because they accumulate through the food chain and create environmental problems (Praveena et al. 2010; Paul and Sinha 2015). Higher concentrations of heavy metals can form harmful complex compounds, which critically effect different biological functions (Rajbanshi 2009). The presence of heavy metals in the wastewater of industry is a

Table 1 Potential industrial and agricultural sources for metals in the environment. (Fifield and Haines 2000; Yahya et al. 2018)

S. No.	Metal	Sources
1	Fe	Textiles, paints, fuels and refineries
2	Zn	Pesticides, fertilizers, glass, fuel, etc.
3	Pb	Fertilizers, acid-batteries, alloys, wear and tear of tyres and plastic, vehicles
4	Cd	Batteries and electrical; pigments and paints; alloys and solids; fuel; plastic; fertilizers
5	Ni	Batteries and electrical; pigments and paints; alloys and solids; fuel; catalysts; fertilizers
6	Cu	Vehicles, electrical gadgets, utensils, catalysts
7	Cr	Fertilizers, pigments

potential risk to aquatic ecosystem, animal, and human. High concentrations of heavy metals often pose a serious threat to biota and the environment of any ecosystem (Cheng 2003). Heavy metal pollution can be a much more serious problem because they cannot be degraded by natural processes and persist in soil and sediment from where they are released gradually into water bodies as sink. "Heavy metals" is a collective term, which applies to the group of metals and metalloids with a atomic density greater than 4 g/cm 3, or 5 times or more, greater than water (Hawkes 1997). Heavy-metal contamination is not a modern problem arising out of industrialization e it began when humans started processing ores (Renberg et al. 1994; Sharma et al. 2003).

Generally, most of the heavy metals enter the in river from different sources (Lettinga 1995; Maekawa 2003; Mehmood et al. 2019), it be can be either natural by erosion and weathering and or anthropogenic (Gupta et al. 2013; Sheykhi Moore 2016). In view of the intense human activity, natural sources of heavy metals from leaching and weathering of rocks in the environment are usually of little importance (Dixit et al. 2015). The most important anthropogenic sources of heavy metal are various industries, vehicles and domestic sewage (Paul 2017; Singh et al. 2018). The practice of discharging waste from industries and untreated domestic sewage into the aquatic ecosystem is continually going on that leads to the increase in the concentration of heavy metals in river water (Wang et al. 2011; Capangpangan et al. 2016). The industries which attribute heavy metals in river water are generally metal industries, paints, pigment, varnishes, pulp and paper, tannery, distillery, rayon, cotton textiles, rubber, thermal power plant, steel plant, galvanization of iron products and mining industries as well as unsystematic use of heavy metal-containing pesticides (Morrison et al. 2001; Mohan et al. 2006; Ogbonna et al. 2008; Parveen et al. 2017) and fertilizer in agricultural fields (Suthar et al. 2009; Sindern et al. 2016). These heavy metals have accumulative effect at the low level in drinking water and ground water (Prabha and Selvapathy 1997). Ansari et al. (1999) determined the concentrations of Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Sn and Zn in sediments of the river Ganga and according to them about 90% of the contents of Cd, Cr, and Sn; 50–75% of organic carbon, Cu and Zn; and 25% of Co, Ni and Pb in sediments are derived from the anthropogenic input in relation to the natural background values. Sarkar et al. (2007) also analyzed the level of dissolved heavy metals such as Fe, Zn, Mn, Cu, Pb, Hg at three ecologically distinct zones along the course of the river Ganga- Babughat, Diamond Harbour and Gangasagar in West Bengal and reported high values for Hg and Pb which can be attributed to the discharge from pulp and paper manufacturing units and to atmospheric input (Pretty 2002; Pulles et al. 2005; Ram et al. 2007; Rast 2009) and runoff of automobile emission (Singh et al. 2018; Rashid et al. 2019). The most important heavy metals from the point of view of water pollution are Zn, As, Cu, Pb, Cd, Hg, Ni and Cr as some of these metals (e.g. Cu, Fe, Mn, Ni, and Zn) are required as nutrients in trace amount for life processes in plants and microorganisms but become toxic at higher concentrations (Paul 2017) while other such as Pb, Cr, and Cd has no known biological function but are toxic elements (Ghannam et al. 2015). These heavy metals are not readily degradable in nature and accumulate in the animal as well as

human bodies to a very high toxic amount leading to undesirable effects beyond a certain limit (Adakole and Abolude 2012: Govind and Madhuri 2014). The fatal diseases such as eyelid edema, nephritis, renal tumor, extensive lesions in the kidneys, anuria, nasal mucous membranes (Pei et al. 2012; Pawari and Gawande 2015) and pharynx congestion, increase blood pressure and cardiovascular diseases, osteoporosis, cancer, headache (Sartor et al. 1974; Salem et al. 2000; Scannell and Duffy 2007; Wosnie and Wondie 2014; Yuan et al. (2014) and malfunctions of different systems of the body caused by heavy metals (Jaishankar et al. 2014; Solenkova et al. 2014). They are also known to interfere with synthesis and metabolism of the hormones (Sharma et al. 2014).

7 Conclusion

Untreated wastewater drastically changes the physico-chemical and biological characteristics of freshwater ecosystems. Wastewater contains persistent pollutants and harmful microbes which not only decrease the quality of freshwater environment but also damages permanently aquatic and associated biota. The foremost threat due to discharge of untreated wastewater causes eutrophication in stagnant freshwater ecosystems. Eutrophication not only decreases the water holding capacity in wetlands and lakes, but also depletes the dissolved oxygen level below the service to fish fauna. Besides this untreated wastewater becomes pollutant factory for freshwater ecosystems. Presences of these kinds of pollutants in freshwater ecosystem have long-term impacts on aquatic and associated biota. Therefore, need of an hour is to monitor the quality of freshwater ecosystem on regular basis and focus should be given to the treatment of effluents prior to its discharge into the freshwater ecosystem.

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