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Role of Inorganic Pollutants in Freshwater Ecosystem - A Review.

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Abstract

Pollutant is a substance produced either by a natural source or by human activity which has an adverse on the environment, that is, which causes environmental pollution. Environmental pollution is a worldwide problem. Water is the most natural resource that exists on our planet and is essential for survival and the development of modern technology. Thus, rapid industrialization is one of the main causes for aquatic pollution. One of the most important categories of water pollutants is inorganic chemical. Inorganic contaminants of aquatic environment caused by naturally occurring substances (Fluoride, Arsenic & Boron), industrial waste (Heavy metals like Mercury, Cadmium, Chromium, cyanide etc.,) and systems to the distribution of drinking water (Aluminium, Copper, Iron, Lead & Zinc). Naturally occurring inorganic materials mainly contaminate ground water, industrial and agricultural waste; mainly surface water such as rivers, lakes, ponds and pipes of distribution systems, mainly tap water. The present review gives a brief account on the role of inorganic pollutants in freshwater ecosystem.

Keywords: Inorganic pollutant, Heavy metals, Freshwater ecosystem, Chennai.

Introduction

Aquatic ecosystems are highly complex, dynamic and subject to many internal and external relationship that are subject to change over time. The pollutants enter the aquatic system and create serious problems causing extensive damage to the life and activities of the living aquatic organisms and even to mass mortality [1]. Pollutants change the water chemistry which affects the water quality and upset the ecological balance in the aquatic ecosystem. Most pollutants that enters the aquatic environments are chemical in nature and range from completely toxic substance such as agricultural pesticide, cyanide and salt of various heavy metals to nutrient such as phosphate, nitrate, fertilizer and organic matter of domestic and industrial origin[10,16]. (The various water pollutants can be classified as following: Sewage and other oxygen demanding wastes, Infectious agents, Plant nutrients, Exotic organic chemicals, Inorganic chemicals and chemical compounds, Sediments, Radioactive substances, Heat, Oil and Detergents). The aquatic ecosystem has received considerable attention due to their heavy metals toxicity which are dangerous to aquatic biota as it can be bioaccumulated in them through food chain. Pollutants mainly that enter the inland water bodies may extensively through atmospheric deposition, erosion due to anthropogenic activities, mixing of untreated industrial effluents, draining of domestic sewage, dumping of mixing wastes etc., A brief list of inorganic elements whose are most commonly present in municipal and industrial waters in given in Table1 along with their sources and adverse effects.

Table 1: Toxic Elements Commonly Present In Municipal and Industrial waste waters

Element	Sources	Adverse effects
Arsenic (As)	Pesticides, Chemical wastes, Mining bi-products	Enzyme-inhibitor, Carcinogenic
Beryllium (Be)	Nuclear power and Space industries, Coal.	Toxic, Carcinogenic
Boron (B)	Industrial wastes, Detergent formulations, Coal.	Toxic to some plants
Cadmium (Cd)	Industrial discharge, Metal plating, Ni-Cd batteries, Mining waste.	Causes high blood pressure, kidney malfunctioning, anaemia, disorder of bone marrow.
Chromium (Cr III & Cr VI)	Metal plating industries, Tanning process.	Cr (VI) carcinogenic.
Copper (Cu)	Metal plating industries, mining, mineral leaching.	Toxic to plants and algae.
Fluorine (F)	Natural geological sources, industrial waste.	Causes bone damage, mottled teeth.
Lead (Pb)	Plumbing, mining, coal, gasoline	Causes anaemia, kidney malfunctioning, nervous disorder.
Manganese (Mn)	Mining of industrial waste, microbial action of Mn minerals of low pH	Toxic to plants
Mercury (Hg)	Mining, industrial waste, coal.	Highly toxic in the form of CH_3Hg^-, Hg^{2+}.
Molybdenum (Mo)	Natural sources, industrial waste	Toxic to animals
Selenium (Se)	Natural sources, coal.	Toxic
Zinc (Zn)	Metal plating industries, industrial waste.	Toxic to plants.

Most of the inorganic chemicals contained in aquatic environments are heavy metals, inorganic anions and radioactive materials. It is to be noted pertinently that it is not presence of a particular chemical but its concentration which actually matters in chemical toxicology. Thus elements such as As, Al, Sb, Ba, Be, Cd, Co, Cu, Ce, Pb, Mo, Hg, Zn etc., which are listed as environmental hazards, act as nutrients in trace concentrations and are essential for normal growth and development of animals and human beings. And these heavy metals get transferred through food web into human beings creating public health problems. The permissible limits for some common elements as lay down by the United States public health drinking water standards and BIS (Bureau of Indian Standards) are given in Table 2.

Table 2: Permissible Amounts of Various Elements in Drinking Water Permissible limit (ppm – parts per million)

Element	According to USPH Standard	According to BIS Standard
Arsenic (As)	0.05	0.05
Barium (Ba)	1.0	No relaxation
Beryllium (Be)	1.0	1.5
Boron (B)	1.0	No relaxation
Cadmium (Cd)	0.01	No relaxation
Chloride (Cl)	250	600
Chromium (Cr VI)	0.05	0.05
Copper (Cu)	1.0	No relaxation
Cyanide (CN^-)	0.05	No relaxation
Fluoride (F^-)	1.5	1.5
Phosphate (PO_4)	0.1	No relaxation
Lead (Pb)	<0.05	No relaxation
Manganese (Mn)	<0.05	No relaxation
Mercury (Hg)	<0.05	No relaxation
Molybdenum (Mo)	0.05	No relaxation
Selenium (Se)	0.05	No relaxation
Zinc (Zn)	5.5	5

(The drinking water should be colourless and odourless. Its pH should lie between 6 to 9. It should be free from harmful microorganisms and its dissolved oxygen content should lie between 4 and 6ppm. It should not contain the above mentioned chemicals beyond their permissible limits).

There are two main sources for heavy metals into the environment that is lithogenic (natural process) and anthropogenic (Human activities). During recent decades, urban and industrial activities are increasing heavy metals into the aquatic ecosystem, when they exceed standard concentration, they have toxic effects on living organisms also they decrease survival growth and species diversity[4]. Some inorganic pollutants of aquatic system and their sources are listed in Table 3. Due to urbanization and widening industries, these contaminants were released into adjoining aquatic system in the industrial area. This ultimately affects the biochemical and nutritional perspective of aquatic ecosystem.

Table 3: Some Common Inorganic Pollutants

Pollutants	Representative examples	Sources
Acids	Sulphuric acid, Phosphoric acid etc.,	Mine runoff, wool seouring waste, iron pickle liquor.
Alkalis	Caustic soda, Lime	Tannery waste, Cotton processing waste.
Cations	Mercury (II), Lead (II)	Metallurgical operations.
Anions	Sulphides, Cyanides	Plating waste, Gas liquor, Mine runoff.

Radio Activity

Many radioactive elements like uranium, thorium and actinium, have always existed in the earth's crust. Granite rocks are particularly rich in radioactive materials. A part of these radionucleides enter the natural water courses. However, the background radiation of water receiving radio isotopes from natural sources is very low. The danger lies in any large scale increase in radiation due to the development of nuclear fission processes and also due to the increased man – made sources of radioactivity in medicines, industry and research.

When radionucleides are taken up by aquatic organisms, exchange takes place with chemically similar elements already present in the organism's body. For eg., radioactive Strontium – 90 and Radium – 226 replace Calcium. Thus Strontium – 90 becomes concentrated in scales and bones of fish. Phosphorus – 32 is readily absorbed by bones of aquatic animals. Waterweeds tend to assimilate Strontium – 90 and Radium – 226.

Once the isotopes are accumulated in the body, these start emitting radiations. For example, Strontium – 90 is a β – emitter.

$$^{90}Sr_{38} \longrightarrow {}^{30}Y_{39} + {}^{0}\beta_{-1}$$

$$^{226}Ra_{88} \longrightarrow {}^{222}Rn_{86} + {}^{4}He_{2}$$

The radiations emanating from these elements cause a multitude of hazardous effects. Since, the aquatic flora and fauna can concentrate radioactivity, the possibility exists that those used as food by man could bioaccumulate dangerous amounts of radiations in the human body[1].

Soaps and Detergents

Soaps are the sodium or potassium salts of fatty acids. These are manufactured by the saponification of fats and oils. Synthetic detergents or syndates were developed as soap substitutes in an economy which was running short of edible fats and oils. Surfactants fall into four major categories, depending on their ionic activity. These are anionic cationic, non – ionic and amphoteric. The last three categories include only synthetic detergents. The anionic surfactant category, however, includes both soaps and detergents[16].

Toxicity to Aquatic Organisms

Water plants and animals are adversely affected by the synthetic detergents. Rooted plants like *Ranunculus aquatilis* are unable to grow if the concentration of syndets in water exceeds 2.5ppm. A concentration of 3ppm of common household detergents causes 50% mortality of trout fish in 12weeks. Soaps are less toxic. These cause fish mortality only when their level exceeds 10ppm. Moreover, it has been observed that the toxicity of soaps is greatly reduced in hard water due to their precipitation as insoluble calcium or magnesium salts[4,27]. The lethal concentration of commonly used surfactants are given in Table 4.

$$\mathbf{2RCOO^{-}Na^{+} + Ca^{2+} \longrightarrow (RCOO)_2Ca + 2Na^{+}}$$

$$\mathbf{2RCOO^{-}Na^{+} + Mg^{2+} \longrightarrow (RCOO)_2Mg + 2Na^{+}}$$

Table 4: Toxicity of Surfactants to Fish

Type	Minimum lethal concentration (ppm)	
	Pure water	Hard water
Soaps: Sodium palmitate Sodium state	10 -12 10 – 12	900 – 1000 250 – 300
Detergents: Sodium lauryl sulphate (anionic)	6 – 7	6 – 7
Poly glycol ether (non – ionic)	2 – 3	2 – 3

Inorganic minerals and chemical compounds

A large variety of inorganic chemicals find their way into normal water from municipal and industrial waste waters and urban run offs. These pollutants (comprising of compounds of As, Ca, Cd, F, Hg, Na, Pb etc.,) injure or kill fish and other aquatic life and also render the water unfit for dinking or for industrial use. A prominent example is the presence of mercury in water. Anaerobic bacteria in bottom muds convert inorganic mercury into methyl mercury CH_3Hg^+, which can lead to mercury poisoning in living being. In petroleum drilling, brine is discharged along with crude oil when the latter is pumped to the surface. Sometimes the volume of brine maybe more than three times the volume of crude oil recovered. This brine is a potential pollutant for water. Minerals containing sulphur(eg., iron pyrites, copper pyrites) on coming in contact with air and water yield sulphuric acid which is carried into lakes and rivers by water draining from the mines. The presence of the acid affects aquatic life.

In cold countries, NaCl and $CaCl_2$ are added in large amount to melt snow from the roads and contaminate well water and also find their way into lakes and rivers, and seriously affect the aquatic life [6,38,54].

Thermal pollution

Thermal or temperature pollution refers to the discharge of heated water from electricity generating plants into water course. The abrupt change in the temperature of natural water has severe environmental consequences. Of all forms of physical pollutants, thermal pollution is the most important[1].

Naturally occurring substances in aquatic ecosystems

Inorganic chemicals are usually present in natural water at much higher concentrations than their organic counter parts. Many of these chemicals are naturally occurring and should be considered as an integral part of those particular waters eg: Calcium, Carbonate & Bicarbonate in hard waters, rather than as "contaminants".

Major elements

These are the components of drinking water usually present in the highest concentrations, and which have a major impact on taste and aesthetic quality eg., the ability of a water to deposit scale.

Sodium (Na)

Sodium salts are usually highly soluble in water and can leach from strata bearing such salts. However the highest levels of sodium in water are usually associated with saline intrusion at the coast or from underground salt deposits. Sodium is extremely low toxicity but evidence from animal studies does indicate that high levels of salt in the diet may result in hypertension[15,26,51]. Exacerbation of congestive heart failure, which is aggravated by excessive salt intake, has also been reported as consequence of high sodium levels in drinking water. The major effects of high sodium levels in drinking water for most individuals is an adverse effect on taste. The taste threshold in water depends on both the associated anion and the temperature. The taste thresholds for NaCl, nitrate and sulphate at room temperature are 150mg/l, 190mg/l, & 420mg/l respectively.

Chloride (Cl)

Chlorides are highly soluble and are leached from rocks & soil, eventually reaching the sea. Na, K, Ca, MgCl are widely used in industry in the production of industrial chemicals and fertilizers and in snow and ice control. Industrial and sewage discharges, run – off from de – icing operations and saline intrusion all contribute to chloride levels in surface and ground water[55]. Chloride levels in unpolluted waters can be below 10mg/l but concentrations in drinking water after higher than this. Chloride in drinking water normally contributes less than 2% to the average dietary intake of about 6g/day. Chloride is an essential element and the chloride ion does not appear to have an adverse effect on health itself. The toxicity of chlorides depends on the associated cation. The primary pollution with chloride in drinking water, apart from a contribution to the corrosivity of the water, is its effect on taste. The taste threshold of the chloride anion is dependent on the associated cations and the taste thresholds for Na, Ca & KCl are 210, 222 & 310mg/l respectively[47].

Aluminium (Al)

Aluminium third most abundant element in the earth's crust, occurs primarily in soil as alumino silicates. These minerals are insoluble and contain aluminium bound covalently to silicon and oxygen atoms. Therefore, aluminium content of soil does not interfere with nutrient uptake or cause biological activity. However when acid rainfalls on forest soil, the alumino silicates release aluminium either as free ions, Al^{3+}, or as monomeric hydroxides, $[Al(OH)^2]^+$, $[Al(OH)_4]^-$. In these forms, aluminium is soluble in water. It is therefore mobilized and taken up by trees through the roots. Aluminium is toxic to plants. It kills the roots and eliminates the favorable microbes. It also interferes with nytrient cations uptake. The net result is that the forest areas start declining[18.] In 1970's a condition was identified in dialysis patients which was characterized by insidious onset of altered behavior, dementia, speech disturbance, muscular twitching and convulsions this was termed as dialysis dementia. Patients were shown to have substantially elevated serum aluminium levels and high concentrations in many tissues including brain. A correlation between aluminium in water used to prepare dialysis fluid was established and controlling this and other sources of aluminium, including phosphate binders, resulted in control of the condition[56].

Other inorganic contaminats

There are many inorganic contaminants found in water which are usually present at lower concentrations than the major components.

Arsenic (As)

Arsenic is a metalloid widely distributed in the earth's crust and the main sources of arsenic compounds in water are pesticides, fungicides, pharmaceuticals and herbicides. Arsenic contamination may also occur due to discharge of industrial wastes. Elemental arsenic is not soluble in water. Dissolution of arsenic minerals is another source of arsenic compounds. Arsenic can exist in four valence states: -3, 0, +3 and +5. As (V) is generally stable form in the oxygenated environment. Under natural conditions, the highest concentrations of arsenic are found in groundwater as a result of influence of rocks such as arsenopyrite (FeAsS). As (III) compounds are highly toxic. Arsenic is structurally similar to phosphorus, its presence interferes with the process of phosphorylation in human body[5.] Arsenic is also known to cause lung cancer in humans, dermatitis and hair loss. However arsenic in drinking water or ingestion through food is clearly associated with cardio – vascular and skin pathology also suspected to cause liver & skin cancer. Arsenic compounds are protoplasmic poisons that attack enzymes. Arsenic is one of the few compounds classified by IARC in group I, known to be carcinogenic to humans [21].

Antimony(Sb)

Antimony has been identified in natural waters in both Sb(III) and Sb(V) oxidation states and as methyl antimony compounds. A mixture of antimony trioxide and antimony pentoxide in an antimony smelting plant exhibited symptoms such as chronic coughing, bronchitis, emphysema, conjunctivitis and staining of the teeth [15].

Barium (Ba)

Barium is found in both igneous and sedimentary rocks and can be leached by water of low pH, as the nitrate or one of the halides. Levels of barium in food are low and the total intake of barium at low water concentrations is about 1mg/day. Barium is primarily of interest because it has been shown to cause significant and persistent increase in mean systolic blood pressure in a study in rats, with a no observed adverse effect level of 0.51mg/kg body weight/day and a lowest observed adverse effect level of 5.1mg/kg body weight/day [2].

Boron

Boron is a naturally occurring element that is found in the form of borates in the ocean, sedimentary rocks, soil, coal and estuarine water [38,55]. Boron chemistry in water is poorly characterized but it would appear that boron is probably normally present in the form of undissociated boric acid. Boron as boric acid is rapidly absorbed from the gastrointestinal tract in humans[2]. Chronic exposure to boric acid and borax leads to gastrointestinal and kidney problems with loss of appetite, nausea and the appearance of erythematous rash. Boron is subjected to be an endocrine disrupter based on results of animal experiments it caused testicular atrophy and spermatogenic arrest[37].

Cadmium (Cd)

Cadmium is placed in between zinc and mercury in group 12 triad of the periodic table. It is however, more close to zinc than mercury in its physical and chemical properties. Its affinity for sulphydryl group induces, its solubility in lipids which, in turn, causes it to bioaccumulate in liver & kidneys. Since zinc and cadmium have similar properties, the ores of the two metals occur together in nature. During extraction of zinc, cadmium is released to the environment as a by – product. As a result, soil and water in the vicinity of zinc smelters have an abnormally high concentration of cadmium. In fact, zinc metallurgy is the most important source of cadmium in the environment. Cadmium is extremely resistant to corrosion. Before its toxic properties were documented, this heavy metal was extensively used for electroplating other metals, especially those metallic devices that were to remain in contact with sea water. Subsequently, cadmium leached into the sea and entered the marine food chain. The most notable example of cadmium poisoning occurred in Japan in the 1950's, about 200 people living in Jintsu river valley suffered from a disease which came to be called ("itai itai – which means It hurts! It hurts!"). The river required cadmium – containing effluents from a zinc refinery located along its coast. Downstream, the river water was used for irrigating rice fields. Cadmium thus became a component of diet. Once in the human body, cadmium replaced calcium in the bones (the two metals have similar size and charge). Symptoms similar to those of rheumatism set in. Subsequently, the bones softened and became susceptible to fractures. Consumption of cadmium – contaminated sea food causes enzyme poisoning. Cadmium displaces zinc in many vital enzymatic reactions, resulting in disrupting or cessation of activity. This normally leads to gastroenteritis [4,41].

Chromium (Cr)

Chromium does not occur free in nature. In combined state, it occurs as chromite ores[32]. Chromium from natural sources in only found in driving waters at low concentrations of upto 2 or 3µg/l. Chromium occurs as Cr (VI) & Cr (III) with the former being the more soluble form. The major sources of chromium in most surface water and some shallow ground waters is human industrial activity and concentrations in excess of 50µg/l have occasionally been reported[45,48,49]. Food is normally the major source of chromium in the diet, but drinking water can make a significant contribution in some circumstances. The total intake of chromium from food and water is estimated to be between 52 & 943 µg/day[49]. Chromium(III) is an essential element in human nutrition and is necessary for glucose metabolism in necessary for glucose metabolism in particular. Chromium (VI) has been shown to be carcinogenic to humans by inhalation in occupationally exposed populations. IARC classify Cr (VI) in group I. There is also evidence that Cr(VI) is genotoxic invitro and invivo in occupationally exposed human groups [22,23].

Fluoride (F)

Fluoride commonly occurs in the form of minerals such as fluorspar, cryolite and fluorapatite. Al, Ca & MgF are of low solubility in water but NaF is highly soluble. Many waters contain low levels of fluoride, less than 1mg/l, but in supplies associated with fluoride rich minerals, particularly from underground sources, concentrations may exceed this and may even reach 10mg/l [47,52.]. However fluorides are added to drinking water in many aprts of the world in order to prevent dental caries and in these circumstances drinking water concentrations are usually adjusted to some where between 0.6 & 1.5mg/l. fluorine, as fluoride, is an essential element which is involved in mineralization of teeth and bones. Increasing bone density is observed at concentrations in excess of 3 – 6mg/l and crippling skeletal fluorosis with significant deformation of the skeleton occurs with long term exposure to concentrations in excess of about 10mg/l.

Iron (Fe)

Iron is one of the most abundant elements in the earth's crust and is found as a range of salts & minerals eg., oxides, hydroxides, carbonates & sulphides both as Fe(II) & Fe (III). In anaerobic ground waters, where iron is present as ferrous ion (Fe II), concentrations can be up to 10mg/l but less than 3mg/l is more typical. Iron salts are used as coagulants in drinking water and cast iron pipes may increase the concentrations of iron in drinking water.

Lead (Pb)

Lead is one of the oldest metals known to man. The most important natural source of lead in the environment is the weathering of rocks. The lead content of the rocks is eroded by fast moving rivers and carried to long distances. Wind – blown dusts, volcanic eruptions, forest fires and sea salt sprays are some other natural phenomena leading to the disruption and concentration of lead in the environment. The man – made sources of lead have played a greater havoc with the environment. Lead has been mined and worked by man for millennia. Its ductility, high strength, high density, impermeability to radiation and other properties make it a very useful metal. Lead is used in acid storage batteries, ammunition, solder and casting materials. Most of the lead poisoning incidents in children below the age of five are caused by eating flecks of lead – containing paints from the walls of deteriorating building. This behavior is termed as pica. Lead monoxide, also called litharge, is an orange – yellow pigment that is used in glazing pottery. When acidic foods like fruit juices and pickles, are stored in improperly glazed earthen wares, lead slowly leaches from the glaze and become a component of the diet. Lead enters drinking water from old conduct water pipes. Lead poisoning also called as plumbism or saturnism. Once lead enters in the human body it tends to concentrate in the bones. It remains in the bones in a relatively inert form, causing no ill effects. However, when the body feels shortage of an essential element like calcium or phosphorus, the blood leaches out these minerals from the bones and supplies it to the relevant organ. In this process, lead too becomes labile and enters the blood stream. It then concentrates in the tissue where it elicits toxic effects[5,41].

Manganese (Mn)

Manganese is an extremely abundant element, occurring mainly with iron, and concentrations in lakes and rivers ranges from 1 to about 600µg/l [3]. Manganese is an essential element but no manganese deficiency has been identified in humans[53]. In general, manganese has been considered to be low toxicity, but it is a well estabilished neurotoxin at high doses by the inhalation route[3]. However manganese appears to be poorly absorbed from the gastrointestinal tract although it is possible that soluble manganese from food. In Japan, symptoms of neurotoxicity were reported in a number of individuals, particularly among the elderly, in a population exposed to contaminated well water containing manganese at a concentration which was probably close to 30mg/l [25].

Mercury (Hg)

In aquatic ecosystems, mercury exists in elemental, inorganic and organic forms. Elemental mercury (Hg^{o}) is the only metal in liquid form at room temperature. It has high volatility and relatively low water solubility[26]. Aqueous inorganic mercury has two valences, +1 and +2. Mercury with valence +2 is more widely spread in environment[6]. Mercury is discharged into the aquatic systems both by natural sources and man – made sources. Mercury in the form of cinnabar (HgS) or in metallic state is embedded in igneous rocks, in particular basalt & granite. These rocks contain about 0.080ppm mercury content. Each year about 800 tonnes of mercury are released to the environment through weathering of rocks. The natural contribution of mercury to the aquatic systems is minor and stable. Except for locations near rich deposits of mercury – bearing minerals, the only concentrated sources of mercury in the aquatic systems are those resulting from human activities. Mercury content of the aquatic systems has elevated due to progressive urbanization and industrialization.

Table 5: Body burden at the onset of symptoms of methyl mercury poisoning

Symptoms	Body burden (ppm)
Paresthesia	0.50
Ataxia	1.00
Dysphasia	1.75
Deafness	3.50
Death	4.00

Table 5 provides data on various diseases caused by methyl mercury poisoning in humans. Methyl mercury chloride readily penetrates the fetus through the placenta. The concentration of mercury in the blood and the brain of the fetus is about 20% higher than in the mother. Infants whose mothers are exposed to large amounts of methyl mercury chloride are liable to be afflicted with mental retardation, cerebral palsy and convulsions.

Selenium (Se)

Selenium concentration in drinking water are usually less than 10µg/l but in areas with seleniferous rocks, concentrations can reach several hundred µg/l [54]. Selenium is an essential element through there are few reports of selenium deficiency in humans. The recommended daily intake for adults and infants are 0.9µg/kg & 1.7µg/kg respectively [38]. There are many instances of adverse effects in human populations exposed to high levels of selenium in food. These are primarily manifested as brittle hair and nails, skin lesions, moulted teeth and in some cases, changes in peripheral nerves [13].

Summary

The heavy metals generally enter the aquatic environment through atmospheric deposition, erosion of geological matrix or due to anthropogenic activities caused by industrial effluents, domestic sewage and mining wastes. The metal contaminants in aquatic systems usually remain either soluble or suspension form and finally tend to settle down to bottom or taken by the organisms. The progressive and irreversible accumulation of these metals in various organs of aquatic creatures leads to metal related disease in the long run because of their toxicity, thereby endangering the aquatic biota and other organism. The ligands of any metal maybe important factor to cause toxicity, the organometallic forms eg., methyl Hg and tetraethyl Pb can be highly toxic; while the organometallic derivatives are less toxic eg; cobaltocerium cation. The bioaccumulation of toxic metals can occur in the body and food chain. So, the toxic metals generally exhibit chronic toxicity. For example, the radioactive heavy metals like radium can imitate calcium to be incorporated into the bone, but the similar hazards can also due to Pb or Hg. However barium Ba, and aluminium Al are exceptions as they can be quickly excreted by the kidneys. Many heavy metals (including essential ones) are poisonous above their threshold levels. The heavy metals usually enter the body through respiration, ingestion and skin.

Conclusion

For the welfare of the water bodies, government shall devise strategies for the safe disposal of industrial waste and domestic sewage.

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