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REVIEW ARTICLE

Heavy Metal Pollution in Mangrove Region: A Review

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ABSTRACT

Water is the driver of nature and best of all things. Water is a "Cradle of Life" on which all organisms play. Next to air water is one of the natural resources for life and it is likely to become a critical scarce resource in further. The total life of the world depends on water and hence the hydrological study is very much essential to understand the relationship between its different tropic levels and food webs. Wetlands are one of the most useful natural resource systems, and are "essential life" support system. They play a vital role in controlling water cycles and cleaning the coastal environment and also they are open ecosystem which is sustained by the flow of energy and nutrients from the neighboring marine and land systems and in turn influences them. The tidal forest is used as a synonym of mangroves. Moreover, the mangrove forest provides to human resources such as fuel, building materials for house, boats and fishing equipment, food stuffs such as fish, mussels, leaf vegetables, honey, sugar, vintage and alcoholic drinks and traditional medical remedies.

Key words: Water, Heavy metal, Mangroves and Pollution.

1. INTRODUCTION

Mangrove forest are one among the world's most productive ecosystem, they are often referred to as 'tidal forest', 'coastal forest' or 'Oceanic rain forest. They are the woody plants that grow in tropical latitude along the land sea interface, bays, estuaries, lagoons, backwaters and in the rivers, where the water still remains saline. The mangrove ecosystems support genetically diverse groups of aquatic and terrestrial organisms. These forest ecosystems also support marine fisheries and protect the coastal zone, thus helping the coastal environment and economy.

The mangroves are the most productive ecosystem which can efficiently fertilize the sea, potentially protect the coastal zone and vitally serve as the breeding and feeding grounds of fishes and also support large number of terrestrial flora and fauna [1]. The mangrove exists under very hostile and inhospitable condition. The plants which grow there have to encounter higher salinity, tidal extremes, wind velocity, high temperature and muddy anaerobic soil. No terrestrial plants can survive well under these adverse conditions [2].

Mangrove forests fix more carbon dioxide per unit area than phytoplankton in tropical oceans. Also the mangrove plants have great potential to adapt to the changes in climatic (precipitation and temperature) the rise in sea levels and the incidence of solar ultraviolet β-radiations. It is believed that mangrove vegetation also promotes sediment accretion. Salinity of seawater may greatly affect the morphological and physiological characters of mangrove plant taxonomy [3].

A number of industrial units in and around located on this coast and discharge their effluents, treated and or untreated into the sea, and coastal towns also discharge untreated municipal sewage into the sea. Environment and development are two side of the same coin. The need for development through socio economic activities especially with the growing populations and a desire for higher standard of living with industrial production in obvious practically all socio-economic activities for example Industries, agriculture, transport, construction, of road housing have contributed to the environmental degradation including water, air and soil. The complexity of the problems due to the involvement of increasing parameters, have necessitated a multi-disciplinary approach to environment pollution. The role of water in nature not only for the view point of human considration but also forms the viewpoint of a suitable habitat for numerous organisms. Rapid industrialization and extensive use of pesticides in agriculture have

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put a severe strain on the aquatic ecosystem resulting in the deterioration of its quality. Increasing pollution of water bodies has becomes a matter of great concern over a period of last few decades [4].

Water pollution may be defined as the "alternation of physial and biological properties of water or any addition of foreign material and the natural water which may have harmful effect on living beings, human agricultural system and other biological aspects, either directly or indirectly or immediately or after sometimes or after a very long period". Among the several characteristics of water quality the most important factors such as temperature, pH, dissolved oxygen, electrical conductivity, total dissolved solids, biological oxygen demand, chemical oxygen demand and nutrients, like phosphate, silicate, nitrate and nitrites, ammonia etc., and heavy metals *viz* copper, chromium, cadmium, lead, zinc, manganese and iron will play an important role in the life of aquatic organisms [5].

Nearly 80% of ocean pollution enters from the land, virtually anthropogenic activities have serious effect on the quality of nearby water environment. The fertilizers that the farmers used previously are gradually washed by rain into the surface water or ground water nearby, chemicals / toxic chemicals / toxic substances released from the chimneys enters the atmosphere and then reaches the surface as rain entering rivers, lakes and finally seas causing water pollution that in why? It is such a difficult problem to the human beings at present. Further, nearly 8 billion peoples disposing sewage wastes to the environment. Sewage disposal affects immediate surrounding environments and leads to many water – borne diseases. The sewage water contains several chemicals and carries pathogens, which inturn cause illness such as hepatitis, cholera and typhoid. Fertilizers and sewage combined together to form rich nutrient which in turn can produce harmful algal bloom that are naturally reduces dissolved oxygen content in the water bodies so that aquatic organisms face respiratory problem.

Heavy metals are considered as major resources of pollution in natural water. These have received considerable attention because of the inherent toxicity to the living aquatic forms. The toxicity of heavy metals in water in affected by pH, hardness, alkalinity and organic materials. Another type of toxic pollution comes from heavy metals such as cadmium, mercury and lead. Recently, a high toxic chemical called tributyltin (TBT) is used in paints to protect boats from the ravaging effects of the ocean. Mineral, containing heavy metallic elements are of widespread occurrence in rocks and soils, when they weathered, cations of the heavy metals are liberated and find their may into surface waters and soil waters. Lead, copper and zinc have been extensively mined and whose environmental levels have been strongly influenced by man [6] all are toxic to living animals and are considered as serious pollution.

In aquatic ecosystem metallic compounds occur in low concentration. Heavy metals may come from natural sources, leached from rocks and soils according to their geochemical mobility and also from anthropogenic source as the result of human land occupation, and industrial pollution. Depending on their solubility, these metals may be eventually associated with suspended particulate matter or accumulate in the bottom sediments. The increase of industrial activities has intensified environmental pollution problems and the deterioration of several aquatic ecosystems, with the accumulation of metals in the target organs. Trace elements are essential to life but at high concentration may become hazardous. Heavy metals such as cadmium, arsenic and lead can cause several problems in aquatic environments due to their persistence, toxicity and tendency to accumulate in tissue.

Phytoplankton's are of immense value as food and plays an important role in the natural purification of polluted water [7]. Phytoplankton constitutes the very basic of nutrient cycle of aquatic ecosystem. They play a key role in maintaining proper equilibrium between abiotic and biotic components of an aquatic ecosystem and they have been regarded as the chief primary producers of the natural ecosystem. Their density has been reported to be effected by the quality of water [8] the physico chemical characteristics of water can enhance or inhibit the growth of plankton, due to the presence of a complex mixture of nutrients and toxicants in the effluent. These changes may favour or impede primary production and secondary production of the biota. Anyhow, it may promote transference of pollution tolerant species to reduce biodiversity and stability.

Zooplankton are the most important food of many fishes species, are highly sensitive to ambient both a good indicator of aquatic pollution which is an important consideration for water managers [9]. The composition of zooplankton community is influenced by various features of water quality, reduction by planktivorus fishes and the composition of the phytoplankton community. The structure and activity of the herbivours

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zooplanktons community can in turn exert substantial feedback by influencing the composition and biomass of the plankton community.

2. POLLUTION AND TOXICITY OF MANGROVES

The levels of Zn and Fe in the mangrove environments of Sundarbans were on the higher side due to drainage form the neighbouring river. The effect of heavy metals copper, mercury, cadmium and nickel an enzymatic activity of the five bacterial strains isolated form mangrove sediments of Tuticorin coast have been studied. In general, the enzymatic activity of the strain decreased with increseing concentration of heavy meatals through some starins showed tolerance to copper; the activity was less when compared to control [10]. Impact of diesel spill on *Acanthus illicofolius* at Mangalavanam has been studied. *A. ilicifolios* population up to the high tide level showed wilting on the third day of diesel leak from the Hindustan Petroleum Corporation Ltd. And subsequently the leaves shows chlorosis and finally the entire plant dried [11].

During premoonsoon, due to high salinity and pH, the metal level in the plasma of horseshoe crab and aquatic phase decreased. *Lycastis merukensis* a polychate was studied over a period of two years for metal contamination it exhibited a threshold for copper after which the metal concentration was depleted, even through the sediment concentration was higher indicating a regulatory mechanisms after reaching a particular threshold [12]. Bioassay to determine the in-situ impact of trace metal addition at different concentration on the primary productivity of a sewage mixed brackish water canal has been evaluated the efficiency of toxicity of the metal studied was observed in the following order Cu>Cd>Zn>Pb, the median effective concentration on both pimary production and respiration was determined. Lead was observed to have no impact on community respiration [13].

3. DESTRUCTION AND DEGRADATION OF MANGROVES

Mangroves are degrading in many areas. Luxuriant mangrove sites are rich in biodiversity of flora and fauna, whereas the degrading sites are poor in biodiversity. A comparison was made among luxuriant and degrading sites in Pichavaram mangrove forest for physico-chemical and biological variables, the data revealed that the causes of natural degradation of mangrove are mainly due to high salinity, low level of available nutrients, and poor microbial counts in the soil substrates. In Andaman and Nicobar Islands, Tsunami has caused considerable change on the mangroves stands at the island; while *Avicenna marina* and *Sonnertia alba* were not generally affected *Rhizophora sps*, got affected due to Tsunami waves [14]. Developmental and anthropogenic activities grazing and spread of prawn farming are the major threat to Kerala mangroves [15].

Mangroves in Mahanadi delta got degraded during the course of time due to various industries like paradeep phosphates LTD, Oswall chemicals and Fertilizers Ltd and paradeep port. As a result mangroves are existing at present in shrubby form mainly with few trees [16]. The increase in the biotic pressure on mangroves in India has been mainly due to land use changes and an account of multiple uses such as fuel, fodder, wood, fiber, paper and medicine. Along the west coast alone, almost 40% at the mangrove area has been converted to agriculture and urban development [17].

Degradation of mangroves in Krishna wetland is associated with the poor pattern of tidal flushing due to the formation of topographically elevated area which may be due to monsoon floods. [18] demonstrated the magnitude of the ongoing deforestation in India and other Asian Countries through remote sensing. Thane Creek, Maharashtra receive 1000 Million liters/day of industrial effluent and domestic sewage and approximately 3000 metric tones of solid waste per day from 300 authorized and unauthorized dumping grounds situated in the vicinity of Thane creek. This led to encroachment and subsequent reclamination resulting in indiscriminative destruction of mangrove mudflats, hindering the tidal flow leading to situation and pollution. It also disturbed the breeding and feeding habitat of organisms like fishes, Crabs and Prawn [19]. The total reclamation and mangrove cover in wetlands around Mithiriver, Malad creek, Manore Creek, Thane creek, Mankhurd and Mahul creek was approximately 100 ha. in the last decade excluding the naturally degraded mangrove areas.

4. HEAVY METALS IN SEDIMENTS

Living organisms require trace amount of heavy metals for its survival while it exceeds to its level can be detrimental to organisms. All the heavy metals exist in colloidal, particulate and dissolved phases. Aquatic organisms may be adversely affected by heavy metals and tend to higher tropic level in the aquatic system. Heavy metals are finding their way into the system through chemical and physical weathering of rocks

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decomposition of plants and animals, detritus and plant exudates the anthropogenic inputs and predominantly from pollution centers and industrialized regions.

Mangrove acts as a buffer between land and sea which prevents free flow of minerals from land to sea the Silent receiver of metal eventually may slow significant metal contamination in the sediments the sediments in the mangroves are capable of trapping heavy metals without causing any significant effect to vegetation. Study done in Derwent estuary revealed high concentration of zinc and lead due to zinc refining company found near the estuary. Moreover the study by [20] suggests that material concentration in sediment samples from Jequia mangrove forest, Brazil have significantly exceeded the natural concentration of heavy metals. It has been reported that in many countries the failure of fishery was attributed to the reduced zooplankton especially copepod population [21].

Heavy metals in the sediments are essential to assess the extent of metal pollution. The distribution of heavy metals in solution has widely been recognized as a major factor in the geochemical behavior, transport and biological effects of these elements in natural waters [22]. Sediments samples have also been widely used to monitor heavy metal pollution in coastal areas. Moreover, sediments have aptly been called as trace elements trap because they eventually receive almost all the heavy metals, which enter the aquatic environment [23]. Some studies were carried out on the distribution of heavy metals in water and sediments from Indian coastal regions are limited. Many investigations have been carried out on adsorption of dissolved metals in estuarine in relation with the role of physical and chemical parameters [24].

Sediment is indicator of quality of overlying water and its study is a useful tool in the assessment of environmental pollution study. Heavy Metal cycling is a serious problem addressed in mangrove environment [25]. Hydrogen sulphide is a major pollutant of the water bodies; the blackening of sediment in the polluted area was due to the local chemical reaction where sulphates get converted the sulphides. Analysis of pollutants in sediments is vital as they were adsorbed by material in suspension and by fine-grained particles. The total organic Carbon of sediment has a major role in keeping fertility of soil and there by flourishing the biological activity [26] recorded elevated concentration of heavy metals in sediments at Walajapat, Vellore, Tamil Nadu. Heavy metals are extremely toxic and they are present in our immediate environment. They occur in soil, surface water and plants and readily mobilized by human activities that include mining and discarding industrial wastes material in natural ecosystem that includes forest, rivers, lakes and oceans.

Several hydrochemical studies were made in the Coastal water which includes those of [27] who studied the sediments characters and its relation to hydrographic of Cochin estuary. Analyzed the organic matter from chilka lake horizontal and vertical distribution of organic carbon in the mangrove sediments have been studied by [28]. [29] had studied the organic carbon, Nitrogen and Phosphorus content in sediments of Mondovi estuary. [30] studied the particulate organic carbon in relation to physico-chemical along the Southwest Coast of India. [31] have investigated the suspended sediments distribution of Beypore estuary. [32] studied the spatial and temporal geochemical variation of the pichavaram mangrove ecosystem. [33] have been studied the several distribution and behaviour of nutrients in Mulki Estuary.

In a plant soil system, strong absorption and fixing of heavy metals by soil can easily cause residual accumulation in the soil, resulting in over absorption of heavy metals by growing plant. The plant products are harmful to the health of humans. It is consider that mangroves show the ability to accumulate metals and possess a certain tolerance to relatively high levels of heavy metals pollution. Many studies had been carried out on various plants to determine its heavy metals accumulation capability [34]. One of the major sources of heavy metal pollution is the mining and swelling of metalliferous ores. Water pollution around the mining and smelting areas has been clearly demonstrated by the high concentration of heavy metals in water, sediments and aquatic organisms. One method of phytoremediation is phytoextraction which uses metal accumulating plants to remove pollutant from contaminated soil by concentration them in the harvestable above ground parts.

Aquatic plants can absorb bulk mineral salts either from the sediments via the root system from the water phase by the leaves or from both sources [35]. The uptake of heavy metals by plants are passive and its translocation from roots to other plants organs in generally low [36]. In natural environments the association of heavy metals and their distributions depend in various parameters including redox conditions. They may act as a

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sink or a source of heavy metals in coastal environment, because of their physical and chemical properties. Elevated concentration of heavy metals have been recorded in mangrove, sediments all over the world which after reflects the long term pollution caused by human activities. Heavy metals are amongst the most serious pollution within the natural environment due to their toxicity, persistence and bioaccumulation problems.

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