

Aquatic ecosystem is an important natural system and vital resource for living beings. It can be stagnant or flowing water ecosystem. The aquatic ecosystems are classified into freshwater, brackish and marine ecosystems based on the salinity levels. It includes oceans, lakes, rivers, streams, estuaries and wetlands.

Aquatic environment consists of biotic and abiotic components. The abiotic features are its physical and chemical aspects and biotic features include its living composition. There exists a close relationship between biotic and abiotic components of an aquatic ecosystem. Hence in aquatic ecosystem water, sediment and its living organisms are linked with each other.

In an aquatic system, water plays important role in the regulation of global scale ecosystem processes, linking atmosphere, lithosphere, and biosphere by moving substances among them and enabling chemical reactions to occur. Water exhibits its own physicochemical characteristics that represent the quality of water body. The functioning of an aquatic ecosystem and its stability to support life forms depends on its physicochemical characteristics. Similarly sediments in aquatic ecosystem are analogous to soil of terrestrial ecosystem as they are the source of substrate, nutrients and home for living aquatic resources. Sediments play important role as key catalysts of environmental food cycles and the

dynamics of water quality. The functioning of an aquatic ecosystem, directly or indirectly depends on the sediment quality. The Sediment quality is determined by its various physicochemical parameters. In the same way the functioning of an aquatic ecosystem depends upon its biotic composition. They form a trophic level and the source of energy in the aquatic environment. In the trophic level fish play an important ecological role in the overall food web. Fish are an integral part of our environment being an important resource providing food, recreation and economic value. Fish cannot live in isolation as they are part of an ecosystem and they interact with the physical, chemical and biological environment of an aquatic system. They are totally dependent on the ecosystem for growth, reproduction and survival.

With the advancement of human culture, aquatic ecosystem is polluted to such an extent that clean water is becoming more precious. The causes of pollution are several man made activities like population growth, deforestation, urbanizations, increasing living standards and rapid industrialization. Aquatic pollution is the world's biggest health risk and continues to threaten both quality of life and public health. In developing countries 70 % of industrial wastes are dumped untreated into water bodies polluting the usable water. Industrial discharges containing toxic chemicals, phenols, aldehydes, ketones, cyanides, metallic wastes, plasticizers, acids, oil and grease, dyes, suspended solids, radioactive wastes etc. contaminate the

water bodies. Along with the discharges, numbers of metals are released in an aquatic environment. Among them heavy metals are a special group of metals having density higher than water. Under this group Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Zinc (Zn) etc. are included.

Water pollution is a serious problem in India as almost all of its surface water resources and a growing percentage of its groundwater reserves are contaminated by toxic organic, inorganic biological pollutants. In many cases these sources have been rendered unsafe for human consumption as well as for other activities such as irrigation and industrial needs. This shows that degraded water quality can contribute to water scarcity as it limits its availability for both human use and for the ecosystem.

Aquatic pollution results changes in water and sediment quality affecting aquatic organisms which in turn affect human health through food chain. Wastewaters in receiving water bodies change the water and bottom sediment chemical composition, destroy the biological balance of the self-cleaning processes and finally cause unpredictable changes in the ecosystem. Pollution disrupts food chain and severely affects the ecosystem.

Aquatic animals totally dependent on the ecosystem for growth, reproduction and survival bio-accumulate pollutants in considerable amount in tissues over a long time of exposure. Fish occupy top position in an aquatic food web providing food for other lower trophic levels as well as

human beings. Polluted water and sediment can bring many behavioural, physiological, histological, haematological and other different changes in the fish community. The population depending on the polluted water body for domestic water supply and fish as source of protein gets affected.

Keeping in view the importance of aquatic ecosystem, the present work was designed for systematically monitoring the pollution to protect the aquatic environment from serious hazards. A combination of Physico chemical and biological monitoring with special reference to bioaccumulation can provide a good indication of conditions and potential risks to the water body. Very few scientific approaches have been made in this aspect. Therefore present work was focused to monitor the present status of Tapi estuary in all three levels: water, sediment and its biotic component (fish) in Hazira industrial area of Surat district. The study was also focused on bioremediation measures for the removal of heavy metals from the aquatic environment.

Surat is the largest city and has various small and large scale industries of pharmaceuticals, textiles, chemical, paper and pulp, refineries etc. which contribute in industrial development of Gujarat but at the same time these industries pollute the aquatic ecosystems by the discharge of effluents in the water system. The city also discharges domestic as well as agricultural wastes in the surrounding water system. In Surat district, Hazira industrial area is a major industrial destination where many multimillion

industries are in operation. It is known as the industrial hub of India. It is located on the bank of the Tapi estuary, eight kilometers from the Arabian Sea and 25 km from Surat.

Estuaries are important coastal ecosystems which occur where there is a confluence of fresh and marine environments and create a salinity gradient from the inner to outer estuary. The Tapi estuary is permanent tropical estuary and one of the major estuaries on the Gulf of Khambhat. It is located at geographical position lat 21°40'N and long 72° 40'E. Its length from source to mouth is about 720 km and with a catchment area of approximately 1,650,000 km². The estuary receives industrial effluents released from urban cities like Surat and many chemical and fertilizers industries in and around Hazira industrial area.

In order to carry out the study in Tapi estuary, three sampling sites Dumas, Magdalla and Hazira near Mora village were selected. The present work was focused to study water and sediment quality with distribution of heavy metals in water, sediment and fish. Brackish water fish, mudskipper (*Boleophthalmus dussumieri*) which is commercially important as a cheap source of food and ecologically important as an indicator of heavy metal pollution was selected for the study.

The work was planned to carry out for two consecutive years (2011-2013). Analyses of water parameters included were temperature, turbidity, conductivity, total solids, total dissolved solids, total suspended solids, pH,

salinity, dissolved oxygen, biological oxygen demand, chemical oxygen demand, nitrite, nitrate, phosphate, calcium, chloride, sodium, potassium, oil & grease and total petroleum hydrocarbon. Analysis of sediment parameters included were pH, moisture, total solid, percent carbon, organic matter, nitrate, phosphate and total petroleum hydrocarbon. Among different heavy metals having hazardous effect on aquatic ecosystem, four heavy metals viz., mercury, cadmium, lead and zinc were selected for the study from water, sediment and fish (*Boleophthalmus dussumieri*). Among the studied heavy metals lead was chosen for bioaccumulation and bioremediation study as it is hazardous for living organisms and was found above the permissible limits during the investigation in water, sediment and in mudskipper. Bioaccumulation experiments in fish (*Boleophthalmus dussumieri*) were carried out in the laboratory using different concentrations of lead solution. Fungi (*Aspergillus niger*) was selected for bioremediation experiment on the basis of existing scientific literature.

Findings of present study revealed that important physicochemical parameters of water showed no significant difference between sampling sites except for dissolved oxygen and chloride. BOD, COD and oil & grease were above primary water quality criteria for designated best use classes (EPA 1986). Heavy metals in all three levels were found above the prescribed limit given by WHO/FAO (1984). Significant difference in the distribution of heavy metals in water, sediment and mudskipper (*Boleophthalmus dussumieri*)

was found. Bioaccumulation experiment concluded that mudskipper accumulated significant concentration of lead in muscles during the exposure period of 192 hours. Bioremediation experiments focused that fungi (*Aspergillus niger*) had a high potential to accumulate lead and can be used as biosorbent for removal of heavy metals from wastewater and industrial effluents containing higher concentration of heavy metals.

Overall the findings of present study indicated that the Tapi estuary was affected by anthropogenic as well as industrial pollution. Detailed findings of the present work would be highlighted in the thesis.

The results obtained from this study would be effective in monitoring both environmental quality and health of the living organisms inhabiting the Tapi estuary. The study will be a useful tool for future researchers for further assessment of aquatic pollution due to heavy industrialization. It is expected that the data generated from this scientific study will help to implement required policies and programmes to evaluate the extent of pollution.

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