1. INTRODUCTION

The flora and fauna of any water body is indispensable to all shapes of life. It makes up 50-97% of the weight of all plants and animals and almost 70% of human body (Allan, 1995). Besides water is also inevitable resource of agriculture, industrial manufacturing, transportation and many other human endeavors. In spite of its importance the grievance is that water is the most wretchedly managed resource in the world (Chutter, 1998). In determining the quality of life the availability and quality of water always have played significant role. Water quality is hermetically linked to the state of economic development (Chennakrishnan *et al.,* 2008). There are different sources which are responsible to ground and surface water pollution. The careless sewage of industrial effluents may contribute greatly to the poor quality of water (Mathuthu *et al.,* 1997) in urban areas. Most of the water agents in the areas of the developing country are used as the end points of discharging effluents from industries. Increased shift in water quality due to industrial pollutions one of the major environmental constraintsall over the world. Large quantities of nutrients and toxic substance due to industrial effluents and domestic sewage contribute to a number of adverse effects on the water bodies and the aquatic biota (Chhonkar *et al.,* 2000).

Industrialization through the set-ups of plants and factories has become a crucial factor to the development of a country's economic growth. The waste or by-products discharged from plants and factories are appearing fatal to the environment. Because those products contain various kinds of contaminant the surface and ground waters and soil as well. There are number of facts behind ill-treating the waste. One of the major facts or reasons is the lack of highly efficient waste treatment technology. The ins and outs illustration of the consequences of the industrial discharge on the environmental health is the only focus of this chapter. The industrial refusals

carry various type of pollutant to the river, lake and ground water. The fresh water is inevitable as it is massively consumed by human drinking, bathing, irrigation and so forth. The presence of industrial contaminants in water may decrease the production of crops and growth of plant and baneful to the aquatic living organisms too.

The inland fishery resources of India are observed as much as of its diversity in composition and their productive potentials. A vast expands of open inland waters in forms of river, canal, and estuary, lagoon, reservoir, lake, pond, tank and so forth is bestowed upon India. The resources are the pivotal sources of livelihood for the rural especially the fishermen community. Presently, around 14 million people are involved in fishing, aquaculture and relevant activities (Fisheries Division, ICAR, 2006). Inland aquatic organisms are the most natural system on this planet. Most of the natural and human activities functioning in the basin are reflected by the quality and quantity of water and timings of its use as well. Any type of health concern is reflected in the form of unwanted habitat condition. The ecosystem and health management in inland open waters are a great cause of fish production and also greatly contribute to obtaining sustainable fish harvest.

In India are flowing 14 major rivers like Ganga, Brahmaputra, Brahmani, Cauvery, Godavari, Indus, Krishna, Mahanadi, Mahi, Narmada, Periyar, Sabarmati, Subarnarekha and Tapti covering 83% of the drainage basin and accounting for 85% of the surface stream(Fig. 1). More than 50% of the country's surface stream are covered by Brahmaputra, Ganga, Indus and Godavari basin. Besides there are 44 medium and 55 small rivers most of which originate from coastal mountains. Out of 14 major rivers only 4 ones are long lived, which are Brahmaputra, Ganga, and Mahanadiand Brahmani. The Cauvery, Mahi, Sabarmati and Periyar flow through less downfall zones. Apart from the river Ganges with a catchment or drainage area of more than 10

million ha there are another major rivers like Indus with 32.1 million ha, Godavari with 31.3 million ha, Krishna with 25.9 million ha and the Mahanadi with 14.2 million ha. The total drainage area of medium rivers is approximately 25 million ha where the Subarnarekha with a 1.9 million ha catchment area is the largest among the medium rivers in the country.

In West Bengal, the Hooghly River is a 260 km. long tributary of the river Ganga. It provides the nearby plains with constant supply of water for irrigation, human use and industrial purpose. The rampant increase in urbanization and industrialization at Naihati(north 24-Parganas, West Bengal, India) located at the east bank of river Hooghly cause water pollution e.g. the jute, paper and pulp mills effluents and the household ones gets discharge into the river, causing water pollution. The riverine system including catchments and watersheds with microbial load is found to be system being affected by an increased function of several organic and inorganic pollutant contents as has been observed in Gola river (Chandra *et al.*,2006), Narmada river (Sharma *et al.*, 2008) and Damodar river (Chatterjee *et al.*, 2010). The industrial pollutants stuffed with organic and inorganic dissolved solids and other unwanted chemicals cause grave water concerns (Tyagi *et al.*, 2000) and alongside the shifting physical and chemical properties of water and the interactions in between carry an adverse effect on the biological characteristics of aquatic ecosystems of rivers (Downing 1971) and watersheds (Guissani *et al.*, 2008).

The ground and surface waters sprang from the Ganga and its tributaries have been noticed with significant increase in the pollutants (Singh *et al.*, 2007; Jain *et al.*, 2007). Henceforth the prevention of river water pollution needs an operative monitoring of physicochemical and microbiological parameters (Bonde 1977; Ramteke *et al.*, 1994). Efforts for sustainable development of environmental health are made on constant monitoring and assessment of river pollution as a part of understanding the anthropogenic effects or human activity orient pollution

on environment. In marine and estuarine environmentspetroleum hydrocarbon pollution is a worldwide concern (Mackey & Hodgkinson 1996). Through the accidental oil over-oozes are the most evident source of pollution, it has been shown that the long-standing low-level oil release from such source as industries and oil refineries have a chronic ecological upshot, even though there is no noticeable evidence of the acute effects (Mackey & Hodgkinson 1996). The oil pollutants by increasing native microbial flora have been causing natural biodegradation over the years (Atlas 1981).

Water profanation due to release of ill-treatedindustrial effluents into water fields is major agitation the global scenario (Mathuthu *et al.,* 1997). Other usual kinds of pollutantsinclude pathogenic organisms, oxygen requiring bio-substances, plant nutrients that augment algal blooms, biotic and abiotic toxic substances (Cornish and Mensahh, 1999).

The river water through its three dimensional properties - chemical, biological, physical- denotes its values serving our domestic, agronomic and industrial pursuits. Provided the ethnic pursuits put diffractions in water characteristics i.e. water is no more conducive as previous to human needs the water is ascribed to be contaminated (Fetter 2001). Rivers sustaining opulent diversities of flora and fauna serve the sirius society with water for drinking and washing; for food, drugs, medicines, paints, fibers, woods and so forth. Peasants attain the river-benefits through irrigation for crops. The long lived vegetation along the river causeways offers life preserving food and fodder to the pastoral communities pasturing their herds or other live-stocks over a wide range of mostly arid steppes and mountains during drought-stricken husky season. Urbane and city lives use and Misuse rivers to discharge their wastes.

With the emerging ace for water and degradation of the spick and span water resources the use of terminally existing quality water for agriculture evokes a new challenge and demand for environmental management. If we turn our look to the use of water for industrial purpose it is seen that though such use is very low as compared to agricultural use but the industrial discharges on ground or surface water bodies barter the water resources into uncongenial one for other pursuits (Tiwary and Mahapatrea, 1999; Behera and Reddy,2002; Buechler and Mekala, 2005). The three-fourth of the pure water drawn and used for household and industrial purposes are bartered into filthy discharges of domestic and industrial pursuits, which indispensably mix-up with surface water and thus strafing water quality. We could tellingly use the 'marginal quality water' for other purpose like irrigation. The reuse of discharged water for irrigation, carrying domestic sewages or of vetted industrial gushes is often vindicated by the experts in many places of India, ached as water-debt or water-wanting cantons.

Relevantly, a fact to be revealed that the socio-economic and environmental fruits of the above reuse are not well planted in paper-pencil, particularly in case of industrial effluents for the developing country like India demanding irrigation exceedingly.

The river silts, one of the prime components of riparian ecosystem, play the role of key vehicles of heavy metals in this ecosystem (Gale *et al.*, 2006).The silts or sediments regulate the metals depot and transport to the neighbouring environs (Cuong and Obbard, 2006). The four causes governing the metal distribution in natural water organs are the substratum sediment formation, the ceased sediment forms, sedimentary metals with different geochemical halos and aquatic elixir (Morillo *et al*., 2004; Mohiuddin *et al.*, 2011). Several natural issues like dwindling of rocks and minerals, gush of water, current, water ends up to sea and so forth as well as manmade

issues like unmanaged or partly treated sewage discharges, aqua-cultivation of prawn and fish etc. are answerable agents behind heavy metal sedimentations in rivers.

The metals after encroaching into the water bodies become conglomerated with organic and inorganic particles, get accumulated and bring forth heavy metal concentration (Jeon *et al*., 2003; Ochieng *et al*., 2007). But some sediment cramped metals may reintegrate with water by means various natural incidents like potential change of oxidization and reduction process, acidification, organic ionizing levels etc. may re-impose hostile effects on existent aquatic creatures (Rauret, 1998; Liu *et al*., 2009).

The heavy trace metal distributions and concentrations in river silts are assailing aquatic existents at an anxiouspace(Mohiuddin *et al*.,2010 - 2011). Besides, the unwavering viral or toxic chemicals get installed in fish organs until the polluting sources are unburdened from the pollutants and thus leaving to human health a dreadful impact (Mulligan *et al*., 2001; Lasheen and Ammar, 2009).

The trace elements find the river sediments as their final destination as the solid stuffs settle down to the sediments over a period of time. The water soluble substances with a bond of inorganic substances finally precipitate, conglomerate and form complexes in water (Wasserman and Wasserman 2008; Souza and Wasserman 2015). The fjord hold ecosystem is a ceaseless and complex natural phenomenon marked with an extreme rate of deposition and production in the sediments (Pang *et al*., 2015). This phenomenon is also vulnerable to the trace elements attacks through various environmental and anthropogenic phenomena like erosion, early metagenesis, river born or fluvial transport, aqua-cultivation, burning of petrifaction orient fuels and agriculture (Radenac *et al*. 2001; Alagarsamy 2006; Buccolieri *et al*. 2006; Pang *et al*. 2015).

The small and microscopic organisms drifting or floating in the sea or fresh water are the planktons which are the vital components of aquatic food web. Planktons are such mini aquatic existents which are non-swanky or poorly lithe to move beyond the transits of currents and live the bare or marine water. The term 'plankton' was thought out by Victor Hansen, a German marine biologist for such tiny organisms (Battish, 1992). In Hansen's glossary 'plankton' (singular one) comprising all organic grits is a microscopic organism which far away from the banks and bottom of the water bodies drifts in water with ease and reluctance. The plankton with green plant cell is called as 'phytoplankton' and with animal cell is termed as 'zooplankton' (APHA 20th edition, 1998). The quantity of phytoplankton in water organs mirrors the environmental action and influence of the world of nature. Some of the species of phytoplankton due to producing toxic elements are assumed to be noxious ones. However those species of phytoplankton are small in quantity, but bulk of the phytoplankton are immensely adjuvant. Some genres of phytoplankton or zooplankton can be the significative of the environmental health by regarding their conditions or responses in the elapsed few days or weeks. Whether the eutrophication is environmental or anthropogenic phenomena can be indexed by the chemical characteristics of plankton (lipids or natural isotopes).

Planktons are the key factors of any aquatic food web. The plankton volumes vary with seasons and pollutions. The genres of phytoplankton were reckoned as significant biological indicative of water characteristics or quality (Parvateesam and Mishra, 1993; Sudhakaret *et al.*, 1994; Ragotham and Jaiswal, 1995; Hedge and Sujatha, 1997; Pawar *et al.*, 2006; Kumawat, 2006; Mandal *et al.*, 2010; Maityet *et al.*, 2017).

Zooplankton confirms the pecuniary effective demography of fish. The phytoplankton and fish are characterized with the key process of energy transfer in between (Howich&Wilhm, 1984). Zooplankton, small protozoan are open floating multi-cellular creatures, e.g. mollusks and other animals which are sustained by plankton. Some of the maggots of bigger animals such as fish, mollusks and segmented marine worms of phylum Annelida are considered as larval plankton or meroplankton including the samples of the most of Animalia kingdom group and ensuing as holoplankton in oceanic or pelagic environment. The zooplankton makes it possible to make energy transfer at secondary tropic level in aquatic food chain. The transformation of plant elements into animal tissues is made possible by their feeding on phytoplankton, that subsequently forms the primary food for higher animals including fishes, particularly at their their maggot or larval phases. Protozoa, Rotifera, Cladocera, Copepoda and Ostracoda are subjected to the zooplankton of fresh water. Many of the zooplankton are of microscopic uni or multi cellular appearances with the sizes ranging from microns to millimeters or above. The zooplankton play a key role to make perusal on the animal bio-pluralities in aquatic ecosystems.

The outliving of the water existents including fish is bulldozed by the organic and inorganic chemicals, a major contaminating factor in aquatic environment. Metals due to their strong toxic impact and bioaccumulation efficacy in aquatic ecosystems are of certain worries among the environmental pollutants. Fish is mostly at the apex of aquatic food hierarchy and from water accumulate in them a chuckle amount of specific metals. The environmental hazards and manmade hazards are the two principal roots of ensuing heavy metals in aquatic ecosystems. The heavy metals comprising of incumbent and non-incumbent substances have certain effects on eco-toxicology as they are immensely stable and possess a strong capacity of being toxic to existing creatures (Adeniyi and Yusuf, 2007).

The heavy metals from nearby water and food may be absorbed by fish, which in a malignant extent may concentrate in various tissues and port the toxicant payoffs to a critical stage. Besides, waters get significantly concentrated with metal accumulation by fish and that concentration is below the track-out limit in quotidian water samples. Hence, fish might finely assert to be the elements for unearthing metal contaminations in fresh-aqua ecosystems. The studies on heavy metallic levels in several water organs were rampantly conducted (Samanta S. *et al*., 2005; Toufeek M. E., 2005; Authman and Abbas, 2007).

The variances in various metal uplift and refinement periods in different genres of fish is exceedingly ascribed with metal bio-deposits. The metal concentration in different fish tissues iscaused by a serious role of the water characterized with umpteen factors like seasonal, physical and chemical features (Javed and Usmani, 2011). The incident that the fish combs i.e. gills are in unswerving coalescence with water and metal accumulation in gills in consequence reflects the metal concentration in water the fish lives in, whereas that same in liver limns the metal depots in water. The fishes require to be veiled with a great caution and care to ensure deterring unwanted maximal level of toxic trace metal transmission to human health from fish consumption.

The use of biota to count the impact of human made pollution on the integrity of rivers is deserving significance (Miller *et al.,*1988; Rosenberg &Resh, 1993; Scott & Hall, 1997; Gafnyet al, 2000; Hughes, 2000; c Karr *et al.,* 2000). In the rivers of several parts of the world determining fish community structure is an another deft initiative to access biotic integrity (Karr, 1986; Edds, 1993; Paller *et al.,* 1996; Ganasasn& Hughes, 1998; Waite & Carpenter, 2000; Meador & Goldstein, 2003) as complex biotic and abiotic processes can gleam the diversity of human activities causing changes in fish structure and composition.

Several studies are available of fish community structure and environmental decline in consequence to anthropogenic effects such as agriculture, urbanization and also forth (Klein, 1979; Goldstein, 1981; 1985; Roth *et al.,* 1996; Lammert& Allan, 1999; Schlieger, 2000; Waite & Carpenter, 2000; Meador &Goldstein, 2003). The changes in the fish species composition play an important role in characterizing environmental standards. For example, a huge human population can be used to reflect the biomass and energy in the system and likewise the number of species can reflect the habitats diversity and fish behavior. Moreover increased amount of nutrient-contents (increased nitrogen and phosphorus levels) of water will increase BOD and COD (Mahdieh and Amirhossein, 2009), which adversely affect the cold-water fish more than the warm water fish.

Haldi river is a tributary of Hooghly river flowing through Purba Medinipur district in West Bengal. It is the last major river to joins the Haldi and Hooghly estuaries before the latter flows into sea. The presence of Hadia port-cum-industrial complex in the downstream region of the River Ganga (also known as the Hooghly River) has accelerated the pollution problem with a much greater dimension (Mitra, 1998). The major industries located in Haldia includes petrochemical and refining sectors of IOC, Haldia Petrochemicals Ltd., Mitsubishi Chemical Corporation Pvt. Ltd., South Asian Petrochemical Ltd., and some oil and gas terminals. Apart from these units, there is a detergent unit of HLL, Tata Chemical Ltd., pesticide unit of Shawallace Pvt. Ltd., Exide Industries Ltd., vegetable oil units, etc. A considerable quantity of toxic and hazardous substance is released into this important aquatic system through these industrial effluents along with huge organic load emanating from agricultural and several non-point sources (such as discharges from fishing vessels and trawlers and run-off from adjacent

landmasses). Downstream and confluence of the mouth of Haldi river presence on their aquatic biota depending in the selection of experimental work.