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CHAPTER 2

Studies on the Present Status of Waste Feed Fish Diversity about Water Parameters in East Calcutta Ramsar Wetland

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Abstract

In West Bengal, India, the East Kolkata Wetland (EKW) is an important Ramsar Site with a wealth of biodiversity. It is extremely important for both ecological and socioeconomic reasons and is essential for preserving biodiversity, restoring the ecosystem, protecting the environment, and reducing pollution. The largest wastewater-fed aquaculture system in the world is housed there. By using sewage from the city, it serves as an excellent resource recovery system and lowers the enormous costs associated with maintaining waste treatment facilities. The wetlands create jobs, supply vital foods like vegetables and fish, and act as a lifeline for about 150,000 people. It supports a variety of plants and animals as well as many microbes. It is a fantastic natural resource that must be protected for the good of society. In this area, 59% of the fish species are threatened, vulnerable, or endangered. There are 58 indigenous species of fish and 13 invasive species in the East Kolkata Wetlands' fish variety. It is concluded that anthropogenic pressure resulting from the conversion of wetland habitats to agricultural lands, habitat destruction, overexploitation, willful destruction, aquatic pollution, disease, the introduction of exotic species, and a general lack of understanding of the importance of biodiversity are significant contributing to the rich diversity of fish's alarming vulnerability in their natural habitat.

Keywords: Wetland, East Calcutta, West Bengal, water parameters, Waste feed, fish diversity, present status

Introduction

Wetlands have been also regarded as one the essential life-supporting ecosystems on this planet and are considered as the most productive ecosystems since they constitute large flora and fauna diversities. Nearly 6% of the world is made up of wetlands, which are the area where terrestrial and aquatic ecosystems converge

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(Williams, 1990). About 60 years ago, East Kolkata Wetland (EKW), now widely praised as an example of intelligent use of wetlands, did not figure significantly in the biological transition from a dangerous jungle to an asset of wise use of wetlands. Due to the Bidyadhari River's backwater marsh and spill area, these areas were known as salt lakes. The name "salt lakes" comes from the brackish water caused by the Bay of Bengal's tidal effects. Due to navigational difficulties, the marshes back then were solely useful from a defense standpoint. Since the early 15th century, the Ganges river's eastward migration has caused a metamorphosis in the process of delta development in central and south Bengal. The termination of the channels was indicated by the cutting off of several distributaries and re-distributaries from the upland flow. The Bidyadhari people vanished by the end of the 18th century as a result of human intervention in the area, mostly in the form of channelization, which accelerated the process of silt deposition in the river beds. About 100 plant species, including Sagittaria montividensis, cryptocoryne ciliata, Cyperus spp., crostichum aureum, and Ipomoea aquatica, have been identified in and near the East Calcutta Wetlands. In these wetlands, a variety of water hyacinth species can be found (Mandal, 2021). Water hyacinth is used by the local fishermen and farmers to decrease erosion by forming a barrier between the land and the water. There are also a lot of coconut and betel nut plants in the region. Here, a wide range of crops are grown, such as sacred basil, cauliflower, eggplant, pumpkin, and sunflower. Additionally, there are vast tracts devoted to paddy farming. After air, water is the second most essential element for life as we know it (Saha *et al.*, 2021). India's economy greatly depends on its fishery; because of the importance of fish to fish bherries (Captain Bherry, Eco-water hub, etc.), fish are an economically significant category of aquatic animals (Chaudhuri *et al.*, 2008). Within the East Kolkata Wetlands, there are currently 264 operational bheries, or shallow fresh or brackish water basins used for pisciculture. The 12,500 hectares total area is composed of around 45.93% aquatic bodies and 38.92% cultivated land. The remaining area is made up of urban and rural settlements (10.42%) and waste disposal sites (4.73%). The East Kolkata Wetlands' exceptional biodiversity is directly endangered by species loss and habitat degradation as a result of human effects. (Kumar and others, 2018). EKW is important from an ecological and economic perspective. The local population's way of life as well as the habitats of numerous different species of organisms will suffer from the loss of this wetland. Domestic and industrial waste from different city neighborhoods might enter the EKW through canals. As water passes through these several routes, the rubbish gets diluted and eventually finds its way into the fish ponds in different proportions. EKW is one of the best agroeconomic zones in Kolkata due to the self-purification techniques employed in the pollution detoxification process there (Saha *et al.*, 2021). Measuring some of the physicochemical characteristics of water is therefore essential. Aquaculture using a multidisciplinary approach and scientific attention to the water quality standards are the best ways to rehabilitate this wetland (Saha et al., 2021). Seasonal variation is a major problem in this tropical region because of the large variations in temperature and rainfall that occur between the pre-monsoon and post-monsoon seasons. The correct assessment of critical physicochemical water parameters, including temperature, pH, dissolved oxygen (DO), total dissolved solids (TDS), biological oxygen demand (BOD), chemical oxygen demand, nitrate-nitrogen, ammonia-nitrogen, and phosphate-phosphorous, at different times of the year, is essential for fish health management. EKW is a valuable source of nutrients and is also home to bacteria that are productive and have commercial value (Saha *et al.*, 2021).

East Calcutta Wetlands

The East Calcutta Ramsar Wetland is located in the eastern suburbs of Kolkata, India, between 22°25' and 22°40' N and 88°20' and 88°35' E (Fig. 1). Important ecosystem services provided by the local fish ponds include flood control, the recycling of municipal wastes and effluents (produced in urban and semi-urban regions), aesthetic beauty, fish production, and livelihood (Fig. 2) (Mandal, 2021). A region of land where the soil is consistently or occasionally soaked with rainwater is called a wetland. Wetlands are said to have the most biological diversity of any type of habitat. In this regard, macrobenthic communities serve two purposes: they serve as links in the food chain and they aid in the purification of contaminated water. Sen and Ghosh, 1987). Intertidal marshes, salt meadows with large wastewater treatment areas such as settling ponds (referred to locally

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as Jheels and Bheries), sewage canals (RSC), farms, oxidation basins, dumping grounds, green zones, and cultivable lands are all included in this enormous region (EKW) (Jhingran, 1991). Under the "Ramsar Convention," EKW was classified as a "wetland of international importance" on August 19, 2002, and as a "Ramsar site" in November of the same year. Up to 2002, a total of 19 wetlands in India, including ECW, were recognized as Ramsar sites.

Figure 2: East Calcutta Wetland (EKW)

Ecological Status of East Calcutta Wetlands

The primary emphasis is on the different kinds of water birds that live in and near the East Kolkata Wetlands (EKW) and the alterations that these birds exhibit. Living things are, in reality, sensitive to the conditions in which they live. Pollution from human activity kills many species and lowers the number of others (Fig. 3). The condition of the environment in the research area is examined using these variations in abundance. Repeated monitoring revealed a significant shift in this wetland ecosystem in addition to providing information regarding the existence, number, and species composition of birds in the study area (Ghosh et al., 2018). The biodiversity of birds has changed dramatically in recent years. In the 1960s, the Indian Zoological Survey identified 248 different species of birds from the Salt Lakes. Between 1978 and 1983, Prakriti Samsad documented 123 different species of birds from the Salt Lakes. Larger bird species like the Openbill Stork and Spoonbill, as well as numerous other duck and teal species like the Pintail, Shovlers, Redcrested Pochard, Turfed Pochard, Baer's Pochard, shelduck, Brahminy Duck, Comb Duck, Barheaded Goose, etc., have disappeared as a result of reclamation of Salt Lakes and changes made to aquatic and other species (Ghosh, 2005).

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Predatory birds such as the Brahminy Kite, Pallas's Fishing Eagle, Osprey, Laggar Falcon, and now vultures, which were common in the past, are no longer considered worthy of further investigation. The tiny cormorant, grey heron, purple heron, pintail, common teal, and other gorgeous migrating birds are a few examples.

Figure 3: Ecological view of East Calcutta Wetland (EKW)

Water parameters

East Calcutta Wetlands is a globally significant location for the organic waste and domestic sewage that are successfully recycled into pisciculture habitat. According to Dutta and Chakraborty (2017), macrobenthic fauna is in charge of efficiently utilizing sediments, and their variety reveals the state of a wetland based on the quality of its sediments.

Parameters of water quality

There are three types of water quality parameters physical,chemical, and biological (Saha *et al.*, 2021).

Physical Parameters

- **Turbidity**

The cloudiness of water is called turbidity. It gauges how well light can travel through water. Plankton, silt, organic matter, suspended particles, clay, and other particulate matter in water are the causes. Nephelometric turbidimeters, which represent turbidity in units of NTU or TU, are used to measure turbidity. A TU is the same as one milligram per liter of suspended silica. For the typical human, turbidity greater than 5 NTU is apparent, but in dirty water, it surpasses 100 NT. Since groundwater naturally filters out impurities as it percolates through the soil, it often has relatively low turbidity.

- **Taste and odor**

Taste and smell foreign substances including organic molecules, inorganic chemicals, or dissolved gases can affect the taste and odor of water. These resources could be household, agricultural, or natural. A volume of sample A is measured, and it is then diluted with a volume of sample B of odor-free distilled water until the resulting combination's odor is hardly perceptible at a total mixture volume of 200 ml. This quantitative process

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determines the numerical value of odor or taste. The unit of odor or taste is expressed in terms of a threshold number as follows: TON or TTN = (A + B) / A (1) where TON is the threshold odor number and TTN is the threshold odor number.

- **Solids**

Solids can be found in suspension or in solution in water. The water sample is passed through a glass fiber filter, which can be used to identify these two types of solids. By definition, the dissolved solids flow through the filter with the water, while the suspended solids are collected on the top. The solids will remain as a residue if the filtered portion of the water sample is put in a tiny dish and subsequently evaporated. TDS, or total dissolved solids, is the common term for this substance.

- **Electrical conductivity**

A solution's capacity to transport or conduct an electrical current is measured by its electrical conductivity (EC), which is the case with water. The conductivity rises with the concentration of ions because ions in solution carry the electrical current. As a result, it is among the key factors taken into consideration when assessing whether water is suitable for irrigation and combating fires.

- **Temperature analysis**

The biogeochemistry of wetlands is mostly influenced by temperature. The rate at which biological activities occur increases with temperature. Surface water temperature ranged from 29.2 °C (in captain Bheri during 1984) to 32 °C (in Munshir Bheri during 2015). Seasons and bheries have significantly different surface water temperatures ($p < 0.01$), as shown. While all three of the chosen bheries are situated in the same geographic region of EKW, there may be differences in their levels of exposure to solar radiation. The local level differences may be associated with the shade that the flora provides around the chosen bheries.

Chemical parameters

- **Pigments analysis**

Each sampling site provided one liter of surface water, which was then filtered through a 0.45 µm Millipore membrane using a vacuum pump in order to perform a pigment analysis. The residue and filter paper were completely dissolved in 90% acetone and then chilled for about a full day in order to extract all of the pigment. The mixture and supernatant were then centrifuged at 5000 rpm for about 20 minutes. The residue and filter paper were completely dissolved in 90% acetone and then chilled for about a full day in order to extract all of the pigment. Next, using a Systronics UV-visible spectrophotometer to measure the optical density at 750, 664, 647, and 630 nm, the solution was centrifuged for around 20 minutes at 5000 rpm. We then determined the chlorophyll pigment count using the supernatant solution. Coloration of the phytoplankton was done after a small turbidity blank correction for all extinction values. The 750 nm signal was subtracted from all optical densities in order to accomplish this.

- **Evaluating pH value**

pH is one of the most important factors in water quality. It can be defined as the hydrogen ion concentration divided by the negative logarithm. This dimensionless measure expresses the strength of an acidic or basic solution. Actually, the acidity or basicity of the water is indicated by the pH scale. Seven is neutral on the pH scale, which runs from 0 to 14. A base solution is indicated by a pH of greater than 7, and acidity is indicated by a pH of less than 7. Pure water is neutral at 25°C, with a pH of nearly 7.0. Since atmospheric carbon dioxide gas has a pH of roughly 5.6 (slightly acidic), regular rainfall has this value. At home, drinking water should have a pH of 6.5 to 8.5. Pure water is neutral at 25°C because its pH is almost 7.0. Since atmospheric carbon dioxide gas has a pH of roughly 5.6 (slightly acidic), regular rainfall has this value. For domestic use and the

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requirements of living organisms, drinking water should have a pH of 6.5 to 8.5. In pure water, there are excess hydrogen (H^+) ions, while in basic water, there are excess hydroxyl (OH^-) ions. For the survival of plant and animal life, the pH of the water in rivers, lakes, and wetlands is vital. Most animal species cannot survive in water that is either too acidic (typically below 5.0) or too basic (over 9.0). The optimal pH range is 7.0 to 9.0 for many species. Fish that inhabit the study areas.

- **Acidity**

Acidity is the measure of acids in a solution. Water has an acidity that is defined as the pH at which it can quantitatively neutralize a strong base. Usually, hydrolyzed salts like aluminum and ferric sulfates, mineral acids, and carbon dioxide are the culprits behind acidic water. A few of the processes that acids can impact are chemical reactions, biological activity, and corrosion. Water becomes acidic due to the dissolution of carbon dioxide, which can either form carbonic acid (H_2CO_3) through atmospheric reactions or by the respiration of aquatic life. By titrating standard sodium hydroxide (0.02 N), the acidity level is determined using phenolphthalein as an indicator..

- **Alkalinity**

The ability of water to neutralize acids by adding up all of its titratable bases is known as its alkalinity. To calculate the amount of lime and soda required for water softening (e.g., for corrosion control in conditioning the boiler feed water), the alkalinity of the water must be measured. In water, the presence of hydroxide (OH^-), bicarbonate (HCO_3^-), carbonate (CO_3^{2-}), or a combination of two of these ions is the primary cause of alkalinity. According to the following equation, it is impossible for OH^- and HCO_3^-ions to exist together since they react to form CO_3^{2-} ions together: $OH^- + HCO_3^- \rightarrow CO_3^{2-} + H_2O$ (8. Titration using a standard is used to determine alkalinity. Water with high levels of acidity or alkalinity could be a sign of chemical or industrial pollution. Volcanoes and other natural sources can also produce alkalinity or acidity. Fish and other aquatic life are shielded from abrupt pH fluctuations by the buffering effect of the acidity and alkalinity found in natural waters. For example, in the event that an acidic chemical somehow contaminates a lake that was naturally alkaline, an acid-alkaline interaction takes place, maintaining the lake's pH at the same level. At least 20 mg/L of calcium carbonate should be present in the buffering capacity to safeguard aquatic life.

- **Chloride**

Although chloride is a naturally occurring element in groundwater, streams, and lakes, a relatively high concentration of chloride in freshwater (250 mg/L or more) may be a sign of wastewater pollution. Chlorides can enter surface water through a variety of sources, including wastewater, agricultural runoff, and chloride-containing rocks. Although most people find high levels of chloride ions Cl^- in drinking water to be unpleasant, these concentrations have no detrimental effects on the general public's health. Chlorides are generally not hazardous to humans, despite the fact that sodium in table salt has been connected to heart and kidney issues. Small amounts of chlorides are required for normal cell activity in both plants and mammals.

- **Sulphate**

Sulfate ions (SO_4^{2-}) are present in both natural water and wastewater. Naturally occurring deposits of magnesium sulfate (also called Epson salt) or sodium sulfate (also called Glauber's salt) leach, which is usually the cause of the high sulfate concentration in natural water. There isn't a major health danger to the general public, even though high concentrations in drinking water may taste terrible or have undesirable laxative effects.

- **Nitrogen**

Organic nitrogen, ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen are the four types of nitrogen found in water and wastewater. When sewage contaminates water, the majority of the nitrogen is present as organic matter and ammonia, which microorganisms then convert to nitrites and nitrates. A fundamental nutrient

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for plant growth, nitrogen in the form of nitrate can also be a growth-limiting element. The rapid growth of algae that lowers the quality of the water can be induced by high nitrate content in surface water. Chemical fertilizers used in agricultural regions can leach nitrates into groundwater. An acute and serious health risk to babies is posed by excessive nitrate concentrations in drinking water (more than 10 mg/L). Methemoglobinemia, often known as blue baby illness, is caused by a reduction in the blood's oxygen-holding capacity due to a reaction between nitrate ions and hemoglobin.

- **Water hardness**

A phrase used to describe the characteristics of heavily mineralized waters is "hardness." Water containing dissolved minerals can lead to issues like scale buildup in hot water pipes and trouble creating a lather when using soap. Natural waters are mostly made hard by the ions of calcium (Ca^{2+}) and magnesium (Mg^{2+}). They mostly get into water via coming into touch with rock and soil, especially limestone deposits. Bicarbonates, sulfates, and occasionally chlorides and nitrates are the forms in which these ions are found. In general, surface water is softer than groundwater.

- **Dissolve oxygen [DO]**

Wetlands are formed due to their surroundings such as compressed dirt and rainfall. Dissolved oxygen is what is needed for organisms, such as small fish and green algae, which are present in the wetland and without it they will not survive. Dissolved Oxygen (DO) ranged from 3.92 ppm (in 4 no bheri during 2003) to 6.77 ppm. There exist pronounced variations in DO between years and berries ($p < 0.01$) as per data. The variation between the three selected bheries may be attributed to different degrees of exposure to solar radiation. Dissolved oxygen (DO) is considered to be one of the mostimportant parameters of water quality in streams, rivers, and lakes. It is a key test of water pollution. The higher the concentration of dissolved oxygen, the better the water quality.Oxygen is slightly soluble in water and very sensitive to temperature. For example, the saturation concentration at 20°C is about 9 mg/L and at 0°C is 14.6 mg/L.

- **Biological oxygen demand [BOD]**

Microorganisms such as bacteria eat organic materials. They use oxygen in the process of breaking down organic matter. The microorganisms use the energy released during the breakdown of the organics to grow and reproduce. These simpler chemicals include CO_2 and H_2O. The oxygen that is used up during this process in water is the DO. As the bacteria break down the organic molecules in the water, the DO content will decrease if oxygen is not continuously added, either naturally or artificially. The biological oxygen demand (BOD) is the name given to this oxygen requirement. The higher the BOD that the microorganisms use, the more organic matter there is in the water. The BOD is a metric used to quantify the strength of sewage; high BOD indicates strong sewage, whereas low BOD indicates weak sewage. Under normal conditions, it takes 20 days or longer for microbes to completely break down organic material. The ultimate BOD is the amount of oxygen required in a given volume of water to entirely break down or stabilize all biodegradable organic compounds.

- **Chemical oxygen demand [COD]**

All organic materials, both biodegradable and non-biodegradable, are measured using a metric called chemical oxygen demand, or COD. Potassium dichromate, a potent oxidizing agent, sulfuric acid, and heat are used in this chemical test; the results can be obtained in as little as two hours. In every case, for the identical sample, COD levels are greater than BOD values.

- **Toxic substances**

More than a hundred substances found in water have been classified as hazardous organic compounds in the literature. They are mostly man-made pollutants and are not present naturally in water. These substances include solvents, disinfectants, pesticides, and insecticides. Mass spectrophotometry, high performance liquid

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chromatography (HPLC), and gas chromatography (GC) are three extremely advanced instrumental techniques used to measure them.

- **Nutrients**

Fish is an excellent source of high-quality protein and heart-healthy fat. Heme iron, which is easily absorbed by the body, is found in fish. Together with calcium, they also include thiamin, niacin, vitamin B_6, vitamin B_{12}, and vitamin D. However, it appears that the recommendation to consume two meals of fish per week needs to be changed to two portions of saltwater fish per week based on recent studies. It seems that our blood levels of the vital fatty acids EPA and DHA are unaffected by the number of freshwater fish we eat.

Biological parameters

Biological parameters of water quality one of the most helpful indicators of water quality may be the presence or lack of living organisms. Biologists can survey fish and insect life of natural waters and assess the water quality based on a computed species diversity index (SDI) hence; a water body with a large number of well-balanced species is regarded as a healthy system. Some organisms can be used as an indication for the existence of pollutants based on their known tolerance for a specified pollutant. Microorganisms exist everywhere in nature. Human bodies maintain a normal population of microbes in the intestinal tract; a big portion of which is made up of coliform bacteria. Although there are millions of microbes per milliliter in wastewater, most of them are harmless. It is only harmful when wastewater contains wastes from people infected with diseases that the presence of harmful microorganisms in wastewater is likely to occur (**Fig. 3**).

a) Bacteria

Bacteria are considered to be single-celled plants because of their cell structure and the way they ingest food. Bacteria occur in three basic cell shapes: rod-shaped or bacillus, sphere-shaped or coccus, and spiral-shaped or spirellus. In less than 30 min, a single bacterial cell can mature and divide into two new cells.

b) Algae

Algae are microscopic plants that have pigments used in photosynthesis, such chlorophyll. They are autotrophic creatures that support themselves by turning inorganic elements into organic matter by using energy from the sun, throughout this process they take in carbon dioxide and give off oxygen. They are crucial for stabilizing pond wastewater treatment as well. Because of the issues with taste and odor they generate, algae are typically considered to be nuisance species in the water supply. Some algae species are extremely harmful to the environment and public health; for instance, drinking water with blue-green algae can kill domestic animals like cattle.

c) Virus

Known to possess all the genetic information required for self-reproduction, viruses are the smallest known biological structures. A strong electronic microscope is the only way to observe them. Requiring a host to survive, viruses are parasites. They have the ability to flow past filters that stop bacteria from getting through. Waterborne viral infections are known to cause infectious hepatitis and poliomyelitis. Through disinfection procedures carried out in the water treatment facility, the majority of waterborne viruses can be rendered inactive.

d) Protozoa

Protozoa are single-celled tiny organisms that feed on solid organic matter, bacteria, and algae. Higher level multicellular animals then eat the protozoa. Aquatic protozoa, often known as zooplankton, are free-floating organisms in water. Cysts are formed by them.

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Different types of Flora and Fauna

The East Calcutta Wetlands and the surrounding areas are home to roughly 100 different plant species. they consist of Ipomoea Aquatica, Cyperus spp., Sagittaria montividensis, and Cryptocoryne ciliata. In the 1950s, Patuli was included in the Sunderbans. Water hyacinths of various varieties can be found growing across these wetlands (Kundu et al., 2007). In order to reduce erosion, local fishermen and farmers utilize water hyacinth to form a buffer between the land and the water. Numerous coconut and betel nut plants can also be seen in the area. This region grows a wide range of vegetables, including sacred basil, cauliflower, eggplant, pumpkin, and sunflower. Paddy cultivation occupies tracts of land. According to Mandal and Bandhopadhya (2018), a variety of fish species are raised in the sewage-fed ponds known as Bheris located in the East Kolkata marshes. In addition, marsh and small Indian mongooses live in the area. These fish include tilapia and silver carp. Key species in and around the East Calcutta Wetlands are the palm and small Indian civets. From this area, about 20 mammals have been reported. The Buff striped keel back (Amphiesma stolata), Smooth water snake (Enhydris enhydris), Checkered keel back (Fowlea piscator), and Bronze back tree snake are among the snakes that can be found in the East Calcutta Wetland (Kumar et al., 2018).

Fish diversity of East Calcutta Wetlands

308 city-sewage-fed fisheries are currently in operation in this unique system, where sewage treatment and pisciculture are carried out in the same pond. Aquaculture uses eight native fish (Catla catla, Cirrhinus mrigala, Labeo bata, Labeo calbasu, Labeo rohita, Lates calcarifer, Liza cephalous, Liza parsia) and nine exotic fish (Argistichthys nobillis nobilis, Clarias gariepinus, Ctenopharyngodon idela, Cyprinus carpio, Hypothalmicthyes molithrix, Oreochromis mossambica, Oreochromis nilotica, Pangassius sutchi, Piaractus brachypomus)) (Jhingran, 1991). The availability of 45 native and 9 exotic fish species at East Kolkata Wetlands (EKW), the only Ramsar site in West Bengal, is important for the prudent use of sewage water, particularly for aquaculture and the preservation of biological variety. 58 fish species, 11 prawn species, 3 crab species, and 20 mollusc species are among the commercially significant aquatic species found in the EKW. Ten alien fish species and forty-eight native fish species make up the 58 species. There are 58 fish species in EKW, of which 17 are cultivated and 41 are wild. East Kolkata Wetlands (EKW), the only Ramsar site in West Bengal, is particularly significant for the judicious use of waste water, especially for aquaculture and harbouring the biological diversity. 58 fish species, 11 prawn species, 3 crab species, and 20 mollusc species are among the commercially significant aquatic species found in the EKW.

Ten alien fish species and forty-eight native fish species make up the 58 species. Of the 58 species of fish found in EKW, 17 are found in culture and 41 are found in the wild. 308 city-sewage-fed fisheries are currently in operation in this unique system, where sewage treatment and pisciculture are carried out in the same pond. Eight native fish—Catla catla, Cirrhinus mrigala, Labeo bata, Labeo calbasu, Labeo rohita, Lates calcarifer, Liza cephalous, and Liza parsia—as well as nine exotic fish—Argistichthys nobillis nobilis, Clarias gariepinus, Ctenopharyngodon idela, Cyprinus carpio, Hypothalmicthyes molithrix, Oreochromis mossambica, Oreochromis nilotica, Pangassius sutchi, and Piaractus brachypomus—are utilized in aquaculture (Hussan, 2016). There are 45 native fish species and 9 alien species to choose from, including Cyprinus carpio, Aristichthys nobillis nobilis, and Clarias gariepinus. Kolkata, the seventh most populous city in India, avoids paying an astonishing Rs 4,680 million in sewage treatment expenses annually thanks to the wetlands. It takes care of more than 80% of the metropolis's sewage, sustains over 50,000 agro-workers and supplies (Fig. 5) roughly one-third of Kolkata's requirement of fish (Mandal and Bandhopadhya, 2018).

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Figure 4: Fish diversity in EKW

Relation between fish diversity and water parameters

Fish diversity and water quality are inextricably linked. Water temperature generally plays the most significant function because it is the key to the majority of water quality metrics. The diversity of fish increases in tropical warm water, then in cool water and in cold water. Fish diversity and water quality—or, to put it more accurately, water mixture content—have species-specific relationships. It may be advantageous if the properties of the mixing of natural and synthetic particles, chemicals, and microorganisms in the water change in a way that favors a greater variety of fish species. If this shift in mixture content is directed outside of the range of favorable conditions for the species that are already present in the specified water body, it will have a detrimental effect (Kumar et al., 2018). The choice is both straightforward and time-consuming: you must weigh changes in the water content of rivers, lakes, and other bodies of water against the natural range of conditions that are ideal for each species of fish that is currently in existence as well as for all significant organisms that are part of this fish species' food chain. A considerable problem here can be presence/ emergence of aggressive fish species, changes in species competition for food, and availability of new fish species which can potentially appear owing to changes in water mixture content (Hussan, 2016).

Figure 5: Fish handling and transport in EKW

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Environmental impacts in East Calcutta Wetlands

According to estimates, these wetlands absorb 250 million gallons of sewage water every day through this DWF. The Kolkata Municipal Corporation (KMC) is estimated to produce around 2500 metric tons of garbage and 600 million liters of sewage and wastewater per day. These sewage and wastewater are drawn into the wetlands known as bheries by the EKW fishery owners. In all, 364 bheries are in operation within EKW (Ghosh et al., 2018). Approximately 18,800 liters of wastewater per second (lps) can be accommodated in the current 4400 hectares of fisheries that are fed by sewage. The organic molecules in the wastewater and wastewater gradually decompose over a few days. The amount of organic load in the fish ponds varies from 20 to 70 kg per ha per day. The environmental impact assessment report on the East Kolkata Wetlands is positive overall. The government first took action to protect these water bodies in 1992 when the Kolkata High Court issued an order designating the EKW as a conservation area. In 2004, the EKW management committee was established. The East Kolkata Wetlands (Conservation and Management) Act was passed into law in March of 2006. On November 16, 2005, the East Kolkata Wetlands (Conservation and Management) Act, 2006, which supports the policy of conservation and management of EKWs and related topics, came into effect.

Sustainable Management of the East Kolkata Wetlands

Stopping the increasing degradation of the East Kolkata Wetlands and preserving and restoring their natural features is an urgent priority for our society. The steady loss of system efficiency was caused by an inadequate comprehension of the importance of these wetland practices. The following major concerns have been highlighted for the management and conservation of East Kolkata Wetlands based on an evaluation of the hydrological, ecological, and socioeconomic factors as well as an examination of man-made practices:

a) All drainage channels and distributaries inside the wetlands should be brought under a comprehensive action plan, and the restoration of the crucial drainage structures is required for the appropriate maintenance and operation of the wastewater recycling processing the wetlands. Water circulation and flushing can be improved by desilting the incoming sewers. 346-446 Review Biodiversity, traditional practices and sustainability challenges of East Kolkata Wetlands RRBS, 2012 in the wetlands systems. Pollution in landfill locations can be reduced with improved waste segregation, appropriate trash handling, and sustainable waste management techniques.

b) The wetlands' fish and vegetable crops may be negatively impacted by the industrial effluents, particularly those discharged from the adjacent tanneries. It is imperative to identify these industrial facilities and subject them to stringent pollution control measures. The pollution issue can be effectively mitigated by common in-situ effluent treatment systems for the polluting companies.

c) A list of safe species to cultivate on the garbage farms in these locations should be given to farmers, and a detailed assessment of the degree of heavy metal and industrial pollution contamination of the food chain through various species should be conducted for the safety of human health. The correct identification, scientific applications, and management of pollution of the bioindicator species of these wetlands should be the main areas of focus. To eradicate the contaminants, hype accumulators of the same should be grown in the contaminated area. Using insecticides, herbicides, and other hazardous chemicals in culture ponds housing vulnerable species need to be prohibited.

d) The creation of a thorough genetic database and biodiversity map for the wetlands will allow for the potential use of different resistant and tolerant gene variants for scientific investigations. Using microbial strains for isolation and culture will help with the use of bioremediation techniques. The application of preferential conservational solutions based on varying degrees of sensitivity will be aided by comparative vulnerability studies of the wetland species. Remote sensing and GIS applications, in addition to the use of biotechnological and microbiological research techniques, are crucial for these investigations.

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e) By enhancing the circumstances and habitats for breeding, the populations of all species of waterfowl should grow. To preserve important bird species, a thorough understanding of their eating patterns, population dynamics, and unique needs is necessary. Additionally, native and endemic species, particularly fish raised in fisheries, should be prioritized for protection.

f) Enhancing the water use efficiency in irrigation systems, diversification of cropping patterns in the wetlands areas and the implementation of rainwater harvesting structures in agricultural fields can stabilize the groundwater system and also can enhance the watersecurity of the local people.

g) Stewardship of ecosystems, sustainable resource development, and enhancement of livelihoods ought to be the primary goals of management plans. Some of the major consensus-building elements that will support sustainability are institutional development, communication, education, and public awareness. Implementing the comprehensive approach of wetland conservation effectively requires the growth of ecotourism and the improvement of the social and economic stability of the community.

Conclusion

By utilizing the solid and liquid waste from Kolkata and the surrounding areas, the East Kolkata Wetland contributes significantly to resource recovery. It also produces vegetables and fish and employs a large number of people. Along with its abundance of flora and animals, the East Kolkata Wetland is home to a diverse range of microorganisms. For the sake of the nation's ecological stability and economic development, the East Kolkata Wetland, which is valued as a national treasure and provides abundant natural resources, must be protected. This is the biggest collection of fish pond sewage in one location worldwide. However, it is disappearing as a result of urban growth, which disregards the sewage-fed aquaculture system's advantages for the environment, economy, and ecology. It is essential to comprehend the science underlying the management techniques that fisherman have developed. Based on an estimation of the global ecosystem services, wetlands are valued at 75% more than lakes and rivers, 15 times more than forests, and 64 times more than grasslands and rangelands. In order to preserve the East Calcutta Wetlands and raise the level of living for those who live in the majority of the wetland's interior, five actions must be implemented. It is necessary to evolve focused and directed developmental programs. The East Kolkata Wetland is currently facing several environmental stressors as a result of chemical and anthropogenic contamination. Prior to allocating funds for development, it is necessary to determine the areas and target groups, as well as to prioritize the specific demands.

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