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Artificial Floating Island: Solution to River Water Pollution in India. Case Study: Rivers in Pune City

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Abstract. World is facing many tribulations related to wastewater treatment and India being second most populated country in the world, it fighting with water pollutions for ages. Lack of resources to operate wastewater treatment plant in most of the places is responsible for increasing pollution. A technology which uses natural resources is the only way out of this problem. One of such technology is Artificial Floating Island; it can treat the polluted river water along its course. It is nothing but, wetlands which floats on water surface with help of buoyant material. According to the surveys, the rivers in Pune city are perfect examples of polluted rivers in India. Discharge of raw sewage or partially treated waste water is the prime reason for water pollution. Artificial Floating Islands (AFI) can be effectively used in water bodies with organic pollutants. Therefore, AFI is can prove to be ideal system to control pollutions of rivers in India. AFI will help to retain the ecology of rivers; it is a robust and sustainable technique to treat river water.

Keywords: River water pollution, Artificial Floating Islands, Rivers in Pune city, organic pollutants.

1. Introduction

All the ancient civilizations have developed along the banks of rivers, as they provided them with most essential need "Water". All the ancient civilizations of the world have flourished near the river beds. Rivers provide fertile soil and water to the area on river banks; any effect on the water quality of rivers is directly reflected on the health and lifestyle of the people depending on it. River Water pollution is one of the major concerns of many countries. In a country like India, where rivers are considered as goddesses, numerous factors are responsible for the degrading quality of river water. All the factors affecting the quality of water should be handled with equal attention.

2. Factors Affecting River Water Quality

2.1. Disposal of Untreated Sewage

India generates 20,000 Million Liters per day (MLD) of sewage out of which 30% is treated in Sewage Treatment Plant (STP) and remaining sewage is disposed in the natural water bodies untreated. A survey was conducted on Sewage Treatment Plants in India by Central Pollution Control Board (CPCB). According to this survey most of the Sewage Treatment Plants are not operating with the design efficiency. Approximately 30,000 MLD of pollutants enter India's rivers, 10,000 million litres from industrial units alone.

2.2. Littering

India's garbage generation stands at 0.2 to 0.6 kilograms of garbage per head per day. Many times, waste is dumped into river or on street side which is then carried to river with runoff. Many rivers in India are nothing but body of water, little more than a flowing garbage dump, with fully 57 percent of the waste finding its way to rivers. Garbage cascades down the banks, giving off the fetid stench of a cesspool. Center for Science and Environment's (CSE) second volume of the seventh State of India's Environment report -

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Excreta Matters (71 cities: a survey), claims that Indian cities are wallowing in their waste and the rivers becoming a dumping ground for it. In this report CSE profiles 71 cities on their waste water management capability and maps the state of groundwater and its sources. There are more such cities and villages which are not even surveyed, what we see now is just tip of the iceberg.

2.3. Disposing of Ritual Materials

India being a country with 82% of population is Hindu by religion. Many people perform various rituals which includes disposal of the ritual material in the river, as it is considered a sacred water body. At some places, even the dead bodies are dumped into the river. In this attempt of cleaning sins, it is forgotten that the river is getting polluted. Immersion of thousands of sculptures made of Plaster of Paris (POP) during different festivals is one of the crucial problems. Tones of POP are deposited in the river bed and inorganic paints of the sculptures add toxic pollutants in the river.

2.4. Human Activities

River being the most important source of water is used by humans in every possible way. People bath, wash cloths and utensils, chattels are cleaned in the river. Open defecation is practiced widely in rural and some urban regions, during rainy season it causes pollution, as it is washed in to the river. According to UNICEF, about 626 million people or nearly 51% of the population in India still defecate in the open.

2.5. Oil Seepage and Agricultural Pollutants

Spillage of oil through vessels and leakage through pipeline is one of the components responsible for river water pollution. Excess of fertilizers are washed in to the nearby water body and joins river course. It has been estimated (Qasim and Sen Gupta, 1983) that in 1984, 5 million tones of fertilizers, 55 000 tonnes of pesticides, and 125000 tonnes of synthetic detergents were used in India. Roughly about 25% of all these can be expected to ultimately end up in the rivers every year.

3. Case Study: River Mula – Mutha

Pune is the eighth largest metropolis in India. Pune city is situated on the banks of Mula and Mutha (tributary of River Mula) River in a gentle rolling valley with small hillocks and off Western Ghat ranges all around the city having population 5,518,688 (2010). During its course through the city, River Mula and River Mutha are poured with sewage from approximately 150 nullahs. 60% of the sewage water is treated and reaming untreated water is discharged into the river, moreover excessive littering, disposal of ritual material (garlands, god-goddess idol made of plaster of Paris), human activities and discharge of industrial waste are the major cause of degrading river water quality.

Lack of awareness, low sewage treatment capacity and scarcity of resources is adding on to the problem. With the increasing pollution of water bodies and constant failure of petitions and action plans related to river cleaning, there is a need of some innovative technique which will be cost effective and easy to maintain.

Main concern today is to find an alternative method to treat the river water without changing its course, which will be cost effective, highly efficient, simple but robust to remove nutrients such as nitrates, phosphates etc. Thus, Artificial Floating Island Technique for treating the river water is proposed

3.1. Artificial Floating Island Technique

The Artificial Floating Island (AFI) is a floating structure on which aquatic vegetation such as reed grows. The main purpose is to purify water, create habitats, improve landscape, and preserve lakeshore by wave absorption. AFI technology was originally developed as fish spawning reef in 1950's. It is kind of new ecological method and didn't attract much attention until 1995. After that there is a big increase of AFI application case in Germany and also other countries, such as Japan and U.S.A. And recently it is widely recognized as Eco-technology, and installed at many lakes and ponds in U.S.A., investigation revealed that about 15 companies laid artificial floating islands, and the number of those so far is approximately 2,000 reaching 24,000m^2.

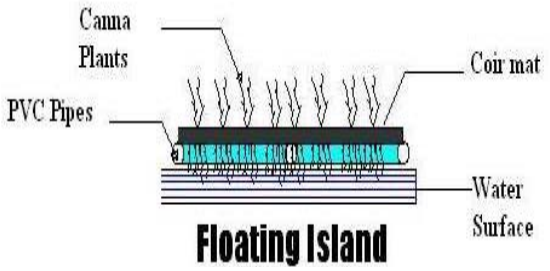

Fig. 1: Schematic Diagram of Floating Island

Fig. 2: Artificial Floating Island

3.1.1. Functions

There are many functions of AFI concerning water environment management such as water purification, habitat for wild life, and improvement of lake shore scenery listed as follows:

- **To purify water:** The growth of aquatic plants densely on the AFI and the micro-organisms attached in the AFI help purify water a lot. Besides, the AFI can inhibit growth of phytoplankton due to that it occupies water surface and form a "shadowing effects".
- **To create habitat for fish and birds:** AFI can support growth of aquatic plant and thus create a habitat and offer shelter for birds, insects, and other bio-organisms. It provides "spawning bed" for fish. As a result, the ecological diversity is intended to restore and improve after construction of AFI.
- **To break wave and protect littoral zone:** The AFI is designed to dissipate wave and can help stabilize and protect littoral zone through reducing wave impacts and erosion, and thus advantageous to the recovery and growth of vegetation in the littoral zone.
- **To improve landscape:** The growth of different plants on floating island forms a favorable landscape.

3.1.2. Suitable Installation Places

The AFI creates artificial near shore mini-ecosystem through utilization of water surface instead of occupying the shoreline space. Since the AFI uses floating platforms to support vegetation, it can move up and down with the fluctuation of water level, and also can be move from place to place. Due to its unique features, it is suitable for the following places:

- It is effective structure for the dam lakes with violent fluctuations in the water level;
- It is suitable for the lakes and marshes involving difficult in the recovery of vegetation zone due to the waves,
- It is also possible for the ponds and marshes requiring accents in the landscapes, shores requiring the spawning site for fish and habitat for birds.

3.1.3. Structural Classification

The AFI is composed of the vegetation base-AFI platform and the fixing system-anchor. According to its platform structure, the AFI is classified into two types, the dry type and the wet type. The Wet type with frame is the most frequently used type until now, sharing about 70% or more, dry type shares 20%, and wet type without frame shares about 10%.

3.1.4. Vegetation base and Vegetation

Coconut palm fibers are most often used as the vegetation base. Other than thosein coco palm fibers, vegetation bases are often made of special foam polyurethane, fishing nets, foam polyurethane beads, and the combination of these materials in many cases.

Vegetation used on island varies with change in climatic conditions and quality of the water. Canna Cannaceae proves to be effective. Some of the other plants which are suitable in climatic condition of India are, *Arum maculatum, Vetiveria zizanioides, Crinum jagus,* etc.

3.1.5. Size and configuration

One side of a unit range from about 1 to 5 meters, but many of them have a side ranging 2 to 3 meters, transportability, workability, and durability being taken into account. The most popular configuration is four-sided.

4. Surveys

4.1. Primary Survey

- Survey of River Mula was carried out, which included determination of River bed profile and River velocity profile. The velocity of the river at the section of maximum depth was observed as 6cm/sec i. e. 0.06m/sec. Velocity of the river is suitable and will provide proper contact time with the roots for proper working of AFI.
- Maximum depth of the river is 6 metres at a distance of approximately 30mtrs from the bank of the river. Therefore, AFI can be installed in the dentations on the river bank where risk of AFI getting washed away will be minimal.
- From the experiments carried out, it is observed that Dissolved Oxygen in the river Mula and Mutha is less than 4mg/l. Permissible limit for Dissolved oxygen is 4mg/l for survival of living organism in the water.
- According to the experimental observations BOD of the River Mula varies from 40-60 mg/l and BOD of River Mutha varies from 20 -144mg/l. Even after presence of number of STPs on the river BOD of both the rivers is much greater than the permissible limit. This indicates presence of large amount organic waste in the river water. Therefore further treatment of river water is necessary.
- COD of the water should be less than 250mg/l. COD of water in River Mula is in between 250mg/l - 390 mg/l and that of water in River Mutha is between 155mg/l -550mg/l. COD of River water is greater than permissible limit, the present COD of water indicates the presence of organic as well as inorganic matter. The water from River Mula and Mutha cannot be used for any purpose without treatment. AFI can reduce the BOD by 60-80% in suitable and can also efficiently reduce the COD. Therefore, AFI can be effectively used.
- Total Suspended Solid (TSS) in water of River Mula is 200mg/l to 300mg/l and that of River Mutha is 200mg/l to 600mg/l. TSS of the River water is less than permissible limit which is 2000mg/l.
- BOD and COD content of the water indicates presence of sewage in the water, this is due to discharge of untreated wastewater in the Rivers. From the survey carried out on the river banks it was observed that number of nullahs is let out in the river without any treatment. Nutrients in the water are used by plants on AFI for their growth; as a result nutrient content can be reduced naturally.
- River also has bad odour and greenish colour which is due presence large amount of sewage. Surface River is covered with Water Hyacinth throughout the year except during the monsoon, this also indicates the presence of sewage. Application of AFI will not only treat the water, but it will also increase the aesthetic beauty of river. Flower plants which are pleasant can be used in AFI.

4.2. Secondary Survey

Conventional Water Treatment requires constant power supply and maintenance. Lack of continues electric power supply and proper maintenance has lowered the efficiency of STPs in Pune. It also evident from the PMC report and articles in the newspaper that capacity of the STPs' is not enough to treat the daily sewage water from the city and high amount of money is invested to erect new STPs and achieve 100% treatment of sewage. But erecting STPs and maintaining them to operate at full capacity and efficiency is

other side of coin. Efficiency of the STPs is highly dependent upon the loading conditions and hence is relatively low.

On the other hand AFI needs no energy for its operation and can withstand fluctuation in the water level and sewage loading. Hence use of AFI should be promoted on a larger scale by Pune Municipal Cooperation (PMC) in some stretches of Mula Mutha River so that one can reap various benefits out of it. Automatically it will help to restore the ecology of the river by promoting treatment of water and growth of aquatic fauna.

5. Conclusion

About 40% untreated wastewater is discharged in the River Mula and Mutha. Present state of Rivers in the Pune city is so abominable that they are on the verge of being declared "Dead". Adopting a technology which will treat river water must be of prime concern to each individual. The waste water should be treated at the source itself, but even if it is let out into the river after treatment, it will not have any effect on the pollutant already present in the river. To exterminate the pollutants in river, it is necessary to treat the river water as well and here AFI can help us. One can simultaneously start treating the water at various places with the help of Artificial Floating Islands, so that the ecology of the Mula Mutha River can be restored. Climate of India is suitable for use of AFI, the temperature and atmosphere can accelerate the process of conversion of complex matter in simpler form. According to various studies, with proper selection of Plants and site, AFI can reduce BOD and COD by 80 and 60 percent respectively. The root system converts the complex molecules in simpler nutrient form; this simple form of nutrient is consumed by other aquatic organisms, thereby it improves water quality in a eco-friendly way. AFI can prove to be a great support system to save our rivers and life depending on them.

6. Acknowledgement

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