PHYTOREMEDIATION : ASUSTAINABLE SOLUTION FOR AQUATIC POLLUTION

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Abstract*: Lakes are the convenient source of water to meet the domestic and industrial needs of town. They are also important in maintaining the ground water level, aesthetic value and ecosystem of surrounding area. Lakes have very sensitive and complex ecosystem as they do not have self-cleaning ability and therefore readily accumulates pollutants. Amongst the various anthropogenic activities, discharge of sewage is the major cause of eutrophication leads these beautiful water bodies under great environmental threat. In this paper/article a case study of Naik Lake is discussed. During investigation it was observed that values of many physico-chemical parameters were higher than permissible limits of BIS standards. Study of phytoplankton diversity and occurrence of some pollution indicator species indicates high degree of organic pollution and eutrophic nature of Naik Lake. Certain phytoremediation techniques such as Phytorid Technology and Artificial Floating Islands (AFI) must be used by municipal corporations for the sustainable development of such natural resources. This paperalso aims to collect information and popularize the eco-friendly techniques for ecorestoration of lakes.*

Key words: *Lake pollution, phytoremediation, phytorid technology, Artificial Floating Island (AFI).*

Introduction :

The lakes are built for the aesthetic purpose as well as they are important components of the artificial water collection system. Their contribution to the ecosystem functions is also very significant.But, most of the lakes are degraded, depleted or contaminated mainly by various anthropogenic activities. Hence to combat with such types of environmental pollution certain eco-friendly and sustainable technologies must be adopted by municipal corporations, civic societies and other competent authorities.

Common sources of water pollution:

Freshwater biomes have suffered mainly from pollution. Runoff containing various types of pollutants such as industrial waste, fertilizers etc. added into lakes, ponds and rivers which increases algal growth and ultimately support process of eutrophication. After the death of algal material it settles down at the bottom of aquatic body and increases organic pollution. This has very adverse effects on flora and fauna of water bodies. Amongst the various anthropogenic activities, discharge of sewage is the major cause of eutrophication

leads these beautiful water bodies under great environmental threat.The release of wastewater from drains or sewers includes human wastes, soaps and detergents which causes serious environmental problems.Sewage causes enrichment, increment in the body of water by high levels of plant and algal nutrients (nitrogen and phosphorus). Also increases Biological Oxygen Demand (BOD), as BOD increases Dissolve Oxygen (DO)decreases.

Materials and Method:

The study was carried out with respect to following aspects.Evaluation of effect of anthropogenic activities on lake.Evaluation of trophic status of lakes by Palmer's Pollution Index. Limnological survey of the lake for biological characteristics.Recommendation for the restoration and the conservation of lake. Regular visits to Naik Lake were conducted periodically.Water samples for analysis were collected from different sites of Naik Lake.

Palmers Pollution Index (PPI): is a biotic index based on organic pollution indicator species.For rating the organic pollution of the water bodies, this index is used. In this index, the algae present in the water sample are identified and the genera present from the prescribed list are noted. For the calculation of index, summations of assigned number scored by each genus arecounted. (Palmer, 1969)

Standard scale of Palmer's Pollution Index:

1-15 : Indicates clean but, increasing nutrient enrichment to optimal level.

15-20 : Indicates presence oforganic pollution.

>20 : Indicates very high organic pollution.

Table : List of algal species recorded

Sr. No.	Algal species	Values of PPI	Family
1.	*Spirulina*	-	Cyanophyceae
2.	*Merismopedia*	-	
3.	*Oscillatoria*	5	
4.	*Anacystis*	1	
5.	*Anabaena*	-	
6.	*Navicula*	3	Bacillariophyceae
7.	*Nitzschia*	3	
8.	*Pinnularia*	-	
9.	*Fragillaria*	-	
10.	*Ankistrodesmus*	2	Chlorophyceae
11.	*Actinastrum*	-	
12.	*Chlorella*	3	

13.	*Cosmarium*	-	
14.	*Scenedesmus*	4	
15.	*Coelastrum*	-	
16.	*Selenastrum*	-	
17.	*Pediastrum*	-	
18.	*Clostriadium*	-	
19.	*Euglena*	5	Euglenophyceae
20.	*Phacus*	2	
Value of Palmer's Pollution Index = 28			

Conclusion:

Yearlong physico-chemical, biological and bacteriological analysis of Naik Lake indicates the eutrophic condition of lake which makes it unfit for any human use. Very high value of Plamer's Pollution Index (28) shows there is highdegree of organic pollution in lake. Study of phytoplankton diversity and occurrence of pollution indicator species such as *Oscillatoria, Navicula, Nitzschia, Chlorella, Scenedesmus, Euglena* shows high organic pollution and eutrophic nature of lake. The similar observations were recorded by Hosmani and Bharti, (1980); Trivedy, (1988); More and Nandan, (2000; Khalid DheyaaAbdulwahid, (2016).

During the study period, coliform investigation values were always>16000/100ml which indicate high fecal contamination in lake. To avoid further aging of lake, it is essential to minimize the ingressof pollutants and sewage into the lake water and removal of macrophytes to reduce the organic load.Also municipal corporations must use certain sustainable solutions to minimize pollution of water bodies. Some sustainable solutions are discussed below.

Sustainable solutions:

Phytoremediation: Phytoremediation originates from the Greek word phyton which means 'plant' and remediummeans 'remedy'. For restoration of polluted water& soil environment to their previous natural state, a biological technique i.e. phytoremediation is used. Phytoremediation is defined by UNEP (2012 a,b) as the use of living green plants for in situ removal, degradation and containment and contaminants in soils, surface waters and ground water. (Science direct).In this technique living plants and their related microorganisms are used to remove contaminants from the polluted environment or to convert contaminants to a comparatively lesser toxic form.

(1) This technology is used widely because compared to other remedies; it is less destructive and generally affordable

(2) Another advantage is that it adds aesthetic beauty to a degraded soil as it involves growing beautiful vegetations.

In this paper information regarding following two phytoremediation techniques are discussed

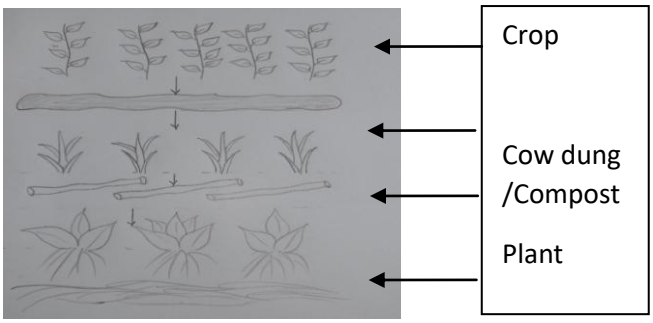
(I) Artificial Floating Island (AFI)

(II) Phytoremediation technique

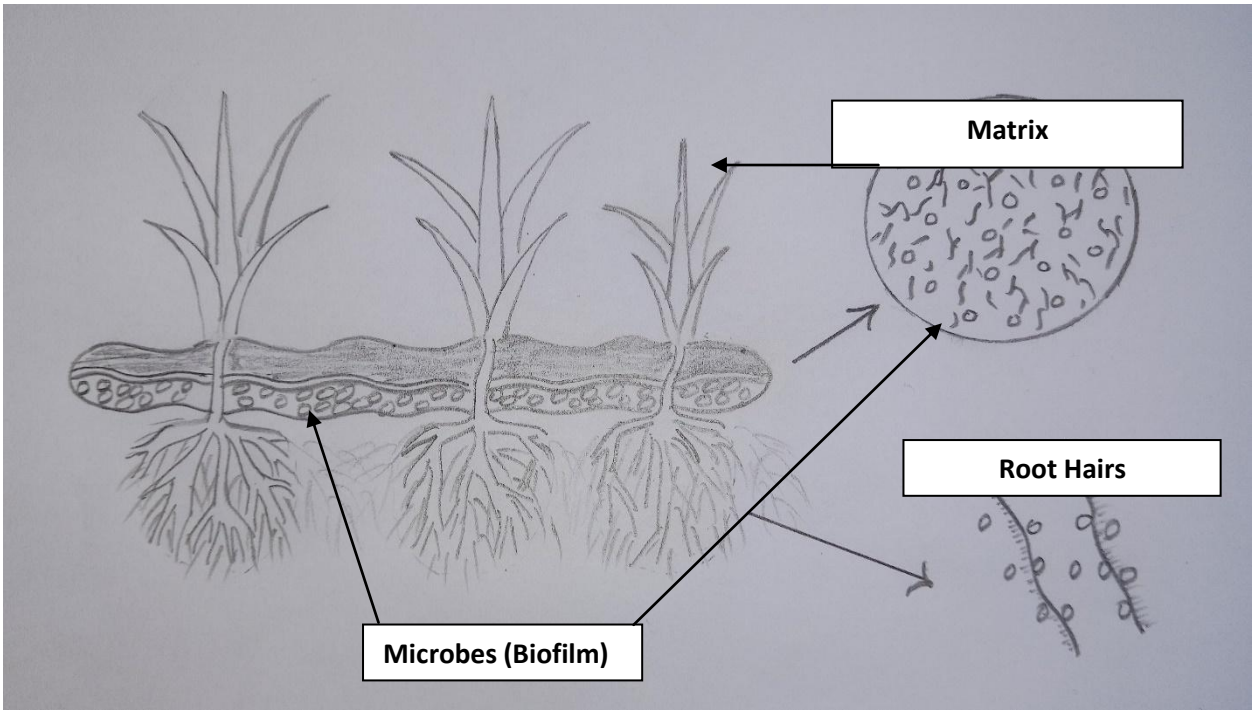
(I) Artificial Floating Island (AFI): The AFI are an innovative floating structure on which suitable aquatic vegetation grows in hydroponic manner with buoyant frames floating on the surface of water bodies.Artificial floating islands (AFIs) are variation of wetland treatment systems for water quality improvementYueya Chang (2017) In this technique, plants are forced to take their nutrition directly from the water, which improve the uptake rates of nutrients from water bodies. AFI can be made by using bamboo or PVC pipes and coir covered with soil and plants are anchored in the water to create floating island that clean the water. The plants root grows through the raft bottom into the lake, where they absorbs nitrogen, phosphorous and other impurities. A biofilm created by bacteria on the raft and roots, consumes nitrogen and phosphorous which ultimately converts them into less harmful substances. Pollutants such as particulates and metals are also filtered out, since suspended solids bond to the biofilm. As a result the water becomes cleaner which allows light to penetrate upto deeper layer which increases the photosynthetic activities of plants of lower layer, bringing oxygen deeper. The organic matter that attaches to the underside of the floating island also provides food for fish and island provide habitat for birds, which ultimately improves aesthetic value of the lakes. The plants used in AFI can be easily harvested and subsequentlyprocessed into biogas, biofertilizers and other biomaterial impelling the practical application of the technology due to potential economic returns. Further if we want to manage and control the position of AFI at desired location a radio control device can be installed on the AFI and can be moved from one place to another with the help of remote control.

Buoyant structure: In AFI buoyancy is provided artificially through the use of floating structure or raft which support the growth of plant. Sometimes expanded polysterene foam, fishing nets, PVC pipes, polysterene sheets, bamboo have been used to provide flotation. In this technology, generally coconut palm is used as a vegetation base.

According to quality of water and climatic condition plants are used in AFI. More often *Canna cannaceae, Arum maculatum, Viteveriazizanoides, Crimumjagus*are used. Even *Typha* and*Eichornia* can be properly used in this technique. A working unit ranges from 1 to 5 meters are used.



A.



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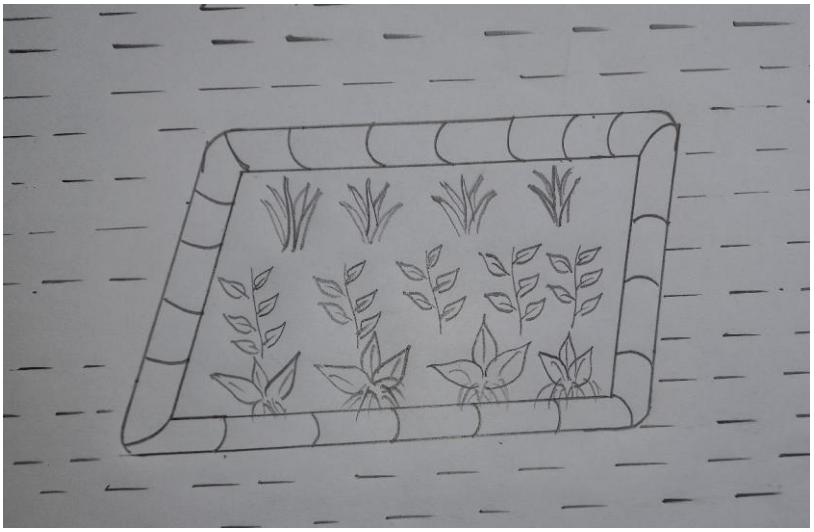
A and B :Working structure of AFI



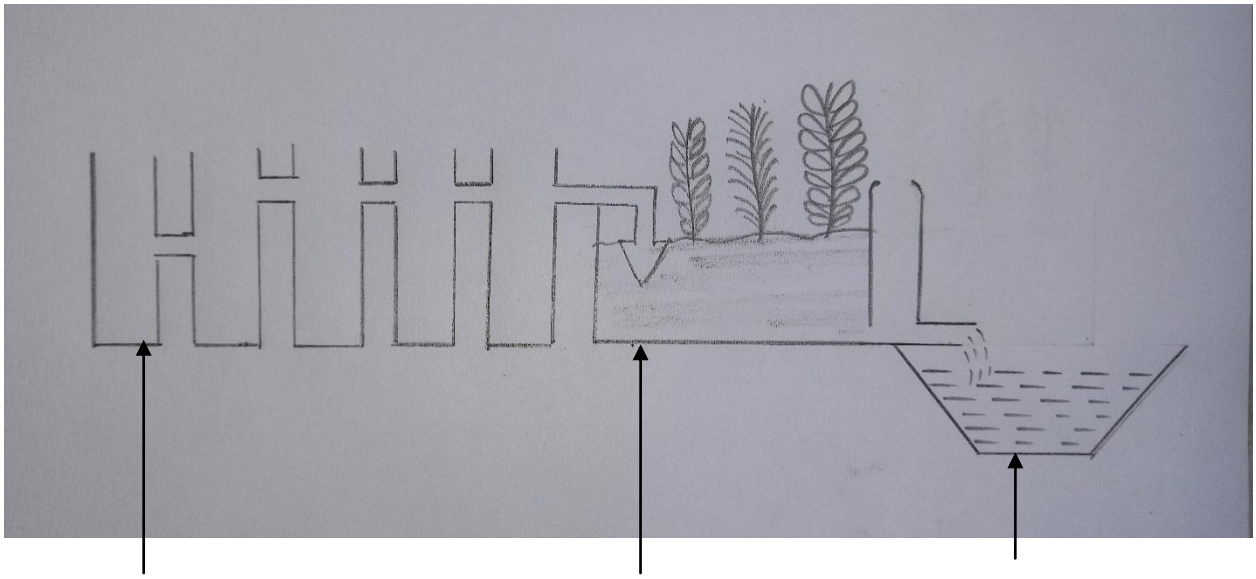
Artificial floating Island

Environmental benefits of AFI:

1) The dense growth of aquatic plant and the micro-organisms attached in the AFI helps to purify water.
2) It also inhibits the growth of phytoplanktons which increases light penetration upto deeper layer.
3) AFI creates a habitat and offer shelter for birds, insects and other organisms which improves the biodiversity of lake.
4) AFI can protect littoral zone through reducing wave impacts.
5) AFI improves aesthetic beauty of lake.
6) In conventional water treatment system like ETP / STP, constant power supply and maintenance is required. However, for the operation of AFI there is no energy is needed.

(II) Phytoridtechnology:

'Phytorid Technology' is a technology where wastewater can be treated naturally without the addition of chemicals. The phytorid technology is subsurface flow type wherein water is applied to the cells/beds filled with porous media such as gravel and stone (Kaalipushpaetal, 2017). The 'Phytorid Technology' is a combination of the physical, chemical and biological processes which resulted into ultimate treatment for the waste water (Anuradha Patil and Sagar Gawande, 2016)In this technology aquatic or semi aquatic plants such as species of *Typha, Phragmities, Canna, Nerium*, *Colocassia*etc. along with their associated biota is used.Constructed wetlands are engineered systems to utilize the natural functions of wetland vegetation, soils and their microbial populations to treat wastewater (Mayur Sanadiya, 2018). 'Phytorid Technology' is an improved wetland ecosystem for treatment of wastewater. In this technique a system/cell is developed by using porous media such as crushed bricks, gravel/stones and wastewater is allow to flow on the bed. The system comprising three zones viz. Inlet Zone (made up of crushed bricks and gravel), Treatment Zone (having specific plant species) and Outlet Zone. These systems have capacity to remove BOD/COD, suspended solids, phosphorous, nitrogen and fecal coliforms. It is suitable for secondary and tertiary treatment of municipal wastewater, management of sludge, treatment of industrial or agricultural effluent.



BiodigesterPhytorid BedCollectionofWater

Working structure of Phytorid Technology

Environmental benefits of Phytorid Technology:

1) It requires less space
2) It requires negligible operation and maintenance expenses
3) It requires minimum electricity requirement
4) Cost-effective as compare to conventional treatment system
5) Facilitates recycle and reuse of water
6) It increases aesthetic beauty of surrounding area as it resemble like garden
7) No foul odor and No mosquito nuisance

Hence, I strongly recommend the use of AFI and Phytorid technology for eco-restoration of Naik and other lakes and also for other degraded wetlands. Municipal Corporations and Civic Societies should take initiation to install AFI and Phytorid technology in various lakes of cities which will definitely help to improve the ecological condition of lakes and increase the biodiversity of water bodies, which ultimately makes our city a true SMART CITY.

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