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Studies on Rejuvenation of Futala Lake, Nagpur

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ABSTRACT

Futala Lake is situated near Telankhedi garden on Amaravati road in Nagpur city. Discharge of domestic sewage and effluents from upstream and surrounding residential areas, run-off from the catchment area has significantly contributed to the pollution of the lake. Water quality and sediment analysis for various physico-chemical and biological parameters in Futala lake water, conducted by NEERI, revealed that there is degradation in the ecological health and biological wealth of the lake. The lake is in mesotrophic condition and ecotechnological measures are needed to rejuvenate the lake. The measures suggested are construction of sediment basins in the inlets of the lake followed by construction of wetland. A number of species viz. Bulrushes, Sedge, Cattails *(Typha)* etc. have been identified for wetland construction. This paper emphasis on the management and conservation methods needed to be employed in restoring the Futala Lake.

Keywords: Rejuvenation, Futala lake, effluents, Sediment basin, and wetland.

INTRODUCTION

Lakes are often visualized as a uniform mass of water, evenly mixed from top to bottom, particularly with shallow depth. In fact, lakes are extremely heterogeneous or patchy. The physical, chemical and biological characteristics of lakes vary widely. Lakes vary physically in terms of light penetration, temperatures and water currents, chemically in terms of nutrients, major ions and contaminants, biologically in terms of structure, population number and growth rates. The Futala Lake and its environs near telankhedi garden on Amravati road, Nagpur is a picnic spot. It is a rainwater impoundment with an area of 26.3 hectors and 4-5 meters deep during monsoon. The lake is subjected to pollution due to human activities and cattle washing. It is used as a stocking tank for the major carps and other fishes. The lake is used for recreational fishing activity. Also idol immersion is practiced since long time. This has increased the nutrient load and toxic heavy metals concentration in the lake water.

The lake aesthetics deteriorated gradually due to bad odour all around the year. The Nagpur Improvement Trust (NIT) has decided to clean and restore the lake and beautify the surrounding to develop it again as a picnic spot. In view of this, NIT approached NEERI to undertake study on the environmental status of Futala Lake and suggest appropriate intervention to improve the water quality of the lake. In this study, environmental status of Futala Lake has been assessed to suggest appropriate intervention to improve the water quality of the lake.

Problems in Futala Lake

The main problem in Futala Lake has arisen due to discharge of domestic sewage and effluents from upstream and surrounding residential areas. During rainy season the run-off brings the eroded topsoil from the catchment, which gets settled in the lake causing turbidity in lake water. Release of wastes through inlet streams contributed to the internal nutrient loading of the lake. Immersion of idols has been in practice since a very long time. This has increased the nutrient load and concentration of toxic heavy metals in the lake water.

Excessive nutrient load (C, N, and P) in Futala Lake has caused heavy growth of water hyacinth, water lily, hydrilla, wolfia, potamogeton and algae. Anaerobic conditions are developed in the bottom of the lake. The acids produced cause release of phosphorus and nitrogen from organic sediments into the water column of the lake. These nutrients feed the weeds and algae in the lake. Anaerobic bacteria discharge toxic gases into the lake water including hydrogen sulphide (H_2S), ammonia (NH_3) and methane (CH_4). These compounds are toxic to fish thus reducing the food chain efficiency.

METHODOLOGY

The lake water quality with respect to physico-chemical and biological aspects has been evaluated to arrive at the status of the lake. Identified from the secondary data available, water quality assessment was carried out before Ganesh festival and after Ganesh festival to study variation and impact due to immersion of idols on lake water quality. The samples from Futala Lake were collected from ten sampling locations (Fig 1). Water samples were collected from surface and bottom with the help of depth sampler. Lacky's microsect drop method was used for quantitative estimation of phytoplankton and organisms were expressed in number per milliliter. Samples for zooplankton were collected with the help of conical plankton net. Samples were collected filtering 20 liters of surface water through the plankton net. Quantitative estimations were carried out with the help of Sedgwick-rafter cell. Shannon-wiener diversity index (SWI) values were assigned to the organisms in order to decide the trophic status of the water body. Sediment samples were collected using a sediment sampler for nutrient parameter. Water quality assessment was carried out as per standard methods **(APHA, AWWA and WEF, 2005).** The bottom sediment analysis was carried out for TKN, PO_4, total organic matter, organic carbon and heavy metals analysis as per the method of soil analysis **(Black, C. A. 1996)**

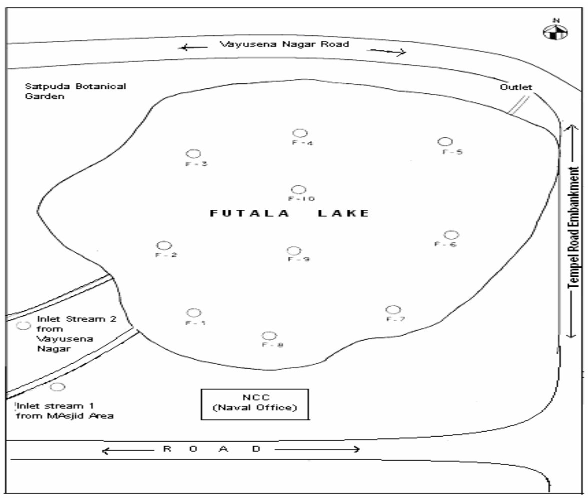

Figure 1.Map showing sampling locations of Futala Lake

OBSERVATION AND DISCUSSION

The water quality analysis shows **(Table 1)** that all the samples of both surface and depth water zones were well saturated with dissolved oxygen 7-9 mg/l for surface water and 5.3 to 6 mg/l for depth water, showing high photosynthetic activity. BOD was in the range 5 to 7 mg/l. COD was observed in the range 4.8 to 16 mg/l in surface water and 7.2 to 30 mg/l in depth water samples. Nitrate and phosphate was observed in the range of 2 to 4mg/l and 0.02 to 0.16 mg/l in surface water and 2to 4 mg/l and 0.03 to 0.23 mg/l in depth water. A positive correlation was observed between algal count and phosphorus content **(Fig 2).** Statistical analysis showed significant coefficient of correlation between N: P and phosphate and N: P and Nitrate- nitrogen **(Fig 3 & 4).** Lake water with phosphate more than 0.05 mg/l and nitrates more than 0.5 mg/l are eutrophic and highly polluted **(Toner, 1977)**. The range in values of total phosphorus, mean and maximum chlorophyll-a, mean and maximum secchi depth as observed during the study period is presented in **Table 2**. The chemical analysis results indicate, according to the boundary condition for classification of lakes and reservoirs as defined by the organization of economic cooperation and development that the status of Futala Lake is in mesotrophic state and is in the progress towards eutrophication.

Heavy metal concentrations at all the locations were estimated for Arsenic, lead, cadmium, copper and chromium **(Table 3)**. All the metals were found to be present below BIS: 10500 limits.

Table 1: Water Quality of Futala Lake

Sl. No.	Sample Code	Turb. (NTU)	pH	Cond. µS/cm	TDS (mg/L)	Total Alkal. (mg/L)	Total Hard. (mg/L)	Ca (mg/L)	Mg (mg/L)	F (mg/L)
1	F1A	3.48	7.8	452	271.2	180	220	44	27	0.6
2	F1B	45.50	7.4	453	271.8	172	219	43	27	0.8
3	F2A	5.50	7.6	452	271.2	188	224	58	19	0.6
4	F2B	88.20	7.5	454	272.4	180	197	49	18	0.8
5	F3A	3.79	7.2	464	278.4	184	193	52	15	1.0
6	F3B	14.88	7.4	476	285.6	172	187	50	15	1.0
7	F4A	3.47	7.7	453	271.8	188	189	58	11	0.8
8	F4B	141.76	7.5	465	279	180	176	48	14	0.9
9	F5A	3.57	7.6	454	272.4	192	195	47	19	1.0
10	F5B	56.09	7.1	468	280.8	180	156	45	11	1.0
11	F6A	3.09	7.7	454	272.4	192	188	56	12	0.8
12	F6B	32.08	7.4	464	278.4	180	146	49	6	0.8
13	F7A	1.65	7.6	461	276.6	188	188	51	15	0.9
14	F7B	18.93	7.4	482	289.2	180	132	46	4	0.8
15	F8A	1.40	7.5	451	270.6	192	146	50	5	0.7
16	F8B	49.34	7.4	465	279	180	131	47	4	0.8
17	F9A	1.75	7.7	450	270	188	150	46	9	0.9
18	F9B	186.72	7.4	455	273	180	136	34	13	0.9
19	F10A	1.85	7.5	451	270.6	188	171	46	14	0.9
20	F10B	16.37	7.4	464	278.4	164	158	41	14	0.9
21	IS 1	3.00	7.5	494	296.4	208	160	36	17	1.2
22	IS 1-Con	4.55	7.5	452	271.2	180	147	42	10	1.0
23	IS 2	1.44	7.4	445	267	172	153	38	14	1.0
24	IS 2-Con	3.83	7.5	453	271.8	184	151	36	15	0.9

Sl. No.	Sample Code	Cl (mg/L)	NO_3 (mg/L)	SO_4 (mg/L)	PO_4 (mg/L)	Na (mg/L)	K (mg/L)	TKN (mg/L)	DO (mg/L)	BOD (mg/L)	COD (mg/L)
1	F1A	62	4	12	0.06	30	4	2	6.0	6.0	15.2
2	F1B	64	5	15	0.07	32	5	6	3.6	11.0	32.0
3	F2A	54	4	30	0.10	30	4	4	6.2	7.0	14.4
4	F2B	56	5	34	0.19	36	6	9	3.6	8.0	32.8
5	F3A	56	5	21	0.09	32	3	1	6.7	6.5	16.0
6	F3B	60	6	32	0.11	36	5	4	3.6	9.0	24.0
7	F4A	56	6	9	0.12	33	3	1	6.7	6.0	32.0
8	F4B	58	7	15	0.13	35	4	3	2.6	9.5	44.8
9	F5A	58	5	8	0.07	33	4	3	6.8	6.0	19.2
10	F5B	68	6	9	0.09	37	7	5	3.0	7.5	30.4
11	F6A	56	4	8	0.07	33	3	2	7.5	4.5	16.8
12	F6B	56	7	10	0.09	35	4	6	3.5	9.5	31.2
13	F7A	56	5	10	0.06	33	3	1	6.0	4.5	16.0
14	F7B	56	5	20	0.09	35	6	3	3.6	7.0	78.4
15	F8A	54	3	9	0.06	33	3	2	6.6	8.5	13.6
16	F8B	56	6	10	0.08	37	4	2	2.6	13.5	29.6
17	F9A	58	4	15	0.06	34	3	2	6.6	9.5	15.2
18	F9B	60	6	17	0.08	38	4	2	3.6	12.0	30.4
19	F10A	54	4	8	0.01	33	3	4	6.6	9.5	28.0
20	F10B	56	6	11	0.05	34	6	4	2.4	11.0	43.2
21	IS 1	56	6	9	1.30	38	4	7	4.5	7.0	22.4
22	IS 1-Con	54	8	11	3.60	37	5	8	6.0	10.5	24.0
23	IS 2	54	7	11	2.30	39	8	7	4.9	3.5	32.0
24	IS 2-Con	54	7	13	6.34	40	8	7	5.5	9.0	12.0

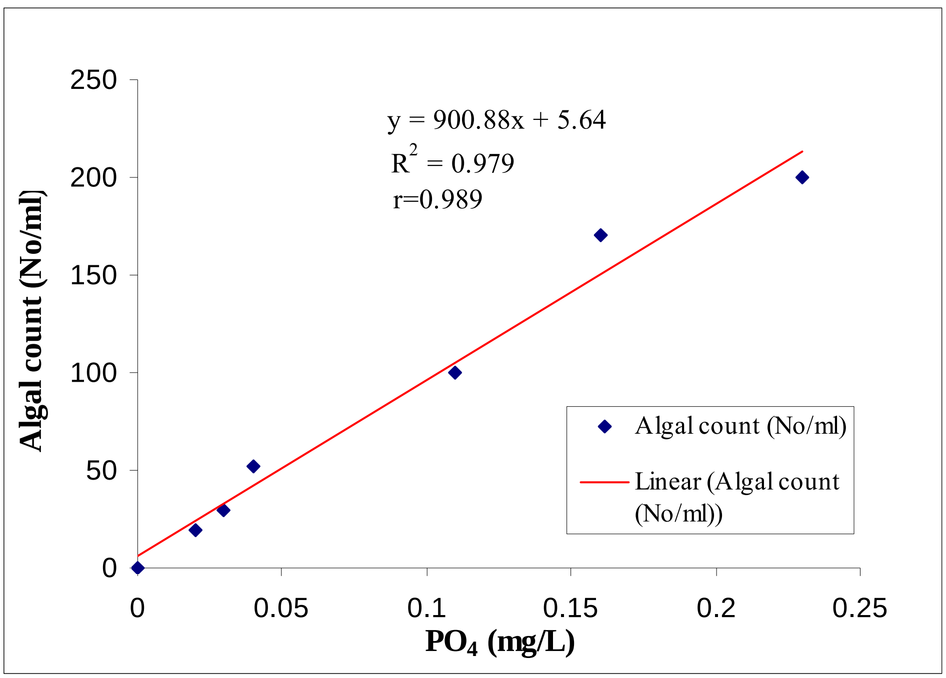

Figure 2: Correlation of Algal count and phosphate in the lake water

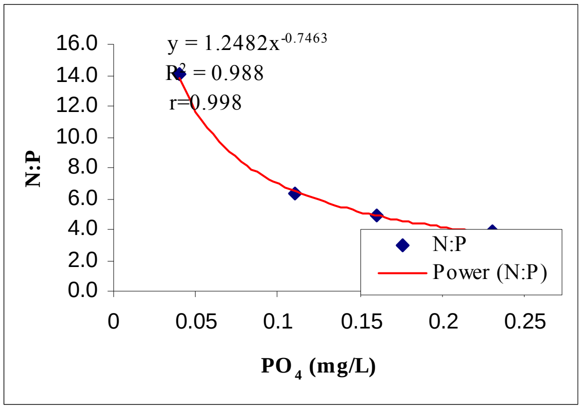

Figure 3: Nitrogen phosphorous ratio and phosphate content in the lake water

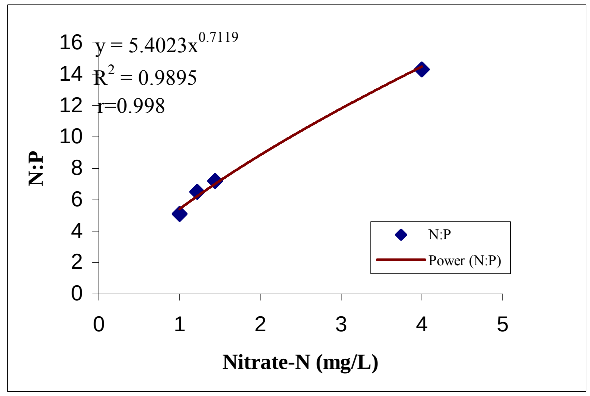

Figure 4: Nitrogen phosphorous ratio and Nitrate nitrogen content in the lake water

Table 2. Average values of total phosphorous, mean and maximum Chlorophyll-a mean and maximum Secchi depth.

Sl. No	Sampling locations	5 Parameters				
		Total Phosphorous (µg/L)	Mean Chlorophyll-a (µg/L)	Maximum Chlorophyll-a (µg/L)	Mean Secchi Depth (m)	Minimum Secchi Depth (m)
1.	F1A	50	3	8.2	1.0	0.8
2.	F1B	55	2.5	6.5		
3.	F2A	97	4	10.2	1.0	0.7
4.	F2B	145	3.6	7.5		
5.	F3A	65	3.0	9.6	1.2	0.9
6.	F3B	65	2.5	7.2		
7.	F4A	70	3.2	7.0	1.0	0.7
8.	F4B	80	2.4	5.9		
9.	F5A	50	4.5	13.6	1.5	0.9
10.	F5B	70	4.0	9.6		
11.	F6A	44.5	3.6	8.0	1.9	1.0
12.	F6B	60	3.0	6.5		
13.	F7A	40	2.9	8.0	1.0	0.6
14.	F7B	70	2.5	6.5		
15.	F8A	45	3.0	9.6	1.0	0.6
16.	F8B	75	2.4	7.5		
17.	F9A	55	3.8	11.6	2.0	1.0
18.	F9B	80	2.9	5.6		
19.	F10A	24.5	4.5	13.6	2.0	0.9
20.	F10B	56	2.9	5.9		
21.	IS1	132.5	8	18.9	1.2*	0.6*
22.	IS1-Con	313	8.5	20.3		
23.	IS2	563	8.3	20.9	1.0*	0.4*
24.	IS2-Con	4772	8.7	23.6		

6
7 * Values are for the confluence point of the inlet stream to the lake

Table 3 Heavy Metal Analysis of Futala Lake Water

Sample ID	Iron as Fe (mg/L)	Manganese as Mn (mg/L)	Zinc as Zn (mg/L)	Copper as Cu (mg/L)	Aluminium as Al (mg/L)
F1A	ND	0.097	ND	ND	0.156
F2B	4.721	0.426	ND	ND	2.26
F2A	ND	0.071	ND	ND	0.011
F2B	13.371	0.993	0.019	ND	6.26
F3A	ND	0.086	ND	ND	0.101
F3B	0.861	0.286	0.032	ND	0.64
F4A	ND	0.1	ND	ND	ND
F4B	4.731	0.581	ND	ND	2.308
F5A	ND	0.09	ND	ND	0.015
F5B	6.771	0.872	ND	ND	3.148
F6A	ND	0.118	ND	ND	0.047
F6B	2.641	0.31	0.049	ND	1.498
F7A	ND	0.139	ND	ND	0.088
F7B	2.789	0.272	0.005	ND	1.556
F8A	4.739	0.517	0.007	ND	2.166
F8B	ND	0.111	ND	ND	ND
F9A	ND	0.133	ND	ND	ND
F9B	17.539	1.532	0.031	ND	8.316
F10A	ND	0.132	ND	ND	ND
F10B	1.829	0.272	0.013	ND	0.901
IS1	0.26	0.129	0.305	ND	0.079
IS1-Con	ND	0.111	ND	ND	ND
IS2	ND	0.043	0.006	ND	ND
IS2-Con	ND	0.096	ND	ND	ND

Sample ID	Chromium as Cr (mg/L)	Cadmium as Cd (mg/L)	Cobalt as Co (mg/L)	Lead as Pb (mg/L)	Arsenic as As (mg/L)
F1A	ND	ND	ND	0.031	0.022
F2B	ND	0.003	0.047	0.048	0.07
F2A	ND	0.002	ND	0.049	0.029
F2B	0.003	0.006	0.126	0.063	0.042
F3A	ND	0.003	ND	0.055	0.043
F3B	ND	0.003	0.012	0.047	0.046
F4A	ND	0.002	ND	0.035	0.023
F4B	ND	0.003	0.049	0.052	0.074
F5A	ND	0.002	ND	0.038	0.035
F5B	ND	0.004	0.072	0.059	0.092
F6A	ND	0.002	ND	0.043	0.033
F6B	ND	0.004	0.028	0.066	0.07
F7A	ND	0.002	ND	0.007	0.026
F7B	ND	0.002	0.025	0.043	0.067
F8A	ND	0.004	0.047	0.046	0.028
F8B	ND	0.003	0.003	0.026	0.071
F9A	ND	0.002	ND	0.022	0.032
F9B	0.011	0.009	0.163	0.087	0.052
F10A	ND	0.002	ND	0.029	0.023
F10B	ND	0.002	0.016	0.031	0.041
IS1	ND	0.003	0.005	0.052	0.05
IS1-Con	ND	0.002	ND	0.031	0.026
IS2	ND	0.002	ND	0.024	0.029
IS2-Con	ND	0.003	ND	0.054	0.037

Bottom sediments have long been acknowledged as a potential source of phosphorus nutrient to the overlaying water of lakes and impoundments. Sediment analysis **(Table 4)** showed that lake deposits in bottom sediment are enriched with nutrients. The reason for higher levels of heavy metals in the sediment samples is due to the precipitation of metals associated not strongly with waste discharge but with the immersion of large number of idols during the Ganesh festival and biocycle of aquatic biota. The concentration of heavy metals in sediment shows that the sediment is not acceptable for landuse and recreational facilities as compared to the guidelines recommended by European countries **(Wedder et.al, 1983)**

Lake Restoration – Treatment options

Water quality and treatability studies carried during the investigations suggest following treatment options for lake restoration.

Alum treatment:

Aluminum sulfate (Alum) is a nontoxic material commonly used in water treatment plant for flocculation and coagulation of turbid water. In lakes alum is used to control algae, not by killing the algal, but by reducing the amount of nutrient phosphorus in the water.

On contact with water, alum forms flocs (aluminium hydroxide precipitate). Aluminium hydroxide reacts with phosphorus to form an aluminium phosphate compound. The compound is insoluble in water under most conditions hence the phosphorus can no longer be used as food by algal organisms. As the alum flocs slowly settle, phosphorus is lowly removed partially from the water. Thus turbidity settles at the bottom of the lake and penetration of sunlight increases. The average depth of Futala lake is 4m and volume 10, 52, 000 cu m. research conduction revealed that 10520 kg of alum dose will be required for effective treatment as per10 mg/l. Proper mixing of alum is necessary for effective coagulation of alum. A motorboat is suitable for creating turbulence and mixing of alum.

Biological treatment:

The adaptations of biological control methods are sometimes adequate for reduction of aquatic weeds in the rejuvenation practice. The organisms used for this purpose are called biocontrol agents or simply bioagents. The advantageous prime considerations amongst biological control of aquatic weeds are

1. Biological control is free of pollution hazards
2. It is free of non target damage quarrels
3. It is more permanent
4. When fish, snails or certain mammals are employed as bioagent they pay for themselves in terms of human food.

A number of bioagents have been examined for their beneficial use against weeds in different countries. The more promising bioagents of aquatic weeds in the expansion of biological control programme are *common carp, Chinese gram carp, tilapia and silver carp.* These carps are voracious feeders of weed they consume weeds as much as their body weight.

Wetland management:

Some aquatic weeds can scavenge inorganic and organic compounds from water. These weeds are capable of absorbing and incorporating the dissolved materials into their own structure. The aquatic weeds purify effluents or domestic sewage.

Table 6. Sediment quality of Futala lake

Sl. No.	Sample Code	pH	Moisture content (%)	Total N (g/Kg)	Total K (g/Kg)	Total Na (g/Kg)
1	F1C	7.5	44	0.8	6	20
2	F2C	7.4	60	0.5	6	15
3	F3C	7.6	45.0	0.7	8	20
4	F4C	7.8	46.0	0.78	9	20
5	F5C	7.8	44.0	0.85	8	21
6	F6C	7.4	36	0.88	5	19
7	F7C	7.6	44	0.89	6	20
8	F8C	7.6	46	0.95	8	19
9	F9C	7.4	45	0.86	8	20
10	F10C	7.4	36	1.2	8	22

Sl. No.	Sample Code	Total P (g/Kg)	Organic Carbon (%)	Organic Matter (%)	Soluble Sulphate (g/Kg)	Soluble Chloride (g/Kg)
1	F1C	0.6	36	56	8	0.5
2	F2C	0.6	30	56	9	0.6
3	F3C	0.5	65	92	23	0.5
4	F4C	0.8	56	96	25	0.5
5	F5C	0.9	36	87	19	0.9
6	F6C	0.6	40	89	45	0.9
7	F7C	0.6	45	86	30	0.8
8	F8C	0.8	56	79	31	0.7
9	F9C	0.8	60	79	12	0.8
10	F10C	0.8	60	80	50	0.9

For Futala lake wetland management can attain this practice. The inlet stream carrying domestic waste, before entering into the lake body, is stored into the wetland and purified by species of aquatic weeds suitable for the particular condition and then allowed to flow into the receiving water body

Aquatic weeds may also be used for removing partially harmful metals from water such as cadmium, nickel, mercury etc. Aquatic weeds can remove and concentrate these harmful elements, which may become 4000-20000 times more concentrated in the plants than the water. The best growing aquatic weeds are common reed, bulrush, water hyacinth, duckweeds, elodea, hydrilla, lotus etc. Moreover, the aquatic plants can be harvested and safely used as fertilizer, or for fiber or biogas production etc. Nitrates, ammonium compounds, phosphates and organic carbon are nutrients often needed in fertilizer composition. Aquatic plants therefore promise to provide an indigenous source of inexpensive source of organic fertilizer, and soil conditioner available to the low-income group of farmers. Thus wetland management is advantageous also towards the manure and fertilizer production from natural aquatic weeds.

Aeration:

Aeration system accelerates digestion of the organic bottom deposits that stimulate excessive weed and algae growth. Aeration reduces anoxic conditions and produce aerobic conditions by bacterial seeding which speeds up aerobic digestion. Aeration is a practical solution for taste and odour control when volatile compounds, such as hydrogen sulfide, ammonia cause the problem. It is generally a single most efficient method of reversing pond and lake aging.

Aeration is mainly based on the artificial water circulation by pumps, jets, and bubbled air, diffusion aeration system, which causes destratification of lake. Destratification has the potential to reduce phosphorus (P) concentration in lakes. During summer stratification when the hypolimnion is oxygen poor, P becomes more soluble (dissolvable) and is released from the bottom of sediment into the hypolimnion. Because stratified lakes can sometimes partially mix, this allows greater amounts of P to “escape” into the epilimnion. These increased P levels in the lakes surface waters can potentially stimulate an algal bloom. Thus the P load from the sediments should be reduced, which in turn can lead to decrease in algal abundance.

Two methods have been employed to aerate water of stratified lakes, artificial circulation and hypolimnetic aeration. Oxygenation can induce precipitation of phosphorus, iron and manganese and lower manganese and lower ammonium content and increase pH. Artificial mixing can reduce growth of blue green algae (cyanobacteria) in lake. Studies are done by installation of bubble plume, which reduces 20 times the growth of microcystis from previous observations. Bottom layer mixing of lake by forced air injection is found to be effective against stratification and nutrient enrichment. It dilutes the concentrations of nutrients by mixing and allows aerobic conditions in the bottom layer of the lake. Hypolimnetic oxygenation prevents formation of anoxic zone and greatly reduces the extent of hypoxic zone. This greatly increases fish predation and diversity. Hypolimnetic aeration of large enclosures is used to evaluate aeration effects on oxygen, H_2S and CH_4 levels. The results of hypolimnetic aeration study confirmed reduction of internal loading through nitrification and alteration of sediment phosphorus dynamics. Reduction of accumulator CO_2 decreases Ca, Mg, HCO_3 and PO_4 through $CaCO_3$ co precipitation

Sediment basins:

Sedimentation is the deposition of soil particles that have been transported by water or wind. Sediments get deposited along the flow of river/stream. As the sediments get deposited in the river or the reservoir, the total storage capacity of the reservoir reduces; as the storage capacity reduces, the life of the reservoir also reduces. The sediment deposited leads to erosion of the banks, their side’s slopes etc. it also affects the aquatic life, physical and chemical properties of water. It is necessary to reduce the amount of sediments entering the reservoir for more life, less erosion and to maintain the stability of the reservoir.

A sediment basin is a water storage area provided by excavating a pond by placing an earthen embankment across a low area to intercept sediment-laden runoff. Sediment basins are generally larger and more effective in retaining sediment load than temporary sediment traps. These are also known as desilting basins, which collect and trap sediment runoff. Sediment basin reduces the water flow to allow the sediment to settle down. The purpose of constructing a sediment basin is to remove the large amount of sediments due to runoff from the surrounding area to make water on the down stream of basin/ tanks free of sediments. It is placed in such a way that maximum amount of sediment get entrapped into the basin and sediment free clear water pass through the basin into the reservoir / lake. Sediment basins are located and designed in such a way that failure of the structure would not result in loss of life, houses or construction to public property like commercial buildings, streets etc.

Rejuvenation of Futala Lake

The following two long-term technological interventions are suggested to restore the lake water quality

Design of sediment basin:

When the rainfall water enters the lake it brings along with it sediments, debris making the water turbid and unhealthy. This runoff water needs to be treated before entering the lake to make it free from sediments. There are few structural methods to remove the sediments like sediment traps, sediment basins, silt fence, rock dams etc. Sediment basins also known as desilting basins are temporary basins that collect and trap sediment runoff. Sediment basin reduces the water flow to allow the sediments to settle down. Basins are located at such a place that would not result in loss of life, damage to the buildings, streets etc. It requires large surface area however these are not to be located in live streams. Basin is created by excavation or by constructing an embankment. Sediment basins are temporary structures with a minimum life span of 3-4 years. The sediment basins are designed in such a way to have maximum settling of particle size (0.005 mm). Basin shape is assumed rectangular with length to width ratio as 2:1 or greater. Embankment side slopes are 2:1 or flatter with a minimum top width of 2.5 m and 3 m in height. In case of embankment greater than 3 m in height and minimum top width 3 m the side slopes must be 2.5:1 or flatter.

Wetland construction:

Wetlands are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to maintain saturated conditions. These can either be preexisting natural wetlands (e.g. marshes, swamps, bogs, cypress domes and strands, etc.) or constructed wetland systems. Constructed systems can range from creation of a marsh in a natural setting where one did not permanently exist prior to intensive construction involving earth moving, grading, impermeable barriers or erection of containers such as tanks or trenches. The vegetation that is introduced or emerges from these constructed systems will generally be similar to that found in the natural wetlands. Wetlands are comparatively shallow (typically less than 0.6 m) bodies of slow-moving water in which dense stands of water tolerant plants such as cattails, bulrushes, or reeds are grown. In manmade systems, these bodies are artificially created and are typically long, narrow trenches or channels.

Wetland Function and Values:

Wetlands provide a number of functions and values. Wetland functions are the inherent beneficial processes occurring in wetlands. Most wetlands provide several functions and values. Under appropriate circumstances constructed wetlands can provide:

1. Water quality improvement;
2. Disposal of treated effluent into natural wetlands;
3. Use of effluents or partially treated wastewater for enhancement, restoration, or creation of wetlands;
4. Use of constructed wetlands for wastewater treatment.

Monitoring plan for rejuvenation of lake
Monitoring water quality:

In order to ensure effective performance of the already implemented rejuvenation works it is necessary to continue the monitoring of the water quality of the Futala lake water and sediments. The lake water quality should be studied after the initiation of the corrective measures. In order to get indication of the impact of rejuvenation measures it is necessary that the Futala lake water should be monitored regularly. The frequency of sampling is once every month for physico-chemical parameters pH, turbidity, conductivity, DO, COD, and for bacteriological parameters total coliforms and faecal coliforms.

Monitoring wetland:

The wetland is checked periodically to observe general site conditions and to detect major adverse changes, such as erosion or growth of undesirable vegetation. Vegetation is monitored periodically to assess its health and abundance. For wetlands that are not heavily loaded, vegetation monitoring need not be quantitative and qualitative observations of the site will usually suffice. Large systems and those that are heavily loaded require more frequent, quantitative monitoring. More frequent monitoring is required during the first five years after the wetland is installed.

Monitoring sediment basins:

Periodic monitoring of sedimentation basin is essential to achieve good efficiency of the settleable material. Accumulation of sediment load in the basin has to be removed and transported to the identified dumping site(s). The efficiency of basin may decrease with accumulation of settleable material and sediment load may pass in to the Futala Lake defeating the purpose of the structure. Further, ineffective working of the sedimentation basin may lead to water level rise and accumulation of silt in the basin affecting the performance of the wetland developed.

CONCLUSION

Present state of health of Futala Lake has been depicted. Causes of deterioration of the lake and present hydrological status are put forward. Concerns for improving health of the lake has been expressed and conceptual strategies for rejuvenation, conservation and management of Futala Lake have been suggested. Environmental monitoring plan is also suggested for monitoring and management of Futala lake water quality.

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REFERENCES

APHA, AWWA & WEF. 2005. Standard Methods for the Examination of Water and Wastewater, 21th Edition.

Black C.A., 1993. Methods of Soil Analysis, Part 2, C. A. Black, Number 9 in series Agronomy.

Toner. P. F., (1977) Eutrophication water Resources Division, A Foras Forbartha.

Trivedi R.C., CPCB. (1980). Biological Indicators and Indices of Environmental Pollution, Proceedings of the Workshop held at Osmania University, Hyderabad, India.

Webber M.D., A. Kloke, J. Ch. Tjell. (1983). A Review of Current Sludge Use Guidelines for the Control of Heavy Metal Contamination in Soils. In proceedings of the EC Concerted action cost 68. Ter: Third International Symposium, processing and use of sewage sludge, Brighton, England, September 27-30.