Determination of eutrophication factors in Boye pond

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INTEGRATED DEVELOPMENT FOR WATER SUPPLY AND SANITATION

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BOYE POND, WHICH is located at the east of Jimma town, was come to being in 1967 by Jimma city council aimed to conserve hippopotamus and recreation purpose.

Such type of pond, which is constructed across a valley to form a reservoir where water is stored, is known as hill-type pond. Such type of pond can provide water for crop irrigation, live stock and recreation, as well yield substantial quantities of fish (Huner, 1995).

The pond receives water from two rivers, Kito and Awetu. They enter the pond after they converge at about 3 km above the pond. Awetu passing through Jimma town receives all types of municipal wastes and discharged to the pond with extensive amounts of pollutants. Due to this fact, at present Boye pond is in state of progressive Eutrophication. There is an extensive growth of aquatic vegetation, which seriously impedes fishing, boating and swimming. There are emergent plants rooted at the bottom and growing above the surface of water along the shoreline. As a result the pond has lost the objective for which it was designed. Its recreational value is unthinkable as the situation has changed. It emits bad odor due to anaerobic decomposition, as a result of excessive waste load. This can result in the rise of biological oxygen demand (BOD) and depletion of oxygen in the water which leads to the death of aquatic animals (Lauiran, 1995).

Eutropuication factors, phosphate and nitrate are present in sewage from cities, from feed lots, from artificial fertilizer put in the crop, from septic tank and from natural sources. In city sewage much of the nitrate and phosphates come from human wastes. Adding of these nutrients through this process to fresh water may encourage such an explosion in algal population that a "bloom" resultS. While algal bloom present an increase in the productivity of the ecosystem, they are undesirable for several reasons. The respiratory needs of algae may so deplete the oxygen content (DO) of the water during the night that fish suffocate. Further more the decay of aquatic weed may cause such unpleasant tastes and odor to the water as to degrade its attractiveness. This becomes a wide spread problem in the most countries with large populations and intensive agriculture (AMBIO, 1994).

Where both nitrogen and phosphorus are plentiful, algal bloom occurs which may produce a variety of nuisance conditions. Phosphorus appears to be the most practical nutrient to control. (Salvato, 1992).

Materials and methods

Dividing the pond into three stations to have representative samples for analysis was carried out. The samples were collected for three different days. Samples were taken using wagtech lea liter a crylic water bottle (catalogue number 7500-B20) and clean glass stoppered glass bottle were used to transport the samples to the laboratory by storing in an icebox with in two hours.

The collected samples were analyzed by using standard laboratory methods: Stannous chloride for orthophosphate, direct nesslerization for Ammonia, Phenol disulfonic acid method for Nitrate - Nitrogen, open reflux titrimetric for COD, the Acid modification now Winkler method for DO and conventional titration method for BOD pH meter (glass electrode) for pH and temperature and Turbidometer model 46500 for turbidity. And finally the results were analyzed and tabulated manually.

Results

1. Nutrients

Phosphate had similar concentration throughout the sites. It was 0.058, 0.081 and 0.068 mg/L at site 1, 2 and 3 respectively, and as phosphorus the mean concentration was 0.202 mg/L (Table 1). Nitrate concentration was found to decrease down the pond, which was 0.3 mg/L, 0.195 and 0.075 mg/L at site 1, site 2 and site 3 respectively (Table 1). Similarly the nutrient contribution of the two rivers (Kito and Awetu) was determined and Awetu was found to contribute about 2.6 times greater concentration of phosphorus than that of Kito (Table 1).

2. Selected Physical & Chemical parameter

The selected parameters were generally found to fluctuate down the pond and are shown in table 2 and table 3.

Table 1. The nutrient concentration of Boye pond at different sites with relative contribution from Awetu and Kito

S.No	Parameter*	Depth	Site 1	Site 2	Site 3	Awetu	Kito
1	$PO4^{-3}$ m g/l	1m	0.058	0.061	0.068	0.168	0.064
2	as P "	1m	0.189	0.199	0.222	0.548	0.21
3	NO_3^- "	1m	0.3	0.195	0.07	0.642	0.3
4	NO_3^-- N "	1m	0.68	0.044	0.046	0.145	0.0585

*All values given are the mean of three measurements.

Table 2. The BOD, COD, NH^3 and DO level at different sites of the pond

S.No	Parameter*	Depth	Site 1	Site 2	Site 3
1	BOD (in mg/l)	1m	10.4	6.4	6.0
2	COD "	1m	126.7	51.5	31.7
3	DO "	1m	5.2	3.9	0
4	NH_3 N "	1m	1.16	0.303	0.286

*The values given are the mean of three measurements.

Table 3. Selected physical parameters

S.No	Parameter*	Depth	Site 1	Site 2	Site 3
1	Temperature (^{0}C)	1m	24.5	24.0	20.3
2	PH	1m	6.45	8.77	6.03
3	Turbidity (NTu)	1m	159	58	13

* All values given are the mean of three measurements.

Discussion

The most characteristics sign that a reservoir is undergoing Eutrophication is the formation of green scum consisting of millions of microscopic algal cells on the surface of water and growth of aquatic weeds along the shore line (Charles, 1980). Boye reservoir has showed these typical characteristics, Eutrophication, which is associated with elevated concentration of nitrogen and phosphorus. The critical value for phosphorus has been established as some where near 0.005 mg/L (AMBIO, 1994; FAO, 1995). The mean concentration of phosphorus in the Boye pond was 0.2 mg/L, which is about 40 times the critical value. It was also indicated that any reservoir or lake having 0.01mg/L phosphorus and 0.3 mg/L Nitrogen can expect to have major algal bloom (Salvato, 1992).

The relative contribution of nutrients from the two rivers (Kito and Awetu) has showed reasonable results as expected. Phosphorus contribution of Awetu River (Table 1) is about 2.6 greater than that of Kito. This is because of the fact that Awetu receive effluents and liquid wastes indiscriminately discharged from Jimma town, and effluent is known to contain large concentrations of nitrate and phosphate.

The BOD and COD were found to decrease down the pond. This may indicate that some stabilization was achieved as the pond has sluggish flow. The PH value has increased at the center (site 2) that indicates the high algal "bloom" which causes alkaline condition during metabolism (Sawer,1994). DO level of Boye pond is generally at concentration that endangers aquatic life (table 2), for it was indicated that the lower DO of water body decrease biologic diversity (Anne, 1990). The DO level was found to decrease down the pond even though BOD was decreased. Starting near site 2 the pond was covered by aquatic weeds and oil layer which might have hindered surface absorption of oxygen while the existing DO was depleted due to respiration and stabilization of organic wastes under the layers. As a result DO concentration at site 3 down stream to the covered surfaces was found to be zero up to the surface level. This has created obnoxious odor due to an aerobic condition in the pond. It was created unpleasant odor to its surrounding people.

Generally due to the above mentioned reasons the recreational value of the reservoir has deteriorated hippopotamus were migrated to mini Gibe river, therefore it has lost the objective for which it was designed. In addition the surrounding people were complaining that vast land area is covered by eutrophied pond with out any use. It was also suggested that this vast land area could have been used for different irrigation purposes if the water was permitted to go on its natural stream or if it were not impounded.

Conclusion and Recommendation

It is evident that the general ecosystem of Boye pond is perturbed due to human interference for amenity purpose. However, the purpose of impounding the river did not considered the environmental impacts. In addition no follow up was taken to maintain ecological balance and biological diversity. These have resulted in migration of hippopotamus, abnixicous odor and nuisance environment, a good breeding site for mosquito, and reduction of fishery products. At present the pond has generally lost its designed purposes and needs extensive remedial measures to sustain its ecological integrity. Therefore, the release of the impounded water and control of effluent entering the pond that enhanced the level of nutrients need to be considered as alternatives to restore the normal river flow and save the natural ecosystem of the dying pond.

With this in view the following recommendations are forwarded for consideration.

- Further research is required in the area of:
  - Biological aspect of the reservoir;
  - Detail environmental impact assessment.
- There should be a wastewater treatment plant for effluent entering into the pond to reduce the level of eutroplication and pollution status.
- The impoundment should be released so as to maintain self purification, aeration and restoration of the natural river Ecosystem.
- Environmental protection agency should be empowered for technologically based effluent regulation.

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