

Assessment of Impeding Hydrochemical Aggravates as Adjudicators to Characterize Restoration Strategy for Lake Sambhaji at Dist: Solapur (MS), India



Environmental Science

KEYWORDS : Hydrochemical aggravates, characterization, restoration strategy.

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ABSTRACT

Monitoring water quality is imperative to recognize the nature and extent of pollution and the water quality management plan is important for restoration of ecosystem. This provides directives to prioritize pollution control efforts and evaluate the effectiveness of the planned efforts. Monitoring water quality should follow a standardized and a defined protocol. In India, the water quality assessment authority under the Environment Protection Act 1986 provides directives in the form of protocol for the monitoring of water quality. The present investigation of assessment of impeding hydrochemical aggravates as indicators to characterize restoration strategy for Lake Sambhaji at Dist: Solapur (MS), India, is an attempt to draw out major contemplations to design restoration strategies for Lake Sambhaji. The results portray hydrochemical stressors at Lake Sambhaji. The hydrochemicals analyzed for the conformity with the standards defined by Central Pollution Control Board, Maharashtra Pollution Control Board, and World Health Organization, and it was found that the lake water of lake Sambhaji is polluted. Further removal of shoreline vegetation has accelerated and forced erosion of sediment and nutrients into a lake. Hydrologic alteration identified includes flow regulation with modification due to siltation in the regular and the natural path of inflow streams due to anthropological activities and rain has been identified. The research outcomes portray an immediate need to design restoration measures.

Introduction:-

A wide range of human and natural processes affect the biological, chemical, and physical characteristics of water, and thus impact water quality [UNEP 2010]. Water is being polluted since long and the widespread issues are pathogenic pollution, toxicity and salinity which could lead to concerns regarding eutrophication, depletion of oxygen and deterioration of ecological health. The factors responsible for the degradation of water quality in major are identified as - domestic, industrial sources, sewage, along with run-off and industrial effluents that add large amount of nutrients in the surface water resulting in eutrophication. The domestic sewage acts as an excellent breeding ground for mosquitoes and also contaminates the groundwater, the only source of drinking water in many areas of our country.

In India the administration of water quality is carried out in accordance to the Water Prevention and Control of Pollution Act 1974. The main objective of the act is to maintain and reinstate the wholesomeness of national aquatic resources by control and prevention of pollution, setting various functions for the Central Pollution Control Board (CPCB) and at the State Pollution Control Boards. The act does not define the altitude of wholesomeness to be maintained in different water bodies of the country. The CPCB has tried to define the wholesomeness in the way of protection of human uses and thus takes human uses of water as the base to identify the water quality objectives for the water bodies across the country. The monitoring of water quality is needful to know how the quantity and quality of water in a water body meets the requirements of user end and how it re-

lates to the standardized quality standards and to know whether or not the existing waste discharges conform with the existing standards and regulations.

Materials and methods:-

The study area, Lake Sambhaji to be located at 3.6 km, approx., at the city Solapur of Maharashtra state. It is a natural lake with an area of 25.35 ha. The lake is located Geographically, between Latitude: N 17° 38' 55.61 & Longitude: E 75° 54' 13.9, an altitude of 491.94 m msl. The water from the reservoir is being used at in addition to irrigation and fisheries use. **The standard methods of sampling and analysis were followed as per the guidelines provided by CPCB 2007-08. Grab samples of the perennial lake Sambhaji were secured in glass bottles for the analysis of general, nutrients, organic matter, major ions, microbiological in terms of total cloiforms and samples were analyzed for colour by visual method, temperature by thermometer, pH by pH meter, electrical conductivity by conductivity meter, dissolved oxygen by DO Meter, turbidity by nephelometer, total dissolved solids by gravimetry, Ammonical Nitrogen (NH₄-N), total phosphate, nitrite + nitrate-N, by Colorimetry, biochemical oxygen demand (BOD) by DO consumption in 5 days, at 27° C, chemical oxygen demand (COD) by potassium dichromate method, sodium by flame photometry, potassium by flame photometry, calcium by EDTA titrimetric, magnesium by EDTA titrimetric, carbonate as CaCO₃, bicarbonate as CaCO₃ by Titrimetric, chloride by argentometric titration, sulphate by turbidimetry, fluoride by ion meter colorimetry, total coliform by MPN method, arsenic, lead and mercury by cold vapour by AAS.**

Table 1;Water Quality Criteria; (CPCB – 2007-8)

Designated Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	<ul style="list-style-type: none"> Total Coliform Organisms MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6mg/L or more Biochemical Oxygen Demand 5 days 20°C 2mg/L or less
Outdoor bathing (Organised)	B	<ul style="list-style-type: none"> Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/L or more Biochemical Oxygen Demand 5 days 20°C 3mg/L or less
Drinking water source after conventional treatment and disinfection	C	<ul style="list-style-type: none"> Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/L or more Biochemical Oxygen Demand 5 days 20°C 3mg/L or less

Propagation of Wild life and Fisheries	D	<ul style="list-style-type: none"> pH between 6.5 to 8.5 Dissolved Oxygen 4mg/L or more Free Ammonia (as N) 1.2 mg/L or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	<ul style="list-style-type: none"> pH between 6.0 to 8.5 Electrical Conductivity at 25°C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/L



FIG; 1 MAP OF MAHARASHTRA STATE

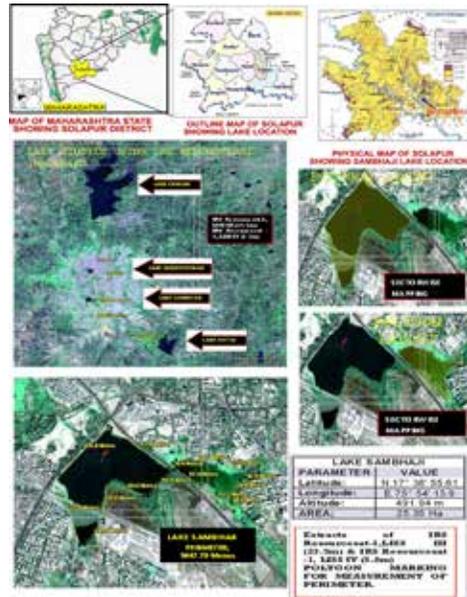
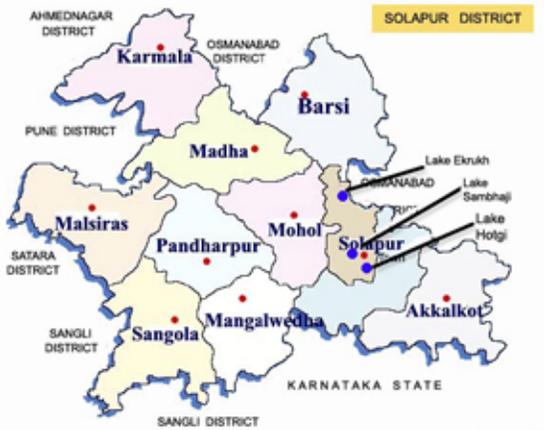
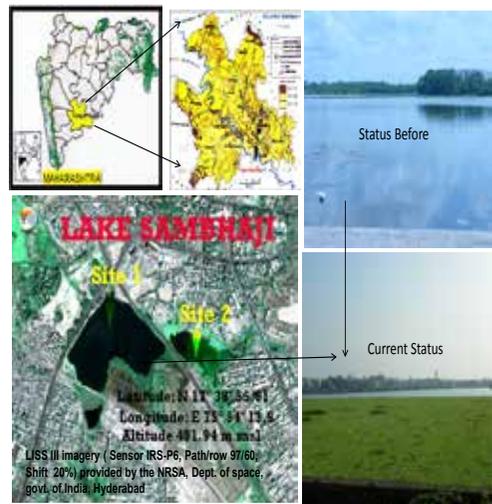


FIGURE 4; LOCATION & SITE STUDY DETAILS



FIG; 2 MAP OF SOLAPUR DISTRICT SHOWING LAKE LOCATION



Figure; 5 Comparative status of the study site Results and discussions;

The hydrochemical aggravates being the measure of biodegradable organic matter where higher values of BOD indicate depleting dissolved oxygen. The BOD value recorded indicates unhealthy nature of lake water (Table1). The hydrochemical criteria for pH, TDS, TS, TSS, total hardness, electrical conductance, ammonical nitrogen, chlorides, sulphates, BOD, COD are considered to be substances affecting potable use of water. Major source of phosphorous is through domestic sewage, detergents, fertilizers and industrial effluents. The BOD (*Biological Oxygen demand*) recorded as 5.2 mg/L indicates organic pollution and is severely polluted if considered with the MPCB standards of the class A-II for the public water supply, and cannot be considered as class A/B/C/D/E as per CPCB guidelines.

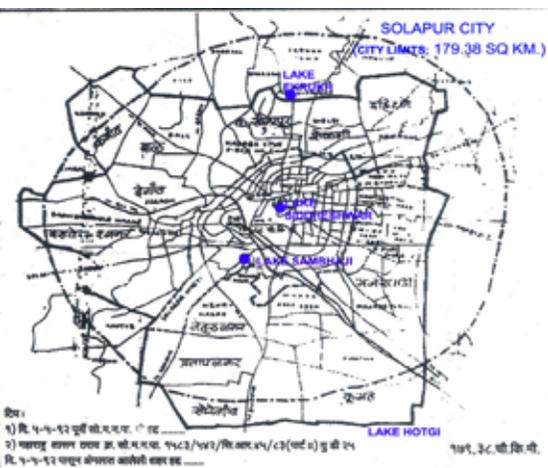


FIG 3; City limits of Solapur with marked loci of lakes under study.

Table 2. Comparative studies of Sambhaji lake waters (Post-monsoon water samples studied)

Water Constituent / property	Sample at Lake Sambhaji Site 2	Sample at Lake Sambhaji Site 1	Standards defined by * CPCB & ** IS 10500 for CLASS A-II/III	Elucidation As per CPCB & IS 10500 Standards
pH	7.65	8.42	6.5 – 9.0 * 6.5 – 9.5 **	unhealthy according to CPCB & IS standards
Electrical Conductivity (mS/cm) at 25°C	1.87	1.85	1000x10 ⁻⁶ mhos * III (0.01 mS/cm)	Unhealthy according to CPCB Standards
Total Dissolved Solids (mg/L)	1205	1024	1500 * 500 **	Unhealthy according to CPCB & IS standards
Hardness (CaCO ₃ mg/L)	600	593	50 * I	Unhealthy according to CPCB Standards
Calcium as Ca (mg/L)	140	125	75 **	Unhealthy according to IS standards
Magnesium as Mg(mg/L)	53	60	30 **	Unhealthy according to IS standards
Carbonate as CO ₃ (mg/L)	0	9	300 **	Unhealthy according to IS standards
Bicarbonate as HCO ₃ (mg/L)	490	459		
Chlorides (mg/L)	332	310	600 * 250 **	Unhealthy according to CPCB & IS standards
Sulfates (mg/L)	140	92	400 * I	Unhealthy according to CPCB Standards
BOD (mg/L)	4.3	5.2	10 * III	Unhealthy according to CPCB Standards
COD (mg/L)	18	16		-
Ammonical Nitrogen (mg/L)	Nd	Nd	1.2 * III	-
Turbidity (NTU)	32	91		-
Dissolved Oxygen (mg/L)	1.6	1.9	Not less than 3 * III	Unhealthy according to CPCB Standards
Nitrates as NO ₃ (mg/L)	0.006	0.04	45 * & **	Unhealthy for Agriculture,
Nitrite as NO ₂ (mg/L)	4.00	7.00	3 (acute) **	
Phosphorous as P (mg/L)	5.6	8.8		-
Potash as K (mg/L)				
MPN (cfu/ml)	480	220	0	Unhealthy according to CPCB & IS standards
Mercury as Hg (mg/L)	Nd	Nd	0.001 * I	-
Arsenic as As (mg/L)	Nd	Nd	0.3 * I	-
Lead as Pb (mg/L)	0.002	0.004	0.1 * I	Unhealthy according to CPCB & IS standards

Note;

C.P.C.B. = Central Pollution Control Board

IS: 10500 = Indian Standard Specifications for Drinking Water IS: 10500

* = CPCB ** = IS 10500

A I = Unfiltered Public water supply after approval, (MPCB)

A III = Not fit for human consumption, Fish & Wild life propagation (MPCB)

Regarding COD (*Chemical Oxygen demand*), COD determines the amount of oxygen required for chemical oxidation of organic matter or the measure of chemically oxidizable organic matter. The COD value recorded was 16 mg/L indicates its category as A IV according the water quality standards classified by MPCB indicating it to be fit for agriculture and industrial purpose. The dissolved oxygen DO, was recorded as 1.6 mg/L indicating it to be considered as class AI, A II, A II or A IV as per MPCB guidelines. Regarding chlorides, which chlorides occur naturally in water where discharge of sewage contributes to the addition of chlorides. It is the major inorganic anion in water and waste water. The chloride value recorded is of 332 mg/L, where the desirable limit being 250 mg/L as defined by the IS 10500 standards. The higher value indicates addition of chlorides due to the discharge of sewage.

The electrical conductance or conductance is the rapid measure of the total dissolved solids. It is an important parameter for determining suitability of water and wastewater for irrigation. Further the electrical conductance is reciprocal to electrical resistance. It is numerical expression of the ability of water sample to carry an electric current. The value recorded if 1.87 mS/cm/ 0.00180 mho/cm/ at 25°C.

Nitrates represent the end product of oxidation of nitrogenous matter and its concentration may depend on the nitrification and denitrification activities of microorganism. It is the highest oxidized form of nitrogen where the desired limit is 45 mg/L as specified by IS and MPCB and are considered as substance affecting the health of the lake. The nitrate value was found 0.04 mg/L which falls far below the desirable limits.

Higher values indicate pollution and facilitate growth of algae and causes eutrophication. Phosphate is an important plant nutrient and plays a role of limiting factor among all other plant nutrient so its determination is useful. The recorded value is 8.8 mg/L. This indicates pollution due to sewage disposal and laundry activities at the lake Sambhaji.

pH Because most of the chemical and biochemical reaction are influenced by the pH it is of great practical importance. The adverse affect of most of the acids appear below 5 and of alkalis above the pH 9.5. The pH of water gets drastically changed due to disposal of wastes, biological activity and temperature changes. Extreme pH results in rapid fish kill and alteration in flora and fauna. The pH value recorded at lake Sambhaji was 8.42 tending to be towards high alkaline status. This has a possibility in alteration in the biological diversity and popu-

lation thus causing a serious threat to the ecological health to the lake Sambhaji. However the desirable limits according to MPCB are between 6.5 to 8.5 that falls under the desirable limits.

Alkalinity in terms of CaCO_3 is about 300 mg/L, and 50 mg/L for the designated class AI as the desirable limit as per MPCB. It constitute an important parameter in determining the quality of water. In polluted waters silicates, phosphates, borates, etc. contribute to alkalinity of water. A record of 600 mg/L of CaCO_3 indicates that the lake water of lake Sambhaji has attained the maximum permissible limits as designated by MPCB. Lead was analyzed to be present as 0.004 mg/L indicating it to be in the permissible limits.

The total coliforms recorded as MPN were 400 cfu/ml, where the CPCB indicates permissible limits of 50 MPN or less, MPCB permits 250 MPN. Thus higher the number of coliforms indicates the lake water to be unfit as class A as per CPCB.

Lake Sambhaji is a semi-natural lake. The source of water inflow is-rainfall or drain, and occasionally most of the part dries off in intense summers and inadequate rainfall. The lake serves for recreation, washing/Laundry, idol immersion. Sewerage has not been provided yet and there is no sewage treatment followed. Solid waste disposal in lake occurs because of religious offerings/idol immersion, addition or deposition or paraphernalia, washing/Laundry. The lake is used as a biological resource for; reeds & grasses for thatch or fodder and fishing. The Lake serves as groundwater recharge and supports a rich biodiversity & socio-cultural aesthetic values. The laundry activity is the source of pathogenic organisms being added directly into the lake waters. Besides, the accumulation of huge quantity of detergents the chemical pollutants cause the lake water unpleasant and unfit for supporting biological development. The lake's state has not been monitored for several years. Huge siltation has been observed at the lake.

Conclusions;

The investigation calls immediate attention towards actions for the restoration of the ecological health of the lake. The water analysis indicates that the lake water does not support the basic purpose and as such the water is unhealthy. It is needful to design immediate action to restore and maintain the water quality of the lake Sambhaji. Various studies as phytoremediation and bunding models to prevent silt loads are therefore under consideration, the need of the hour.

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