Improvement of Lake Water Quality Index using "Nitrolite Mineral"

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Abstract : A wide range of human and natural processes affect the biological, chemical and physical characteristics of water and thus impact water quality. Contamination by pathogenic organisms, trace metals, and human-produced and toxic chemicals; the introduction of non-native species and changes in the acidity, temperature, and salinity of water can cause harm to the aquatic ecosystems and make water unsuitable for human use.

Numerous human activities impact water quality, including agriculture, industry, and mining, disposal of sewage, population growth, urbanization, and climate change. Agriculture can cause nutrient and pesticide contamination and increased salinity. Nutrient enrichment has become one of the planet's most widespread water quality problems (UN WWAP 2009), and worldwide, pesticide application is estimated to be over 2 million metric tonnes per year (PAN 2009). Industrial activity releases about 300-400 million tons of heavy metals, solvents, toxic sludge, and other waste into the world's waters each year (UN WWAP Water and Industry). About 700 new chemicals are introduced into commerce each year in the United States alone (Stephenson 2009). Mining and drilling create large quantities of waste materials and byproducts and large-scale waste-disposal challenges.

Solving water quality problems requires strategies to prevent, treat, and remediate water pollution. As a first order intervention, pollution can be prevented before it enters waterways; second, wastewater can be treated before it is discharged; and third, the biological integrity of polluted water courses can be physically restored through remediation. And fourth, also we can be improve Water Quality Index of the Lake can by taking "Nitrolite Mineral".

1. INTRODUCTION

Water pollution has a duel effect on nature. It has negative effects on the living and also on the environment. The effects of pollution on human beings and aquatic communities are many and varied. Water pollution causes approximately 14,000 deaths per day, mostly due to contamination of drinking water by untreated sewage in developing countries. An estimated 700 million Indians have no access to a proper toilet, and 1,000 Indians children's die every day and so many other countries too. Nearly 500 million Chinese lack access of safe drinking water.

Definitely with all these, we can expect that there is going to be a reduction in productivity. Biomass and diversity of communities are to be expected when large amount of toxic materials are released into the streams, lakes and coastal waters in the ocean. Much of aquatic pollution involves sewage in which organic waste predominate. This waste can increase secondary productivity while altering the character of the aquatic community. Most fishes especially the species desired as food by man are among the sensitive species that disappear with the least intense pollution.

Water pollution leads to damage to human health. Disease carrying agents such as bacteria and viruses are carried into the surface and ground water. Drinking water is affected and health hazards result. Direct damage to plants and animals nutrition also affects human health. Plants nutrients including nitrogen, phosphorus and other substances that support the growth of aquatic plant life could be in excess causing algal gloom and excessive weed growth. This makes water to have odour, taste and sometimes colour. Ultimately, the ecological balance of a body of water is altered. Sulphur dioxide and nitrogen oxides cause acid rain which lowers the pH value of soil and emission of carbon dioxide cause ocean acidification, the ongoing decrease in the PH of the Earth's Oceans as CO_2 becomes dissolved.

1.1 Need for Preserving Water Quality for Surface Water Sources

A wide range of human and natural processes affect the biological, chemical and physical characteristics of water and thus impact water quality. Contamination by pathogenic organisms, trace metals, and human-produced and toxic chemicals; the introduction of non-native species and changes in the acidity, temperature, and salinity of water can cause harm to the aquatic ecosystems and make water unsuitable for human use.

Numerous human activities impact water quality, including agriculture, industry, and mining, disposal of sewage, population growth, urbanization, and climate change. Agriculture can cause nutrient and pesticide contamination and increased salinity. Nutrient enrichment has become one of the planet's most widespread water quality problems (UN WWAP 2009), and worldwide, pesticide application is estimated to be over 2 million metric tonnes per year (PAN 2009). Industrial activity releases about 300-400 million tons of heavy metals, solvents, toxic sludge, and other waste into the world's waters each year (UN WWAP Water and Industry). About 700 new chemicals are introduced into commerce each year in the United States alone (Stephenson 2009). Mining and drilling create large quantities of waste materials and byproducts and large-scale waste-disposal challenges.

Solving water quality problems requires strategies to prevent, treat, and remediate water pollution. As a first order intervention, pollution can be prevented before it enters waterways; second, wastewater can be treated before it is discharged; and third, the biological integrity of polluted watercourses can be physically restored through remediation.

There are both technological tools and approaches for meeting water quality goals and non-physical approaches such as pricing, economic incentives, and legal/regulatory tools. Water Quality Index is commonly used tool for assessment of surface water quality. There are also methods to restore water quality and watershed systems through ecohydrological approaches. Healthy, resilient ecosystems play an important role in preventing pollution before in enters waterways, in treating and restoring polluted waters.

1.2 Background of Solapur City

Solapur is an ancient historical place dating back to 90 BC. Solapur is one of the important town places in Maharashtra state. It is well linked by rail & road with other cities, and is situated 400 km. SE of Mumbai. Its spread is approximately between 17^0 36' to 17^0 42' N latitude and 75^0 50' to 75^0 58' E longitude (SOI Topo sheet 47 0/14). It is the 7th largest city in the state by population size is 9, 51,118 (according to Census of 2011), heading towards 12 lakh - to be a metropolitan.

Solapur is under the arid to semi arid climatic condition. It receives irregular, erratic scanty rainfall, with annual average of around 500 mm to 700 mm. It is included in rain-shadow zone and drought prone region of part of south central India. Solapur experiences relatively higher temperature throughout the year, reaching highest up to 45^0- 48^0 in April-May months, and has relative humidity varying between 20 to 90%.

1.3 Sources of Water for Solapur City

Ekrukh tank is an earthen dam having 2200 m length, 23 m height and maximum depth of water 21.70 m, built on Adila River (1859-1869) by British Rulers, is 6 km. north of Solapur city. When tank is with full capacity then its total water quantity is 61.61 mm.[3] The Watershed area is of 412 sq.kmsspreaded in 17 sq. km area. It has no dead stock of water.

Hotgi tank which is 12 kms- southeast of Solapur city is an earthen dam of 12 m height built in 1944 during British Rule on Hotginala. It has water quantity spread in 192 hectors with water storage of 5.27 mm^3 and watershed basin area of 59.57 sq. kms. It has no dead stock of water.

Ujani Dam- on Bhima River built in (1968 to 1980) is 103 km west - north west of Solapur city on the border of Solapur and Pune District. Its basin area considered is 14856 sq. km. with 29000 hector of land under water and total water reserves - 3, 32,000 mm^3 of which 1520.87 mm^3 is usable by gravity flow (46%) while 1799.13 mm^3 is as dead stock (54%) which can be used by pumping. Total evaporation (average) in the area is 26.15% per year, i.e. about 581.08 mm. Such heavy evaporation rate is due to circumferial surface area (exposed) of 33650 hector land and average maximum summer temp rising to about 46°C. It is interesting to note that requirement of Bombay city per day is about 3.00 mm^3 of water and in comparison - maximum daily evaporation in summer from Ujani dam is 4.038 mm^3.Siddeshwar and Kambar Lake – Water from this lakes are not used for drinking purpose but used for recreational, washing purpose.

1.4 Objective of Study

- To monitor water quality of Siddheshwar, Kambar and Ekrukh lake for eight months.
- To develop a water quality rating.
- To develop water quality index by using "**Nitrolite mineral"** for above three lakes.
- To compare WQI of above lakes.
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1.5 General Information of "Nitrolite Mineral"

***Formula:**
$Na_2Al_2Si_3O_{10} \cdot 2H_2O$
System: Orthorhombic
Colour: White, Colorless, Red, ...
Hardness: 5 - 5½
Member of: Zeolite Group
Name: Named in 1803 by Martin H. Klaproth from the Greek natron, "soda," in allusion to its sodium content and lithos, "stone." Not to be confused with natrolite (of William Hyde Wollaston) in 1812 for a soda-bearing scapolite.

- **Chemistry of Natrolite**

Chemical Formula:	Na2[Al2Si3O10]•2(H2O)
Composition:	Molecular Weight = 380.22 gm
	Sodium 12.09 % Na 16.30 % Na_2O
	Aluminum 14.19 % Al 26.82 % Al_2O_3
	Silicon 22.16 % Si 47.41 % SiO_2
	Hydrogen 1.06 % H 9.48 % H_2O
	Oxygen 50.49 % O
Empirical Formula:	$Na_2Al_2Si_3O_{10}$•$2(H_2O)$
Environment:	Occurs in the cavities of amygdaloidal basalts and other related rocks.
IMA Status:	Valid Species (Pre-IMA) 1803

Locality:	Bohemia of Czechoslovakia. Link to MinDat.org Location Data.
Name Origin:	From the Greek natron, "soda," in allusion to sodium content and lithos - "stone."
Name Pronunciation:	Natrolite + Pronunciation

2. RESEARCH METHODOLOGY

2.0 GENERAL:

This chapter includes the information regarding the area which was used for the study purpose and the brief information about the water quality parameters which were studied for calculating the water quality index (WQI).

2.1 Study Area:

The study was carried out for three lakes, which are situated at different locations of Solapur city. For every lake five different points at different position on lake were selected for the sampling purpose.

The lakes which are selected for the study are namely as:

1. Ekrukh Lake

Duration of sampling was August 2015 to March 2016 (eight months).

2.1.1 Ekrukh Lake:

Ekrukh Lake is located near Solapur city, Tal. North Solapur, Dist. Solapur. The toposheet no. is 47 O/9 the latitude of site is 75º 55’ 00” and longitude is 17º 44’ 00”. The latitude and longitude of every point chosen for sampling are shown in table 2.1.

Table 2.1 Latitude and Longitude of Ekrukh Lake

Sampling position	Latitude	Longitude
Point 1	75º 55’ 22”	17º 43’ 39”
Point 2	75º 55’ 42”	17º 44’ 6”
Point 3	75º 54’ 20”	17º 43’ 20”
Point 4	75º 54’ 20”	17º 43’ 34”
Point 5	75º 54’ 26”	17º 44’ 31”

Fig 2.1 Map Showing Location of Sampling Points

2.2 Materials

2.2.1 Sampling Equipment:

1. Plastic bottles of five no’s
2. BOD bottles of 300 ml volume - five no’s
3. Thermometer
4. Thermo Cole box

2.2.2 Sampling Procedure:

One and half liter of water sample is taken from every point in a clean plastic bottle every month. Separately 300 ml sample of water is taken into a special BOD bottles for BOD testing. For DOfixation two drops of two different chemical solutions were added. Firstly two drops of manganese sulphate [$MnSO_4$] were added and secondly two drops of Alkali-iodide-Azide [NaOH-KI-NaN_3] were added. If brown ppt is formed then the sample is chosen for the further testing. The temperature is measured at the site with the help of thermometer. The whole BOD bottles were taken into a thermo Cole box in which coolant is placed to cool the BOD bottles and then the box is taken to the lab for the further testing.

Following tests were performed on collected samples:

2.3 Methods:

Following tests were conducted on collected water samples.

Instrumental Methods:

- p^H test
- Turbidity
- Electric Conductivity
- Total Dissolved Solids[TDS]
- Sodium [Na]
- Potassium [K]

Chemical Method:

- Alkalinity
- Dissolved Oxygen [DO]
- Chemical Oxygen Demand [COD]
- Biological Oxygen Demand [BOD]
- Hardness

- Total Suspended Solids
- Total Solids
- Chloride

Biological Method:

- Most Probable Number [MPN]

3. RESULTS AND DISCUSSION

3.0 GENERAL:

In this chapter the variation in different parameter for every lake throughout the period of nine month were represented in graph and justification for every variation is discussed.

3.1 Variations of Parameters

3.1.1 pH Monitoring

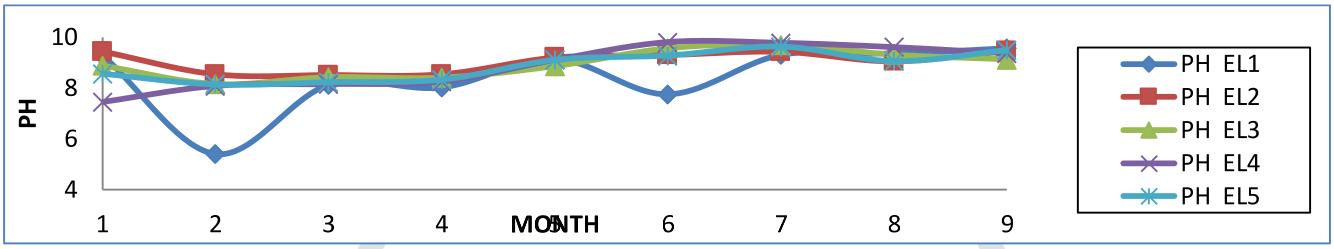

Fig.3.1.1 pH Variation in Ekrukh Lake

The average value of ph of EkrukhLake a is 8.32. At EkrukhLake on point EL1 in monsoon season because runoff dilution happened so ph value was suddenly decreased.

3.1.2 Alkalinity Monitoring

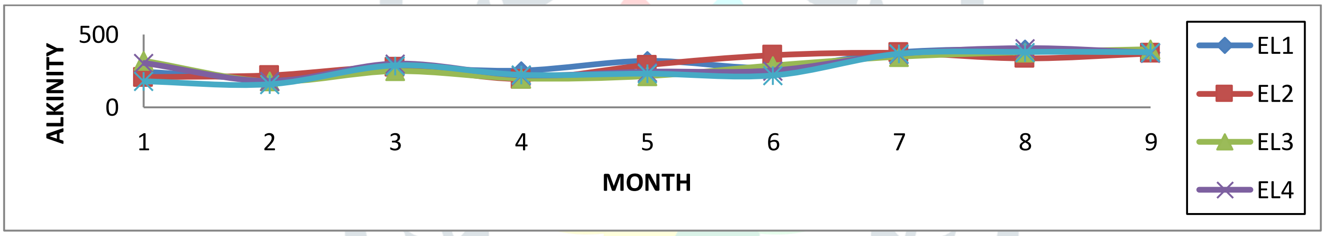

Fig.3.1.2 Alkalinity Variation in Ekrukh Lake

Alkalinity value less than 100 mg/lit is desirable for domestic use. The average value of alkalinity of EkrukhLake, is 356.62. The total alkalinity values in our observation indicated that water was hard .the low alkalinity during rainy season (August and September month) may be due to dilution and higher value of alkalinity in winter and summer season (October to April month) might be due to presence of excess of free CO_2 product as a result of decomposition process coupled with the mixing of sewage and domestic waste.

3.1.3 Chloride Monitoring

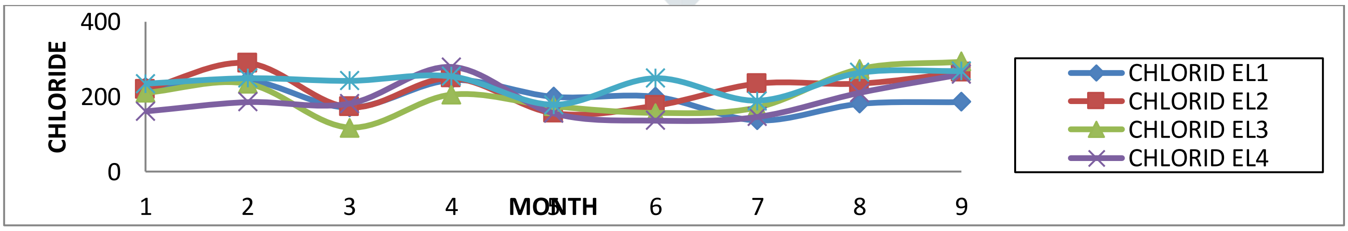

Fig.31.3 Chloride Variation in Ekrukh Lake

The average value of chloride of Ekrukh Lake is 210.49. The high concentration of chloride is considered to be indication pollution due to high animal waste of animal origin. Chloride in all three lakes was found to be exceeded the expectable limit.

3.1.4 Hardness monitoring

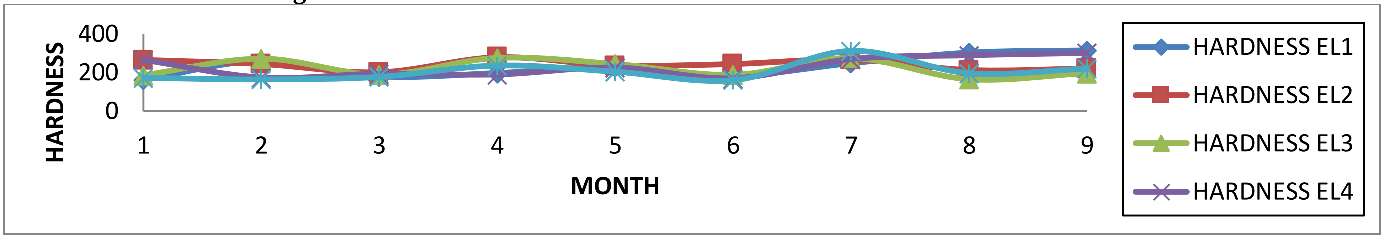

Fig.3.1.4 Hardness Variations in Ekrukh Lake

The average value of hardness of Ekrukh Lake is 225.2. Higher of hardness can be attributed to low water level and higher rate of evaporation of water and addition and magnesium salts.

3.1.5 DO Monitoring

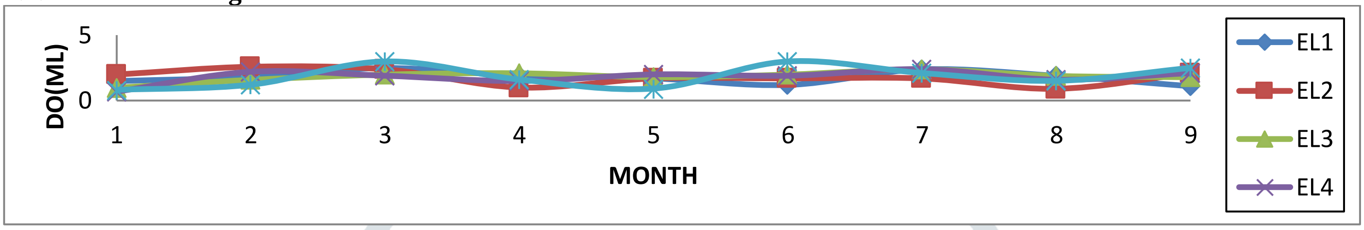

Fig.3.1.5 DO Variation in Ekrukh Lake

The average value of hardness of Ekrukh Lake is 1.81.. This can be attributed to addition of effluents containing oxidizable organic matter and decay of vegetation leading to consumption oxygen from water.

3.1.6 K Monitoring

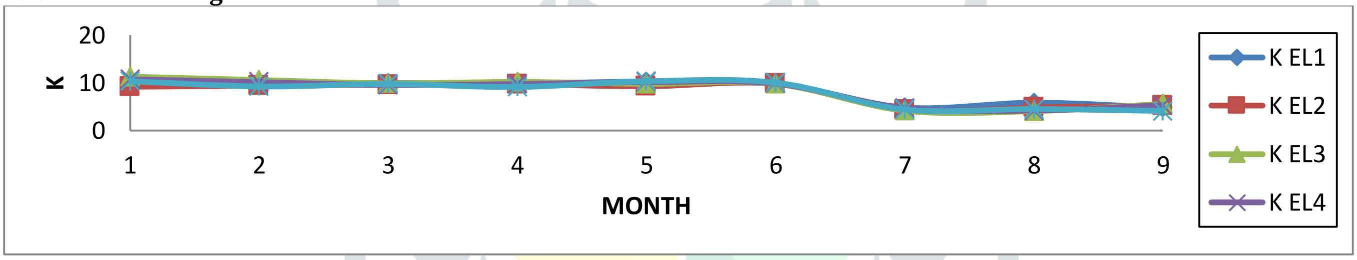

Fig.3.1.6 K Variation in Ekrukh Lake

The average value of potassium of EkrukhLake is 8.20. In the more dilute waters where sodium contents are below 10 mg/L, the potassium concentration may commonly be a half or a tenth that of sodium.

3.1.7 Na Monitoring

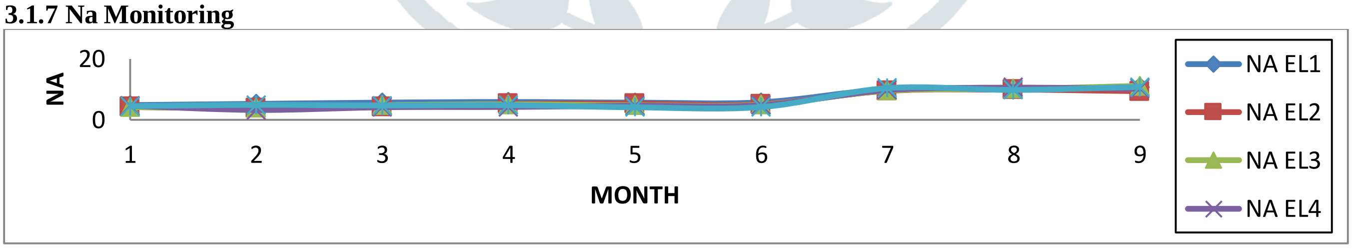

Fig.3.1.7 Na Variation in Ekrukh Lake

The average value of sodium of Ekrukh Lake is 6.49. Due to washing of cloth which leads to use of detergents in lake causes increase sodium value in Ekrukh Lake.

3.1.8 Turbidity monitoring

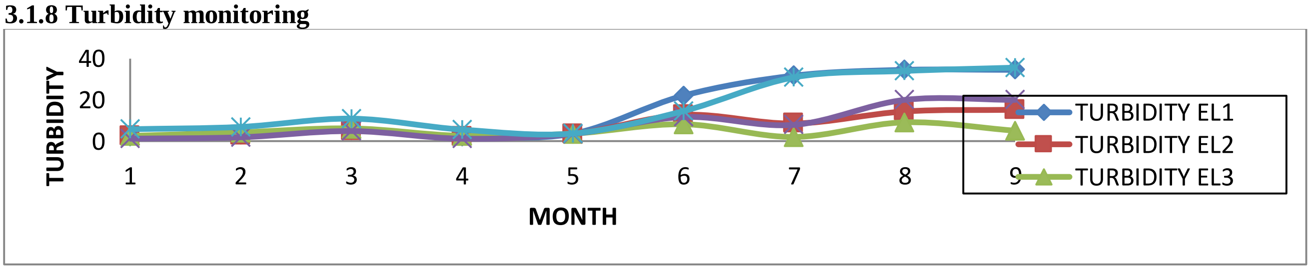

Fig.3.1.8 Turbidity Variations in Ekrukh Lake

The average value of turbidity of Ekrukh Lake is 10.48. Due to decreasing of depth of water turbidity was increasing in Ekrukh Lake.Turbidity is a measure of the cloudiness of water. Cloudiness is caused by suspended solids (mainly soil particles) and plankton (microscopic plants and animals) that are suspended in the water column. Moderately low levels of turbidity may indicate a healthy, well-functioning ecosystem, with moderate amounts of plankton present to fuel the fuel the food chain. However, higher levels of turbidity pose several problems for stream systems. Turbidity blocks out the light needed by submerged aquatic vegetation. It also can raise surface water temperatures above normal because suspended particles near the surface facilitate the absorption of heat from sunlight.

3.1.9 TS Monitoring

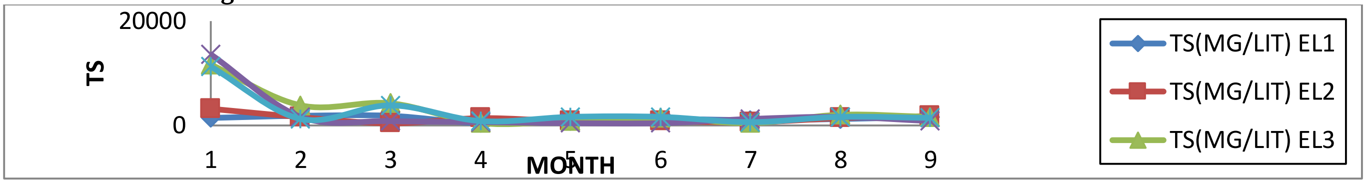

Fig.3.1.9 TS Variation in Ekrukh Lake

The average value of total solid of Ekrukh lake is 2093.Thus, it is related to both conductivity and turbidity. Total solids are severe in Ekruk Lake.

3.1.10 TDS Monitoring

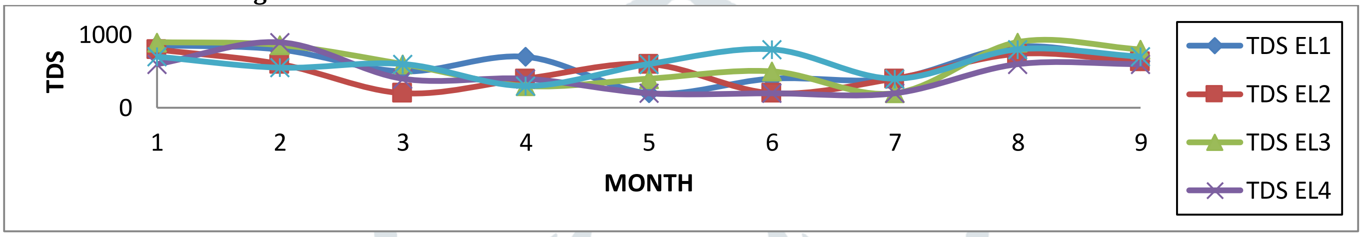

Fig.3.1.10 TDS Variation in Ekrukh Lake

The average value of total dissolved solid of Ekrukh Lake is 553.77. Primary sources for TDS in receiving waters are agricultural and residential runoff, leaching of soil contamination and point source water pollution discharge from industrial or sewage from domestic area in lake.

3.1.11 EC Monitoring

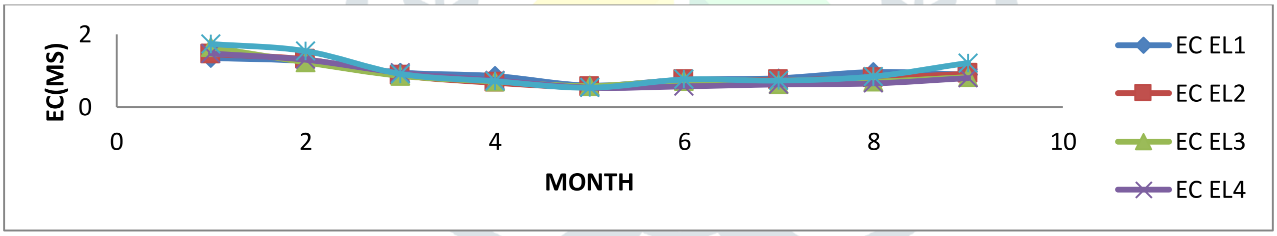

Fig.3.1.11 EC Variation in Ekrukh Lake

The average value of electrical conductivity of Ekrukh Lake is 0.97.It is an indirect measure of the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, iron and aluminum which is more in Lake. Inorganic dissolved solids are essential ingredients for aquatic life. They regulate the flow of water in and out of organisms' cells and are building blocks of the molecules necessary for life. A high concentration of dissolved solids, however, can cause water balance problems for aquatic organisms and decrease dissolved oxygen levels

3.2. Water Quality Index (WQI) These parameters are specified as per classified use of water (Table 3.1below) depending on various uses of water. The following classifications have been adopted in India.

Table 3.2.1Class of Water

Classification	Type of use
Class A	Drinking water source without conventional treatment but after disinfection.
Class B	Outdoor bathing.
Class C	Drinking water source without conventional treatment followed by disinfection.
Class D	Fish culture and wild life propagation.
Class E	Irrigation, industrial cooling or controlled waste disposal.

Table 3.2.2 TOLERANCE LIMITS FOR INLAND SURFACE WATERS, CLASS – C

S. No.	Characteristic	Tolerance limit
1	pH Value	6.5-9.2
2	Dissolved Oxygen	4
3	MPN	5000
4	Alkalinity	120
5	Chlorides	600
6	Hardness	600
7	Total Dissolved Solids	1500

Water quality index determined by using weighted average method for Ekrukh Lake are shown in Table 3.2.3

Table 3.2.3 Average WQI Determination of Ekrukh Lake from Month August 2018 to March 2019

Parameter	Mean Test Results (V_i)	Units	Standard Permissible Value(S_i)	$1/S_i$	$K=(1/(1/S_i))$	$W_i=\sum K/S_i$	QI(Rating)	WIQI
PH	8.48		8.50	0.118	2.63	0.3095	100.00	30.95
DO	1.20	ml	4.00	0.250	2.63	0.6576	0.00	0.00
MPN	2400.00	mg/100ml	5000.00	0.000	2.63	0.0005	60.00	0.03
Alkalinity	251.20	mg/l	120.00	0.008	2.63	0.0219	0.00	0.00
Chlorides	210.04	mg/l	600.00	0.002	2.63	0.0044	80.00	0.35
Hardness	209.40	mg/l	600.00	0.002	2.63	0.0044	80.00	0.35
TDS	772.00	mg/l	1500.00	0.001	2.63	0.0018	80.00	0.14
			SUM=	0.380	2.63	1.0000	SUM	31.82
							Total WQI=	31.82

3.3 Improvement of WQI using "Natrolite Mineral"-

After checking the present WQI of the Ekrukh, Siddheshwar and Kambar Lake. It is identified that the water in these Ekrukh, Siddheshwar and Kambar Lake having severe polluted. Improvement of WQI was done by taking **"Nitrolite Mineral"**

"Nitrolite mineral" crushed using mortal & petals & converted into powdery form. Then it passing through 75 micron Sieve. Water from Ekrukh, Siddheshwar and Kambar Lake filtered from 12 gm Powder of **"Nitrolite Mineral"** through the 25 ml. burrete and collected the filtrate. After collecting the filtrate, checking the all parameter of Water Quality. It seens that all water Quality parameter decreases & increases the WQI of the Ekrukh, Siddheshwar and Kambar Lake. This is carried for three months. Water quality Index of Ekrukh, Siddheshwar and Kambar Lake was done & improvement was taken by **"Nitrolite mineral".**

Table 3.3.1 Average WQI Determination of Ekrukh Lake using Natrolite Mineral from Month August 2018 to March 2019

Parameter	Mean Test Results (V_i)	Units	Standard Permissible Value(S_i)	$1/S_i$	$K=(1/(1/S_i))$	$W_i=\sum K/S_i$	QI(Rating)	WIQI
PH	7.65		8.50	0.118	2.63	0.3095	100.00	31.63
DO	3.25	ml	4.00	0.250	2.63	0.6576	40.00	16.32
MPN	0	mg/100ml	5000.00	0.000	2.63	0.0005	60.00	8.02
Alkalinity	160.32	mg/l	120.00	0.008	2.63	0.0219	0.00	0.00
Chlorides	175.32	mg/l	600.00	0.002	2.63	0.0044	80.00	3.35
Hardness	160.22	mg/l	600.00	0.002	2.63	0.0044	80.00	12.35
TDS	360.32	mg/l	1500.00	0.001	2.63	0.0018	100.00	4.18
			SUM=	0.380	2.63	1.0000	SUM	65.65
							Total WQI=	65.65

3.4 Quality Rating

Table3.2.3 and 3.3.1 shows quality rating used for study

Table 3.4.1 Rating Scale Calculating WQI for Ekrukh Lake

Physico Chemical Factors	**Ranges**				
PH	7.0-8.5	8.51-8.7	8.71-8.9	8.91-9.2	>9.2
	-	6.81-6.9	6.71-6.8	6.51-6.7	<6.5
DO	>7.0	6.1-7.0	5.1-6.0	4.1-5.0	<4
MPN	0-500	501-1500	1501-3001	3001-5000	>5000

Alkalinity	21-50	50.1-70	70.1-90	90.1-120	>120
	-	15.1-20	10.1-15	6.1-10	<6.1
Chloride	0-150	150.1-300	300.1-450	450.1-600	>600
Hardness	0-150	150.1-300	300.1-450	450.1-600	>600
TDS	0-500	501-800	801-1000	1001-1500	>1500
Rating	100	80	60	40	0
Extent of Pollution	Clean	Slight Pollution	Moderate	Excess	Severe

Ekrukh Lake.

The result obtained in present study revealed that certain human activities such as a surface runoff from resulting rainfall, washing animal and cloths.

water quality index of Ekrukh Lake of WQI is 31.82.

Hence if water is to be used for drinking, complete treatment followed by disinfection is needed.

This water filtered using "**Nitrolite mineral"** the WQI increases & comes moderate to slightly pollute & this water we can use for drinking, complete treatment followed by disinfection is needed.

4. CONCLUSION

Assessment of water quality of Ekrukh was done & improvement was taken by using **"Nitrolite mineral".**

Assessment period of project was from August 2018 to March 2019 & Improvement using "**Nitrolite mineral"** was from January 2016 to March 2016. The water quality index was developed from various water parameters like pH, DO, MPN, Hardness, Alkalinity and BOD. After exploration of test MPN was found excess in all three water bodies, along with excessive pollution. After using "**Nitrolite mineral"** WQI increases severe to excess or slightly pollute.

Table 4.1 Water Quality Index Ranges

RANGES	POLLUTION
00 TO 40	Severe
40 TO 60	Excess
60 TO 80	Slightly
80 TO 100	Clean

1. Concluding index that 20 to 30 index for Ekrukh lake. Excess pollution rate alarming to people of Solapur. Using Nitrolite mineral increases the WQI i.e. 65 to 70 index for Ekrukh lake.

2.Considering existing Scenario it has been essential for authority of Solapur to have a look at the this situation & take appropriate measure to use the **"Nitrolite mineral"** for improvement of WQI ,which will serve as with good water quality and also encourage lake tourism in Solapur.

5. References

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