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Lake Water Quality Indexing To Identify Suitable Sites For Household Utility: A Case Study Jambhulwadi Lake;Pune(MS)

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ABSTRACT
Water management practices need a fresh look in order to avoid water crisis in the next two decades. This essentially requires looking for proper management practices for growing economy and population. The water resources of the Lake basins remain almost constant while demand of water for various purposes is increasing. Water pollution as a corollary of accelerated industrial growth has drawn concerns over public health and environment. Water is required for different purposes like domestic, agricultural, hydro-power, navigation, recreation, etc. Utilization in all these diverse uses of water should be optimized and an awareness of water as a inadequate resource should be fostered. Water quality index (WQI) is precious and unique rating to depict the overall water quality status in appropriate treatment technique to meet the concerned issues. This paper elaborates on the WQI concepts and current scenario of Jambhulwadi Lake which will help in future as natural potable groundwater resource. It also focuses on case scenario of calculating WQI using Weighted Arithmetic Water Quality Index an example dataset. The quality of water way to evaluate by testing various physico-chemical parameters such as pH, Temperature, Total Dissolved Solid (TDS),Alkalinity Total Hardness, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD),Chemical Oxygen Demand (COD), Nitrites, Phosphate, Conductivity.

***Keywords*:** Dataset, Jambhulwadi Lake, Parameter, Quality, Status, WQI

I. INTRODUCTION

It is well known that hygienic water is undeniably essential for healthy living. Rivers and Lakes are the most important natural resource for human development but they are getting polluted by messy disposal of sewage, industrial waste and plethora of human activities, which affects its physicochemical and microbiological quality.[1,2] As deterioration of river and Lakes water quality increasing day by day, it is necessary to monitor the water quality so as to evaluate the production capacity Water quality. Water management practices need a fresh look in order to avoid water crisis in the next successive days. This essentially requires looking for proper management practices for growing economy and population as the water resources of the basins remain almost constant while demand of water for various purposes is increasing. Water is required for different purpose like domestic, agricultural, hydro-power, thermal power, navigation, recreation, etc. consumption of all these diverse uses of water should be optimized and an awareness of water as a scarce resource should be fostered. Lakes indicate important life support system by helping in recharging of aquifers and regulating hydrological cycle. Restoration and recharge of water tables is possible due to the lakes, so the lakes play important role in our life.[3] The lakes also act as natural traps system for sediments and nutrients so that they helps to regulate water quality and sedimentation of the river system from the catchment area for ground water. For a sustainable development of water resources, it is necessary to know the factors responsible for change in quality water and to estimate the available water resources. Planning, development and management of water resources need to be governed by common integrated standpoint considering local, regional, State and national context, having an environmentally sound basis, keeping in view the human, social and economic needs. All the elements of the water cycle, i.e., evapo-transpiration, precipitation, runoff, river, lakes, soil moisture, and ground water, sea, etc., are interdependent and the basic hydrological unit is the Lake basin and river basin, which should be considered as the basic hydrological unit for planning.[1,4]

II. WATER QUALITY INDEX FOR JAMBULWADI LAKE

The water quality generally defined as its fitness for the beneficial uses for drinking by people &animals, for support of aquatic life, irrigation of land and for recreation. The degradation in the quality of water is however a direct effect of human interference in Natural Cycles. Though this interference affects the quality of water locally as well as on global scale but the studies in a particular

area shows that the fresh water quality can be improved. WQI summarizes the relative changes in the underlying group of the water-quality variable. A water quality index provides a single number (like a grade) that expresses overall water quality at a certain location and time based on several water quality parameters. Jambhulwadi lake is located at Ambegaon Khurd, Off Pune-Banglore Highway, Pune - 411 046. Maharashtra INDIA with Co-ordinates N18˚26'19.8" E73˚50'35.8"

The objective of an index is to turn complex water quality data into information that is understandable and useable by the public.[2,4] A single number cannot tell the whole story of water quality; there are many other water quality parameters that are not included in the index. The index presented here is not deliberately aimed at human health or aquatic life regulations. However, a water index based on some parameters can provide a simple indicator of water quality as whole number. This gives a general idea that the possible problems with the water in the region can be overcome.

Table.1 Existing Water Supply in Pune City

Source and Type of water	Rivers	Mula, Mutha, Pavna	Natural
	Dams	Khadakwasla, Panshet, Warasgaon, Temghar	Natural
	Lakes	Pashan lake, Katraj lake	Natural
	Ground water	399 dug wells, 4,820 bore wells.	Manmade
Storage capacity of different sources	Dam	Storage Capacity (Thousand Million Cubic Feet)	
	Panshet	10.64	
	Warasgaon	12.81	
	Temghar	03.71	
	Khadakwasla	01.96	
	TOTAL	29.12	
Water coverage	Number of water Distribution Zones	48	
	Coverage of water supply Tap connections (in %)	94.19	
	Per capita average water supply (in LPCD)	194	
Water losses	Transmission and distribution losses (in %)	25	

Fig. 1 Jambhulwadi Lake Location

2.1 Methods Used For Assessment of Water Quality Index:

Initially, WQI was developed by Horton (1965) in United States by selecting ten most commonly used water quality variables like dissolved oxygen (DO), pH, coliforms, electrical conductivity alkalinity and chloride etc. and has been widely applied and accepted in European, African and Asian countries. The assigned weight reflected in significance of a parameter for particular use and has considerable impact on the index. Then after a new WQI similar to Horton's index has also been developed by the group of Brown in 1970, which was based on weights to individual parameter.[1,5] Recently, many modifications have been considered for WQI concept through various scientists and experts. The values of parameters are harmful for human health if they occurred more than defined limits Table shows the Parameters in defining water quality can be grouped into three board categories: physical, chemical, and biological.

Table 2 Parameters to Define WQI

Physical Factor	Chemical Factor	Biological Factor
Water Temperature	pH	Ephemeroptera
Total dissolve solids	BOD	Trichoptera
Odour of water	COD	Lecoptera
Color of water	Heavy metals	E.coli
Taste of water	Dissolved oxygen	Coliform Bacteria
Total suspended solids	Total Hardness	
Turbidity	Orthophosphates	

2.2 The method used for assessment of Water Quality Index

Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables. The method has been widely used by the various scientists and the calculation of WQI was made by using the following equation.

$$WQI = \frac{\sum Q_i W_i}{\sum W_i} \text{----------(1)}$$

The quality ratio scale (Qi) for each parameter is calculated by using this expression:

$$Q_i = 100\left[\frac{V_i - V_o}{S_i - S_o}\right] \text{----------(2)}$$

Where,

V_i is estimated concentration of i^{th} parameter in the analysed water .

V_0 is the ideal value of this parameter in pure water.

V_0= 0 (except pH =7.0 and DO = 14.6 mg/l).

S_i= recommended standard value of i^{th}parameter.

S_0=Maximum permissible limit

The unit weight (W_i) for each water quality parameter is calculated by using the following formula:

$$W_i = \frac{k}{S_i} \text{----------(3)}$$

Where, K = proportionality constant and can also be calculated by using the following equation:

$$k = \frac{1}{\sum \frac{1}{S_i}} \text{----------(4)}$$

Table 2 WQI Rating as per Weighted Arithmetic

Water Quality Index Value	Rating of Water Quality	Grading
0-25	Excellent Water Quality	A
26-50	Good Water Quality	B
51-75	Poor Water Quality	C
76-100	Very Poor Water Quality	D
Above 100	Unsuitable for Drinking Purpose	E

2.3 Pros and Cons of Weighted Arithmetic WQI

Incorporate data from multiple water quality parameters into a mathematical equation that rates the health of water body with number. Overall less number of parameters required in comparison to all water quality parameters for particular use. It is useful for communication of overall water quality information to the concerned citizens and policy makers.[1,6] It reflects the composite influence of different parameters i.e. important for the assessment and management of water quality. This properly describes the suitability of both surface and groundwater sources for human consumption.

At the same time these points should not be get neglected such as WQI may not carry enough information about the real quality situation of the water. Many uses of water quality data cannot be met with an index. There may be the possibility of eclipsing or over-emphasizing of a single bad parameter value. A single number cannot tell the whole story of water quality; there are many other water quality parameters those were not included in the index. WQI based on some very important parameters can provide a simple indicator of water quality. All these WQI models have been developed for flowing or standing water resources such as lakes, rivers, streams, etc. The WQI takes the complex scientific information and synthesizes into a single number between 0 and 100.

III. MATERIAL AND METHODS

To determine the suitability of Jambhulwadi Lake water for irrigation, drinking and other purposes, a number of water quality parameters were determined. For monitoring water quality various analytical methods are used, depending upon the purpose of study, data available, and information required etc. For this various field and laboratory analysis was performed.

3.1 Field Procedures

1) Survey of the area
2) Selection of sampling stations
3) Frequency and method of sampling
4) Determination of some parameters on field.

3.2 Survey of Area

An extensive survey of the area was performed, to obtain the following information.

1) Geological setting of the area
2) Climatic conditions
3) Vegetation
4) Inhabited area along the lake
5) Industrial area along the lake

The work of reconnaissance survey is essential for the purpose of establishing control points and collection of first hand information of various important field data .The best route, modified or alternate, is then provisionally marked on the maps. This route shall form the basis for the detailed survey of the line.

The aim of this study was to study the spatial and longitudinal variations in the water quality. For this purpose samples were taken, during monsoons at regular intervals and also one sample was taken for post-monsoon and pre monsoon season. (Frequency of sampling was not very high, because of some unavoidable circumstances, arising due to the vast area undertaken for the study.) Water sample should collect from different location in Lake Body.

Table 3 Sample station Location over Lake

Sample	Location
Sample Station-1	N18^{0}26'19.4", E73^{0}50'28.1"
Sample Station-2	N18^{0}26'19.8", E73^{0}50'35.8"
Sample Station-3	N18^{0}26'14", E73^{0}50'37.7"
Sample Station-4	N18^{0}26'8.1", E73^{0}50'30"
Sample Station-5	N18^{0}26'11.3", E73^{0}50'24.2"
Sample Station-6	N18^{0}26'14.8", E73^{0}50'28.6"

1) Samples were collected in plastic bottles of capacity 3 litre each.

2) Wherever possible samples were collected from the middle of the Lake, sometimes with the help of rope and a sampler.

3) Bottles in which samples were collected were first washed and rinsed properly with the lake water.

4) A separate bottle was used for each station.

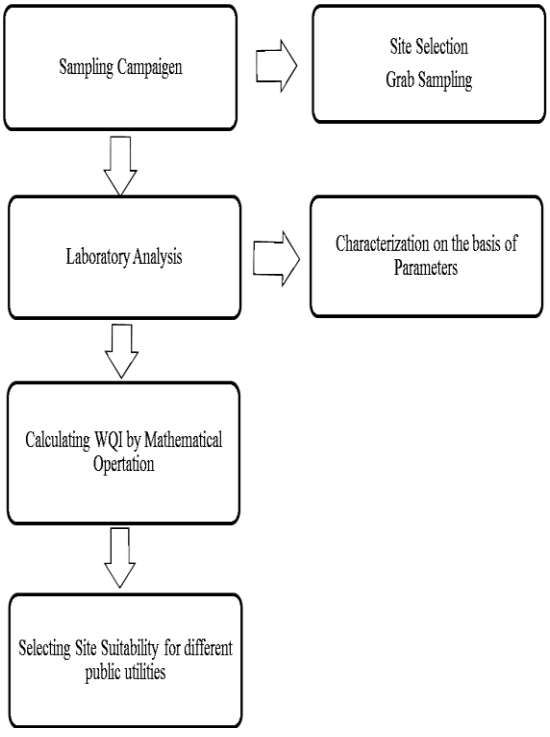


Fig. 2 Methodology to Determine WQI

Table3 Results of Laboratory Analysis (Pre-Monsoon)

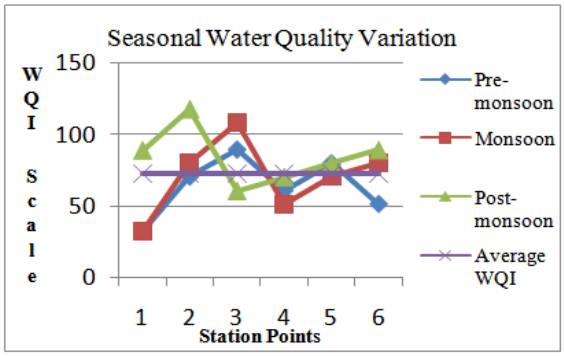
PRE- MONSOON								
Result Analysis								
01-08-2015								
S. N.	Parameters	Unit	Station Point 1	Station Point 2	Station Point 3	Station Point 4	Station Point 5	Station Point 6
1	Temp	^{O}C	39.8	39.7	39	39.2	39.5	39.6
2	pH	-	8.6	8.7	8.6	8.6	8.5	8.6
3	TDS	ppm	390	240	220	230	230	220
4	Alkalinity	mg/l	160	164	160	160	168	148
5	Hardness	mg/l	73.91	73.91	47.82	52.17	73.91	65.21
6	DO0	mg/l	5.2	4.9	5.1	3.8	4.8	4.6
7	BOD	mg/l	2.8	2.9	2.6	3	2.8	3.2
8	COD	mg/l	58	102	96	78	64	32
9	Nitrites	mg/l	1.64	9.3	9.2	9.82	1.47	1.94
10	Phosphate	mg/l	0.03	0.07	0.09	0.06	0.08	0.05
11	Conductivity	mmhos/cm	250.2	260.83	340.2	321.2	311.23	326.5

Table 4 Results of Laboratory Analysis (Monsoon)

MONSOON								
Result Analysis								
19-10-2015								
S. N.	Parameters	Unit	Station Point 1	Station Point 2	Station Point 3	Station Point 4	Station Point 5	Station Point 6
1	Temp	^{O}C	37.5	36.5	34.5	35.5	35.3	34.5
2	pH	-	8.5	8.7	8.8	8.8	8.5	8.7
3	TDS	ppm	190	188	185	185	199	192
4	Alkalinity	mg/l	176	172	176	168	180	172
5	Hardness	mg/l	87.91	70.32	65.93	87.91	70.32	74.72
6	DO0	mg/l	4.9	5.2	5.1	4.8	4.6	4.7
7	BOD	mg/l	2.6	2.8	2.4	2.9	3.1	3.2
8	COD	mg/l	64	128	96	64	64	32
9	Nitrites	mg/l	0.79	18.11	16.4	14.82	3.06	10.89
10	Phosphate	mg/l	0.09	0.08	0.11	0.05	0.07	0.08
11	onductivity	mhos/cm	278.5	240.2	300.2	342.1	267.5	318.8

Table5 Results of Laboratory Analysis (Post monsoon)

POST-MONSOON								
Result Analysis								
10-02-2016								
S. N.	Parameters	Unit	Station Point 1	Station Point 2	Station Point 3	Station Point 4	Station Point 5	Station Point 6
1	Temp	^{O}C	26.3	26.2	25.8	25.9	27	26.5
2	pH	-	8.7	8.8	8.4	8.7	8.7	8.6
3	TDS	ppm	173	178	176	175	180	186
4	Alkalinity	mg/l	156	160	188	148	188	176
5	Hardness	mg/l	61.53	48.35	52.74	79.12	65.93	70.32
6	DO0	mg/l	4.8	5.1	4.6	4.8	5.2	4.7
7	BOD	mg/l	2.6	2.8	2.4	2.9	3.2	3
8	COD	mg/l	28	92	68	55	42	51
9	Nitrites	mg/l	1.91	19.55	17.81	16.25	4.22	12.19
10	Phosphate	mg/l	0.09	0.12	0.06	0.07	0.08	0.09
11	Conductivity	mmhos/cm	238.5	258.2	301.2	315.4	298.4	305.2



Graph 1 Seasonal Water Quality Variation over different Station points

IV. RESULT AND DISCUSSION

From WQI Rating as per Weighted Arithmetic WQI is 72.91 is in grading C indicate Poor Water Quality in Jambhulwadi Lake. pH of water play vital role for the biotic compound because most of biotic plants and animals can endure in moderate range of pH. Here pH for all season is slightly alkaline indicates alkalinity of lake water body. It was recorded 8.4 as lowest in post monsoon season over station point 3 and also highest pH also in post monsoon over station point 2. The marked difference in the pH values of station due to effluent source variation over station points. On the other hand TDS for Pre monsoon is comparatively more than monsoon and post- monsoon season it indicate variation in Total hardness of lake water. Alkalinity and total hardness of lake water is in permissible limit for all seasons. Dissolved Oxygen, Biological Oxygen Demand indicates Presence of oxygen in Lake Water body, which also in permissible limit indicates presence of aquatic life in Lake Body. Also other parameter used for analysis work is not much affected from their standard limits. It is possible to make water in Jambhulwadi Lake as potable with proper conservation, rehabilitation and adequate Techniques.

V. CONCLUSION

The overall planning and management of water is assessment of the surface and groundwater quality of water resources so that water from Jambhulwadi Lake becomes potable as well serviceable. Access to potable and safe water for domestic needs can be used from station point 5. On Station point 5 we have minimum variation for all parameter for all seasons as well as water quality index is nearly same as average water quality index which is 72.91 for all seasons. We can provide water intake structure over station point 5, so that it will more economical for further treatment for quality assurance of water. There is temporal and spatial variation in parameter which may affect water quality index of groundwater and lead to enhance adverse effect on potability of water body for other station in Lake. Water from station point 4 and station point 6 can be used for agriculture, Irrigation, amusement purpose. Water Quality index of this station should not much disturb as compare to station point 1 and station point 3 water quality indexes. To maintain WQI for station point 1 and station point 3 required some conventional filtration techniques so that water from that station becomes serviceable.

REFERENCES

[1] K. C. Khare and M.S. Jadhav, Water Quality Assessment of Katraj Lake, Pune (Maharashtra): A Case Study, *The 12th World lake conference: 292-299*

[2] S.D. Jadhav, D.G. Kanase, R.W. Jawale, V.V.Dhapte, M.S. Jadhav, Water Quality Assesment of Katraj Lake in Pune City.

[3] Anaokar G.S., Aher D.N., Kele V. D. Restoration Of Ground Water In Katraj Lake Basin By Determination Of Water Quality Index, Pune, Maharashtra.-(IJMTER) *Volume 2, Issue 7, [Jully-2015] Special Issue of ICRTET'2015*

[4] Nidhi Jain, R. K. Shrivastava, Comparative Review of Physicochemical Assessment of Katraj Lake, Pune, *Volume : 3, Issue : 8 , Aug 2014 , ISSN No 2277 – 8179*

[5] Anand. P. A. and Anaokar G.S. Determination of Water Quality Index of Mutha River; *A. Report Year 2013 – 2014.*

[6] Shweta Tyagi, Bhavtosh Sharma,Prashant Singh, Rajendra Dobhal ; Water Quality Assessment in Terms of Water Quality Index.
[7] Avnish Chauhan and Suman Singh; Evaluation Of Ganga Water For Drinking Purpose By Water Quality Index At Rishikesh, Uttarakhand, India
[8] Bahura, C.K., (1998), A study of Physicochemical Characteristics of a highly entropic temple tank in bikaner, Rajasthan, *Journal of Aquatic Biology, 13 (1 and 2), pp 47-51.*
[9] Deepshikha Sharma and Arun Kansal. Water quality analysis of River Yamuna using water quality index in the National capital territory, India (2000–2009).
[10] APHA., Standard methods for examination of water and waste water, 19th Edition., Washington, DC
[11] Bureau of Indian Standards, Specification for drinking water. IS: 10500, New Delhi, India, 2012
[12] Kavita Parmar &Vineeta Parmar ;Evaluation of water quality index for drinking purposes of river Subernarekha in Singhbhum District;*International Journal of Environmental Sciences Volume 1, No1,2010.*
[13] Guidelines for Drinking-water Quality, Fourth Edition, World Health Organization ISBN 978 92 4 154815 1.-2012
[14] Nazneen J. Shaikh, Alim A. Sayed, Khan. E.M, Study of Physicochemical characteristics of water quality in Katraj lake, Pune, *International Journal Of Environmental Sciences Volume 4, No 1, 2013*
[15] National Water Policy (2012) Government of India Ministry of Water Resources