Science and Technology Publishing (SCI & TECH)
ISSN: 2632-1017
Vol. 5 Issue 3, March - 2021

Assessment Of Water Quality Characteristics And Productivity Status Of Dimbhe Reservoir Using Rs And Gis Tools

Nandkishor A Ingole*; Karthik Ramesh* and **Devidas Belsare
*Open Source Fisheries Project Tata Trusts, World Trade Centre, Colaba, Mumbai-400001, India
** Former Prof. of Dept of Bioscience, Bhopal University, MP, India
Email ; ningole@tatatrusts.org

***Abstract*—A limnological investigation of the manmade reservoir is necessary to evaluate the potential fish production and to provide information that could be useful in fisheries development planning. In this direction, the present study was conducted on Dimbhe reservoir located on across river Ghod near village Dimbhe, Taluka Ambegaon, Dist. Pune. The reservoir was divided into three zones viz., in Riverine, Transitional and Lacustrine. Twenty hydrological parameters were analyzed for different points on dated 22 Oct. 2018 during rainy season sampling points were selected with the help of GPS. The assessment of water quality of the reservoir reflects the uses of water, as well as the condition of the site from where water sample was taken. Also present study deals with application of geospatial technology for discrimination of different hydrological parameters and past status of fish fauna of Dimbhe reservoir. GIS technique has been used to demarcate the water quality parameters map of Dimbhe reservoir. Tropic status of the reservoir was mesotropic in nature found on the basis of hydrological indices. Correlation matrix of hydrological parameters was found at 5 % levels of significance. Finally concluded that good status of water quality of this reservoir is essential for the development of culture and capture based fisheries.**

Keywords—Water Quality Parameters, Zonation and Reservoir Status

INTRODUCTION

Inland aquatic resources in developing regions around the world are of immense significance in terms of food security as well as economic growth and the alleviation of poverty**.** In reservoir ecosystem, climatic and edaphic factors are responsible for energy fixation and nutrient dynamics, thus considered to be of first order importance followed by morphometric factors (basically area, mean depth, irregularity of shoreline) having a significant bearing on productivity. Mean depth (volume/area) of reservoirs is considered to be one of the most important morphometric parameters indicative of the extent of the euphotic littoral zone **(Vass and Sugunan, 2008)**. Reservoirs contribute considerably to the inland fish production of India which has been estimated at 93,000 tonnes **(Anon, 2006). Rybakov and Shelekhova (2014)** suggested that in shallow and small reservoirs, the reservoir bed may serve as a source of autochthonous nutrient loading as well as evaluate the levels of pollution and its impact on diatom in the riverine zone. However, in Indian reservoirs it has been noticed that the catchment determines the water quality to a larger extent than the basin soil. In majority of Indian reservoirs drastic fluctuations in water level have been observed to impact on fishes, plankton, benthos and periphyton pulses that coincide with the period of least water level and that all the communities are at low ebb during the months of maximum water level and water discharge **(Ingole, *et al.,* 2014**).

In the present investigation, horizontal zonation and mapping of Dimbhe reservoir water body have been done for the first time. The main purpose of this study was to determine the hydrological parameters of this reservoir at selected sampling stations in different zones. Thus, the investigation was attempted to assess the water quality status with a view to elaborate certain aspects of management for the betterment of localities.

MATERIAL AND METHODS

Study Area

The Dimbhe reservoir was created by constructing an earthern dam across the river Ghod and situated (73.74327 E, 19.09565 N) in Pune district of Maharashtra having total water spread area is 1,280 hectors (ha). Salient features of Dimbhe dam and reservoir and sampling station map enclosed as **(Table 1** and **Fig. 1).**

Table 1: Salient features of Dimbhe dam and reservoir (Pune)

SALIENT FEATURES		
1	Year of commencement	1987
2	Year of Completion	2000
3	Name of River	Ghod
4	District	Pune
5	Tehsil and Block	Ambegaon
6	Latitude	19.0965 ^{O}N
7	Longitude	73.7432 ^{O}E
8	Type of Dam	Earthen Dam
9	Name of Circle	Maharashtra Krishna Valley Development Corporation,Pune-11
10	Name of Division	Kukadi Irrigation Division No.1 Narayangaon
11	Max. Height of Dam	67.21 m (220.5 ft)
12	Length of Dam	852 m (2,795 ft)
14	Catchment Area	298 Sq.Kms
15	Annual average Rainfall	150 cm to 400 cms
16	Maximum storage Level	719.145 m
17	Dead storage level	682.75 m
18	Crest Lavel	711.145 m
19	Total Surface Area	17,547 km2 (6,775 sq mi)
20	Gross Capacity at FRL	38,220,000.00 m^3 (1.349726562×109 cu ft).
21	Named instrument installed with specification	-
22	Present condition of instrument	-
23	Frequency of Observation	-
24	Behavior of Dam after Construction	Satisfactory
25	Present performance of the dam	Satisfactory

(*Source* : Kukadi Irrigation Division No.1, Narayangaon, Pune)

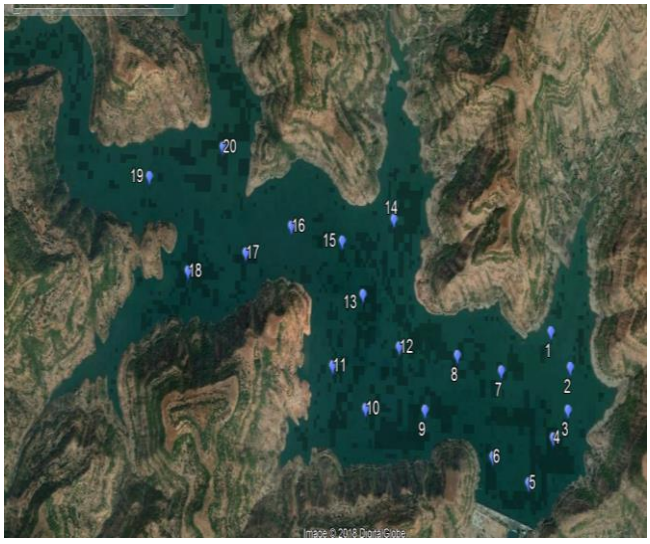

Fig. 1: Water sampling station of Dimbhe Reservoir

Collection of sample

For this study water samples were taken from twenty sampling station (9:00 am - 04:00 pm) in Dimbhe reservoir selected by using mobile Global Positioning System (GPS) in different zone (Riverine, Transitional and Lacustrine), moreover, the water quality condition and specific feature of each zone of reservoir are showed in **Fig. 2.**

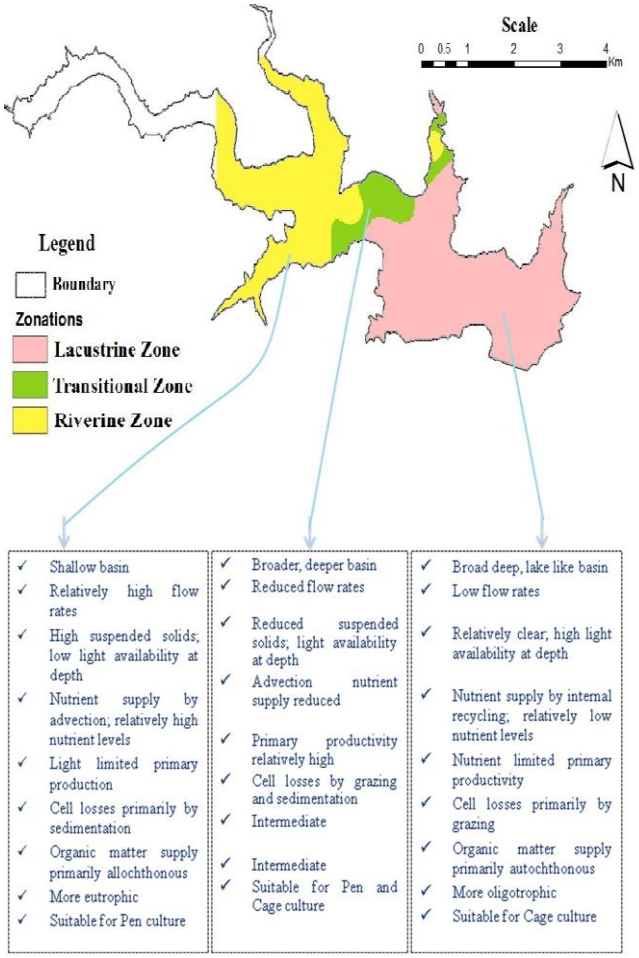

Fig.2. Horizontal zonation of water quality conditions in Dimbhe reservoir (Modified from **Thornton, *et al.*, 1996**)

Samples were collected and mapping done during October (monsoon season) so as to obtain the temporal area of the water body. The water parameters quality is including water temperature (digital thermometer, *HM Digital, Inc.*), pH using digital pH meter (HI 98107), Total Dissolved Solid (TDS) using digital TDS (HM Digital, Inc.), E. conductivity (conductivity meter *HI98303*) and also estimated the reservoir depth using digital depth meter.

The Statistical Package for the Social Sciences (SPSS, v-16) software was used for the analysis of multi correlation and statistical description.

Layer Generation in QGIS

Layers in QGIS v.2.18 was created by interpolating point value of physico-chemical parameters. The

physico-chemical parameters of water in CSV format were used as input file in QGIS v.2.18 software. The layers were classified into different classes considering the variability in the interpolated data. Shape file of dam has created using landsat-8 imagery data **(Fig. 3.)**

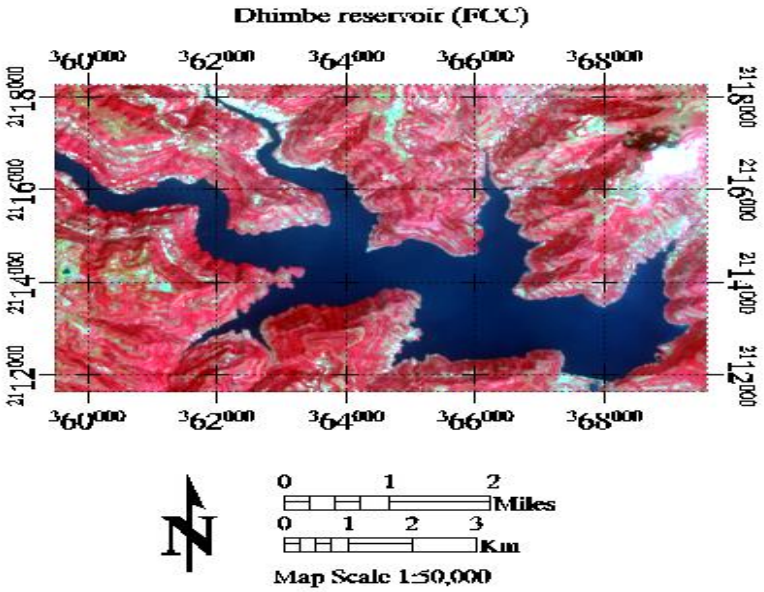

Fig. 3. False Colour Composition (FCC) image of Dimbhe Reservoir (LC-8 on 22 Oct. 2017)

RESULT AND DISCUSSION

Among various hydrological parameters, Temperature ($^{\circ}$C), Conductivity **(**µs/ml), TDS (mg/l), and pH, DO (mg/l) considerably station varied **(Table 2).**

Table. 2. Physico-chemical parameters of Dimbhe reservoir (22 Oct. 2017)

Sr. No.	Lat (^{O}N)	Long (^{O}E)	Depth (m)	TDS (ppm)	Elect. Cond. (µS/ml)	pH	Temp (^{O}C)
1	19°6' 33.89"	73°44'54.55"	14.9	39	79	7.5	27.1
2	19°6'24.30"	73°45'03.09"	28.7	38	77	7.8	27.0
3	19°6'12.65"	73°45'01.84"	29.4	39	78	7.8	27.1
4	19°6'05.07"	73°44'55.11"	68.1	38	77	7.9	27.0
5	19°5'52.78"	73°44'44.07"	81.2	38	76	7.9	27.1
6	19°5'59.38"	73°44'28.20"	50.2	36	75	7.9	27.0
7	19°6'22.69"	73°44'32.09"	21.6	39	78	8.1	27.0
8	19° 6'26.45"	73°44'12.31"	11.2	38	77	7.9	26.9
9	19° 6'11.25"	73°43'57.92"	35.2	48	94	8.3	26.9
10	19° 6'11.13"	73°43'31.36"	21.5	42	86	8.1	26.8
11	19° 6'22.43"	73°43'16.29"	12.9	53	108	8	26.9
12	19° 6'28.21"	73°43'46.15"	24.1	39	78	7.9	26.8
13	19° 6'42.30"	73°43'29.48"	69.7	51	104	8.1	26.9
14	19° 7'3.65"	73°43'43.18"	13.4	50	102	8.1	26.8
15	19° 6'57.05"	73°43'19.65"	26.7	53	105	7.9	26.8
16	19° 7'0.75"	73°42'56.31"	15.6	52	104	8	26.9
17	19° 6'52.80"	73°42'35.82"	16.2	50	103	7.9	26.9
18	19° 6'47.09"	73°42'9.85"	12.3	54	106	8	26.8
19	19° 7'13.38"	73°41'50.55"	34.5	56	113	8.2	26.8
20	19° 7'22.58"	73°42'23.89"	23.5	55	111	8.4	26.7

Temperature

The optimum temperature of water for survival and growth of fishes is between 26 to 32°C **(Nelly, *et al.*, 2014).** Maximum water temperature was 27.1°C in lacustrine zone at 1, 3 and 5 station could be due to high suspended particle found in this zone having property in water column absorb and scatter sunlight and hence determine the extinction of solar radiation and minimum was found (26.7°C) in riverine zone in monsoon season could be due to water come from high altitude region. Recorded average temperature was 26.9±0.11 °C. Thematic map of the water temperature distribution is shown in **Fig. 4.**

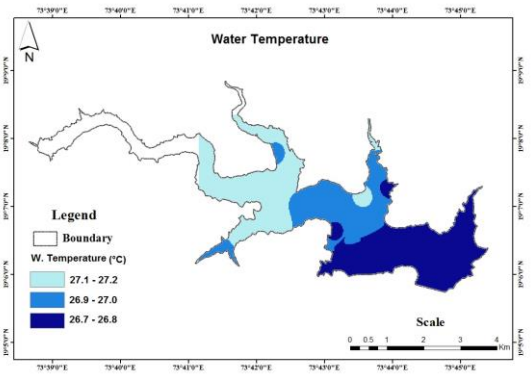

Fig.4. Water Temperature (°C)

pH

The pH fluctuated from 7.5 to 8.4 with an average of 7.9. The minimum pH observed was 7.5 in the lacustrine zone at station No. 1; it may be due to gradual dilution of alkaline soil towards the lacustrine zone, while 8.4 pH at station No. 20 in the riverine zone, may be due to dissolution of atmospheric CO_2. The majority of the Indian reservoirs have moderately alkaline pH (**Vass and Sugunan, 2008)**. Thematic map of the pH distribution is shown in **Fig. 5.**

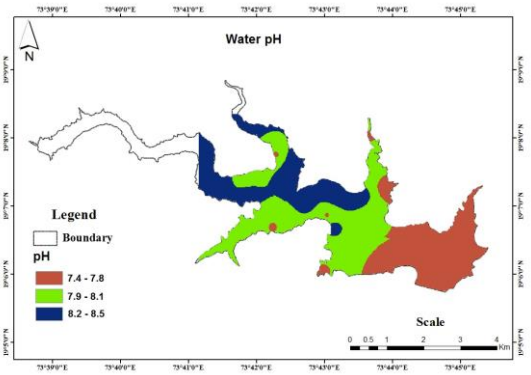

Fig. 5. Water pH

TDS

The maximum TDS recorded was 56 mg/l in the riverine zone at station No. 19, it may be because of high load of suspended solid from catchment area and minimum in lecustrine zone (36 mg/l) at station No. 6 might be due to the settlement of dissolved solid in deep and stagnant water. The average of TDS was 45.4±7.2 mg/l**.** Thematic map of the TDS distribution is shown in **Fig. 6.**

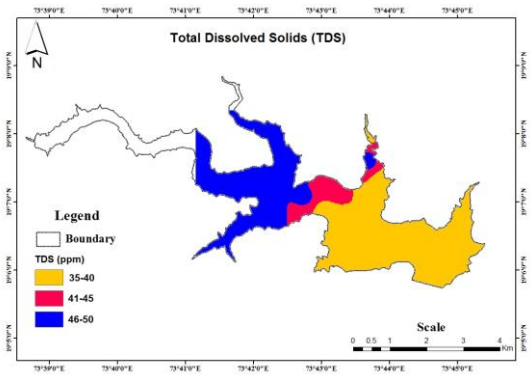

Fig. 6. Total Dissolved Solids (TDS) (ppm)

Electrical Conductivity

Electrical conductivity reflects the capacity of water to conduct electrical current, and is directly related to the concentration of salts dissolved in water. The electrical conductance range was 75 to 113 µs /ml with an average of 91.5 µs /ml. It was low in lacustrine zone (75 µs /ml) at station No. 6 may be because of less dilution of water therefore resulted in decrease electrical conductance and high in riverine zone (113 µs /ml) at station No. 19 may be due to more ion concentration in water therefore resulted in increase electrical conductance. **Olsen (1950)** classified water bodies having conductivity values greater than 500.00 µS/ml as eutrophic. According to this criterion Dimbhe reservoir water falls under the category of mesotrophic. Thematic map of the electric conductivity distribution is shown in **Fig. 7.**

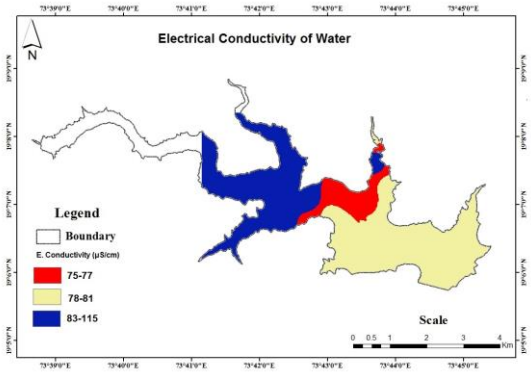

Fig. 7. E. Conductivity (µS/cm)

Trophic status

Trophic status of the Dimbhe reservoir is under the category of Mesotrophics on the basis of different indices given by some investigators **(Table-3)** and existing net primary productivity was 230-260 mg $^{c}/M^{3}$ /day calculated by CIFE (Mumbai) in 2006.

Table 3: Descriptive Statistics of annual average of hydrological parameter

Parameters		Water quality Range				Trophic Status	References
	N	Minimum	Maximum	Mean	Std. Deviation		
Temperature	20	26.7	27.1	26.9	0.11	Meso-thermal	Lee *et al.* (1981)
Conductivity	20	75	113	91.5	14.4	Mesotrophic	Olsen (1950)
TDS	20	36.0	56.0	45.4	7.2		
pH	20	7.5	8.4	7.9	0.19	Alkaliphilous	Venkateswarlu (1983)

Correlation analysis

The correlation matrix of different hydrological parameters of Dimbhe reservoir showed in **Table- 4.** TDS positively correlated with electric conductivity (R^2= 0.99, p<0.01), pH (R^2= 0.56, p<0.01) while had significantly negative correlation with temperature (R^2= -0.69, p<0.01), and vice-versa. The electric conductivity positively correlated with pH (R^2= 0.56, p<0.01), while negative with water temperature (R^2= -0.69, p<0.01) and vice-versa. pH was negatively correlated with temperature (R^2= 0.66, p<0.01) and vice-versa. The water temperature negatively correlated with all estimated parameters.

Table 4: Correlation matrix of hydrological parameters for Dimbhe reservoir

Parameters		TDS (ppm)	E. Cond. (µS/ml)	pH	Temp (°C)
TDS (ppm)	Pearson Correlation	1			
	Sig. (2-tailed)	20			
	N				
E. Cond. (µS/ml)	Pearson Correlation	0.995**	1		
	Sig. (2-tailed)	.000	20		
	N	20			
pH	Pearson Correlation	0.569**	0.562**	1	
	Sig. (2-tailed)	.009	.010	20	
	N	20	20		
Temp (°C)	Pearson Correlation	-0.696**	-0.696**	-.663**	1
	Sig. (2-tailed)	.001	.001	.001	20
	N	20	20	20	

**. Correlation is significant at the 0.05 level (2-tailed).

a. Listwise N=20

FISH SEED STOCKING STRATEGIES

Stocking density of fingerlings (80-100 mm) should be with respective of reservoir water spread area at elevation 713.25 m (14.698 Mm^3) on useful storage level (The volume of water stored in a reservoir between the minimum pool and normal pool levels is called the useful storage) because it may be a conservation storage and flood-mitigation storage, in a multipurpose reservoir. The ideal time for seed stocking is on end of month of September or first week of October because of low water inflow, low pressure of water outflows, minimum chances of seed drain out, less turbidity or sediment, good water quality and more abundant of food availability (phyto and zooplankton). According to **Murugesan *et al.* (1999) and Selvaraj *et al.* (2000)** recommended the stocking rate of 400-500 / ha (100-120 mm) and other various management measures for enhancement of is fish production from small reservoirs.

FISH CATCH

In the first year 2006-07, the catch was totally 20530 kg3670 kg of Catla, etc., plus 16860 kg Chela in 72 fishing days. The size of the Catla in 2006 was about 700 gm. In 2010, the total catch has been 24000 kg, with 4381 kg Chela and 10340 kg Indian Major Carps (IMC), in 147 fishing days. It is concluded that average fish production 11.54 kg/ha from 1,280 hectors of water spread area of Dimbhe reservoir. The above is the result of aggressive stocking of Indian

Major Carps IMC (Catla, Rohu&Mrigala) as advised by the CIFE.

CONCLUSION

The study suggests the good status of water quality of reservoir. Reservoir water has found to be suitable for culture based capture fisheries. Cultural practices like pen and cage culture can be carried in late monsoon (mid week of September) to the early pre monsoon (mid week of April) season in the riverine and lacustrine zone. Fish seed stocking can be stock on end of month of September or first week of October.

REFERENCES

Vass K.K. and Sugunan V.V., 2008. Status of Reservoir Fisheries in India: Status of reservoir fisheries in five Asian countries. (eds. By De Silva, S.S. and Amarasinghe, U.S.). NACA Monograph No. 2., Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand. 113p.

Anon. ,2006. XI Five Year Plan for Fisheries, Report of the Working Group, Planning Commission. Government of India, New Delhi.

Rybakov D.S., Shelekhova T.S., 2014. Diatoms in bottom sediments as indicators of pollution of urban aquatic ecosystems, *Russian Journal of Ecology*, 45, (1) pp 38-45.

Ingole N. A, R. N. Ram and Kumar Prem, 2014. Study of morphometrical changes and suspended sediments in Nanak Sagar reservoir of Uttarakhand, India, using remote sensing data & its impact on Ichthyofaunal diversity, *Eco. Env. & Cons. 20 (Suppl.)* ; pp. (S373-S379)

Nelly, A., L.K. Isyagi, R. Veverica, Asiimwe and D.W.H. Daniels, 2014. Manual for the Commercial Pond Production of the African Catfish in Uganda, USAID, USA and Cooperative Agreement: 617-A-00-0500003-00, pp: 222

Olsen, S.: 1950. Aquatic plants and hydrospheric factor, I. Aquatic plants in Switzerland, Arizona. J. Sevensk. Botanisk Tidskriff, 44, 1-34.

Lee, G.F., R.A. Jones and W. Rast 1981., Alternative approach to trophic state classification for water quality management. Occasional paper No. 66. Department of Civil and Environmental Engineering Program. Colorado, State University, Fort Collins, Colorado.

Venkateswarlu, V. 1983., Taxonomy and ecology of algae in the river Moosi, Hydrabad, India. II. Bacillariophyceae. In: Bibliotheca Phycologica. (Ed.: J. Cramer), 66, 1-41.

Thornton J., Steel A. and Rast W., 1996. Reservoirs (Chap-8) Water Quality Assessments- A Guide to Use of Biota, Sediments and Water in Environmental Monitoring- Second Edition by Deborah Chapman.