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Morphometric Features and Hydrology of Kadgaon Freshwater Reservoir, (M.S.) India

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Abstract:

The present research work deals with morphometric features and hydrological study of Kadgaon freshwater reservoir. The work is carried out during the year 2011-2012. The submergence area covered by this reservoir is about 3.25 hector and actual submergence area measured by the GPS is 6.15 hector. The physic-chemical parameters such as temperature, transparency, turbidity, pH, EC, Free CO_2, total alkalinity, Total hardness, Ca, Mg, Chloride, total dissolved solids, phosphorous, DO and BOD were carried out as per standard methods. The correlation analysis was done for 11 selected parameters. From the investigation it is observed that the water from the reservoir is suitable for drinking, agricultural and domestic purposes. The water is also suitable for Fishing.

Key words: Freshwater reservoir, Morphometric features, Physico-chemical parameters, Correlation analysis.

Introduction:

The world's water reservoirs are under pressure and must be managed for human survival. It is therefore, necessary to have

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most relevant information for arriving at rational decision that will result in the maximum benefit to most of the people. Accurate and reliable information on the water resource system can therefore be a vital aid to strategic management of the water reservoirs (Gupta and Deshpande, 2004).

Water reservoirs are recognized as aquatic ecosystems that harbor high biological diversity provide sustenance for millions of people and face on going threats as a result of human activities throughout the world (Gopal and Chauhan, 2001). The water reservoirs are most important water resources for the local people, mainly for drinking and domestic purpose. Hence, the environmental monitoring and conservation of freshwater bodies is of prime importance.

In the present investigation, morphometric features and mapping of Kadgaon water body have been done for the first time. Physico-chemical properties have been investigated to know its status. Thus, the investigation is attempted to assess the water quality status with a view to elaborate certain aspects of management for betterment of localites.

Materials and Methods:

Study area:

Gadhinglaj is located at 16^{o} 13' 26" N and 74^{o} 26' 9" E, Tahsil of Kolhapur District from Maharashtra. The population is about 216257, distributed in 90 small as well as large villages occupying about 48094 ha of area. Throughout the Tahsil, there are number of small and large water bodies along with an important River Hiranyakeshi, which is lifeline of the Tahsil. The people, who are living away from river, are very dependent on these water bodies for domestic uses like drinking, washing and agricultural irrigation.

Collection of samples:

The samples of surface water were collected monthly from Kadgaon freshwater reservoir during July 2011 to June 2012. Samples were collected in plastic container. The analysis was carried out within 12 hrs. in the laboratory.

Mapping by GPS:

The morphometric data of freshwater body with special reference to actual submergence area was evaluated by walking around the periphery of water body through selection of two co-ordinates with the help of hand held Global Positioning System (GPS Model: GARMIN eTREX vista HCx and Software: Mapsource). The survey and mapping were done during monsoon and summer season so as to obtain temporal area of water body, in the year 2010-11.

Analysis of physico-chemical parameters:

The standard methods were used for analyzing physico-chemical parameters. Temperature was measured at the study site by using thermometer. DO was fixed at study site and analyzed in laboratory by Winkler's method. The analyses of other parameters were made by the standard methods recommended by APHA, AWWA and WPCF (2005) and Trivedi and Goel (1984).

Results and Discussion:

The Morphometric features are presented in Table 1.

Morphometry:

The freshwater reservoir of Kadgaon is located in Gadhinglaj tahsil (16º 15" 221' N, 74º 18" 122' E) of south western part of Maharashtra. Kadgaon is a small village which is situated 8 Km away from Gadhinglaj. The reservoir was constructed in 1996 by Jilha Parishad. Submergence area covered by this

reservoir is about 3.25 hector and actual submergence area by GPS is 6.15 hector. Length and height of dam is 174 meters and 17.27 meter. The catchment area of the reservoir is 0.32 sq. km. The reservoir is manmade and perennial.

The monthly variations in Physico-chemical and microbial parameters are presented in Table 2.

Temperature:

The quality of any aquatic ecosystem depends upon the physico-chemical characteristics and biological diversity. Temperature is an important factor controlling the planktonic flora (Hutchinson, 1957). The seasonal cycle on phytoplankton of an aquatic ecosystem may be affected by temperature (Mc Camble, 1952). In the present study, the monthly variations in atmospheric and water temperature ranged from 22°C to 35°C and 20°C to 29°C respectively. It was minimum in the month of November, while maximum in the month of May.

Transparency:

Seechi disc transparency is highly valuable and helps to determine the productivity zone of water body (Golterman *et al.* 1978). The level of transparency ranged from 24±1.63 to 68.66±2.49 cm with an average of 47.45±2.10 cm. It was low in the month of July while increased in the month of November.

Turbidity:

Clay, silt, organic matter, plankton and other microscopic organisms causes turbidity in natural water and it has been considered as a limiting factor for biological productivity in freshwater. The annual variation in turbidity ranged from 0.61±0.008 to 40.23±0.94 NTU with an average of 11.36±0.8 NTU. It was minimum in the month of November while maximum in the month of June.

pH:

The pH of water is highly governed by CO_2, carbonates and bicarbonates equilibrium (Chapman, 1996). The pH value fluctuated from 6.71±0.012 to 8.22±0.024 with an average of 7.45±0.125. The fall in pH was observed during August while rise during April. As per Jhingram (1982) the water is suitable for fishing.

Electric conductivity:

Conductivity of water depends upon the concentration of ions, nutrient status and variations in dissolved solid contents (APHA, 2005). The annual variation in electrical conductance, ranged from 0.236±0.002 to 0.364±0.002 mho/cm with an average of 0.322±0.005 mg/l. It was low in the month of July while high in the month of April. Dilution of water during rainy season causes a decrease in electrical conductance. As per Deo *et al.* (1993) the water of this reservoir is good for irrigation purpose. Similar trend of the E.C. values recorded higher during summer months and lower in monsoon have been given by Krishnamoorthi and Selvakumar (2010).

Free CO_2:

The amount of free CO_2 present in natural lentic water is generally lower and the concentration is generally maintained by diffusion from the atmosphere, respiration of animals and plants, bacterial decomposition of organic matter, sewage inflowing ground water. The level of free CO_2 ranged from 0 to 26.4±2.07 mg/l with an average of 7.21±0.00 mg/l. It was absent from the month of November to May. High concentration of free carbon-dioxide is due to the respiration of organisms and absence of photosynthesis (Narayana *et al.* 2005).

Total alkalinity:

The alkalinity in water is usually imparted by the salts of weak acids. The natural water bodies show a wide range of

fluctuations in total alkalinity values depending upon the location and season (Jingram, 1982). Alkalinity also depends upon nature of bottom deposits (Patil *et al.*, 2015). Monthly variation in total alkalinity ranges from 142±1.63 to 191.33±3.39 mg/l with an average of 171.70±2.14 mg/l. Rise in the level of total alkalinity during summer season might be due to increased rate of organic decomposition, evaporation of water while fall in the level of alkalinity in monsoon season due to dilution of water. As per Spence (1967) the water of this reservoir is considered as nutrient rich.

Total hardness:

The total hardness of water is the sum of concentration of alkaline earth metal cations present in it. Ca and Mg are the major cations, which impart hardness. In the present study, the content of total hardness ranged from 99.66±1.24 to 170.66±0.94 mg/l with an average of 147.47±3.33 mg/l. It was minimum in the month of July and maximum in the month of December and March. Elevation of hardness during summer season can be attributed to decrease in water volume, increase in rate of evaporation and anthropogenic activities. Rise in the level of hardness during December due to dilution of water by the rains. As per Kannan (1991), the water of this reservoir is moderately hard to hard. Therefore hardness of this reservoir was within the permissible limit (WHO, 1984). Hardness below 300 mg/l is considered as potable. Water of the reservoir is suitable for drinking purpose.

Calcium:

It is an important component of the carbonic buffer system and also cycles through biotic and abiotic components of the ecosystems. Calcium is a main cation or factor causes water hardness in natural water. It originates from natural process called dissolvent of minerals containing calcium and other sources such as industrial and agricultural wastes and it is

non-toxic. The level of calcium ranged from 26.99±0.37 to 48.38±0.75 mg/l with an average of 36.69±0.17 mg/l. It was declined in the month of July while inclined in the month of January. The maximum desirable limit of calcium in drinking water is 75 mg/l (WHO, 1993). Calcium content in water of this reservoir is within the desirable limit.

Magnesium:

Magnesium is essential for growth of the phytoplankton. Monthly variations in magnesium values from 17.67±0.37 to 32.63±0.13 mg/l with an average of 26.92±0.28 mg/l. the lower values were recorded during the month of July and higher during the month of March. Permissible limit of magnesium content for drinking purpose is 50 mg/l. Magnesium content of this reservoir is within the permissible limit.

Chloride:

Chloride is an important nutritious element in plant and animal life. Generally freshwater contains 8.2 mg/l of chloride per liter in general (Swarnlata and Rao, 1998). The chloride values ranged from 16.09±1.33 to 77.62±1.33 mg/l with an average of 37.80±0.94 mg/l. It was decreased during August and increased during March. High concentration of chloride indicates the large amount of organic matter. The higher values of chlorides during summer months may be due to reduction in water level (Patil *et. al.*, 2013). The desirable limit of chloride concentration in drinking water is 250 mg/l (WHO, 1984). As per these criteria the chloride values of this reservoir lies in the acceptable limit. Chloride in excess impart a salty taste to water and people who are not accustomed to high chlorides may be subjected to the laxative effects (Jadhav *et al.*, 2012). Similar trend of chloride values noted lower in monsoon season, higher in summer season has been given by Sharma *et al.* (2011).

Total Dissolved Solids

All water in nature contains dissolved solids. As water is the universal solvent which dissolves different types of material as compared to other solvent (Welch, 1952). In natural water dissolved solids are composed of carbonates, bicarbonates, chlorides, phosphates, nitrate, calcium, magnesium, potassium, sodium and iron. In the present study, the total dissolved solids ranged from 130.66±0.94 to 231.66±1.24 mg/l with an average of 180.09±6.10 mg/l. It was minimum in the month of July and maximum in May. According to Wilcox (1955), the water with TDS values less than 500 mg/l is considered good. Therefore, the water of this reservoir is suitable for drinking as well as irrigation purpose.

Nitrogen:

Nitrogen is generally considered as the primary limiting nutrient for phytoplankton biomass accumulation (Rabalais, 2002). Monthly variation in Nitrogen values ranged from 00 to 1.19±0.73 mg/l with an average of 0.35±0.11 mg/l. it was totally absent in the month of September, October, November, December, January and February. It was higher in the month of July. The total nitrogen increased during monsoon season is due to agricultural runoff with rich source of nitrogen applied as fertilizer.

Phosphorous:

Inorganic phosphorus or orthophosphate plays dynamic role in water bodies as it is taken up by phytoplankton. Weathering of phosphorus bearing rocks, leaching of the soils around the catchment area by rain, cottar dung and soils are the sources of phosphorus in natural water (Jhingram, 1982). The value of phosphorus ranged from 00 to 1.14±0.001 mg/l with an average of 0.05±0.06 mg/l. It was totally absent in the month of September, November, December, January, February, March, April and May. It was higher into month of August.

Dissolved oxygen:

Dissolved oxygen is important factor that supports aquatic life. Diffusion of oxygen from air into water through photosynthesis and consumption by biota, all affects the solubility and availability of many nutrients and therefore affecting productivity of aquatic ecosystems (Wetzel, 1983). Variation in dissolved oxygen ranged from 5.81±0.18 to 10.81±0.19 mg/l with an average of 8.30±0.02 mg/l. It was minimum in the month of April and May while maximum in the month of November.

Biological dissolved oxygen:

BOD is the amount of oxygen required by the organisms engaged in the utilization and ultimate destruction or stabilization of organic matter. The level of BOD ranged from 1.49±0.19 to 6.89±0.33 mg/l with an average of 4.48±0.012 mg/l. It was decreased in the month of July while increased in May.

Correlation analysis:

Correlation matrix for Kadagaon water reservoir is expressed in Table 3. The results showed that water temperature positively correlated with turbidity, pH and chlorides. It has negative correlation with EC, total alkalinity and total hardness, significantly negative correlation with transparency and high level negative correlation with dissolved oxygen. Transparency positively correlated with pH, total alkalinity and total hardness while highly significant positive correlation with DO while negatively correlated with turbidity, EC and chlorides. Turbidity negatively correlated with pH, EC, total alkalinity, total hardness, chlorides and DO. pH has positive correlation with total alkalinity and high level positive correlation with total hardness and chlorides. It was negatively correlated with DO. Electric conductivity positively correlated with total alkalinity and high level positive correlation was exhibited with total hardness and chlorides while negatively correlated with DO. Total alkalinity was positively correlated

with chlorides, DO and significantly positive correlation with total hardness. Total hardness positively correlated with chlorides and negatively correlated with DO while chlorides also negatively correlated with DO.

Conclusion

The study suggests the good status of water quality. The water of this reservoir is found to be suitable for drinking, agricultural and fishing.

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Plate 1: Google map of Kadagaon water reservoir

Plate 2: GPS map of Kadagaon water reservoir

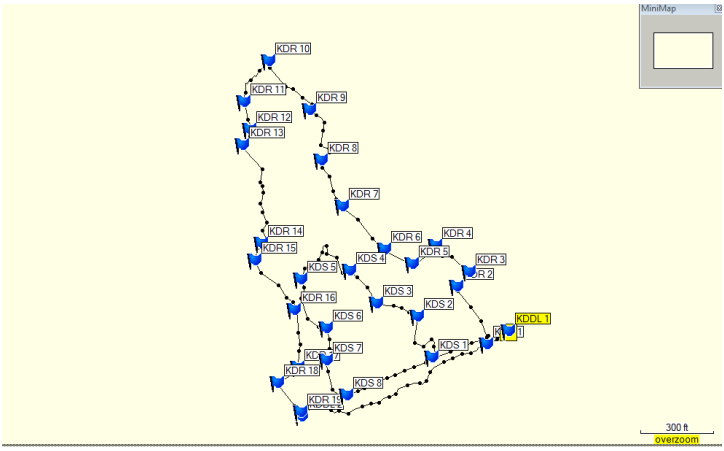

Table 1: Morphometric features of Kadagaon water reservoirs.

Parameters	**Kadagaon**
Latitude	16⁰ 15' 221"
Longitude	74⁰ 18 122"
Type of stream	Local
Year of completion	1996
Top bund level (m)	52
MWL (m)	NA
FSL in (m)	NA
Silt level (m)	NA
Storage capacity (Cu.M)	NA
ICA (ha)	NA
Height of dam (m)	17.27
Length of dam (m)	174
Catchment area (sq. km)	0.32

Submergence area (ha)	3.25
Actual submergence area by GPS (ha)	6.15
Ecological status	Perennial

Table 2: Physico-chemical parameters of Kadagaon water reservoir

Parameters	Minimum	Maximum	Average
AT	22	35	31.10
WT	20	29	29.10
Transparency	24±1.63	68.66±2.49	47.45±2.10
Turbidity	0.61±0.008	40.23±0.94	11.36±0.8
pH	7.71±0.012	8.22±0.024	7.45±0.125
EC	0.23±0.002	0.364±0.002	0.322±0.005
Free CO2	0	26.40±2.07	7.21±0.00
TA	142±1.63	191.33±3.39	171.70±2.14
TH	99.66±1.24	170.66±0.94	147.47±3.33
Calcium	26.39±0.37	48.38±0.75	36.69±0.70
Magnesium	17.67±0.37	32.63±0.30	26.22±0.28
Chlorides	16.09±1.33	77.62±1.33	37.80±0.94
TDS	130.66±0.94	231.66±1.24	180.09±6.10
Nitrogen	0	1.19±0.73	0.35±0.11
Phosphrous	0	1.14±0.01	0.05±0.06
DO	5.81±0.18	10.81±0.19	8.30±0.02
BOD	1.49±0.19	6.89±0.33	4.48±0.012

Note: All values are in mg L^{-1}, except temperature (^0C), transparency (cm), turbidity (NTU), pH and E.C. (mhos cm^{-1})

Table 3: Correlation matrix of physico-chemical parameters for Kadagaon water reservoir

	WT	Transparency	Turbidity	pH	EC	TA	TH	Calcium	Magnesium	Chlorides	DO
WT	1										
Transparency	-0.654*	1									
Turbidity	0.195	-0.263	1								
pH	0.029	0.044	-0.419	1							
EC	-0.039	-0.112	-0.189	0.738**	1						
TA	-0.563	0.532	-0.354	0.2	0.398	1					
TH	-0.302	0.289	-0.427	0.682*	0.832**	0.684*	1				
Calcium	0.055	0.106	-0.44	0.678*	0.813**	0.412	0.827**	1			
Magnesium	-0.411	0.334	-0.368	0.618*	0.761**	0.735**	0.973**	0.676*	1		
Chlorides	0.366	-0.377	-0.381	0.738**	0.734**	0.215	0.651*	0.722**	0.558	1	
DO	-0.763**	0.767**	-0.159	-0.303	-0.272	0.405	-0.022	-0.101	0.006	-0.603*	1