

Physico-chemical profile of historical Ramala Water Reservoir of Chandrapur Maharashtra

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Abstract

Ramala water reservoir is located in the heart of Chandrapur city constructed by Gond king around 600 years back with the purpose to provide water to the citizens for various uses. However, at present, the condition of this reservoir is much pathetic which leads not only to the death of the fishes but the posing threat to the citizens' health. Therefore, the present work was carried out to find out the physico-chemical perspective of this lake. This study is experimental in nature. The Ramala water reservoir was the subject of study. The water samples were collected once in the middle of the month from November 2020 to March 2021. Almost all parameters except phosphate and nitrate were shown to contain under the permissible limit and indicate water may be consumed. The boom in aquatic vegetation is observed due to a high degree of eutrophication. It has been concluded through the study that the water under study is useful for human consumption and also for fisheries.

Keywords: Eutrophication; physico-chemical; pollution; water; WQI.

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1. Introduction

Water is an indispensable source of nature and is present in various states. About 71 percent of the earth's surface is covered with water (Issac & Kandasubramanian, 2021). Of this only 0.3 to 0.5 percent is available to mankind in the form of fresh water and therefore it is very imperative to use it carefully. However, with the increasing rate of population water gets polluted due to industrialization, and excessive use of fertilizers, pesticides, detergents, and plastics.

These days plastic pollution has been threatening the water-dwelling organism which finds their way in the form of nano-plastic into terrestrial organisms like a human being and other domestic and wild animals. Plastic which throws out indiscriminately finally causes soil, air, and water pollution. This plastic gets broken down into very fine particles even less than 200nm nano-plastic (Besseling, 2014; Lechner, 2014; Wagner, 2014).

The physico-chemical nature of water would thus affect the macro-plastic to get converted into nano-particle through the effect of temperature and light. This nano-plastic by entering into the living system and perhaps into cells may cause a dreadful effect that could be beyond our expectations.

The overall health of any aquatic body depends on many factors like climatic, geomorphological, geochemical, and pollution (Kumar *et al.*, 2001). Every aspect of aquatic organisms depends on the nature of water. The study of the physico-chemical nature of water enables us to find out whether the water is potable or can be used for aquaculture practices. For successful exploitation of water bodies for aquaculture, it needs to study the physico-chemical parameters that influence biological productivity in general.

1.1. Purpose of study

However, several studies are available on the limnological perspective of freshwater bodies in India (Kumar, 1995; Naganandini and Hosmani, 1998; Pandey *et al.*, 2000; Patil and Tijare, 2001; Gupta and Shukla, 2006). The present study was aimed at finding out whether this water is useful for human consumption and pisciculture or not.

2. Materials and Methods

2.1. Data

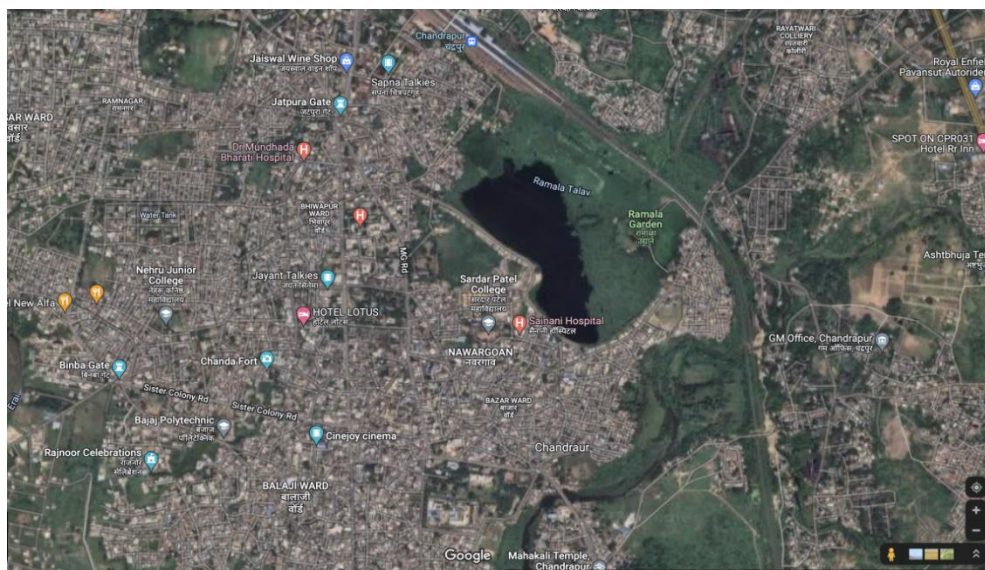
Ramala water reservoir located in the heart of Chandrapur city (Fig.1) 19°57'16.3"N 79°17'19.5"E. The water samples were collected once in the middle of the month from November 2020 to March 2021. The sampling and analysis of various physico-chemical parameters were done following the standard procedures of Trivedi and Goel (1986) and APHA (4). The experimental results were compared to the permissible limit of drinking and irrigation water quality standards (BIS, 1991).

2.1. Analysis

In the present study, fifteen parameters were considered (Water temperature, pH, acidity, total alkalinity, free CO₂, Dissolved Oxygen (D.O.), B.O.D. (Biochemical Oxygen Demand), Chloride, Sulphate, Phosphate, Nitrate, Calcium, Magnesium, and total hardness. Calculation of entire data was carried out by using the WPS Excel and for assessing the suitability of water consumption (WQI-water quality index) the method of Brown *et al.*, 1972 was used.

Figure

1 Google map indicating the location of Ramala lake in Chandrapur city



3. Results

Ramala water reservoir is a source of water exploited for fisheries. The variations in physico-chemical characteristics concerning the following parameters were analyzed in this study which is discussed as follows.

Temperature: Temperature affects the various physico-chemical parameters during the day as well as night and also the physiology and behaviors of all kinds of aquatic animals and plants. The water temperature of the Ramala reservoir was found minimum in November and maximum in January (Table-1 and Figure-1). The range of temperature obtained during the winter season seems to be suitable for fish survival and production as described by Das (1997) and Bhatnagar and Devi (2013).

pH: The pH is the hydrogen ion potential of water at a given temperature. According to the Bureau of Indian Standard (BIS), the permissible limit of pH of potable water is in the range of 6.5 to 8.5. However, the pH of water in the studied reservoir was in the range of 6.23 to 7.41. There is a slight variation in pH that incline towards acidity in some samples and alkaline in other may be due to the discharge of domestic waste by the people residing nearby the reservoir. Fish are suggested to have a blood pH of 7.4 (Gebremichael and Fantahun, 2019). Agbaire *et al.*, 2015 have reported that the pH range of 6.5 to 9 is good for fish production. (Table-1 and Figure-1). Thus, the pH of the Ramala reservoir is suitable for the growth and health of fish.

Acidity: Acidic water is not good for the health and survival of aquatic flora and fauna. Water becomes more acidic at night due to respiratory end production, carbon dioxide. Besides this heavy air pollution having acid-producing gas also lead a causes acid rainfall which drained water bodies and makes them acidic. The acidic content in the present study was found to be minimum in January and maximum in December (Table-1 & Figure-2)

Total Alkalinity: Ramala reservoir shows maximum total alkalinity of 76 mg/l in the month of January whereas the lowest (44 mg/l) in November. In the winter season, the total alkalinity remains in the

range of 44 to 76 mg/l and this is an acceptable range for human consumption according to the water quality standard of BIS 10500-2012.

Free Carbon Dioxide: Aquatic plants, animals, and microbes all contribute this parameter to the aquatic body through its respiratory. Free carbon dioxide in the water forms carbonic acid which dissociates and fluctuates the pH at various levels depending upon its concentration in water. In the present study free carbon dioxide was calculated to be 4.6 to 7.7 mg/l. However, the excessive carbon dioxide is lethal to fish and interferes with the growth of fish by decreasing the pH of a water body to acidic.

Dissolved Oxygen: Water gets oxygen through diffusion from the surrounded atmosphere and photosynthetic activities of aquatic plants. Kumar and Puri (2012) have mentioned oxygen levels above 13-14 mg/l can be harmful to aquatic life and its excessive amount may cause the death of fish due to gas bubble disease. However, Oli, 1990 suggested below 2.5 mg/l of dissolved oxygen is lethal to the fish commodity. And the low concentration of it amounts to organic pollution of the aquatic body (Verma and Agrawal, 1989). In the present study, we observed 3.7 to 6.4 mg/l from November 2020 to March 2021 and this level permits water for human consumption, and of course, it is also good for fish culture.

Biochemical Oxygen Demand: It is an amount of oxygen utilized by microbes in stabilizing organic matter of the water body and hence, it reflects the number of organic pollutants in water. The high value of BOD reflects the high level of pollution due to the higher number of microorganisms in the water body (Martin and Hine, 2000). BOD in the Ramala reservoir was recorded to be 1.4 mg/L to 4.6 mg/L. The minimum value was in January and the maximum in November. This level comes under permissible for human water consumption as it is less than 5.

Chloride: Chloride is present in form of salt. It is essential for maintaining the osmotic balance in fish, but the high chlorine content of water is lethal to fish fauna. Sources of chloride could be the domestic sewage of the city that comes to this reservoir is more or amounts. In the present study, the chloride was estimated to be 152 mg/l in December and the lowest in January. This concentration of chloride is not harmful to the fish culture. According to WHO (1971), this range of chloride in water is suitable for drinking purposes. Kumar and Puri (2012) reported that the public drinking water should not exceed 250mg/l. However, fish and aquatic organisms cannot withstand the high level of chlorides.

Sulphate: According to the Public Health Engineering Department (PHED) of the Government of Himalaya the permissible limit of sulphate in drinking water is 200 mg/l and the rejection level is 600 mg/l. In the present investigation, the Ramala reservoir was recorded to contain 83 to 117 mg/l of sulphate in February and March 2021 and this indicates the water is quite good for human consumption.

Phosphate: An increase in phosphate in water leads to heavy growth of algae and also the aquatic vegetation together with nitrate due to eutrophication. Environmental Protection Agency (EPA), 1986 suggested limit of phosphate in the reservoir should not be more than 0.024 mg/l. Ramala reservoir was recorded to have a range of 0.47 to 0.62 mg/l during the entire winter season (Table-1 and Figure-2).

Nitrate: Nitrate is a very important inorganic substance that needs to produce varieties of amino acids and nitrogen bases of genetic and non-genetic materials through metabolism in all sorts of organisms. The increased amount of nitrate is dangerous as it leads to excessive growth of aquatic plants in a water body. During the study period amount of nitrate was measured to be within permissible range as far as its human consumption is concerned. EPA, 1986 suggested 10 mg/l of nitrate in drinking water. In the present study, it was estimated to contain 59 to 73 mg/l through the entire winter season.

Calcium: The amount of calcium measured from November 2020 to March 2021 was in the range of 32.9 to 68.7 mg/l. This range is under the permissible limit for human consumption and also fish can also tolerate this much amount of calcium present in the water.

Magnesium: Permissible limit of magnesium in drinking water is 30 mg/l (PHED, Govt. of Meghalaya), and its rejected limit is 150 mg/l and above. The Ramala reservoir contains magnesium in the range of 28 mg/l to 45 mg/l an entire winter season. It can be concluded with respect to amount of magnesium level in the studied reservoir that can be used for human consumption as the rejection limit is 150 and above.

Total Hardness: Permissible limit of magnesium in drinking water is 200 mg/l (PHED, Govt. of Meghalaya) and according to Indian Standard (IS 10500-1991) desirable limit is 300 mg/l and the permissible limit is 600 mg/l. However, the total hardness of the Ramala reservoir was estimated to be 106 to 168 mg/l during the winter season from the month of November 2020 to March 2021.

WQI: The water quality index (WQI) suggests the consumability of water by a human. According to results obtained during the winter season from the month, of November 2020 to March 2021 was in the range of 93 to 180.9 and the range between 91 to 100 indicates the water is more suitable for human consumption. Thus, from the present investigation, we concluded that the water is fit for human consumption and also for fish culture in general.

Table 1

Physicochemical Profile of Ramala Reservoir of Chandrapur, Maharashtra through Winter Season from Nov-2020 to Mar-2021.

Parameters	Months of Winter Season in India				
	November	December	January	February	March
Water temperature	27.8	28.7	27	28.9	29.7
pH	6.51	6.23	7.18	7.41	6.38
Acidity (mg/l)	32.3	34.7	28.2	32.4	32.4
Total alkalinity (mg/l)	44	58	76	66	64
Free CO ₂ (mg/l)	4.6	5.2	7.7	4.8	6.2
D.O. (mg/l)	3.7	4.8	5.6	6.4	5.2
B.O.D. (mg/l)	4.6	4.3	1.4	1.7	2.3
Chloride (mg/l)	142	152	87	105	127
Sulphate (mg/l)	86	94	87	83	117
Phosphate (mg/l)	0.48	0.47	0.59	0.62	0.47
Nitrate (mg/l)	62	59	72	73	68

Calcium (mg/l)	63.2	68.7	54	63	32.9
Magnesium (mg/l)	42.8	33.2	45	42	28
Total hardness (mg/l)	106	128	112	144	168
WQI	159.6	180.9	115.67	93	128.29
Remark	Fit	Fit	Fit	Fit	Fit

Figure 2

Physiochemical profile of Ramala reservoir of Chandrapur, Maharashtra, through the winter season from November 2020 – March 2021

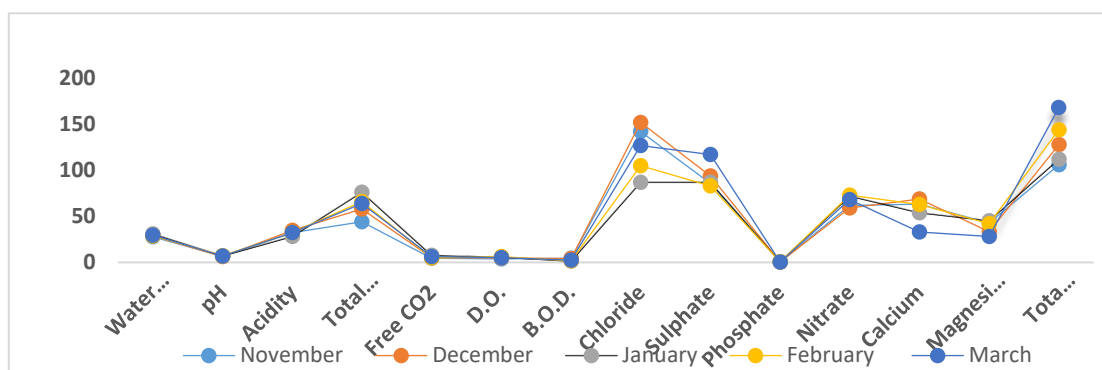
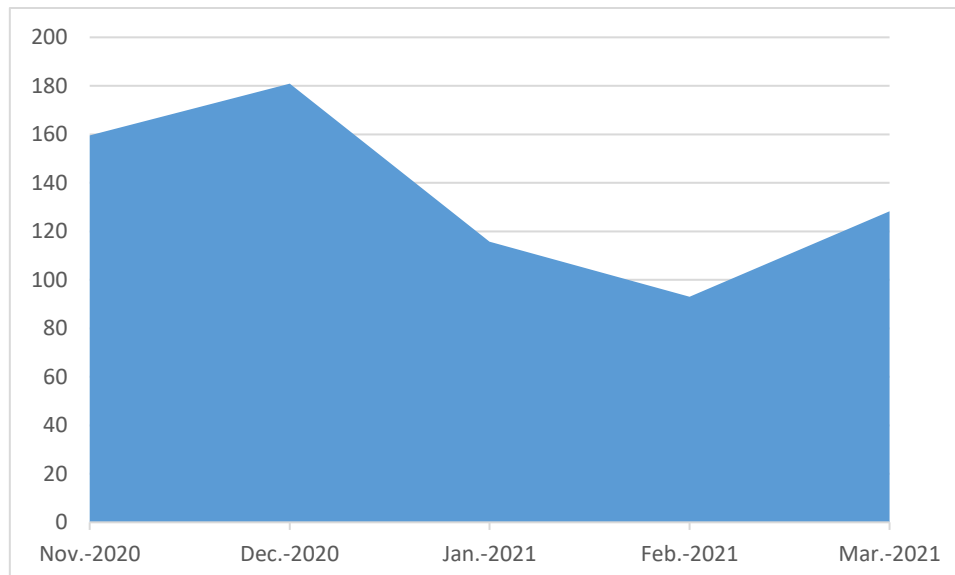


Figure 3

Water quality index (WQI), during months of water



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4. Conclusion

As per our study carried out from the months of November 2020 to March 2021 the quality of water was found to be suitable for human consumption because the calculated water quality index was greater than 100 except in the month of February 2021. The heavy growth of aquatic vegetation is due to eutrophication. Heavy aquatic vegetation in the ponds could prove lethal to fishes and hence reservoir needs extensive water treatment.

It has been observed that Ramala reservoir receives a domestic discharge and plastic waste from some part of the city which add pollutants to a water body, such practice should be not allowed by the people either or municipality.

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