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Study of characteristics of water and fish production in Umrar Dam of Umaria District (M.P.) India

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Abstract
Present study were carried out for physico-chemical parameters of water Umrar dam of Umaria district, Madhya Pradesh, India. The aim of the study was to establish the safety of water and fishes from the Lake. Different physico-chemical parameters such as pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Total Alkalinity (TA), Total Hardness (TH), Chloride (Cl), Nitrates (NO_3), Phosphate (PO_4), Turbidity and Total Dissolved Solids (TDS) of lake water were investigated during pre-monsoon, monsoon and post-monsoon period. The results on physico-chemical parameters of water and clearly indicate highly productive nature of the Umrar dam. The water quality parameters showed maximum values during pre-monsoon compared to rainy and winter seasons. It was inferred from the results of water quality and soil analysis that Umrar dam was productive in nature.

Keywords: Total Alkalinity (TA), Total Hardness (TH), Chloride (Cl), Total dissolved solid (TDS)

Introduction

India's inland water bodies are as diverse as they are plentiful. These are important source of food and also provide employment for the people of rural India. India is the second largest producer of Inland fishes. At present, about 80 % of inland fish produced in India is derived from aquaculture and 20 % from capture fisheries. In India water reservoirs have a rich and varied spectrum exceeding about 400 species. These made ecosystem offer enough scope for stock manipulation through ecological maneuverings paving the way for production hikes at relatively low capital investment. Majority of reservoirs in our country are not being scientifically managed, only some are half-heartedly managed or sometime even not managed too.

In limnological study the consideration of physico-chemical factors contribute in making up of the specific ecosystems, which determined the trophic dynamics of the water body. It is necessary to know the physico-chemical properties of water to study the culture practices of the fish in water bodies. The productivity of a water sheets depends primarily on the physico-chemical and biological characteristics of water. These properties again depend on the nature of bottom soil and climatic conditions. In India first ecological study on a dam was carried by Shukla and Shukla (2022) [1] on Mohan Ram Talab of Shahdol (M.P.).

The physico-chemical parameters of water like temperature, pH, electric conductivity, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total alkalinity, carbonates, bicarbonates, calcium, magnesium, hardness, chlorides, sulphates, nutrients like nitrates and phosphates, turbidity and total dissolved solids are important to know the trophic nature of the water body. Water bodies are generally of three types oligotrophic, mesotrophic and eutrophic. Usually mesotrophic water bodies are highly productive in nature.

In this study a perennial small water reservoir known as Umrar dam, which is the most disturbing reservoir is used for different purposes to analyze the effect of change of physico-chemical parameters on fish population distribution and for monitoring of the pollution status of this lake, however somehow lead to the better environmental management of fish production and help to save this water body.

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The present study was conducted in an Umrar dam. Umrar dam is an irrigation project situated near of Dadari Villages of Karkeli block of Umaria District. The project has an annual irrigation potential of 2429 ha, Culturable Command Area of 2313 ha and Gross Command Area of 3238 ha.

This is a medium Irrigation project, completed in the year 1979-1980. It is built across a local River called Umrar River under Ganga basin intercepting a catchment area of 60.22 km². The project comprises of homogeneous earth dam having the total length of main dam 995m with 1st subsidiary dam of 351m and 2nd subsidiary dam of 495.60m. The maximum height of the dam is 24.85 m. The spillway crest has an ogee shape. It is 140 m long. Its latitude is 80°-49'-05" N and longitude is 23°-29'-05''E. Itis located in Ganga Basin. The studies were conducted on physico-chemical parameters of water and soils in relation to fish production. The following physico-chemical parameters of water were analyzed to know the status of reservoir and its impact on fish production. The parameters were hydrogen ion concentration (pH), Dissolved Oxygen (DO), carbonates, bicarbonates, total alkalinity, calcium, magnesium, nitrates, phosphates, chlorides, sulphates, turbidity and dissolved solids. These parameters were analyzed thrice in a month for two years in selected stations of the reservoir. The average value was obtained for each month. The soil parameter such as pH, Electrical Conductivity (EC), nitrogen, phosphorous, potassium and organic matter were also analyzed.

Sampling Procedure

The water samples were collected in five stations of the reservoir and one liter of water was collected in a wide mouth polythene bottle and tightly stopper for subsequent physico-chemical analysis. Another bottle of the same capacity was similarly filled with surface water for biological analysis. Soil sample was collected from the same stations at a depth of one meter water level into a polythene container for the physico-chemical analysis. The methods adopted for the analysis of physico-chemical parameters are briefly described below.

Hydrogen ion concentration with the help of pH meter; Turbidity at 420 nm by using formazine polymer as turbidity standard for reference and expressed in formazine units; Total Solids (TS) estimated by evaporation of 50 cm³ aliquot at 105°C and desiccation of the revolve to constant weight, finally calculated as mg/cm³; Dissolved Solids (DS) a part of the sample was filtered through Whatman No 1 filter paper and 50 cm³ aliquot of filtrate was evaporated at 105°C and desiccated to constant weight and finally calculated as ppm;

Dissolved Oxygen (DO) was fixed in the field by winklerization and analyzed by titrimetry and finally expressed as mg/cm³ at ambient temperature; Carbonates and bicarbonates were estimated in 50 cm³ aliquot by acidimetry using phenolphthalein and methyl orange as indicators; Nitrate nitrogen estimated by phenol disulphonic acid method; Calcium determined by EDTA titration method using murexide as indicator; Magnesium measured by EDTA titration method using eriochrome/ solochrome black as an indicator; Phosphates measured by EDTA titration method and dissolved chloride content was estimated by argentimetry using potassium chromate as an indicator (Wilcox LV, Hatcher, 1950; APHA, 1995)[2, 3].

All the physico-chemical analysis were completed within 48 hours after the collection of the samples and all stipulated precautions were followed during the collection, storage, handling and processing so that the precision and accuracy were within the ranges prescribed by APHA (1995) [3], Golterman (1971) [4] and Neeri (1987) [5].

Results and Discussion
Physico-Chemical parameters of water
Study on various physico-chemical parameters in relation to fish production were analyzed in Umrar dam, 2020-2022, which are as follow

Hydrogenion Concentration (pH): The pH of water has significant role in survival of aquatic biota. The pH ranged from 7.8 to 8.4 and 8.0 to 8.5 during 2020-2021 and 2021-2022, respectively in the reservoir were observed. Post-monsoon season showed high pH. The mean pH recorded was 8.3 and 8.2 during 2020-2021 and 2021-2022, respectively (Table 1).

The functional stability of aquatic ecosystem depends upon the buffering capacity of water. This is reflected from the fluctuation of the hydrogen ion concentration brought about by the operational dynamics of CO_2, bicarbonates and carbonates. Most of the fresh water bodies are alkaline due to the above components. The productivity of inland water is good in a slight alkaline reaction with pH between 7.5 to 8.5 (Piska, 2000 and Piska et al. 2000 & 2004) [6-8].

The alkaline pH provides the growth to natural food organisms and increases the productivity and fish yield. Similar reports were made by Das and Nandi (2001) [9] observed that pH between 6.5 and 9.0 supports a good fishery. It has direct effect on fish growth as well as on the growth and survival of fish food organisms.

Table 1: Physico-chemical parameters of water of Umrar dam during 2020-21 & 2021-22

| Parameters	Season year 2020-21				Season year 2021-22				Grand mean
	Per-Monsoon	Monsoon	Post- Monsoon	Mean	Per-Monsoon	Monsoon	Post- Monsoon	Mean	
pH	8.4±0.4	7.8±0.6	8.1±0.6	8.83	8.5±0.6	7.9±0.3	8.2±0.5	8.2	8.5
EC (µS/cm⁻¹)	1470±118	1180±117	1290±120	1313	1420±102	1240±104	1380±100	1346	1329.5
DO (mg/cm³)	6.22±0.8	6.01±0.6	5.85±0.8	5.92	6.33±0.10	6.12±0.8	5.59±0.7	6.01	5.96
TA (mg/cm³)	158±82	90±75	114±82	114	158±10	97±8	121±12	128	121.3
TH (mg/cm³)	288±84	198±86	213±85	233	281±85	201±90	250±92	246	239.5
TDS (mg/cm³)	590±8.6	860±7.4	650±7.3	700.0	598±76	890±80	680±82	723	711
Turbidity (NTU)	19±2.6	27±2.8	21±2.5	23.65	21±2.9	26±2.12	24±2.8	23.66	22.33
Cl (mg/cm³)	345±8	228±32	310±40	294.33	371±52	241±60	312±56	308	301.0
NO₃ (mg/cm³)	35.8±4	20.3±6	27.6±2	27.9	36.1±8	22.4±6	28.4±4	28.9	28.4
PO₄ (mg/cm³)	8.58±0.6	5.10±0.2	6.94±0.5	6.86	8.27±0.8	5.00±0.5	6.98±0.6	6.75	6.80
pH = Hydrogen ion concentration EC = Electrical conductivity DO = Dissolve oxygen			TA = Total alkalinity TH = Total hardness TDS = Total dissolved solid			Cl = Chloride NO₃ = Nitrate PO₄ = Phosphate			
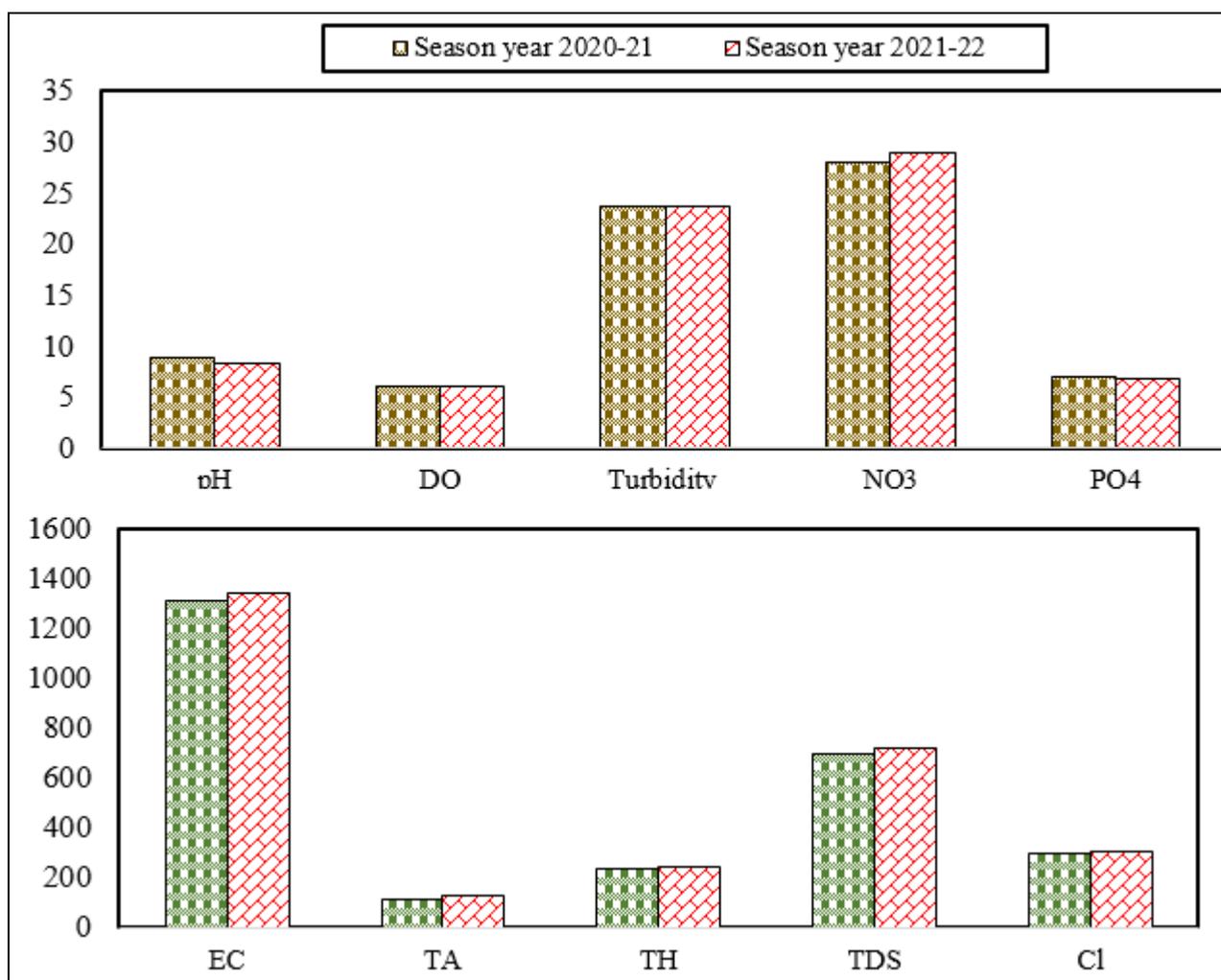
Fig 1: Graph analysis of average values of Physico-chemical parameters of water of Umrar dam during 2020-21 & 2021-22

pH is the most important factor in determining the reservoir productivity. The water pH is more or less a reflection of bottom soil. It has been revealed that less than 5 and more than 10 pH was lethal to fish. pH of water undergoes a diurnal change alkaline medium. In slight alkaline pH (7-8 pH) water was observed more suitable for fish life (Das and Nandi, 2001) [12].

Electric Conductivity (EC): The conductivity ranged from 1180 μS/cm to 1470 μS/cm and 1240 μS/cm to 1420 μS/cm was recorded during 2020-2021 and 2021-2022 respectively. The maximum conductivity was noticed in pre-monsoon period and minimum was in monsoon period (Table 1). It has been observed that EC between 20 and 1500 μs/cm is suitable for aquaculture. Higher value of EC occurred due to the decomposition of macrophytes, dead animal and evaporation. The conductivity of water depends on ions present in the water. The conductivity reflects the nutrient status of the water and distribution of macrophytes. Minimum conductivity may be due to dilution of water, caused by monsoon rains and utilization of ions by the living community of the reservoir. Higher values of conductivity was recorded, may be due to decomposition of macrophytes, dead animals present in the reservoir, evaporation and evapo-transpiration of the reservoir. Electrical conductivity has significant positive correlation with free carbon dioxide, bicarbonate, alkalinity, potassium and phosphate and negative correlation with dissolved oxygen carbonate alkalinity and nitrates.

Unni *et al*. (1998) [10], has reported that seasonal variation of conductivity showed maximum (4949 μS/cm) in summer of Tawa reservoir, Madhya Pradesh. The input of nutrient ions through thermal power effluents and its subsequent distribution and dilution resulted in the longitudinal decline of conductivity in the reservoir. Das (2000) [11] has studied the limno-chemistry of some important reservoirs of Andhra Pradesh and observed specific conductivity in the range of 316 to 610 μS/cm. The majority of Indian reservoirs have low values of specific conductivity.

Dissolved Oxygen: In the present investigation the highest value of dissolved oxygen was recorded in the premonsoon months (6.22 mg/cm³) during 2020-2021 and in the month of July (6.33 mg/cm³) during 2021-2022 respectively. The average values for the both years were 5.92 and 5.96 mg/cm³, respectively (Table 1), with over all mean of 5.96 ppm.
The lower values of dissolved oxygen in monsoon season and higher values in pre-monsoon were due to the surficial water of the reservoir during monsoon months, subjected to wind generated turbulence and resultant mixing of surface and surface water layers. Thus, in monsoon months, there establish oxygen equilibrium between the water and air. This is not disturbed by the vertical gradient of phytoplankton's or bacterial populations.
The pollution stress is increased in water bodies due to the enrichment of nutrients and decline of dissolved oxygen. The presence of pollutants like organic wastes caused rapid

depletion of dissolved oxygen. Substances like NH_3, nitrates, H_2S and oxidisable inorganic substances also decrease the dissolved oxygen in water (DAS and Srivastava, 2001) [12].

Das (2002) [13] studied the limino-chemistry of important reservoirs of Andhra Pradesh and stated that dissolved oxygen along with turbidity could provide information about the nature of an ecosystem better than any other chemical parameters. It has been observed that dissolved oxygen concentration more than 5 mg/l favors good growth of flora and fauna. Umrar dam being a polluted and highly eutrophic reservoir showed higher dissolved oxygen in pre-monsoon due to algal bloom.

Total alkalinity: Present study revealed that the concentrations of total alkalinity were observed higher in the pre-monsoon season in 2020-2021 and 2021-2022. The average values of alkalinity were found 114 mg/cm^3 in 2020-2021 and 128 ppm in 2021-2022 in the water of present reservoir. Low carbonate concentration was found in monsoon period in all cases. The values of alkalinity concentration of 90 mg/cm^3 in 2011-2012 and 97 ppm in 2021-2022 respectively were noted in dam (Table 1). The overall mean concentration was found to be 121.3 mg/cm^3 during the study period.

The alkalinity of the water is mainly due to carbonates, bicarbonates and partially hydroxides. Carbonates and bicarbonates along with free CO_2 and carbonic acid form four species of inorganic carbon of the fresh water carbonic system. Their interaction with water molecules results in the displacement of H^+ and OH^- ions and manifestation of a specific pH at which, the relative concentration of H_2CO_3, HCO_3^- and CO_3^{2-} were fixed (Piska *et al.* 2000 and Shrivastava NP (2005) [6, 14].

Total hardness: In the present study, the minimum total hardness was recorded in the monsoon (198 mg/cm^3 and 201 mg/cm^3) during 2020-2021 and 2021-2022. The maximum total hardness was recorded in the pre monsoon (207 mg/cm^3 and 281 mg/cm^3) during 2020-2021 and 2021-2022, respectively (Table 1).

The total hardness of water is caused by Ca and Mg ions present in water. Hardness could be temporary due to carbonates and bicarbonates or permanent due to sulphates and chlorides. Biologically temporary hardness plays a key role in buffering capacity, thus neutralizing the pH due to addition of acidic products. It has a great effect on biotic diversity of an ecosystem. Maximum values of the calcium and magnesium were found during pre-monsoon months (94 ppm; 101 ppm and 45.9 mg/cm^3; 50.3 mg/cm^3) during 2020-2021 and 2021-2022, respectively. Lowest values were found during monsoon months (21 mg/cm^3; 74 mg/cm^3 and 18.1 mg/cm^3; 19.2 mg/cm^3) during 2020-2021 and 2021-2022, respectively (Table 1).

The relative composition and concentration of the Cations in the aquatic ecosystem determines the water quality for different uses. The hardness is due to calcium and magnesium, which are bivalent ions. Calcium and magnesium cycle through biotic and abiotic components of the ecosystem. As a result ambient concentration is under the influence of the photosynthetic precipitation, biotic utilization and tropholyte release. Higher hardness values were recorded during summer. The lower values of calcium were found during winter and magnesium in monsoon months (Boyd, 1973) [15]. Swingle has suggested that total hardness of 50 mg/cm^3

CaCO$_3$ equivalent was the dividing line between soft and hard water (Swingle, 1968) [16]. He reported that the pond water having a hardness of 15 mg/cm^3 or above were satisfactory for growth of fish and do not require additional of lime.

Chlorides: The chloride content was found high during pre-monsoon months and low during monsoon months. The ranges of chlorides were found to be 228 mg/cm^3 to 345 mg/cm^3 and 241 mg/cm^3 to 371 mg/cm^3 during the study period (Table 1).

Natural water normally has a low chloride content compared to bicarbonates and sulphates. High chlorides indicate pollution from domestic sewage and industrial effluents. Chloride content above 250 mg/cm^3 makes water salty (Pulle and Khan, 2001) [17].

Nitrates: Maximum nitrates were found during pre-monsoon months in both cases. The highest value of nitrates were (35.8 mg/cm^3 and 36.1 mg/cm^3) found during 2020-2021 and 2021-2022 respectively (Table 1). The low values of nitrate were found in January (20.3 mg/ cm^3 and 22.4 mg/cm^3) in both the years.

Nitrate nitrogen in water of Indian reservoirs was found mostly in traces and seldom exceeds 0.5 mg/l (DAS, 2001)[18]. The major reservoirs have very low concentration of nitrogen and phosphorous (0.56 ppm) Das *et al.* (2001)[19]. The highly productive reservoir with nitrate range of 0.75 to 1.65 mg/cm^3 was noticed.

Phosphate: The values of phosphate were ranged from 5.10 ppm to 8.58 ppm during 2020-2021 and 5.00 mg/cm^3 to 8.27 mg/cm^3 during 2021-2022 (Table 2). High values of phosphates during pre-monsoon were due to reduced water level.

During monsoon period high values of phosphate were recorded. It was contributed by the surface run off and mixing with the influent water of the reservoir. Piska in Ibrahimbagh and Shathamraj reservoirs of Ranga Reddy district were also reported similar results (Piska, 2000 and Piska *et al.* 2000) [6, 7].

In the present observation the concentration ranges of the phosphates were agreeable with the opinion of Sugunan and Sinha (2000) [20] which were 7.235 ppm and indicate that the reservoir is under highly productive in nature. Ecologically phosphorous is often considered as the most critical single element in the maintenance of aquatic productivity. Large number of lakes and ponds gave the phosphorous fertility range as 0.00-0.02 mg/cm^3 (low productivity) 0.02-0.05 mg/cm^3 (fair productivity) 0.05-0.10 mg/cm^3 (good productivity above 0.2 mg/cm^3 as excessive (Yelavarthy, 2002) [21].

Turbidity: Maximum turbidity values were found during the monsoon period in all the cases during the study period. The mean turbidity values were found to be 23.65 NTU in 2020-2021 and 22.33 NTU in 2021-2022 respectively (Table 1). A remarkable change in the turbidity value was noticed with the onset of winter season. Minimum turbidity values were found in pre-monsoon period in both years. Post-monsoon average was found 19 NTU and 21 NTU during 2020-2021 and 2021-2022 respectively.

Water turbidity is mainly due to suspended inorganic substances like clay, silt, phytoplankton and zooplankton and sand grains (Piska, 1999) [22]. Reservoirs with clay bottom are

likely to have high turbidity. Turbidity reduces the sunlight penetration and photosynthesis, hence acts as a limiting actor. High turbidity reduces the dissolved oxygen in water. In less turbidity waters, the aquatic weed growth is more. In high turbid waters, the sand grains accumulate in the gills of fish and prawns, causing suffocation and excessive secretion of mucous.

In turbid waters, more light is scattered and absorbed rather than transmitted in straight lines. The light penetrates only to shallow depths. The lower layer of water, being devoid of photosynthetic plants and also being in close contact with the decaying organic matter, suffers from oxygen depletion, causing the death of fishes (Piska, 2000 and Piska *et al.* 2000) [6, 7].

Total dissolved solids: The total dissolved solids were maximum during pre-monsoon season during entire study period. These values were lowest during monsoon period. Highest values of total dissolved solids were 860 and 890 mg/cm^3 during 2020-2021 and 2021-2022 respectively (Table 1).

During the present study, minimum amount of dissolved solids have been observed in pre-monsoon when the water level comes down considerably due to evaporation. The increase in the concentration could be directly related to the surface area of the reservoir. Large amounts were due to run off water from attachment area. Aher *et al.* (2007) [23], reported that seasonal change in water quality parameters of Kagdipura swamp near Aurangabad were high due to the sewage. Salve and Hiware (2007) [24] studied the water quality parameters of Wamparakalpa reservoir Nagpur and reported alkaline nature of water and useful for drinking. Rao (2005) [25] and Rajashekar *et al.* (2007) [26], studied the water quality parameters of Nadergul reservoir and reported mesotrophic nature and water in useful for irrigation and fishing activities.

Conclusion
The study concludes that physicio-chemical parameters of water such as pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Total Alkalinity (TA), Total Hardness (TH), Chloride (Cl), Nitrates (NO$_3$), Phosphate (PO$_4$), Turbidity and Total Dissolved Solids (TDS) were suitable for fish culture.

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