Assessment of Water Quality of the Maniyad Reservoir of Parala Village, district Aurangabad: Suitability for Multipurpose Usage

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Research Article

Abstract:The main source to fulfill the enormous needs of water both for domestic and agricultural purposes is water under Earth. The increased demand on water resources in India as a result of progressive urbanization, socio-economic growth, agricultural activities and development of industries. The objective of this study was to evaluate water quality of the Maniyad Reservoir of the Maniyad River and assess its feasibility for multi-purpose usage. The Maniyad Reservoir is situated in the Aurangabad district of Maharashtra (India) and was constructed in 2003. Water samples were collected during monsoon, post-monsoon and pre-monsoon season of 2008 and 2009. Physico-chemical parameters analyses were carried out for pH, electrical conductivity, TDS, alkalinity, Ca, Mg, TH, Cl^-, Na and K. The reported data were in compliance with WHO, BIS guidelines and EEC directives. It is concluded that the reservoir water is fit for multipurpose uses, namely, drinking, domestic, irrigation, fisheries, livestock, recreational activities and industrial, and should be properly managed accordingly.

Key wards: Physico-chemical parameter, Maniyad Reservoir, water chemistry, Parala Village, Aurangabad

Introduction:

The Maniyad Reservoir is a reservoir, constructed on the Maniyad river, near village Parala, Taluka Vaijapur, Dist. Aurangabad, Maharashtra. It was constructed in 2003. The water from the reservoir is utilized for irrigation and domestic purpose as well as for pisciculture. However, as basic data on the water quality of the reservoir is not available and to bridge this gap present investigation was undertaken during the year 2008 and 2009. The main purpose was to gain a basic knowledge of the of Maniyad Reservoir for the enhancement. Geologically study area is covered by the Deccan Trap lava flows of upper Cretaceous to lower Eocene age and the basaltic lava flows belonging to the Deccan Trap is the only major geological formation (CGWB, 2000, Deshpande & aher, 2009, 2011).

Materials and Methods:

The physico chemical parameters of water were analyzed to know the status of reservoir. In the present study analysis of the geochemical characteristic of water to assess its suitability for domestic and irrigation purposes has been done. Samples collected in the month of April (pre-monsoon), July (monsoon) and October (post monsoon).

Water quality parameters such as pH and electrical conductivity (EC) were analyzed immediately (APHA, 1985). Other parameters were later analyzed in the laboratories of P.G. Department of Geology, Govt. Institute of Science. Total dissolved solids (TDS) were computed by multiplying the electrical conductivity (EC) by a factor (0.64). Total hardness (TH) as $CaCO_3$ and calcium (Ca) were analyzed titrimetrically, using standard EDTA. Magnesium (Mg) was calculated by taking the differential value between total hardness (TH) and calcium (Ca) concentrations. Chloride (Cl)) was determined titrimetrically by standard

$AgNO_3$ titration. The content of Sodium (Na) and Potassium (K) in groundwater was estimated flame photometrically, employing Elico Flame Photometer. All parameters are expressed in milligrams per litre (mg/l) and milliequivalents per litre (meq/l), except pH (units) and electrical conductivity (EC). The electrical conductivity (EC) is expressed in micromhos per centimetre (lS/cm) at 25^0C.

Results and Discussion:

The seasonal variations of the water quality in the reservoir are present in Table 1.

pH

The pH of the water, which is a measure of effective hydrogen ion activity, pH value is defined as a negative logarithm of hydrogen ion concentration, more precisely of hydrogen ion activity in moles per liter. It is a quantitative expression for acidity or alkalinity of water. Most of the biological processes and biochemical reactions are pH dependent. The pH of water ranged between 7.6 to 8.2 and 7.7 to 8.3 during the year 2008, 2009 respectively indicating alkaline nature of the reservoir water (Table 1).

Electrical Conductivity (EC)

Electrical current is the ability of an object to conduct electric current. It depends upon the presence of various ionic species in the water. The Electrical Conductivity **(**EC) of water ranged between 230 to 330 micro mhos/cm during 2008 and 233 to 350 micro mhos/cm during 2009 (Table 1). In the present study the EC values were within limits of WHO (1984) and BIS (1998).

Total dissolved solids (TDS)

In natural water dissolved solids are composed of carbonates, bicarbonates, chlorides, sulphate and phosphate. Concentrations of dissolved solids are important parameter in drinking water. The total dissolved solids (TDS) indicate the general nature of salinity of water. The total dissolved solids (TDS) ranged between 149.5 to 214mg/l in 2008 and 151.45 to 227.5 mg/l in 2009 (Table 1) and all are within the permissible limit prescribed by WHO (1984) and BIS (1998).

Calcium (Ca)

Calcium is the major constituent of most igneous rock, metamorphic and sedimentary rocks. The principal sources of calcium in groundwater are some member of the silicate mineral group like plagioclase, pyroxene and amphibole among igneous and metamorphic rocks, and limestone, dolomite and gypsum among sedimentary rocks. The ranges of calcium in the reservoir were from 72 to 110 mg/l in 2008 and 74 to 119 mg/l in 2009 (Table 1), calcium was within the permissible limits of WHO (1984) and BIS (1998). The main source of calcium in natural water is leaching of rocks in the catchment (Rajeshekhar, 2007).

Magnesium (Mg)

Magnesium is an important component of basic igneous rocks, in natural water magnesium occurs with calcium and the principal sources in the natural waters are various kinds of rocks. The magnesium value ranged between 162.98 to 216.13 mg/l during 2008 and 167.49 to 233.91 mg/l in 2009. Magnesium added to the reservoir, by leaching of rocks in the catchment. Very high concentration of magnesium imparts an unpleasant taste to the potable water (Piska, 2000).

Total Hardness (TH)

Hardness is an important criterion for determining the usability of water for domestic, drinking and many industrial supplies. Water hardness is the measure of the capacity of the water to react with soap. A total hardness value varies from 230 to 260 mg/l during 2008 and 240 to 279 mg/l during 2009 (Table 1) which may be due to presence of calcium and magnesium. All values of total hardness are within limits prescribed by WHO (1984) and BIS (1998).

Chloride (Cl)

Chloride ions are generally present in natural waters and its presence can be attributed to dissolution of salts. The chloride content in study area has shown variation from 80 to 86 during 2008 mg/l and in 2009 it varies from 82 to 88 mg/l (Table 1). All values of chloride are within limit prescribed by WHO (1984) and BIS (1998).

Bicarbonate alkalinity (HCO_3)

The alkalinity of natural waters is due to salts of carbonate, bicarbonates, borates, silicates and phosphates along with hydroxyl ions in free State. The primary source of carbonate and bicarbonate ions in groundwater is the dissolves carbon dioxide; water charged with carbon dioxide dissolves carbonate minerals, as it passes through soil and rocks, to give bicarbonates. The bicarbonate alkalinity varies from 145 to 170 mg/l in 2008 and 142 to 171 mg/l in 2009 (Table1). Natural water with high alkalinity is generally rich in phytoplankton and is considered as conductive for fish production (Piska, 2000).

Sodium (Na)

Sodium is the sixth most abundant element in The Earth's crust and sodium stems from rocks and soils. Not only seas, but also rivers and lakes contain significant amounts of sodium. The Sodium content shown variation from 20 to 24 mg/l during 2008 and 22 to 24 mg/l in 2009 (Table 1) and all values are within maximum permissible limit prescribed by WHO (1984) and BIS (1998).

Potassium (K)

The main sources of potassium in ground water include rain water, weathering of potash silicate minerals, use of potash fertilizers and use of surface water for irrigation. The potassium content shown variation from 8 to 10 mg/l during 2008 and 9 to 10 mg/l in 2009. The European Economic Community (EEC) has prescribed the guideline level of potassium at 10 mg/l in drinking water. As per European Economic Community (EEC) criteria and all values of reservoir fall within the guideline level of 10 mg/l.

Sodium adsorption ratio (SAR)

The sodium adsorption ratio (SAR) indicates the effect of relative cation concentration on sodium accumulation in the soil.
Sodium adsorption ration (SAR) is calculated using the following formula:
$SAR = [Na^+] / \{([Ca^{2+}] + [Mg^{2+}]) / 2\}^{1/2}$
Ions are expressed as milliequivalents per liter (meq/l).
The water having SAR less than or equal to 10 are said to be excellent quality, 10-18 are good, 18 to 26 are fair and about 26 are said to be unsuitable for irrigation (USDA, 1954). Sodium adsorption ratios for water samples of the reservoir are less than 10 indicate excellent quality for irrigation.

Kelley's Ratio (KR)
Sodium measured against Ca^{2+} and Mg^{2+} is used to calculate Kelley's ratio (Kelly, 1940). The formula used in the estimation of Kelley's ratio is expressed as,
Kelley's Ratio (KR) = $Na^+ / Ca^{2+} + Mg^{2+}$
A Kelley's Ratio (KR) of more than one indicates an excess level of sodium in waters. Hence, waters with a Kelley's Ratio less than one are suitable for irrigation, while those with a ratio more than one are unsuitable for irrigation. Based on Kelley's Ratio (KR) values, all values less than 1 and are suitable for irrigation (Table 1).

Soluble sodium percent (SSP)

The Soluble sodium percent (SSP) for groundwater was calculated by the formula,

$$SSP = \left[NA^+ / \left(Ca^{2+} + Mg^{2+} + Na^+\right)\right] \times 100$$

Where the concentrations of Ca^{2+}, Mg^{2+} and Na^+ are expressed in milliequivalents per liter (epm). The Soluble Sodium Percent (SSP) values less than 50 or equal to 50 indicates good quality water and if it is more than 50 indicates the unsuitable water quality for irrigation. Based on Soluble Sodium Percent (SSP) values, all values

less than 50 and indicates good quality water (Table 1).

Residual sodium carbonate (RSC)

Residual sodium carbonate (RSC) was calculated by the formula (Eaton 1950).

$$RSC = (HCO_3^- + CO_3^{2-}) - (Ca^{2+} + Mg^{2+})$$

Groundwater having less than 1.25 or equal to 1.25 epm of Residual sodium carbonate (RSC) is safe water for irrigation purpose, water is having less than 1.25 to 2.5 epm of Residual sodium carbonate **(**RSC) is marginally suitable for irrigation purpose whereas water having more than 2.5 epm of Residual sodium carbonate **(**RSC) is not suitable for irrigation purposes. Based on Residual sodium carbonate **(**RSC) values, all values less than 1.25 and were safe for irrigation (Table 1).

Conclusion:

Based on present investigation it is concluded that the reservoir water is fit for multipurpose uses, namely, drinking, domestic, recreational activities, irrigation, fisheries, livestock and industrial, and should be properly managed accordingly.

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Table [1] Seasonal fluctuations of water quality parameters in the reservoir

Seasons	pH	EC	TDS	Ca	Mg	TH	Cl	HCO3	Na	K	SAR	KR	SSP	RSC
2008														
Monsoon	7.6	300	195	80.16	191.16	240	86	150	20	8	0.2772	0.0442	4.2322	-17.21
Post-monsoon	7.9	230	149.5	72	216.13	260	80	170	24	10	0.3196	0.049	4.6669	-18.52
Pre-monsoon	8.2	330	214.5	110	162.98	230	84	145	23	10	0.3257	0.053	5.0355	-16.482
Minimum	7.60	230.00	149.50	72.00	162.98	230.00	80.00	145.00	20.00	8	0.28	0.04	4.23	-18.53
Maximum	8.20	330.00	214.50	110.00	216.13	260.00	86.00	170.00	24.00	10	0.33	0.05	5.04	-16.48
Average	7.83	284.00	184.60	88.83	189.88	244.00	83.20	156.00	22.20	9.20	0.31	0.05	4.64	-17.45
2009														
Monsoon	7.7	310	201.5	88	196.38	250	88	155	22	9	0.299	0.047	4.459	-17.956
Post-monsoon	7.9	233	151.45	74	233.91	279	82	171	24	10	0.309	0.046	4.363	-20.07
Pre-monsoon	8.3	350	227.5	119	167.49	240	83	142	23	9	0.319	0.051	4.836	-17.351
Minimum	7.70	233.00	151.45	74.00	167.49	240.00	82.00	142.00	22.00	9	0.30	0.05	4.36	-20.07
Maximum	8.30	350.00	227.50	119.00	233.91	279.00	88.00	171.00	24.00	10	0.32	0.05	4.84	-17.35
Average	7.98	295.20	191.88	94.80	199.84	257.60	84.60	156.20	23.00	9.40	0.31	0.05	4.57	-18.56