Analysis Of Trace Metals From Water Samples Of Siddheshwar Reservoir Near Hingoli District, Maharashtra

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Abstract: Different water samples were collected during the study period of July 2009 to June 2011 from Siddheshwar dam near Hingoli, Maharashtra, followed standard methods of sampling. Two different metals were estimated by using standard method. The observed values were compared with drinking water quality standards prescribed by WHO to assess the levels of trace metals in surface water of the selected study area. The water was found to be excessively contaminated with iron, invariably at both the sites which is alarming. The water was deficient of zinc which is a micronutrient. The statistical parameters such as mean, minimum, maximum, variance, standard deviation and correlation of coefficient were calculated. Correlation coefficient matrix among the parameters was calculated and correlations between various parameters were worked out.
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Key words: Heavy metals, Drinking water, Permissible limit, Siddheshwar dam.

1. Introduction

Surface water is an essential component of earth's hydrosphere and an indispensable part of all terrestrial ecosystems. Water is needed in all aspects of life. An adequate supply of water of suitable quality makes a major contribution to economic and social development. However, many parts of the world are facing the pollution of fresh water. Humans have been polluting their water since civilization began leading to problems of scarcity and contaminations are becoming severe (Theoneste et. al., 2008).

The rate of water pollution of all types has increased much more as compared to other fields of pollution due to the discharge of all sorts of obnoxious matter into it.

Pollution of the healthy environment by heavy metals is a worldwide concern, because these metals are indestructible and most of them have toxic effects on living organisms, when they exceed a certain concentration (Harte et. al., 1991).

Heavy metals may occur naturally. As a result of normal earth phenomenon such as ore formation, weathering of rocks, leaching, or in the case of mercury, degassing may make these metals available to the biosphere. It may also occur as a result of human activities such as burning of fossil fuels, mining, smelting, discharging of industrial, agricultural, domestic wastes and deliberate environmental application of pesticides release more of these metals into the environment (Sadik, 1990).

Though some metals like Cu, Fe, Mn, Ni and Zn are essential as micronutrients for life processes in plants and microorganisms, other like Cd, Cr and Pb have no known physiological activity and have been proved detrimental beyond a certain limit (Marschner, 1995). Heavy metals are critical in this regard because of their easy uptake into the food chain and bioaccumulation processes (Beijer and Jernelov, 1986).

The pH of water determines the solubility and bioavailability of chemical constituents such as nutrients and heavy metals. The metals tend to be more toxic at lower pH because they are more soluble at acidic pH. Though an increase in pH levels may have no direct impact on aquatic life, they greatly influence the availability and solubility of all chemical forms in the water and this might aggravate nutrient problems leading to a destabilization of the ecosystem. Fortunately, the buffering capacity of surface water prevents major changes in pH (Eletta and Adekola, 2005).

Iron is fourth most abundant element, by weight, in the earth's crust. In natural waters, iron exists in either the reduced ferrous or the oxidized ferric states (Ussher et. al., 2004). The iron is naturally present in water, its other sources are earth crust, rocks, industrial and municipal wastes, metal dust, microbial activity and corrosion activity. It causes diseases like Haemochromatosis, Siderosis, taste, gastrointestinal bleeding, Pneumonities, convulsions, vomiting, jaundice, coma and promotes iron bacteria. The deficiency of iron causes anemia, weakness, malaise, apathy. Iron in domestic water supply stains laundry and porcelain (Saini, 2006).

The concentration of zinc in natural water is generally low. The carbonates, oxides and sulphides of zinc are sparingly soluble in water while the highly soluble chlorides and sulphides tend to form zinc hydroxide and zinc carbonate. It is toxic to plants at higher level. Also it causes cramps, disagreeable taste to water, Zinc fever (chills), nausea, oedema of lungs and renal damage to the human beings (Krishnamurthy and Vishwanathan, 1991).The sources of zinc in water are industrial wastes, metal plating, plumbing paints, galvanized iron pipes, varnishes, fixtures, electroplating, ventilators, etc.

The principal objective of the present study is to examine the pollution levels of Siddheshwar dam with respect to the most important heavy metals namely iron and zinc.

2. Study Area

Siddheshwar dam constructed on Purna river at Siddheshwar village in the Hingoli district of Maharashtra state. The river Purna, a tributary of Godavari river rises in the hills of Aurangabad district and after a winding course of about 250 miles, it joins Godavari below Purna railway junction. Siddheshwar dam serve as an important source of several benefits and facilities to the region of Hingoli, Parbhani and Nanded districts. It is situated at northern part of Marathwada region of Maharashtra. This has been selected for carrying out the present research work.

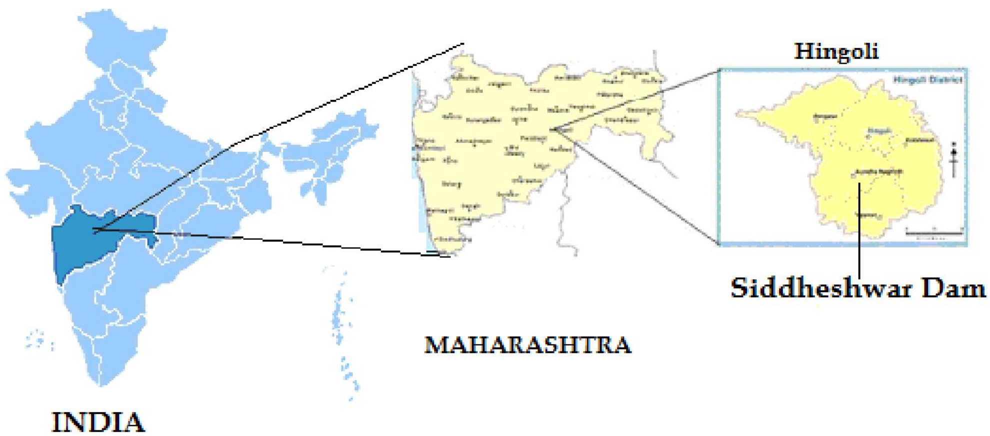

Figure 1. Location of Siddheshwar dam near Hingoli.

3. Material And Methods

The present investigation work has been undertaken for the systematic analysis of Iron and Zinc from this water reservoir. The water samples were collected from three sampling sites and named S_1, S_2 and S_3. The sampling site S_1 is near the gate of reservoir, S_2 is middle of dam and S_3 is near the pump house. The water sampling was carried out twice in a month. Water containers were cleaned properly before use. Water containers were cleaned properly before use. Water temperature measured by micro thermometer at the sampling sites only. The pH value of water sample under investigation was measured using digital pH meter. The iron and zinc were estimated by Thiocynate and Dithiozone methods respectively given in APHA (1998).

Correlation matrix for analysed water parameters were calculated to give introspection on the relationship among the parameters. Negative sign represents that the two variables do not have similar trend of variation where as positive value represents similar trend (Johnson, 1998).

The correlation coefficient between the variables X and Y is given by the well known relation

$$\text{Correlation coefficient (X,Y)} = \frac{\sum (X-\bar{X})(Y-\bar{Y})}{\sqrt{\sum (X_i-\bar{X})^2 \sum (Y-\bar{Y})^2}}$$

The Mean, Standard deviation and Variance are obtained by formulas as,

$$\text{Mean} = \frac{\sum x}{N}$$

$$\text{Standard daviation} = \sqrt{\frac{\sum (x - \bar{x})^2}{N-1}}$$

$$\text{Variance} = \frac{\sum (x - \bar{x})^2}{N-1}$$

In this formulas, $\bar{X}$ and $\bar{Y}$ are the values of the mean, N is the sample size and X and Y are two variables.

4. Result And Discussion

Table 1. The monthly mean values of iron and zinc concentration (mg/L) of Siddheshwar dam water during July 2009 to June 2010.

Months	Sampling Site	Temperature(^{0}C)	pH	Iron(mg/L)	Zinc(mg/L)
July	S_1	26.0	7.5	0.1	0.0
	S_2	26	7.5	0.15	0.0
	S_3	26.0	7.5	0.2	0.0
August	S_1	27.4	7.79	0.4	0.1
	S_2	26.9	7.66	0.3	1.05
	S_3	26.5	7.53	0.2	2.0
September	S_1	27.6	7.8	0.5	2.5
	S_2	27.5	7.75	0.35	2.25
	S_3	27.5	7.7	0.2	2.0
October	S_1	27.7	7.8	0.6	2.6
	S_2	27.6	7.8	0.4	2.6
	S_3	27.6	7.8	0.2	2.6
November	S_1	27.8	7.51	0.2	2.7
	S_2	27.9	7.52	0.25	2.7
	S_3	28.0	7.35	0.3	2.7
December	S_1	25.0	7.5	1.8	2.8
	S_2	25	7.4	1.47	2.85
	S_3	25.0	7.3	0.15	2.9
January	S_1	26.4	7.02	1.3	2.8
	S_2	26.3	7.01	1	2.85
	S_3	26.2	7.01	0.70	2.9
February	S_1	31.6	7.9	1.4	2.9
	S_2	31.7	7.9	1.1	2.95
	S_3	31.8	7.91	0.8	3.01
March	S_1	33.0	8.05	1.8	3.0
	S_2	33	8.06	1.7	3.05
	S_3	33.1	8.07	1.6	3.10
April	S_1	33.0	8.08	1.2	3.0
	S_2	33.1	8.09	1.3	3.05
	S_3	33.2	8.10	1.4	3.10
May	S_1	33.1	8.2	1.2	3.5
	S_2	33.1	8.2	1.3	3.55
	S_3	33.2	8.2	1.4	3.6
June	S_1	30.0	7.3	0	3.4
	S_2	30.0	7.3	0	3.45
	S_3	30.1	7.3	0	3.5
Mean	S_1	29.03333	7.704	0.875	2.158333
	S_2	29.00833	7.682	0.776667	2.529167
	S_3	28.96667	7.647	0.595833	2.325833
Minimum	S_1	25	7.02	0	0
	S_2	25	7.01	0	0
	S_3	25	7.01	0	0
Maximum	S_1	33.1	8.2	1.8	3.5
	S_2	33.1	8.2	1.7	3.55
	S_3	33.2	8.2	1.6	3.6
Standard Deviation	S_1	2.961674	0.346	0.64965	1.305553
	S_2	3.015553	0.354276	0.592366	1.023021
	S_3	3.118663	0.376	0.573846	1.175356
Variance	S_1	8.771515	0.120	0.422045	1.70447
	S_2	9.093561	0.125511	0.350897	1.046572
	S_3	9.726061	0.141	0.329299	1.381463

Table 2. The monthly mean values of iron and zinc concentrations (mg/L) of Siddheshwar dam water during July 2010 to June 2011.

Months	Sampling Site	Temperature(^{0}C)	pH	Iron (mg/L)	Zinc (mg/L)
July	S_1	24	7.4	0.0	0.0
	S_2	23.9	7.4	0.0	0.0
	S_3	23.9	7.4	0.0	0.0
August	S_1	24.8	7.7	0.0	0.0
	S_2	24.4	7.5	0.0	0.0
	S_3	24	7.3	0.0	0.0
September	S_1	25	7.8	0.0	0.8
	S_2	24.8	7.75	0.0	0.85
	S_3	24.7	7.7	0.0	0.9
October	S_1	25.1	7.1	1.0	0.9
	S_2	25	7.1	1.4	0.95
	S_3	25	7.1	1.0	1.0
November	S_1	25.2	7.2	1.6	3.8
	S_2	25.3	7.15	1.6	3.1
	S_3	25.5	7.1	1.8	2.1
December	S_1	24	7.57	1.2	2.9
	S_2	23.9	7.55	1.4	2.45
	S_3	23.8	7.53	1.6	2.0
January	S_1	24	6.99	0.4	3.0
	S_2	24.5	6.97	1.2	2.6
	S_3	25	6.95	1.3	2.2
February	S_1	26	8.04	1.2	3.10
	S_2	25.5	8.06	0.9	2.67
	S_3	25	8.08	0.6	2.25
March	S_1	25	8.12	1.0	3.2
	S_2	25	8.16	0.65	2.75
	S_3	25	8.2	0.3	2.3
April	S_1	26	8. 18	1.4	3.4
	S_2	26	8.19	1.5	2.9
	S_3	26	8.21	0.8	2.4
May	S_1	27	8.24	1.2	3.0
	S_2	26.5	8.25	0.9	2.5
	S_3	26	8.26	0.6	2.0
June	S_1	27	8.10	0.0	0.0
	S_2	26.5	8.07	0.0	0
	S_3	26	8.05	0.0	0.0
Mean	S_1	25.175	7.703	0.75	2.008333
	S_2	25.10833	7.669	0.795833	1.730833
	S_3	25.01667	7.656	0.666667	1.4625
Minimum	S_1	24	6.99	0	0
	S_2	23.9	6.97	0	0
	S_3	23.8	6.95	0	0
Maximum	S_1	27	8.24	1.6	3.8
	S_2	26.5	8.25	1.6	3.1
	S_3	26	8.26	1.8	2.4
Standard Deviation	S_1	0.94014	0.447	0.621582	1.475178
	S_2	0.892859	0.463768	0.647533	1.257685
	S_3	0.779083	0.488	0.647138	0.949615
Variance	S_1	0.883864	0.200	0.386364	2.300833
	S_2	0.797197	0.215081	0.419299	1.581772
	S_3	0.60697	0.239	0.418788	1.03142

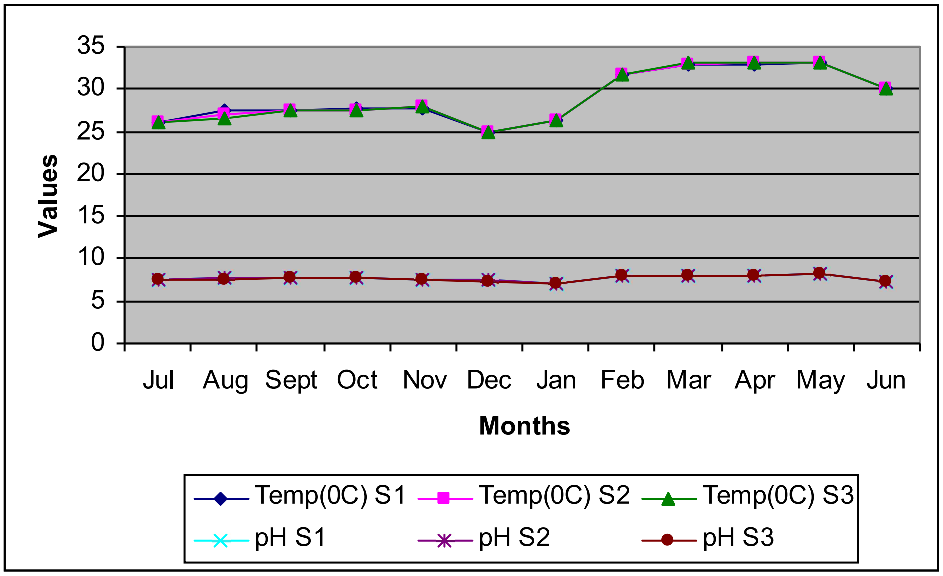

Figure 1. Monthly mean values of temperature and pH of Siddheshwar dam water during July 2009 to June 2010.

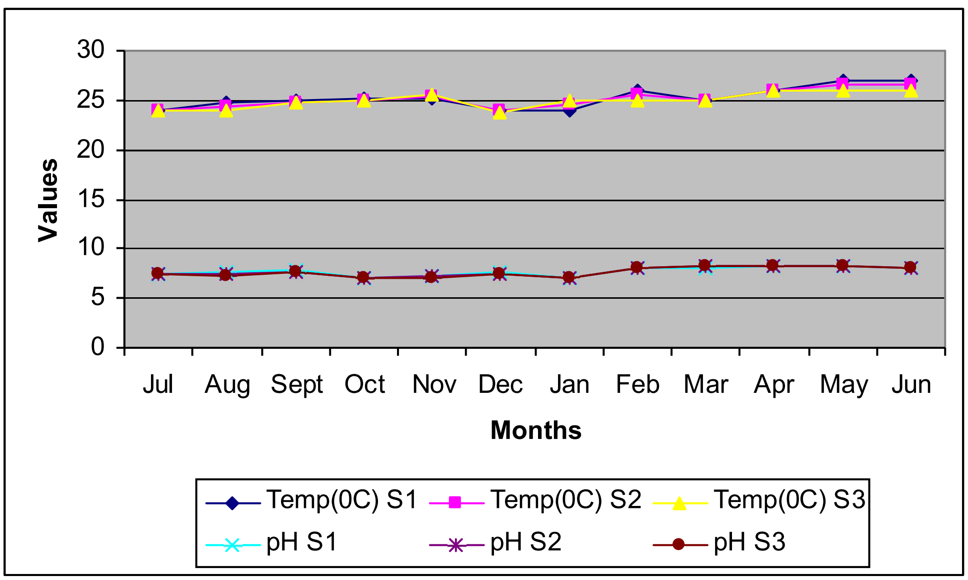

Figure 2. Monthly mean values of temperature and pH of Siddheshwar dam water during July 2010 to June 2011.

Table 3. Correlation coefficient matrix of analysed variables.

Variables	Temperature	pH	Iron	Zinc
Temperature	1			
pH	0.433429	1		
Iron	0.282714	0.090078	1	
Zinc	0.48142	0.151136	0.588061	1

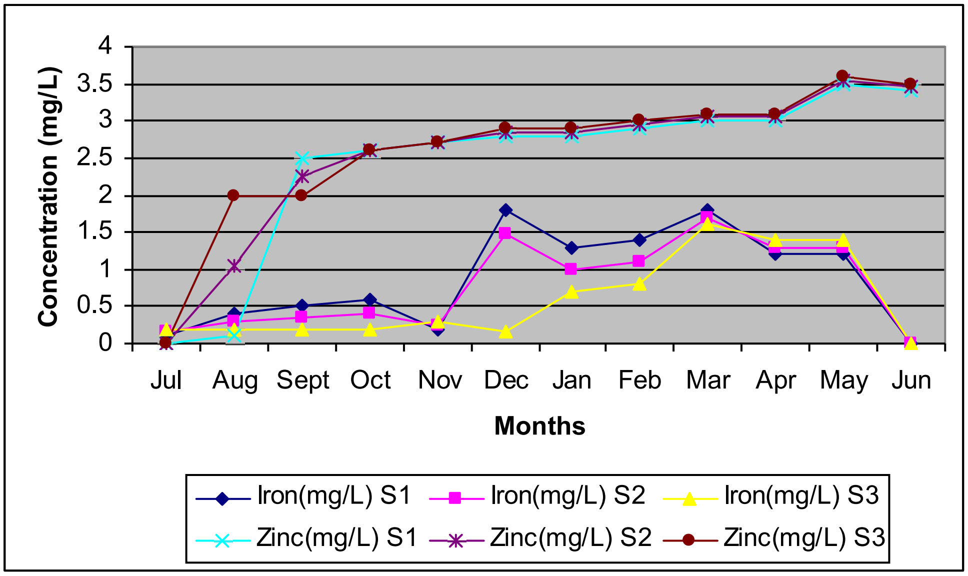

Figure 3. Monthly mean values of Iron and Zinc content of Siddheshwar dam water during July 2009 to June 2010.

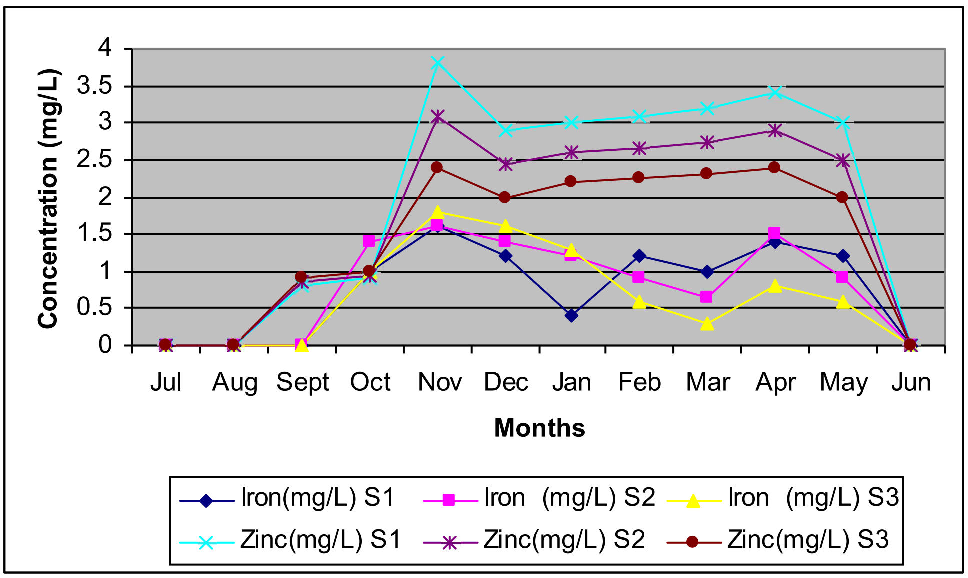

Figure 4. Monthly mean values of Iron and Zinc content of Siddheshwar dam water during July 2010 to June 2011.

The iron and zinc content with pH and temperature from Siddheshwar dam water is presented in table 1 and 2.

The highest temperature was 33.1^{0}C in the month May 2010 and lowest 25^{0}C in the month of December 2009 at sampling station-1. The sampling station-2 showed the maximum temperature 33.1^{0}C in the month of May 2010 and minimum 25^{0}C in the month of December 2009. The sampling station-3 showed the maximum temperature 33.2^{0}C in the month of May 2010 and minimum 25^{0}C in the month of December 2009. The highest temperature 27^{0}C in the month May 2010 and lowest 24^{0}C in the month of December 2009 at sampling station-1.The sampling station-2 showed the maximum temperature 26.5^{0}C in the month of May 2011 and minimum 23.9^{0}C in the month of December 2010. The sampling station-3 showed the maximum temperature 26^{0}C in the month of May 2011 and minimum 23.8^{0}C in the month of December 2010. The highest temperature found in summer and lowest in winter.

The highest pH 8.2 in the month of May 2010 and lowest 7.02 observed and noted in the month of January 2010 at sampling station-1. The sampling station-2 showed the maximum pH 8.2 in the month of May 2010 and minimum 7.01 in the month of January 2010.The sampling station-3 showed the maximum pH 8.35 in the month of May 2010 and minimum 7.01 in the month of January 2010. The highest pH was 8.24 in the month of May 2011 and lowest 6.99 in the month of January 2011 at sampling station-1. The sampling station-2 showed the maximum pH 8.25 in the month of May 2011 and minimum 6.97 in the month of January 2011. The sampling station-3 showed the maximum pH 8.26 in the month of May 2011 and minimum 6.95 in the month of January 2011. In present work the mean values of pH was observed within the permissible limit. The maximum pH values occur in summer season could be by low water level, uptake of CO_2 by the photosynthetic organisms like phytoplanktons, microorganisms or aquatic plants, formation of carbonates, bicarbonates and hydroxides. And the low pH may be due to decaying of organic matter.

The iron concentration in the month March of 2010 was found to be highest i.e. 1.8 mg/L and lowest 0.0 mg/L in the month of June 2010 at sampling station-1. The sampling station-2 showed the maximum 1.7 mg/L concentration in the month of March 2010 and minimum 0.0 mg/L in the month June of 2010.The sampling station-3 showed the maximum 1.6 mg/L concentration in the month of March 2010 and minimum 0.0 mg/L in the month June of 2010.The iron concentration was estimated highest 1.6 mg/L in the month of November 2010 and lowest 0.0 mg/L in the month of July, August, September of 2010 and June 2011 at sampling station-1.The sampling station-2 showed the maximum 1.6 mg/L concentration in the month of November 2010 and minimum 0.0 mg/L in the month of July, August, September of 2010 and June 2011 .The sampling station-3 showed the maximum 1.8 mg/L concentration in the month of November 2010 and minimum 0.0 mg/L in the month July, August, September of 2010 and June 2011. In the present work mean iron concentration was observed more than the permissible limit (0.3 mg/L) by WHO.

The zinc concentration in the month of May 2010 was found to be highest that is 3.5 mg/L and lowest 0.0 mg/L in the month of July 2009 and June 2010 at sampling station-1. The sampling station-2 showed the maximum 3.55 mg/L concentration in the month of May 2010 and minimum 0.0 mg/L in the month of July 2009.The sampling station-3 showed the maximum 3.6 mg/L concentration in the month of May 2010 and minimum 0.0 mg/L in the month of July 2009 and June 2010 .The zinc concentration was estimated highest 3.8 mg/L in the month of November 2010 and lowest 0.0 mg/L in the month of July, August 2010 and June 2011 at sampling station-1. In the sampling station-2, the concentration was recorded maximum 3.1 mg/L in the month of November 2010 and minimum 0.0 mg/L in the month of July, August 2010 and June 2011 .In the sampling station-3, the concentration was recorded maximum 2.4 mg/L in the month of November 2010 and minimum 0.0 mg/L in the month of July, August 2010 and June 2011. All the values of two water samples during present work were found below the maximum permissible limit (WHO, 2004).

The high content of iron may be due to the leaching from surrounding red soil or surface runoff or oxygen concentrations at water-sediment interface often approach a zero in summer. The reduction of oxygen causes the reduction of Fe^{3+} to soluble Fe^{2+}, which is then transported upward in the water column. The oxygenated water results in reoxidation to the insoluble Fe^{2+}, which settles to the bottom to repeat the cycle (Ramesh and Anbu, 1996). The low iron concentration is due to dilution by rainwater. The maximum values of zinc in water may be due to summer season, immersion of idols and minimum due to addition of rainwater in monsoon season.

Both the metals iron and zinc showed variations among the entire study period. Their concentrations are minimum in monsoon and maximum in summer seasons. The mean values of iron are 0.812, 0.786 and 0.631 mg/L in sampling site S_1, S_2 and S_3 respectively. The average zinc content are 2.08, 2.13 and 1.89 mg/L in sampling site S_1, S_2 and S_3 during study period respectively. In summary, sampling site S_1 having greater values of iron than site S_2, and S_3.

The values of analysed water parameters with the mean, minimum, maximum, standard deviation, variance and correlation coefficient were shown in tables. The iron and zinc shows highest correlation coefficient 0.588061 among all other parameters. The correlation coefficient for analysed parameters of reservoir water is showed in table 3.

Bhosle and Wavde (2009) investigated the iron metal concentration ranged from 1.30-5.63 mg/L, 0.63-2.35 mg/L and 0.60-1.91 mg/L from upstream, midstream and downstream site of Godavari river at Nanded, Maharashtra during July 2005-June 2006 respectively.

Gautam et. al. (2011) detected iron 0.426 to 1.48 mg/L and 0.186 to 1.456 mg/L in Kagina river at Gulburga district during post and pre-monsoon seasons. Also they got iron ranged between 0.174 to 2.186 and 0.521 to 7.701 mg/L from Krishna river of Bagalkot district of Karnataka in post and pre-monsson seasons.

Ajibade et. al. (2008) studied water quality of aquatic media of Kainji Lake, National Park, Nigeria for two years 2005-06. The mean iron content in dry and wet seasons are 2.627 and 6.007 mg/L in 2005 respectively. Also the iron content 2.874 and 3.30 mg/L in dry and wet seasons in the year 2006 respectively from different selected sites of the river Oli, river Manyera, river Nuwanzurugi and river Poto.

Dhanalakshmi et. al. (2008) found iron concentration minimum 3.15 mg/L to maximum 4.05 mg/L from Sulur pond at Coimbatore, Tamilnadu during October 2001 to Septmber 2002, the highest iron concentration due to washing of vehicles.

Mane et.al. (2010) observed zinc level content varied from 4.1 – 6.15 mg/L from Yeoti lake, Mohol, Maharashtra during the study period of June 2009 to May 2010.

Sinha (2004) found zinc concentration varied between 0.090 to 5.050 mg/L and 0.090 to 5.0 mg/L from pre-monsoon and after onset of monsoon period in different sites of Sai river at Raibareli, India respectively. This zinc deficiency might hamper the growth of algae and cause problems of metalloenzyme synthesis.

Obasohan (2008) recorded highest mean zinc concentration of 1.02 mg/L and lowest 0.85 mg/L from upstream and downstream locations of Ibiekuma stream, Ekpoma, Nigeria respectively in wet season. Also the zinc concentrations 1.12 mg/L at upstream and 1.05 mg/L at downstream were recorded in dry season.

Ubalua et. al. (2007) observed zinc concentration ranged from 3.80 – 6.80 µg/L and 364 – 6.48 µg/L from dry and rainy seasons respectively. They observed an average zinc content 4.82 µg/L from Aba river, Nigeria This study was carried out by Ubalua et. al. (2007). The Cr was absent in maximum number of samples in dry, rainy seasons in water samples.

5. Conclusion

From the observed results and discussion it may be concluded that variations occurred in metal contents from both the sites of Siddheshwar water reservoir during the study period. In the present work the mean values of pH was observed within the permissible limit. Also in this work mean iron concentration was observed more than the permissible limit (0.3 mg/L).All the values of zinc in water samples during present study were found below the maximum permissible limit (5.0 mg/L) prescribed by WHO.

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