International Research Journal of Environment Sciences ISSN 2319–1414
Vol. **2(6),** 31-38, June **(2013)** *Int. Res. J. Environment Sci.*

Preimpoundmental studies on Water Quality of Narmada River of India

Soni Virendra[1], Khwaja Salahuddin[2] and Visavadia Manish[1]
[1]Department of Zoology, Bahauddin Science College, Junagadh-362001, Gujarat, INDIA
[2*]Department of Botany, Bahauddin Science College, Junagadh-362001, Gujarat, INDIA

Available online at: www.isca.in
Received 20th April 2013, revised 1st May 2013, accepted 17th May 2013

Abstract

The present study revealed the effect of impoundment on the water quality of the Western part of river Narmada. Impoundment turned lentic ecosystem into lotic one which adversely disturbedphysicochemical characteristics of water like pH, TDS, total alkalinity, total hardness, chloride, DO and BOD.The present aim is to assess the Water Quality Index (WQI) of different study sites oflimnological significance of the river in 2012. Five different sites were singled out to ascertain the impact of impoundments on overall quality of water. The values of WQI have been observed in the range of 69 and 124 at S – 1 and S – 5 study sites, respectively. The site S – 5 indicated very poor water qualitywhich indicated that the physicochemical characteristics were under severe pressure. The deterioration in water quality from S–1 to S-5 was attributed to the impact of impoundment on the river as well as increasein anthropogenic activity.

Keywords: DO, BOD, impoundments *and WQI.*

Introduction

Water is most indispensable requirement for all living organisms and any alterationsin water may lead to the issue of survival for these organisms. Water maintainedby several physicochemical factors and any decrease or increase cause the deathof organisms as cited by Pritchard[1]. Water quality and therisk to waterborne diseases are critical public health concerns in many developingcountries today. The increasing anthropogenic pressure influences in recent years in and around aquatic systems and their catchment areas have contributed to a large extent to deterioration of water quality and dwindling of water bodies leading to their accelerated eutrophication as reported by Bhatt[2]. Good quality of water is essential for living organisms. The quality of water can be assessed by studying its physical and chemical characteristics as well as by plankton growing in it. Because of vast population and negligence of human being the quality of water is being deteriorated day by day. The limnology plays an important role in decision making process for problems like dam construction, pollution control, fish and aqua culture practice. Changes in the water quality affect the biotic community of the aquatic ecosystem which ultimately reduces the primary productivity as per Rossiter[3].

Water quality index is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water. The physicochemical characteristics like pH, BOD, dissolved oxygen, total alkalinity, total hardness, chloride contents etc. in one way or another has significant influence on aquatic life. Aquatic organisms are influenced by changing in water quality as reported by Chatterjee and Raziuddin[4]. Impoundmentactivities on aquatic ecosystems cause major disturbances of aquatic life.Several aquatic organisms are dwindling day by day so there is utmost need of application oriented limnological research so that we are able to utilize water resources to the fullest. There is large fluctuation of physicochemical factors before dam formation and after completion of dam as per Rao[5]. The blocking of a river and the formation of a lake significantly alters the ecological conditions of the river, which have changes in its physicochemical features like pH, total alkalinity, total hardness, TDS, chloride, dissolved oxygen and BOD. Some of the parameters showed significant changes resulting into deterioration of water quality. It destroys the aquatic habitats for many organisms. The loss of water quality is imminent due to the formation of impoundments.

Material and Methods

Narmada is the fifth largest river of India. It is commonly known as the Life line of Madhya Pradesh. The major part of Narmada river (88%) flows in this state. It originates from Amarkantak of eastern MP and it flows towards West and joins Arabian sea at Bharuch in Gujarat. The present study was conducted at five important sites namely Omkareshwar U/S, Omkareshwar D/S, Maheshwar Dam, Mandleshwar and Koteshwar which were renamed as S – 1, S – 2, S – 3, S – 4 and S – 5 respectively for limnological purpose. These study areas are situated in a stretch of 220 kms. of the western zone of Narmada river. S–1 represents preliminary impoundment stage. S–2 has a large number of submerged rocks and lesser amount of sand and pebbles. S–3 is located near Mandleshwar city, dam construction was in progress so it represents the preimpoundmental stage. S–4 is located along Mandleshwar city and S–5 is located at a distance of 5 km from Nisarpur village of Dhar district in Madhya Pradesh (figure 1).

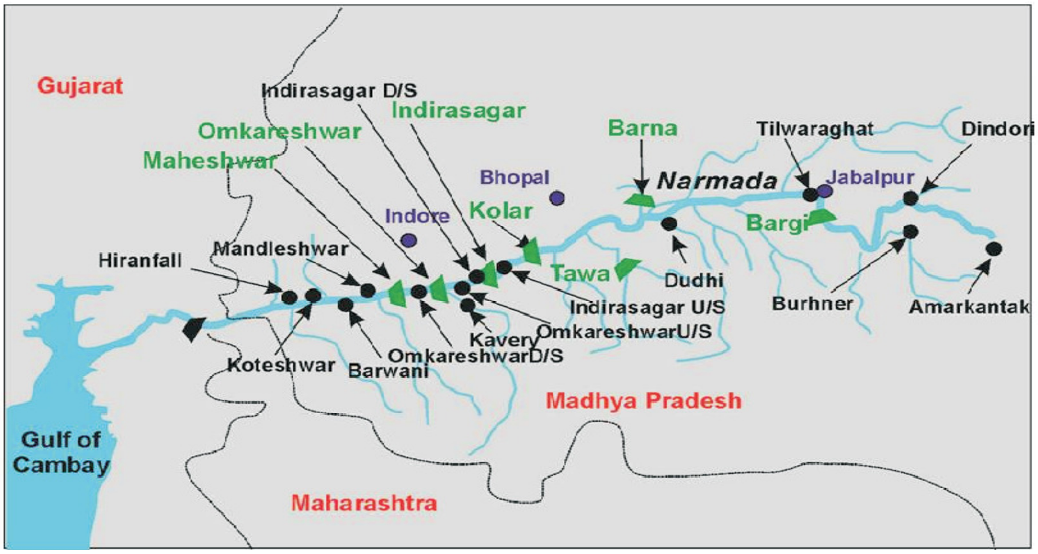

Figure-1
Map showing the different sites of Narmada river of India

Physicochemical characteristics were analysed as per the methods given in APHA[6] and NEERI[7] (table-1).

Table-1
Physicochemical parameters and their methodology

S.No.	Parameters	Unit	Methodology
1	pH	-----	Digital electrode pH Meter
2	Alkalinity	mgl^{-1}	Titrimetry with H_2SO_4
3	Total hardness	mgl^{-1}	Titrimetry with EDTA
4	Total Dissolved Solids	mgl^{-1}	TDS Method
5	Chloride	mgl^{-1}	Argentometric method
6	Dissolved Oxygen	mgl^{-1}	Winkler's method
7	BOD	mgl^{-1}	BOD_5 method

Water quality index (WQI) is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water. WQI was calculated by Weighted Arithmatical Index method given by Brown.[8]

$$WQI = \sum_{n=1}^{n} q_n W_n / \sum_{n=1}^{n} W_n$$

Where, qn = 100 [V_n - V_{io}]/ (S_n - V_{10})], q_n = Quality rating for the n^{th} water quality parameter, V_n = estimated value of the n^{th} parameter at a given sampling station, S_n = standard permissible value of n^{th} parameter, V_{io}= ideal value of n^{th} parameter in pure water. (pH = 7, DO = 14 mg/l and for other parameter = 0), W_n = unit weight for n^{th} parameter, S_n = standard value for n^{th} parameter, K = constant for proportionality.

Results and Discussion

The pH of the water is directly proportional to temperature of water. The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrientsseasonal variation of all physicochemical parameters were established as per Pejman[9]. Its minimum value (8.05) was noted at S- 5in summer season and maximum value at S – 5 during winter (figure 2).

Water shows alkalinity due to presence of salts of weak acids and strong bases. Alkalinity in water is caused due to presence of carbonates, bicarbonates and hydroxides. Alkalinity is the buffering capacity of a water body. It measures the ability of water bodies to neutralize acids and bases thereby maintaining as table pH. Water as a good buffer contains compounds, such as bicarbonates, carbonates, and hydroxides, which combine with hydrogenions from the water thereby raising the pH of water. The values of total alkalinity ranged between 115.50 mgl^{-1} to 138 mgl^{-1} in winter and monsoon season, respectively. S- 3 has its least values while S – 5 showed its maximum concentration (figure 3).

When water passes through or over deposits such as limestone, the levels of $Ca^{2+,}$ Mg^{2+} and HCO_3^- ions present in the water can greatly increase and cause the water to be classified as hard water.Total hardness ranged between 136.5 mgl^{-1} to 172.42 mgl^{-1} in winter and monsoon season, respectively. Its minimum values noted at S- 2 and maximum was found to be at S – 4 (figure 4).

Total dissolved solids (TDS) refers to any minerals, salts, metals, cations or anions dissolved in water. Salts like carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron etc. are dissolved in natural water. The high content of dissolved solids increases the density of water. The TDS values varied from 228 mgl^{-1} to 357 mgl^{-1}. Its highest value was observed in monsoon season at S- 4 (figure 5).

Chlorides may get into surface water from several sources such as rocks agricultural runoff, wastewater from industries, oil well wastes, effluent wastewater from wastewater treatment plants, and road salting etc. Warhate[12] opined the chloride contents indicate domestic as well as industrial pollution. The values of chloride contents ranged between 18 mgl^{-1} to 26 mgl^{-1} at S- 2 and S – 4 sites, respectively Low level of chloride at other sites indicated no human interference (figure 6).

Dissolved oxygen (DO) is probably the most crucial and important water quality variable in freshwater body. DO analysis measures the amount of gaseous oxygen (O_2) dissolved in an aqueous medium. This gas is an essential for the metabolism of aerobic organisms and also influences inorganic chemical reactions. Therefore, knowledge of solubility and the oxygen distribution is essential for analysis of both biological and chemical processes within water bodies. Oxygen is considered a limiting factor, especially in river and in water with a heavy load of organic material. Organisms have specific oxygen requirements. Low dissolved oxygen may prove fatal for many organisms for their survival according to Abowei[10].In present study, dissolved oxygen fluctuated in the range of 7.06 mgl^{-1} to 8.78 mgl^{-1}.Its lowest value was observed at S-1 in monsoon and the highest was noticed at S-1in winter season, respectively (figure 7).

BOD is measure of determining the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period.According to Sindhu[11] and Singh[12] BOD is a measure of the organic matter present in the ambient water. It is not a precise quantitative test, although it is widely used as an indication of the organic quality of water. It is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C and is often used as a robust surrogate of the degree of organic pollution of water. BOD is used for pollution indicator in water. Its values were found under permissible limit ranged between 3.52 mgl^{-1} to 10.33 mgl^{-1}at S- 1 and S – 5, respectively (figure 8).

Padmanabha[13] reported best water quality in winter season followed by summer and monsoon season; the present investigation agreed with him and reported similar findings. They concluded that the water was safe for drinking, irrigation and industrial purposes. As compare to their study in the present study on the Western part of the river the values of WQI was higher (WQI >70). Sinha[14] described the WQI limit for water, if it is 0 – 25 water quality is excellent, its values between 26 – 50 showed good water quality, 51 – 75 indicated poor water quality, 76 – 100 indicated very poor quality of water and 100 and above indicated water is unsuitable for drinking purposes. During the present study the values of WQI were found in the range of 69.10 to 98.05 at S - 1, 75.45 to 87.21 at S - 2, 83.44 to 96.95 at S – 3, 79.89 to 101.46 at S – 4 and 89.78 to 124.03 at S – 5, respectively. The highest value of WQI was reported in monsoon season while its minimum value has been observed in winter season and moderate value noticed at S – 1 to S – 5 in summer. Highest value of WQI (124.03) was observed at S - 5 during monsoon season while minimum value (69.10) was reported at S - 1 during winter season (figure 9).

The present study indicated very poor water quality (WQI 69.10 to 124.03) in different seasons and found unsuitable for drinking purposes as corroborated by Mishra and Patel[15]. The decrease in water quality occurred due to impoundments on the river to large extent but the anthropogenic activity also caused to small extent.Rangachari[16] reported that the impoundment of the Narmada river has caused significant alteration of physical and chemical characteristics. Pandit[17] reported physicochemical variables like pH, hardness, alkalinity, suspended solids, dissolved oxygen, BOD etc. all showed very significant spatial variations in this study (table-2).

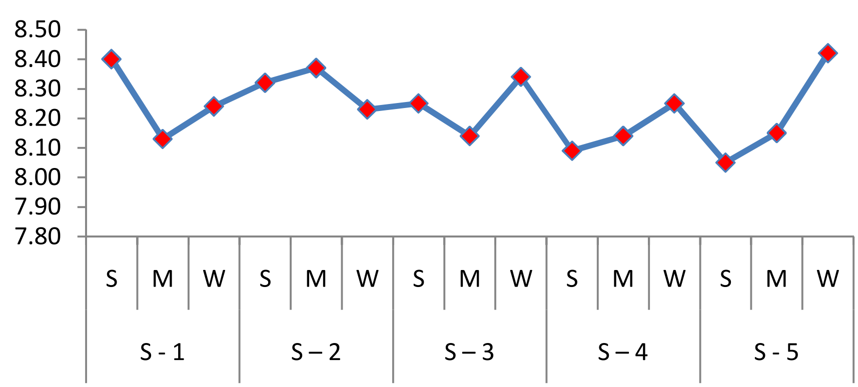

Figure-2
Seasonal variation in the values of pH at different study sites

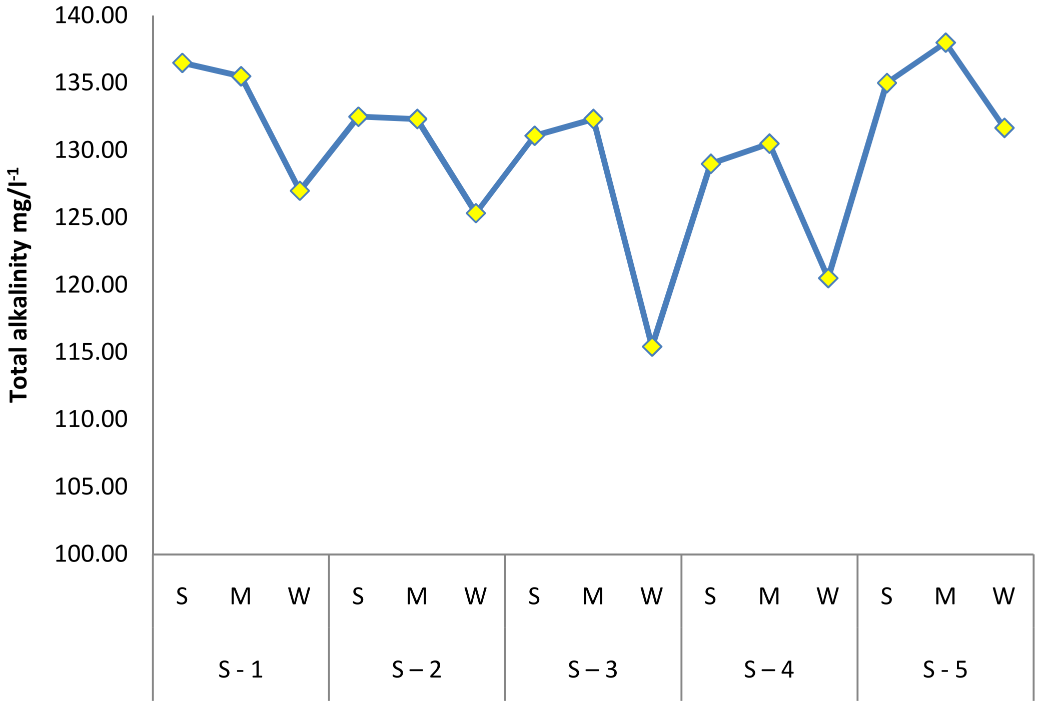

Figure-3
Seasonal variation in the values of Total alkalinity at different study sites.

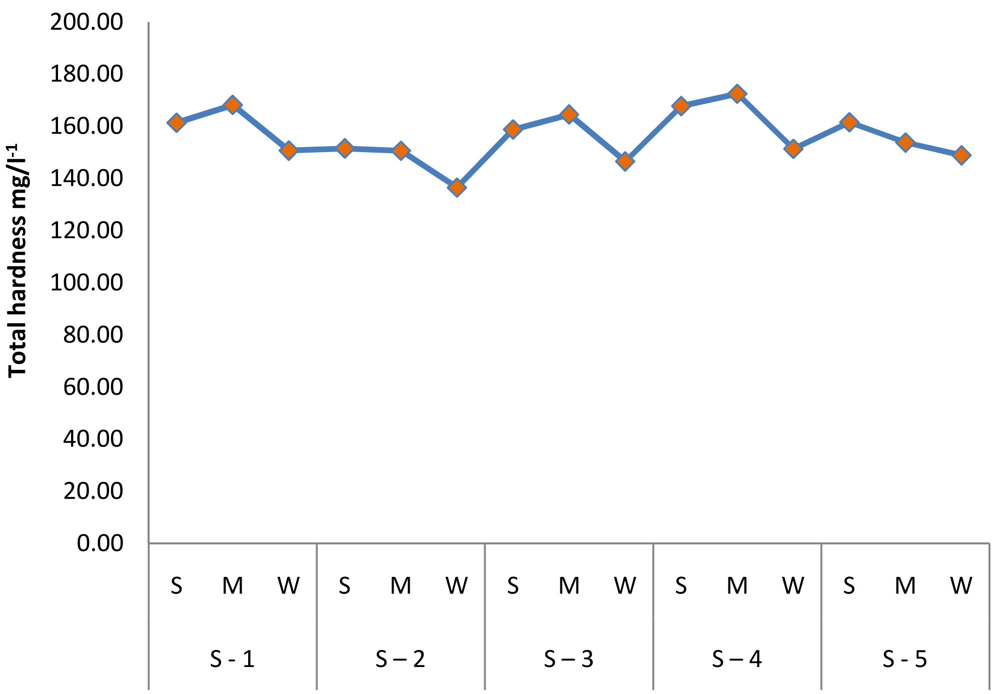

Figure-4
Seasonal variation in the values of Total hardness at different study sites.

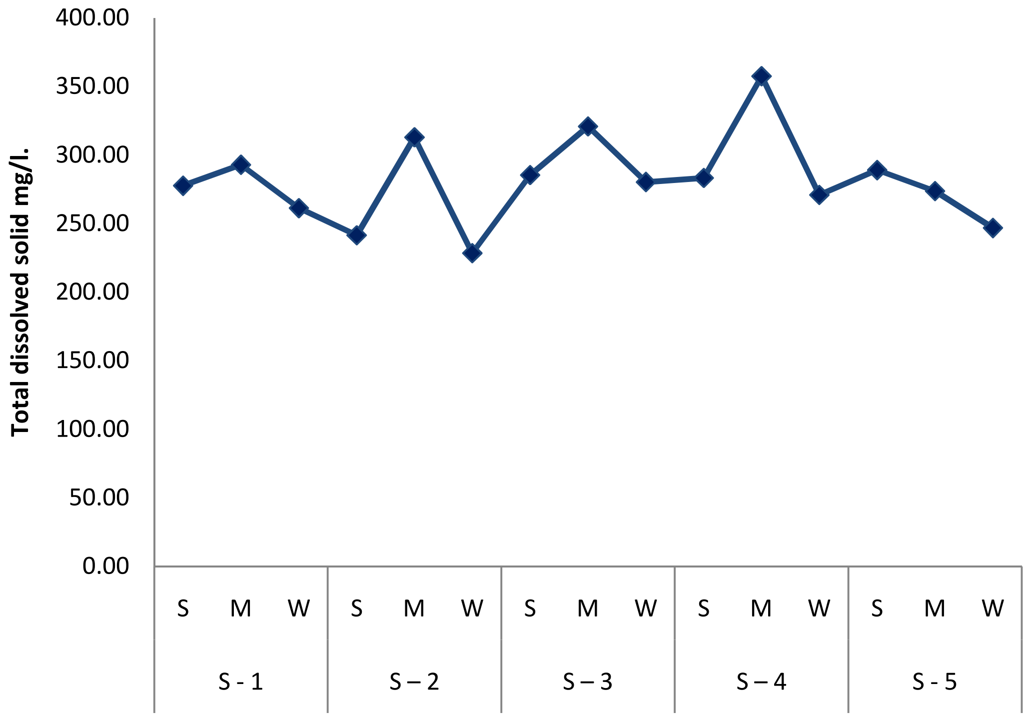

Figure-5
Seasonal variation in the values of TDS at different study sites.

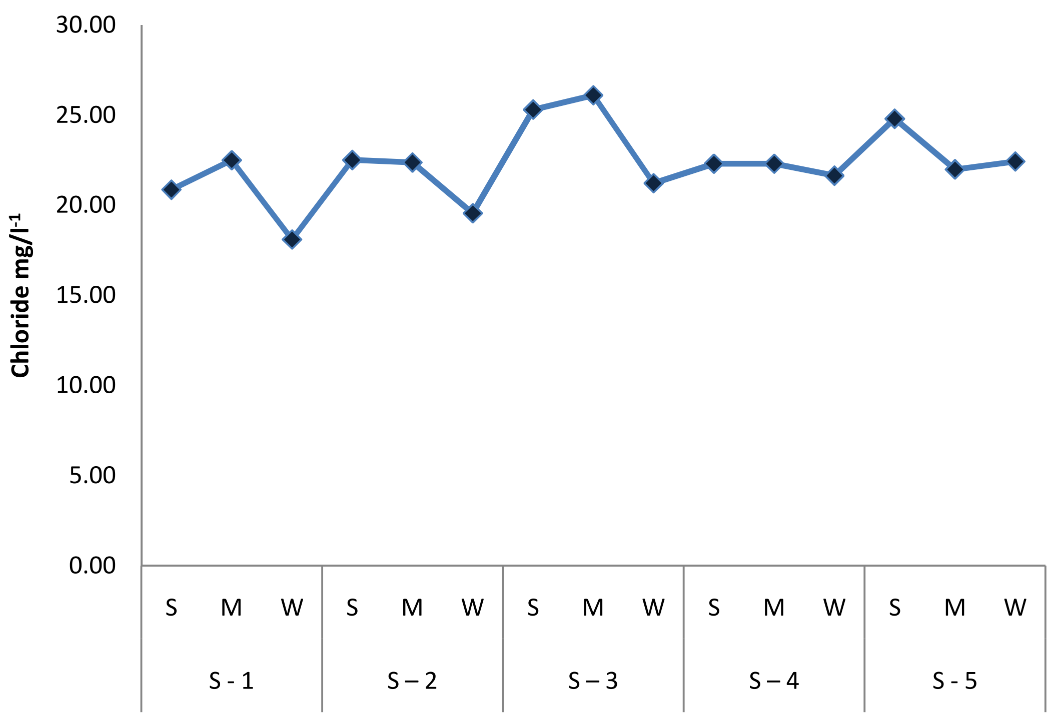

Figure-6
Seasonal variation in the values of chloride at different study sites.

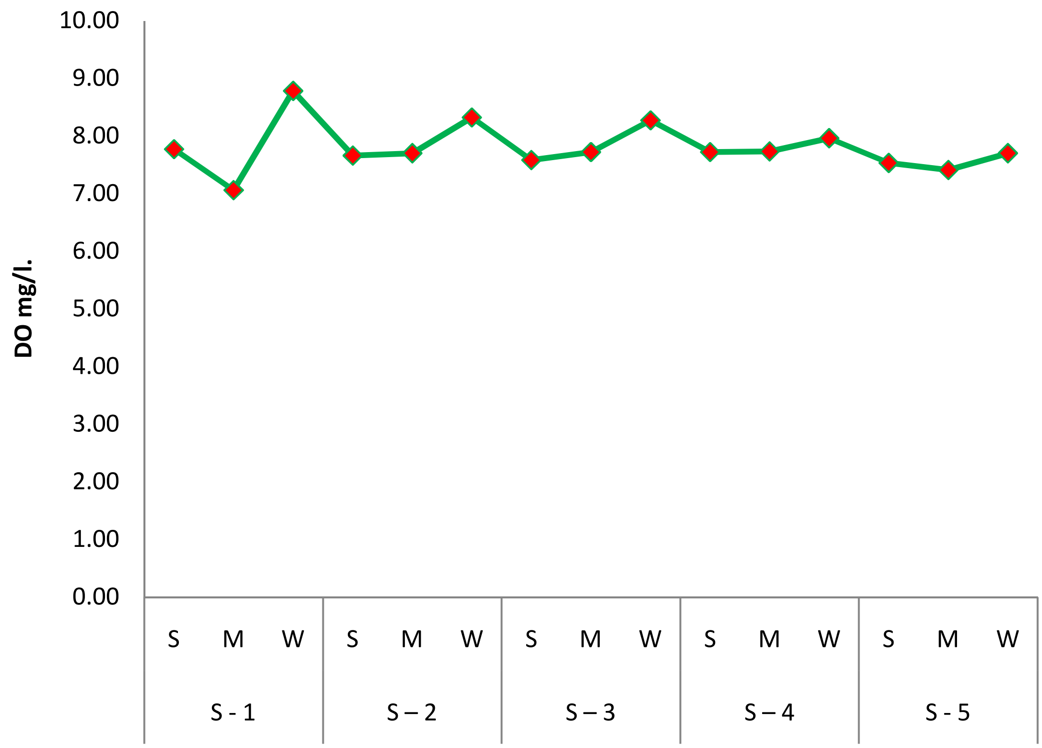

Figure-7
Seasonal variation in the values of DO at different study sites.

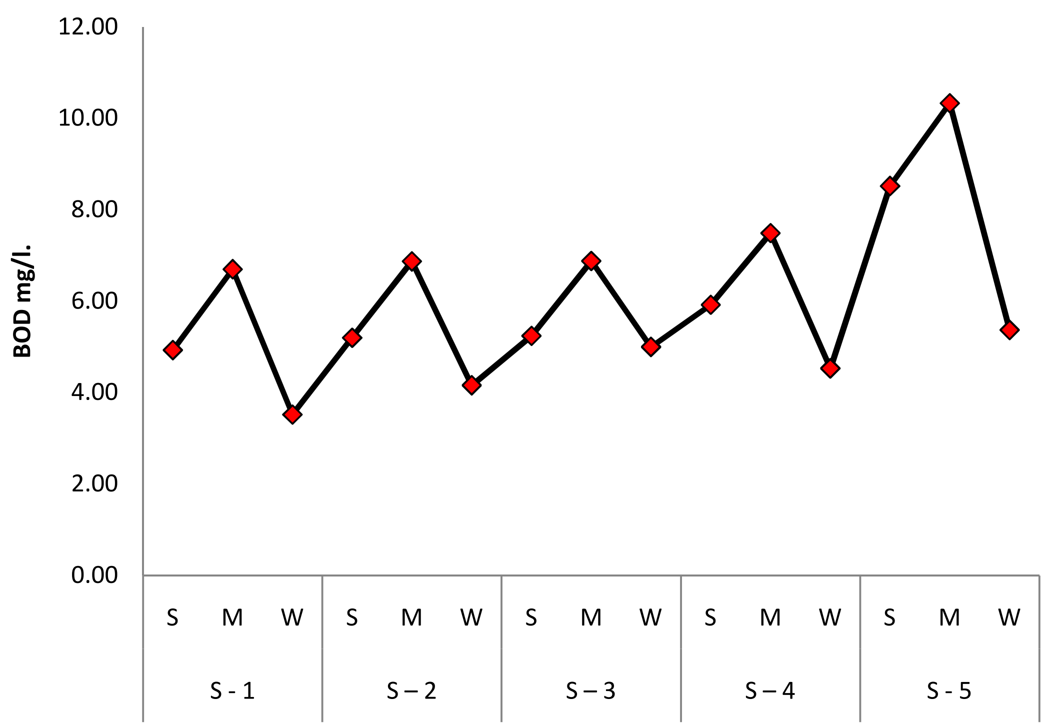

Figure-8
Seasonal variation in the values of BOD at different study sites.

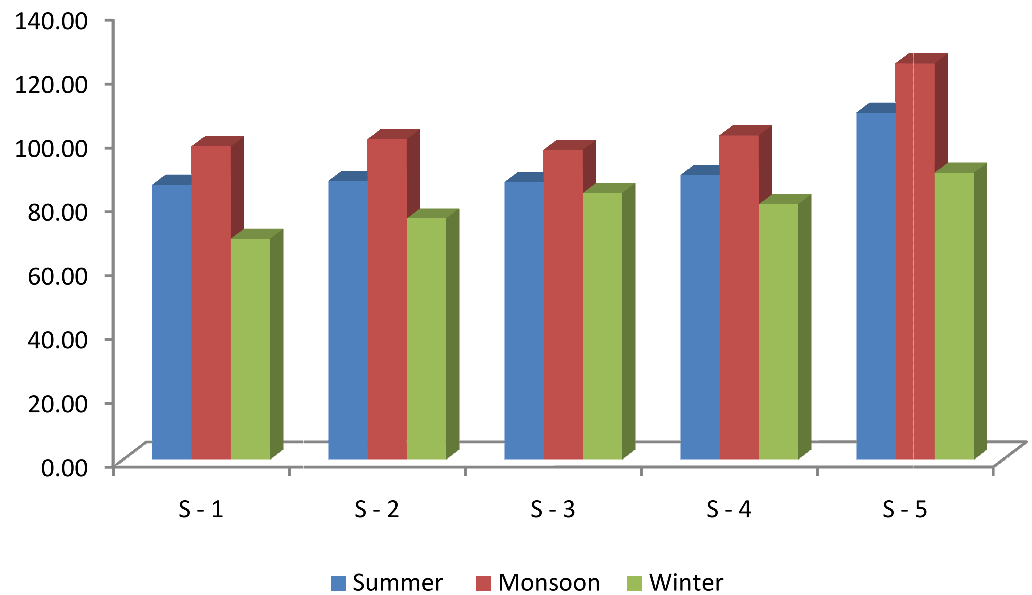

Figure-9
Seasonal fluctuations in the values of WQI at different study sites

Table-2
Details of WQI with respect to different sites of all seasons of physicochemical parameters of Narmada river

Study sites		qpH	qTDS	qDO	qBOD	q T. alk.	qT. Hard.	q Cl -	qpH *wn	qTDS *wn	qDO *wn	qBOD *wn	qT.alk .*wn	qT. Hard. *wn	qCl *wn	sum qnwn	WQI
S -1	S	93.33	55.50	71.15	98.60	113.75	53.78	8.35	20.35	0.17	26.32	36.48	1.71	0.32	0.06	85.41	**86.03**
	M	75.33	58.57	78.54	134.00	112.92	56.06	9.00	16.42	0.18	29.06	49.58	1.69	0.34	0.06	97.33	**98.05**
	W	82.67	52.23	60.63	70.40	105.83	50.22	7.24	18.02	0.16	22.43	26.05	1.59	0.30	0.05	68.60	**69.10**
S -2	S	88.00	48.27	72.29	104.00	110.42	50.50	9.01	19.18	0.14	26.75	38.48	1.66	0.30	0.06	86.58	**87.21**
	M	91.33	62.57	71.88	137.40	110.28	50.19	8.95	19.91	0.19	26.59	50.84	1.65	0.30	0.06	99.55	**100.28**
	W	82.00	45.67	65.42	83.20	104.44	45.50	7.82	17.88	0.14	24.20	30.78	1.57	0.27	0.05	74.90	**75.45**
S -3	S	83.33	57.07	73.13	104.80	109.23	52.92	10.13	18.17	0.17	27.06	38.78	1.64	0.32	0.07	86.20	**86.83**
	M	76.00	64.17	71.67	137.60	110.28	54.83	10.44	16.57	0.19	26.52	50.91	1.65	0.33	0.07	96.25	**96.95**
	W	89.33	56.05	65.94	100.00	96.18	48.83	8.49	19.47	0.17	24.40	37.00	1.44	0.29	0.06	82.83	**83.44**
S -4	S	72.67	56.63	71.67	118.40	107.50	55.92	8.92	15.84	0.17	26.52	43.81	1.61	0.34	0.06	88.35	**88.99**
	M	76.00	71.48	71.56	149.80	108.75	57.47	8.92	16.57	0.21	26.48	55.43	1.63	0.34	0.06	100.73	**101.46**
	W	83.33	54.16	69.17	90.60	100.42	50.44	8.66	18.17	0.16	25.59	33.52	1.51	0.30	0.06	79.31	**79.89**
S -5	S	70.00	57.78	73.65	170.40	112.50	53.83	9.92	15.26	0.17	27.25	63.05	1.69	0.32	0.07	107.81	**108.60**
	M	76.67	54.72	74.90	206.60	115.00	51.25	8.80	16.71	0.16	27.71	76.44	1.73	0.31	0.06	123.13	**124.03**
	W	94.67	49.33	71.88	107.40	109.73	49.61	8.98	20.64	0.15	26.59	39.74	1.65	0.30	0.06	89.12	**89.78**

Conclusion

On the basis of the present research, it can be concluded that the deterioration in the water quality was observedat all sites. Impoundment on the river has affected its water quality to greater extent. Dissolved oxygen fluctuated in the range of 7.06 mgl^{-1} to 8.78 mgl^{-1}. WQI indicated poor water quality so its water can only be used for irrigation purposes but not suitable for direct human needs. Highest value of WQI (124.03) was observed at S-5 during monsoon season while minimum value (69.10) was reported at S-1 during winter season. A step must be taken to stop ingression of organic pollutants so that the organic load could be minimized and resources can be recovered in a sustainable way. It is recommended that anthropogenic activity must be reduced at the river banks.

Acknowledgement

Financial assistance from NVDA, Bhopal, Madhya Pradesh (India)is thankfully acknowledged. The authors are also thankful to Dr. S. C. Kothari Head, Department of Zoology, Vikram University for providing laboratory facilities to complete the research work.

References

1. Pritchard M., Mkandawire T. and O'Neill G.J., Assessment of groundwater quality in shallow wells within the southern districts of Malawi, *Phys. Chem. Earth*, **33,** 812–823 (**2008**)

2. Abowei J.F.N. Salinity dissolved oxygen, pH and surface water temperature conditions in Nkoro River, Niger Delta, Nigeria, *Advance Journal of Food Science and Technology,* **2(1),** 36-40 **(2010)**

3. Sindhu S.K. and Sharma A., Study on some physico-chemical characteristics of ground water of district Rampur - A statistical approach, *E.J.Chem*., **4**(**2**), 162-165 (**2007**)

4. Singh M.R., Gupta A., Asha S. and Beeteswari K.H., Physicochemical properties of water samples from Manipur river system, India, *J. Appl.Sci.Environ Manage,* **14(4),** 85–89 **(2010)**

5. Padmanabha B and Belagali S.L. Water Quality Index of Kabiniriver in the Kallahally Village of Nanjangud Taluk, Mysore District, Karnataka (India), *J. Environ. Sc. and Engg.* V., **49**(**1**), 48–50 **(2007)**

6. Sinha M.P., Effect of waste disposal on water quality of river Damodar in Bihar, Physicochemical characteristics, In ecology and pollution in Indian rivers (Ed. R. K. Trivedy), 216–246 **(1988)**

7. Mishra P.C. and Patel R.K., Quality of drinking water in Rourkela, Outside the steel township, *J. Env. And Poll.,* **8**(**2**), 165–169 **(2001)**

8. Rangachari R., SenguptaNirmal, Ramaswamy R. lyer, BanerjiPranab and Singh Shekhar, Large Dams: India's Experience. Final Report, Prepared for the World commission on Dams (WCD) **(2000)**

9. Pandit A.K., Rathore S.A. and Bhat S.A., Limnological features of freshwater of Uri, Kashmir, *J. Res. Dev*. **1,** 22-29 **(2001)**

10. Bhatt F.A. and Yousuf A.R., Limnological features of some lotic systems of Kashmir in: *Bio- resources,* 57-70 (**2004**)

11. Rossiter H.M.A., Owusu P.A., Awuah E., MacDonald A.M. and Schäfer A.I., Chemical drinking water scope for advanced treatment, *Sci. Total Environ*., **408,** 2378–2386 **(2010)**

12. Chatterjee C. and Raziuddin M., Determination of water quality index (WQ1) of a degraded river in Asnol industrial area, West Bengal, *Jour. of Env and Poll.,* **1**(**2**), 181-189 **(2002)**

13. Rao K.S., Bhatnagar G.P., Hasija S.K., Shrivastava S., Wanganeo A., Salman S., Valecha V., and Singhal P.K., Pre and Post Impoundment limnological studies of Narmada Basin Development for its water quality, a compiled report on the three zones of Narmada basin, N.V.D.A., Bhopal, M.P., India **(1992)**

14. APHA, Standard methods for examination of water and wastewater 21st ed. *American Public Health Association,* Washington D.C. **(2005)**

15. NEERI, Manual on water and waste water analysis. National Environmental Engineering Research Institute, Nehru Marg, Nagpur, India **(1986)**

16. Brown R.M., McCleiland N.J., Deininger R.A and O'Connor M.F., A water quality index – crossing the psycho – logical barrier (Ed Jenkis, S.H.) *Proc. Int. Conf. on Water Poll. Res., Jerusalem,* **6**, 787– 797 **(1972)**

17. Pejman A.H., Bidhendi N.G.R., Karbassi A.R., Mehrdadi N., Bidhendi E.M., Evaluation of spatial and seasonal variations in surface water quality using multivariate statistical techniques, *J. Environ Sci&Technol***, 6(3),** 467-476 (**2009**)