www.cafetinnova.org

Indexed in
Scopus Compendex and Geobase Elsevier, Chemical Abstract Services-USA, Geo-Ref Information Services-USA, List B of Scientific Journals, Poland, Directory of Research Journals

ISSN 0974-5904, Volume 08, No. 02

International Journal of Earth Sciences and Engineering

April 2015, P.P.215-221

Evaluation of Water Quality in and around Byramangala Reservoir, Ramanagaram District, Karnataka, India

L UDAYA SIMHA AND MAHESH BABU
Department of Civil Engineering, BMS College of Engineering, Bangalore, India
Email: *ludayasimha@gmail.com*

Abstract: In the present study, field investigations on quality of open-sources and bore-well waters were undertaken in and around Byramangala reservoir, which comprises the settlements Byramangala, Bannigere and M.G. Doddi. Twenty five samples from the selected points were collected during the months of Feb, April and June. Sixteen chemical parameters have been considered for the analysis. The investigations revealed that some of the parameters, including heavy metals, have shown striking relation with the rainy days, showed the trends of decrease in their concentration (dilution) or increase in the concentrations (leaching). The alarming situation was observed with respect to surface sources like reservoir and pond, where Dissolved Oxygen was less than 4ppm. The hardness at all the points was above permissible limit. The 16-28% of samples showed poor quality as per WQI for drinking water.

Keywords: *Water quality, Bore well, Open well, Heavy metals, Dissolved Oxygen*

1. Introduction

Water is essential for life on earth. Water is exposed to innumerous natural and/or anthropogenic influence. These could be harmful to the human when high concentrations were found in Water sources. The large production of wastes in modern society often poses a threat to ground water quality. The ground water in many areas of Bangalore is contaminated. Ground water contamination is typically a local phenomenon affecting the uppermost aquifers. The contamination of ground water by heavy metals and pesticides has also assumed great significance during recent years due to their toxicity and accumulative behavior. Ayesha, et al.,.(1998)[5], studied the Madivala Lake water quality in Bangalore. They observed that the direct discharge of sewage from parts of Jayanagar and J.P. Nagar has increased the pollution of the Lake. Ali M. B et al. (1999)[4], focused on toxic metal pollution, nutrient status of the lake and their magnification by algae and macrophytes in Lake Nainital. Water was found to be contaminated with metals like Cr, Cu, Fe, Mn, Ni, Pb and Zn. The level of metals amongst various components of lake varied considerably in different seasons. Chandrasekhar (2003)[10], studied the impact of urbanization on Bellandur Lake, Bangalore. The study showed higher values of alkalinity, BOD and COD and low levels of dissolved oxygen, indicating the polluted nature of the lake. Jan, et al, (2008)[13], has revealed presence of polyaromatic hydrocarbons, organocholrine, polychlorinated nitrate-M and other carcinogenic residues in the water samples around Byramangala. Nusrat jan (2008)[18], studied the physico-chemical characteristics and heavy metal residues in the Byramangala lake. They observed that the water in the reservoir was most affected by anthropogenic activities. The reservoir was found to be seriously affected by heavy metals. Anupama, et al, (2009)[7], observed that environmental status of Madiwala Lake with respect to microbial pollution is continuing to deteriorate. A.S. Jumbe and N. Nandini (2009)[3], reported that Cadmium (Cd), Cobalt (Co), Chromium (Cr), Nickel (Ni), and Lead (Pb) exceeded drinking water standards in the varthur lake, Bangalore. A.S. Jumbe and N. Nandini (2009)[14], opined that most lakes in Bangalore are polluted. The observed Pollution Load Index (PLI) between heavy metals in the lakes produced the following outputs as Ni > Pb > Cd > Cu > Cr > Co > Zn> Mn. Purushotham, et al,(2010)[19], opined that the calculated Lake water quality in Nagpur showed fair water quality rating in autumn season which then change to medium in rainy season and higher during summer season. Mahapatra et al. (2011)[15], have found that the alkalinity, TDS, conductivity and hardness values were higher in Varthur Lake. A. Abdul Jameel , et al,(2012)[2], have reported that the concentrations of toxic metals like Pb, Cr, etc are present in slight excess in one or two stations that too in only one season in the stretch of Tamilnaadu and Pondichery. A. Ramesh, et al., (2012)[6], have investigated the ground water samples in Peenya Industrial area, Bangalore. They concluded that the hardness and nitrates, hexavalent chromium and lead were found exceeding the drinking water limits. P. Ravi kumar , et al, (2013)[20], have worked out WQI values for two tanks in Bangalore. They have reported that Sankey tank water belongs to good water class with WQI values ranging from 50.34 to 63.38, the Mallathahalli lake water falls under poor water category with WQI value ranging from 111.69 to 137.09. The study of kodiakanal lake by D. Karunasagar, et al, (2006) [11], showed the contamination of mercury.

Jayadev, E.T. Puttaih (2013)[12], analysed Vrishabhavathi river water samples , which reveals that the water is highly contaminated at selected points which are not suitable for drinking and irrigation.

2. Materials and Methodology

2.1. Study Area

This study has been initiated because the main source of input to the reservoir is from Vrishabhavathi stream, which carries the pollutants from an urban settlement, Bangalore.

The Byramangala village is situated in Bidadi taluk at 12^0 44'North, 77^0 25'East of Ramanagaram district. It is about 38 km away from Bangalore and 5 km from Bidadi Railway station /Bus station, which is situated on Bangalore-Mysore road/railway line. The Byramangala Village is located between the reservoir and a medium sized pond (Fig.1). The Byramangala reservoir is the biggest lake in Bidadi taluk. It spreads over an area of 412 hectare. It comes under the administration of Department of Fisheries which carries a routine maintenance of this lake. The major crops grown in and around village are Paddy, Ragi, Sunflower, Vegetables, Sugarcane, and mulberry. The Population statistics of study areas are shown in Table-1.

Table1: *Population statistics of study areas (Source; Byramangala panchayat)*

Village	No. of Families	No. of Males	No. of females	Total
Byramanagala	542	869	856	1725
M.G. Doddi	42	100	88	188
Bannigere	135	216	179	395

The village with its panoramic landscape and lush greenery attracts the visitors. The Byramangala reservoir shelters a large number of aquatic birds including migratory and resident birds. The agricultural land surrounding the lake gives a nice land scape to the reservoir.

The Fig.2 shows stream network of Byramangala reservoir. It rises on the high ground to the north of the city and follows a steep rocky course for about 32 kms until it reaches Byramangala reservoir. The main source of inflow to Byramangala reservoir is Vrishabhavathi River. The Vrishabhavathi Valley is a tributary of Arkavathi River which it meets 50 kms south of the city. The reservoir is constructed way back in 1940 and this is the only source of water to be extensively used for irrigation. Byramangala reservoir receives sewage and storm water from the Vrishabhavathi River and the surrounding localities. The reservoir water is highly polluted as it receives both industrial effluents and untreated sewage from the Bangalore Urban Area. The treated wastewater/partially treated wastewater is let to the Vrishabhavathi valley.

Fig1. *Location of Byramangala and Bannigiri Villages*

Fig2. *Stream Network of Reservoir*

2.2. Sampling Method

The sampling points selected around the reservoir covering the three villages. As far as possible the radial pattern was maintained keeping Byramangala tank as center as shown in Fig.3. The red dots indicate the sampling point locations. The lines I to V, were five radial lines along which the variations of parameters were investigated.

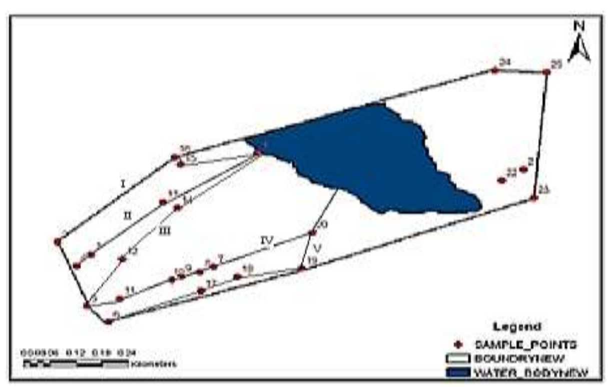

Fig 3 *Distribution of Sampling points in Study area*

2.3. Collection of Samples

Water samples were collected from 25 points of Byramangala reservoir surrounding areas. The Samples were collected three times, once in months of February, April and June, 2012. There was a rain during April month in that area. The Samples were collected into pre-cleaned polyethylene cans for analysis of physicochemical and heavy metals. Each of the samples was analyzed for pH, electrical conductivity, total hardness, calcium hardness, magnesium hardness, nitrate, chlorine, fluoride, dissolved oxygen, conductivity, potassium, sodium, copper, iron, chromium, nickel using standard methods as given in APHA[1].

3. Results and Discussion

Among the three villages considered, Byramangala is the prominent and has the more settlements. The field investigation consists of knowing the radial variation of the parameters and spatial distribution of the parameters considering all the points. Table 2 shows the details of the radial pattern from the reservoir and features of the sampling points.

The variations of major parameters like total hardness, nitrate, chlorine, fluoride, dissolved oxygen, copper, iron, chromium, nickel were discussed here. Figures 4 to 13 represent the sample variation of the major parameters along the path IV. BW and OW stand for borewell and open well respectively. In most of the cases, the concentrations of the pollutants were almost same for the months of February and June. The concentrations of the pollutants either less or more depending on the effect of dilution or leaching in the month of April, during which rain had occurred.

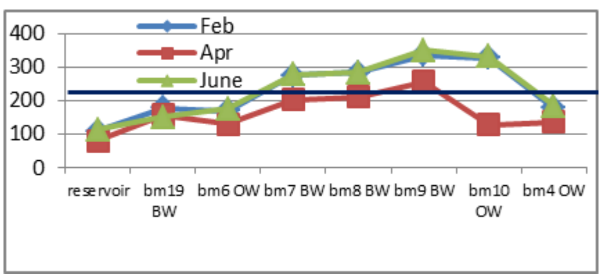

Fig 4 *Variation of Chloride*

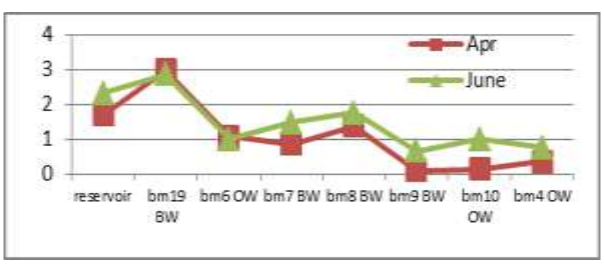

Fig 5 *Variation of Fluoride*

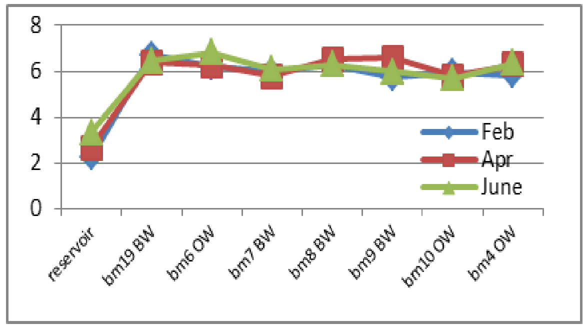

Fig 6 *Variation of DO*

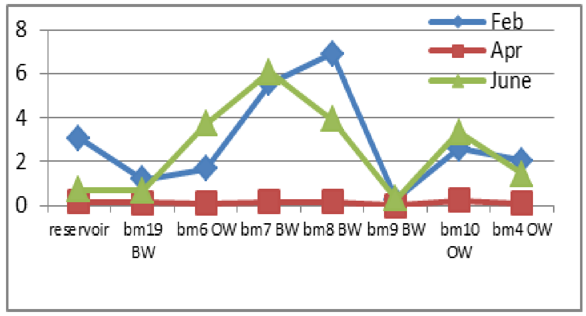

Fig 7 *Variation of Iron*

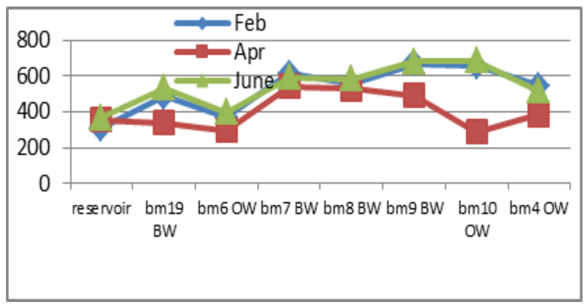

Fig 8 *Variation of Total Hardness*

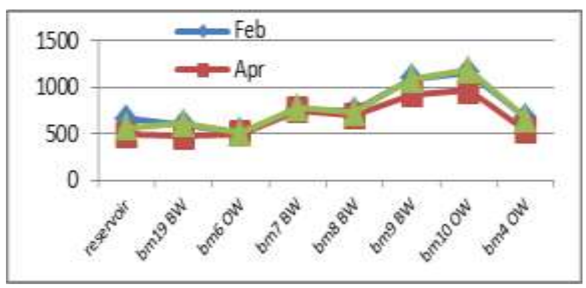

Fig 9 *Variation of TDS*

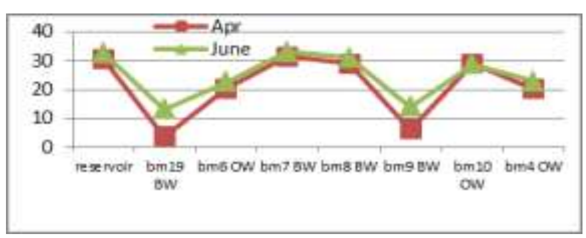

Fig 10 *Variation of Nitrates*

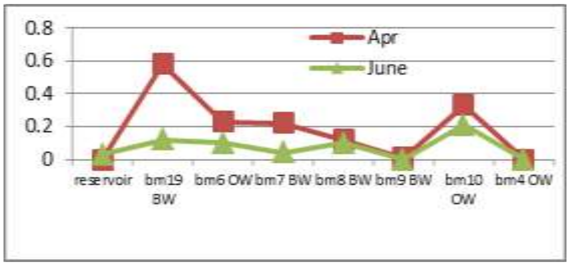

Fig 11 *Variation of Nickel*

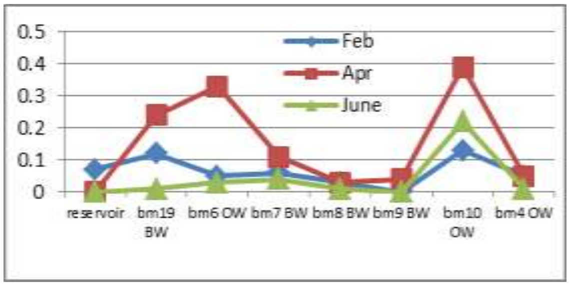

Fig 12 *Variation of Copper*

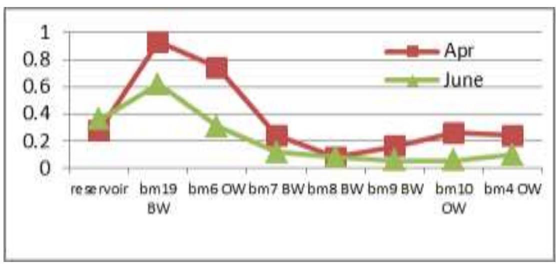

Fig 13 *Variation of Chromium*

Nitrates were found to be well within the stipulated range. Nitrates and fluoride did not show much variation during the months April and June. Fluoride was found to be slightly more in reservoir and nearby borewell bm19 and bm14 (sources of drinking water), showed the value of around 2.3 ppm. The heavy metals like nickel, copper and chromium were also found be at alarming rate at bm19, bm6, bm2, bm4, bm10, bm11, bm12, bm13, bm14 and bm15 in the month of April indicating the dangerous effect of leaching from the nearby sources. The trend shows during, especially, in initial rainy days the levels of chromium, copper, nickel would be more. Among the observed wells, the bore-well numbers 2,11,13,14,15 and 19 are drinking water sources according to the villagers. A cautious message had been conveyed to the villagers in this regard. The presence of nickel could be due to leaching from metals in contact with drinking-water, such as pipes and fittings. Most copper contamination takes place at some point in the water delivery system. This occurs as a result of micro-corrosion of the copper pipes or fittings, which are widely used in household plumbing. The presence of chromium was definitely a case of industrial pollution, which had seeped towards the wells. The higher concentration of iron was observed in most of the wells during dry months, viz. February and June. It may be due to from corrosion of iron or steel well casing or water pipes. During April the value was almost zero at all the points under consideration. The more threatening factor to the reservoir was DO content. The DO content was observed to be around 2 in all the three months. The similar trend was observed at pond, which was at 4ppm. This shows the level of pollution in the surface water bodies at the study site.

The effect of radial distance on parameters, like chlorides, DO, total hardness, from the reservoir showed increasing trend. Fluoride showed decreasing trend. The other parameters trend can be opined as inconclusive.

The spatial distributions of average values are shown in Fig. 14 to 23. The lower concentration to higher concentration is shown in colours yellow to brown.

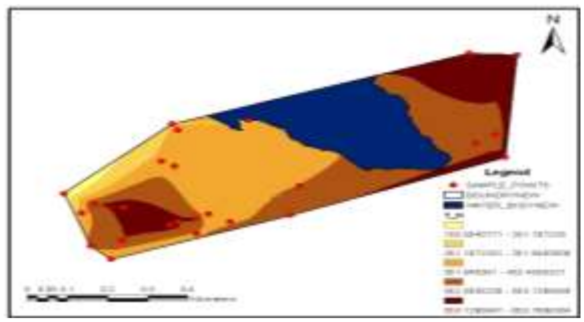

Fig 14 *Spatial Variation of Total Hardness*

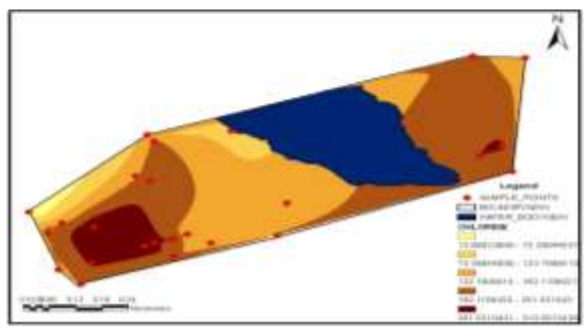

Fig 15 *Spatial Variation of Chloride*

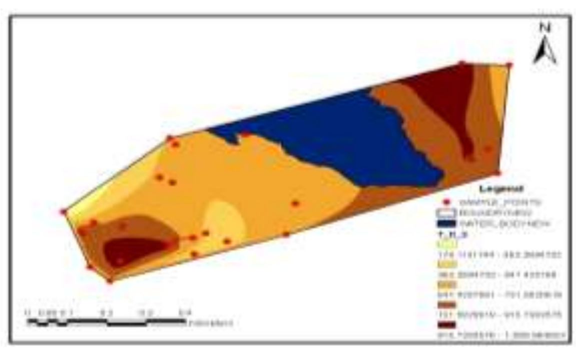

Fig 16 *Spatial Variation of TDS*

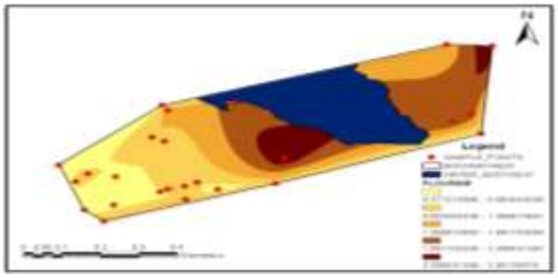

***Fig 17** Spatial Variation of Fluoride*

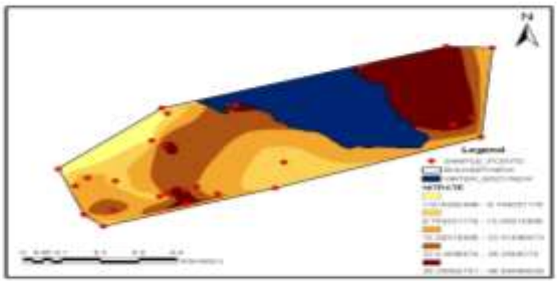

***Fig 18** Spatial Variation of Nitrates*

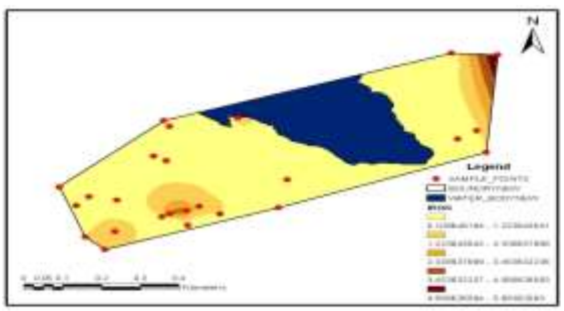

***Fig 19** Spatial Variation of Iron*

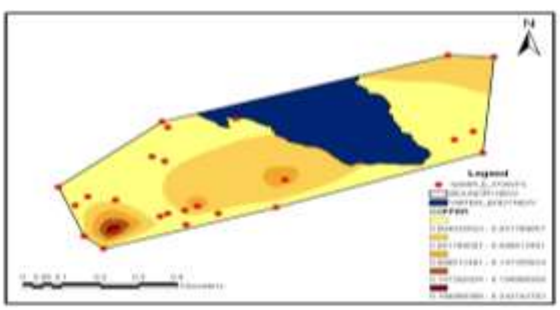

***Fig20** Spatial Variation of Copper*

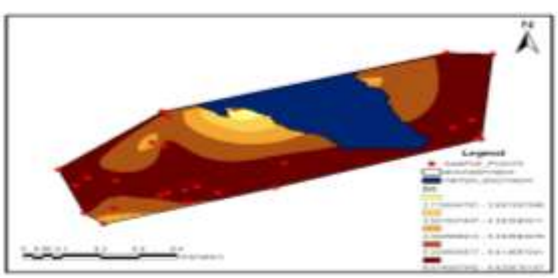

***Fig 21** Spatial Variation of DO*

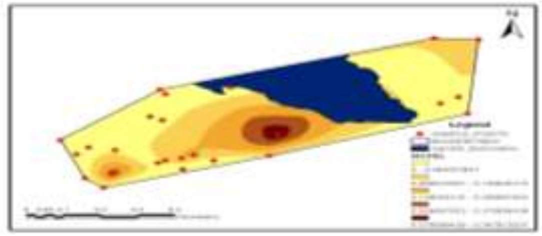

***Fig 22** Spatial Variation of Nickel*

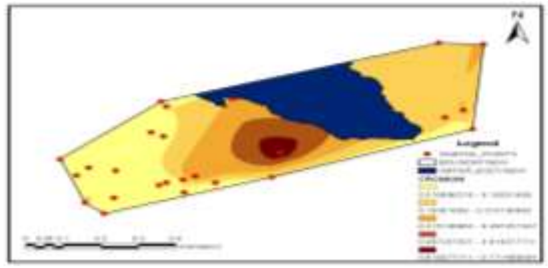

***Fig 23** Spatial Variation of Chromium*

4. Water Quality Index

Water Quality Index (WQI) is a very useful tool for communicating the information on overall quality of water (Pradhan et al., 2001[18], Mahuya Das Gupta Adak et al., 2001[16], Bhaven et al. 2011[8] and Srinivasa Kushtagi et. al. 2012[21]). To determine the suitability of groundwater for drinking purposes, Water Quality Index (WQI) was computed for the study area samples (Table 3).

***Table 3:** Water quality based on WQI value*

WQI value	Water quality	Percentage of water samples (February)	Percentage of water samples (April)	Percentage of water samples (June)
<50	Excellent	40	16	12
50-100	Good water	52	68	60
100-200	Poor water	8	16	28
200-300	Very poor water	00	00	00
>300	Water unsuitable for drinking	00	00	00

From the above table, water quality seems to be better in Feb than other two months of sampling. Ingeneral, WQI showed 8 to around 30 percent of samle would be poor quality. It was noticed that the percetage fall under excellent were the open source points. It indicates that WQI accoding to chemical analysis, most of the open source points can be used for drinking purposes in the Byramangala region. However, the decision should be taken based on the biological investigations also, which was not carried out in the present study. The data showed that the quality of water was improved under the action of rain (eg. April). According to the analysis most affected area was Bannigere. Among the two sources, one was falling under poor. In M.G. Doodi, out of the three sources two were bore wells and one was poen well source. Open well and one bore well (Point 22) sources were with good water quality and another was falling in the poor water quality.

5. Conclusions

Based on the investigation carried out, the following conclusions can be drawn: The heavy metals like nickel, copper and chromium were found to be at alarming rate in the rainy days, indicating the dangerous effect of leaching from the nearby sources. The other parameters showed the trend of decrease with the rain fall. Most of the samples (about 22 out of 25) showed TDS value beyond the desirable limit of 500 mg/l. However, all the samples were within the permissible limit. The parameters pH, Calcium Hardness, Chlorides, Nitrite, Sodium, Potassium, Copper were oscillating around permissible limit. Fluoride concentration at some of observation points in Byramangala was above the permissible limit. Reservoir concentration was around 2.3 mg/l. The most affected areas were Bannigere (2.5 ppm) and M G Doddi (2.5 ppm). Dissolved oxygen was very less in pond (4 mg/l) and reservoir (2.5 mg/l), which indicate that they were "severely polluted". Iron concentration was high in bore wells compared to open water sources. The effect of radial distance from the reservoir on parameters, like chlorides, DO, total hardness, showed increasing trend. Fluoride showed decreasing trend. The WQI values were found to be 16-28% poor with respect to drinking water quality. The observations showed the clear relation between the rainy month and the non-rainy month(s). The lower end of the value is observed during rainy days. The high value of WQI was found to be mainly from the higher values of total dissolved solids, chloride, and hardness in the groundwater.

References

[1] APHA (American Public Health Association), AWWA WEF, *Standard Methods for Examination of Water and Wastewater*, 19th edition. Washington DC, 1995.

[2] A. Abdul Jameel, J. Sirajudeen and R. Abdul vahith, "Studies on heavy metal pollution of ground water sources between Tamilnadu and Pondicherry, India", Advances in Applied Science Research, 3 (1):424-429, 2012

[3] Aboud S. Jumbe and N. Nandini, "Impact assessment of heavy metals pollution of Vartur lake, Bangalore" Journal of Applied and Natural Science 1(1):53-61, 2009

[4] Ali M. B., Tripathi R. D., Rai U. N., Pal A. and Singh S. P, Physico- chemical characteristics and pollution level of lake Nainital (U.P., India): Role of macrophytes and phytoplankton in biomonitoring and phytoremediation of toxic metal ions. Chemosphere. Volume 39, Issue 12, *p 2171-2182*, 1999.

[5] Ayesha, Parveen and Ramachandra T.V, "Limnological studies on Madiwala lake", Waters.Project report, *April 1998*

[6] A. Ramesh, B.S. Nagendra Prakash, P.V. Sivapullaiaih, A.S. Sadhashivaiah, " Assessment of Ground Water Quality in Designated Peenya Industrial Area and Estate, Bangalore, India – A Case Study", *International Journal of Environmental Protection*, Vol. 2 Iss. 6, PP. 21-25, 2012

[7] B. Anupama, Aboud S. Jumbe and N. Nandini," Assessment of Water Quality in Madiwala Lake, Bangalore in Relation to Faecal Contamination" Volume 8, Issue No. 3, Sep 2009 , Page No 553-558, 2009

[8] Bhaven N. Tandel, JEM Macwan and Chirag K. Soni,." Assessment of Water Quality Index of small lake in south Gujarath region, India", Proceedings of ISEM-2011, Thailand, 2011.

[9] BIS (Bureau of Indian Standards) 10500, Indian standard for drinking water- specification, First revision, p 1-8.1991

[10] Chandrasekhar, J.S., Lenin Babu, K., and Somasekhar, R.K., "Impact of urbanization on Bellandur lake, Bangalore - A case study.", J. Environ. Biol. 24(3): 223-227, 2003

[11] D. Karunasagar, M.V. Balarama Krishna, Y. Anjaneyulu, J. Arunachalam, "Studies of mercury pollution in a lake due to a thermometerfactory situated in a tourist resort: Kodaikkanal, India", Environmental Pollution 143, 153e158, 2006

[12] Jayadev , E.T. Puttaih, " Studies on heavy metals contamination in Vrishabhavathi river water and ground water of the surrounding river", International Journal of Scientific & Engineering Research Volume 4, Issue 1, January-2013

[13] Jan, N., Nandini, N., Jumbe, A. S. & Anupama. B.S., "Impact of Municipal and Industrial Pollution on Byramangala Lake, Bengaluru Rural District, India",. Taal 2007 : The 12th World Lake Conference, 1717–28, 2008.

[14] Jumbe, Aboud S. Nandini, N." Heavy metals analysis and sediment quality values in Urban lakes" American Journal of Environmental Sciences, Source Volume: 5, Source Issue: 6, Nov, 2009

[15] Mahapatra, D.M., Chanakya, H.N. and Ramchandra,T.V, “Assessment of Treatment capabilities of Varthur Lake, Bangalore”, India’, *Int. J. Environment, Technology and Management*, Vol. 14, Nos. 1/2/3/4, pp. 84-102, 20i1.

[16] Mahuya Das Gupta Adak., Purohit, K.M., and Jayita Datta, “Assessment of drinking water quality of river Brahmani”, Indian Journal of Environmental Protection, 8(3) 285-291, 2001

[17] Nasrut jan “impact of muncipal and industrial pollution on Byramangala lake, Bangalore rural district, India” the 12th world lake conference, 2008

[18] Pradhan, S.K., Dipika Patnaik., and Rout, S.P, “Water quality index for the groundwater in and around a phosphatic fertilizer plant”. Indian Journal of Environmental Protection, 21, 355-358, 2001.

[19] Purushottam J. Puri* ,M.K.N. Yenkie, D. G. Battalwar, Nilesh V. Gandhare and Dewanand B. Dhanorkar, “Study And Interpretation Of Physico-Chemical Characteristic Of Lake Water Quality In Nagpur City (India)”, RASAYAN J Chem, Vol.3, No.4 , 800-810, 2010

[20] P. Ravikumar, Mohamma Aneesul Mehmood,, R. K. Somashekar , “Water quality index to determine the surface water quality of Sankey tank and Mallathahalli lake, Bangalore urban district, Karnataka, India”, Appl Water Sci, 3:247–261, 2013

[21] Srinivasa Kushtagi and Padaki Srinivas, “Studies on chemistry and Water Quality Index of ground water in Chincholi Taluk, Gulbarga district, Karnataka, India”, International Journal of Environmental Science, 2, 1154-1160, 2012.

Table 2: *Details of sampling points in the Study Area*

Path No	Point No.	Sample Point Name	Latitude (N)	Longitude (E)	Elevation ft	Purpose	Source
I	1	Reservoir	N12° 44' 12.0"	E77° 25' 31.1"	2304	Multi-purpose	vrishabhavathi
	15	bm14	N12° 45' 14.1"	E77° 25' 30.3"	2302	Drinking	Open well
	16	bm 15	N12° 45' 15.3"	E77° 25' 28.9"	2301	Drinking	Open well
	2	bm 1	N12° 45' 3.7"	E77° 25' 12.6"	2143	Drinking	Cauvery water
II	1	Reservoir	N12° 44' 12.0"	E77° 25' 31.1"	2304	Multi-purpose	vrishabhavathi
	13	bm 12	N12° 45' 8.4"	E77° 25' 26.4"	2292	Irrigation	Open well
	3	bm 2	N12° 45' 1.6"	E77° 25' 15.7"	2338	Drinking	Bore well
	4	bm 3	N12°44' 59.8"	E77° 25' 14.2"	2310	Domestic	Open Well
III	1	Reservoir	N12° 44' 12.0"	E77° 25' 31.1"	2304	Multi-purpose	vrishabhavathi
	14	bm 13	N12° 45' 7.8"	E77° 25' 26.9"	2290	Drinking	Open well
	12	bm 11	N12° 44' 59.9"	E77° 25' 20.1"	2276	Drinking	Bore well
	5	bm 4	N12°44' 53.5"	E77° 25' 14.8"	2243	Domestic	Bore well
IV	1	Reservoir	N12° 44' 12.0"	E77° 25' 31.1"	2304	Multi-purpose	vrishabhavathi
	20	bm19	N12° 45' 1.4"	E77° 25' 43.9"	2310	Drinking	Bore well
	7	bm 6	N12° 44' 57.5"	E77° 25' 30.9"	2292	Domestic	Open Well
	8	bm 7	N12° 44' 55.7"	E77° 25' 28.7"	2296	Domestic	Bore well
	9	bm 8	N12° 44' 55.7"	E77° 25' 26.3"	2384	Domestic	Bore well
	10	bm 9	N12° 44' 56.1"	E77° 25' 25.9"	2383	Domestic	Open well
	11	bm 10	N12° 44' 55.3"	E77° 25' 19"	2267	Domestic	Open well
	5	bm 4	N12°44' 53.5"	E77° 25' 14.8"	2243	Domestic	Bore well
V	20	bm 19	N12° 45' 1.4"	E77° 25' 43.9"	2310	Drinking	Bore well
	19	bm 18	N12° 44' 55.5"	E77° 25' 42.6"	2285	Drinking	Mini Water tank
	18	bm 17	N12° 44' 55.4"	E77° 25' 35.1"	2375	Drinking	Bore well
	17	bm 16	N12° 44' 52.8"	E77° 25' 29.9"	2349	Drinking	Bore well
	6	bm 5	N12° 44' 50"	E77° 25' 16.5"	2280	Irrigation	Pond
OTHER POINTS							
	21	MG1	N12° 45' 7.1"	E77° 26' 11.5"	2313	Drinking	Bore well
	22	MG2	N12° 45' 6"	E77° 26' 8.4"	2320	Drinking	Mini Water tank
	23	MG3	N12° 45' 2.3"	E77° 26' 14.3"	2309	Irrigation	Open well
	24	BG1	N12° 45' 23.2"	E77° 26' 11.2"	2351	Domestic	Bore well
	25	BG2	N12° 45' 22"	E77° 26' 16.8"	2361	Domestic	Bore well

Sampling point index: bm- Byramangala, MG – M.G. Doddi and BG- Bannigere