



Evaluation of Groundwater quality of the Taj city –Agra,Uttar Pradesh, India

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ABSTRACT

The physico-chemical parameters of groundwater were evaluated in the present research for different locations in the Agra city, Uttar Pradesh, India. Ten groundwater samples were collected from five sampling locations in pre-monsoon and post-monsoon season. The parameters which were selected for the research work namely pH, E. Conductivity, Alkalinity, TDS, COD, BOD, Fluoride, Cu, Fe, Mn, Ni, Pb and Zn. The analysis revealed that there is minute difference in the pre and post-monsoon season readings which does not effect on the groundwater quality. In the research work area the analysis reveals that the groundwater quality is very poor and unsuitable for drinking. Groundwater urges proper treatment before supply as the concentration of parameters like Alkalinity, TDS, COD, Ni and Pb exceed the acceptable limit for drinking water standards.

Keywords- *Physico-chemical parameters, groundwater samples.*

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INTRODUCTION

Water is called matrix of life because it is necessary part of all living systems and is the medium from which life developed and depend on it [5]. Most of human deed demand the use of water in many ways such as food, production, nutrition are reliant on water availability in sufficient quantities and good quality [7]. But regrettably the lack of the good water increases regularly due to contamination of water and overutilization, so the drinking water analysis is very important and essential for human health problems [15]. However abundant it is distributed across the earth, about only 2.5% of it is fresh water, of which only 0.03% on the surface and 0.75% in the form of groundwater is potable [11]. Groundwater is the major source of water for drinking, irrigation and industrial purposes. The availability of water determines the location and the activities of human beings in an area, and our growing population is placing great demand upon natural fresh water resources [12]. The physicochemical pollutants that badly affected the quality of groundwater is likely to arise from various sources, including land application of fertilizers, infiltration of effluent from sewage treatment plants, industrial waste, ponds, etc. [15]. Pollution of water is due to overburden by means of population pressure, uncontrolled use of pesticides in agriculture, industrialization and human activity [17]. Once the groundwater is contaminated, its quality cannot be maintained by stopping pollutants from the source therefore it becomes very important to regularly monitor the quality of groundwater. In recent years, because of rapid urbanization, growing population and industrialization, the rate of discharge of pollutants into the environment is higher than the rate of purification which ultimately affects these water bodies [10]. Groundwater resource is under threat from pollution either from human life style manifested by the low level of hygiene practiced in the developing countries [8]. Hence, there is a great urge for the protection and proper awareness for the groundwater quality. Thus, the research work is oriented to evaluate the groundwater quality for drinking and other useful purposes for people of this area.

Study Area- Agra is situated on the bank of River Yamuna. The Agra district lies in western U.P., between 27.11' degree Latitude North and 78.0' degree to 78.2' degree Longitude East. Its Altitude is 169 meters above sea level. On the North Agra is bounded by Mathura District, on the South it is bounded by Dhaulpur District, on the East it is bounded by Firozabad District and on the West it is bounded by Bharatpur (Figure1).

In Agra during June to September average monsoon rainfall is 628.6 millimeters. Agra has a status of being one of the hottest and the coldest city in India. The aquifers system of the study area is made up mainly of the alluvial sandyfacies in the form of granular zones of sands, gravels and rock particles occasionally mixed with kankars.



Figure 1: Location map of Agra city

MATERIAL AND METHODS

Sample collection- Groundwater samples were collected from five selected locations during pre-monsoon and post-monsoon season namely (Sikandra (S1), Dayalbagh (S2), Sadar (S3), Tajmahal area (S4) and Collectrate (S5) . Samples were taken in pre-cleaned plastic bottles. Samples were carried out for analysis immediately for parameters, which need to be determined instantly and rest of samples were refrigerated at 40°C to be analysed later. All the samples were collected from submersible which are used for drinking and other useful purposes in the selected sampling locations.

Physicochemical analysis- The collected samples were analysed for major physical and chemical water quality parameters like pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Dissolved Solids (TDS), Chemical oxygen demand (COD), Biochemical oxygen demand (BOD), Fluoride (F), Copper (Cu), Iron (Fe), Manganese (Mn), Nickel (Ni), Lead (Pb) and Zinc (Zn) using standard procedures. pH was measured by pH meter, E. conductivity by digital conductivity meter, Alkalinity by indicator method, TDS by filtration method, COD and BOD by titration method, Heavy metals (Cu, Fe, Mn, Ni, Pb, Zn) by atomic absorption spectrophotometry and Fluoride by ions selective electrode method. All the reagents and solutions were prepared and purified according to standard method for the analysis of water.

RESULT AND DISCUSSION

Table 1: Physicochemical parameters for different locations of Agra city

Sampling Locations →		Sikandra (S1)		Dayalbagh (S2)		Sadar (S3)		Tajmahal Area (S4)		Collectrate (S5)	
Parameters	WHO/BIS	Pre.	Post.	Pre.	Post.	Pre.	Post.	Pre.	Post.	Pre.	Post.
pH	6.5-8.5	6.70	6.75	7.00	7.05	7.10	7.13	7.21	7.31	7.10	7.20
E. Conductivity	5-50	2.39	2.37	3.38	3.37	2.34	2.31	2.39	2.37	2.58	2.55
Alkalinity	200	746	750	800	805	802	812	940	950	846	850
TDS	500	709	707	1030	1025	690	683	720	707	770	763
COD	10	152	150	104	100	106	100	54	50	98	95
BOD	6.0	1.4	1.2	1.8	1.4	1.2	1.0	1.4	1.1	1.6	1.2
Fluoride	1.0	1.0	1.2	.9	1.4	1.0	1.0	1.2	1.1	1.0	1.2
Cu	.05	.048	.044	.038	.033	.046	.042	.044	.041	.044	.042
Fe	.3	.198	.191	.100	.098	.121	.111	.152	.149	.215	.213
Mn	.1	.026	.023	.031	.029	.036	.033	.038	.036	.046	.040
Ni	.02	.982	.971	.758	.751	.848	.844	.898	.894	.934	.930
Pb	.01	.088	.086	.221	.218	.308	.306	.342	.338	.130	.128
Zn	5.0	.522	.519	.708	.701	.521	.519	.460	.459	.669	.666

Where Pre. – Pre-monsoon, Post.- Post-monsoon, All the parameters are in mg/l except E. Conductivity which is in $\mu\text{s}/\text{m}$ and TDS in ppm.

pH - The acceptable limit of pH for drinking water is 6.5-8.5. The value of pH was recorded from 6.70 to 7.31 at sampling locations during pre and post-monsoon season. The samples are found to be in the permissible limit as composed with the standard values of WHO/BIS. (Fig.1)

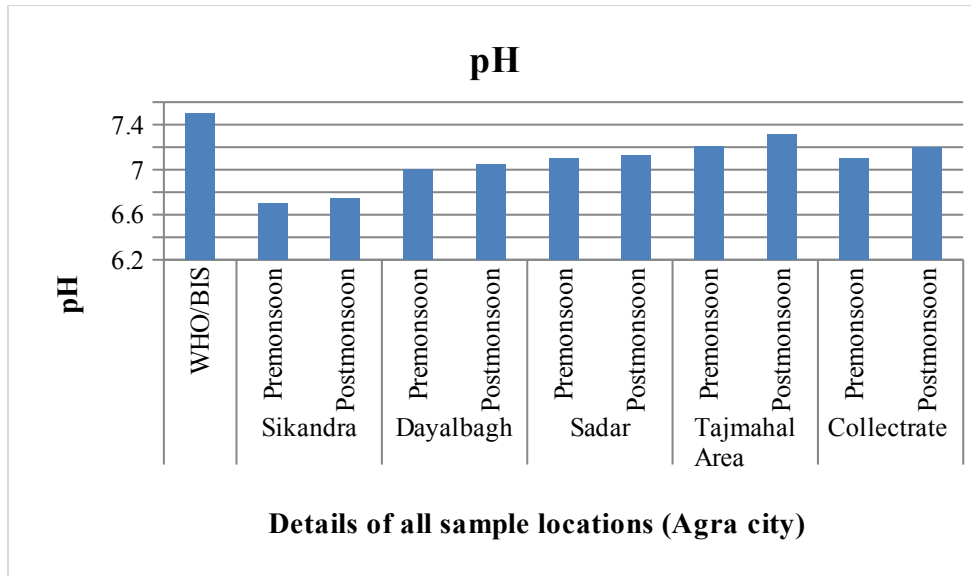


Figure 1: Variation of pH at sample locations of Agra city

E. Conductivity- Electrical Conductivity is a useful device to estimate the purity of water [1]. The permissible limit for Electrical Conductivity (EC) is $5.00 \mu\text{s}/\text{m}$. The value of EC in the sampling area ranged from $2.31 \mu\text{s}$ - $3.38 \mu\text{s}$. The samples are found to be below the permissible limit as compared with the standard values of WHO/BIS. High EC values indicate the presence of high amount of dissolved inorganic substances in ionized form. (Fig.2)

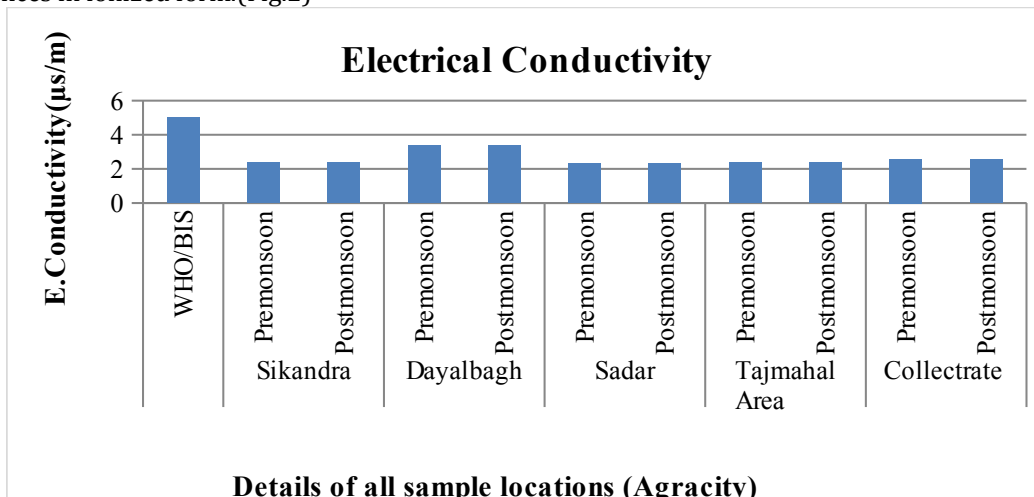


Figure 2: Variation of E. Conductivity at sample locations of Agra city

Alkalinity- Alkalinity in water gives an idea of the presence of natural salts in water. The cause of alkalinity is the minerals which dissolve in water from soil. The various ionic species that contribute to alkalinity includes bicarbonate, hydroxide, phosphate, borate and organic acids. These factors are characteristics of the source of water and natural processes taking place at any given time. The value of alkalinity was found 746 - 950 mg/l at sampling locations and found above the limit prescribed by WHO/BIS. (Fig.3)

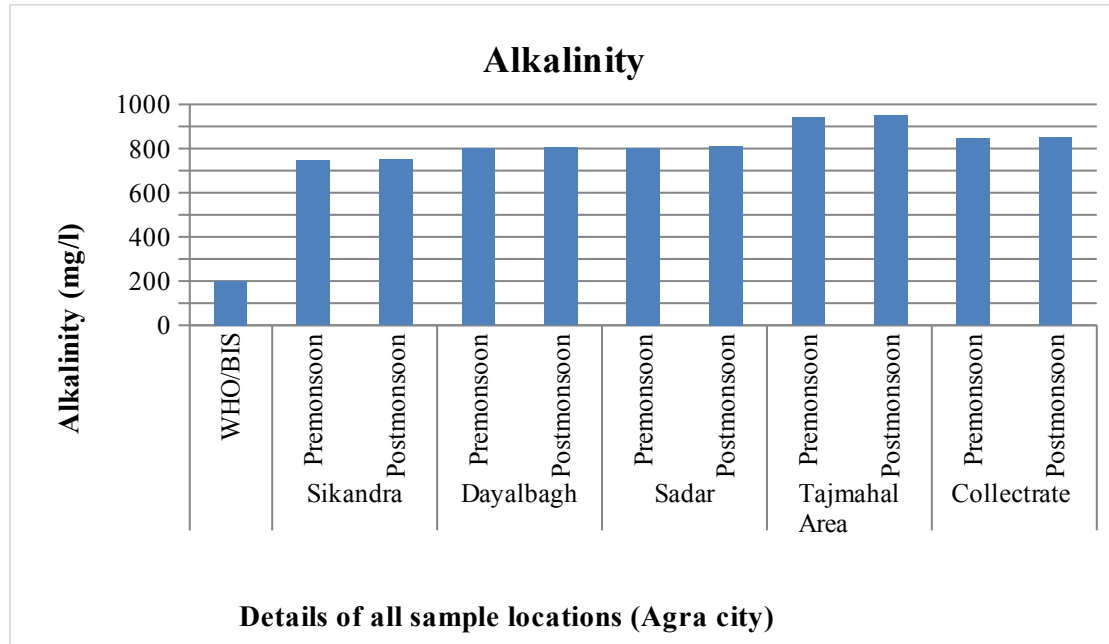


Figure 3: Variation of Alkalinity at sample locations of Agra city

TDS- The permissible limit of TDS for drinking water is 500-2000 ppm [3]. Total Dissolved Solids usually related to conductivity. Water containing more than 500 mg/l of TDS is not considered suitable for drinking water supplies, though more highly mineralized water may be used where better quality water is not available [10]. The value of TDS in the study area was found 683 ppm - 1030 ppm. The TDS values of all the water samples of the selected locations are greater than the limit prescribed by WHO/BIS. (Fig.4)

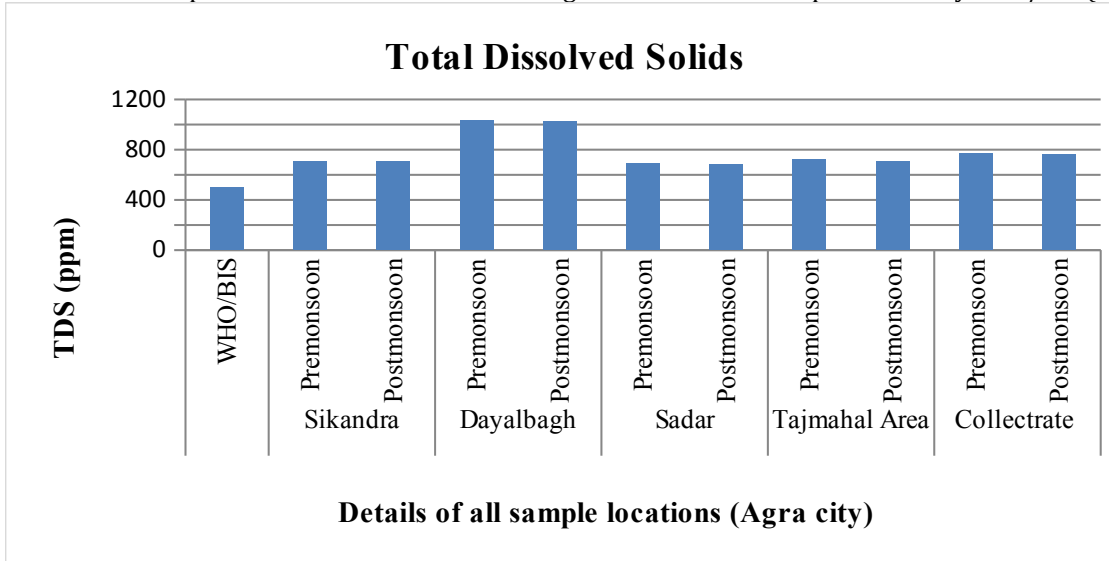


Figure 4: Variation of TDS at sample locations of Agra city

Chemical Oxygen Demand – Chemical Oxygen Demand is a measure of pollution in water bodies. COD values of the ground water samples in the present study area varied from 50-152 mg/l and all the samples of pre and post-monsoon season are found exceeding the acceptable limit of WHO/BIS. It may be due to seepage from sewage drainage or industrial discharge in nearby factories and localities (Perween, S. and Fatima, U., 2016). From (Fig.5) it is clear that all the water samples exceed the recommended range.

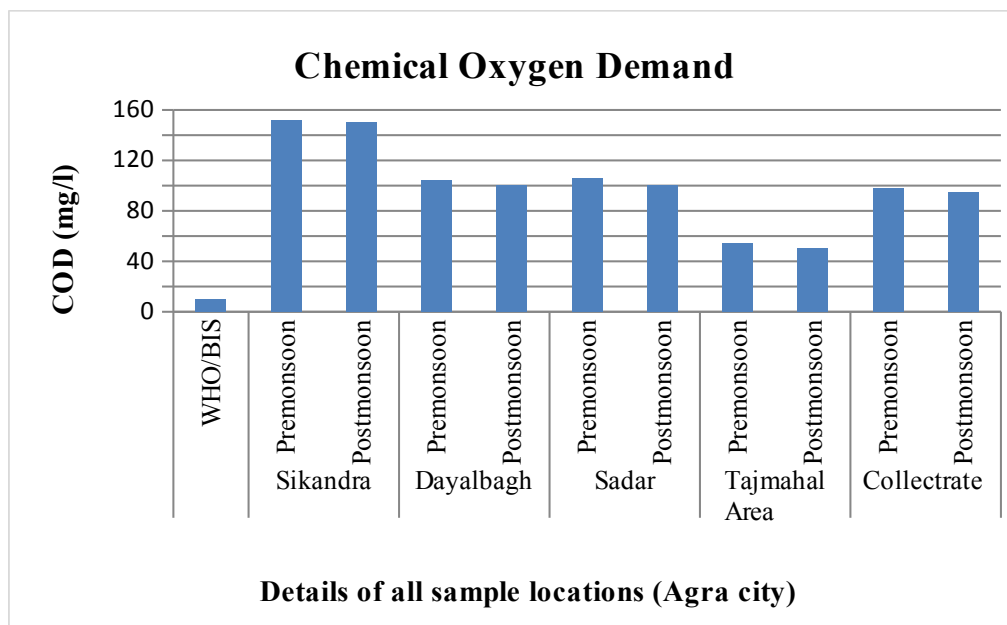


Figure 5: Variation of COD at sample locations of Agra city

Biochemical Oxygen Demand - In the present research BOD values of various ground water samples were found from 1.0-1.8 mg/l and all the samples were found below the acceptable limit of WHO/BIS (Priyadarshi, H., 2018). From (Fig.6) it can be seen that all the water samples below with the recommended limit.

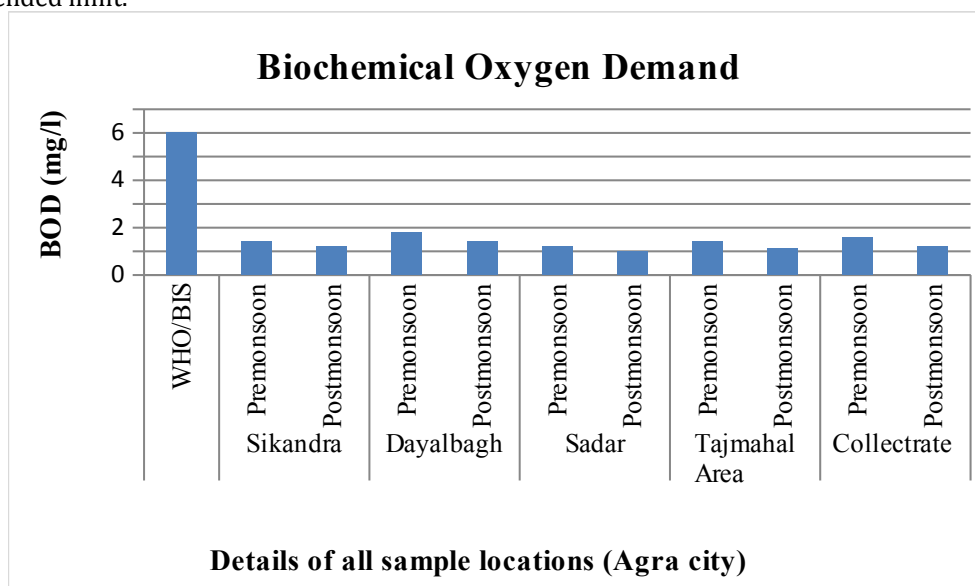


Figure 6: Variation of BOD at sample locations of Agra city

Fluoride (F) - The WHO (2011) and BIS (10500- 2012) estimates the maximum allowable limit for fluoride uptake to human's in drinking water as 1.5 mg/l. The fluoride in the ground water samples of the sampling area varied from 0.9- 1.4 ppm and most of the samples of pre and post-monsoon were found below with the permissible limits of WHO/BIS [1].(Fig.7)

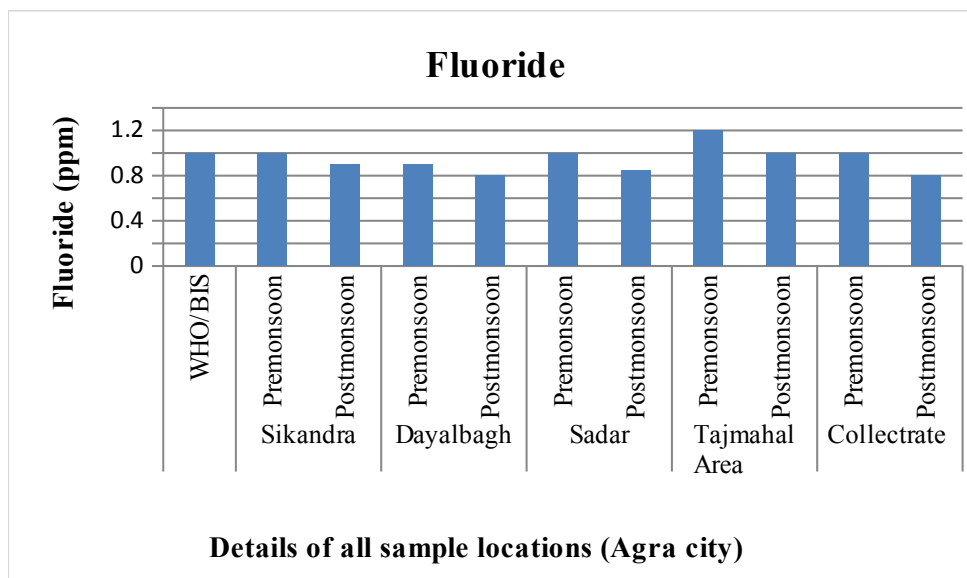


Figure 7: Variation of Fluoride at sample locations of Agra city

Copper (Cu) - Copper is both a necessary nutrient and a drinking-water contaminant. The acceptable limit of Cu is .05 mg/l. The Copper values of the research area varied from 0.033 – 0.048 mg/l and most of the samples were found below the permissible limits of WHO/BIS [6].(Fig.8)

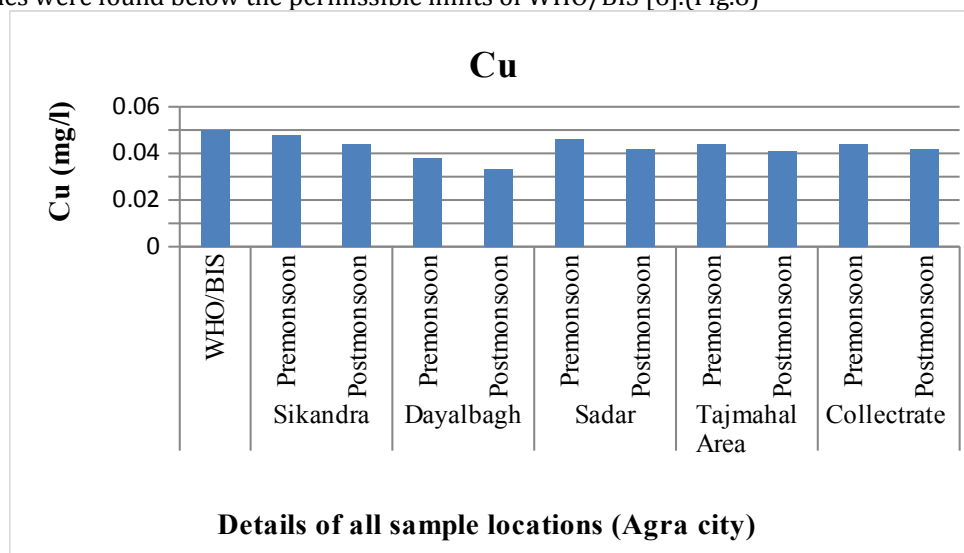


Figure 8: Variation of Cu at sample locations of Agra city

Iron (Fe) - Iron in trace amounts is essential for nutrition. The iron value in the pre and post-monsoon water sampling was found 0.1 – 0.215 mg/l and most of the samples were found below with the permissible limits of WHO/BIS [2]. The permissible limit of iron is 0.3 mg/l respectively. High concentrations of iron generally cause inky flavor, bitter and astringent taste to water.(Fig.9)

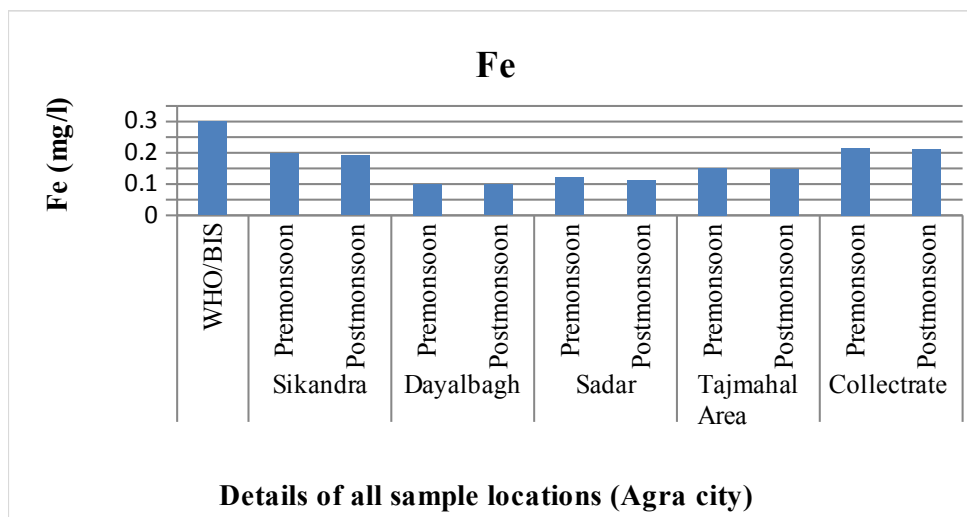


Figure 9: Variation of Fe at sample locations of Agra city

Manganese (Mn)- Manganese at levels above 0.1 mg/l, in water supplies causes an undesirable taste in beverages and stains sanitary ware and laundry. The Manganese in the ground water samples of the research area varied from 0.023 – 0.046 mg/l and most of the samples were found below the permissible limits of WHO/BIS [6].

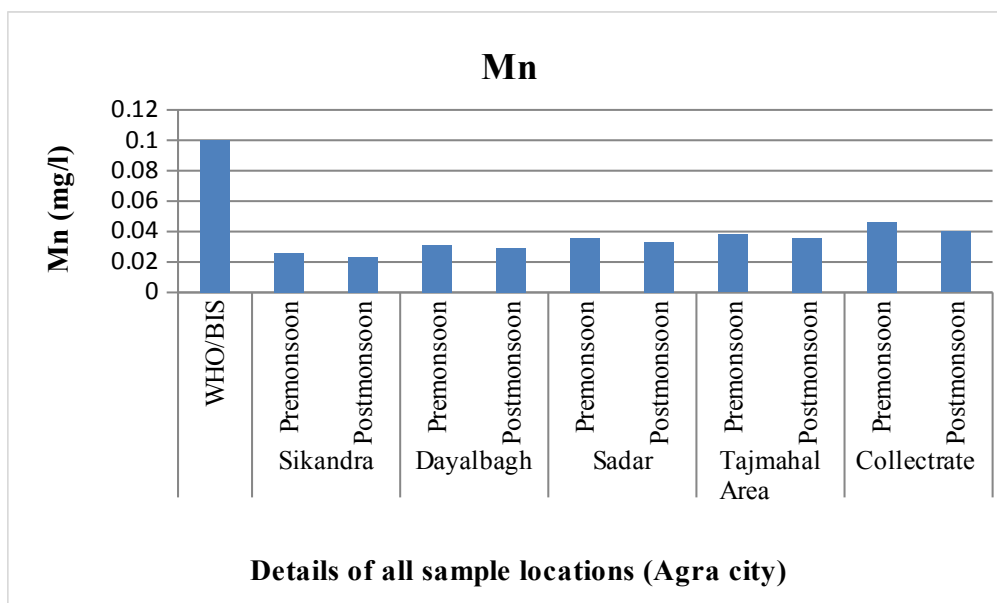


Figure 10: Variation of Mn at sample locations of Agra city

Nickel (Ni) - Nickel is found naturally in both food and water, and may be increased by human pollution. The permissible limit of Nickel in the groundwater is 0.1mg/l (BIS, 2012). The Nickel value in the groundwater samples was found from 0.751 – 0.982 mg/l and most of the samples were found above with the permissible limits of WHO/BIS.(Fig.11)

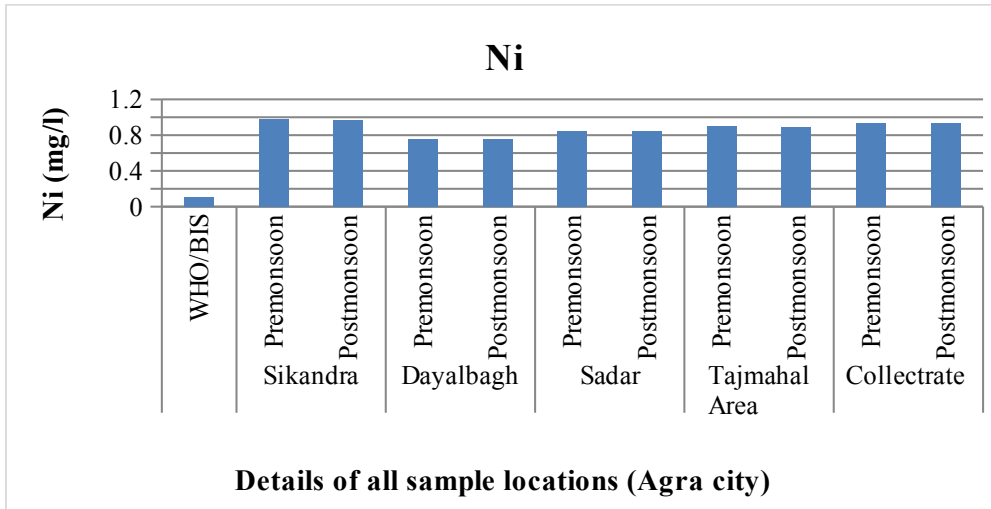


Figure 11: Variation of Ni at sample locations of Agra city

Lead (Pb) - The concentrations of lead in the groundwater normally do not exceed 0.05 mg/l, respectively. The lead in the groundwater samples of the research area in the pre and post-monsoon season varied widely from 0.086 - 0.338 mg/l and most of the samples were found above with the permissible limits of WHO/BIS.(Fig.12)

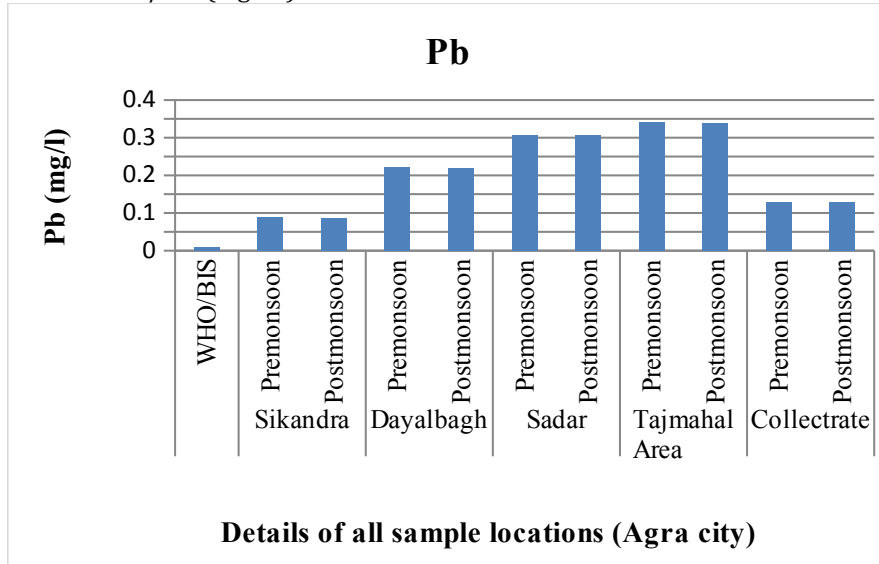


Figure 12: Variation of Pb at sample locations of Agra city

Zinc (Zn) - Zinc is an essential trace element. In general, concentration of zinc in surface water and groundwater normally do not exceed 5mg/l, respectively. The zinc in the groundwater samples of the study area varied widely from 0.459 - .708 mg/l and most of the samples were found below the permissible limits of WHO/BIS [2].

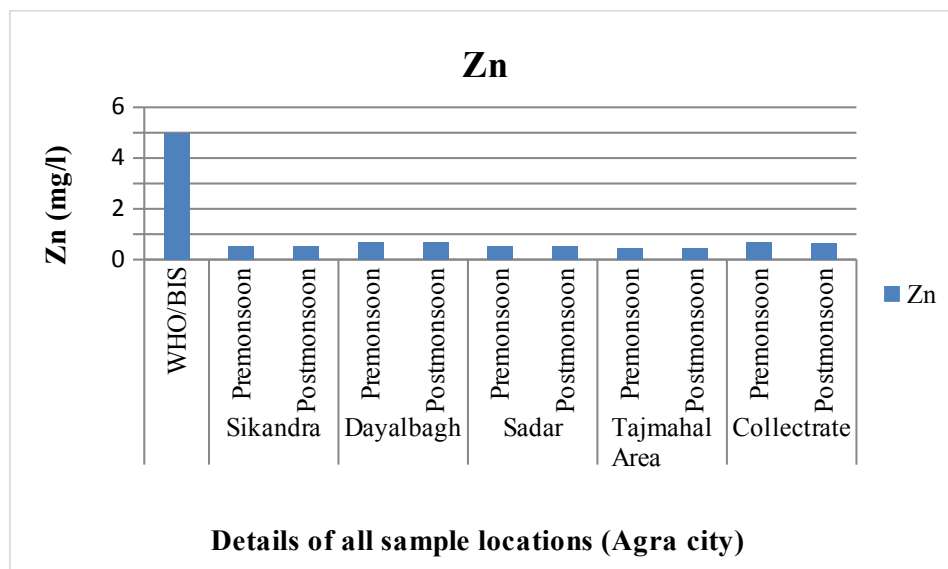


Figure 13: Variation of Zn at sample locations of Agra city

CONCLUSION

In the present time the groundwater is the primary source for drinking and other useful purposes for humans. The concentration of Alkalinity, TDS, COD, Ni and Pb exceed the acceptable limit of drinking water standards and the concentration of E. Conductivity, BOD, Fluoride, Cu, Fe, Mn, and Zn below with the acceptable limit of drinking water standards in both pre and post-monsoon season. The research work indicates that the groundwater quality is very poor and unsuitable for drinking in the study area. Groundwater urges proper treatment before supply for the people of this area. It is very clear from the graphs that there is no change in the water quality in both the seasons pre-monsoon and post-monsoon. The study emphasizes the urgent need for regular underground water quality monitoring to assess pollution activity from time to time. Public awareness program should be organized to create a sense of awareness to save water around their habitants.

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