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# Study of Ground Water Characteristics near Yamuna River Bank in Agra City

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**Abstract:** The ground water exploration is a must to fulfill population demand of the Agra city. The ground water contamination is so high it cannot be directly used for drinking purpose because of its poor quality. The aim of present study is to examine the status of ground water in Agra city along Yamuna river bank in our laboratory investigation, we find that the range of various parameters of ground water are pH (7.3-7.7), Acidity (52-68 mg/l as CaCO<sub>3</sub>), Alkalinity (58-82 mg/l as CaCO<sub>3</sub>), Total dissolved Solid (1390-2990 mg/l), Chloride (362-626 mg/l), Hardness (414-646 mg/l as CaCO<sub>3</sub>). Out of all these parameters T.D.S, Chloride & hardness are exceed their permissible limit as specified by I.S 10500-2012 of drinking water & ph, Acidity, Alkalinity are within the permissible limit of I.S 10500-2012.

**Keywords:** Groundwater, parameters, Water quality, near Yamuna bank, Agra.

## I. INTRODUCTION

The wonder of natural world is Water. Water is one of the most basic need for all the living beings. Primarily two assets of drinking water, among them first is surface water which includes river, lakes and second one is ground water which is mainly from the escape of surface water and is retained in subsoil. To sustain life ground water and surface water is crucial natural resources. In diverse forms and from diverse resources the water utilize by human beings. In this research paper I focused on the ground water quality of Agra city.

Agra city is surrounded by many leather tanneries and small scale dyeing mills and their effluents are discharged in to the Yamuna River causing impact on the quality of the underground water.

Solid waste from industries is being dumped near the factories and subjected to reaction with percolating rain water and reaches the ground water level.

The percolating water picks up a large amount of dissolved constituents and reaches the aquifer system and thus it contaminates the ground water.

Over burden by means of population pressure, unplanned urbanization, unrestricted exploration policies and discharge of the wastewater in inappropriate manner enhance the adulteration of harmful compounds to the groundwater.

The specific objectives of the study were to assess various parameters of groundwater in Agra city near Yamuna river bank.

## II. METHODOLOGY

### A. Study Area

The Agra City in Agra district is situated 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. Agra is bounded by Mathura District in North, Dholpur district in south, Firozabad district in East and Bharatpur district in West. Agra is situated on the bank of Yamuna river Our study area is in Vaibhav Puram Radha Nagar Balkeswar, Agra i.e, situated right side of Yamuna river.

### B. Sample Collection

For collecting Water sample we have selected seven points, out of which one from river Yamuna namely (S0) and six from ground water at different location at a distance about 50 meters (approx) and up to 300 meters (approx) from the bank of the river Yamuna. Ground water points are namely as, (S1), (S2), (S3), (S4), (S5), (S5), (S6) from there sample were collected. The six Water sample were collected from the houses having submersible pump withdrawing water from a depth of about 50 feet & they are all unconfined aquifer.

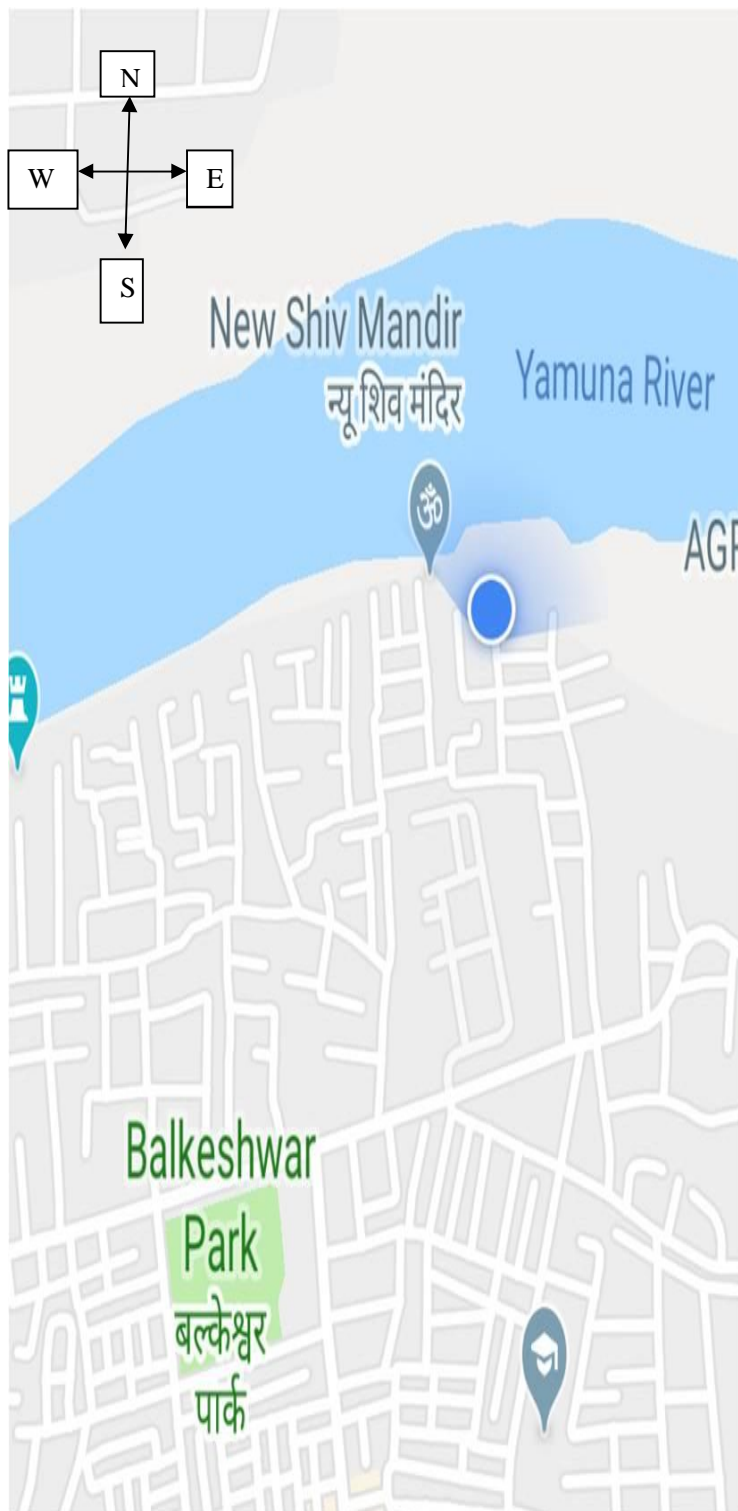


Fig. 1 Google map site picture

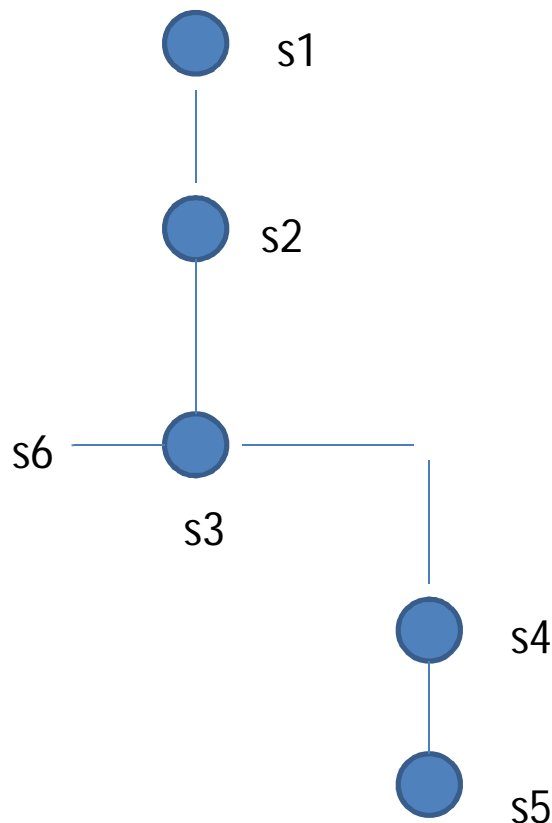
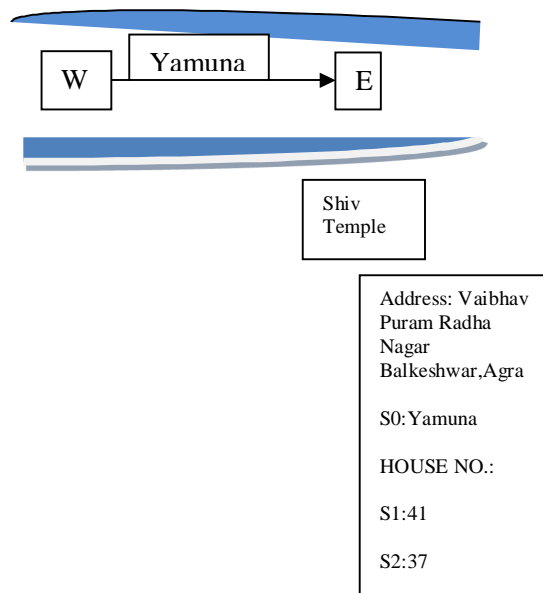


Fig.2 50m distance b/w two points (approx)

**C. Determination of Ground water Characteristics**

The collected water samples were analyzed for various parameters i.e, pH, Acidity, Alkalinity, Total dissolved Solid, Chloride & Hardness. For finding these parameters in our P.H.E lab we use standard method as prescribed in C.P.H.E.E. manual.

### III. RESULTS & DISCUSSION

We have taken readings of various water samples during January, February, March, April in 2019 which are shown below in table no.1.

Table 1(Characteristics of ground water at different location)

Location IS 10500- 2012	Parameters																							
	pH (6.5-8.5)				Acidity				Alkalinity ≤ (200 mg/l as CaCO <sub>3</sub> )				T.D.S ≤ (500 mg/l)				Chloride ≤ (250 mg/l)				Hardness ≤ (200 mg/l as CaCO <sub>3</sub> )			
	Jan	Feb	March	April	Jan	Feb	March	April	Jan	Feb	March	April	Jan	Feb	March	April	Jan	Feb	March	April	Jan	Feb	March	April
S0	7.3	7.4	7.6	7.7	30	34	40	44	34	40	42	50	1140	1160	1310	1350	210	218	234	242	220	238	244	254
S1	7.5	7.5	7.6	7.7	58	64	66	68	66	70	72	74	1390	1480	1590	1650	362	418	452	460	414	446	460	470
S2	7.6	7.6	7.7	7.8	56	62	62	66	70	74	74	78	1670	1790	1840	1880	414	446	484	494	446	478	492	502
S3	7.4	7.5	7.5	7.6	62	64	64	68	60	70	70	76	2050	2110	2390	2450	448	462	522	562	490	514	526	538
S4	7.6	7.7	7.8	7.9	52	62	62	62	72	72	80	82	2620	2710	2780	2850	508	522	552	562	522	546	558	574
S5	7.3	7.4	7.5	7.7	64	66	66	66	58	58	62	76	2880	2930	2980	2990	536	574	614	626	578	602	622	646
S6	7.5	7.5	7.5	7.6	60	64	64	68	62	62	62	76	2080	2140	2390	2455	486	502	528	536	478	520	530	542

#### A. pH

In ground water samples maximum pH was recorded as 7.9 at sampling location S4 and minimum was 7.3 at S5 location .The pH value varies between 7.3 to 7.9.

#### B. Alkalinity & Acidity

Alkalinity value in water gives an idea of natural salts present in water. The cause of alkalinity is the presence of 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. Alkalinity increases which is due to the discharge of sewage water to Yamuna & temperature also responsible for increasing alkalinity. The ground water samples maximum value of alkalinity was found as 82 mg/l as CaCO<sub>3</sub> at sampling location S4 and minimum 58 mg/l as CaCO<sub>3</sub> at S5 sampling location and found under the limit prescribed(200-600mg/l as CaCO<sub>3</sub>) by I.S 10500-2012.Acidity maximum value 68 mg/l as CaCO<sub>3</sub> at sampling location S3 & minimum value 52 mg/l as CaCO<sub>3</sub> at sampling location S4.

#### C. Total Dissolved Solid

Total Dissolved Solids is usually related to conductivity. Water containing more than 500 mg/l of TDS is not considered desirable for drinking water supplies, though more highly mineralized water may be used where better quality water is not available. The maximum value of TDS during the study period was found as 2990 mg/l at sampling location S5 and minimum was 1390 mg/l at S1 location. The TDS values of all the water samples of the selected places are greater than the limit prescribed by IS-10500-2012.T.D.S increases every month in the study period i.e, Jan to April this is because of more addition of waste water in Yamuna river & also the volume of water in river decreases during this period which is also a reason of increasing in T.D.S value.

#### D. Chloride

Chloride usually occurs as NaCl, CaCl<sub>2</sub> and MgCl in widely varying concentration, in all natural waters. The ground water maximum value of chloride was recorded as 626 mg/l at sampling location S5 and minimum was 362 mg/l at S1 location.

#### E. Hardness

Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water (Patil and Patil, 2010) & in this case due to increases of adulteration with sewage hardness is increases in the river water. Total Hardness was found in the sample water ranges from 414 mg/l as CaCO<sub>3</sub> (S1) to 646 mg/l (S5), which shows the values higher than the permissible limit prescribed by I.S 10500-2012. According to some classifications, water having hardness up to 75 mg/l as CaCO<sub>3</sub> us classified as soft, 76-150 mg/l as CaCO<sub>3</sub> is moderately soft, 151-300 mg/l as CaCO<sub>3</sub> as hard and more than 300 mg/l as CaCO<sub>3</sub> as very hard (Saravanakumar and Ranjith Kumar, 2011). On this basis, the results show that all the samples were having very high value of hardness.

#### IV. STATISTICAL ANALYSIS OF VARIOUS PARAMETER

The correlation study is useful to find a predictable relationship which can be exploited in practice. It is used for the measurement of the strength and statistical significance of the relation between two or more water quality parameters.

The correlation coefficients( $r$ ) were calculated and correlation matrix was obtained. Here,  $r$  is a dimensionless index which is in the range of -1.0 to +1.0 inclusive 0. It exhibits the extent of a relation between variables. The values of  $r$  from 0 to 1 and its indications are shown in Table 2. The  $r$  values we calculate using M.S excel .The values of correlation coefficients for different variables are listed below month wise & then its analysis according to its  $r$  values is also listed below in Table 7.

Table 2 Indication of values of coefficient  $r$

Value of $r$	Indication of the relation
0 - 0.2	Very poor correlation
0.2 - 0.4	Slightly significant correlation
0.4 - 0.6	Moderate correlation
0.6 - 0.8	High correlation
0.8 - 1	Very high correlation

Table 3 Correlation matrix for various parameters in January

Parameter	pH	Acidity	Alkalinity	T.D.S	Chloride	Hardness
pH	1					
Acidity	0.24667	1				
Alkalinity	0.815128	0.724173	1			
T.D.S	0.026419	0.597954	0.444189	1		
Chloride	0.275176	0.890466	0.74452	0.879584	1	
Hardness	0.265261	0.885619	0.736194	0.886175	0.99989	1

Table 4 Correlation matrix for various parameters in February

Parameter	pH	Acidity	Alkalinity	T.D.S	Chloride	Hardness
pH	1					
Acidity	0.366699	1				
Alkalinity	0.736635	0.820942	1			
T.D.S	0.264475	0.641205	0.3427	1		
Chloride	0.340094	0.908823	0.628897	0.893569	1	
Hardness	0.337096	0.923405	0.659442	0.883695	0.995433	1

Table 5 Correlation matrix for various parameters in March

Parameter	pH	Acidity	Alkalinity	T.D.S	Chloride	Hardness
pH	1					
Acidity	-0.12528	1				
Alkalinity	0.466252	0.782722	1			
T.D.S	-0.08377	0.60775	0.430053	1		
Chloride	-0.09036	0.901621	0.689166	0.881748	1	
Hardness	-0.08421	0.900532	0.689723	0.880999	0.999808	1

Table 6 Correlation matrix for various parameters in April

Parameter	pH	Acidity	Alkalinity	T.D.S	Chloride	Hardness
pH	1					
Acidity	-0.16371	1				
Alkalinity	0.250036	0.886654	1			
T.D.S	0.111652	0.515498	0.694993	1		
Chloride	0.075386	0.835281	0.908173	0.884417	1	
Hardness	0.083764	0.820825	0.896908	0.890849	0.999337	1

Table 7 Indication of values of coefficient r

	Very poor correlation (0-0.2)	Slightly significant correlation (0.2-0.4)	Moderate correlation (0.4-0.6)	High correlation (0.6-0.8)	Very high correlation (0.8-1.0)
Jan	(+)T.D.S & pH	(+)Acidity & pH	(+)T.D.S & Acidity	(+)Alkalinity & Acidity	(+)Hardness & Chloride
		(+)Chloride & pH	(+)T.D.S & Alkalinity	(+)Chloride & Alkalinity	(+)Hardness & T.D.S
		(+)Hardness & pH			(+)Hardness & Acidity
					(+)Chloride & Acidity
					(+)Chloride & T.D.S
					(+)Alkalinity & pH
Feb		(+)Acidity & pH	(+)Hardness & Alkalinity	(+)Alkalinity & pH	(+)Alkalinity & Acidity
		(+)T.D.S & pH		(+)T.D.S & Acidity	(+)Chloride & Acidity
		(+)T.D.S & Alkalinity		(+)Chloride & Acidity	(+)Chloride & T.D.S
		(+)Chloride & pH			(+)Hardness & Acidity
		(+)Hardness & pH			(+)Hardness & T.D.S
					(+)Hardness & Chloride
March	(-)Acidity & pH		(+)Alkalinity & pH	(+)Alkalinity & Acidity	(+)Chloride & Acidity
	(-)T.D.S & pH		T.D.S & Alkalinity	(+)T.D.S & Acidity	(+)Chloride & T.D.S
	(-)Chloride & pH			(+)Chloride & Alkalinity	(+)Hardness & Acidity
	(-)Hardness & pH			(+)Hardness & Alkalinity	(+)Hardness & T.D.S
					(+)Hardness & Chloride
April	(-)Acidity & pH	(+)Alkalinity & pH	(+)T.D.S & Acidity	(+)T.D.S & Alkalinity	(+)Alkalinity & Acidity
	T.D.S & pH				(+)Chloride & Acidity
	Chloride & pH				(+)Chloride & Alkalinity
	Hardness & pH				(+)Chloride & T.D.S
					(+)Hardness & pH
					(+)Hardness & Acidity
					(+)Hardness & Alkalinity
					(+)Hardness & T.D.S
					(+)Hardness & Chloride

**V. MEASURES SUGGESTED TO IMPROVE THE GROUND WATER QUALITY OF AGRA FOLLOWING**

**A. Rain Water Harvesting**

To improve ground water quality the better way is to recharge the ground water as much as possible with the roof top rain water harvesting.

**B. Proper Disposal of Waste**

Legitimately discarded lethal substances like unused pharmaceuticals, synthetics, paint, engine oil, and other substances are required to be properly disposed off in environmental friendly technique.

**C. Save Water**

We can save water by using various techniques like Re-use grey water, Turn off the tap while brushing your teeth or hand washing & use spray nozzle in tap by atomizing water we can save at least 60% of water.



*D. Natural other Alternatives*

Use all natural/nontoxic household cleaners. Materials such as lemon juice, baking soda, and vinegar make great cleaning products, are inexpensive, and environmentally-friendly.

## VI. CONCLUSION

Analysis of water samples collected from the above locations of Agra city revealed that water samples do not comply with IS 10500-2012 standard for drinking purpose. Groundwater in Agra region needs precautionary measures before drinking so as to prevent health effects on human beings.

- A. T.D.S, Chloride & Hardness are found higher than the permissible limit.
- B. ph, Acidity, Alkalinity are found under the permissible limit.
- C. Correlation matrix for various parameter shows that no significant changes in our readings during four months of study i.e, Jan to April 2019.
- D. In our research we found that the reading values were increases every month during our study period i.e, Jan to April 2019.

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