



## Research Article

### QUALITY OF GROUND WATER USED FOR DRINKING IN ORAI, DISTRICT- JALAUN, UTTAR PRADESH

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#### ABSTRACT

The present investigation is to study the nature of ground water of the jalaun-orai, which is located in Jalaun district utter Pradesh. Ground water samples collected from industrial area and residential area in twenty different stations were analysed. It is situated near highway NH-25 in between Jhansi and Kanpur and on Birayan panwari SH-21. It is located in the Bundelkhand region. Physico-chemical analysis of water was carried out referring the standard method 1992. The concentration of heavy metals, temperature, PH, TDS, DO, BOD, COD, Chloride, Sulphate, Phosphate and alkalinity were compared with the standards for WHO for drinking water. The mean value of each parameter together with its standard deviation (SD) and Coefficient variation (CV) were calculated. A systematic calculation was made to determine the correlation coefficient  $r$  and  $t$  amongst the parameters. In the present study heavy metals like copper, cobalt and Iron in all they were below the permissible limit prescribed by WHO.

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## INTRODUCTION

Ground Water is one of the most important and basic natural resources. Water is not only one of the most essential commodities of our day-to-day life, but the development of this natural resource also plays a crucial role in economic and social development processes. While the total amount of water available in the world is constant and is generally said to be adequate to meet all the demands of mankind, its quality and distribution over different regions of the world is uneven and causes problems of scarcity and suitability. It is therefore imperative that man develops, uses and manages this scarce commodity as rationally and efficiently as possible. In order to execute this task, accurate and adequate information must be available about the quality of this natural resource under constantly changing human pressures and natural forces (CPCB, 2012). Water is a prime natural resource, a basic human need and a precious national asset and hence its use needs appropriate planning, development and management. It has unique chemical properties due to its polarity and hydrogen bonds so that it is able to dissolve, absorb and adsorb various compounds. Therefore in nature, water is not pure as it acquires contaminants from its surrounding and that arising from humans and animals as well as other biological activities.

Water quality analysis is important aspect in ground water studies. The hydro chemical study reveals quality of water for its suitability for drinking, agriculture and industrial purposes (Agarwal, 2013). Groundwater is also often withdrawn for agricultural, municipal, and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is hydrogeology, also called groundwater hydrology. Typically, groundwater is thought of as liquid water flowing through shallow aquifers, but, in the technical sense, it can also include soil moisture, permafrost (frozen soil), immobile water in very low permeability bedrock, and deep geothermal or oil formation water (Annal, 2014). The ever increasing development in all the sectors like industrial, agricultural and urban is increasing the contamination of water resources system. Pollutants are accumulated in ground water and soil due to the processes of continuous discharge of industrial, agricultural and domestic effluents (Malassa, 2014). The quality of ground water depends on a large number of hydrological, physical, chemical and biological factors. Generally higher proportions of dissolved constituent are found in ground water than in surface water because of grater interaction of groundwater with various materials in geological strata Ground water has been used a major source of drinking water in both rural and urban areas in the world. In India, almost 80% of the rural population depends on untreated ground wate (Tripathi, 2015).

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Table 1.

S. NO.	Sampling location	Water Source	Depth in fit	Description of sampling location
1	Medical College (RW-1)	Tube Well	200	Near Government .Medical College, Kanpur Road Orai
2	Industrial Area (IW-2)	Hand Pump	80	Industrial Area Gate no 1 Orai
3	Court (RW-3)	Hand Pump	75	District Court Near Kalpi Bus Stand Orai
4	Industrial Area (IW-4)	Hand Pump	80	Industrial Area Gate no 2 Orai
5	Vikashbhawan (RW-5)	Hand Pump	80	Near jilaparisha Jalaun Road Orai.
6	D M Office (RW-6)	Hand Pump	80	D M Office Jalaun Road Orai.
7	Nayapatel Nagar (RW-7)	Tube Well	200	Near patel Nagar Orai
8	Thadesawri Mandir (RW-8)	Tube Well	200	Near Thadesawri Mandir Jail Road Orai
9	Bus Stand (RW-9)	Hand Pump	90	Konch Bus Stand Orai
10	Ram Nagar(RW-10)	Tube Well	200	Near D VC Degree college Orai.
11	Railway Station (RW-11)	Tube Well	270	In front of Railway Station Road Orai.
12	Radhakrshna Mandir (RW-12)	Tube Well	250	Near Radhakrshna Mandir Galla Mandi Rath Road Orai
13	Moni Mandir (RW-13)	Hand Pump	50	Near Over Bridge Rath Road Orai
14	Twoun Hall (RW-14)	Hand Pump	80	Near Twoun Hall Orai
15	Bhagat Sing Crosing (RW-15)	Hand pump	80	Machchhar Chauraha Orai.
16	Jila Hospital (RW-16)	Tube Well	200	Raj Marg Orai
17	Tulshi Nagar(RW-17)	Hand Pump	80	Near Ice Factory Orai
18	Ghanta Ghar (RW-18)	Tube Well	200	Men Market Orai Near Ghanta Ghar
19	R T O Office(RW-19)	Hand Pump	80	Churkhi Road Orai
20	Indra stadium (RW-20)	Hand Pump	80	Near stadium Orai

The quality of ground water depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region. Industrial waste and the municipal solid waste have emerged as one of the leading cause of pollution of surface and ground water. In many parts of the country available water is rendered non-potable because of the presence of heavy metal in excess. The situation gets worsened during the summer season due to water scarcity and rain water discharge. Contamination of water resources available for household and drinking purposes with heavy elements, metal ions and harmful microorganisms is one of the serious major health problems (Patil, 2012). Pollution of water is due to increased human population, industrialization, use of fertilizers in agriculture and men made activity. Water parameters such as temperature, turbidity, nutrients, hardness, alkalinity, dissolved oxygen etc. are some of the important factors that need to be considered during water quality assessment studies. The physical and chemical methods are concerned with a variety of procedure, each applicable to a particular situation. In many instances a combination of chemical analysis is needed to obtain a reasonably accurate picture of the quality of water (Verma, 2014).

### Study area

Orai is a city and a municipal board in Jalaun district in the Indian state of Uttar Pradesh. It is the district headquarters for Jalaun District which is part of Jhansi division. It is situated near Highway NH25 in between Jhansi and Kanpur and on Bilrayan-Panwari SH21. It is located in the Bundelkhand region. Orai is located at 25°59'N 79°28'E / 25.98°N 79.47°E. This place has a composite climate, with high temperatures during the summer and low during the winter. Relative humidity remains about 40-50%. The climate of Orai district is characterized by a hot summer and general dryness except rainfall during the southwest monsoon season.

### MATERIALS METHODS

The water from hand pumps and bore wells were collected monthly once for 4 month from march- 2015 to June 2015. The water samples were collected in polythene double Stoppard bottles, which were cleaned previously with acid and deionised

water (NEERI, 1986). Chemical used in the study were AR/GR grade and obtained from M/S Qualigens - Fisher Scientific, Mumbai. Physical parameters like temperature, pH, TDS, EC and DO were determined on the site with the help of multi parameter analyzer kit. The total hardness, BOD, COD, Chloride, sulphate, phosphates and alkalinity were determined by titration methods. The metals Cu, Ni, Co, Pb, and Fe were analyzed by atomic absorption Spectrophotometer (Electronic Corporation of India limited, Hyderabad following the procedure prescribed in standard methods (APHA, AWWA, 1992). Locations of the study area were show in Table-1.

## RESULTS AND DISCUSSION

### Physico-Chemical Characteristics of Ground Water

The ground water samples were analysed some parameter like temperature, pH, TDS, TH, Alkalinity, DO, BOD, COD, chloride, sulphate, phosphate and heavy metal Analysed all the result are presented in Table-2, Table-3 and Figure-1and 2. Drinking water standard values are presented in Table-4.

### Study of Physico-Chemical Parameter

Temperatures of the samples were found between 30°C to 35 °C, the highest temperature was recorded 35.1°C at sampling station RW5 Vikash Bhawan. The pH values of drinking water sample are range between 6.2 to 7.3. Its highest value found 7.3 and lowest value found 6.2. Total dissolve solid content of a sample of water is important in deciding wither the water suitable for drinking purpose or not. In the present study the lowest value of TDS are RW10 Ramnagar (53 mg/l) and the highest value of RW6 DM Office (232mg/l). All the result was below the permissible limit prescribed by WHO as 500 mg/l. In the present study the TH of water was found to be 140 to 553 mg/l. The highest value was found 553 mg/l at sampling location RW<sub>13</sub> Moni Mandir and lowest value was found 140 mg/l at sampling location RW5 Vikash Bhawan All the result were below the permissible limit prescribed by WHO(1994) as 300 - 600 mg/l. The DO value range from 1.0 mg/l to 7.0mg/l the highest DO was observed at(7.0mg/l) RW<sub>13</sub> Moni Mandir as show in Table-2 and lowest value was recorded at sampling station RW<sub>14</sub> .(1.0mg/l) RW<sub>13</sub> Moni Mandir sampling station above of permissible limit prescribed by WHO as 4.0 mg/l.

**Table 2. Physico-chemical characteristics of ground water quality in Orai, District- Jalaun, Uttar Pradesh**

Sampling Stations	Temp (°C)	PH	TDS	Total Hard.	DO	BOD	COD	Chloride	Sulphate	Phosphate	alkalinity
RW <sub>1</sub>	34.0	6.6	110	340	2.6	8.5	9.2	275.0	1.59	0.035	210
IW <sub>2</sub>	35.0	6.8	216	380	1.7	11.6	20.0	30.0	1.62	0.068	170
RW <sub>3</sub>	31.2	6.7	85	278	3.6	5.2	10.3	45.0	1.14	0.003	198
IW <sub>4</sub>	31.0	6.2	112	360	1.4	13.8	31.0	23.0	3.29	0.013	205
RW <sub>5</sub>	35.1	6.8	56	140	3.9	4.8	6.7	63.0	1.42	0.008	194
RW <sub>6</sub>	33.5	7.1	232	170	4.3	5.6	9.2	21.5	1.23	0.010	220
RW <sub>7</sub>	30.0	6.3	140	210	2.9	6.3	13.4	31.8	5.69	0.024	108
RW <sub>8</sub>	31.0	6.5	68	235	5.2	2.9	5.8	23.0	0.03	0.001	197
RW <sub>9</sub>	31.2	6.7	127	546	3.1	7.2	19.2	69.0	1.76	0.021	215
RW <sub>10</sub>	32.3	7.2	53	236	3.5	5.4	10.8	36.5	2.34	0.005	218
RW <sub>11</sub>	31.5	6.2	184	315	2.3	5.0	8.9	77.2	0.08	0.002	233
RW <sub>12</sub>	30.0	6.4	78	184	4.2	5.3	14.3	103	1.92	0.016	209
RW <sub>13</sub>	31.0	6.9	60	553	7.0	5.2	8.7	41.0	4.64	0.008	220
RW <sub>14</sub>	32.4	7.5	204	310	1.0	9.2	23.0	80.0	2.56	0.014	187
RW <sub>15</sub>	34.3	6.7	145	456	2.0	10.2	28.0	115	1.82	0.027	230
RW <sub>16</sub>	31.2	7.3	122	432	4.3	5.8	24.6	76.0	3.42	0.003	148
RW <sub>17</sub>	32.0	6.4	96	520	3.0	6.5	14.2	62.5	2.79	0.001	212
RW <sub>18</sub>	30.5	6.5	131	530	4.6	8.4	16.7	140	0.63	0.007	189
RW <sub>19</sub>	33.0	6.7	89	324	3.7	3.4	9.0	166.0	0.41	0.014	196
RW <sub>20</sub>	34.3	6.4	127	295	2.9	3.6	9.5	260.0	1.05	0.006	242
Means	32.225	6.695	121.75	340.70	3.36	6.695	14.62	86.925	1.972	0.014	200.05
SD	1.640	0.362	53.15	129.74	1.40	2.820	7.367	73.391	1.456	0.016	30.672
CV	5.08	5.41	43.65	38.08	41.79	42.12	50.37	84.42	73.83	109.79	15.33

**Table 3. The correlation coefficient (r). Among various water quality parameter (Statistical analysis of ground water quality in Orai Jalaun)**

	Temp °C	PH	TDS	Total Hard.	DO	BOD	COD	Chloride	Sulphate	Phosphate	alkalinity
Temp °C	1										
Ph	0.2467	1									
	1.0799										
TDS	0.2549	0.1695	1								
	1.1181	0.7297									
TH	-0.1661	-0.0205	0.0118	1							
	-0.7143	0.0871	0.0502								
DO	-0.3316	0.0917	-0.5170	0.0770	1						
	-1.4910	0.3907	-2.561	0.0500							
BOD	0.1210	-0.0268	0.4096	0.3389	-0.6222	1					
	0.5170	0.1138	1.9048	1.5281	-3.370						
COD	-0.0820	0.1181	0.3286	0.4147	-0.5387	0.8044	1				
	-0.3491	0.5043	1.4760	1.9334	-2.7122	5.7437					
Chloride	0.3457	-0.1742	-0.0567	0.0963	-0.1307	-0.1122	-0.1543	1			
	1.5630	0.7504	-0.2409	0.4105	-0.5590	-0.4788	-0.6623				
Sulphate	-0.3322	0.1210	-0.0904	0.1726	0.0440	0.2546	0.3275	-0.314	1		
	-1.4942	0.5170	-0.3850	0.7434	0.2076	1.1167	1.4701	-1.405			
Phosphate	0.4320	0.0095	0.4295	0.0785	-0.4312	0.5773	0.2937	0.086	0.091	1	
	2.0319	0.0404	2.0175	0.3338	-2.0275	2.9994	1.3032	0.366	0.390		
Alkalinity	0.2911	-0.1114	-0.0974	0.1280	0.0374	-0.1134	-0.1873	0.298	-0.511	-0.2542	1
	1.2933	0.4754	-0.4149	0.5474	0.1589	-0.4839	-0.8090	1.325	-2.527	-1.1150	

he BOD value range from 2.9 mg/l to 13.8 mg/l, the highest BOD was observed (13.8 mg/l) at sampling station IW<sub>4</sub> Industrial area while lowest value was observed (2.9 mg/l) at sampling station RW<sub>8</sub> Thadeswari Mandir. Value of BOD at sampling station IW<sub>2</sub> Industrial area (11.6), RW<sub>15</sub> (10.2), RW<sub>14</sub> Town hall (9.2), RW<sub>1</sub> Medical college (8.5), RW<sub>18</sub> Ghanta Ghar (18.4), RW<sub>9</sub> Bus stand (7.2) are higher than the permissible limit prescribe by WHO as 6mg/l. Khan *et al.*, 2004 studied ground water quality of Nanded City and reported BOD value from 0.72 mg/l to 6.12 mg/l. The COD value range from 5.8 mg/l to 31.00 mg/l as show in Table-2. The value of COD at sampling stations IW<sub>4</sub> Industrial area (31.0), IW<sub>2</sub> Industrial area

(20.0), RW<sub>7</sub> Naya patel nagar (13.4), RW<sub>9</sub> Bus stand (19.2), RW<sub>12</sub> Radha Krishna mandir (14.3), RW<sub>14</sub> Twoun hall (23.00), RW<sub>15</sub> Bhagat singh crossing (28.00), RW<sub>16</sub> Jila hospital (24.00), RW<sub>17</sub> Tulshi nagar (14.00), and RW<sub>18</sub> Ghanta ghar (16.00), are higher than the permissible limit prescribe by WHO as 10mg/l. G.B. Panth *et al.*, 2011 studied of determination of some parameter of ground water Wadali Talo, Amravati, Maharashtra in India and reported chloride concentration ranged from 2.00 to 5.00mg/l. The concentration of Chloride ranged from 21.00 to 275 mg/l can be seen from the table-2. Chloride concentrations in 18 sampling stations are below the permissible limit except two location RW<sub>1</sub> medical

colleges (275mg/l) and RW<sub>20</sub> Indra stadium (260mg/l). G.B. Panth et al studied of determination of some parameter of ground water Wadali talo, Amravati, Maharashtra in India and reported chloride concentration ranged from 113 to 226mg/l. The sulphate value ranged from 0.03 mg/l to 5.69 mg/l. All the sulphate values were recorded with in the (0.03 to 5.69 mg/l) range of permissible limit prescribed by WHO (1994) as 250mg/l. In the present investigation of all the water samples have low phosphate concentration.

negative relationship with DO, Chloride, Sulphate and Alkalinity. Total hardness in present investigation showed positive relationship with TDS, DO, BOD, COD, Chloride, Sulphate, Phosphate and Alkalinity and negative relationship with Temperature and pH. The dissolve Oxygen of the ground water in orai during month of March to April showed significant positive relationship with pH, DO, Sulphate and Alkalinity and negative relationship with Temperature TDS, BOD, COD Chloride, and Phosphate.

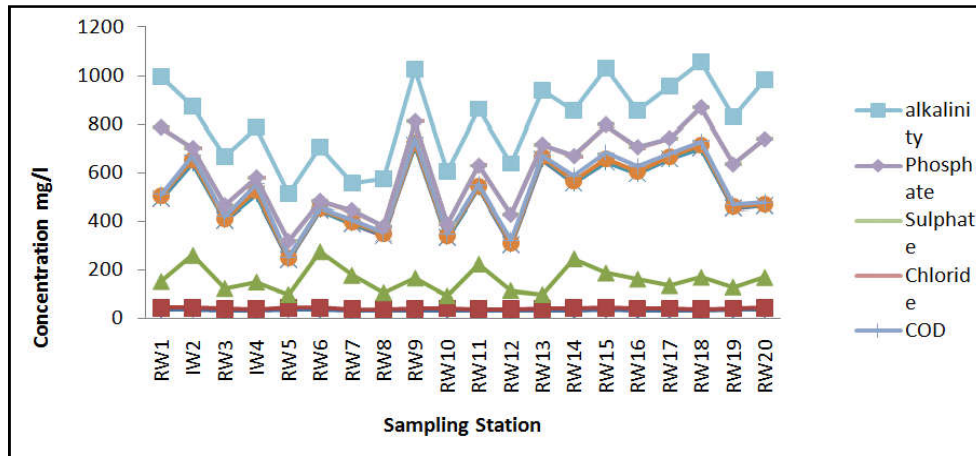


Fig. 1. Physico-chemical parameter in ground water of Orai (Jalaun)

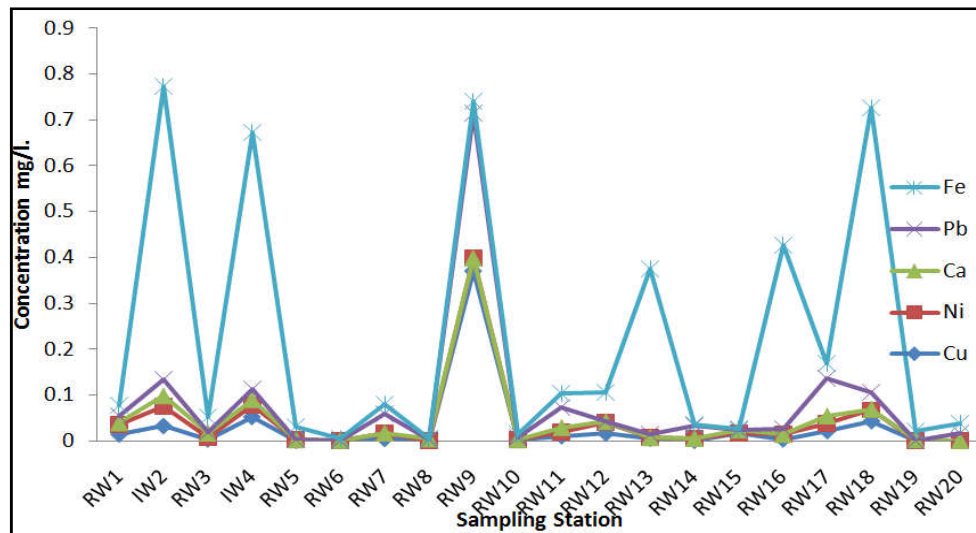


Fig. 2. Metal concentration of ground water sample in Orai (Jalaun)

They were very low concentrations well below the permissible limit. The minimum and maximum concentrations of total alkalinity were 108 to 242 mg/l respectively. Alkalinities in all the sample are below the permissible limit prescribe by WHO. The present study deal with various relationship derived statistically by calculation (r) among the physico-chemical characteristic. The (r) value investigated negative 23 times and positive 43 times showed positive relationship in the present ground water study. Temperature showed positive relationship with pH, TDS, BOD, Chloride ,Phosphate and Alkalinity and negative relationship with TH, DO, COD and Sulphate. pH showed positive relationship with TDS, DO, COD, Sulphate and Phosphate and negative relation with TH, BOD, Chloride and Alkalinity. TDS showed positive relationship with Temperature, pH, TH, BOD, COD and Phosphate significant

Biological oxygen demand in the present investigation showed negative relationship pH, DO, Chloride alkalinity and significant positive relationship. With temperature, TDS, TH, COD, Sulphate and phosphate. Chemical oxygen demand showed positive relationship with pH, TH, TDS, BOD, sulphate and Phosphate and negative relationship with temperature , DO, chloride and alkalinity. Chloride showed negative relationship pH, TDS, DO, BOD, COD, and Sulphate and significant positive relationship with temperature, TH, Phosphate and alkalinity. Sulphate showed significant positive relationship between ground water with pH, TH, DO, BOD, COD, and Phosphate and negative relationship with temperature, TDS, Chloride and Alkalinity. Phosphate showed significant positive relationship with temperature, pH, TDS, TH, BOD, COD, Chloride and Sulphate and negative relationship with DO and

Alkalinity. Alkalinity showed significant positive relationship between ground water temperature, pH, DO, and chloride and negative relationship with pH, TDS, BOD, COD, Sulphate and phosphate. Investigated the different Physico-chemical characteristic of ground water of orai and stabilized the co-relation by ANOVA statistical software. The table value of 5% significant level was 2.101 and at 1% level were 2.878. In the case of DO and TDS, COD and DO and Alkalinity and Sulphate we established a co-relationship which were negative and value were -2.56, -2.71 and -2.52 respecting which was greater than 5% significant level. For COD and BOD we have found positive value of co-relationship at 1% significant level i.e. 5.743 and BOD and dissolve oxygen were found negative value of co-relation at 1% significant level i.e. 3.291. It showed that DO, TDS, COD, Alkalinity, Sulphate, BOD play major role in the physico-chemical characteristic of ground water of Orai (Jalaun) during study period.

**Table 4. Heavy metal concentrations of ground water in Orai, District- Jalaun, Uttar Pradesh**

Sampling Stations	Cu	Ni	Ca	Pb	Fe
RW <sub>1</sub>	0.014	0.021	0.004	0.015	0.022
IW <sub>2</sub>	0.032	0.043	0.023	0.036	0.64
RW <sub>3</sub>	0.003	0.005	0.009	0.003	0.030
IW <sub>4</sub>	0.052	0.025	0.013	0.023	0.56
RW <sub>5</sub>	ND	0.002	ND	0.001	0.026
RW <sub>6</sub>	0.001	ND	ND	ND	0.004
RW <sub>7</sub>	0.004	0.012	0.001	0.043	0.019
RW <sub>8</sub>	ND	ND	0.004	ND	ND
RW <sub>9</sub>	0.37	0.029	ND	0.316	0.027
RW <sub>10</sub>	0.002	ND	ND	0.005	0.006
RW <sub>11</sub>	0.010	0.009	0.010	0.044	0.029
RW <sub>12</sub>	0.016	0.023	0.003	ND	0.062
RW <sub>13</sub>	0.005	0.002	ND	0.009	0.36
RW <sub>14</sub>	ND	0.004	0.001	0.029	ND
RW <sub>15</sub>	0.017	ND	0.006	0.002	ND
RW <sub>16</sub>	0.003	0.011	ND	0.012	0.40
RW <sub>17</sub>	0.021	0.017	0.016	0.083	0.031
RW <sub>18</sub>	0.043	0.024	0.002	0.037	0.62
RW <sub>19</sub>	ND	ND	0.002	ND	0.018
RW <sub>20</sub>	ND	ND	ND	0.017	0.02

**Table 5. Correlation analysis of heavy metal content of Orai(Jalaun)**

	Cu	Ni	Co	Pb	Fe
Cu	1				
Ni	0.3923	1			
Co	0.3170	0.5622	1		
Pb	1.4180	**2.8840		1	
Fe	0.9621	0.3990	0.3008		1
	1.4966	1.8460	1.3379		
	-0.0754	0.4610	0.3008	-0.1769	
	-0.3207	*2.2039	1.3379	0.7625	

**Table 6. WHO guideline for drinking water quality, 1984**

Parameter	Standard value
Temperature	25 <sup>0</sup> C to 35 <sup>0</sup> c
PH	8.5 mg/l
TDS	500Mg/l
Total hardness	300-600mg/l
DO	4Mg/l
BOD	6 mg/l
COD	10mg/l
Nitrate	45 mg/l
Sulphate	250mg/l

## Study of heavy metal

Metal contents like copper, nickel, cobalt, lead and iron the mean value were observed as (0.039), (0.016), (0.007), (0.042) and (0.169) mg/l respectively. The S.D. value of copper (0.081), nickel (0.006), lead (0.069), and iron (0.228) of each metal between very little variation the coefficient variation value of copper (206.18), nickel (77.09), cobalt (86.61) and lead (165.44) showed significant coefficient variation from one station to other.

### Copper

Copper concentration was found range from 0.001 to 0.052 mg/l. Copper concentration was not detected at five sampling station. All samples were below the recommended level of WHO (1.0mg/l). Sabhapandit et al, 2011 studied the physico-chemical characteristics of ground water and surface water in Gohpur Sub-division of Sonitpur District, Assam (India) and reported copper concentration ranged between 1.3 to 7.4 mg/l.

### Nickel

The minimum and maximum concentrations of nickel were 0.002 to 0.043 mg/L respectively. Samples showed measurable concentrations of nickel, expect of IW<sub>2</sub> Industrial area (0.043), IW<sub>4</sub> industrial area (0.025), RW<sub>9</sub> Bus stand (0.029), and RW<sub>18</sub> Ghanta ghar (0.043) samples exceeded the maximum contaminant limits for WHO drinking water. Reddy *et al.*, 2012 Carried out determination of heavy metals in groundwater in around Triturate, Chittoor (di) Andhra Pradesh, in India and found nickel concentration of 0.11 to 0.098mg/l

### Cobalt

Cobalt is commonly found at low concentrations in most of the ground water. Cobalt is the present study observed value range between 0.001 to 0.023 mg/l all sample are below of permissible limit of WHO. Venkata Subba Raju *et al.*, 2014 studied determination of heavy metals in ground water by SPSR Nellore District, Andhra Pradesh India. International Journal of Innovative Research in Sciences, Engineering and Technology, reported the Cobalt concentration vary from 0.01mg/l to 0.043 mg/l.

### Lead (Pb)

The Lead concentrations of all the samples were found ranged between 0.01 to 0.316mg/l. Values of lead at sampling station RW<sub>9</sub> bus stand (0.316), and RW<sub>16</sub> Jila hospital (0.083) mg/l are more than value of WHO limit Meitei *et al.*, 2013. A comparative study of the ground and surface water quality with reference to heavy metal concentrations in the Imphal valley Manipur, India and recorded to lead concentration ranged from 0.00 to 0.05 mg/l.

### Iron (Fe)

The minimum and maximum iron concentrations were observed ranged between 0.004 to 0.64mg/l. All samples were found below the permissible limit. Tripathi *et al.*, 2013 Studied the Iron content in Ground water of Maihar Region, Satna, India and Iron was found ranged between 0.01 to 1.0mg/l. Copper is positively correlated to nickel, cobalt and lead and

negative correlated to iron, nickel and cobalt showed positive relationship with all the metal content. Lead showed negative relationship with iron and positive relationship with Copper, nickel and cobalt. Iron in the present investigation showed positive relationship with Nickel and cobalt and negative relationship with copper and lead. The table value of 5% significant level was 2.101 and at 1% level were 2.878. Iron and nickel showed positive relationship i.e. 2.2039 which is greater to the 5% significant value. For Cobalt we have found positive value of co- relationship at 1% significant level i.e. 2.8840. It showed that iron, nickel, cobalt play major role in the chemical characteristic of ground water in orai (jalaun) during the study period.

## Conclusion

The analysis of ground water quality parameter of ground water from twenty different location in Orai city shows that the temperature, pH, TDS, TH, DO and Sulphate were within permissible limit. BOD values in the study area are between 2.9 to 13.8 mg/l. Six sampling station showed higher BOD concentration then the limit précised by WHO<sup>17</sup>. Chemical oxygen demand arranged between 5.8 to 31.0mg/l. 50% of the sample head COD values higher than the permissible limit prescribed by WHO as 10mg/l. The maximum and minimum concentrations of chloride were 21.0 to 275mg/l respectively. The value for sample from station Rw<sub>1</sub> and Rw<sub>20</sub> were higher than the prescribed limit. Heavy metal like Copper, Cobalt and Iron is all samples below the recommended level, while Nickel concentration at sampling station Iw<sub>2</sub>, Iw<sub>4</sub>, Rw<sub>9</sub>, Rw<sub>18</sub> and Lead concentration at sampling station Rw<sub>9</sub> and Rw<sub>16</sub> are more than the permissible limit prescribed by WHO. It indicates the extant of pollution occurred due to the industrial effluents urbanization and other anthropogenic activities increased human interventions in the ground water quality. Proper monitoring is needed to avoid anthropogenic contamination.

## REFERENCES

- Agarwal Monika, Jain Sushma and Shandilya A.K. 2013. Hydro-Chemical Evaluation of Ground Water of Area Around Raisar, Bikaner District, Rajasthan, India *Int. Res. J. Environment Sci.*, 2(5): 72-78.
- Annal C. Florence, 2014. Ground Water Suitability for Drinking in Dindigul Block of Dindigul District, Tamil Nadu, India *Int. Res. J. Environment Sci.*, 3(12): 1-4.
- Guidelines for Water Quality Monitoring Central Pollution Control Board Parivesh Bhawan East Arjun Nagar, Delhi-32, 2012
- Khan A.M., Kumar. T.A., Hasant D., Trivedi R.C., 2005. *Water Pollution Research* 42: 13-18.
- Malassa Husam, and Hadidoun Mohamad , 2014. Assessment of Ground water Pollution With Heavy Metals In North West Bank/Palestine by ICP-MS. *Journal of Environmental protection*, 5: 54-59.
- Meitei L Sanjoy, Ku Rakesh, 2013. A comparative study of the ground and surface water quality with reference to heavy metal concentrations in the Imphal valley Manipur, India, *IJERS*, 3 (6): 1858-1867.
- NEERI, Manual on Waste Water Analysis, Nagpur, 1984.
- O. Venkata Subba Raju, P.M.N Prasad, V. Varalakshmi and Y.V. Rami Reddy, 2014. Determination of Heavy metals in Ground water By ICP-OES in Selected Coastal Area of SPSR Nellore District, Andhra Pradesh, India, *International Journal of Innovative Research in Science, Engineering and Technology*, 3(2): 9745-9749.
- Patil P.N, Sawant. Deshmukh D.V., R.N., 2012. Physico-chemical Parameters for Testing of Water – A review, *IJERS*, 3 (3): 1194-1207.
- Pethe G.B., Lawankar T.R., Sogasane A.A., Dawale N.E., Mahajan D.T. and Narwade M.L., 2011. Studies in Determination of Some Parameters of Ground water, *European Journal of Experimental Biology*, 1 (1): 97-102.
- Reddy V. Hanman, Prasad P. M. N., Reddy A. V. Ramana and Reddy, Rami Y. V., 2012. Determination of Heavy Metals in Groundwater in around Triturate, Chittoor(di) Andhra Pradesh *Scholars Research Library*, 4(6): 2442-2448.
- Sabhapandit Pranab and mishra Abanikar, 2011. Physico-chemical Characteristics of Ground and Surface Water in Gohpur Sub-division of Sonitpur District, Assam India. *Journal Environ. Science & Engg.*, 53(1): 89-96.
- Standard Methods for the Examination of Water and Wastewater; APHA, AWWA and WEF, 21<sup>st</sup> Edition 2005.
- Tripathi Indra Prasad, Dwivedi Arvind Prasad and Tiwari Vipin., 2015. Quality and Assessment of Ground Water in Satna MP India. *Journal of Applicable Chemistry*, 4 (2): 615-623.
- Ttripathi I.P., Mishra S.N., Panday Shailesh, Dwivedi Arvind Prasad, 2013. Iron contents in Ground water of Maihar Region, Satna, India, *Research Journal of Chemical Sciences*, 3(11): 95-97.
- Verma Apoorv and Pandey Govind. 2014. A Study of Groundwater Quality in Urban and Peri-urban Areas of Gorakhpur City in India, *Int. Res. J. of Applicable Chemistry*, 3(1): 6-8.
- WHO, Guideline for Drinking Water Quality, Vol 2, Geneva, 1984.

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