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EFFECT OF NALLAHS ON GROUNDWATER IN INDORE CITY

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ABSTRACT

It is generally assumed that ground water is safe (free from pathogens) and does not contain harmful constituents. But this belief is not true under all circumstances. The unscientific disposal of human and animal wastes is found to be the main anthropogenic activity that has lead to the contamination of ground water with micro-organisms, nitrates, etc.

To check the level of contamination in Indore city by the seepage of the existing nallahs, a monitoring of ground water quality was carried out for one month January 2017 to February 2017 from eighteen groundwater sources in Indore city. Analysis was carried out for assessment of 21 parameters including mineral, demand, nutrient, bacteriological and metal analysis. The analysis data reveals that the quality of groundwater in Indore city has deteriorated to a large extent making it unfit for drinking and irrigation purpose. The chemical composition of groundwater from basaltic aquifer has severely altered due to the percolation of industrial effluents in the past decades and sewage from existing nallahs into the groundwater.

KEYWORDS:Physico - chemical parameters, ground water quality, nallahs, total coliforms etc.

INTRODUCTION

Water pollution is a major problem in the global context [1, 2]. It has been suggested that it is the leading worldwide cause of deaths and diseases [3], and that it accounts for the deaths of more than 14,000 people daily. An estimated 700 million Indians have no access to a proper toilet, and 1,000 Indian children die of diarrheal sickness every day. Some 90% of China's cities suffer from some degree of water pollution and nearly 500 million people lack access to safe drinking water. In addition to the acute problems of water pollution in developing countries, industrialized countries continue to struggle with pollution problems as well. In the most recent national report on water quality in the United States, 45 percent of assessed streammiles, 47 percent of assessed lake acres, and 32 percent of assessed bay and estuarinesquare miles were classified as polluted.

The metropolitan city Indore is a commercial and industrial centre of Madhya Pradesh and lies in the heart of Malwa Plateau. Indore covers an area of 3831 sq km with a total population of the district 32,72,335 (2011 census) with the density of 9,718 per sq. Km. It is bounded by N latitudes 22˚ 31’ and 23˚05’ and E longitudes 75˚25’ and 76˚ 15’. The district is bounded by Ujjain District in the north, Dewas District in the east, Khandwa District in the south and Dhar district in the west. The District is divided into 4 Tehsils, 4 Development Blocks having 661 villages. Indore city is divided into 12 zones and 85 wards by Indore Municipal Corporation, Indore [4, 5, 6 and 7].

The district is drained by four tributaries of River Ganga, viz., the Chambal, the Gambhir, the Khan and the Kshipra. These rivers are generally flowing from south to north. The southern fringe of the district, south of the Vindhya hills is drained by the river Narmada, flowing from east to west. The district lies 75% in the Chambal sub basin and 25% in the Narmada basin. Location map of Indore is given in Figure 1.

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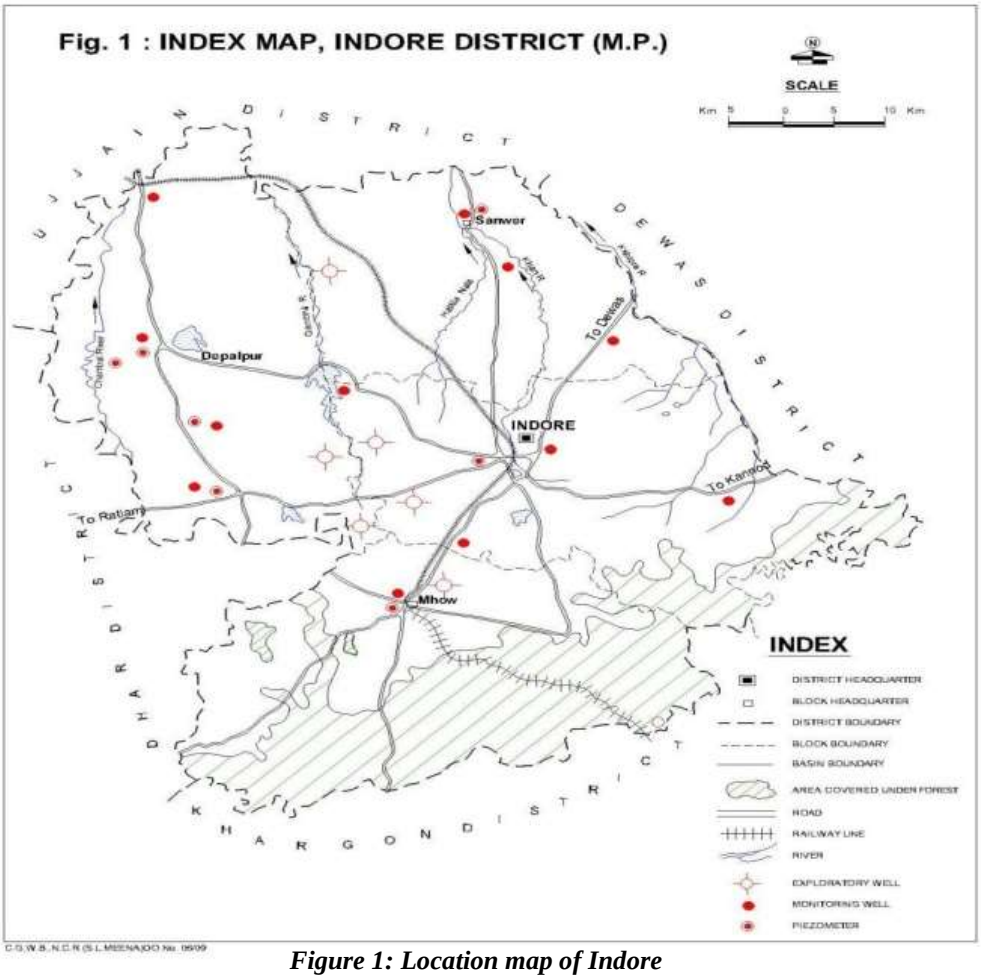

Figure 1: Location map of Indore

MATERIAL AND METHOD

Samples were collected directly in pre-washed and rinsed, polyethylene/glass containers identified for respective parameters. Stipulated procedure was followed for washing of sample containers. Field parameters like Temperature, pH and dissolve oxygen, which are non conservative and could not be preserved, were analyzed immediately after collection was per standard procedure. Samples were analyzed based on the standard procedures of water analysis of bacteriological and physicochemical parameters [8, 9]. The description of the sampling stations is given in table 1.

Table 1: Description of sampling points.

Sample Code	Location Name	Location	Sample Code	Location Name	Location
GW-1	Palda	22.685228 75.889773	GW-10	Moti tabela	22.706642 75.852655
GW-2	Palasia	22.725116 75.887766	GW-11	Navlakkha	22.698930 75.877483
GW-3	Bapat	22.754448 75.878733	GW-12	Usha Phatak	22.723854 75.862579
GW-4	Sanwer Road	22.763026 75.847731	GW-13	Juni Indore	22.709614 75.861852

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GW-5	Satya Sai Bag colony	22.742159 75.847776	GW-14	Shankar Bagh	22.733257 75.851208
GW-6	Bhagirathpura	22.747096 75.862496	GW-15	Sadar Bajar	22.725203 75.852679
GW-7	Sanyogitagunj	22.707106 75.875101	GW-16	Niranjanpur	22.776728 75.890502
GW-8	Choithram Mandi	22.682212 75.851711	GW-17	Dhar Road	22.708749 75.829324
GW-9	Khajuri Bazar	22.719017 75.854470	GW-18	Race Course Road	22.728295 75.878791

RESULT AND DISCUSSION

The monitoring of water quality was carried out for one month January 2017 to February 2017 from eighteen groundwater sources in Indore city. The sampling sites were selected within 0.5 to 2 km from the Nallhas, the source of pollution in the city. Analysis was carried out for assessment of 21 parameters including mineral, demand, nutrient, bacteriological and metal analysis. Parameters including pH, temperature, turbidity and electrical conductivity were monitored on site. Sampling, analysis and preservation of water samples were carried out as per Standard Methods for the Examination of Water and Wastewater [8].

The average analysis results for all the eighteen ground water samples is given in Tables 2 and 3.

Groundwater Quality

Color

Color is measured in Platinum Cobalt Scale. The color obtained in all the ground water samples GW-1 to GW-18 is 1 or less than 1.

pH

The pH value ranges between 6.9 and 8.3. The lowest value is observed in GW-14 i.e 6.9 whereas higher pH values were observed in samples GW-2, all the ground water samples showed good pH range or values. It is also observed that all the water samples lie in the range of 6.5 – 8.5 prescribed by Indian Standards for Drinking Water.

Turbidity

Turbidity is measured in Nephelometric Turbidity Unit (NTU). The turbidity for nearly all the samples remained less than 1 NTU except for sample GW-10 and GW-15, the turbidity lies in the range 2 – 4.5 NTU. The reason for the high values may be due to organic contaminants coming into the well.

Electrical Conductivity

Electrical conductivity (EC) is a useful tool to evaluate the purity of water. Maximum EC is recorded in GW-4 (1843.4 µ mhos/cm) and the minimum EC at GW-11 (734 µmhos /cm). In general the EC for maximum samples is above 1200 µmhos/cm.

Total Dissolved Solids

The Total Dissolved Solids (TDS) of the water samples ranged from 425 mg/L to 1350 mg/L. TDS value of 425 mg/l is shown by sample GW-11, whereas GW-4 showed a value of 1350 mg/l.

Chemical Oxygen Demand

The Chemical Oxygen Demand (COD) values obtained for the water samples are quite low ranging between 3 – 18 mg/l. The low COD values are shown by samples GW-2, GW-9, GW-10, GW-16 and GW-17.

Alkalinity

The values of alkalinity in the water samples varied from 206 - 580 mg/l. In all the samples alkalinity values have crossed the desirable limit of 200 mg/l.

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Table 2 : Average analysis data for ground water samples GW-1 to GW-9.

S. No.	Parameters	Unit	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW-8	GW-9
1	Temperature	°C	24	25	24	24	25	25	24	24	24
2	Color	Pt. Co. Scale	1	1	1	1	1	1	1	1	1
3	Odour		Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
4	pH	pH Unit	7.36	8.1	8.05	7.35	8.25	7.35	7.4	7.75	7.35
5	Turbidity	N.T.U.	1.25	1.65	1.8	1.2	1.55	1.3	0.95	0.65	0.75
6	Sp. Conductivity	µMhos/cm	1105.3	929.3	1027.15	1831.4	1046.9	1497.9	1046	986.45	1493.15
7	Total Dissolved Solids	mg/L	647	531	505	1310	528	1054.5	656.5	569.5	1149.5
8	C.O.D.	mg/L	7	6.5	10.5	14	5.5	11.5	4.5	7	6
9	Total Alkalinity	mg/L	350	295	352	375	296	518	404	304	420
10	Total Hardness (as $CaCO_3$)	mg/L	449	288	280	708	98	694	368	190	450
11	Calcium	mg/L	92	83.6	85.6	156.8	26.4	145.7	89.6	48	128
12	Magnesium	mg/L	58.8	18.7	15.81	75.84	7.7	79.2	34.55	16.8	31.2
13	Chloride	mg/L	131.95	106.05	120.705	359.9	150.5	231.6	117	138	241
14	Sulphate	mg/L	66.9	65.6	51.905	184.15	45.9	80.2	65.5	64.15	229.9
15	Ammonia	mg/L	0.023	0.01	0.008	0.0025	0.001	0.0045	0.011	BDL	BDL
16	Nitrate	mg/L	7.6015	7.3785	3.2105	11.1255	2.9655	10.0595	10.251	4.0715	9.9625
17	Fluoride	mg/L	0.7305	0.672	0.837	0.3115	0.4715	1.041	0.504	0.7615	0.7645
18	Total Coli form	MPN/100 ml	36.5	44	42.5	35.5	38	40	27	32	15
19	Iron	mg/L	0.02	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
20	Manganese	mg/L	0.0235	0.004	BDL	BDL	BDL	BDL	BDL	BDL	BDL
21	Zinc	mg/L	0.0275	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

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Table 3 : Average analysis data for ground water samples GW-10 to GW-18.

S. No.	Parameters	Unit	GW-10	GW-11	GW-12	GW-13	GW-14	GW-15	GW-16	GW-17	GW-18
1	Temperature	°C	25	25	24	24	24	25	25	24	24
2	Color	Pt. Co. Scale	1	1	1	1	1	1	1	1	1
3	Odour		Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
4	pH	pH Unit	7.25	7.2	7.3	7.2	7.35	7.5	7.3	7.35	7.35
5	Turbidity	N.T.U.	3.2	0.8	0.95	0.65	0.75	2.85	0.5	0.75	1.4
6	Sp. Conductivity	µMhos/cm	850.75	781.7	1263.6	1238.45	1350.05	1187.5	1190.4	1493.15	1475.65
7	Total Dissolved Solids	mg/L	521.5	475.5	692	847	796.5	807	856	1149.5	873
8	C.O.D.	mg/L	4	7.5	8	8.5	12	12.5	5	6	8
9	Total Alkalinity	mg/L	420	362	392	552	528	512	328	420	480
10	Total Hardness (as $CaCO_3$)	mg/L	322	300	260	356	592	512	428	450	394
11	Calcium	mg/L	80.8	74.4	78.4	86.4	132	127.2	111.2	128	102.4
12	Magnesium	mg/L	28.8	27.35	15.3	33.6	62.85	46.55	36	31.2	33.1
13	Chloride	mg/L	62.99	53	130	150	136	105	194	241	136
14	Sulphate	mg/L	36.15	17.15	89.8	74.5	27.15	98	129.15	229.9	152.38
15	Ammonia	mg/L	0.0015	BDL	BDL	0.002	0.005	0.0015	BDL	BDL	BDL
16	Nitrate	mg/L	3.5805	2.569	3.057	9.7665	3.4925	8.7915	10.776	9.9625	8.3265
17	Fluoride	mg/L	0.951	0.9495	1.0775	0.679	0.379	0.4535	0.689	0.7645	1.0185
18	Total Coli form	MPN/100 ml	37	23	11.5	22	42	41.5	38.5	15	17.5
19	Iron	mg/L	BDL	0.012	BDL	BDL	BDL	BDL	BDL	0.002	BDL
20	Manganese	mg/L	BDL	BDL	0.017	0.0375	BDL	BDL	BDL	BDL	0.0115
21	Zinc	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.024

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Hardness
Total Hardness of the analyzed water samples varies from 80 to 744 mg/l. Water samples GW-4 and GW-6 exceed the permissible value of 600 mg/l and rest of the water samples show the values above 200 mg/l. The hardness is due the calcium and magnesium salts.

Calcium
Calcium ions contribute the greatest portion of the hardness occurring in natural waters. The concentration of calcium varies from 33.6 to 160 mg/l being minimum for GW-5 and maximum value is obtained in sample GW-4. The permissible limits prescribed by Indian Standards for Drinking Water is Ca^{++} = 200 mg/l.

Magnesium
Magnesium ion (Mg^{+2}) concentration varies from 7.7 to 86.4 mg/l being minimum again for sample GW-5 and the maximum value for sample GW-4. The permissible limit prescribed by Indian Standards for Drinking Water is Mg^{++} = 100 mg/l.

Chloride
The highest concentration of chlorides was recorded in GW-4 (365 mg/l) and the lowest at GW-11 (44 mg/l). High chloride content in groundwater can be attributing to lack of underground drainage system and bad maintenance of environment around the sources. Chloride salts in excess of 100 mg/1 give salty taste to water. When combined with calcium and magnesium, may increase the corrosive activity of water. It is recommended that chloride content should not exceed 250 mg/1.

Sulphate
Sulphate concentration is varying from 16.6 to 255.2 mg/l and these values are within permissible limits prescribed by Indian Standards for Drinking Water (400 mg/l).

Nitrate
The minimum and maximum concentration values obtained lies in the range 2.27 to 11.34 mg/l. All these values are less than the desirable limit prescribed by Indian Standards for Drinking Water (45 mg/l).

Fluoride
Fluoride concentration for water samples varies from 0.176 to 1.223 mg/l. The values for fluoride are also less than the desirable limit prescribed by Indian Standards for Drinking Water (1.0 mg/l) except for GW-6, GW-10 and GW-12.

Iron
It is found that none of the water samples show the iron concentration except GW-1, GW-11 and GW-17. The iron concentration ranges from BDL to 0.02 mg/l.

Manganese
Concentration obtained for manganese lies in the range BDL to 0.041 mg/l. None of the water samples cross the desirable limit (0.1 mg/l) and are far less than the permissible limit (0.3 mg/l) as prescribed by Indian Standards for Drinking Water.

Zinc
The desirable limit for zinc is 5.0 mg/l as prescribed by Indian Standards for Drinking Water. The concentration for zinc varies from BDL to 0.036 mg/l. The maximum concentration of 0.036 mg/l is obtained for GW-1.

Total Coliforms
The limits prescribed by the Indian Standards for Drinking Water is there should not be any coliforms in 100 ml sample. The Most Probable Number (MPN count) obtained for all the ground water samples is undesirable. It ranges from 2 to 48 MPN/100 ml. The minimum value is obtained for GW-12 (2 MPN/100 ml) and maximum value is 48 MPN/100 ml for GW-2 and GW-6.

Graphical representation for some important parameters for all eighteen water samples is given in the **Graphs 1 to 9**.

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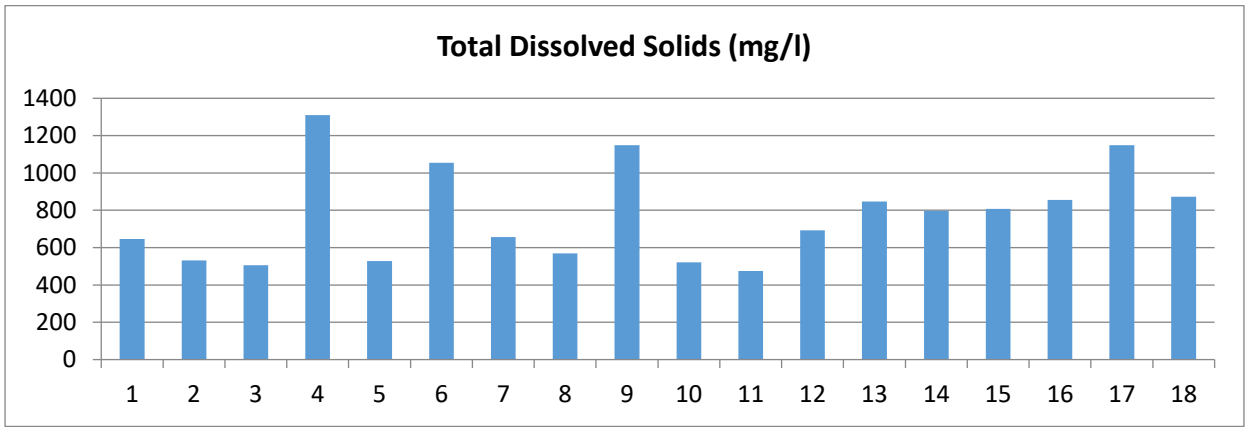
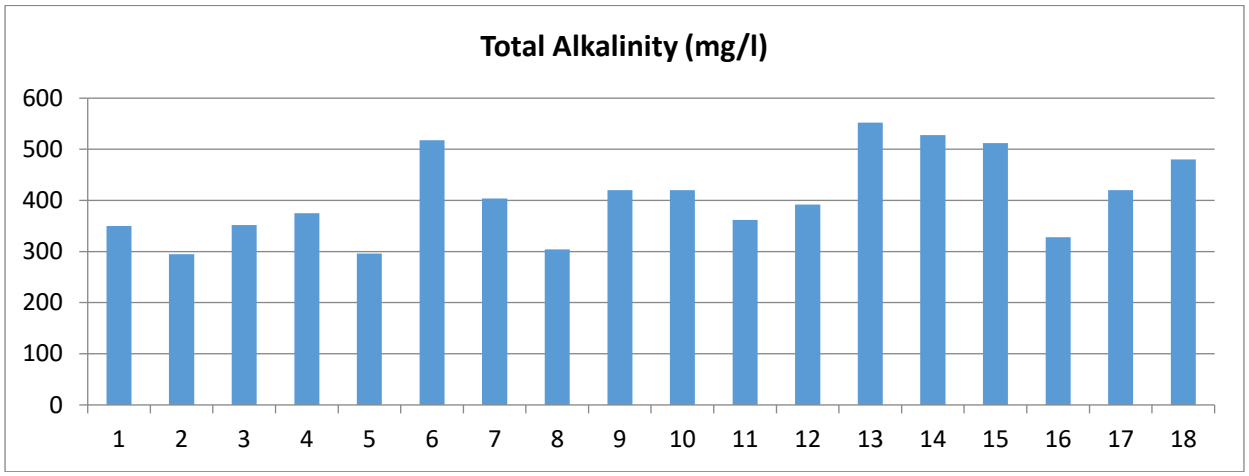
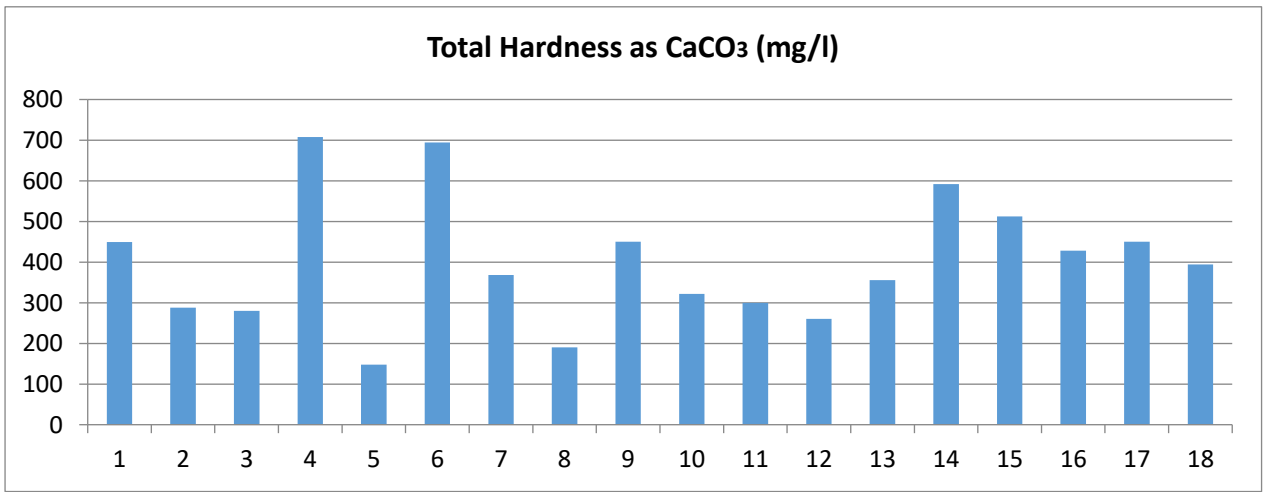


Graph 1: Graphical representation of Total Dissolved Solids for all eighteen water samples.



Graph 2: Graphical representation of Total Alkalinity for all eighteen water samples.



Graph 3: Graphical representation of Total Hardness for all eighteen water samples.

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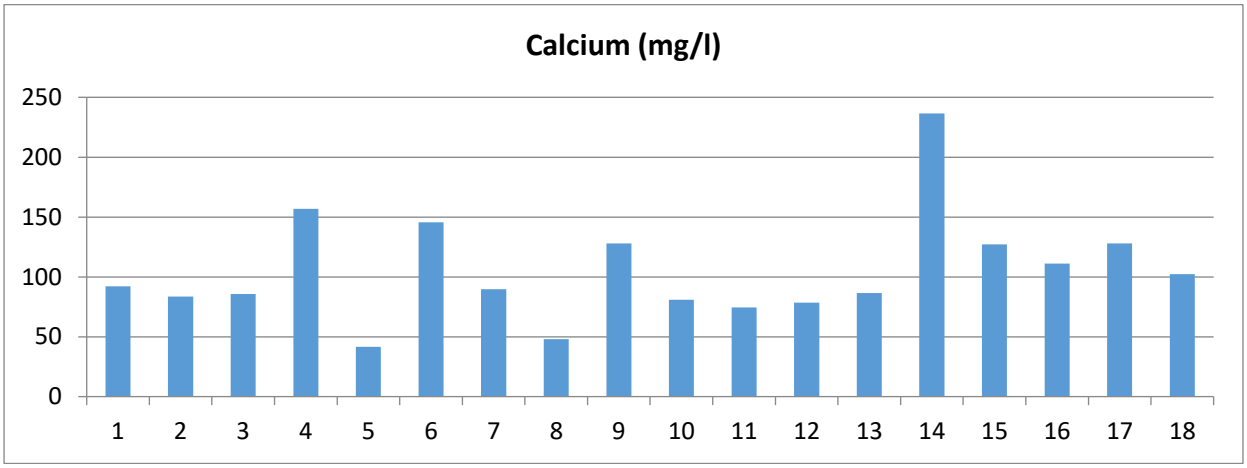
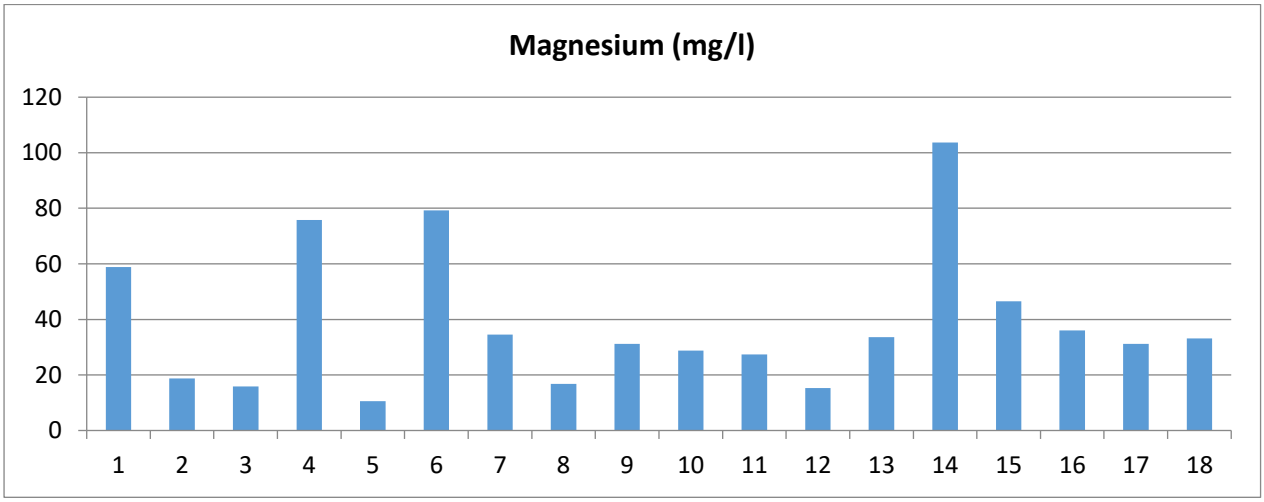
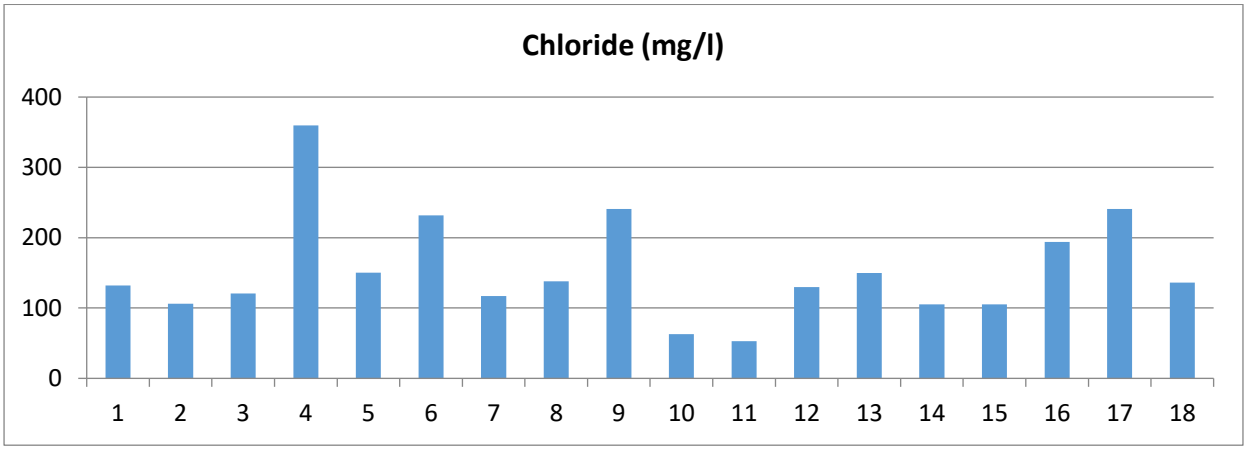


Graph 4: Graphical representation of Calcium ions for all eighteen water samples.



Graph 5: Graphical representation of Magnesium ions for all eighteen water samples.



Graph 6: Graphical representation of Chloride ions for all eighteen water samples.

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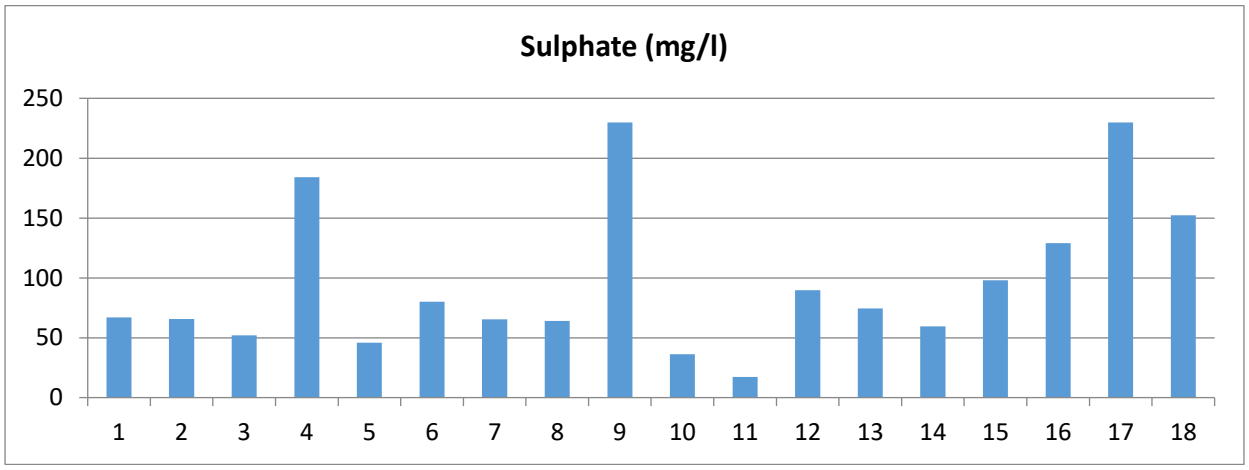
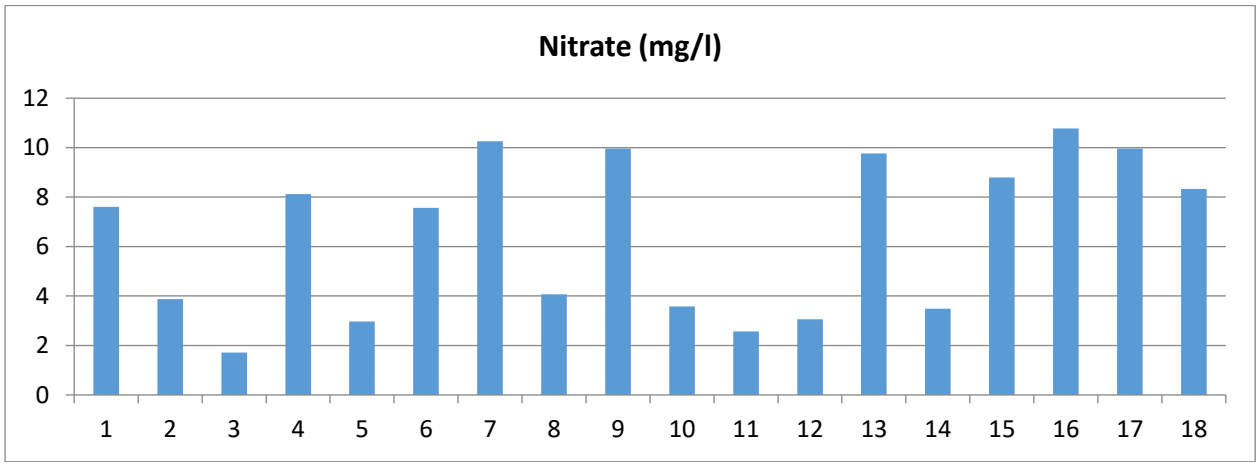
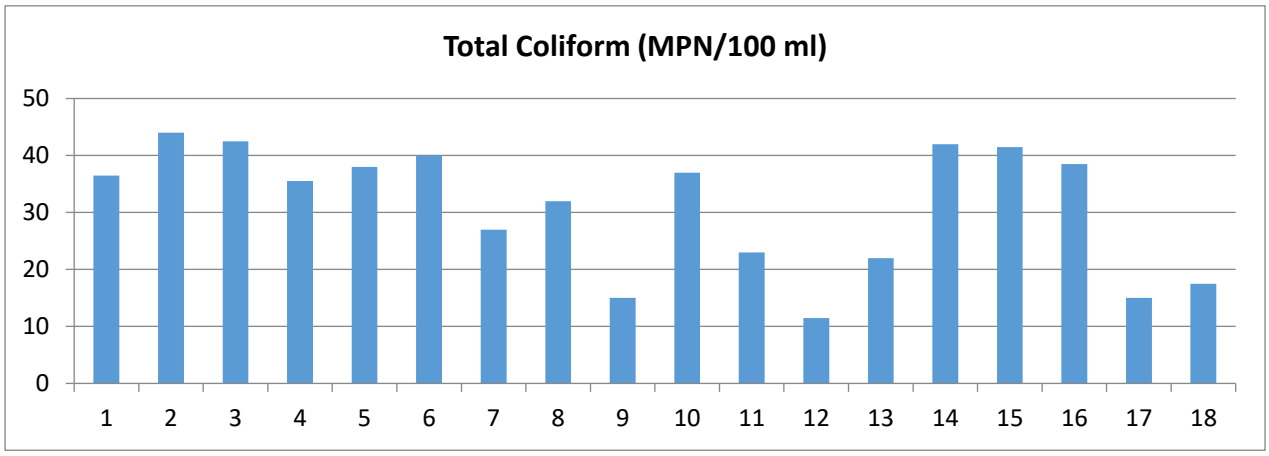


Graph 7: Graphical representation of Sulphate ions for all eighteen water samples.



Graph 8: Graphical representation of Nitrate ions for all eighteen water samples.



Graph 9: Graphical representation of Total Coliforms for all eighteen water samples.

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CONCLUSION

The analysis data reveals that the quality of groundwater in Indore city has deteriorated to a large extent making it unfit for drinking and irrigation purpose. The chemical composition of groundwater from basaltic aquifer has severely altered due to the percolation of industrial effluents in the past decades and sewage from existing nallahs into the groundwater. Despite the remedial steps, there is no improvement in groundwater quality and pollution is still taking place. The non-usage of the polluted groundwater in the area is not helping in dilution of this water.

The parameters which affect or alter the water quality are alkalinity, calcium and magnesium hardness, chlorides, sulphates, sodium, phosphates and Total coliforms.

From the present analysis data it can be concluded that Ground Water of the Indore city is deteriorated in few areas. The reason for its deterioration being:-

- Basaltic Rocks.
- Sewage percolation through the River Khan, River Saraswati and Different other local nallahs.
- Industrial & Commercial activities in the city area during past decades.

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