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Physico-chemical Analysis and Mapping of Ground Water Quality in Residential Area of Two Different Zone of Central India

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Abstract: *Madhya Pradesh literally means' central province' and is located in the geographic heart of India, between latitude 21.2^{0}N-26.87^{0}N and longitude 74^{0}02'-82^{0}49'E.In the present study forty sampling location were selected from study area. The ground water samples of residential area in two different zone of central India were collected and analyzed for various physic-chemical parameters, i.e. Temperature 24.67^{0}C to 26.87^{0}C, pH 5.9 to 8.53, Turbidity 0.10 to 4.77, Total Hardness 191.67 to 926.67 mg/l, TDS 141.3 to 533.67 mg/l, DO 1.43 to 5.90, BOD 3.07to 19.17, COD 3.23 to 49.89, nitrate 0.09 to 6.47, Sulphate 0.01to186.3, Phosphate 0.001 to 2.83 mg/l, in water of residential area of two different zone of central India were found. Temperature, pH, Turbidity, nitrate and sulphate of all the samples of study area were found below the permissible limit prescribed by WHO. The results of analysis of ground water quality in residential area of two different zone of central India, it indicates that extent of pollution occurred due to the urbanization and other anthropogenic activities increased human interventions in the ground water quality.*

Keywords: *Physico-chemical Parameters, Ground Water, Residential Area, Central India.*

1. INTRODUCTION

Water is the key to life. All life on the planet earth is sustained by water, though a significant portion of the earth's surface is covered with water. However the amount of fresh water which is the usable form of water is relatively a tiny portion of total water availability (Malik.*et al*,2014).The ground water source levels change by the regular withdrawal and hence the quality of ground water source levels change by the regular withdrawal and hence the quality of ground water reported seasonal as well as annual change in the ground water quality (Gerge *et al*, 1990; Rajmohan *et al*,1997; Singh *et al*, 2000; and Tripathi *et al*, 2013).Ground water which now account for 80% of rural and 60% of urban water supply in India is depleting at an alarming rate in several states (Gayatri *et al*, 2001; Dwivedi *et al*, 2013).

Municipal sewage discharge is one of the problems and sewage water treatment is perhaps the most challenging environmental problem in India and all over the world. Various efforts and research is being vigorously pursued to complete treatment and healthy discharge as reuse sewage water and industrial effluents. The sewage water commonly contains both solids wastes and liquids wastes generated by various human activities and also sewage water contains various trace metals and metal compounds Now a day, both surface and ground water resources are contaminated by various sources like industrial effluents, agricultural discharge and municipal waste water, associated with large amount of inorganic and organic toxic pollutants along with harmful pathogens (Okoh *et al*, 2002). In most of the developing countries huge debt burdens and due to population explosion and rapid urbanization, people rely heavily on water resources and polluting in the absence of better alternatives (Eo *et al*, 1996; Calamari *et al*, 1994). The developing countries like India ground water is the major source of drinking water. In arid and semiarid regions ground water plays an important role in the development and the public health of the population. The estimation showed that ground water is the source of drinking for one third of the world population. The suitability of ground water for drinking purpose is determined by its quality (Annal *et al*, 2014).

The water quality parameters like pH, Dissolved oxygen, total hardness and chemical oxygen demand have much influence on human health. The water sources with very low/high pH can cause ill health. Depleted dissolved oxygen will affect living marine organisms. The carbonate salts can cause hardness and they make the water unsuitable for human activities (Rao 1978). The potential health effects of high nitrate levels are diverse, including reproductive problems (Kramer *et al*, 1996), methemoglobinemia and cancer. Infants are especially at risk for methemoglobinemia (blue- baby syndrome), and while little conclusive evidence exists for this disorder occurring where levels are below 10 ppm, higher values found throughout the world can significantly elevate the risk (Gupta *et al*, 2000). Some health professionals also believe that methemoglobinemia may often be under-or misdiagnosed (Johnson and Kross 1990). Sulphate ion present in water in high concentration may cause temporary and acute effects on humans and animals, including diarrhea. It is estimated that 1.4 million child deaths occur from diarrhea every year due to poor water quality. If excess amount phosphates present in water causes risk to human beings as algae produce toxins, which damage neurological syste and causes skin disease (Santhi *et al*, 2014).

1.1. Objective

To determine the physico-chemical characteristics of various ground water samples in residential area of two different zone of central India.

1.2. Study Area

Madhya Pradesh is the second largest state in the country by area. It borders the state of Uttar Pradesh to the north-east, Chhattisgarh to the southeast, Maharashtra to the south, Gujarat to the west and Rajasthan to the North West.Madhya Pradesh literally means' central province' and is located in the geographic heart of India, between latitude 21.2^0N-26.87^0N and longitude $74^0$02'-$82^0$49'E.The Central India covers the seven states of our country, it has long industrial development and also has deep cultural heritage.

2. Material and Methods

We assume Madhya Pradesh as a central India (study area) which is divided in to two zones (a) East Zone of Central India (b) West Zones of Central India. In the present study we are intended to find out the diffuse chemical pollution in Central India on the basis of a Residential area and different water bodies. We have designed twenty sampling stations district for this study in east zones i.e. Rewa, Satna, Sidhi, Singrauli, Shahdol, Umaria, Katni, Panna, Chhatarpur, Jabalpur, Mandala, Dindori, Siwani, Chhindwara, Narsinghpur, Hosangabad, Betul, Damoh, Sagar, Bhopal and twenty district in west zone i,e. Gawaliar, Shivpuri, Ashok Nagar, Datiya, Muraina, Bhind, Guna, Tikamgarh, Vidisha, Raisen, Sihora, Rajgarh, Sajapur, Dewash,Ujjain, Ratlam, Indore, Khandawa, Burhanpur and Harda of Central India. Forty water samples were collected from bore well and tube wells of two different zones of central India samples were collected in polythene bottles and analyzed for various water quality parameters as per standard procedures (AWWA, 1999).The experimental values were compared with standard values recommended by world health organization (WHO) for drinking purposes. The locations of sampling station are shown in table –1and fig-1

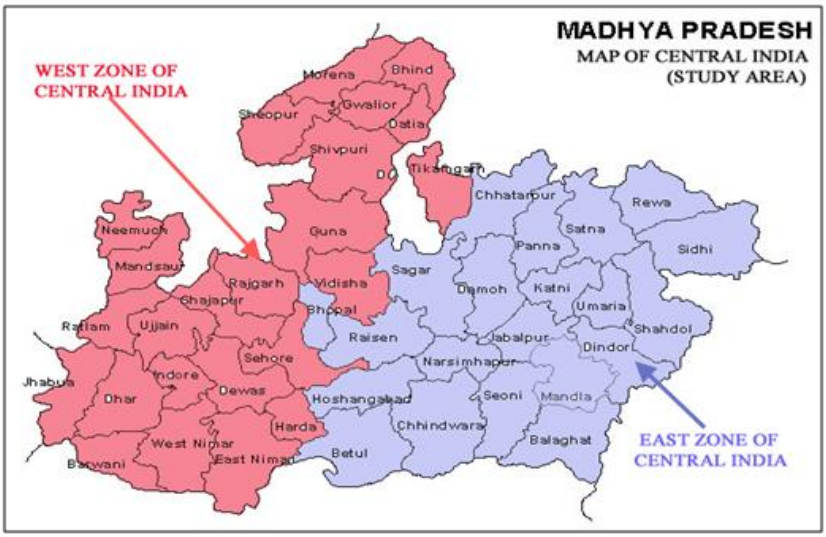

Table1. *Location of sampling station in Residential Area of Two Different Zone of Central India*

S.N.	sampling station
1	R_1= Rewa Near Bus Stand,
2	R_2= Satna Near District Hospital,
3	R_3= Sidhi Near Sanjay Gandhi P.G. College,
4	R_4= Singrauli Near Railway station,
5	R_5= Shahdol Near New Bus Stand,
6	R_6= Umaria Near Govt. R.V.P.S. College,
7	R_7= Katni Near Swetamber Temple,
8	R_8= Panna Near Bus Stand,
9	R_9= Chhatarpur Near Higher Secondary,
10	R_{10}= Jabalpur Near S.B.I. Chhorha,
11	R_{11}= Near R.D. P.G College Mandala,
12	R_{12}= Dindori Near Main Post Office,
13	R_{13}= Near Govt P.G. College Siwani,
14	R_{14}= Chhindwara Near State Bank of India,
15	R_{15}= Narsinghpur Near Railway Station,
16	R_{16}= Near District Hospital Hosangabad,
17	R_{17}= Betul Near Excellence School,
18	R_{18}= Damoh Near Bus Stand,
19	R_{19}= Sagar Near Railway Station,
20	R_{20}= Bhopal Near Hamidia Hospital.
21	$R_{21=}$ Near Gajaraja Medical College Gawaliar
22	$R_{22=}$ Near Tatyatope Park Shivpuri
23	$R_{23=}$ Ashok Nagar Near Busstand
24	$R_{24=}$ Datia Near Pitamabra Temple
25	$R_{25=}$ Muraina Near Railway Station
26	$R_{26=}$Bhind ,Near Head Post Office
27	$R_{27=}$ Near Delhi Public School Guna
28	$R_{28=}$ Civil Line Tikamgarh
29	$R_{29=}$ Near S.A. Institute of TechnologyVidisha
30	$R_{30=}$Raisen,Near Higher Secondary School
31	$R_{31=}$Sihore, Near Railway Colony
32	$R_{32=}$ Near Anjalilal Temple ,RajgarhBiora
33	R33=Near GhatiShajapur Housing Board Colony.
34	R_{34}=Near Tilak Nagar Dewas
35	R_{35}=Near DussehraMaidan, Ujjain
36	R_{36}= Near Sai Baba MandirRatlam
37	R_{37}=Near Maheswari Higher Secondary School, Indore.
38	R_{38}=Near MalviyaColony,lalchowkiKhandwa.
39	R_{39}=Near Bus Stand Burhanpur District
40	R_{40}=Near HardaPolytechhnique College.

3. RESULT AND DISCUSSION

The ground water samples were analyzed some parameters like, temperature, pH, turbidity, Total hardness, TDS, DO, BOD, COD, nitrate, sulphate and phosphate. Average physico-chemical characteristics of the ground water sample of study area were analyzed all the results are shown in table-2 and figure-2 to 12.

3.1. Temperature

In the present study the temperature was found ranged between 24.67^{0}C to 32.73^{0}C**.** The maximum temperature was recorded at sampling station (R_{14}) Datia near Pitambara Temple. Arya *et al*, 2011 studied assessment of underground water quality: A Case study of Jhansi city, utter Pradesh, India, reported temperature values varied between 12.0 ^{0}C to 32.0^{0}C.Karunakaran *et al*, 2009 temperature is basically important for the Chemical and biological reactions of organisms in water. The increase in temperature decrease the portable of water because of elevated temperature carbon dioxide and other volatile gases which import taste are expelled

3.2. pH

The pH of all the water samples varied from 5.9 to 8.53, the highest pH was observed 8.53 at sampling station (R_7) katni near swetambartample and the minimum value 6.90 (R_{40})near harda polytechnique college. Shrivastava *et al,* 2014 studied ground water quality assessment of Birsinghpur Area, Satna District, Madhya Pradesh and PH Concentration was found ranged from 6.8 to 7.8. Gupta *et al,* 2010 slight alkaline range of pH may be explained on the basis of occurrence of limestone rocks in the surrounding of the sampling stations. Limestone changes into its soluble from, that in Calcium Bicarbonate under anaerobic Condition and provides slight alkalinity to the water.

3.3. Turbidity

Turbidity of water was found to be 0.10 to 4.77 NTU. All the water samples of turbidity were found below the permissible limit set by WHO. Tripathi *et al,* 2014 studied physico-chemical parameters and correlation coefficients of ground waters of shahdol District and turbidity was found ranged between1.5to 4.0 NTU. Turbidity of water is actually the expression of optical property in which the light is scattered by the particles present in the water. Clay, slit, organic matter, Phytoplankton and other microscopic organisms cause turbidity in lake water.

3.4. Total Hardness

In the present study the total hardness of water was observed to be 191.67 to 921.67 mg/l. The highest value was found 921.67 mg/l at sampling station (R29) near S.A. Institute of Technology Vidisha. Sunita *et al,* 2005 Studied hydrogeo-chemistry of ground water, Gooty Area, Anantapur District, Andhra Pradesh and total hardness values were found ranged between 360 to 4040 mg/l. Hardness is caused by polyvalent metallic ions dissolved in water, which in natural water are principally magnesium and calcium.

3.5. TDS

The results show that study area TDS values are between 141.3 to 533.67mg/l. Maximum concentration is found water samples collected from katni, which is 533.67 mg/l. Minimum concentration is 141.3 mg/l found in ground water sample of khandwa. (R38).Sharma *et.al,* 2014 Studied a Physico-chemical Analysis and management of ground water Bodies from 20 locations of Jodhpur Districts, detected the TDS values varied from 960 ppm to 3650 ppm. The term total dissolved solid refer mainly to the inorganic substances that are dissolved in water. The effects of TDS on drinking water quality on the levels of the individual components, excusive hardness, mineral deposition and corrosion are common properties of highly mineralized water.

3.6. Dissolved Oxygen

The condition in case of dissolved oxygen (DO) is slightly complicated since in complicated since in contrast to other pollutants; the quality of water is enhanced if it contains more oxygen. An ideal DO value of 5.0 mg/l is the standard for drinking water. In study area at has been found between the ranges of 1.43 to 5.90 mg/l. Maximum concentration is found in ground water samples collected from Sihore (R_{31}) is 5.90 mg/l. Tripathi *et al,* 2015 studied Quality and assessment of ground water in Satna, Madhya Pradesh, reported the D.O. values varied from3.90 to 5.92 mg/l.

3.7. Biochemical Oxygen Demand

Biochemical oxygen demand varied from 3.07 to 19.17 mg/l. Maximum BOD was found (919.17 mg/l) at sampling station (R_{31}) Sihore, Near Railway colony. Values of BOD at sampling station R_2(7.43), R_4(10.73), R_9(6.27), R_{16} (6.33), R_{18}(6.43), R_{21} (15.17), R_{22} (9.30), R_{23} (13.67), R_{24} (11.23), R25 (8.43), R26 (7.30) , R27 (18.83), R29 (6.33), R30 (9.77) , R31(19.17) R35 (6.63), R37 (6.80) and R38 (6.3) mg/l are higher than the permissible limit prescribed by WHO as 6.0 mg/l. Dwivedi *et al,* 2016 studied Quality of Ground Water Used for Drinking in Orai, District- Jalaun, Uttar Pradeshand reported the BOD Values varied from2.9 to13.8 mg/l.BOD refers the oxygen used by the microorganism in the aerobic oxidation of organic matter. Therefore with the increase in the amount of organic matter in the water the BOD increases.

3.8. Chemical Oxygen Demand

The chemical oxygen demand was found ranged between 3.23 to 49.87 mg/l. COD value at sampling station R_8(12.83), R_{21}(37.0), R_{22}(18.75), R_{23} (11.50) , R_{24} (34.97), R_{25} (49.87), R_{27} (27.30) , R_{28} (14.

17), R_{29} (46.37) , R_{30} (32.90), R_{32} (31.80) , R_{33} (15.27), R_{35} (19.90) , R_{36} (12.50) , R_{37} (11.37) , and R_{38} (10.33) mg/l are more than the standard limit set by WHO 10.0 mg/l. Chemical oxygen Demand is defined as the amount of a specified oxidant that reacts with the samples under controlled condition and is often using as a measurement of pollutants in natural water(AWWA, 1999). Chaurasia *et al*, 2013carried out pollution sources and water quality of River Mandakini at Chitrakoot, Analyzed the chemical oxygen demand in mandakini River Chitrakoot found COD ranged between 12-140 mg/l.

3.9. Nitrate

In the present study the nitrate content of water was found to be 0.09 to 6.47 mg/l. The maximum value of 6.47 mg/l was observed at location (R_{19}) (Sagar , near railway station) while the minimum value 0.09 mg/l was observed at , which is within permissible limit prescribed by WHO for drinking water standard. Srinivas *et al*, 2012 Studies on chemistry and Water Quality Index of ground water in Chincholi Taluk, Gulbarga district, Karnataka India, nitrate content was observed ranged from 26.2 to 122.0 mg/l. Mahananda *et al*, 2010 monitoring of nitrate is important in drinking water because of health effects on human beings.

3.10. Sulphate

Sodium sulphate and magnesium sulphate exert a cathartic action in the human being and also surface is associated with respiratory illness. Therefore the recommended limit of sulphate content in drinking water is 200 to 250 mg/l. The concentration of sulphate ranged from 0.001 to 186.3 mg/l in the study area. The maximum concentration of (186.3 mg/l) was detected at sampling station R_{27} (Guna District).The results obtained in the present study showed that sulphate content in all water samples were 0.001to 1286.3 mg/l and is within permissible limit. Tripathi *et al*, 2016 studied the physic-chemical studies on ground water and surface water in and around Katni city; Madhya Pradesh observed the sulphates values varied from 2.9 to 81.93 mg/l.

3.11.Phosphate

In the present study the phosphate concentration varied from 0.001 to 2.83 mg/l. The maximum concentration of phosphate 2.83 mg/l was detected at the location R10 (Jabalpur near S.B.I. Chaorha) while minimum concentration of phosphate was observed to be 0.001 mg/l at R12 (near Govt. P.G. college Siwani) sampling station. Santhi et al, 2014worked physico-chemical studies on water quality in thirukattlupallinearthanfavur and reported the phosphate content varied from 0.1 to 1.8 mg/l

Table2. *Average Physico-Chemical Characteristics of ground water in Residential Area of Two Different Zone of Central India*

S.N.	District	Two different Zone of Central India	Sampling Code	Temp rature	pH	Turbidity	Hardness	TDS	DO	BOD	COD	Nitrate	Sulphate	Phosphate
1	Rewa	East Zone	R_1	29.37	6.50	2.37	228.33	345.33	4.68	3.60	5.37	4.17	5.53	0.187
2	Satna	East Zone	R_2	29.23	7.40	2.00	468.33	312.00	3.56	7.43	5.70	5.13	9.90	1.867
3	Sidhi	East Zone	R_3	25.27	6.57	1.23	322.67	412.67	1.43	5.57	5.50	0.30	0.03	0.007
4	Singrauli	East Zone	R_4	28.77	7.67	0.73	261.33	285.00	4.27	10.73	8.00	0.55	8.33	0.480
5	Shahdol	East Zone	R_5	28.53	6.77	0.27	191.67	252.67	4.03	3.10	7.13	0.82	4.97	0.026
6	Umaria	East Zone	R_6	26.07	7.70	2.40	215.33	328.00	3.10	4.53	6.33	3.47	170.00	0.167
7	Katni	East Zone	R_7	25.97	8.53	1.90	567.00	533.67	3.53	5.60	7.70	1.70	27.50	0.002
8	Panna	East Zone	R_8	27.93	7.10	4.77	362.33	341.00	3.03	3.70	12.83	0.80	10.03	0.029
9	Chhatarpur	East Zone	R_9	29.43	7.23	2.57	229.67	321.67	5.47	6.27	7.40	0.53	5.37	0.130

10	Jabalpur	East Zone	R_{10}	28.87	7.67	2.97	312.00	333.00	3.20	3.40	6.30	5.47	8.60	2.833
11	Mandala	East Zone	R_{11}	24.93	7.33	4.10	270.33	388.67	1.80	5.67	7.20	5.20	0.01	0.013
12	Dindori	East Zone	R_{12}	28.20	6.53	1.23	368.67	332.33	4.13	3.07	6.33	2.87	14.73	0.001
13	Siwani	East Zone	R_{13}	27.77	6.80	2.90	263.33	292.33	3.73	3.10	9.17	3.63	23.47	1.267
14	Chhindwara	East Zone	R_{14}	32.73	8.23	1.43	265.67	414.67	5.57	5.03	5.93	3.53	6.77	0.024
15	Narsinghpur	East Zone	R_{15}	25.93	7.23	0.10	236.00	321.00	4.63	4.50	3.50	7.80	12.30	0.008
16	Hosangabad	East Zone	R_{16}	25.77	7.97	1.67	210.33	369.67	3.10	6.33	7.00	7.63	7.93	0.060
17	Betul	East Zone	R_{17}	30.10	8.33	0.27	257.33	245.33	4.00	3.63	5.80	6.63	7.33	0.000
18	Damoh	East Zone	R_{18}	27.97	6.67	2.13	312.33	286.67	3.50	6.43	7.80	5.43	7.80	0.037
19	Sagar	EasZone	R_{19}	28.30	7.37	2.10	305.67	320.33	3.73	4.20	3.93	6.47	7.53	0.080
20	Bhopal	East Zone	R_{20}	27.67	6.87	2.33	214.67	323.00	2.97	3.63	8.50	5.23	5.53	0.047

Table-2 continue……

21	Gawaliar	West Zone	R_{21}	26.90	7.60	1.87	736.67	280.00	5.13	15.17	37.00	2.12	38.67	0.241
22	Shivpuri	West Zone	R_{22}	25.47	7.13	2.97	643.67	259.33	4.20	9.30	18.73	0.09	15.33	0.026
23	Ashok Nagar	West Zone	R_{23}	27.87	8.20	1.77	500.33	276.33	3.90	13.67	11.50	0.42	36.33	0.036
24	Datiya	West Zone	R_{24}	28.27	7.80	0.60	414.67	173.33	3.00	11.23	34.97	0.16	25.00	0.030
25	Muraina	West Zone	R_{25}	25.40	8.00	3.07	548.33	172.57	5.27	8.43	49.87	0.60	31.67	0.013
26	Bhind	West Zone	R_{26}	27.50	7.80	2.67	639.33	215.67	5.73	7.30	4.97	0.15	40.33	0.011
27	Guna	West Zone	R_{27}	24.77	6.73	2.73	697.67	323.20	2.10	18.83	27.30	0.04	186.33	0.064
28	Tikamgarh	West Zone	R_{28}	25.00	7.67	1.43	726.00	312.67	4.03	5.70	14.17	0.79	31.33	0.020
29	Vidisha	West Zone	R_{29}	27.27	8.27	3.83	921.67	266.93	3.83	6.33	46.37	0.30	37.33	0.052
30	Raisen	West Zone	R_{30}	27.10	7.83	1.80	730.00	212.07	3.40	9.77	32.90	0.46	27.00	0.021
31	Sihor	West Zone	R_{31}	26.43	7.97	2.77	751.67	200.67	5.90	19.17	9.40	0.50	53.00	0.034
32	Rajgarh	West Zone	R_{32}	30.60	8.20	3.87	683.33	243.43	3.63	5.20	31.80	0.73	41.00	0.036
33	Shajaput	West Zone	R_{33}	25.17	7.60	2.43	329.00	219.00	3.33	5.33	15.27	0.53	13.00	0.013
34	Dewash	West Zone	R_{34}	29.23	8.30	0.20	522.33	256.67	5.60	5.13	3.23	0.41	34.00	0.019
35	Ujjain	West Zone	R_{35}	26.77	8.00	0.90	296.67	156.00	4.00	6.63	19.90	0.61	43.00	0.034
36	Ratlam	West Zone	R_{36}	30.33	7.77	1.73	435.00	274.33	5.40	4.17	12.50	0.51	29.00	0.015
37	Indore	West Zone	R_{37}	29.27	8.13	3.20	475.33	288.00	2.63	6.80	11.37	0.61	96.00	0.011
38	Khandawa	West Zone	R_{38}	24.67	7.00	0.60	305.67	141.33	2.90	6.13	10.33	0.19	20.00	0.040
39	Burhanpur	West Zone	R_{39}	29.43	6.50	1.07	356.67	246.33	4.63	4.50	4.77	0.32	26.00	0.020
40	Harda	West Zone	R_{40}	28.00	7.53	0.27	264.33	160.67	3.13	5.00	7.20	0.09	7.00	0.008

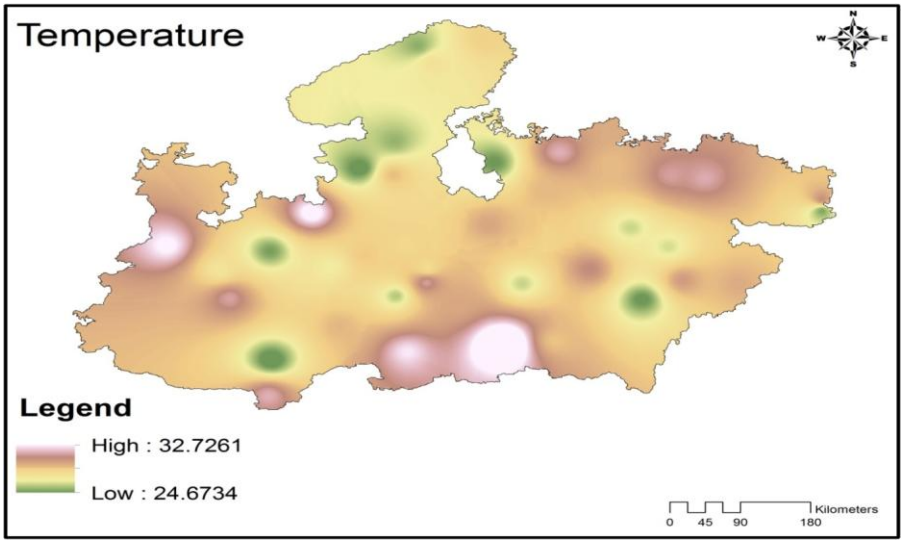

Figure2. *Average Temperature of ground water in Residential Area of Two Different Zone of Central India*

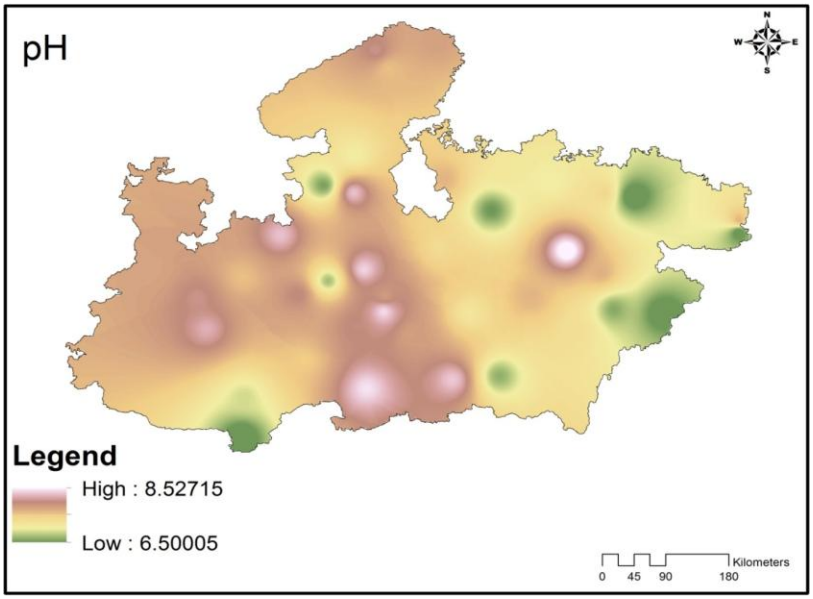

Figure3. *Average pH of ground water in Residential Area of Two Different Zone of Central India*

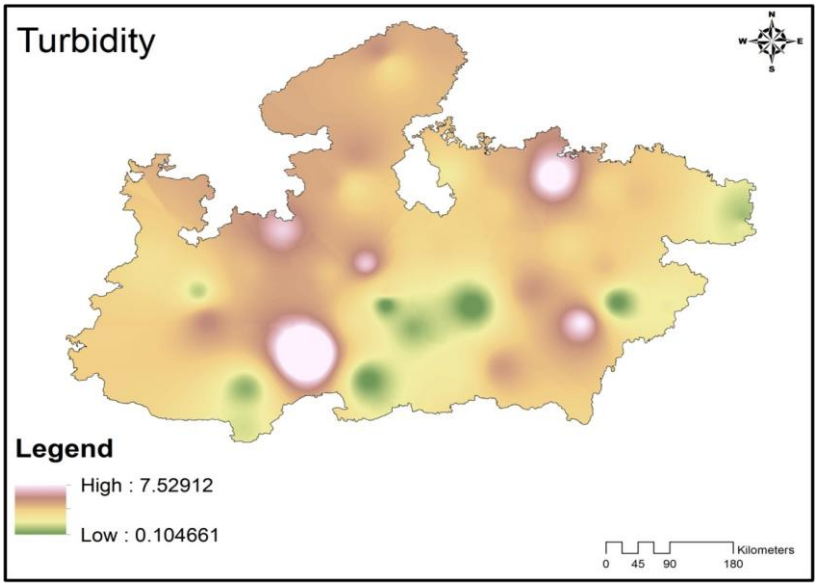

Figure4. *Average Turbidity of ground water in Residential Area of Two Different Zone of Central India*

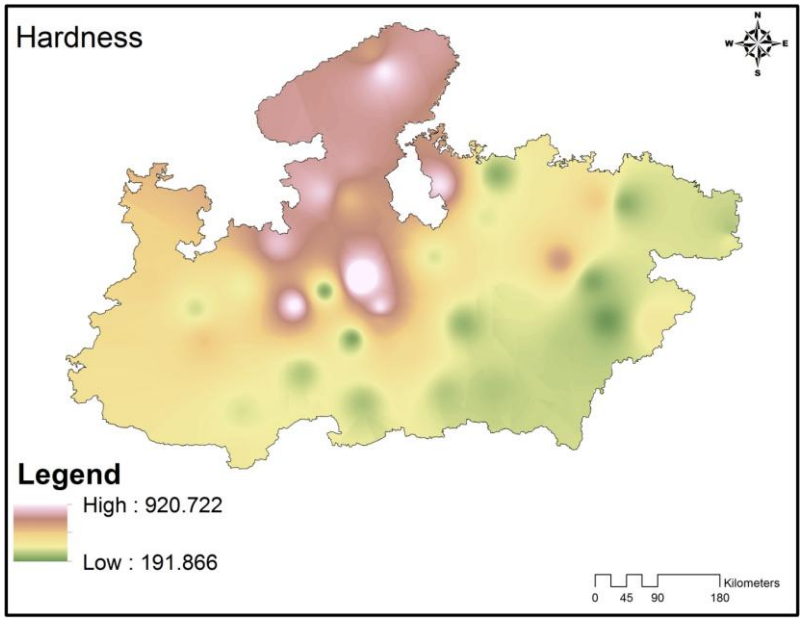

Figure5. *Average Total hardness of ground water in Residential Area of Two Different Zone of Central India*

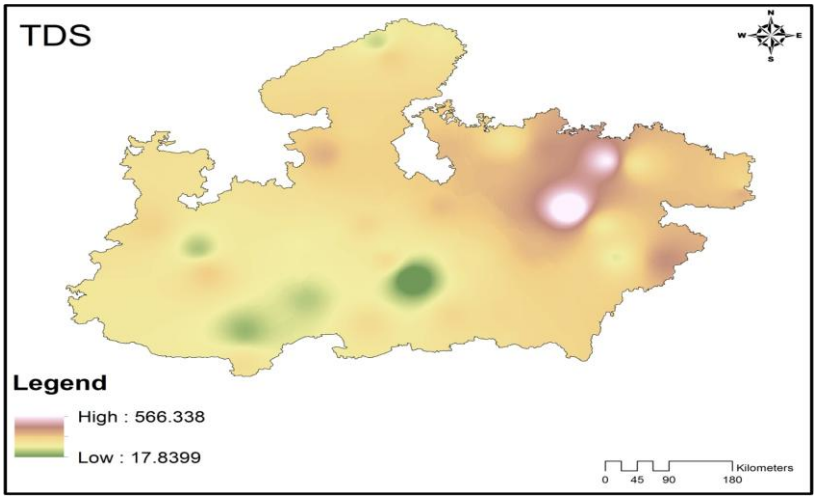

Figure6. *Average T DS of ground water in Industrial Area of Two Different Zone of Central India*

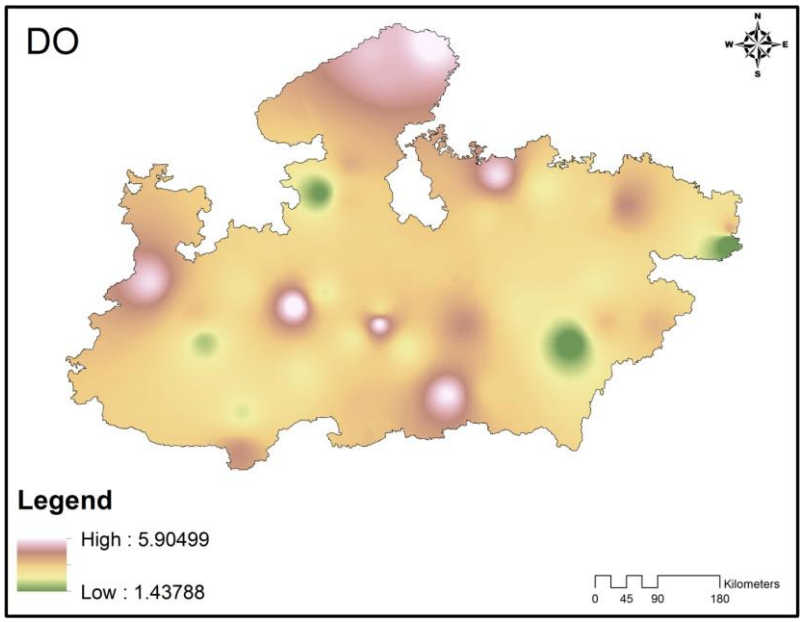

Figure7. *Average DO of ground water in Residential Area of Two Different Zone of Central India*

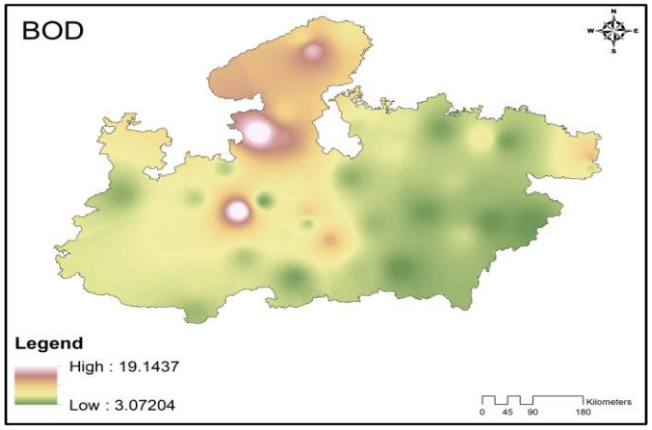

Figure8. *Average BOD of ground water in Residential Area of Two Different Zone of Central India*

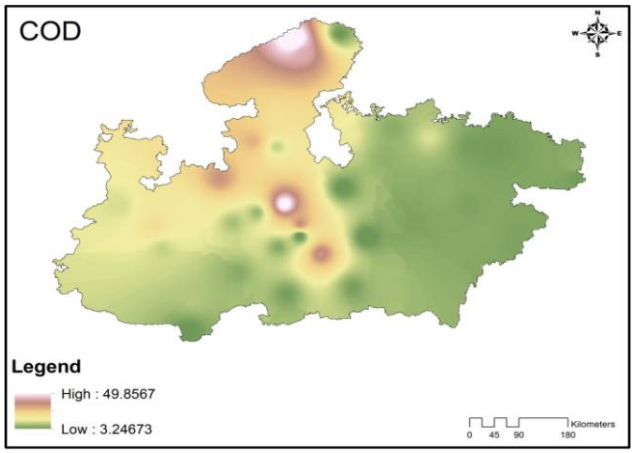

Figure9. *Average COD of ground water in Residential Area of Two Different Zone of Central India*

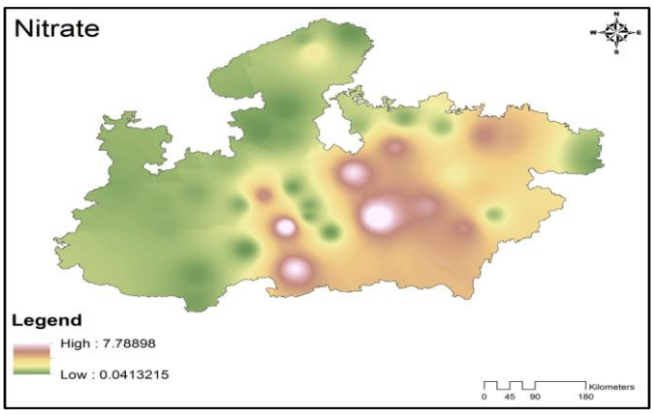

Figure10. *Average Nitrate of ground water in Residential Area of Two Different Zone of Central India*

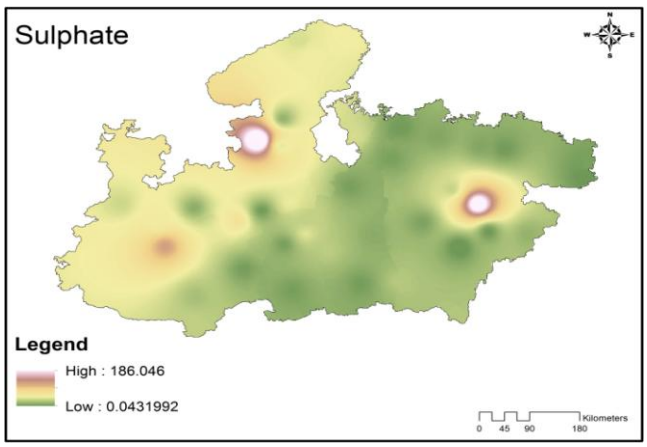

Figure11. *Average Sulphate of ground water in Residential Area of Two Different Zone of Central India*

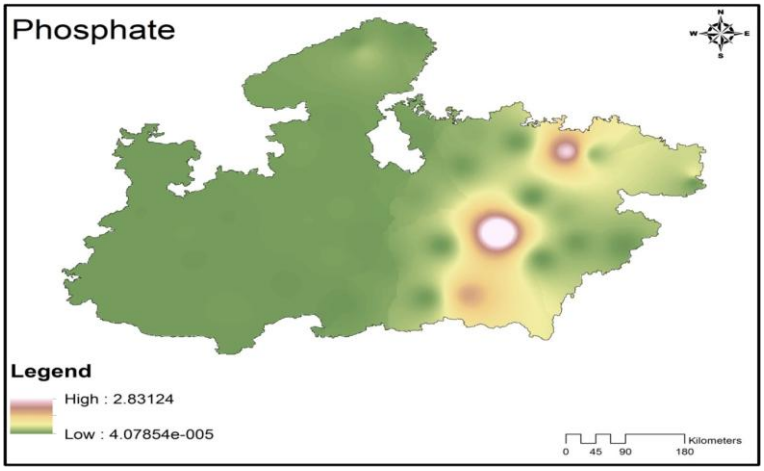

Figure12. *Average Phosphate of ground water in Residential Area of Two Different Zone of Central India*

4. CONCLUSION

The present study has been carried out to evaluate the quality of ground water in residential area of two different zones of central India. Forty sampling location were selected from study area. Sampling was done seasonally, during the study period (of the year 2013 to 2014). These samples were analyzed for eleven (Temperature, pH, Turbidity, Total hardness, TDS, DO, BOD, COD, Nitrate, Sulphate and phosphate) physico-chemical parameters to evaluate their suitability for domestics applications. The results of the above work show that most of the physic-chemical parameters are well within the acceptable limit except some samples of TH, DO, BOD and phosphate in the study area, during the study period mostly exceeded the recommended value of WHO. The chemical oxygen demand concentration exceeds the permissible limit in sixteen samples locations. It indicates that the extent of pollution occurred due to the urbanization and other anthropogenic activities increased human interventions in the ground water quality. Ground water pollution in the studied area showed is controlled by the proper environment management plan to maintain proper health conditions.

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