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Assessment of Physico-Chemical Water Quality of Ground Water at Ten Villages Situated in Chitrakoot, Madhya Pradesh, India

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Abstract:- The monitoring was carried out to ascertain the ground water quality at selected villages i.e. Pathara, Paldev, Guptagodawari, Satianusuya, Rajaula, Chitrakoot Busstand, Ramghat, Kamta Basti, Nayagawa and Hanumandhara during winter, Year 2014. Colour, odour, temperature, turbidity, total suspended solids, total dissolve solids, pH, EC, salinity, total hardness, calcium hardness, magnesium hardness, residual chlorine, chloride, total alkalinity, fluoride, nitrate and iron parameters were selected for above study. The Analyses of above mentioned parameters were done as per the standard methods for examination of water and wastewater (APHA-AWWA, 2005). The results of study were compared with the drinking water quality standards as prescribed by WHO (2011). The concentration of total dissolved solids, electrical conductivity, chloride, calcium hardness, magnesium hardness, total hardness and alkalinity was revealed due to abundant availability of dolomite rocks and lime stone in the study area. The results of the analysis showed that water is not fit for potable without filter and treatment and good for irrigation and other domestic purposes.

Keywords:- *Ground Water Quality, Alkalinity, Total hardness, Nitrate, Fluoride, Iron*

I. INTRODUCTION

The water is main constituent of human body. About 50-60% of human body is made of water. Water is a good solvent allowing most of our metabolic activities to perform with in our body. We can live some weeks without food but only some days without water. It is very important for human survival and requirement for industrial development. The underground water quality depends on the quality of recharged water atmospheric precipitation inland surface water and sub-surface geochemical processes. The main source of drinking water is ground water. Even today more than half the world populations depend on ground water for survival. In many rural and small communities ground water is the main source of potable water. The monitoring and evaluation of ground water quality is important task in present and future due to discharge of untreated domestic sewage, industrial waste and agricultural runoff directly in to the water body around the world. The assessment of ground water for drinking and irrigation purposes needs to be attention regularly. The investigation of water quality is very important for knowing the suitability for various purposes of demand.

Singh et al., (2018) stated that the water has a direct impact on the health of plants, animals and human beings due to exceeded limits, and it varies in the air (0.1–0.6 µg/l), plant (0.01–42 mg/kg), soils (150–400 mg/kg), rocks (100–2,000 mg/kg), and water (1.0–38.5 mg/l). Magesh and Chandrasekhar (2013) reported that water quality depends mainly on underlying rock's geochemical and lithological composition and subsurface factors. The groundwater systems have their unique chemistry and characteristics at each location and depend on various climatic changes, precipitation, surface water, and recharge parameters.

Due to change in chemical composition of the underlying sediments and aquifer, the quality may also vary from place to place. The ground carries higher mineral contents than surface water due to slow circulation and longer period of contact with sediment material in case of ground water changes of ground water quality with the passage of time have hydrologic significances. The investigation was performed for assessment of ground water quality at selected surrounded villages in Chitrakoot area (Madhya Pradesh)

II. MATERIALS AND METHODS

The Chitrakoot area is situated on the northern part of Vindhya Mountain, between lush green forest & vivid river. The climate of Chitrakoot is tropical with hot weather as an average temperature around 49^{o}C in summer while 5^{o}C in winter season. Chitrakoot has an average rainfall around 900 mm. The relative humidity at Chitrakoot varies from 12% to 85% in April and August respectively.

Chitrakoot dham is situated in between latitude 80^{0}51 to 80^{0}56 and longitude 25^{0}8' to 25^{0}12' northern part of Satna, M.P. Chitrakoot. The selected villages for collection of water samples were Pathara, Paldev, Guptagodawari, Satianusuiya, Rajaula, Chitrakoot Bus Stand, Ramghat, Kamta Basti, Nayagawan, and Hanuman Dhara. The temperature, pH and colour were measured at sampling point. The odour, turbidity, total suspended solids, total dissolve solids, EC, total hardness, calcium hardness, magnesium hardness, residual chlorine, chloride, total alkalinity, fluoride, nitrate and iron parameters were analyzed in the laboratory. The high quality chemicals and Glassware's were used in the laboratory and as

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purchased by Qualigens/ Merck and Scott Duran respectively. The analysis of above said parameters performed as per standard methods for examination of water and wastewater as prescribed by APHA and AWWA, 2005. The results of analysis were compared with drinking water quality standards as prescribed by WHO (2011).

III. RESULTS & DISCUSSION

The selected monitoring locations are shown in table 1. The results of analysis of physico-chemical parameters and standard values are given in tables 2 & 3. The discussion of all parameters is given in the ensuring paragraphs.

A. Temperature, Colour, Odour and Turbidity:

The temperature of the samples varies from 26.0 and 32.4 ^{0}C (table 2; figure 1); and the coefficient of variance for the temperature was observed i.e. 6.2 %. Similar finding by Laishram (2014) observed that the average value of temperature was 23.2 ^{0}C. The colour and odour of water samples were nil. The turbidity of samples lies between 2 and 4 NTU (table 2; figure 1) and the coefficient of variance was observed i.e. 27.85 %. All samples showed clear. The turbidity of samples was within the permissible standard limit. The turbidity reveals presence of clay slit, organic matter and micro organism in water. Sinha et.al., (2011) found that average value of turbidity in the range of 5 to 15 NTU at groundwater resources at Sultanpur, Uttar Pradesh.

B. Total Suspended Solids and Total Dissolved Solids:

Total suspended solids was found in the range from 3.60 to 32.0 mg/l in the water samples (table 2; figure 1); and the coefficient of variance was 80.87 %. A total solid comprises the mixture of volatile and non volatile solids present in water may be due to agricultural activities and geological characteristics. The total dissolved solids ranged from 248.0 to 2508.0 mg/l in the water samples (table 2); and the coefficient of variance observed 85.42 %. However for samples Pathra, Paldev, Chitrakoot busstand, Ramghat, Nayagawa, Hanuman Dhara exceeds the WHO permissible limit. The inorganic substances found in the rocks are responsible for total dissolved solids. Manimegalai (2012) stated that the calcium, magnesium, sodium, bicarbonortes, chlorides and sulphates are principal constituents of TDS. The quantity of high TDS present in water may be unsatisfactory for bathing and washing clothes purpose. Ramaza et.al., (2012) found that average values of total solids, total dissolve solids and total suspended solids were in the range of 1180 to 2300 mg/l, 380 to 1600 mg/l, 400 to 1200 mg/l respectively in ground water quality of industrial zone. Chaurasia and Gupta (2016) observed that the minimum and maximum value of total dissolved solids (TDS) was found from 225.6 to 394.4 mg/l. The amount of TDS is directly correlated with electrical conductivity (EC). The concentration of TDS is also estimated by sum of the extent of cation and anion present in water. The internal erosion and weathering of rocks and anthropogenic activities are responsible for much cation and anion reach in water.

C. pH, Electrical Conductivity and Chloride:

All the samples analyzed were of found to be acidic in nature ranging from 6.48 to 7.5 and the coefficient of variance for the pH was observed 5.55 %. The pH values of collected samples were within the permissible limit WHO. Due to changes in temperature, biological activities and photo synthetic activities, the value pH values of water may be changed. As per WHO, very low pH is likely to give rise to off taste and to promote corrosion. The conductivity at water samples varied from 412.0 to 1830.0 µS/cm (table 2) and the coefficient of variance was observed 51.24%. The samples collected from Naygawan, Ramghat, Kamta, Hanumandhara, Godavari, Sati Anusuiya, Rajaula, Chitrakoot Bus Stand, Pathra and Paldev within the permissible limit by WHO.

The discharge of untreated domestic sewage is major source of chloride in water. High concentration of chloride reveals an undesirable taste to water. The values of chloride were in the range of 70.91 to 300.57 mg/l in water samples; and the coefficient of variance for the chloride was observed 53.02%. Nayagawn shown high value of chloride content beyond the permissible limit prescribed by WHO. Similar finding by Tripathi et.al., (1996) studied the fluoride concentration of ground water in Chitrakoot area. They found that the concentration of electrical conductivity, chloride and pH were 630 to 7709.76 µs/cm, 15.5 to 69.58 mg/l and 6.83 to 7.13 respectively. Singh et.al., (2011) found that values of pH, EC and chloride were 6.3 to 7.3, 48.02 to 123.0 µS/cm and 68.2 to 111.1 mg/l respectively. Rao et.al., (2012) assessed that the values of pH, EC and chloride were 6.54 to 9.74, 268.0 to 5996.0 µS/cm and 64.0 to 446.0 mg/l respectively. Thilakavathi et.al., (2011) monitored the ground water quality around Kalpakkam. They found that average value of pH, EC and chloride were 6.7 to 7.6, 347 to 5341µs/cm and 29.0 to 1406.0 mg/l respectively. Achary et.al.,(2011) carried out status of ground water quality in Bhubaneswar with statistical interpretation for the year. They found that average values of pH, chloride and EC were 5.8 to 7.8 mg/l, 16.0 to 300.0 mg/l and 100.0 to 1371.0 µS/cm respectively.

D. Total Alkalinity, Calcium Hardness, Magnesium Hardness and Total Hardness:

Alkalinity is the capacity of solvent to neutralized acid. It is characterized by the presence of hydroxyl ions is solution, therefore, it the major of buffering capacity of the water. The values of total alkalinity was in the range from 92.0 to 480 mg/l (table 2); and the coefficient of variance was observed 32.98 %. In the Chitrakoot bus stand alkalinity values are from to be low permissible limit and other sampling stations are found to be higher than the WHO permissible limit. The calcium carbonate and magnesium hardness of the sample lies between 89.15 to 411.6 mg/l and 18.78 to 137.71 mg/l, respectively (table 2; figure 2); and the coefficient of variance for the calcium hardness and magnesium hardness were observed 46.01 % and 69.51% respectively. The calcium and magnesium ions are main sources of hard water in nature. Ahmad and Faizan (2014) observed that the value of alkalinity was found in between 342-587 mg/L. Dwivedi A.P. (2017) stated that the total

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alkalinity is a measurement of the concentration of such ions dissolved in water that would react to neutralize hydrogen ions. He observed that the value of alkalinity was observed in the range of 210 mg/l - 500 mg/l in the water samples. The total concentration of calcium and magnesium ions present in water represent as equivalent amount of the calcium carbonate. The hard water containing the concentration in the range of 500 to 1500 mg/l ($CaCO_3$) directly correlated with kidney, level stone and death rates from cardio vascular diseases.

Total hardness of the water samples varied from 272 to 976 mg/l (table 2; figure 2); and the coefficient of variance was observed 45.58 %. The water samples were collected from Nayagawn and Kamta showed high concentration. Hard water leads to heart diseases and kidney stone formation. Similar finding by Gupta et.al., (2014) found that the values of total hardness, calcium hardness and alkalinity were 200 to 341 mg/l, 122 to 161 mg/l and 120 to 240 mg/l respectively. Narsimha et.al., (2012) reported that average values of total hardness, calcium hardness and magnesium hardness were 280 mg/l, 158.8 mg/l and 96.6 mg/l respectively.

E. Residual chlorine, Iron, Fluoride and Nitrate:

The residual chlorine of the samples found between 0.1 to 0.2 mg/l; and the coefficient of variance for the residual chlorine was observed 33.34 %. The concentrations of residual chlorine for all the samples were below detectable limits by WHO. Iron is the most abundant transition element. Iron can enter into after systems by leaching natural deposit and acidic mine drainage. The concentrations of iron for all the samples were below detectable limits by WHO. The iron of the samples lies between 0.2 to 0.6 m/l (table 2; figure 3); and the coefficient of variance for the iron was observed 35.48 %. Fluoride present as mineral in rocks. If fluoride concentration beyond 1.0 mg/l in potable water, it becomes toxic to animal and human being. The consumption of more than 1.5 mg/l fluoride, the significance i.e. molting of teeth and bones has been studied and when consume above 3 mg/l skeletal fluorosis may be observed. The concentration of 10 mg/l is exceeded it may cause crippling problem. The present investigation maximum fluoride was record to be 1.0 mg/l (table 2; figure 3) at samples Ramghat Nayagawan, Pathra and Rajaula; and the coefficient of variance for the fluoride was observed 35.71 %. Earlier studies stated that the fluoride concentration was in the range of 0.00–1.34 mg/l in Bhagalpur area (Verma et al., 2017). Mainimegalai (2012) found that average values of iron and fluoride were 1.6 to 1.9 mg/l and 0.2 to 2.0 mg/l respectively. Parvathavarthin and Senthlnathas (2014) found average value of fluoride and iron were 0.04 to 0.12 mg/l and 0.1 to 1.48 mg/l respectively. Similar finding by Sahu et.al., (2014) investigated the average values of fluoride and iron were 0.3 to 14.9 mg/l and 0.005 to 0.801 mg/l respectively.

Nitrate is naturally found in rocks of earth crust. It is also the constituent of plant part and the nitrogen cycle. The low level of nitrate is present in water. High level of nitrate can cause a blood disorder in bodies younger than 3 month and the disorder is called blue, baby syndrome the water collected from all sampling station of pond. The nitrate of water ranges from 5.0 to 100 mg/l (table 2; figure 4); and the coefficient of variance was observed 64.0 %. Ramesh et.al., (2012) found that average values of nitrate and fluoride were 11 - 38 mg/l and 1.0 - 1.2 mg/l respectively. Ierome Charmaine (2011) carried out evaluation of ground water quality in an industrial area in Bangalore (Karnataka). They found that average value of nitrate was 1.9 to 169.6 mg/l.

Table 1: Location of Sampling Stations

S. No.	Name of sampling station	Location of Sampling Station
1.	Pathara	Near Shiv Ji Temple
2.	Paldev	Near higher secondary School
3.	Guptagodawari	Near Market
4.	Satianusuya	Near Ashrama
5.	Rajaula (Chhota Rajaula)	Near Primary school
6.	Chitrakoot Busstand	Busstand
7.	Ramghat	Near Kenara Bank
8.	Kamta Basti	Mid Basti
9.	Nayagawa	Infront of Thana
10.	Hanumandhara	Hanumandhara – Tiraha

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Table 2: Results of Values, Mean, Standard Deviation and Coefficient of Valiance of Parameters Analyzed for Ground Water Quality

S. No.	Parameter	Min. Value	Max. Value	Mean	Standard deviation	Coefficient of variance
1.	Temperature (^{0}C)	26.0	32.4	29.71	1.87	6.2
2.	Turbidity (NTU)	2.0	4.0	2.8	0.78	27.85
3.	Total suspended solids (mg/l)	3.60	32.0	12.52	10.05	80.87
4.	Total dissolved solids (mg/l)	248.0	2508.0	782.30	668.26	85.42
5.	pH	6.48	7.5	6.84	0.38	5.55
6.	Electrical conductivity (µS/cm)	412.0	1830.0	792.40	406.10	51.24
7.	Total hardness (mg/l)	272.0	976.0	470.40	214.44	45.58
8.	Calcium hardness (mg/l)	89.15	411.6	227.06	104.48	46.01
9.	Magnesium hardness (mg/l)	18.78	137.71	57.57	40.02	69.51
10.	Residual chlorine (mg/l)	0.1	0.2	0.12	0.04	33.34
11.	Chloride (mg/l)	70.91	300.57	125.07	66.32	53.02
12.	Total alkalinity (mg/l)	92.0	480.0	314.80	103.84	32.98
13.	Fluoride (mg/l)	0.5	1.0	0.70	0.25	35.71
14.	Nitrate (mg/l)	5.0	100.0	53.50	34.24	64.0
15.	Iron (mg/l)	0.2	0.6	0.31	0.11	35.48

Table 3: Drinking Water Quality Standards (WHO, 2011)

S. No.	Parameter	WHO (Year 2011)
1.	Colour (Hazen unit, Max)	Nil
2.	Odour	Odourless
3.	Turbidity (NTU)	5.0
4.	pH	6.5-8.5
5.	EC (µmhos/cm)	1400
6.	DO (mg/l)	4-6
7.	Total solid (mg/l)	-
8.	TDS (mg/l)	500
9.	Alkalinity (mg/l)	200
10.	Total hardness (mg/l)	300
11.	Calcium hardness (mg/l)	75
12.	Magnesium hardness (mg/l)	30
13.	Chloride (mg/l)	250
14.	Residual Chlorine (mg/l)	0.2- 0.5
15.	Nitrate (mg/l)	45
16.	Fluoride (mg/l)	1.0
17	Iron (mg/l)	0.3

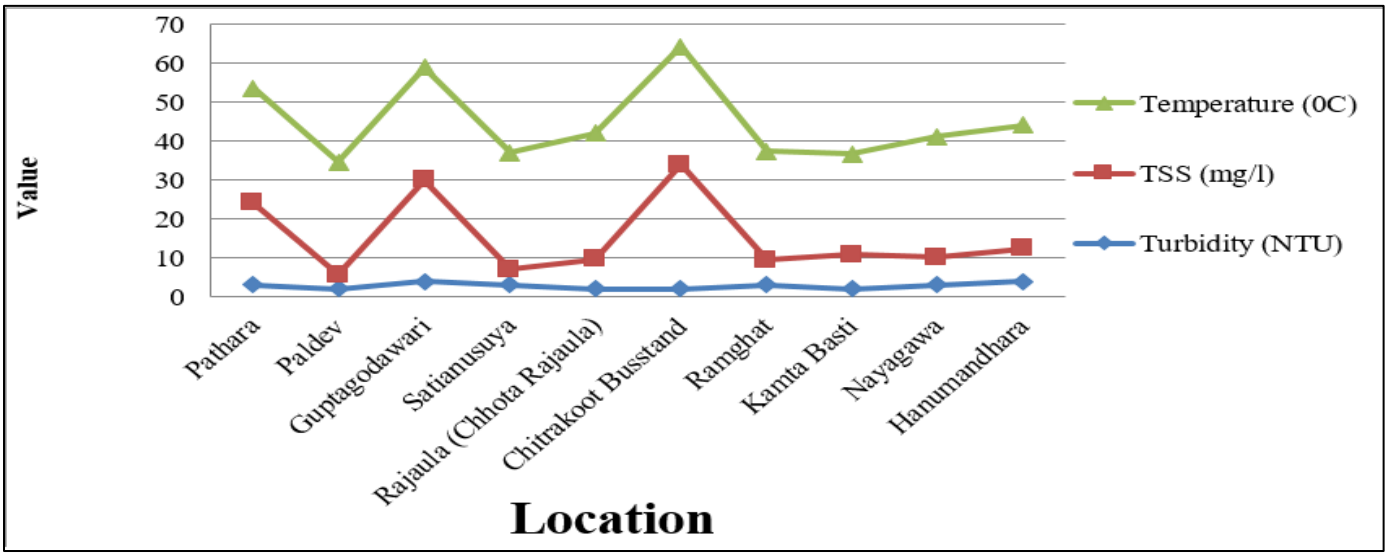

Fig 1: Value of Temperature, TSS and Turbidity in Water Sample at Different Locations

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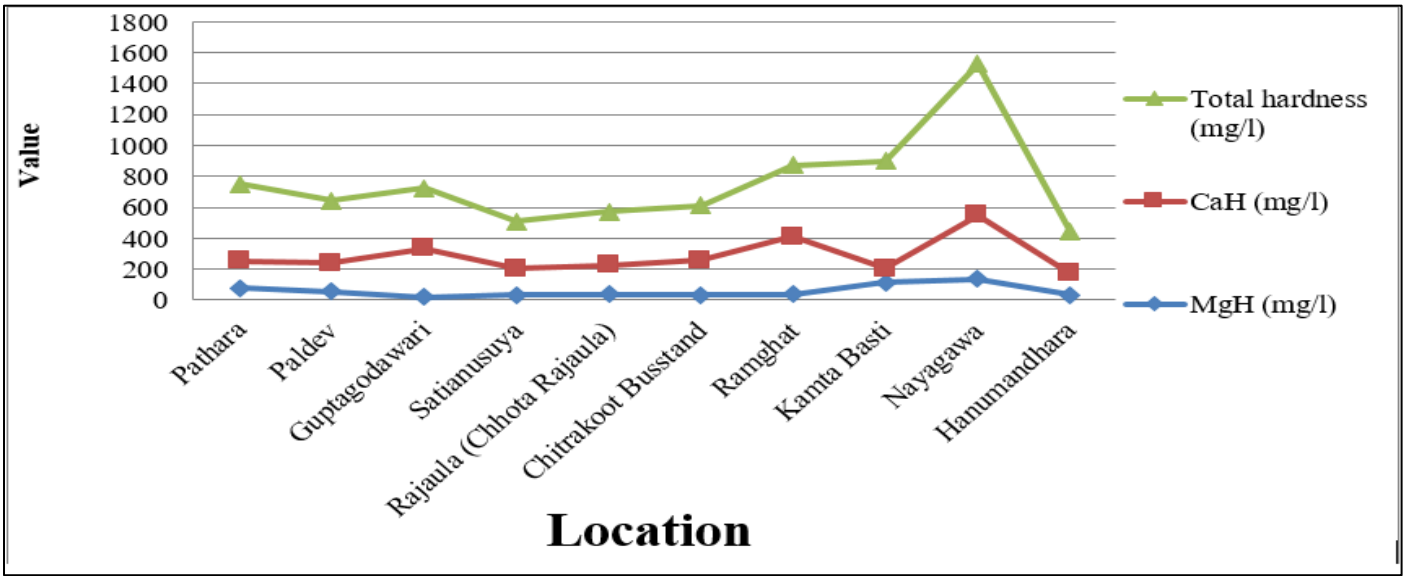

Fig 2: Concentration of Total Hardness, Calcium Hardness and Magnesium Hardness in Water Sample at Different Locations

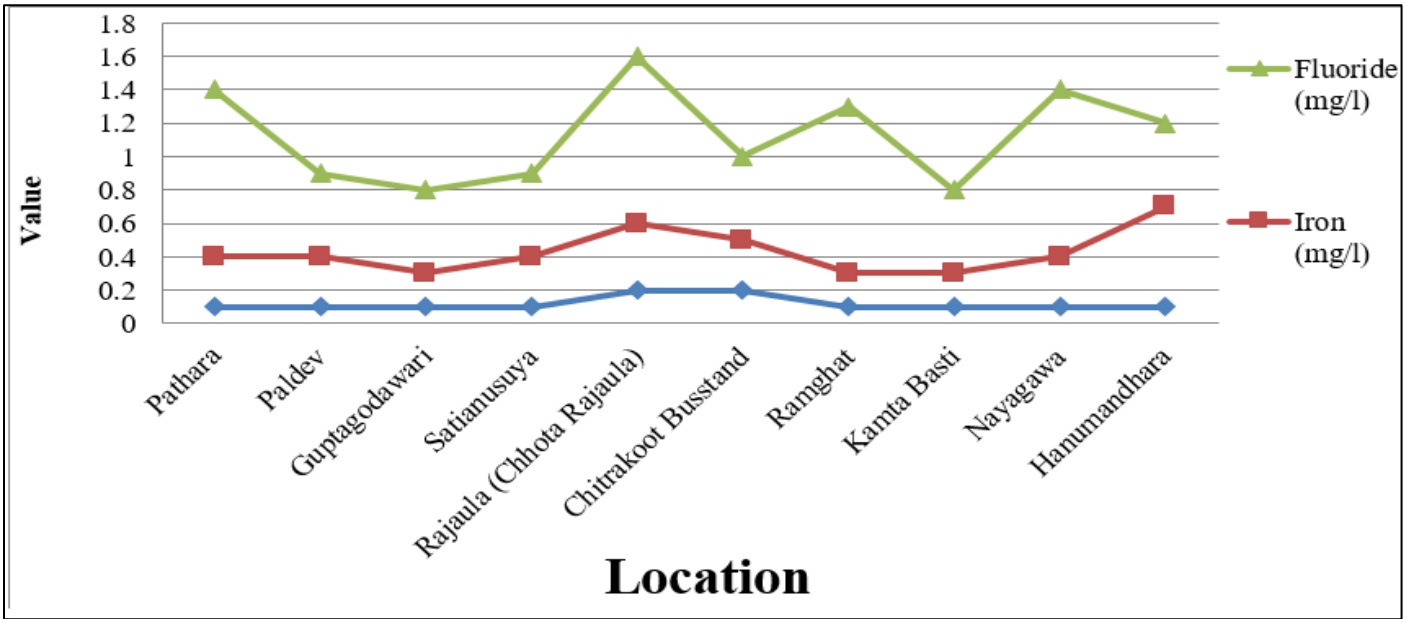

Fig 3: Value of Fluoride, Iron and Residual Chlorine in Water Sample at Different Locations

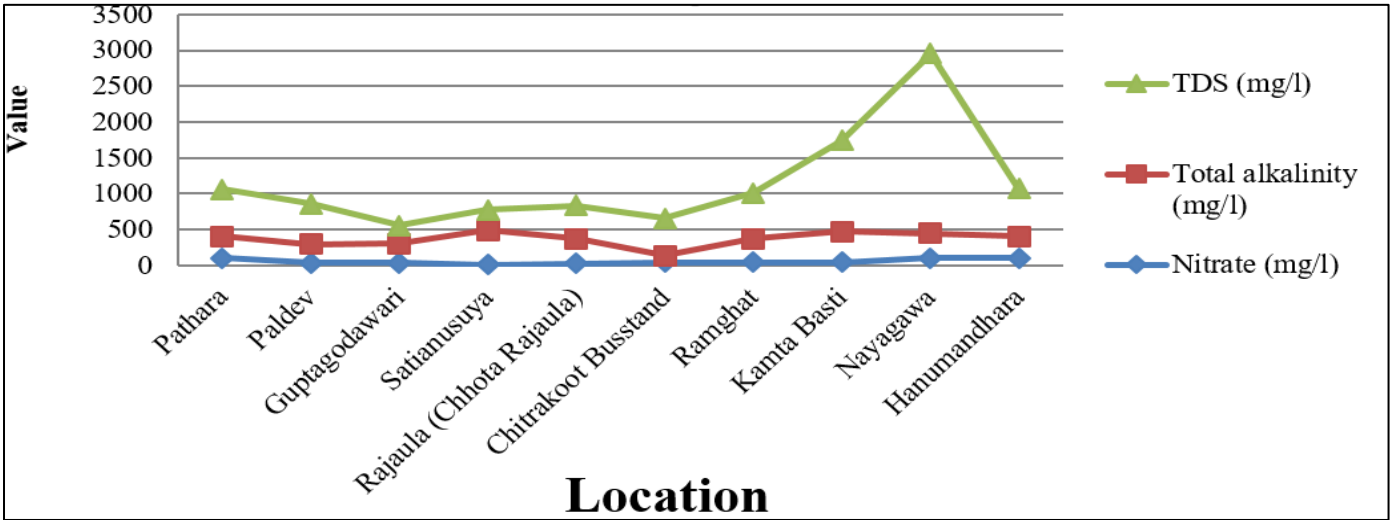

Fig 4: Value of TDS, Total Alkalinity and Nitrate in Water Sample at Different Locations

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IV. CONCLUSION

The assessment is showed that ground water quality was suitable for household and agriculture impetus at the ten selected villages located surrounding in Chitrakoot (Madhya Pradesh). The level of total dissolved solids, total solids, electrical conductivity, chloride, calcium hardness, magnesium hardness, total hardness and alkalinity was found due to abundant of dolomite rocks and lime stone present in the Chitrakoot area. The high concentration of these parameters may have health issue and therefore they require consciousness.

The results of study will be informed to native inhabitant of the locality and imperative beneficial cure must be advised to them to ameliorate the ground water quality at the villages. The ground water quality should be monitored by local Nagal Palika and public health engineering authorities periodically. So, that better actions to be implemented to enhance and promote the quality of water for a safe and well life of inhabitents.

➢ *Management*

- Installation of low capacity pumps
- Periodical monitoring of water level
- Well Development with air Compressors
- Hydrofracturing
- Induction of Sodium hexametaphosphate
- Implementation of water conservation structures

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