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Physico-chemical Characteristics of Ground Water Quality in District Satna (M.P.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The problem of ground water pollution in several parts of the country has become so acute that unless urgent steps for detailed identification and abatement are taken, extensive ground water resources may be damaged. The quality of ground water depends on a large number of individual hydrological, physical, chemical and biological factors. Generally higher proportions of dissolved constituents are found in ground water than in surface water because of greater interaction of ground water with various materials in geologic strata. The work done on ground water of Satna District covering various inorganic non metallic constituents covered are pH, TS, TDS, TSS, TH, DO, BOD, COD, Alkinity, Conductivity.

Keywords: Contamination physical and chemical properties; inorganic, non-metallic constituent; ground water quality.

1. INTRODUCTION

Groundwater is part of the water cycle. It is water that is located beneath the earth's surface in pores and crevices of rocks and soil. Because it is beneath the ground it cannot be seen. This presents different challenges for quantifying and managing the groundwater in comparison with surface water. Groundwater is an important part of the environment. It flows into rivers and

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wetlands, often sustaining them during the summer months or in drought. Trees, shrubs and grasses may also rely on groundwater as their key source of water particularly during times of drought. Presently, increasing threat to groundwater quality due to use of resources has become of great importance. The adverse effects on groundwater quality are the results of man's activity at the ground surface, unintentionally by agriculture, domestic and industrial effluents, unexpectedly by sub-surface or surface disposal of sewage and industrial wastes.

With the increasing demand for groundwater resources caused by an acute shortage of surface water, there is a noteworthy depletion of groundwater levels and quality due to geogenic as well as anthropogenic activities. The quality of world water resources is being increasingly degraded as a consequence of its intensified anthropogenic exploitation. The quality of groundwater is of great importance in determining the suitability of particular groundwater for a certain use (public water supply, irrigation, industrial application, power generation etc.). The quality of groundwater is the resultant of all the processes and reactions that have acted on the water from the moment it condensed in the atmosphere to the time it is discharged by a well. Therefore, the quality of groundwater varies from place to place, with the depth of water table, and from season to season and is primarily governed by the extent and composition of dissolved solids present in it.

A vast majority of groundwater quality problems are caused by contamination, over-exploitation, or a combination of the two. Most of the groundwater quality problems are difficult to detect and hard to resolve. The solutions are usually very expensive, time-consuming and not always effective. Groundwater quality is slowly but surely declining everywhere. Groundwater pollution is intrinsically difficult to detect, since the problem may well be concealed below the surface and monitoring is costly, time-consuming and somewhat hit-or-miss by nature. The wide range of contamination sources is one of the many factors contribute to the complexity of groundwater assessment. It is important to know the geochemistry of the chemical-soil-groundwater interactions in order to assess the fate and impact of pollutant discharged on to the ground.

Pollutants move through several different hydrologic zones as they migrate through the soil to the water table. The serious implications of this problem necessitate an integrated approach in explicit terms to undertake groundwater pollution monitoring and abatement programmes. The intensive use of natural resources and the large production of wastes in modern society often pose a threat to groundwater quality and have already resulted in many incidents of groundwater contamination. Pollutant is being added to the groundwater system through human activities and natural processes. The percolating water picks up a large number of dissolved constituents and reaches the aquifer system and contaminates the groundwater.

The problem of groundwater pollution in several parts of the country has become so acute that unless urgent steps for detailed identification and abatement are taken, extensive groundwater resources may be damaged. The quality of groundwater depends on a large number of individual hydrological, physical, chemical and biological factors. Generally higher proportions of dissolved constituents are found in groundwater than in surface water because of the greater interaction of groundwater with various materials in geologic strata. The water used for drinking purpose should be free from any toxic elements, living and nonliving organism and an excessive amount of minerals that may be hazardous to health. Some of the heavy metals are extremely essential to humans, for example, cobalt, copper, etc. but large qualities of them may cause physiological disorders, the contamination of groundwater by heavy metals and pesticides has also assumed great significance during recent years due to their toxicity and accumulative behaviour. These elements, contrary to most pollutants, are not biodegradable and undergo a global eco-biological cycle in which natural waters are the main pathways. The determination of the concentration laves of heavy metals and pesticides in these waters, as well as the elucidation of the chemical forms in which they appear, is a prime target in environmental research today. The largest available source of fresh water lies underground. The term groundwater refers to this water, which is stored by nature, underground in the water-bearing formation of the earth's crust. The total groundwater potential is estimated to be one third the capacity of oceans. The main source of groundwater is precipitation. A portion of rain falling on the earth's surface infiltrates into ground travels down and when checked by impervious layer to travel further down, forms groundwater. The groundwater reservoir consists of water held in voids within a geologic stratum. The groundwater can be trapped from the following sources.

(a) From natural springs
(b) From wells and bore holes
(c) From infiltration galleries, basins or cribs
(d) From wells and galleries with flows augmented from some other sources:
(e) Spread on surface of the gathering ground
(f) Carried into charging basins or ditches, or
(g) Led into diffusion galleries or wells.

1.1 Hydrochemistry

Water-chemistry is an interdisciplinary science that deals with the chemistry of water in the natural environment. Professional fields such as chemical hydrology, aqueous chemistry, hydrochemistry, water chemistry and hydro-geochemistry are all more or fewer synonyms. The use of chemical characteristics in chemical hydrology is to provide information about the regional distribution of water qualities. Hydrochemistry has significant use for tracing the origin and history of water. Hydrochemistry can also help in gathering information about the environment through which water is getting circulated. Hydrochemistry can be helpful in knowing about residence times, flow paths and aquifer characteristics as the chemical reactions are time and space dependent. The study is essential for the entire system like atmospheric water (rainwater), surface water and groundwater for evaluating their hydrochemistry and pollution level.

1.2 Chemistry of Rainwater

The atmosphere is composed of water vapours, dust particles and various gaseous components such as N_2, O_2, CH_4, CO_4, SOx, NOx, etc. Pollutants in the atmosphere are transported to long distance by the wind. These pollutants are mostly washed down by precipitation and partly as dry fall out. The composition of rainwater is determined by the source of water vapours and by the ion, which is taken up during transport through the atmosphere. In general, the chemical composition of rainwater shows that rainwater is only slightly mineralized with specific electrical conductance (EC) generally below 50 S/cm, chloride below 5 mg/1 and HCO_3 below 10 mg/1. Among the captions, the concentration of Ca, Mg, Na & K vary considerably but the total cations content is generally below 15 mg/1 except in samples contaminated with dust. The concentration of sulphates and nitrates in rainwater may be high in areas near industrial hubs.

1.3 Chemistry of Ground Water

The downward percolation of water is not inactive, and it is enriched in carbon-di-oxide and also acts as a strong weathering agent. Consequently, the chemical composition of groundwater will vary depending upon several factors like rain, which leaches out the salts, residence time of rainwater in the root and intermediate zone, the organic load etc. It may also be pointed out that the water front does not move in a uniform manner as the soil strata are generally quite heterogeneous. The movement of percolating water through larger pores is much more rapid than the finer. The total effect of all the factors charges the ground water with oxygen and carbon dioxide and is most aggressive. This water gradually loses its aggressiveness, as free CO_2, associated with the percolating water gets gradually exhausted through the interaction of water with minerals.

$$CO_2 + H_2O \longleftrightarrow H_2CO_3 \longleftrightarrow H^+ + HCO_3^-$$
$$H^+ + \text{Feldspar} + H_2O \longrightarrow \text{Clay} + H_4SiO_4 + \text{Cation}$$

The oxygen present in this water is used for the oxidation of organic matter that subsequently generates CO_2 to form H_2CO_3. This process runs on still available oxygen is fully consumed.

$$CH_2O + O_2 = CO_2 + H_2O \text{ (Organic matter)}$$

Apart from these, other reactions including microbiological mediated reactions, which tend to alter the chemical composition of the percolating water. For example, the bicarbonate present in most waters is derived mostly from CO_2 that has been extracted from the air and liberated in the soil through biochemical activity. Some rocks serve as sources of chloride and sulphate through direct solution. The circulation of sulphur, however, may be greatly influenced by biologically mediated oxidation and reduction reactions. Chloride circulation may be a significant factor influencing the anion content in natural water.

1.4 Historical Development

Man's search for pure water began in prehistoric times. The story of water supply begins with the grown of ancient capital cities or religious and trade centres. In olden days, most of the community settlements throughout the world ware made near springs, lakes and rivers from where the water supply for drinking and irrigation purposes was obtained. Rig Veda (4000 years B.C.) Make a mention of drinking of wells. Similarly, Ramayana, Mahabharat and Puranas make mention of wells as the principle source of water supply. These wells mostly of shallows depth, dug near river banks. Water was lifted from the wells trough indigenous methods. However, no water treatment or distribution works existed. Apart from India (Bharat), other major civilization of the world, such as Greece, Egypt, and Assyria etc. used wells for their settlements which were located slightly away from springs, lakes and rivers. Joseph's well at Cairo is one of the oldest deep wells excavated in rock to a depth of bout 300 feet. These wells, however, caused water supply problems during periods of drought. It become necessary, therefore, to store water. Cisterns were constructed for collecting rain water while reservoirs were constructed to store water from streams and rivers during the monsoon period. The stored water was conveyed to towns through masonry conduits and aqueducts. The earlier examples are the aqueducts built by Appius Claudius in about 312 B.C. form water supply to Rome. Lyons in Paris, Metz in Germany and Segovia and Serille in Spain built similar aqueducts and syphons for water supply used for drinking, bathing and other purposes. Sextus Julius Frontinus, water commissioner of Rome (A.D.97) reported the existence of nine aqueducts supplying water to Rome and verying in length form 10 to over 50 miles and in cross-section from 7 to over 50 sq. ft., with an estimated aggregated capacity of 84 mgd. The great sewer, known as the cloaca maxima and constructed to drain the Romam Forum, is still in service.

Water is so precious and important in the life these regions there is a saying, "Gagari na phoote, Chahe Balam mar jaye", (The waterpot should not be broken even if the husband dies).

2. STUDY AREA

I selected three villages of Chitrakoot Grampanchayat with the following details: Rajaula village is situated near M.G.C.G.V, Chitrakoot at Satna road. Geographical position of village Rajaula is at latitude N25°08 & E080°50 in Chitrakoot nagar panchayat Satna (M.P.).

Mohkamgarh village is situated near M.G.C.G.V, Chitrakoot. Geographical location of village mohkamgarh is latitude N25°08,E 080°51in Chitrakoot nagar panchayat Satna (M.P.)

Semariya village is situated south west direction from Chitrakoot on tourism place of Gupt Godavari mode and Distance from Chitrakoot about 5 Km. Its G.P.S, Location is latitude N25°07, E080°49.

2.1 Climate

Climate encompasses the temperature, humidity, precipitation, winds, radiation, and other meteorological condition characteristics of a locality or region over an extended period of time. This area experiences a sub-humid and tropical climate with three distinct seasons summer, monsoon & winter. The intervening periods are the transitional period on the basis of IMD long term normal data. The summer is hot and dry with maximum daily temperature ranging between 38° to 43°C. The humidity during this season is lowest ranging between 30 to 53% at 08.30 hrs and 18 to 42% at 17.30 hrs. Summer seasons ends by May and transition period starts. The rainy season commences by late June when south western monsoon sets in over the State. The humidity gradually increases and reaches above 80%.

There is a large variation in temperature both in time and space. The lowest temperature is observed during January when night temperature ranges between 2°C, 6°C over the state. With the start of summer, the temperature starts rising with a maximum during May when the mercury may touch 45°C in central and eastern parts of the state. Gradually with the beginning of the rainy season the temperature drops which again shows a mild rising trend during the intervening period before winter (October, November). The wind speed varies between 8-10 km/hr during the summer season and 4-6 km/hr during winter and rainy seasons.

The climate of study area is characterized by extremes of temperature and dryness, except during the monsoon months. The area comes under the tropical to subtropical climatic condition very specifically. Study area comes under subtropical climatic condition mostly drought-prone region. The cold season is from Dec. to Feb. this is followed by the hot season from March to about the middle of June. The period from mid- June to September constitutes the south – west monsoon season. October and November from the post – monsoon season (Gazetteer of India- 1994).

2.2 Geology

Geology is the study of the earth, its processes, its materials, its history, and its effect on humans and life in general Rocks, Crystal, Mountains, Earthquakes, Volcanoes, Rivers, Glaciers, Landslides and Floods etc.

The regional geology (study area) is mainly characterized by Bundelkhand Granite, Vindhyan system and alluvial deposits, which are Archean, Late Proterozoic and quaternary is age respectively. The whole area covering yellow sandy soil silt dominant were maximum sampling station are coming in the field.

2.3 Rainfall

The minimum rainfall i.e. 0 mm was observed during January, May and November while maximum i.e. 331.1 mm in July in the study area. The short rainfall may be improved by intense forestation and watershed management programmes. Obviously, this will help to raise the groundwater level which would be a great boon to the coming generation.

3. OBJECTIVES

Main objectives of water analysis & all water resource inventories these are following.

- To survey of three villages in order to find out the level of groundwater.
- To search the factors responsible for the underground water level.
- Management of water quality in future.
- Awareness to villagers related to underground water quality.
- Save underground water in future.

4. REVIEW OF LITERATURE

Gupta et al. [1] study on monitoring of well water quality around rajaula village, Chitrakoot, Satna. The parameters investigated ware temperature, pH, turbidity, TDS, EC, BOD, COD, alkalinity, chloride, calcium hardness, magnesium hardness, total hardness, faecal coliform, tec, High level of turbidity, electric conductivity, total dissolved solids, sodium and total hardness were observed. The higher concentration of magnesium may be due to the presence of magnesium rock in the study area.

Patil [2] studied on physicochemical characteristics of groundwater in Amravati-Bhad basin Nandurbar district, Maharastra. 22 water samples were collected and analyzed. He found that overall chemical characteristics of groundwater from dug bore and tube wells suitable for irrigation as well as drinking purposes.

Gupta et al. [3] Studied on assessment of groundwater quality around Kamadgiri parikrama Chitrakoot, Satna. The parameters investigated were temperature, pH, turbidity, TDS, EC, BOD, COD, alkalinity, chloride, calcium hardness, magnesium hardness total hardness, feaceal coliform, Na^+, K^+, Mg^{++} and Ca^{++} ions etc. High level of Ca^{++} and Mg^{++} has been found. Hardness problem at all stations due to presence of limestone and dolomite rocks in the study area.

Gupta and Gupta (2009) studies on evaluation of ground water quality around kamadgiri parikrama at Chitrakoot. The parameters undertaken were temperature, pH, turbidity, TDS, EC, BOD, COD, alkalinity, chloride, calcium hardness, magnesium hardness total hardness, feaceal coliform, Na+, K+, Mg+ and Ca++ ions etc. Extent of Ca++ and Mg++ was found high in all stations.

Gupta and Gupta [4] studied on assessment of drinking water quality of ten selected hand pumps at Chitrakoot, M.P. They found that water of some hand pump was found to have much iron content than its permissible limit however the value were under the desirable limit. Temporary hardness was observed to dominate the permanent hardness which can be removed easily just boiling the water.

Gupta and Gupta [5] studied on correlation and regression of drinking water resources in and around of Kamadgriri Parikrama at Chitrakoot. The physicochemical parameter such as temperature, pH, turbidity, TDS, EC, BOD, COD, alkalinity, chloride, calcium hardness, magnesium hardness total hardness, Na+, K+, Mg+ and Ca++ Ions Were Investigated in order to find out correlation among parameter. The obtained values of physicochemical parameters were also fitted in regression equation for prediction of probable values of different physicochemical parameters of water resources. Water samples were collected from 10 dug wells and analyzed in light of standard methods for examination of water and wastewater.

Gupta et al. [6] studied on assessment of ground water quality of some selected dug wells and hand pumps of Chaubepur village, Chitrakoot. The parameters undertaken pH, turbidity, TDS, EC, BOD, COD, alkalinity, chloride, calcium hardness, magnesium hardness total hardness, Mg+ and Ca++ ions etc. They found that ground water quality of Chaubepur village of Chitrakoot, high values of hardness, alkalinity and conductivity were noticed in selected area due to the natural rock sources. Thus water may be fit for drinking purpose after proper treatment of its.

Gupta et al. [7] studied on assessment of water quality index of dug wells of Chitrakoot area around kamadgiri parikrama. The parameters undertaken were temperature, pH, turbidity, TDS, EC, BOD, COD, alkalinity chloride, calcium hardness, magnesium hardness total hardness, feaceal coliform, Na+, K+, Mg+ and Ca++ ions etc. Extend of Ca++ and Mg++. They found water quality was deteriorated more due to pollution from geogenic as well as anthropogenic sources. Ground water of was not safe for drinking purpose.

Gupta et al. [8] studied on monitoring of water quality of various Bawalis in around Chitrakoot area with special reference to heavy metals. They found that the concentration of Pb and Cu in water of the Bawalis was in the range of 0.1 to 2.146 and nd to 0.07 mg/L, respectively while concentration of Zn, Cr and Fe was found in the range of 0.623 to 2.142, nd to 0.07 and 0.097 mg/L, respectively.

Gupta et al. [9] studied on assessment of physico-chemical characteristics of hand pumps water of Banda city. The physico-chemical parameters investigated were temperature, pH, turbidity, colour, TDS, EC, transparency, BOD, COD, alkalinity, chloride, calcium hardness, magnesium hardness and iron. They found most of the water samples to have total alkalinity and hardness values more than their permissible level. Occurrence of lime stone and dolomite rocks contributed more hardness.

Sina et al. [10] have studied on the effect of well depth on water quality in Neiboring zone of Zayandehroud, Iran. They were found that the location of a well related to surface drainage ways is important in determining the potential for groundwater contamination from surface water flow. Locating a well in a safe place needs careful consideration and planning. To determine the effects of well depth on water quality, the wells up to 4m. depth and 100 m. far from river were selected in Isfahan. Geologically, the earth in this zone composed of clay (more on surface) and sand (Particularly in depths higher than 1m.). Flow direction of river with comparison static level of wells and bottom of river is toward wells. The parameters were measured according to the standard method. Finally, a total of 100 samples were taken and analyzed. Results of this study showed that Total Coliform, Fecal Coliform, COD, NO_3, Total Dissolved Solid and electrical Conductivity showed a range of 3-460 and 0-29 MPN/100 mL, 2-12, 1.39-4.15, 320-783 mg/L and 571-1350 μ moh/cm, respectively. Finally, we observed that NO3, Electrical Conductivity and Total Dissolved Solid increased and Total Coliform, Fecal Coliform decreased with increasing well depth.

Vignesh and Kumar [11] have studied on underground water pollution at Namakkal district Tamilnadu, India. They found that only 49% water was suitable for drinking purpose. The remaining areas are having contaminated water greater than the permissible limit. So this area is constantly monitored and necessary actions should be taken for improving the groundwater quality and also the health of the people.

Gupta et al. [12] reported that groundwater was precious water resource. There was an acute shortage of surface water in many parts of India. Ground water was a dependable source of water supply for domestic and industrial purposes and is also being subjected to severe pollution.

Narsimha et al. [13] assessed the suitability of water quality for drinking purpose in the Hanamkonda area by measuring physic-chemical parameters including major cation and anion compositions. On the basis of nitrate concentration it is illustrated that 61% of samples are suitable for drinking purpose. The chloride content in 27.7% of groundwater sample is above the WHO standard.

Sivasankaran et al. [14] studied 42 bore wells in Pondicherry region, for three seasons during the year 1994-95. The temporal variation in the concentrations of the major ions exhibits an increasing trend towards pre-monsoon and post-monsoon seasons from summer seasons. The study reveals that (i) the water in the alluvial aquifer system has been deteriorated due to sea water intrusion, (ii) the upper layer of the tertiary aquifer is affected to some extent by seawater intrusion and carbonate mineral dissolution and (iii) the characteristics of water in the cretaceous aquifer are mainly due to dissolution of carbonate minerals.

Tripathi et al. [15] carried out fluoride distribution in ground water of Chitrakoot and found that minimum and maximum values for electrical conductivity were 630 and 7709.76 us/cm for chloride were 15.5 mg/l and 69.58 mg/l, for pH were 6.83 and 7.13 for magnesium were 31.67 and 72.05 mg/l, for calcium were 93.35 and 317.1 mg/l, for calcium hardness as CaCO3 was 233.1 and 478 mg/l respectively.

Singh et al. [16] carried out physico-chemical analysis of ground water in Gandhi Nagar area and found that range of pH was 6.3 to 7.3, EC was 48.02 to 123 us/cm, alkalinity was 44 to 271 mg/l, total hardness was 36 to 528 mg/l, TDS was 490 to 1280 mg/l, chloride was 68.2 to 111.1 mg/l respectively.

Chaudhari et al. [18] reported that the ground water quality of some villages of Petlad tahsil of Gujarat, India. Analysis was made are by physico-chemical methods. Fifteen water samples from different villages are under studied for assessment of ground water. On sample from each village is under assessment of physic-chemical solution and various quality parameter are measured including pH, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), content of calcium (Ca), magnesium (Mg), total alkalinity (TA) and chloride concentration present in water. The chemical analysis of water sample show considerable variations and also most of the samples comply with WHO standards for the parameter measured.

Sinha et al. [16] assessed of ground water resources at Sultanpur, U.P. and found that like pH ranged from 8.0 to 8.59 EC from 250-1500 us/cm, alkalinity from 100 to 512 mg/l, hardness from 100 to 396 mg/l, TDS from 324 to 709 mg/l, fluoride from 0.02 to 1.0 mg/l, calcium from 4.8 to 100 mg/1, magnesium from 30 to 88.32 mg/l and Iron from 0.6 to 1.80 mg/l.

Rajappa et al. [19] reported in general ground water quality of Harihara Taluk were analyzed and the analysis resorts that the water quality parameters like pH, EC, TDS, Ca, Mg and Hardness lies within the maximum permissible limit prescribed by WHO and ICMR. Except certain parameters like DO etc, few sampling sites have lower DO than permissible limit due to anthropogenic activities, but this value does not have any impact for the water to use for drinking purpose. Hence this report explains the ground water in Harihara Taluk is suitable for drinking and agriculture purposes.

Chaurasia and Gupta [20] studied that ground water quality for drinking and agriculture use in the Banda District. The ground water samples were analyzed to measure physico-chemical and biological parameters for agriculture and domestic use. The entire ground water samples were from suitable for irrigation purposes based on irrigation quality parameters.

Tiwari et al. (2014) studies of drinking water quality in around Chitrakoot region Tehsil Majhgawan, District Satna, Madhya Pradesh, India and found pH 6.3 – 8.3, TDS 312-733 mg/l, total hardness 296-736 mg/l, EC 424-1033 us/cm, chloride 90-225 mg/l, alkalinity 240-680 mg/l and fluoride 0.5-2.0 mg/l respectively.

5. MATERIALS AND MATHODOLOGY

The study was conducted using measuring tape, G.P.S (Global positioning System), TDS meter and pH meter, plumb bob and I visit selected village for survey. The measuring tape was entered in the well till touching of the upper level of well water. Position of every well was determined with help of G.P.S. Condition of well, Hand pump & Bore well was also recorded.

5.1 Temperature

Water Temperature is a controlling factor for aquatic life: it controls the rate of metabolic activities, reproductive activities and therefore, life cycles. If stream temperatures increase, decrease or fluctuate too widely, metabolic activities may speed up, slow down, malfunction, or stop altogether.

There are many factors that can influence the stream temperature. Water temperatures can fluctuate seasonally, daily, and even hourly, especially in smaller sized streams. Spring discharges and overhanging canopy of stream vegetation provides shade and helps buffer the effects of temperatures changes. Water temperature is also influenced by the quantity and velocity of stream flow. The sun has much less effect in warming the waters of streams with greater and swifter flows than of streams with smaller, slower flows.

Temperature affects the concentration of dissolved oxygen in a water body. Oxygen is more easily dissolved in cold water (1991, Stream keeper's Field Guide: Watershed Inventory and Stream Monitoring Methods).

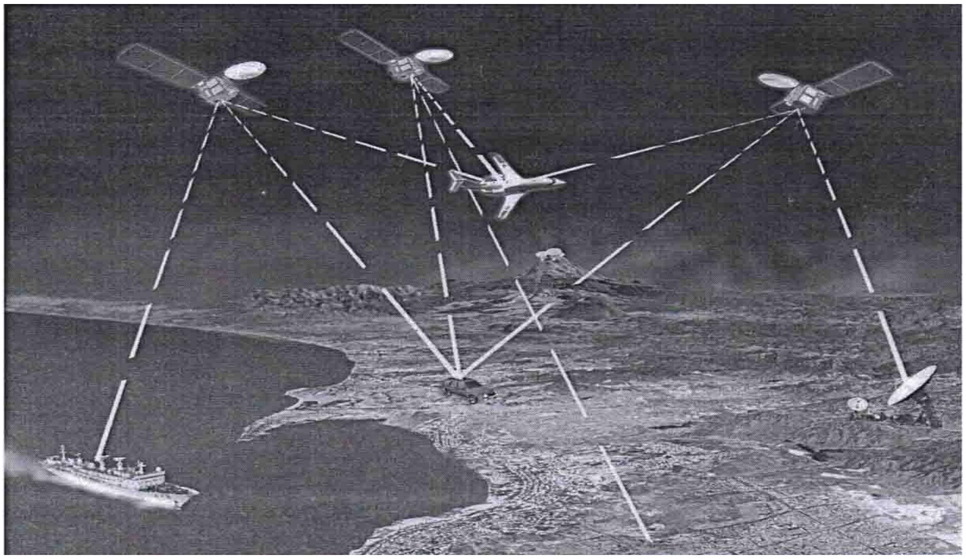

Fig. 3.1.

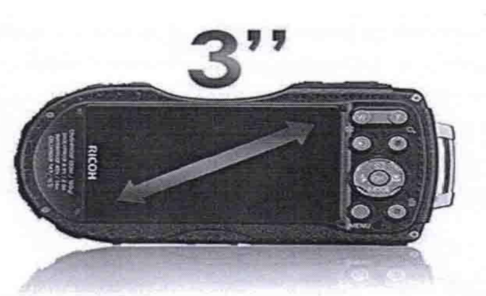

Fig. 3.2. Mesuring tape

Fig. 3.3. G.P.S.

Table 3.1. Details and code of ground water sources of Rajaula Village

S.N.	Name of owner/Identity	Type of source	Code
1	Such Lal	Well	W1
2	In front of Rampal	Well	W2
3	Ramnaresh	Well	W3
4	Gireesh Shrivastav	Well	W4
5	Chhedilal	Well	W5
6	Bhondooram	Well	W6
7	Rampal	Well	W7
8	Raghuraj Prajapati	Well	W8

Table 3.2. Details and code of ground water sources of Mohkamgarh village

S.N.	Name of owner/Identity	Type of Source	Code
1	Baikal Yadav	Hand Pump	HP1
2	Bhullu	Hand Pump	HP2
3	Ramkishor Prajapati	Hand Pump	HP3
4	Lakhana	Hand Pump	HP4
5	Hanuman Prasad Chaturvedi	Well	W1
6	Rahani Mahant	Well	W2

Table 3.3. Details and code of ground water sources of Semariya village

S.N.	Name of owner/Identity	Type of source	Code
1	Govt. of U.P.	Well	W1
2	Chunna Lal	Well	W2
3	Govt. well of U.P.	Well	W3
4	Ramnaresh Tripathi	Well	W4
5	Dhakur Prasad	Well	W5
6	Badhiya Kori	Well	W6
7	Govt. of U.P.	Well	W7
8	Ramsaran Patel	Well	W8
9	Govt. Hospital	Hand Pump	HP1
10	Anant Prakash Tiwari	Hand Pump	HP2
11	Rajkumar Kori	Hand Pump	HP3
12	Atitya Kumar Tripathi	Hand Pump	HP4
13	Ramdeen Pal	Hand Pump	HP5
14	Kailash	Hand Pump	HP6
15	Anant Prakash Tiwari	Hand Pump	HP7
16	Rajkumar Kori	Hand Pump	HP8
17	Aditya Kumar Tripathi	Hand Pump	HP9
18	Ankit Pancher	Hand Pump	HP10

5.2 pH

pH is an important limiting chemical factor for aquatic life. If the water in a stream is too acidic or basic, the H+ or OH- ion activity may disrupt aquatic organisms' biochemical reactions by either harming or killing the stream organisms.

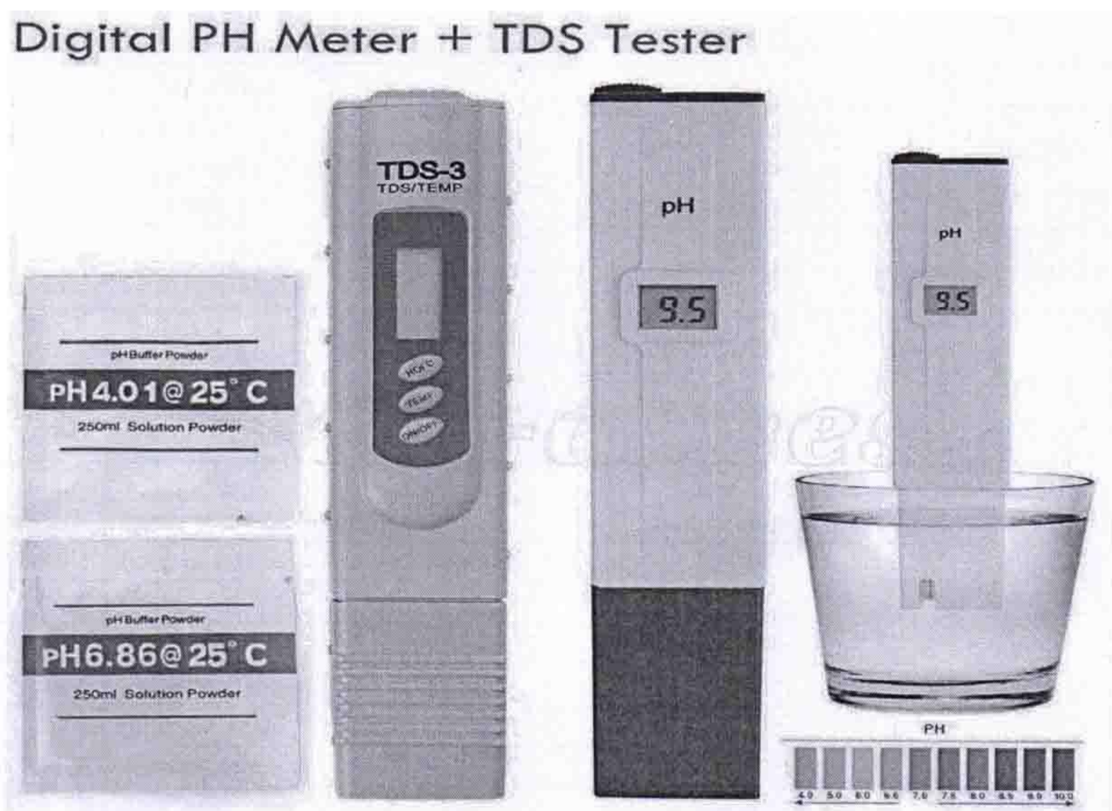

Fig. 3.4. T.D.S. and pH meter

pH is expressed in a scale with ranges from 1 to 14. A solution with a pH less than 7 has more H+ activity than OH-, and is considered acidic. A solution with a pH value greater than 7 has more OH- activity than H+, and is considered basic. The pH scale is logarithmic, meaning that as you go up and down the scale, the values change in factors of ten. A one-point pH change indicates the strength of the acid or base has increased or decreased tenfold. Streams generally have a pH values ranging between 6 and 9, depending upon the presence of dissolved substances that come from bedrock, soils and other materials in the watershed. pH is a scale of intensity of acidity or alkalinity and measures the concentration of hydrogen ions the water. If free H+ is more than OH- ions the water will be acidic or alkaline the other way round. It was measured with the help of digital pH meter (Electronics India, Model 101 E).

5.3 Total Dissolved Solids (TDS)

A large number of salts are found dissolved form in water. The common ones are carbonates, bicarbonates chlorides, sulphates, phosphate and nitrates of calcium magnesium, sodium, potassium, iron and manganese etc. A high content of dissolved solid elevates the density of water influence Osmoregulation of freshwater organism reduce solubility of gases (like oxegen) and utility of water for drinking and utility of water for drinking, irrigation and industrial purpose. It was tested directly from TDS meter.

5.4 Details of Inventory Sites

Data related to details of various inventory sites (Ground Water Bodies) were collected and mentioned in. tables 3.1-3.3.

6. RESULTS AND DISCUSSION

An understanding of ground water occurrence requires a study of the vertical distribution of water in subsurface geologic formation. The earth's crust is called the lithosphere. It is composed predominantly of rock, consisting of disintegrated rock materials such as granite and sandstone. The lithology of a section through the earth's crust reveals the kind of rocks that occur in a succession of layers of strata below the surface that make up any part of the lithosphere.
The outer part of the earth's crust is usually porous to varying depths, at different places. This is the zone of rock facture. The pores or openings in this part of the lithosphere may be partially or completely filled with water. In the surface strata, the openings are only partially filled with water. This strata is called the zone of aeration. The layer below this, where the openings are completely filled with water is called the zone of saturation. The zone of aeration is divided into three zones- the soil water zone, the intermediate zone and the capillary fringe. The zones vary in depth and their limits are not sharply differentiated by differences in physical properties of earth materials. A gradual transition exists from one zone to another.

Formation of strata within the saturated zone below the ground surface from which ground water can be obtained for beneficial use are called aquifers. Ground water reservoirs or water-bearing formation are the other terms commonly used instead of aquifer. These are permeable geologic formations that permit appreciable amounts of water to pass through them. Most aquifers extend over large areas and may be visualized as underground storage reservoirs. The thickness of the zone of saturation varies from a few meter to hundred of meters. For effective disinfection with chlorine, the pH should preferably be less than 8.0 [21].

The portion of the rock or soil not occupied by solid materials may be occupied by ground water. These spaces are known as voids, interstices, pores or pore spaces. The porosity of a rock or soil is a measure of the void space between particles. It is the ratio of void space to the total volume of soil or rock. The size of the pores and the total pore space of an aquifer vary with the type of formation material. Individual pores in a fine-grained material like clay are extremely small, but the total pore space is usually large. While a clay formation has large water-holding capacity, water cannot move readily trough the tiny pores. It is hence not an aquifer even though it may be saturated. On the other hand, a coarse material such as sand contains large pores through which water can move fairly easily. A saturated sand formation is, therefore, an aquifer since it can hold water and transmit it at a satisfactory rate when pressure differences occur. Water enters a ground water reservoir from natural or artificial recharge. It flows out under the action of gravity or is extracted by wells. Ordinarily, the annual volume of water removed or replaced represent only a small fraction of the total storage capacity of the aquifer.

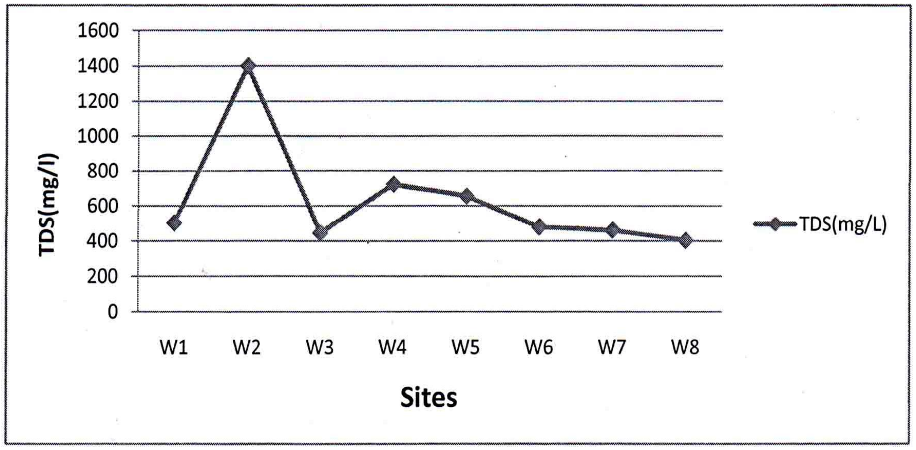

Fig. 4.1. Values of TDS wells of Rajaula Village

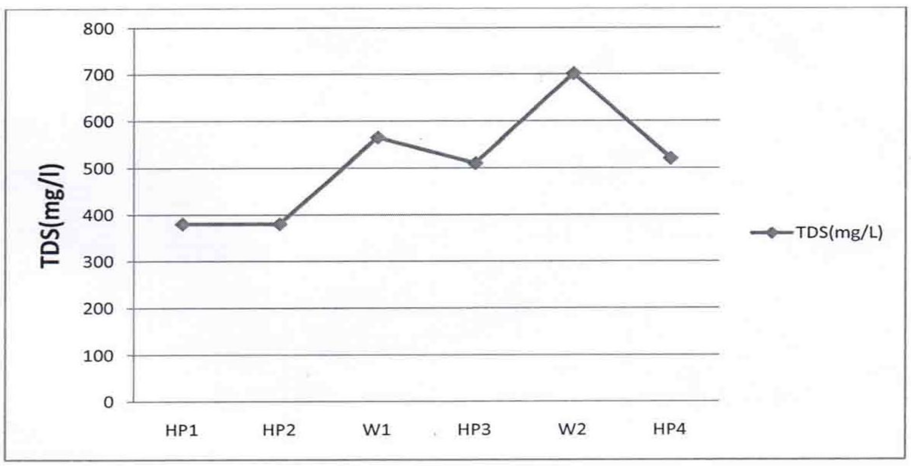

Fig. 4.2. Values of TDS wells & hand pumps of Mohkamgarh village

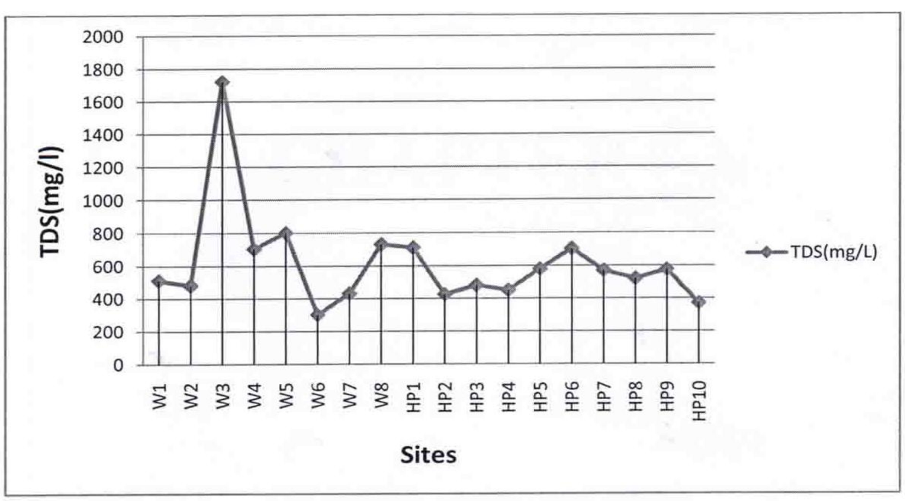

Fig. 4.3. Values of TDS wells & hand pumps of Semariya village

Table 4.1. Water status in wells of Rajaula Nagar Panchayat Chitrakoot

S. N.	Date	Code	Latitude	Longitude	Msl (m)	Total depth (m)	Current water level (m)	Temp. (°C)	pH	TDS	Purpose
1	15.03.2017	W1	N25^{0}08.99	E080°50.448	152.9	21.6	20.8	22	7.1	500	Drinking
2	15.03.2017	W2	N25^{0}08.940	E080°50.741	152.8	19.3	16.73	23	7.5	1400	Not in Use
3	15.03.2017	W3	N25^{0}09.040	E080°50.821	147.5	19.9	18.1	21	7.5	444	Irrigation
4	15.03.2017	W4	N25^{0}08.880	E080°50.763	148	21.6	18.7	24	7.6	722	Not in Use
5	15.03.2017	W5	N25^{0}08.864	E080°50.791	150	17.7	14.2	22	7	655	Drinking
6	16.03.2017	W6	N25^{0}08.740	E080°50.672	154.2	19.9	18.1	23	7.7	479	Drinking
7	16.03.2017	W7	N25^{0}08.740	E080°50.672	154.2	20.13	18.6	21	8	460	Drinking
8	16.03.2017	W8	N25^{0}08.543	E080°50.711	150.4	18.2	16.5	23	7.4	403	Drinking

Table 4.2. Water status in wells & hand pump of Mohkamgarh Nagar Panchayat Chitrakoot

S. N.	Date	Code	Latitude	Longitude	Msl (m)	Total depth (m)	Current water level (m)	Temp. (°C)	pH	TDS	Purpose
1	01.04.2017	HP1	N25^{0}07.992	E080°51.410	151.2	….	….	24	7.2	380	Drinking
2	01.04.2017	HP2	N25^{0}07.938	E080°51.661	156.9	….	….	22	7.7	380	Not in Use
3	01.04.2017	W1	N25^{0}08.110	E080°51.603	150.7	21.5	20.7	23	7.5	565	Irrigation
4	02.04.2017	HP4	N25^{0}08.576	E080°51.577	151.1	…..	…..	23	7.1	510	Not in Use
5	02.04.2017	W2	N25^{0}08.125	E080°51.334	149.7	20.5	19.5	24	7.5	701	Drinking
6	02.04.2017	HP6	N25^{0}08.241	E080°51.331	148.6	…..	…..	22	7.2	520	Drinking

Table 4.3. Water status in wells & hand pump of Semariya Nagar panchayat chitrakoot

S. N.	Date	Code	Latitude	Longitude	Msl (m)	Total depth (m)	Current water level (m)	Temp. (°C)	pH	TDS	Purpose
1	07.05.2017	W1	N25°07.628	E080°49.594	150	11.9	11.2	21	7.5	510	Drinking Domestic
2	07.05.2017	W2	N25°07.628	E080°49.588	149.2	0	0	21	7.4	480	Not in Use
3	07.05.2017	W3	N25°07.639	E080°49.556	153.3	15.2	12	20	7.5	1720	Drinking
4	07.05.2017	W4	N25°07.701	E080°49.686	156.2			25	7.2	704	Not in Use
5	08.05.2017	W5	N25°07.714	E080°49.727	150	17.2	14.1	23	7.6	800	Irrigation
6	08.05.2017	W6	N25°07.730	E080°49.734	150.9	15.2	13.2	21	7.5	300	Not in Use
7	08.05.2017	W7	N25°07.795	E080°49.729	151.6	15.2	13.2	20	7.4	430	Drinking
8	09.05.2017	W8	N25°07.639	E080°49.806	152	15.4	13.2	22	7.6	730	Drinking
9	09.05.2017	HP1	N25°07.651	E080°49.828	156	15.2	13.2	23	7.8	710	Drinking
10	09.05.2017	HP2	N25°07.531	E080°49.788	150			22	7.3	425	Drinking
11	09.05.2017	HP3	N25°07.540	E080°49.796	148			21	7.5	480	Drinking
12	09.05.2017	HP4	N25°07.628	E080°49.594	150			19	7.5	450	Drinking
13	10.05.2017	HP5	N25°07.628	E080°49.588	149.2	105F	55FIST	24	7.5	580	Not in Use
14	10.05.2017	HP6	N25°07.639	E080°49.556	153.3	12.6	12.5	24	7.8	702	Not in Use
15	10.05.2017	HP7	N25°07.701	E080°49.686	156.2	0	0	22	7.4	570	Drinking
16	10.05.2017	HP8	N25°07.714	E080°49.727	150	17.5	13.5	24	7.6	520	Drinking
17	10.05.2017	HP9	N25°07.730	E080°49.734	150.9	11.9	11.2	23	7.5	575	Drinking
18	18.05.2017	HP10	N25°07.795	E080°49.729	151.6	0	0	21	7.5	370	Drinking Domestic

Village wise status of Ground Water resource inventory (Well Hand Pump, Bore well) as on march 15-2017 to may 18-2017 are shown in Tables 4.1, 4.2 & 4.3.

7. CONCLUSION

The inventory of ground water of three village of Chitrakoot Nagar Panchayat performed. In this inventory it was found that water level of the studied water sources became down therefore after some time these water sources might be in drought condition. The main cause of the drought is the cutting of plant. The people of this area have been cutting the forest crudely for 2-3 decades consequently inviting various environmental problem related to loss of natural resources, biodiversity etc. Finally they are destroying the life line of Chitrakoot area. i.e. holy and great river Mandakini.

The above study indicated the ground water quality of the selected hand pumps as almost good consequently water was fit for irrigation and other domestic purposes. Occurrence of lime stone and dolomite rocks produced high total dissolved solids selected sites found higher within limit of WHO and BIS in the study area. The high values of these parameters may have health complications and therefore they need attention.

7.1 Village Rajaual Nagar Panchayat: Chitrakoot

- These results must be shared with people of the area and necessary remedial cure must be suggested to them to improve the water quality more.
- Maximum value of total depth (i.e. 21.6m) was found at this station W1&W4 while minimum (i.e.17.7m) was recorded this station W5.
- Maximum value of temperature (i.e. 24°C) was found at this station W4 while minimum (i.e. 21°C) was recorded this station W3 & W7.
- Maximum value of total pH (i.e.8) was found at this station W7 while minimum (i.e.7) was recorded this station W5.
- Maximum value of TDS (i.e. 1400 mg/l) was found at this station W2 while minimum (i.e. 403 mg/l) was recorded this station W8.
- TDS is major problem most of the site station –W2, W4, & W5 Having TDS concentration higher than the permissible limit indicating that it may cause health effect of the children and older using this ground water.

7.2 Villege Mohkamgarh Nagar Panchayat: Chitrakoot

- These result must be shared with people of the area and necessary remedial cure must be suggested to them to improve the water quality more.
- Maximum value of total well depth (i.e.21.5m) was found at this station W1while minimum (i.e.20.5m) was recorded this station W2.
- Maximum value of temperature (i.e.24°C) was found at this station HP1 & W2 while minimum (i.e. 22°C) was recorded this station HP2 & HP6.
- Maximum value of pH (i.e.7.7) was found at this station HP2 while minimum (i.e.7.1) was recorded this station HP4.
- Maximum value of TDS (i.e.701 mg/l) was found at this station W2 while minimum (i.e. 380 mg/l) was recorded this station HP1 & HP2.

7.3 Village Semariya Nagar Panchayat: Chitrakoot

- These result must be shared with people of the area and necessary remedial cure must be suggested to them to improve the water quality more.
- Maximum value of total well depth (i.e.17.5m) was found at this station W1 while minimum (i.e.16 m) was recorded this station W2.
- Maximum value of temperature (i.e. 25°C) was found at this station W4 while minimum (i.e.19°C) was recorded this station HP4.
- Maximum value of total pH (i.e.7.8) was found at this station HP1 & HP6 while minimum (i.e.7.2) was recorded this station W4.
- Maximum value of TDS (i.e.1720 mg/l) was found at this station W3 while minimum (i.e.300 mg/l) was recorded this station W6.
- TDS is major problem most of the site station – W3, W4, W5, W8, HP1 & HP6 Having TDS concentration higher than the permissible limit indicating that it may cause health effect of the children and villagers using this ground water.

8. SUGGESTIONS AND RECOMMENDATIONS

Selected village of the study represented typical villages where drinking water supply depends upon the groundwater availability. Here main problem is the wastage of water in agriculture, and not aware by the latest techniques of irrigation. Here problem could be solved by generating awareness among the farmers regarding the new agricultural practices and about the more beneficial cash crop. Recharge can be enhanced through applying watershed based practices.

Recharge operation would be desirable at many of this area, not only to preserve the supply, but to increase it in some areas by recharge wells that would compensate for summer peak use, and in other areas to improve the quality of the existing supplies derived primarily from natural recharge. There is reason to believe that maximum ground water development has been achieved in a number of places, and will occur in others more and more frequently in the future. Recharge operations are possible for much of this area.

Water security of the drinking water supply system has to begin with behaviour change in the community of the water users by adopting norms with respect to household level water use, efficiency, wastage, sanitation, contamination. At the distribution level all water supplies need to be monitored.

At the source level the well pumping should be limited to the requirement through improved efficiency of the supply, destruction system. Agriculture water use should be considered as a part of the drinking water sustainability issues and efforts made to reduce the agriculture water pumping by at least 70% and application of fertilizers chemicals reduced to prevent contamination of the groundwater system.

In this broad sense, recharge would seem to be the answer.

- ❖ All the ground water extraction structures should be registered and regulated to avoid over exploitation and deterioration of ground water quality.
- ❖ The water obtained from the ground water structures should be tested and analysed to ensure the suitability of ground water for human consumption.
- ❖ The ground water abstraction sources and their surroundings should be properly maintained to ensure hygienic conditions and no sewage or polluted water should be allowed to percolate directly to ground water aquifer.
- ❖ Proper cement platforms should be constructed surrounding the ground water abstraction sources to avoid direct well head pollution.
- ❖ The surrounding surface area of the ground water abstraction structures should be frequently chlorinated by sue of bleaching power.
- ❖ Possibilities of construction of artificial recharge structures should be explored to augment the ground water recharge.
- ❖ The hand pumps, which have been indentified as having suspected water quality should be painted red to indicate and warn the public the water drawn from the source is not fit for human consumption.
- ❖ In the absence of alternate safe source of water, the water with excessive undesirable constituents must be treated with specific treatment process before its se for human consumption.
- ❖ The ground water drawn from hand pumps should be properly chlorinated to eradicate the presence of bacterial contamination.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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