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HYDRO GEOCHEMISTRY AND GROUND WATER QUALITY EVALUATION OF PULWAMA AND SHOPIAN KASHMIR

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ABSTRACT

The chemical quality of groundwater of district pulwama and shopian, Jammu and Kashmir was assessed for its suitability for drinking and purposes. A total of 19 water samples were collected from bore well dug wells and spring. The water samples were analyzed for different physico-chemical properties, e.g., pH, total dissolved solids (TDS), total harness (11-1), total alkalinity (TA), calcium, magnesium, carbonate, bicarbonate, sulphate, and chloride concentrations. Based on these analyses, parameters like parameters like sodium adsorption ratio, % sodium, residual sodium carbonate, potential salinity, Kelley's ratio and magnesium ratio, index of Base Exchange and Gibb's's ratio, magnesium hazard and exchangeable sodium ratio were calculated. In the study area all the physico-chemical parameters were within maximum permissible limit prescribed by WHO for drinking water quality. As for as the suitability of water for irrigation is concerned all the parameters, suggest that majority of the samples (more than 90%) are desirable for most of the crops and soils. However the magnesium hazard is more than 50% for all the samples which have adverse effects on the soils and crop yield. According to Gibbs ratio all the samples from the study area fall in the rock dominance area suggesting the rock water interaction is responsible for chemistry of groundwater. Also as per the (Na Vs.1-HCO_3) and (Ca+ Mg vs. SO_4+HCO_3) scatter diagrams suggest that silicate and is prominent in the study area. Piper plot suggest that three types of water are present in the study area.

KEYWORDS: TDS, TH, TA, Groundwater, EC.

INTRODUCTION

Water is the most common liquid on our planet, vital to all life forms; it is the dispersion medium for all chemical and biochemical reactions of the living process and takes -part in many of these reactions. In spite of the chemical simplicity of the water molecule, its physical properties are quite remarkable. Many experiments give great insight into the structure and dynamics of water, but these often require the resources of a major research laboratory. Water has been studied since antiquity. What is new is that computers now allow us to start with elementary interactions between molecules and from them predict the large-scale properties of water, such as pressure, temperature, volume, solubility of salts, and so forth. In other words, computers can be used to calculate the physical quantities of water related to everyday life. The volume of the earth's water supply is about 326 million cubic miles. Each cubic mile is greater than 1 trillion gallons. Although water is abundant on a global scale, more than 99% is unavailable for our use. A mere 0.3% is usable by humans, with an even smaller amount accessible. The oceans, ice caps, and glaciers contain most of the Earth's water supplies. Ocean water is too saline to be useful, while glaciers and icecaps are "inconveniently located. Surface water supplies, primarily river runoff, are about 300 cubic miles. That means we have about 1/10,000th of 1% of fresh water to use! But conservation is important. Surface runoff plays an important role in the recycling process. Not only does it replenish lakes, streams, and groundwater; it also creates the landscape by eroding topography and transporting the material elsewhere. Water is continually moving around, through, and above the Earth. It moves as water vapor, liquid water, and ice. It is constantly changing its form. Water on Earth is known by different terms, depending on where it is and where it came from. (i) Meteoric water is water in circulation. (ii) Connate water “fossil" water, often saline. (iii) Juvenile water - water that comes from the interior of the earth. (iv) Surface water - water in rivers, lakes, oceans and so on. (v) Subsurface water - Groundwater, connate water, soil, capillary water Groundwater exists in the zone of saturation, and may be fresh or saline. The movement of water is referred to as the global water cycle (hydrologic cycle). Precipitation, evaporation /transpiration, and runoff (surface runoff' and subsurface infiltration) arc the primary phases in the hydrological cycle. The global water budget is based on the recycling (Movement, storage, and transfer) of the Earth's water supply. The direct process by which water changes from a liquid state to a vapor state is called evaporation. In transpiration, water passes from liquid to vapor through plant metabolism. Groundwater comes from precipitation. Precipitated water must filter down through the vadose zone to reach the zone of saturation, where groundwater flow occurs. The rate of infiltration is a function of soil type, rock type, antecedent water, and time. The vadose zone includes all the material between the Earth's surface and the zone of saturation. Near the upper boundary of the zone of saturation where water pressure equals atmospheric pressure, is the water table. The capillary fringe is a layer of variable thickness that directly overlies the water table. Water is drawn up into this layer by capillary action. The ‘vadose zone has an important environmental role in groundwater systems. As with water, surface pollutants must filter through the vadose zone before entering the zone of saturation. Large amounts of water are stored beneath the earth's surface in aquifers. To be an aquifer, the stored water must be accessible at a usable rate. Aquifers consist of porous material such as sand, gravel, and fractured rock. Aquifers can be confined or unconfined. Confined aquifers have non-porous layers above and below the aquifer zone. The non-porous layers hold water and restrict water movement. Such layers are referred to as aquitards or aquicludes. Clay soils, shales, and non-fractured, weakly porous igneous and metamorphic rocks are examples of aquitards. Sometimes a lens of non-porous material will be found in material that is more permeable. Water percolating through the unsaturated zone will be intercepted by this layer and will accumulate on top of the lens; this water is a perched aquifer perched water table. An unconfined aquifer does not have confining layers that retard water movement. Some aquifers are confined under pressure. These aquifers are called artesian systems. Sufficient pressure results in free-flowing water, either from a spring or from a well. Water is continually recycled through aquifer systems. Ground water recharge is any water added to the aquifer zone. Processes that contribute to groundwater recharge include precipitation, stream flow, leakage and artificial means (injection wells). Groundwater discharge is any process that removes water from an aquifer system. Natural springs and artificial wells are examples of discharge processes. Pumping water from a well causes a cone of depression to form in the water table at the well site. Over pumping can have two effects? It can cause a change in the groundwater flow direction. It also lowers the water table, making it necessary to dig a deeper well. Most of the ground water contains no suspended particles and practically no bacteria and organic material. It is usually colorless and odorless. These features of groundwater make it more hygienic, although it contains more dissolved solids than surface water. However some of these dissolved solids are essential for health, if they do not exceeds the limits given by (WHO, 1993).

Table shows estimated world water quantities after Chow et al.

Water Source	Water volume in cubic miles	Water volume in cubic kilometers	Percentage of fresh water	Percentage of Total water
Oceans, Seas. & Bays	321,000,000	1338,000,000	-------	96.5
Ice caps, Glaciers, & Permanent Snow	5,773,000	24,064,000	68.6	1.74
Ground water	5,614,000	23,400,000	-------	1.7
Fresh	2,526,000	10,530,000	30.1	0.76
Saline	3,088,000	12,870,000	--------	0.93
Soil Moisture	3,959	16,500	0.05	0.001
Ground Ice & Permafrost	71,970	300,000	0.86	0.022
Lakes	42,320	176,400	-------	0.013
Fresh	21,830	91,000	0.26.	0.007
Saline	20,490	85,400	-------	0.007
Atmosphere	3,095	12,900	0.04	0.001
Swamp Water	2,752	11,470	0.03	0.0008
Rivers	509	2,120	0.006	0.0002
Biological Water	269	1,120	0.003	0.0001

Rationale and Significance of the Study

Nature has set the total availability of water in the form of Surface as well as groundwater in true form it was present in pure or as a fresh water. But at present on the earth's surface there is not enough water present in fresh form. In the 19th century surface water was considered best for the domestic, agriculture and industrial purposes. Due to increase in population, and ever increase demand of water due to modernization, industries develop enormous amount of wastes were produced. These wastes mixed with water in direct as well as in indirect way and affects the quality of water, Moreover the agricultural return flow and input of sewage drains into streams cause maximum pollution of surface water bodies. At present all streams remain as sewage drains. The pollution of surface water forces people to exploit groundwater to full fill the demands of fresh water. Ground water is believed to be the better drinking water, as the earth's material is considered as natural filter for the water passing through it. Now it becomes necessary to give the information of water in terms of major ion chemistry. In the present investigation an attempt was made to analyse the groundwater samples collected from district Pulwama and Shopian to bring the physico-chemical analysis. As for as the physical and chemical analysis is considered it helps us to know its suitability for drinking, domestic and agriculture purposes. And this analysis also helps us to know the extent of pollution is higher or lower. And comparing the results to different areas we can see the quality of groundwater at different places: Also we can infer the cause for such cases.

Features of the Pir Panjal Range

The Panjal is the main barrier between the plains of India and the Kashmir valley. The northern flank of the Pir Panjal, along with its complex of Karewa-studded foothills and deeply eroded slopes, is a relief feature of great geographic significance. The Pir Panjal is a lofty mountain chain with many of its peaks rising above the perennial snowline. Some of them rising above 3,500 meters and are capped with extensive glaciers, which project their tongues down the slopes. The highest of the peaks, Tatakuti and Brahina Sakai, rise above 4,500 m above sea level. The Pir Panjal descends through a long gentle slope towards the valley of Kashmir, as opposed to its sharp escarpment-like ascent from the plains of Jammu. The gentle and graded nature of the slopes on the northern flank make it ideally suited to the accumulation of snow. Two distinct sections are recognized in the Pir Panjal Range, as is evident from its alignment into two different axes. In its east-west axis, the range extends for over forty-eight kilometers, ultimately culminating in the Rupri ridge. The headstreams of all the important left bank affluents of the Jehlum (Vishav and Reinbiara) rise in this precipitous ridge. The other section of the range having north-northwest to south-southwest axis, runs up to the Jhelum gorge at Baramulla.

The Valley Floor

Like all sedimentary basins, the Valley has a queer combination of depositional and erosional features, The low-lying areas which are either water-logged or subjected to the recurrent inundation go on receiving layer after layer of silt and fine sand. The numerous affluents of the Jehluxn, which fall down the slopes of the bordering mountains, bring tons of detrital material to the valley floor, building levees and deltaic fans over extensive areas at their confluences. The heaps of deposits, consisting of boulders, sand and silt, in the deltas of Sindh and Liddar deserve special mention. The alluvial flats of the valley are bordered by the Karewa deposits whose denuded tops offer sharp contrast to the gradational features of the low lying tracts. The prolonged fluvial action reduced the Karewas to a highly dissected mass with a network of intertwined gullies. The Karewa formations cover a wide area on the southern periphery of the Valley all along its longitudinal extent. The Karewas differ vastly in their surface characteristics and are divisible into two main types- the sloping Karewas and the flat topped Karewas. Their gently sloping surfaces towards the Valley floor have been cut into deep ravines, ranging frosts 50 to 150 meters in depth. The level-topped Karewas are few and farther apart. Along the edge of the hills from Shupian to Sopore, the sloping Karewa beds have been dissected into a multitude of steep-sided ravines, giving the landscape a typical look of immaturity. Below 1828m, The Kashmir valley has a distinctive homogeneity in the level, as evident from the line of the Jehlum, which is a placid stream all along (Raza, 1978).

Soil Types: A soil map of Srinagar, based on scientific data has not been prepared so far. Based on rock strata and pedogenic characters the following major categories of soils may be identified in Srinagar (Rua, 1978; Hussain, 2005).

Hill soils: These soils are found in the mountainous tract of Srinagar. The depth of soil and soil-profiles on steeper slopes is consequently, shallower than that on gentle slopes.

Alluvial soils: Alluvial soils represent the transported soil group and are found in low-lying areas along the Jhelum and its tributaries. These soils may be classified into: (i) the old alluviums, and (ii) the new alluviums. The old alluviums lie above the banks of rivers and are generally free from floods, while the new alluviums are frequently inundated as they lie in the flood plains of the Jhelum and its tributaries.

MATERIAL AND METHODOLOGY

Sample collection: In order to collect samples from the area, several traverses were made, The traverses help us in locating the sampling sites that are in the form of tube wells and springs. During sampling, it was taken into consideration that the sample is the real representative of the groundwater. About 20 samples were collected in October- November, from tube wells and springs of district Pulwama and Shopian. For effective sampling clean and dry polyethylene bottles were used. During sampling bottle was properly rinsed with the water being sampled. In sampling of tube wells, the pump was operated before collecting the sample for about 5-7 minutes then sample was taken. The samples were sealed and numbered. At the sampling site, after collecting the sample pH and EC were recorded immediately, also elevation above mean sea level, ground water temperature, depth to water table, lithology surroundings of the well/spring was noted; the samples were then stored in a cool place and subsequently brought to laboratory for chemical analysis.

Physical parameters: The physical parameters of the groundwater were determined in the field by using portable water analysis kit. The parameters were determined with the help of water analysis kit include Temperature, EC (Electric conductivity), pH (Hydrogen Ion Concentration) and TDS (total dissolved salts).

Temperature: Principle: Temperature is measured in degree Celsius and is taken immediately after collecting the sample. **Apparatus**: Mercury thermometer. **Procedure**: The temperature of the groundwater samples was noted soon after collecting the sample.

Electric Conductivity (EC): The electrical conductance (conductivity) is a measure of weather a substance allows the electric current to pass through or not. It is expressed in micro mhos/cm, which is equal to one million times the value given in mhos/cm. **Apparatus**: Conductivity meter. **Procedure:** The instrument was made on by connecting the mains lead into mains socket and the function switch was brought to Mhos mode. The electrode after washing with distilled water was dipped in de- ionized distilled water of 0.00 EC value for calibration. After calibration electrode was washed and cleaned and made to dip in the sample whose conductivity was to be measured. The value displayed was the electrical conductivity of the sample, and was noted.

Hydrogen ion concentration (pH): Apparatus: pH meter. **Reagents**: Distilled water. **Procedure**: pH meter was washed with distilled water. pH meter was introduced in the sample and reading was noted after 2-3 minutes.

Total dissolved salts (TDS): Procedure: TDS was calculated using EC by using the following relation. TDS=EC in mhos/cm at 25°C x 0.64.

Chemical parameters: Titration method: The parameter that was analyzed by titrametric method includes calcium (Ca^{++}) magnesium (mg^{++}) chloride and total alkalinity.

Analysis for calcium (Ca^{++}): Reagents used and preparation: (i) EDTA (0.01Moiarity) Dissolve 3.72gms of di sodium salt of EDTA in distilled water to prepare 1000nil of solution. (ii) Sodium hydroxide 1 N Dissolve 40gms of NaOH in distilled water and dilute in 1000ml. (iii) Murexide indicator (ammonium purpurate). Mix 2 gm of ammonium purpurate with 100gm of NaCI and grind. **Procedure**: A 50m1 of sample was taken in a flask .then 2m1 of NIOH solution was added to the sample. Then 0.1-0.2gms of murexide indicator was added to the solution, and was shaken till deep pink color appear the initial reading on the burette was noted, then the solution was titrated against EDTA till purple colour end point was reached. Then the final reading was noted.

Calculation: Ca (mg/1) = AxBx400.8 ml sample. A= ml titrant for the sample B= mg $CaCO_3$ equivalent to ml EDTA titrant of calcium indicator end point.

Analysis for chloride: **Reagents used and preparation**

(i) $AgNO_3$-0.141N.(ii)K_2Cro_4(potassium chromate. Dissolve 5 gm of potassium chromate to 100m1distilled water.

Procedure: 100m1 of sample was taken in a flask, and l ml of potassium chromate was added to it. Then the titration against silver nitrate was done until pinkish yellow end point reached.

Calculation: Cl mg/1= (A -B) xN x 35450, 1m1 sample

A = ml titration for sample B = ml titration for blank (0.25) N = Normality of the $AgNO_3$

Analysis for Magnesium: Reagents: (1) EDTA solution (ii) Buffer solution (iii) Erichrome black T indicator (iv) Murexide indicator. **Procedure:** The total hardness of the sample was determined and the calcium of the same sample was determined.

Calculation: Calculation mg/1= (Total hardness-calcium hardness) x 0.243

Where, calcium hardness (as mg/1 x 2.497) = Ca mg/1 x 2.497

Analysis for total Alkalinity: Alkalinity of water is its acid neutralizing capacity or it is the measure of the capacity of water to neutralize a strong acid. Alkalinity is imparted by carbonates, bicarbonates, phosphates nitrates, borates, silcates etc. Alkalinity is determined in terms of carbonates and bicarbonates because of their higher concentration. Hydroxyl ion present in a sample as a result of dissociation or hydrolysis of solutes reacts with additions of standard acid. Alkalinity thus depends on the end point pH used. Alkalinity is a measure of an aggregate property of water and can be interpreted in terms of specific substances only when the chemical composition of the sample is known.

Spectrophotometry

With the help of spectrophotometer sulphate and nitrate were determined.

Analysis tot sulphate: Principle

Sulphate ion is precipitated in an acetic acid medium with barium chloride so as to form barium sulphate crystals of uniform size. Light absorbance of the barium sulphate suspension is measured by a photometer and the $S0_4^{2-}$ concentration is determined by comparison of the reading with the standard curve.

Reagents used

(i) Buffer solution A; dissolve 30 gm of magnesium chloride ($Mgcl_2$. $6H_20$) 5gm sodium acetate ($CH_3COONa.31120$). 1gm potassium nitrate (KNO_3) 20Ml acetic acid CH_3COOH in 500m1 distilled water and make up to 1000m1. (ii) Buffer solution B; dissolve 30gm $MgC12.6H_20$, 5gm CH_3 $COONa.3H_20$, 1gm KNO_3, 0.111gm NA_2SO_4, and 20ml acetic acid (99%) in 500ml distilled water and make up to 100m1. (iii) Barium chloride crystals 20-30 mesh. (iv) Standard sulphate solution; Prepare a standard sulphate solution by dissolving 0.147gm anhydrous NA_2SO_4 in distilled water and dilute to 1000ml.

Procedure: A 100m1 of sample was taken in a flask; 20m1 buffer solution was added and mixed in stirring apparatus. While stirring a spoonful of BaC12 crystals were added and the watch was set for measurement of time immediately. Stirring was done for 60 E 2s at constant speed. After stirring period ended solution was poured into absorption cell of photometer and the turbidity was measured at 5 ± 0.5 min. Estimate for 5042- concentration in sample was made by comparing turbidity reading with a calibration curve prepared by carrying 5042- standards through the entire procedure. Spacing of standards was kept at 5mg/1 increment in the 0- 40 mg/1 5042- ranges. Correction for sample colour and turbidity by running blank to which BaCI, was not added was made. **Calculation:** SO_42^- mg/1 = mgSO_42^- x 1000/m1 sample.

Analysis for Nitrate: Principle: This technique is used only for screening samples that have low organic matter contents i.e. uncontaminated natural waters and portable water supplies. The NO_3^- calibration curve fallows Beer, s law up to 1mg/l. Measurement of ultraviolet absorption at 220nm enables rapid determination at NO_3^-. Because dissolved organic matter also may absorb at 220nm NO_3^- does not absorb at 275nm a second measurement made at 275nm may be to correct the NO_3^- value this method is not recommended if a significant correction for organic matter absorbance is required although it may be useful in monitoring NO_3^- levels.

Reagents used: (i) Stock nitrate solution**:** Dissolve 0.7218gm potassium nitrate in water and 1000ml 1m1 = 100µg NO_3^- - N preserve with 2m1 $CHC1_3$/1. (ii) Intermediate nitrate solution**:** Dilute 100m1 stock nitrate solution to 1000ml with water, 1ml =10µg NO_3^- - N (iii) Hydrochloric acid solution**:** HCI. **Procedure:** To a 50m1 of clear sample 1 mi. of HCI was added and mixed the solution thoroughly. NO_3- calibration standards in _ha range of 0 - 7mg NO_3^- - N/L were made by diluting to 50ml the following volumes of intermediate nitrate solution 0, 1.00, 2.00, 3.00, 4.00, 35.0m1 made. Treat NO_3^- standard in same manner as possible. Reading absorbance and transmittance against re-distilled water set at 0absorbance or 100% Transmittance at 220 275nm was made. It is recommended wavelength of 220 nm to obtain NO_3^-reading and a wavelength 275nm to determine interference to dissolved organic matter.

Calculation: For samples and standards, subtract two times the absorbance reading at 275nm from the reading at 220nm to obtain absorbance due to nitrate. Construct a standard curve by plotting absorbance due to nitrate against NO3" - N concentration of standard. Using corrected sample absorbances obtain sample concentrations directly from standard curve.

Flame photometer: Using flame photometric method, sodium (Na") and potassium (lc-) concentrations of the samples were determined as discussed below.

Analysis for Sodium: Reagents used: Stock sodium solution: dissolve 2.5-12o.m sodium chloride dried at 140° C to constant weight and dilute to 1000m1 with water 1.00m1= 1.00mg Na. Intermediate sodium solution: dilute 10mi stock sodium solution with water 1.00m1= 0.10mg Na. Use this solution to prepare calibration curve in sodium range of 1-10mg/l.

Standard Sodium solution: Dilute 10m1 dilute solution with water to 100m1 1ml = 10mg Na. Use this solution to prepare calibration curve in sodium range of 1 -10mg/1.

Procedure: A blank and sodium calibration standards were made in stepped amounts in any of the fallowing appreciable ranges 0 - 1.0, 0- 10, or 0 - 100mg/1. Emission intensity was recorded at 589nm. Aspirate calibration standards and samples enough time to secure a reliable average reading for each. Calibration curve from the sodium standards were made and sodium concentration of samples was determined from the calibration curve.

Calculation: Na mg/1= (mg Na/l in portion) x D Where D = dilution ratio = ml sample + ml water/m1 sample.

Analysis for potassium: Reagents used: (i) Stock potassium solution: Dissolve 1.907g KCl dried at 110^0C and dilute to 1000m1 with water; (ii) 1ml = 1.00mg. K (iii) Intermediate potassium solution: Dilute 10ml stock potassium solution with distilled water to I 000m1 = 1 00mg/l. Use this solution to prepare calibration curve in potassium range of 1-10mg/1, (iv)

Standard potassium solution: Dilute 10m1 intermediate potassium solution with water to 100ml; 1.00m1 = 0.010 mg. Use this solution to prepare calibration curve in potassium range of 0.1-1.0mg/l.

Procedure: A blank and K calibration standards in stepped amounts in any of the following appreciable ranges: 0-1, 0-10, or 0-100mg/1 should be made. Emission intensity at 766.5nm. Aspirate calibration standards and samples enough times to secure a reliable average reading for each. A calibration curve from the K standards was constructed. K concentration of samples from the calibration was measured.

Calculation: K+ mg/1= (mg k/1 in portion) x D Where D = Dilution ratio = ml sample + ml water/ml sample.

RESULTS AND DISCUSSION

Hydro geochemistry: The water that occurs underground acquires its chemical composition as a result of very complex hydro-geochemical and biological processes occurring in the soil-groundwater rock system during its movement from the area of recharge to the area where it finally again appears on the surface. Apart from the ionic input from precipitation (recharge), chemical weathering and dissolution of minerals within a geologic formation through which water flows determine the chemistry of groundwater (Tijani, 1994). Water takes its nature from the rocks, through which it flow and is found to be in full conformity with the modern interpretation of the chemical relationship of rocks to water (Chebotarev, 1955) and with the theory of "order of encounter" as stated by Freeze and Cherry (1979). The chemical components and distinctive characteristics of groundwater are mainly established in the unsaturated zone (Salem et al, 2004). In the saturated zone, the geochemical evolution, though less intense than in the soil and unsaturated zones, follows progressive changes in quality of water towards areas of discharge. Groundwater chemistry is mainly divided into major ions, trace elements, and minor elements. Major ion chemistry of gives the first hand information about the quality, rock-water interactions and source of groundwater. In the present study ground water samples from district pulwama and shopian were analyzed for physic-chemical parameters that include temperature, pH, conductivity (EC), total dissolved solids (TDS), total hardness, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, $SO4^{2-}$, HCO^{-}_{3} and NO^{-}_{3}. The statistical parameters of the results of analysis like mean, maximum, minimum and standard deviation is given in the table A and the complete results are given in the table B.

The groundwater quality parameters are generally divided into two categories

Physical parameters: Temperature: The temperature of groundwater is largely dependent on atmospheric temperature, terrestrial heat, exothermic and endothermic reactions in rocks, infiltration of surface water, insulation, thermal conductivity of rocks, rate of movement of ground water, and interference of man on the ground water regime. In general, the mean annual temperature of shallow groundwater approximates that of the mean annual temperature of the air. Groundwater temperature is generally higher than the atmospheric temperature during winter and lower during summer. Maximum temperature fluctuations occur when the water table occurs close to the ground surface. Within the shallow depths, ground water temperature may also be controlled by the degree of insulation in the zone of aeration. Below the zone of surface influence ground water temperature increases approximately 2.9°C for each 100m of depth in accordance with the geothermal gradient of the earth's crust (Todd, 1980). Temperature is very important in determining various parameters like pH, conductivity, saturation level of gases and various forms of alkalinity (Tebutt, 1998). A rise in temperature of water leads to the speeding of chemical reactions in water. Temperature is important for its effects on bio-chemical reactions in organisms present in water. The temperature of groundwater in study area ranged from 4.1°C to 14.5°C with the mean of 11.41t .Temperature showed a lot of variation throughout the study area with deep wells showing high temperature and springs and shallow wells showing low temperature. This may be due to the depth of wells as groundwater occurs at differential depths throughout the study area.

Hydrogen Ion Concentration (pH): Hydrogen Ion Concentration pH is a measure of the acidity or basicity of an aqueous solution. The intensity of acidity or alkalinity of water indicates the concentration of hydrogen ions present. In pure water at 22^{o}C (72^{o}F), H_3O^+ and hydroxyl (OH^-) ions exist in equal quantities; the concentration of each is 1×10^{-7} moles/liter, creating a neutral solution. Consequently the pH of pure water is –log (1×10^{-7}) which equals log (1×10^{-7}), or 7. If acid is added to water, however, an excess of H_3O^+ ions is formed: H^+ (acid) plus H_2O (water) yields H_3O^+ (hydronium ions). When the concentration of H_3O^+ exceeds the concentration of OH^- the solution becomes acidic. In an acidic solution, the concentration of hydronium (H_3O^+) ions can range from 1 to 1×10^{-7} moles/liter depending on the strength and amount of the acid. Therefore acid solutions have a pH ranging from 0 up to but not including 7. The pH in the study area ranges from 6.3 to 7.6 with an average of 7.29 which shows that the groundwater in the area is slightly alkaline in nature.

Electrical Conductivity (EC): The electrical conductivity is a measure of the ability of water to carry an electric current. Chemically pure water is a bad conductor of electric. However, a very small amount of ionized mineral salt in solution renders the water conductive. The more the ions present, the greater will be the conductance of the solution. EC is temperature dependent an increase of 1°C temperature increases the conductance by about 2%. It is calculated as milli-mho or micro-mho or micro-siemens per cm. According to Langenegger (1990), the importance of EC is its measure of salinity, which greatly affects the taste and thus has a significant impact on the user's acceptance of the water as potable. The electric conductivity of groundwater in the study area varied between 63.5 [.LS/cm to163.5 µS/cm with the mean of 126.53 .iS/cm, being higher in the springs and lower in the tube wells. This can be attributed to the contamination of springs due to the surface water mixing in them at shallow depths.

Chemical Parameters

Total Dissolved Solids (TDS): Total Dissolved Solids is a measure of the combined content of all inorganic and organic substances contained in a liquid in: molecular, ionized or micro-granular suspended Run. More than 90% of the total dissolved solids in ground water can be attributed to eight ions: Na+, Ca_2+,K+, Mg+, SO_4-2, Cl-, HCO_3-and CO_3; The concentration of TDS is generally very low in the high rainfall areas and high in some desert brines (Karanth, 1987). TDS gives a firsthand idea about the suitability of water. although TDS is not generally considered a primary pollutant it is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminants. High TDS may affect the aesthetic quality of the water; interfere with washing clothes and corroding plumbing fixtures. For aesthetic reasons, a limit of 1500 mg/L has been established as part of the secondary drinking water standards (WHO, 1993). However, the high content of dissolved solids in water increases the salinity of soils that adversely affect the plants. Salts may harm plant growth physically by limiting the uptake of water through the modifications of osmotic processes (Todd, 1980) in the study area TDS range from 56.7-104.64 with an average of 80.8. TDS are comparatively lower in the groundwater of the study area and show minimum variation. This may be due to the water being less polluted.

Hardness: Hard water is water that has high mineral content. The hardness of water is caused mainly by the concentration of Ca_2+ and Mg_2+ ions, although Fe-H-and Sr also impart hardness. Hardness is expressed in terms of $CaCO_3$ and is divided into carbonate hardness. If the hardness exceeds the alkalinity the excess is termed, "non carbonate hardness". Hard water is a nuisance in homes and industries because of mineral build up on fixture and poor soap and/or detergent performance. Scale deposits in large evaporators such as cooling towers, water.

Magnesium: Magnesium is the seventh most abundant element in the earth's crust and comprises 2.9% (wt.%) of the average composition of the earth's crust. In igneous rocks, magnesium is typically a major constituent of the dark coloured ferromagnesian minerals, especially olivine, pyroxenes, amphiboles, and the dark coloured micas. In altered rocks, magnesium mineral species such as chlorite, asbestos and serpentine occur. Sedimentary forms of magnesium include carbonates such as dolomite, magnesite and hydromagnesite etc. Sewage and industrial wastes are other important contributors of magnesium. Magnesium concentration in the groundwater of the study area ranges from 22.43-132.48mg/1 with an average of 68.75mg/l. magnesium shows lot of variations in the study area, the higher concentration of magnesium in the groundwater of the study area may be due to the rock-water interaction and also due to the use of fertilizers in the study area.

Sodium: Bicarbonates and Carbonates (Total alkalinity): Alkalinity of the water is its capacity to neutralize a strong acid and characterized by the presence of hydroxyl ions' capable of convening with the hydrogen ions. Alkalinity in the natural waters is due to the presence of free hydroxyl ions and hydrolysis of salts formed by the weak acids and strong basis. Dissolution of carbon dioxide is important in enhancing the alkalinity of the water. Almost all the carbonate and bicarbonate ions in groundwater originate in soils from respiring organisms and decaying vegetation and from the dissolution of carbonate rocks such as limestone and dolomite. Weathering of silicates also adds HCO_3 to groundwater (Hem, 1985). Alkalinity in water is due to dissolved species that can accept and neutralize protons. Bicarbonates are not generally regarded as undesirable for municipal supplies, but are highly objectionable for some of the industrial uses. Total Alkalinity in the groundwater of the study area ranged between 135mg/I to 1020 with an average of 294.73mg/l. Total alkalinity showed a lot of variation in the study area with higher Values in springs than in tube Wells. The higher concentration of total study area may be attributed to the rock-w l alkalinity in the after interaction.

Chloride: Chlorine bearing minerals and rocks such as sodalite and chiorapatite and occurs very minor constituents of igneous and metamorphic rocks contribute a very minute amount of chloride to the groundwater. Chloride in groundwater may be contributed from mineral like apatite, mica, and hornblende and from liquid inclusions in igneous rocks (Das and Malik 1988). Considerably sources that are more important are associated with sedimentary rocks, particularly evaporates like halite and sylvite. Abnormal concentrations of chloride may result from pollution by sewage wastes, salting from certain type of trees like coconut and leaching of saline residues ill the soil (Karanth, 1987). Chloride in excess (>250 mg/L) imparts a salty taste to water and people who are not accustomed to high chloride can be subjected to laxative effects (Prakash and Roa, 1989). Chloride can cause corrosive effects on various equipments and very high concentration of chloride is harmful to less resistant crops. The WI-10 (1993) has recommended a maximum permissible limit of 250mg/1, for human consumption. In the study area chloride concentration ranges between 117.4- 332,9mg/I with an average of 225.58mg/1., with higher values in springs and lower values in tube wells. The chloride concentration in the groundwater of the study area is on higher side which may be attributed to contamination of groundwater due to sewage inputs and due to the presence of chlorine bearing rocks in the passage way of groundwater.

Sulphate

The minerals of sulphur are of common occurrence in the igneous and metamorphic which occur as sulphides of heavy metals. When these sulfide minerals under go in contact with aerated water, the sulphur is oxidized to yield sulphate ions that go into solution in the water and contribute sulphate ions to the groundwater. This is the main process of sulphate concentration in the groundwater. Groundwater receives some of the sulphate ions from sedimentary minerals and rocks such as gypsum and anhydrite. Apart from these norm sources sulphate may also be introduced through the fertilizers and also through human activities. The sulphate concentration in the groundwater of the study area ranges from between 5 -11.2 with an average of 7.5mg/l. The concentration of sulphate in the groundwater show very little variation throughout the study area. The sulphate may be contributed by fertilizers to the groundwater and also by the sulphur bearing minerals in the rocks of the aquifer system.

Nitrate: Nitrogen is very minor constituent of rocks, but it is a major constituent of the atmosphere. Nitrogen and oxygen of the atmosphere are combined the electrical discharges during lightening and are dissolved in the rainwater. The average nitrate content of the rainwater Is reported to be 0.2ppm. However a major part of this nitrate may be fixed by plants before the rain water infiltrates below the root zone. Nitrate in groundwater generally originates from nitrate sources on the land surface, in the soil zone, or in shallow sub soil zones where nitrogen rich wastes are buried (Freeze and Cherry, 1979). In some situations, NO^-_3 that enters the groundwater system originates as NO^-_3 in wastes or fertilizers applied to the land surface. These are designated as direct nitrate sources. In other cases, NO^-_3 originates by conversion of organic nitrogen or NH^+_4 which occur naturally or are introduced to the soil zone by human activities. In groundwater with no transformation and little or no retardation. In the study area the concentration of nitrate in the groundwater ranges from 0.87 to 1.31 with a mean value of 1.07. The nitrate concentration shows little variation throughout the study area. The concentration in springs was found higher and lower concentration in well. This may be attributed to the influence of irrigation return flow on the groundwater as lots of fertilizers are used in the farmlands in the study area.

Mechanism controlling groundwater chemistry

Apart from the dissolved ions from the atmosphere the water, that falls on the surface of the earth and that infiltrates into the ground and reaches the ground water where it reacts with its environment and attains composition that corresponds to either its host environment or is in accordance to the precipitation or corresponds to either its host environment or is in accordance to the precipitation or corresponds to evaporation. This was demonstrated by R.J. Gibbs in 1970 whereby he proposed three sources of ions in the ground water namely; the rock dominance, precipitation dominance and evaporation dominance. The chemical data of ground water from the study area was plotted on the Gibbs diagram and all the samples fall in the rock dominance are which suggest that aquifer lithology is responsible for the chemistry of the water in the study area.

Hydrochemical facies: The hydro chemical regime of a study area can be easily known by plotting the analytical values obtained from the groundwater on Piper (1994) trilinear diagrams. These plots include two tangles, one on left hand side for plotting cations and the other on right hand side for plotting anions, The cation and anion fields are then combined to show a single point in a tt central diamond shaped field' h basis of the hydro from which inference is drawn on the geochemical facies concept. This diagram reveals similarities and differences among groundwater samples because those with similar qualities will tend to plot together as groups (Todd, 2001). This diagram is very useful in bringing out chemical relationships among groundwater in more definite terms (Walton, 1970). The geochemical evolution can be understood from the Piper plot, which has been divided into six sub categories viz. I (Ca-HCO_3 type); (Na-C1 type); III (Mixed Ca-Na-11CO3 type); IV (Mixed Ca-Mg-C1 type); V (Ca-Cl types when the samples were plotted on type) and VI (Na-HCO_3 type). In the study three water type the Piper Trilinear Diagram. In the study area the samples fall in the area on the piper plot in which alkaline earth metals exceed alkalies and when the subdivision is done they fall in the following types: (i) Mg-CaCl-HCO^-_3 68.42% (ii) Mg-Cl-HCO_3 type 21.05% (iii) Mg-Ca- HCO_3-Cl type 10.52%.

Groundwater quality for drinking and domestic purposes: The quality of water is as important as the quantity as it decides whether the water in consideration is fit for a particular use or not. It is not only chemical quality of the water that decides whether the water in question is fit foran intended use but also physical parameters such as color, taste, odor and turbidity also bear an influence on the usage of water. However-it is chemical quality of the water that is most important parameter that eventually makes water sate or unsafe a particular intended use. Harmful microorganisms should be absent; however they are not usually considered in ordinary chemical analyses (Hem, 1985). A large numbers of health problems have been identified in developing countries because of the ignorance of water quality According to an estimate of the World Health Organization, around eighty percent of the diseases and over one-third of the total deaths in the developing countries are caused by the consumption of contaminated water (Earth Summit, 1992). In developing countries like India, the quality criteria standards are not followed strictly due to which a lot diseases are caused. Human and other organic life and agriculture requires not only sufficient water for livelihood and growth but also the reliable quality of water. Any deterioration in water quality affects the sustainable development. Various human interferences with nature such as industrialization, urbanization, cause deterioration of the fresh water resources there making them unsafe for human as well as unfit for agricultural purposes. The water quality standards, prescribed by the World Health Organization (1993) for domestic purposes are presented in Table 2 The range concentration of the various parameters determined for the groundwater of the study area is also presented in the table which shows that the concentration of various constituents are within the permissible limit established by the WHO (1993) for drinking and domestic purposes.

Table. 2: Groundwater quality for drinking and domestic purposes .

Parameters	Range	Permissible limit
pH	6.3-7.6	6.5-8.5
EC µmhos/cm	73.5-163.5	1600
TDS (mg/l)	56.7-104.64	1000
Calcium (mg/l)	28.05-194.78	200
Magnesium (mg/l)	22.43-132.48	150
Sodium (mg/l)	9.9-18.7	200
Potassium (mg/l)	0.7-3.2	12
Sulphate (mg/l)	5-11.2	400
Chloride (mg/l)	117.4-332.9	250
Nitrate (mg/l)	0.6-0.38	10

Groundwater quality for agricultural purposes

Water quality, soil types, and cropping practices play an important role for a suitable irrigation practice. Excessive amounts of dissolved ions in irrigation water affect plants and agricultural soil physically and chemically, thus reducing productivity. The physical effects of these ions are to lower the osmotic pressure in the plant structural cells, thus preventing water from reaching the branches and leaves. The chemical effects disrupt plant metabolism. Water quality problems in irrigation include indices for salinity, chlorinity, sodicity (Mills 2003), and alkalinity. The important chemical constituents that affect the suitability of water for irrigation are as follows.

Salinity index: Based on the analysis, the groundwater samples have been classified as pre Handa's classification 1969 and are given in Table 3 It is found that all the samples collected from the study area are categorized under low salinity classes. All the samples (100%) belong to the low salinity category, indicating that the water is of excellent quality. The salinity index of the groundwater samples was computed using the measured electrical conductivity values. Water exhibiting low salinity (classes 1) it considered very well for soils or crops.

Table. 3: Classification of waters based on of EC (Handa 1969).

ECµS/cm	Water salinity	Number of Samples	Percentage
0-250	Low Salinity (Excellent Quality)	19	100
251-750	Medium Salinity (Good Quality)	-----	-----
751-2250	High Salinity (Permissible Quality)	-----	-----
2251-6000	Very High Salinity	-----	-----
6001-10000	Extensively high	-----	-----
10001-20000	Brines weak concentration	-----	-----
20001-50000	Brines moderate concentration	-----	-----
50001-100000	Brines High concentration	-----	-----
>100000	Brines extremely high concentration	-----	-----

Total hardness: In determining the suitability of groundwater for domestic and industrial purposes, hardness is an important criterion, as it is involved in making the water hard. Water hardness has no known adverse effects; however, it causes more consumption of detergents at the time of cleaning, and some evidence indicates its role in heart disease (Schroeder 1960). Hence, the groundwater of the study area was classified on the basis of hardness as per the criteria given by Sawyer and McCarthy 1967 and the classification is presented in the table (iii) Accordingly the groundwater of the study area fall in moderately hard to very hard categories with 5.2, 36.84 and 57.89% of samples falling in the moderately hard, hard and very hard categories indicating that majority of the samples fall in very hard category.

Table. 4: Showing water classes based on hardness.

Hardness mg/l as $CaCo_3$	Water class	Percentage of samples
0-75	Soft	0
75-150	Moderately hard	5.26
150-300	Hard	36.84
Over 300	Very hard	57.89

Sodacity index or SAR: Another important factor for water quality is the sodium concentration to express reactions with the soil and know reduction in its permeability. High sodium-depositing waters are generally not suitable for irrigating the soils, as higher deposition of sodium may deteriorate the soil characteristics. Therefore, SAR is considered a better measure of sodium (alkali) hazard in irrigation, as SAR of water is directly related to the adsorption of sodium by soil and is a valuable criterion for determining the suitability of the water for irrigation. Excessive sodium content relative to calcium and magnesium reduces soil permeability and thus inhibits the supply of water needed for the crops. The SAR measures the relative proportion of sodium ions to those of calcium and magnesium in a water sample. The SAR is used to predict the sodium hazard of high carbonate waters, especially if they contain no residual alkali. The excess sodium or limited calcium and magnesium content are evaluated by SAR which is computed as**: SAR = Na/√(Ca + Mg)/2** where all cationic concentrations are expressed in equivalents per million or mill equivalents per liter. The classification of groundwater samples from the study area with respect to SAR (Todd 1959) is given in Table (v). The SAR value of all the samples are found to be less than I and are classified as excellent for irrigation (i.e., Si category). The sodicity index was calculated using the SAR, with water up to class 2 are generally considered suitable for irrigation, and was used for the classification of the groundwater samples. Based on the sodicity index, all the samples belong to class 0 i.e the water is excellent for irrigation.

Salinity hazard: For the purpose of diagnosis and classification, the total concentration of soluble salts (salinity hazard) in irrigation water can be expressed in terms of specific conductance. Classification of groundwater based on salinity hazard is presented in Table (v) It is found from the salinity hazard classes that all the samples in the study area are excellent for irrigation purposes as they belong to low salinity class (Cl) category. Groundwater samples that fall in the low salinity hazard class (C1) can be used for irrigation of most crops and majority of soils. However, some leaching is required, but this occurs under normal irrigation practices except in soils of extremely low permeability. Groundwater samples that fall in the medium salinity hazard class (C2) can be used if a moderate amount of leaching occurs. High salinity water (C4 and C5) can be used for plants having good salt tolerance but restricts its suitability for irrigation, especially in soils wit restricted drainage (Karanth 1989; 2000). High salinity water (C3, C4, and C5) cannot be used in soils with restricted drainage. Even with adequate drainage, special management for salinity control is required, and crops with good salt tolerance should be selected. Such areas need special attention as far as irrigation is concerned. A more detailed analysis for the suitability of water for irrigation can be made by plotting the sodium absorption ratio and electrical (Richards 1954). conductivity table 5 data on the US Salinity Laboratory (US SL) diagram Accordingly, all the samples from the study area fall in the category of C1S1, indicating a low salinity/low sodium type. Hence the water is excellent for all the types of crops and soils.

Table. 5: Showing salinity hazard classes.

Salinity Hazard Class	EC (μ/cm)	Quality	Percentage of samples
C1	100-250	Excellent	100
C2	250-750	Good	----
C3	750-2250	Doubtful	----
C4 and C5	>2250	Unsuitable	----

Percent sodium

Methods of Wilcox (1995) and Richards (1954) have been used to classify and understand the basic character of the chemical composition of groundwater, since the suitability of the groundwater for irrigation depends on the mineralization of water and its effect on plants and soil. Percent sodium may be defined as the percentage of sodium with respect to the total cations and can be determined using the following formula.

%Na=(Na+ K)/ (Na+ K+ Mg+ Ca).

Where the quantities are expressed in mill equivalents per liter. When the concentration of sodium is high in irrigation water, sodium ions tend to be absorbed by clay particles, displacing Mg_2+ and Ca_2+ ions. This exchange process of Na+ in water for Ca_2+ and Mg_2+ in soil reduces the permeability and eventually results in soil with poor internal drainage. Hence, air and water circulation is restricted during wet conditions, and such soils become usually hard when dry (Sale11 et al. 1999). The classification of groundwater with respect to percent sodium based on Wilcox 1955 is shown in Table 6 and it was found that 94.74 % samples belong to the excellent category and 5.26 % samples fall in good category.

Table. 6: Sodium percent water class (Wilcox 1955).

Percent Sodium	Water Class	Percentage of samples
<20	Excellent	94.74
20-40	Good	5.26
40-60	Permissible	-----
60-80	Doubtful	-----
>80	Unsuitable	-----

Based on Eaton's (1950) classification shown in the Table (6) all the samples belong to the safe category. Wilcox (1948) classified groundwater for irrigation purposes by correlating percent sodium (i.e., sodium in irrigation waters) and electrical conductivity.

Table. 7: Showing Sodium percent water class (Eaton 1950).

Sodium (%)	Water Class	Percentage of Samples
<60	Safe	100
<60	Unsafe	-----

Residual sodium carbonate: In addition to the SAR and% Na, the excess sum of carbonate and bicarbonate in groundwater over the sum of calcium and magnesium also influences the suitability of groundwater for irrigation because in waters having high concentration of bicarbonate, there is tendency for calcium and magnesium to precipitate as the water in the soil becomes more concentrated. An excess quantity of sodium bicarbonate and carbonate is considered to be detrimental to the physical properties of soils, as it causes dissolution of organic matter in the soil, which in turn leaves a black stain on the soil surface on drying. As a result, the relative proportion of sodium in the water is increased in the form of sodium carbonate, and this excess, denoted by RSC, is calculated as follows (Eaton 1950; Ragunath 1987): RSC = $(CO_32- + HCO_3-)$ $(Ca_{2+} + Mg_{2+})$ Where all ionic concentrations are expressed in equivalents per million or milliequivalents per liter. According to the US Department of Agriculture, water having more than 2.50 epm of RSC is not suitable for irrigation purposes.

The groundwater in the study area is classified on the basis of RSC and the results are presented in Table 8. Based on the RSC values, 18 out of 19 pies (94.74%) •showed RSC values less than 1.25ppm, considered too well for inigation. The 5 wing one sample (5.26%) was having a RSC value more than 1.25 sale epm, suggesting the sample has doubtful quality for irrigation.

Table. 8: showing groundwater quality based on RSC (after Richards 1954).

RSC (epm)	Quality	Percentage
<1.25	Good	94.74
1.25-2.50	Doubtful	5.26
>2.50	Unsuitable	----

Kelly's ratio: Sodium measured against Ca_2+ and Mg_2+ is used to calculate Kelley's ratio (Kelly 1940, 1951; Paliwal 1967), which is measure of sodium with respect to calcium and magnesium. However, nowadays, SAR is a better measure for sodium, and this particular ration is not in common use. A Kelly's ratio of more than 1 indicates an excess level of sodium in waters. Hence, waters with TA' Kelly's ratio less than are suitable for irrigation, while those with a ratio more than 1 are suitable. Kelly's ratio in the study area ranged from 0.029 to 0.282, and all the water samples are suitable for irrigation according to Kelly's ratio.

Magnesium hazard: Generally, calcium and magnesium maintain a state of equilibrium in most waters. Calcium and magnesium do not behave equally in the soils system, and magnesium deteriorates soil structure particularly when waters are sodium dominated and highly saline. A high level of Mg is usually due to the presence of exchangeable Na in irrigated soils. In equilibriu-m, more Mg_2+ present in water will adversely affect the soil quality, rendering it alkaline, resulting in decreased and adversely affected crap yields. Paliwal (1972) introduced an impor ratio called index o tant ratif 50% would adversely affect the crop magnesium hazard. Magnesium hazard value of more than yield as the soils become more alkaline.

Magnesium ratio: (Mg_2+) ' 100/(Ca2++Mg_2+) In the study area , the ME values were reported to be in the range of 74.75 to 91.64% indicating that all the samples have magnesium hazard more than 50% thereby indicating their adverse effect on the crop yield purposes as the MB of more than 50%, is harmful to crops. On the basis of magnesium ratio Based on the Mg/Ca ratio, we can classify waters as suitable or unsuitable for irrigation, and all the samples from the study area belong to the safe category Table 9.

Table. 9: Permissible limits of residual Mg/Ca ratio in irrigation water.

Class	Quality	Percentage of samples
<1.5	Safe	100
1.5-3.00	Moderate	-----
>3.00	Unsafe	-----

Exchangeable Sodium Ratio

ESR is yet another parameter which is a measure effect of sodium on the soil and crop yield and can be defined as: ESR = Na^+/ $Ca2^+$ + $Mg2^+$. The ESR values calculated to determine the suitability of water sample for agricultural purposes, varied from 0.029 to 0.282. Indicating that water is of excellent quality for agricultural purposes.

CONCLUSION

In the present study an attempt has been made to analyse the groundwater to know its water chemistry. On analyzing the samples of the study area its physical and chemical parameters were determined by applying different methods in order to know the quality of water It is clear from of groundwater mainly depend on its the data ,results that the overall Hydrochemical character parent rock and also the impact on groundwater due to agricultural and domestic wastes, , FC (Electric conductivity), pH (Hydrogen l ding temperature The physical parameters including temperature, EC (Electric Conductivity), pH (Hydrogen ion Concentration) and TDS dissolved salts) of the groundwater were determined in the field by using portable water analysis kit. In the study area all the deep wells shows lot of variation in the physical parameters. The temperature of ground water in study area ranged from 4.1°C to 14.5°C with the mean of 11.41°C. Temperature showed a lot of variation throughout the study area this may be due to groundwater occurring at differential. The ph in the study area ranges from 6.3 to 7.6 with an average of 7.29 which shows that the groundwater in the study area is slightly alkaline in nature. The EC of groundwater in the study area varied from between 63.5µS/cm to 163.5 µS/cm with the mean value of µS/cm, being lower in springs and higher in the bore wells. In the study area, the hardness ranges from 120-740mg/1 with an average of 337.78. The calcium concentration in the study area ranges between 28.05-194.74 with an average of 54.84 most of the water samples have low to moderate concentration of calcium due to result of water rock interaction. Magnesium concentration for the study area ranges from 22.43-132.48mg/1 with an average of 68.75mg/l. Higher range of magnesium may due to use of agricultural wastes and fertilizers. The study area shows concentration of potassium between traces to 3.2 with an average of1.4 mg/l. higher concentration is mainly due to agricultural effect. In the study area chloride concentration ranges between 117.4-332.9mg/1 with an average of 225.58mg/1. The study area shows SO_4 concentration ranges between 5-11.2 with an average of 7.5mg. The sulphate concentration in the study area may be due to the excess use of fertilizers. The general abundance of the major cations in the study area is in the order Ca>Mg>Na>K Calcium and magnesium ions present in groundwater are particularly derived from leaching of limestone, dolomites, gypsum and anhydrites, whereas the calcium ions is also derived from cation exchange process (barrels 1976). The concentration of calcium ion in the study area is relatively high when compared to magnesium ion concentration and the calcium and magnesium concentration is mostly due to weathering of calcium bearing minerals and leaching of dolomites. The (Ca_2^+ and Mg_2^+) vs. (HCO^-_3 +SO^-_4) scatter diagram (Datta and Tyagi 1996) shows that majority of the samples fall below the eqiline. It is indicating that the silicate weathering is the dominant process for supply of the calcium ions to the groundwater. In addition to silicate weathering, the carbonate weathering process is also a contributor for increasing of calcium ions in this groundwater. The possible source of sodium concentration in groundwater is due to dissolution and weathering of sodium bearing minerals. In the study area the concentration of sodium and potassium ranges from 9.9mg/1 to 18.7mg/1 and 0.7 to 3.2mg/1 with an average value of 14mg/1 and 1.45mg/1 respectively. If the halite dissolution process is responsible for the sodium, Na/C1 ratio should be approximately 1, whereas the Na/Cl ratio greater than 1 typically indicates that the sodium was released from weathering. In the study area the majority of Na/C1 ratio greater than 1 indicating that the silicate weathering is the samples shows dominant process for the release of sodium in the groundwater. Potassium ion concentration in the groundwater also comes from the above said process. Also the HCO_3 vs. Na scatter diagram shows that all the samples fall below the eqiline indicating that silicate weathering is the dominant process in the area. As shown in A. Wilcox (1948) classified groundwater for irrigation purposes by correlating percent sodium (i.e., sodium in irrigation waters) and electrical conductivity. However, nowadays, SAR is a better measure for sodium, and this particular ration is not in common use. A Kelly's ratio of more than 1 indicates an excess level of sodium in waters. Hence waters with a Kelly's ratio less than 1 are suitable for irrigation, while, those with a ratio more than 1 are unsuitable. Kelly's ratio in the study area ranged from 0.029 to 0.282, and all the water samples are suitable for irrigation according to Kelly's ratio. The overall quality of quality of the groundwater in the study area is suitable for drinking Purposes and quality of water for agricultural purposes is found to be excellent based on different standards.

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