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Geochemistry Analysis of Groundwater in Jaipur Industrial Area, Rajasthan (India)

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ABSTRACT

The importance of ground water for the existence of human society cannot be overemphasized. Requirement of water has been rising in the urban agglomerates due to population explosion and growth in commercial activities along with social needs and comfort resulting in crumbling of existing systems of water supply and sanitation. Ground Water is the major source of drinking water in both urban and rural area. Besides, it is a most important source of water for the agriculture and the industrial sector. In Jaipur urban agglomerate, surface water sources like Ramgarh Lake are generally empty and groundwater contributes over 95% of urban water supply. Present aerial dimension of the urban area lies between north latitudes 27° 18' and east Longitude: 95° 24' located almost in the centre of the district and cover an area about 470 km^2 . The Jaipur urban area occupies in part of Sanganer ((45.5 %), Jhothwara (42.5 %) and Amer (12%) blocks of Jaipur district. With the increase in rate of urbanization, population of the city has also increased many folds i.e. about 16 times during the period 1931 – 2006. Old walled city area is the most populated part has mainly contributed high salinity and nitrate pollution in groundwater. Ground water is important source of water supply due to its relatively low susceptibility to pollution in comparison to surface water. Polluted ground water adversely affects the human health as well as environment. The risk of human health by heavy metals (Cd, Cu, Pb, Zn, Ni and Cr) through the intake of locally grown vegetables, cereal crops and milk from wastewater irrigated site. Milk is not directly contaminated due to wastewater irrigation, but is an important route of food chain transfer of heavy metals from grass to animals. Ground water samples were collected from different hand pumps, tube well, house tape water, public tap water etc. to study the chemical parameter, such as pH, EC, Total Hardness, Calcium, Magnesium, Sodium, Potassium, Carbonate, Bicarbonate, Sulphate, and Chloride, with the help of standard method of APHA. Analysis of water for physical, biological and chemical properties including trace element contents are very important for public health studies.

INTRODUCTION

Jaipur city capital of Rajasthan and it is one of fastest growing cities in country & undergoing rapid industrialization. Jaipur city is also popular known as Pink City and is situated towards central part of the district. Jaipur is very much on the world tourist map, known for jams & jewelry and is also popular for Sanganer & Bagru prints. The demand for water has increased over the years and this has led to water scarcity in many parts of the world. The situation is aggravated by the problem of water pollution or contamination. India is heading towards a freshwater crisis mainly due to improper management of water resources and environmental degradation, which has lead to a lack of access to safe water supply to millions of people. Groundwater crisis is not the result of natural factor; it has been caused by human actions. Wells are the main source of franking water and other domestic chores for inhabitants of the area surrounding the factory1. During the two decades, the water level in several parts of the country has been falling rapidly due the an increase in extraction. The number of wells drilled for irrigation of both food and cash crops have rapidly and indiscriminately increased. Rapidly rising population and changing lifestyles has also increased the domestic need for water. The quality of groundwater is getting severely affected because of the widespread pollution of surface water. Besides, discharge of untreated waste water through bones and leachate from unscientific disposal of solid wastes also contaminates groundwater, thereby reducing the quality of fresh water resources. Water quality index is most effective tools that provide the composite influence of individual water quality parameter on the overall quality of water[1] many researchers and projects have been conducted to measure water quality index for various purposes.[2-8] Correlation analysis measures the closeness of the relationship between chosen independent and dependent variables[9]. Once a linear relation has been shown to have a high probability by the value of the correlation coefficient, then the bet straight line through the data points has to be estimated.[10] The objectives of the present work is to analyze the major ion constituents of the groundwater of Jaipur city and classify the water in order to appraise the water quality and its suitability for drinking and irrigation purposes using piper US salinity diagram. Water used for drinking purpose should be free any toxic elements living and nonliving

organism and excessive amount of minerals that may be hazardous to health. Few of the heavy metals are extremely essential to the humans, like copper, cobalt etc., but large quantities of them may cause physiological disorder.[11] Recently heavy metals & pesticides is greater effect to their toxicity so they appears is a prime target in environmental research today. Population of Jaipur city is 3,548,512 and literacy rate in the city was 75.51% and the participation of the male was found to be 86.05% and female was 64.02%. Sex ratio is 909 females for every 1000 males. According to PHED, Jaipur the daily drinking water supply of Jaipur city is 330 mld, out of which 290 mld is used for domestic & remaining 40 mld is for industrial and non-domestic purposes. Actual demand is 150 lpcd and actual per capita supply is 149 lpcd. 98.2% of the supply is through ground sources and 1.8% through surface sources, 64.5% population is covered by sewerage system. The total number of hand pumps existing in city is 1777, out of which 1736 are operational. There are 48 overhead tanks of 40 mld capacity.

MATERIALS AND METHODS

Sampling has been carried out without adding any preservatives in well-rinsed bottles directly for avoiding any contamination and brought directly to the laboratory.[12] Only high pure (AR grade) chemicals and double distilled water was used for preparing solution for analysis. Water sample collected from different hand-pumps, tube-wells, tanks, ponds and house tapes and from various sources at covering extensively populated area, commercial, industrial agricultural and residential colonies various depths according to the standard method of collecting sample at international level i.e. APHA procedure. Water sample collected in good quality polyethylene which cleaned, dried and sterilized with bottles which 2.5 liter capacity. The sample collected were analyzed for major cations like Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) by Titrimetry, Sodium (Na^{+}) and Potassium (K^{+}) by Flame photometer; (ELICO-CL-220) (APHA[2]et al, 1985), anion Chloride (Cl-), Carbonate (CO_3^{2-}) and Bicarbonate (HCO_3^{-}) by Trimetric, Sulphate ($SO4^{2-}$), PO4 and H_2SiO_4 by Spectrophotometer. Trace metal Fe, Pb, Ni, Br, I and Al. Fe was analyzed in Atomic Adsorption Spectrophotometer. Different physical parameter – pH, HC & TDS determined at the site with the help of digital portable water analyzer kit. All respective value result are compared with standard limit recommended by the Bureau of Indian Standard (BSI), Indian Council of Medical Research (ICMR) and WHO.[13]

RESULTS AND DISCUSSION

The quality of groundwater is as important as its quantity because it is the main factor determining it suitability for domestic, drinking, agricultural and industrial purposes.

Chloride (**Cl^{-}**): In the present study after analyzing of 170 ground water sample, chloride concentration was observed between 30 ppm to 2500 ppm with an average of 350 ppm.

In the 43 sample of Jaipur city, the value of chloride is ranging from 45 ppm to 856 ppm with an average of 171.5 ppm. It observed that 37 (83.7%) sample have chloride content less than 250 ppm and are found within desirable limit. Remaining 7 (16.3%) samples have chloride concentration less than 1000 ppm and are found maximum permissible limit.

In industrial area of Jaipur after analyzing 62 ground water samples it observed that the concentration of chloride ranging between 45 ppm to 856 ppm with an average of 171.7 ppm. Out of 62 samples, 56(93.3%) samples have chloride concentration within desirable limit (i.e. below 250 ppm) and 6(9.7%) samples are found within maximum permissible (i.e. below 1000 ppm).

In the Sanganer block the value of chloride in 42 ground water samples is ranging from 30 ppm to 2500 ppm with an average 376 ppm. Out of 42 samples, 37(88.1%) samples are found within the maximum limit and 5 (11.9%) samples are out of maximum permissible limit (i.e. more than 1000 ppm).

In 23 samples of Chaksu block the concentration of chloride is ranging between the minimum 70 ppm to maximum 1000 ppm with an average of 350 ppm. It observed that 9(39.4%) sample have concentration within the desirable limit. 14(60.6%) samples are found within the maximum permissible limit.

It is anions and trouble for irrigation water. Chloride contents water largely influenced by evaporation and precipitation[14]. It is recommended that chloride content should not exceed 250 mg/L. They are generally more toxic than sulphate or most of the plants and are best indicator of pollution.[15-16] Chloride value varies from 32.49 to 624.81 mg/L which are lower than the prescribed by ICMR and WHO standard.

Sulphate (SO_4^{2-}): Sulphate ion is one of the major anions occurring in natural water. In the present study after analyzing 170 samples the concentration of sulphate is ranging between 5.0 ppm to 355 ppm with an average of 125.8 ppm.

In the 43 samples of Jaipur the value of sulphate is ranging from 8 ppm to 91 ppm with an average of 28.6 ppm. In this area all 43 samples are found within the permissible limit (i.e. below 200 ppm).

The value of sulphate in 62 samples of Jaipur industrial area is ranging from 8 ppm to 91 ppm with an average of 28.6 ppm. The sulphate concentrations of all these samples are found within the desirable limit (i.e. below 200 ppm). All samples have sulphates concentration within maximum permissible limit.

In Sanganer block sulphate concentration is ranging from 10 ppm to 350 ppm with an average 86.9 ppm. Out of 42 samples 38 (90.5%) samples are found within desirable limit (i.e. than 200 ppm), and 3(9.5%) samples are found within maximum permissible limits (i.e. less than 400 ppm). All samples have sulphate concentration within maximum permissible limit.

In Chaksu block the concentration of sulphate is ranging between10 ppm to 355 ppm with an average of 125 ppm. The sulphate concentrations of these samples are found within the desirable and maximum permissible limit (i.e. below 400 ppm).

Therefore on the basis of these limits it can say that the sulphate concentration in ground water within the desirable limit of drinking water standard.

Higher value of Sulphate may cause intestinal disorder. Sulphate in most of the samples was found to be lower than highest desirable level i.e. 200 mg/L. Sulphate value varied from 8.55 to 112.5 mg/L and this value are within permissible limits prescribed by TST, ICMR and WHO.

Alkalinity: Desirable limit for total alkalinity is 200 mg/L (ICMR). Value of water sample varies from 160 to 300 mg/L. In ground water, most of the alkalinity is due to carbonate and bicarbonates.

Sodium (Na^+): During the analysis of 170 ground water samples, the value of sodium is ranging between 22 to 1950 ppm with an average of 278.6 ppm. In Jaipur urban the value of Sodium is ranging between 22 ppm to 400 ppm with an average 148.2 ppm. It observed that 31 (72.1%) sample have sodium content less than 200 ppm. Remaining 12 (27.9%) samples have sodium concentration more than 200 ppm.

Sodium value in Industrial areas of Jaipur is ranging from 60 ppm to 718 ppm with an average of 245.9 ppm. Out of 62 samples, 29 (46.8 %) sample have sodium concentration less 200 ppm. Remaining 33 (53.1%) samples have sodium concentration more than 200 ppm. Out of these 33 samples 5 (8.1%) samples have sodium concentration more than 500 ppm and these samples are polluted. This water is not good for drinking.

In Sanganer block the value of sodium is ranging between 30 ppm to 1950 ppm with an average of 348.5 ppm. It observe that 22 (52.4%) sample have sodium content less than 200 ppm. Remaining 19(4.6%) sample have sodium concentration more than 200 ppm. Out of these 19 samples, 5 (11.9%) samples have sodium concentration more 600 ppm, only 1(2.4%) samples have (samples No. 78) sodium concentration more than 1500 ppm and are seriously injurious for human beings.

In the Chaksu block of Jaipur, concentration of sodium is ranging between 69 ppm to 1300 ppm with an average of 381 ppm. Out of 23 samples. 13 (56.5%) samples have sodium concentration less than 200 ppm, 7(30.4%) samples sodium have concentration more than 500 ppm and remaining 3(13.3%) samples have sodium concentration more than 1000 and are seriously polluted. This water is not good drinking.

High sodium value is not suitable for irrigation purpose due to sodium sensitivity of crops and plant. Its value varies from 20.67 to 200 mg/L.

Electrical Conductivity (EC): After analyzing 170 ground water sample the value of electrical conductivity is ranging between 670 µs/cm to 9600 µs/cm with an average 1917.5 µs/cm.

In Jaipur city EC is ranging between 830 µs/cm to 3610 µs/cm with an average of 1579 µs/cm. Out of 43 sample, 6 (14%) sample are out of permissible limit. In Industrial area EC is ranging between 670µ s/cm with an average of 1650.3µ s/cm. Out of 62 sample, 14 (21%) sample are found beyond the maximum permissible limit.

The EC value of Sanganer block is ranging between 750µ s/cm to 9600µ s/cm with an average of 2277.9. In this area 12(28.2%) samples are found in the range of 2000µ s/cm to 4000µ s/cm, 2 (4.8%) sample are found in the range 4000µ s/cm to 6000µ s/cm and 3 samples (7.1%) are found in the range of 6000µ s/cm to 9000µ s/cm. Out of 42 samples highest EC 9600µ s/cm is observed in samples No. 78 of Sanganer block.

In Chaksu block the value of EC ranging between 720µ s/cm to 6580µ s/cm with an average of 2262.1µ s/cm. Out of 23 samples 9 (37.2%) samples are found within the permissible limit and 14 (62.8%) samples are out of permissible limit.

Thus on the basis of above results we can say that EC value of Sanganer block is significantly high in compression of Jaipur city, Industrial area and Chaksu block.

The maximum limit of EC in drinking water is prescribed as 1400 microsiemens/cm (WHO, 2003).

Magnesium (Mg^{2+}): Desirable limit of Magnesium for drinking water are 200 mg/L (BIS: 1999). After analyzing 170 samples urban and rural of Jaipur, the value of magnesium is ranging from 5 ppm to 175 ppm with an average of 47.5 ppm. In 43 samples of Jaipur city the value of magnesium is ranging between 18 ppm to 175 ppm within average of 59.4 ppm. It´s found 36(83.8%) sample are within the desirable / permissible limits (i.e. up to 100 ppm) and 7(16.2%) sample are found slightly polluted having magnesium concentration more than 100 ppm.

The concentration of magnesium in 62 samples of industrial area Jaipur is ranging between 10 ppm to 175 ppm with an average of 34.8 ppm. Expect one all samples are in permissible limit.

In Sanganer area value of magnesium vary from 10 ppm to 155 ppm with an average 52.5 ppm. 10(23.8%) and 29(69%) samples are found within desirable / maximum permissible limit. 3(7.1%) samples are found slightly polluted having magnesium concentration more than 100 ppm.In Chaksu block the magnesium value is ranging from 5 ppm to 98 ppm with an average of 50.3 ppm. All samples are found within the permissible limit (i.e. below 100 ppm).

Total Dissolved Solid (TDS): Total dissolved solid in an important parameter for drinking water and water to be used for other purpose. In the present study of 170 ground water samples, the value of TDS is ranging from 408 ppm to 5568 ppm with an average of 1137.2 ppm.

The value of TDS in the area of Jaipur city is ranging between 498 ppm to 2093 with an average 930.3 ppm. Out of 43 samples, only 1 (2.3%) samples is found beyond the maximum permissible limit (i.e. more than 1500 ppm).

In Industrial area of Jaipur TDS is ranging between 408 ppm to 2784 ppm with an average of 929.7 ppm. In this area out of 62 samples, 5 (8.1%) samples are found beyond the maximum permissible limit.

In Sanganer block TDS value is ranging between 450 ppm to 5568 ppm with an average of 2093.8 ppm. Out of 42 samples, 8(19%) samples are out of permissible limit. Out of these 8 samples, 3 samples have TDS value more than 4000 ppm.

TDS value in the Chaksu block observes in the range of 446 ppm to 3882 ppm with an average of 1638.3 ppm. 12 (52%) sample are found within maximum permissible limit (500 – 1500), 8 (34.8 %) samples are found in the range of 1500 ppm to 3000 ppm and 3(13.1 %) samples have TDS value in the range of 3000 ppm to 4000 ppm. These samples are polluted and not are safe for drinking purpose. In Jaipur industrial area the value of total hardness varying from 177 ppm 800 ppm with an average of 245.2 ppm. Out of 62 samples, only 1

(1.6%) sample is out of permissible limit (i.e. more than 600 ppm).

The value of total hardness in the Sanganer area is ranging from minimum 85 ppm to maximum 915 with an average 347.8 ppm, its observed that out of 42 samples, 36 (85.8 %) sample have TH value below 600 ppm (i.e.in maximum permissible range). Remaining 6(14.2%) sample have TH value more than 600 ppm (i.e. out of maximum permissible limit).

Maximum permissible limit of TDS is 500 mg/L (ICMR). It is represented by the weight of residue left when a water sample has been evaporate to dryness. Beyond the prescribed limit, it imparts a peculiar taste to water and reduce its portability. TDS value varied from 239.60 to 1435 mg/L.

pH: During the analysis of 170 ground water sample from different areas of Jaipur (urban and rural) , it observed that the value of pH is ranging from 6.8 to 9.0 with an average of 8.0 . The maximum pH value 9.0 is obtained in the industrial area of Jaipur. In Sanganer block and Chaksu block pH value is ranging between 7.1 to 8.6 and 7.5 to 8.5 with an average of 8.0 in both areas. All samples are found within the maximum permissible limit.

All biological & chemical reaction are directly dependent upon the pH of water system.[17] Lower pH value may cause tuberculation and corrosion while higher may cause incrustation, sediment deposit and difficulties in chlorination for disinfection of water. In the present study the pH value in all the samples range from 7.3 to 8.5, which are all within the limit.

Fluoride: It is important in human nutrition for development of bones. During the study of 170 ground water samples, the range of fluoride observes from 0.2 ppm to 7.6 ppm with an average of 1.7 ppm.

In the 43 samples of Jaipur city, the value of fluoride is ranging from 0.3 ppm to 2.5 ppm with an average of 0.73 ppm. It observed that 42(97.7%) sample have fluoride concentration less then 1.5 ppm and are found within desirable / maximum permissible limit. Only one sample has fluoride concentration more than 1.5 ppm and is out of maximum permissible limit.

In the industrial area of Jaipur the value of fluoride is arranging between 0.2 ppm to 5.0 ppm with an average of 1.7 ppm. Out of 62 samples, 52 (86.3%) samples are found within the maximum permissible limit and 8 (12.9%) samples have concentration out of maximum permissible limit. In the Sanganer block the fluoride concentration is ranging between 1 ppm to 7.6 ppm with an average of 2.2 ppm. Out of 42 samples, 17(40.5%) samples are found within the maximum permissible limit and 25 (59.5%) samples are found fluoride concentration more than 1.5 ppm. These 25 water samples are polluted and injurious to health.

In 23 samples of Chaksu block the fluoride concentration is ranging between 0.5 ppm to 5.0 ppm with an average of 1.7 ppm. 5(21.7%) samples are found within the maximum permissible limit. Remaining 18(78%) samples found fluoride concentration out of the maximum permissible limit. These samples are polluted and injurious to health.

Therefore on the basis of these result we can say that the concentration of fluoride in Sanganer Block and Chaksu Block is high and this water is not fit for drinking.

The required level of fluoride is 1.0 to 1.5 mg/L. Due to higher concentration of fluoride in ground water may develop molting of teeth, skeletal flurosis, deformation in knee joint. Present study, it is observed that the fluoride content varied from 0.6 to 1.4 mg/L. Fluoride salts are commonly used in steel, aluminum, bricks and tiles industries.[18]

Nitrate (NO_3^-): High concentration of nitrate in water, infants, less than six month old, are suffering from " methamoglobinemia" or "BLU BABY" disease. During the study of 170 ground water samples, value of nitrates is ranging from minimum 10 ppm to 800 ppm with an average of 86.7 ppm.

After analyzing the 43 samples of Jaipur city it observed that the concentration of nitrates is ranging between minimum 7 ppm to maximum 800 ppm with an average of 10 ppm. It observed that 20 (46.6%) sample have nitrates concentration within desirable / maximum permissible limit. Remaining 23 (53.3%) samples have nitrates concentration more than 100 ppm. Out of these samples, 7(16.3%) samples have nitrates concentration more 400 ppm and these are polluted, the water is not fit for drinking purpose.

Nitrates value in Industrial areas of Jaipur is ranging from 10 ppm to 160 ppm with an average of 42.9 ppm. Out of 62 samples 60 (96.8%) samples have nitrates concentration within the desirable / maximum permissible limit. Only 2(3.2%) sample have nitrates concentration more than 100 ppm and are out of permissible limit.

Nitrate value in the area of Sanganer block is ranging from 10 ppm to 350 ppm with an average of 76.1 ppm. Out of 42 samples 33 (78.5%) samples have nitrate concentration within the maximum permissible limit. 10(21.5%) samples have nitrate concentration more than 100 ppm and these samples are out of maximum permissible limit and polluted samples.

It is affecting plant nutrient and moderately toxic. Repeated heavy doses of nitrates on ingestion may also cause carcinogenic disease.[19] Nitrate value varied from 40 to 360 mg/L & maximum permissible limit is 50 mg/L (ICMR).'

Total Hardness (TH): Hardness is an important factor for determine the usability of water for domestic, drinking and may industrial supplies. After analyzing 43 samples of Jaipur city, the value of total hardness is ranging from 200 ppm to 1077 ppm with an average of 440.08 ppm. It is found that 16 (37.2%) samples are within the desirable limits (i.e. below 300 ppm) and 21 (48.8%) samples are found within the maximum permissible limits (i.e. up to 600 ppm). TH value of water sample varies from 150 to 260 mg/L. The desirable limit for total hardness is 300 mg/L (ICMR). The hardness of water is due to the presence of alkaline earth such as calcium and magnesium. Higher value of hardness responsible for incrustation and scaling in pipelines.

Potassium (K^+): It is an essential element for humans, plants and animals and derived chain mainly from vegetation and soil. In the present study of 170 samples from different areas of Jaipur (urban and rural), the concentration of potassium is ranging between trace to 50 ppm.

After analyzing the 43 samples of Jaipur city. Its observe that the concentration of potassium is ranging between minimum 1-9 ppm to maximum 32 ppm, maximum numbers of samples within the permissible limits only 2(24.7%) samples

have concentration more than 30 ppm which are out of permissible limits.

In the present study the concentration of potassium in industrial areas of Jaipur is ranging trace to 50 ppm with an average of 4.0 ppm. Out of 62 samples, 60(96.8) samples have concentration within the limit (i.e. less than 30 ppm), only 2 samples have concentration of potassium more than 30 ppm. Thus such type water is not more polluted and fit for drinking.

Potassium is Sanganer block is ranging between 1 ppm to 35 ppm with average of 4.8 ppm. 40(95.2%) samples are found within the permissible limit. Only 2 samples have potassium concentration more than 30 ppm and which are out of permissible limit.

The main water weathering of potash silicate minerals, use of potash fertilizers and use of surface water for irrigation. It is more abundant in sedimentary rocks and commonly present in feldspar, mica and other clay minerals. BIS has not included potassium in drinking water standard but Europeans Economic Community (EEC, 1980) has prescribed guideline level of potassium 10 mg/L in drinking water. Higher value content in ground water is indicating of ground water pollution.

Calcium (Ca^{2+}): Desirable limit of calcium for drinking water is 100 mg/L (WHO), 200 mg/L (BIS: 1999) AND 200 mg/L (ICMR: 1975). Ground water of metropolitan city, the value of calcium range from 21 to 222 mg/L in pre-monsoon & 19 to 222 mg/L in post-monsoon season. In 43 samples of Jaipur city the concentration of Ca^{+2} is observed in the range of 16 ppm to 260 ppm with an average of 81 ppm. Out of 43 samples, 40(93%) samples found within the desirable and permissible limit (i.e. upto 200 ppm). 3 (7%) sample are out of maximum permissible limit having more than 200 ppm calcium concentration.

The concentration of calcium in the industrial areas of Jaipur is ranging between minimum 15 ppm to maximum 90 ppm with anaverage of 42 ppm. All 62 ground samples are found within the permissible limit.

In 42 samples of Sanganer area the calcium value is ranging between10 ppm to 180 ppm with an average of 55.1 ppm. Out of 42 samples, 32(76%) samples are observed within the desirable and maximum permissible limit (i.e. up to 200 ppm) and 10 samples are out of maximum permissible limit having more than 200 calcium concentration.

The value of calcium in the Caksu block is ranging minimum 12 ppm to maximum 100 ppm with an average of 36.7 ppm. In this area all sample are within permissible limit.Therefore on the basis of result it can be say that TDS value of Jaipur city and Sanganer block is significantly high in compression of Industrial area and Chaksu block.

Carbonate (CO_3^{2-}) and Bicarbonate (HCO_3^-): Presence of carbonates and bicarbonates are the main cause of alkalinity in nature water. Bicarbonate represents the major form since they are formed in considerable amount from the action of carbonates upon the basic materials in the soil. Carbonate value varies from 6-42 mg/L & Bicarbonate value varies from 6.10 to 503.25 mg/L. Evaluation of Water Quality for Irrigation Purpose:

Salinity: Ground water with highly salinity has limitations in its use for irrigation purpose. Salinity is highly related to total dissolved solid (TDS) and electrical conductivity (EC). High concentration of TDS and EC in irrigation water may increase the soil salinity, which affect the salt intake of the plant. Salt present in the water, affecting the growth of the plant directly; also affect the soil structure permeability and aeration, which indirectly affect the plant growth. Soil water passes into the plant through the root zone due to osmotic pressure. Dissolved solid content of the soil water in the root zone increase, it is difficult for the plant to overcome the osmotic pressure and plant root membrane is able to assimilate water and nutrients. Dissolved solid contents of the residual water in the root zone also has to be maintained within limits by proper leaching .[20-21]

Proportion of Sodium to other Cations (SAR): High concentration in water to formation of saline soil and high sodium to development of an alkali soil. Sodium or alkali hazard in the use of water for irrigation is determined by the absolute and relative concentration of cations and is expressed in terms "Sodium Absorption Ratio" (SAR). It is the proportion of sodium is high, the alkali hazard is high and conversely, if calcium and magnesium predominate, the hazard is less. There is a significant relationship between SAR value of irrigation water and the extent to which sodium is absorbed by the soil. If water used for irrigation is high in sodium and low in calcium, the cations exchange complex may become saturated with sodium. This can destroy the soil structure. Method of evaluating the danger of high sodium water is the sodium adsorption ratio, SAR (Rishards, 1954):

Residual Sodium Carbonate: Ground water containing high concentration of carbonate and bicarbonate ions tends to precipitate calcium and magnesium as carbonate. As the result, the relative proportion of sodium increases and gets fixed in the soil there by decreasing the soil permeability. Quality of bicarbonate and carbonate in excess of alkaline earth also influence the suitability of water for irrigation purpose. Excess is denoted by Residual Sodium Carbonate (RSC) and it determined as:

$$RSC = (HCO_3^- + CO_3^{2-}) - (Ca^{2+} + Mg^{2+})$$

RSC exceeds 2.5 ppm, the water is generally unsuitable for irrigation and cause the soil structure to deteriote. If value less than 1.25 ppm indicate that the water is safe for irrigation.[22]

Boron: It is essential to the normal growth of all plants when concentration is very small and when exceed may cause injury. After analyzing 170 samples it observe that the value of boron is ranging between 0.2 ppm to3.00 ppm with an average of 0.8 ppm and these all samples are found within the maximum permissible limit (i.e. less than 5.00 ppm).

Boron is essential nutrient for plant growth; generally it becomes toxic beyond 2 mg/L in irrigation water. It does not affect the physical and chemical properties of the soil but high concentration affects the metabolic activity of the plant.[23]

CONCLUSION

The general taste of ground water is good and layman cannot determine the possible hazards of water quality. Rural and Urban area of Jaipur are growing very fast due to fast and rapid urbanization. Ground water bodies are being polluted by industrial effluents and municipal waste disposal. Ground water supply has registered high value of nitrate in the area where sewage system is not provided for last 20 – 30 years. Solid

wastes from urban area are disposed off in scientifically located and designed site and structure for recycling and reuse. Liquid waste from the cloth printing and dying industry in Sanganer has to an increase in fluoride content in ground water. Bacteriological analysis of the sample indicates some of bacterial contamination. Inadequate maintenance of hand pump, improper sanitation and unhygienic conditions. Industries may adopt cleaner methods of production so as to minimize their waste generation and material energy waste.

Education and involvement of people in its management development, conservation, protection and augmentation projects will be prime request to protect resources against quality degradation and guarantee quality assurances. In irrigation sector sprinkler and drip system of irrigation should be promoted and made mandatory in phased manner, wherever feasible. Low water requirement crop needs to be promoted at suitable and markets should be developed accordingly. In domestic waste water for gardening, recharge and promotion economic use of water in bathing, cleaning, cooking, leakage from domestic taps, pipelines for water supply to urban areas be checked. In Industrial sector, treatment of industrial effluents so as to check pollution of fresh ground resources. Pesticide analysis indicates the presence of some chlorinated at certain location but their content was well within the permissible limits for drinking water at most of the location. The suitable of ground water for irrigation purpose has been evaluated based on Salinity, Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC) and boron content.

Sewerage disposal system should be developed in proper way. Effective solid waste disposal mechanism needs to be properly developed. This can utilized for manufacturing biogas. Use of nitrate fertilizer for gardening should be banned. Promoting de-fluoridation devices like activated alumina in the affected areas. All the ground water abstraction structure for drinking including hand pimps with high nitrate and fluoride concentration should be marked by red paint so as avoid their utility by the common people for drinking purposes. Organizing Mass Awareness Programmes, electronic and press media have provide a meaningful ways and means to educate the masses for water conservation at grass root level. Central Ground Water Board, Jaipur has organized such programs at many places in Jaipur. Also awareness campaigning has for schools, colleges. Message of water conservation was also broadcast & telecast on Akashwani, Door Darshan.

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