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Fluoride and Nitrate Concentration in Groundwater under intensive Agricultural area of Palacode region, Tamil Nadu

[1]K.Ramesh, [2]L.Elango

[1]Assistant Professor, CWR, Dept of Civil Engineering, Anna University, Chennai, India

[2]Professor & Head, Dept of Geology, Anna University, Chennai, India

Abstract: Most of the rural and urban population uses groundwater for domestic and irrigation purposes. In order to assess the groundwater quality, 16 groundwater samples were collected from dug wells and bore wells during January 2016 to determining its suitability for drinking and agricultural purposes in Palacode region of Dhammapuri district. The groundwater samples were analyzed for various physicochemical parameters using standard procedure. Generally, groundwater quality of the study area is hard, fresh to brackish, slightly alkaline in nature. Based on the salinity index, that majority of the samples belong to the high salinity to very high salinity category. The nitrate concentrations are found higher than permissible limit at various locations due to the action of leaching and anthropogenic process. The fluoride concentration in the groundwater of these villages varied from 0.75 to 2.27 mg/l caused dental fluorosis among people especially children of these villages. It is advised that groundwater with high fluoride and nitrate concentration should be avoided for drinking purposes. Gibbs diagrams most of the samples represent the rock-water interaction process. USSL and Wilcox based graphical classification the groundwater samples are fall in moderate to poor water types. In general, groundwater in the study area is influenced by both natural and anthropogenic activities.

Keywords — ***Fluoride, Nitrate contamination, dental fluorosis, drinking and irrigation, Palacode.***

I. INTRODUCTION

Water is essential for life and access to clean drinking water is a necessity for good health. However, clean drinking water is not available everywhere, due to water scarcity and pollution of existing water resources. Groundwater plays a prominent role in water supply system for drinking and irrigation purposes in arid and semi-arid regions of the world. Recent studies reveals that nearly 65% of groundwater in the world is used for drinking purposes, about 20% for irrigation purposes [1,2,3] reported that 1/3 of the world population uses groundwater for drinking purposes, especially developing countries like India and China. Groundwater plays vital role in fulfilling the basic needs of the society and over-exploitation has tremendous stress on this important resources due to increasing demand. Over exploitation of groundwater has become one of the serious problems in many countries including India. The annual extraction of groundwater in India is the highest in the world [4, 5] estimated that approximately 245 x 10^9 m^3 of groundwater is being used for irrigation and also nearly 90% of rural population of the country uses groundwater for drinking and domestic purposes. The people living in rural India are dependent on groundwater for drinking purposes water supplies are the worst affected and there is no alternative source. In developing countries like India, most of the population use untreated groundwater for various purposes, as they do not have access to good quality water. In developing countries, 80% of diseases re directly related to poor drinking water and unsanitary conditions [6]. The intake of chemicals through drinking water is a common phenomenon, Fluoride, nitrates; iron, pesticides and salinity are the predominant causes for contamination of groundwater in the country. Nitrate is also increasingly to contaminate groundwater due to excessive use of fertilizers in agriculture. It has been found 20 out 35 states in India face an endemic problem of fluoride contamination in groundwater. Thus high levels of fluoride and nitrate are largely responsible for making the groundwater unfit for drinking. High fluoride concentrations are especially critical in developing countries, largely because of lack of suitable infrastructure for treatment. Fluoride is a common constituent of groundwater. Natural sources are connected to various types of rocks, agricultural fertilizers and industrial activities also contribute the high fluoride concentration n groundwater. All are directly or indirectly related with the health of human beings. Use of inferior quality of water for drinking will adversely affect human health. Moreover, groundwater pollution is a serious problem in India. As results the incidence of water quality problems has been risen large number of villages. Similarly, water used for irrigation should be of suitable quality to ensure maximum yield from the crops. The quality of irrigation water depends on the concentration of dissolved ions within the recommended permissible limits. The use of inferior quality of water for irrigation will affect the plants as well as soil, reduction in infiltration rate and toxicity due to certain ions and excessive nutrients [7]. Similar studies have also been carried out in India to determine the suitability of water for drinking and irrigation use [8, 9, and 10]. High concentrations of dissolved ions in irrigation water will also affect the growth of plants [11]. Further it can be assessed based on US Salinity Laboratory (USSL)

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diagram, WIcox's diagram and Doneen's permeability index (PI). This will help in adopting proper management for getting better yield from the crops. Water quality analysis is one of the most important aspects in groundwater studies. Study the quality of water which may affect human health and agricultural production. Since groundwater is intensively used for drinking and irrigation purposes, an effort is made in the current paper to discern the hydrochemistry of groundwater and to classify the water in order to evaluate its suitable for drinking and irrigation purposes.

II. STUDY AREA

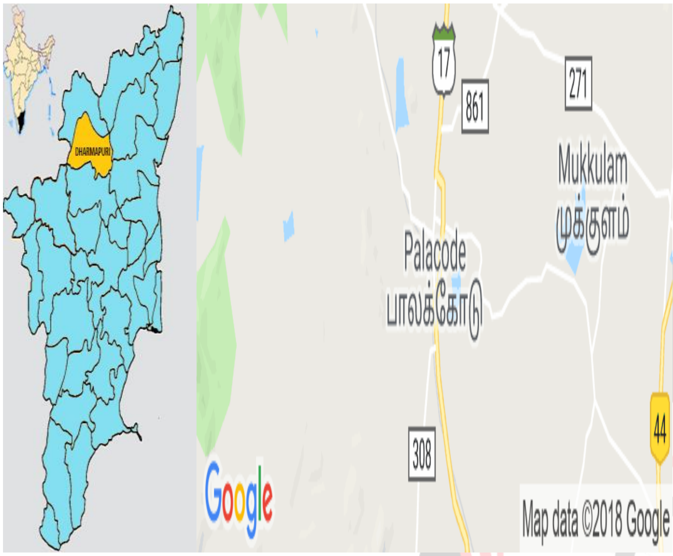

Fig.1 sampling location map in the study area

The present study will carry out in Palacode region is located in 285 km north-west of Chennai. Palacode, also spelt Palkkodu, is a small settlement on the outskirt of Dharmapuri in Dharmapuri district. Palacode, a taluk headquarters town situated 25-km from Dharmapuri (Fig.1). This town is situated along the Royakottah-Hosur-Bangalore Railway Line with a railhead at Palacode. Trains from Bangalore to Coimbatore ply through Palacode. The normal annual rainfall over the taluk varies from about 895 mm. Rainfall is the main source of groundwater recharge in this area. Groundwater is he only source for both domestic and irrigation purpose. Average temperature ranges from 17 to 42ºC. Agricultural produce, tomato in particular, is largely grown in Palacode area. A separate local market for tomatoes is maintained by the Palacode town panchayat, from which produce is transported to all parts of India. The area is underlain by Archaean Crystalline formations with recent alluvial deposits of limited areal and vertical extents along major rivers. Ground water occurs under phreatic condition in the

Well no.	Location of Village	Type of well
1	Sugarmill	Bore Well
2	Chikkarthanahalli	Bore Well
3	Chittharapatti	Open Well
4	Semmanatham	Bore Well
5	G.G.High School	Bore Well
6	Ernahalli	Bore Well
7	Moongilpatti	Open Well
8	ManiyakaranKottai	Open Well
9	Kommanayakanahalli	Open Well
10	P. Cheetihalli	Open Well
11	Jerthalav	Bore Well
12	Mekalampatti	Bore Well
13	Thimmampatti	Open Well
14	Sengodahalli	Bore Well
15	Kodiyur	Bore Well
16	Gowndanur	Bore Well

weathered mantle and semi confined to confined condition in the fracture and fissured zones of these rocks. The yield of large diameter wells in the district, tapping the weathered mantle of crystalline rocks. The groundwater level is low major drinking water bores are upto 900 to 1200 ft deep. The primary occupation of the workforce is agriculture and trade. Nearly 10,000 strong work forces are dependent on agriculture. This town is surrounded on all side by hillocks. The town has gained its importance from Tomato, Mango, Coconut and Banana cultivation. Palacode is popularly known for its tomato market. Chinnar is the important tributaries of river Cauvery.

III. . METHODOLOGY

Groundwater samples were collected in the month of January 2016, from 16 wells located in the study area. Samples were randomly collected from different sources such as tube wells and dug wells following standard sampling techniques. Before collection, the water was left to run from the sources (shallow and deep tube wells) for about 10 min to get representative samples with stable electrical conductivity. All the water samples were collected in pre-cleaned polyethylene bottles of 500-ml capacity. The sampling bottles were soaked in 1:1 diluted HCl solution for 24 h, washed with distilled water, and were washed again prior to each sampling with the filtrates of the sample Proper care was taken at each step to minimize any contamination.

IV. RESULTS AND DISCUSSION

Suitability for drinking purposes

Groundwater quality was assessed for suitability for drinking based on fluoride and EC concentration cross a diverse region of the study area.

Salinity Index

Salinity is an assessment of all soluble salts in samples. The presence of charged particles in the water increases its conductivity. High concentration of salt in irrigation water may increase the soil salinity, which affect the salt intake of the plant. The salts present in the water, besides affecting the growth of the plants 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. As the dissolved solid content of the soil water in the root zone increases, it is difficult for the plant to overcome the

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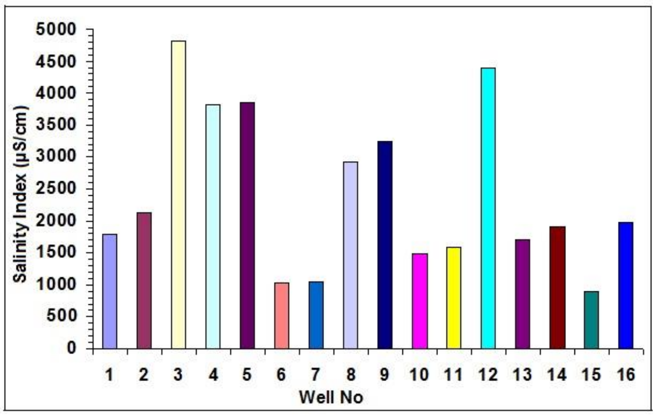

Fig. 2 Salinity Index

osmotic pressure and the plants root membrane are able to assimilate water and nutrients. Thus, the dissolved solid content of the residual water in the root zone also has to be maintained within limits by proper leaching. These effects are visible in pants by stunted growth, low yield, discoloration and even leaf burns at margin or tip [12]. Crop productivity is highly affected due to salinity hazard when electrical conductivity is greater than 3000µS/cm and it is good if electrical conductivity is less than 250 µS/cm. In the study area (Fig.2), the EC varies from 893 to 4820 µS/cm. Based on the analysis, the groundwater samples have been classified [13] and it is found that majority of the samples belong to the high salinity or medium (751-2250µS/cm) to very high salinity or bad (2251-6000µS/cm) category. Those high salinity exhibiting value are suitable for irrigating the medium and high salt-tolerant crops. Higher conductivity value might be due to due to the geological formation and anthropogenic processes acting on hydrochemistry of the regions.

Total Hardness (TH)

Total hardness of water is the sum of concentration of alkaline earth metal cations present in it. Hardness in natural water comes mainly from the leaching of igneous rock and carbonate rocks (dolomite, calcite and limestone). Water containing the soluble salts of calcium and magnesium such as chlorides, sulphates and bicarbonates is called hard water [14]. The hardness in water is derived largely from contact with soil and rock formation. The ability to dissolve the ions is gained in the soil where CO_2 exists in equilibrium with carbonic acid. Hardness increases by metallic on dissolved in water. Water of high hardness is not suitable for domestic, industrial applications and irrigation use. The hardness value ranged from 133 mg/l to 725 mg/l. Hardness is classified as soft (<75 mg/l), slightly hard (75-150 mg/l), moderately hard (150-300 mg/l) and very hard (>300 mg/l) by USGS hardness [15], 4 samples fall in slightly hard, 5 samples fall in moderately hard and 7 samples fall in very hard category (Fig.3). High hardness is attributed to the composition of lithounits constituting the aquifers of the area.

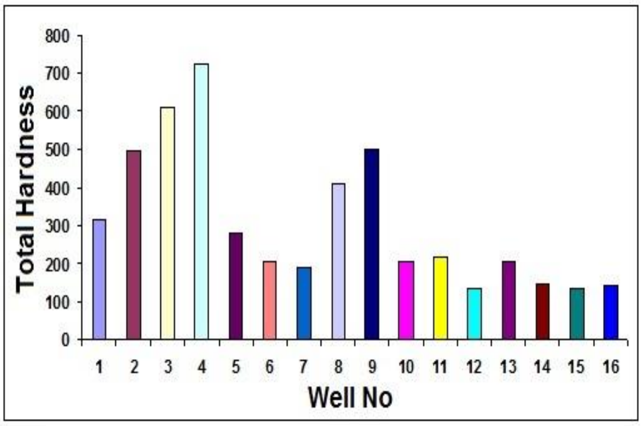

Fig. 3 Total Hardness

Chloride

Chloide is naturally occurring in all types of waters. The chloride content increases as the mineral contents increases. It is commonly found in soils and rocks. High concentration of chloride makes water unpalatable and unfit for drinking and other purposes. Chloride in groundwater may be from diverse sources such as weathering, leaching of sedimentary rocks and soils, and domestic and municipal effluents [16]. Man and other animals' excrete very high chloride quantities together with nitrogenous compounds. Abnormal chloride concentration may result due to pollution of sewage waste and leaching of saline residues in the soil. Higher chloride intake beyond the crop tolerance limits in plants develops symptoms such as leaf burn and drying of leaf tissues. Excessive necrosis is often accompanied by an early leaf drop. Chlorides in drinking water are generally not harmful to human beings. High concentrations may affect persons who already suffer from diseases of heart or kidneys. Chloride play an important role in balancing the levels of electrolytes in blood, but higher concentration of chloride can give hypertension and renal stones [17]. As per World Health Organization [18], the desirable and permissible limits of chloride are 250 and 1000 mg/l, respectively. Chloride concentration in the study area ranges from 89 to 1446 mg/l, almost all the samples are within the permissible limit.

Nitrate

In groundwater, very small quantities nitrate are present through nitrogen cycle in the earth's hydrosphere and biosphere. The presence of nitrate in groundwater is from decomposition of organic matters like plant debris, human and animal wastes, sewage waste, nitrate fertilizers and industrial waste chemicals [19]. Nitrate concentration in water more than 45 mg/l results blue baby disease/methaemoglobinaemia in children [20]. Nitrate is also an indicator of pollution. Continuous intake of NO_3 in high concentration may lead to gastric problems and an increased risk of cancer. Drinking water with concentration >100 mg/l also cause poisoning in livestock. Even though high concentration of nitrate is useful in irrigation, their entries into the water resources increase the growth of certain algae and trigger eutrophication. Nitrate concentration present in the study area ranges from 8 to 122 mg/l in the groundwater exceeds the highest permissible

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limits (45 mg/l) of drinking water standard [20]. Almost majority of (12) samples exceeds the standard limit and considered water is not fit for drinking purposes (Fig.4) The removal of nitrate from groundwater is not an easy process. It may NO_3 concentration is high in those areas where fertilizers and pesticides are being used for intensive agricultural purposes and also lack of sanitation facilities, animal waste dumping yards and human waste.

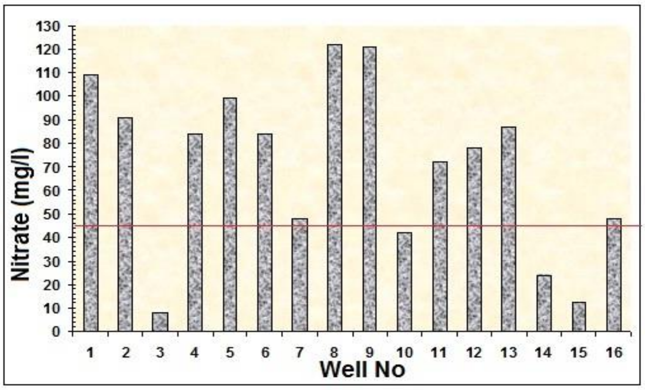

Fig. 4 Nitrate

Fluoride

Fluoride is a common constituent of groundwater. Fluoride is widely dispersed in natural sources in various types of rocks. Agricultural (use of phosphatic fertilizers) and industrial activities (clays used in ceramic industries) also contribute to high fluoride concentrations in groundwater. Fluorine is a common element representing about 0.38 gm/kg of the earth crust, which exists in the form of fluorides in a number of minerals. Fluoride enters the environment through natural as well as anthropogenic sources. The chief sources of fluoride are minerals (fluorite, fluorapatite, micas and hornblend) rocks and sediments. Natural concentrations of fluoride in groundwater depend on the availability of fluoride in rocks and minerals encountered by the water as it moves along the flow path. The distribution of fluoride in groundwater depends on number of factors, such as amount of soluble and insoluble fluorine in source rocks, rainfall, vegetation, pH, redox potential and ion exchange process. Calcium fluoride is a major importance since in its naturally occurring form as fluorspar, it is primary source. The main sources of fluoride in groundwater are various fluoride bearing rocks. Fluoride occurs in traces in much water but higher concentration is observed in groundwater. The fluoride concentration (Fig.5) in this region varies from 0.75 to 2.27 mg/l. Groundwater samples with less than 1.5 mg/l are considered normal and can be represented as low fluoride region whereas concentrations greater than 1.5 mg/l can be represented as high fluoride region indicating high incidence to fluorosis and toxic. The desirable range of fluoride concentration in drinking water is from 0.6 to 1.2 mg/l according to the Bureau of Indian Standard. Thus, if the concentration of fluoride is below 0.6 and above 1.5 mg/l, the water is not suitable for drinking purposes. Based on the concentration of fluoride, the groundwater samples obtained from the region have been classified into two groups as medium (0.6-1.5 mg/l) and high (1.5-3.0 mg/l. Twelve groundwater samples had more than 1.5 mg/l and four sample falls below 1.5 mg/l. People of all age groups are faced with high risk of fluorosis diseases in Palacode region and infant's children and adults were highly affected. Generally it is observed that drinking water having a fluoride concentration above 1.5 - 2.0 mg/l effects dental mottling, an early sign of dental fluorosis which is characterized by opaque white patches on teeth as shown in Figure 5. In advanced stages of dental fluorosis, teeth display brown to black staining followed by pitting of teeth surfaces. Generally excessive fluorides in drinking water damage toot forming cells leading to a defect in the enamel known as dental fluorosis (disfigurement of the teeth) resulting in extensive pitting, chipping, fracturing and decay of teeth. Historical data suggest fluoride in excess of the permissible limit and are attributed to over-withdrawl of groundwater and scarcity of rainfall. The concentration of fluoride is mainly due to the rock water interaction, since no man made pollution has been noticed. The area is devoid of hard rock and hence the possibility of a source in

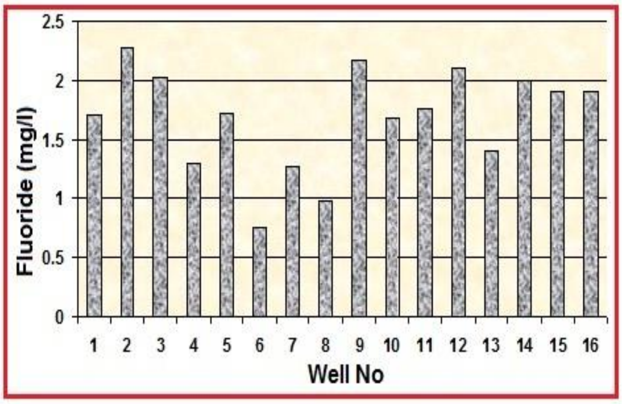

Fig. 5 Fluoride

the common fluoride bearing minerals. Recharging the groundwater in the higher concentration area may improve the groundwater quality. The need to avert is to propagate the risk of dental fluorosis with a view to control and eradicate using efficient techniques of defluoridation. Many people are not at all aware of the water borne diseases affecting their health due to high concentration of fluoride in drinking water which causes dental fluorosis to humans. The people living in rural areas do not have centrally supplied treated water. Thus, in this area it is an instant need to warn the people against the risk of dental and the people are advised to adopt some techniques to defluoridation of groundwater before using it for drinking purposes.

Dental Fluorosis

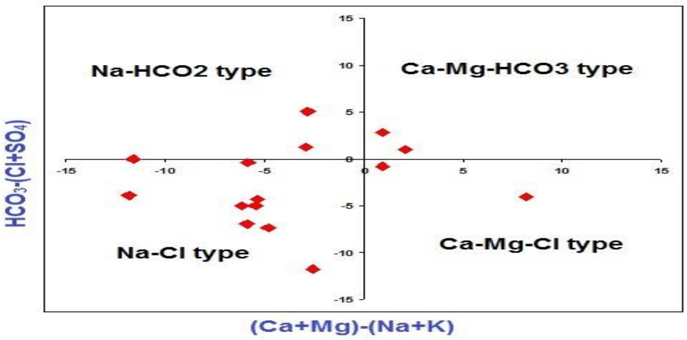

Fig. 6 Chads diagram

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Fluorosis which affects teeth and bones is caused by the intake of excess fluoride. Tooth enamel is principally made up of hydroxyapatite (87%) which is crystalline calcium phosphate [21]. Fluoride which is more stable than hydroxyapatites displaces the hydroxide ions from hydroxapatite. Fluoride of dental enamel occurs when excess fluoride is ingested during the years of tooth calcification-essentially during the first 7 years of life. The amount of fluoride in bone increases upto the age of 55 years. Intake of 1 mg/day is very much essential for healthy growth of teeth, but level higher than the permissible limit of 1.5 mg/l is dangerous to teeth [20, 22]. Deficiency of fluoride leads to dental caries and higher concentration leads to dental and skeletal fluorosis. Fluoridation is the addition of fluoride compounds into drinking water to ranges between 0.8 and 1.0 mg/l for the beneficial effect of tooth and decay prevention. At low concentrations fluoride can reduce the risk of dental cavities. In its mildest form this results in discoloration of teeth, while dental fluorosis includes pitting and alteration of tooth enamel. Even fluoride also circulates in blood and effect foetus nerves and heart. Excess fluoride reduces secretion of thyroid gland by affecting iodine in the body, also cause gastro intestinal problems like loss of appetite, nausea, pain in abdomen, intermittent diarrohea, muscular weakness, excessive thirst etc [23]. High fluoride intake over a period of time can cripple one for life. Fluoride in groundwater poses a great problem in most of the states in India. Fluorosis is a diseases caused by deposition of fluoride in hard and soft tissues of the body. It is usually characterized by discoloration of teeth, become hard and brittle. This is called dental fluorosis. Of fluoride influenced areas where fluoride concentration is more than admissible farthest point of 1.5 mg/l. Dental fluorosis is more inclined in the youngster's upto the age of 8-10 Dental fluorosis in the initially glistening white teeth become dull and yellow-white spots appear on the surface of teeth. Gradually these spots turn brown and present it in brown streaks which are closer to the tip of the teeth. Depending upon the severity, it may be only discolouration of the teeth or formation of pits in the teeth. This colouration of the teeth may be in the form of spots or as streaks.

Chadha's plot

The hydrochemical facies of a particular place are influenced by geology of the area and distribution of facies by the hydro-geological controls. In the present study, the groundwater of the study area has been classified as per Chadha's diagram [24]. The diagram is a somewhat modified version of Piper trilinear diagram and expanded Durov diagram [25]. Hence, a hydrochemical diagram applied to identify different hydrochemical processes as indicated in each of the four quadrants of the graph. These are broadly brief as reverse ion exchange water (Ca-Mg-Cl type), Recharging water (Ca-Mg-HCO_3 type), and Sea water/end member water (Na-Cl type and base ion exchange water (Na-HCO_3 type) Recharging water are formed when water enters into the groundwater from the surface, it carries dissolved carbonate in the form of HCO3 and geochemically mobile Ca. A majority of the samples falls in Na-Cl type water is dominant facies, water type with permanent hardness (Fig.6). The Na-Cl water types indicates interaction of brackish surface water bodies with the groundwater system at water mixing zones and also largely attributed to mineral weathering.

Mechanisms controlling groundwater chemistry: The

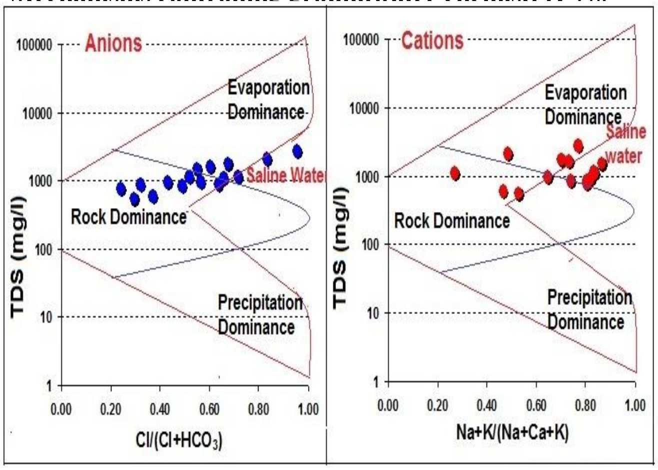

Fig. 7 Gibbs diagram

Gibbs diagram shows the ratio between Cl/(Cl+HCO3) and Na+K(Na+K+Ca) as a major function of TDS and this is useful to access the major sources of dissolved ions, which are precipitation dominance, rock dominance and evaporation dominance [26]. For groundwater samples from the study area (Fig.7) it shows that most of the samples fall in rock-water interaction process and minor samples fall in evaporation category, which suggests that the weathering of rocks primarily controls the major ion chemistry of groundwater in this region. It is used to explain the mechanisms that control the chemical composition of inland waters.

Suitability for Irrigation Purposes

Several methods were used to investigate the suitability of groundwater quality for irrigation purpose. During the present study EC and SAR were used to determine for salinity hazard, EC and Na% were used to determine the salinity hazard and RSC for bicarbonate hazard and Na and Cl were used to determine for specific ions toxicity problems and have been used to classify and understand the groundwater characters, as the suitability of irrigation depends on the mineralization water and its effect on soil and plants

Classification of irrigation groundwater salinity hazard

Good quality of water that is good soil and water management practices can promote maximum crop yield. If there is an increasing concentration of EC, there is also decreasing water intake by the plants as well as affecting crop production. The higher the EC, the lesser the water available to plants, even though the soil may appear wet. Since plants can only transpire pure water, usable plant water in the soil solution decreases as EC increases. The quality of irrigation water also depends on the quantity of dissolved solids. Salinity and SAR helps in determining

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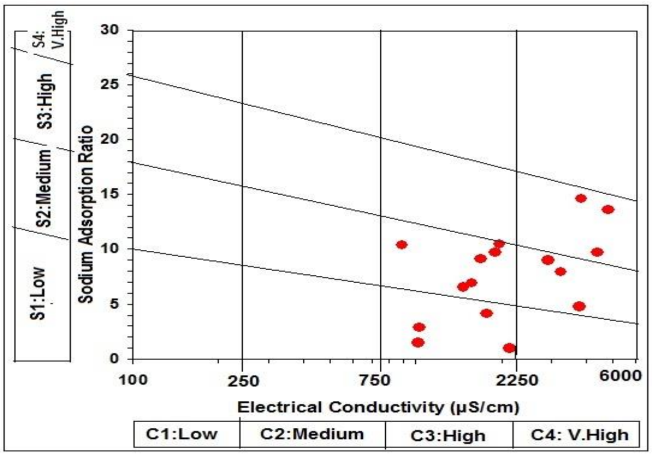

Fig. 8 USSL diagram

whether the water is suitable for the agricultural purpose. Suitability of water for agricultural purposes can better be assessed by SAR because of its direct relation to the adsorption of sodium by soil. SAR values of this study area ranges from 1.02 to 14.63 meq/l. The EC and SAR are plotted on U.S.S.L.salinity diagram [27] which gives direct indication of the salinity and alkali hazard. In classification of irrigation water, it is assumed that water will be used under average conditions with respect to soil texture, infiltration rate, drainage, quantity of water used, climate and salt tolerance of crop. The salinity hazard increase as the soils become finer grained and aridity increase resulting in the concentration of salt in the soil that may require periodical leaching. Excessive sodium content in water renders it unsuitable for soils containing exchangeable calcium and magnesium. Diagram (Fig.8) shows that 6 samples falls in C3S2 (moderate quality of water), 4 samples falls in C3S1 (good quality of water), 3 samples falls in C4S2 (moderate quality of water) and 3 samples falls in C4S3 (bad quality of water), Hence, it was difficult to use these water for irrigation purpose in soils without control of salinity and sodium content. So samples falls within the study area falls under moderate water type to poor water type.

Classification of irrigation groundwater sodium hazard

The excess amount of sodium content in irrigation groundwater samples can affect soil permeability and soil structure that causes sodium hazard and also reducing available water for plant growth, immobilize other nutrient ions which cause shortage of the elements in plants. Utilization of groundwater for irrigational purpose depends on many factors such as texture and composition of soil, type of crop, climate, irrigational practices and finally chemical quality of groundwater, with regards to the quality of water for irrigation, the major parameters of concern are salinity, dissolved solids, conductivity, toxic trace elements and herbicides, besides presence of sodium is also important parameters, the excess quantity of which can deteriorate the soil. High value of sodium may also damage the sensitive cops because of sodium toxicity. Sodium concentration is important in classifying water for irrigation purposes. The Na% ranges from 8.12% to 92.53%. The Na% ranges from <60 are 9 samples of safe limit and rest 7 samples are unsuitable >60. Wilcox [28] proposed a classification based on EC and Na% ion concentration for irrigation water. Wilcox classification (Fig.9) of samples shows that 5 samples falls in unsusitable, 5 samples falls in doubtful, 3 samples in permissible and 3 samples falls in good category. The agricultural yields are generally lower in areas irrigated with water belonging to doubtful and unsuitable categories.

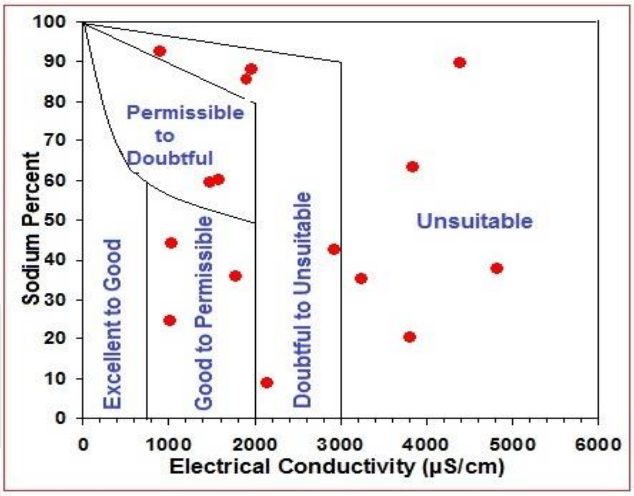

Fig.9 Wilcox diagram

Classification of groundwater bicarbonate hazard

When the concentration of carbonate and bicarbonate increases above the total amount of calcium and magnesium, the water quality may be deteriorated water quality for irrigation purposes. This is denoted as residual sodium carbonate (RSC) index which is calculated [29]. RSC values ranges from -10.25 to 5.02. Excessive RSC causes the soil structure to deteriorate, as it restricts the water and air movement through the soil, burning of leaves of plants, affects crop yield. Similarly irrigation with high RSC water in the fine textured soil will result in the development of alkali soil. If the RSC exceeds 2.3 meq/l, the water is generally unsuitable for irrigation. If the value is between 1.25 and 2.5 the water is marginal quality,

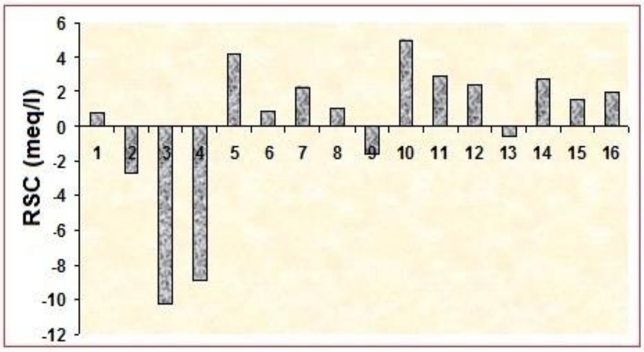

Fig.10 RSC diagram

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while the value is less than 1.25 indicates the water is safe for irrigation. During the study the RSC values clearly indicate that 8 samples falls in the good category, 4 samples fall in medium and 4 samples fall in the bad category (Fig.10). Here, negative RSC at some locations indicate incomplete precipitation of calcium and magnesium.

Permeability Index (PI)

The PI influences the utility of groundwater for irrigation. The quality of water was classified into three categories for irrigation purpose [30]. Class I and II or 75% or more permeability is considered as good and suitable for irrigation. Class III have 25% permeability is not suitable for irrigation. The PI values in the study area vary from 37.30% to 95.81%. According to PI values, the groundwater samples fall class I and Class II indicating water is moderate to good for irrigation purposes (Fig.11).

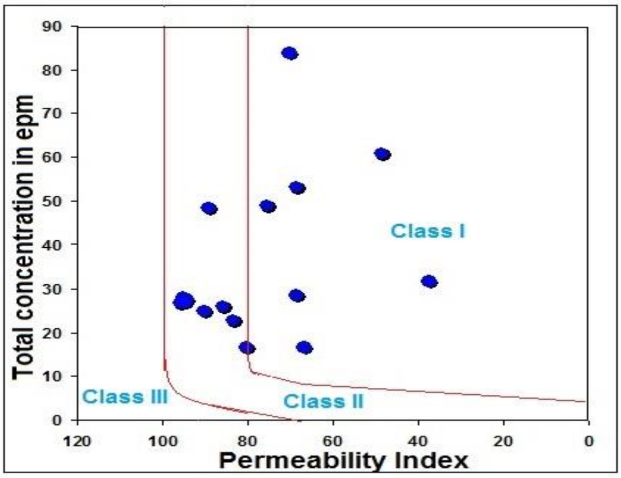

Fig.11 Permeability Index diagram

V CONCLUSION

The groundwater quality Palacode region has been evaluated for their chemical composition and suitability for domestic and irrigation uses. The physiochemical result indicates that groundwater generally has slightly alkaline, moderately saline and hard in nature. The dominant water types are in the order of mixed Na-Cl water type. High fluoride indicates leaching from fluoride rich source rocks. In fact, if the fluoride level in drinking water is more than permissible limit, risk of endemic fluorosis will exist. The sources for high NO_3 to groundwater are from fertilizer and pesticides applications are being used for intensive agricultural purposes and also lack of sanitation facilities, animal waste dumping yards and human waste. Thus high levels of fluoride and nitrate are largely responsible for making the groundwater unfit for drinking in this region. Gibbs plot thus suggests that water chemistry is mainly regulated by rock water interaction. For irrigation suitability based on USSL, Wilcox plot it is observed that groundwater in the area s moderate to bad water type occurred. The PI suggests groundwater quality is moderate to good for irrigation purposes. In general, the quality of groundwater is found to be fit for irrigational purposes in most areas but not suitable for drinking alarming situation of groundwater quality for inhabitants. The overall geochemistry of groundwater in the study area is controlled by natural processes like rock water interaction and anthropogenic induced activities.

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