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Assessment of Groundwater Quality Parameters in and around Jawaharnagar, Hyderabad

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Abstract- The water and environment has become an emotive issue with the people and policy makers. The chief causes for the pollution of water and environment are anthropogenic activities of human beings. The primary objective of this paper is to study the groundwater quality parameters in the surrounding wells of Jawaharnagar, in upper Musi catchment area of Ranga Reddy district in Andhra Pradesh. The bore wells data is collected from the study area for two seasons i.e., post monsoon and pre monsoon in December 2007 and June 2008. The groundwater contour analysis is done by using Arc GIS software. The study reveals that the concentration of major constituents are well within the permissible limits of IS (10500-1994), except in few cases where total hardness and fluoride concentrations are high. From the analysis it has been observed that the groundwater is polluted in the entire study area. Due to this reason during the monsoon seasons the rainwater drains into the solid waste polluting the land leachate existing in the surrounding areas and in the low lying areas. During last few years, the utilization of surface and groundwater for drinking, industrial and agricultural purposes has increased manifolds but consequently it is observed that the water is polluted and affecting the human health, soil nutrients, livestock, biomass and environment in certain areas. Hence a study has been carried out for the quality of the available groundwater.

Index Terms- Groundwater, pollution, leachate, soil nutrients, human health.

I. Introduction

India is a tropical county with a vast diversity of climate, topography and vegetation. Though blessed with fairly high annual rainfall, it is not uniformly distributed in time and space resulting in bulk of the rainfall escaping as runoff. This results in incomplete utilization of available surface water. The scarcity of surface water especially in the lean season in most parts of the country means that groundwater plays a decisive role. India has diversified geological, climatological and topographic set up giving rise to divergent groundwater situations in different parts of the country. Groundwater may be considered as one of the most precious and one of the basic requirements for human existence and the survival of mankind providing him the luxuries and comforts in addition to fulfilling his basic necessities of life and also for industrial and agricultural development thus being a very important constituent of our eco-system.

Telangana region of Andhra Pradesh is classified as hard rock area where surface water resources are limited, with the result, groundwater has become a major source of supply to the village population. The problem connected with supply of safe water to rural communities from individual wells is often neglected. Added to this with rapid solid waste leachate pollution of groundwater due to rapid increasing of population, urbanization and industrialization, the available groundwater is rapidly getting polluted. Unfortunately the surrounding villages and catchment area aquifers affecting from this pollution has resulted mostly from urban human activities.

II. Location and Extent

The study area is the upper part of the Musi basin a tributary of river Krishna of Andhra Pradesh in India. The area falls in the Survey of India Topographic map number 56K/10 to a scale of 1:50,000. The area lies between 17030'01" N to 17032'03" N latitude and 78034'13" E to 78037'47" E longitude. The total aerial extent of the study area is 31.63 Km2. The study area has an average altitude of 535.57 m in western part and gradually decreases towards the east. The area is located at Jawaharnagar near Dammaiguda village and lies between Shameerpet and Kesara Mandals of Ranga Reddy district, Andhra Pradesh. There is a Greater Hyderabad Municipal Corporation solid waste dumping site in the study area. Groundwater in the study area occurs under water table to semi-confined conditions restricted to weathered and fractured formation. The study area contains granite rock formations. The groundwater quality analysis has been carried out for the water samples collected from the seven bore wells for both the seasons located in Dammaiguda, Balaji Nagar, Rajiv Gandhi Karmika Nagar, Ambedkar Nagar, Malkaram, Haridaspally, Bandlaguda Villages. In the present work attempts have been made to detect groundwater quality by using conventional hydro geochemical methods and also to prepare the contour maps for the various water quality parameters by using Arc GIS software. The location map of the study area is shown in figure1.

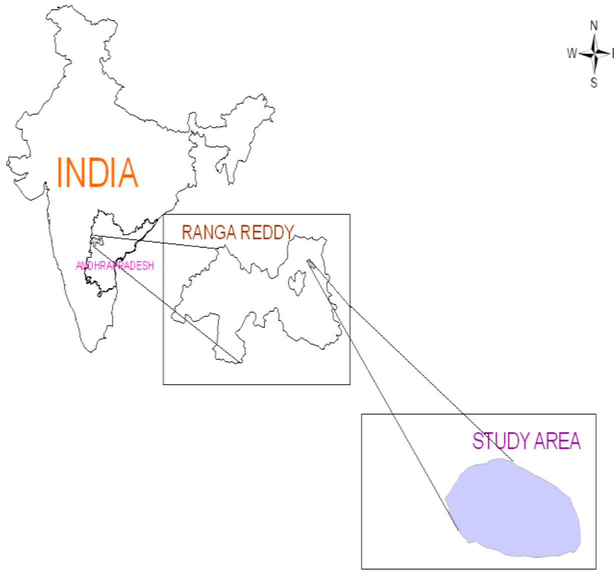

Figure 1: Location Map of the Study Area

III. RESEARCH METHODOLOGY

The groundwater samples are collected during the post monsoon period i.e., December 2007 and pre monsoon period i.e., June 2008 from the seven bore wells located in the study area. The well locations in the study area are represented in figure 2. The quality analysis has been carried out for the parameters like pH, total alkalinity, electrical conductivity, total dissolved solids, total hardness, calcium hardness, magnesium hardness, nitrites, nitrates, sulphates, chlorides and fluorides by following the standard methods prescribed as per IS: 10500-1994 codes.

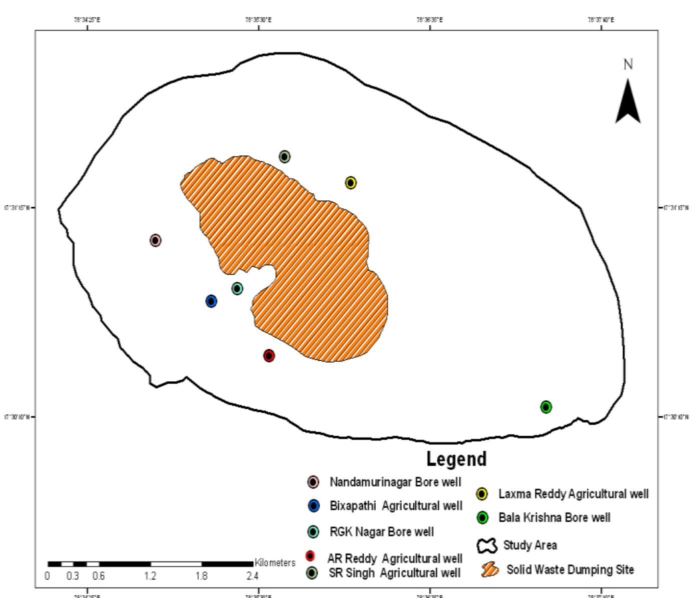

Figure 2: Bore Well Locations in the Study Area

IV. RESULTS

Physicochemical Parameters of Groundwater: The Seasonal wise concentration of ions in groundwater samples is given in Table 1.

Table 1: Seasonal Wise Concentrations of Water Quality Parameters in Groundwater Samples

S.No	Name of the Water Quality Parameter	Bureau of Indian Standard (IS-10500:1994)	Post Monsoon December 2007 (Parameters Range)	Pre Monsoon June 2008 (Parameters Range)
1	pH	6.5 - 8.5	6.76 - 7.81	6.65 - 7.62
2	Total Alkalinity (mg/l)	200-600	240-480	230-460
3	Electrical conductivity(μ mhos/cm)	700-3000	615-1950	583-1898
4	Total Dissolved Solids(mg/l)	500-2000	394- 1248	199-1214
5	Total Hardness (mg/l)	300-600	240-652	230-702
6	Calcium Hardness (mg/l)	75-200	176-376	166-426
7	Magnesium Hardness (mg/l)	30-100	66-280	64-278
8	Nitrites (mg/l)	0.05-5	0.0005-0.1	0.0005-0.15
9	Nitrates (mg/l)	45-100	0.3-14.6	0.5-12.2
10	Sulphates (mg/l)	200-400	25-100	23-123
11	Chlorides (mg/l)	250-1000	40-230	38-358
12	Fluorides (mg/l)	1.0-1.5	1-1.8	0.8-1.4

The pH indicates the acidic or alkaline material present in the water. The pH of the groundwater samples in the study area ranges from 6.76 - 7.81 and 6.65 - 7.62 during post and pre-monsoon respectively. The groundwater in this area is generally acidic in nature due to granitic rock formation. The total alkalinity values in the study area are within the permissible limit and are ranging from 240-480 mg/l during post monsoon period and 230-460mg/l in pre-monsoon period. The high alkalinity of groundwater in certain locations in the study area may be due to the presence of bicarbonate and some salts. The alkaline water may decrease the solubility of metals. The spatial distribution map for Total Alkalinity is represented in figure 3.

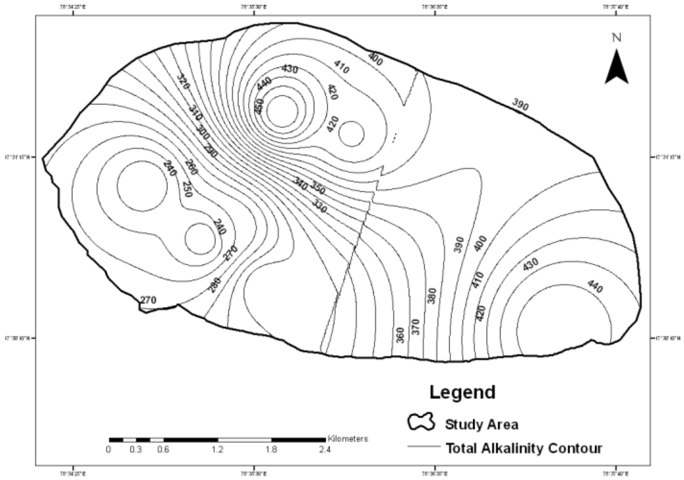

Figure 3: Spatial Distribution Map of Total Alkalinity in the Study Area

The salt concentration is generally measured by determining the electrical conductivity of water. Excess salt increases the osmotic pressure of the soil solutions that can result in physiological drought conditions. The Electrical conductivity values varied from 615-1950 µ mhos/cm and 583-1898 µ mhos/cm during post and pre-monsoon respectively. The highest value of conductivity may be due to high concentration of ionic constituents present in the water bodies. The spatial distribution map for Electrical Conductivity is shown in figure 4 for pre monsoon period.

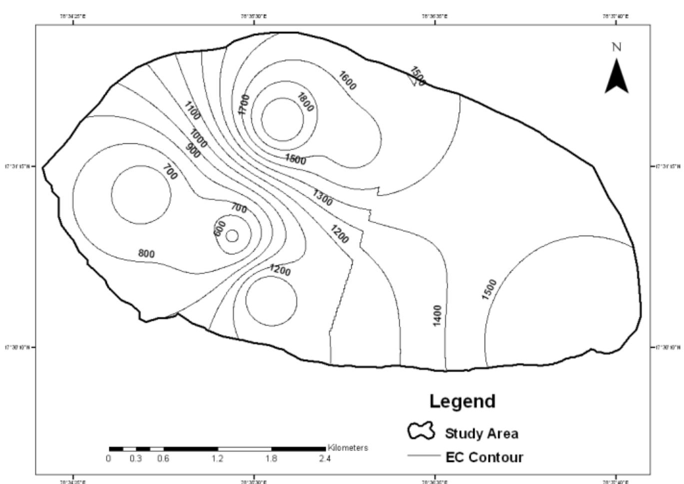

Figure 4: Spatial Distribution Map of Electrical Conductivity in the Study Area

The Total dissolved solids observed in this area is ranging between 394- 1248 mg/l and 199-1214 mg/l in post and pre-monsoon periods. Generally, the higher Total Dissolved Solids causes gastro-intestinal irritation to the human beings, but the prolonged intake of water with the higher Total Dissolved Solids can cause kidney stones and heart diseases. The presence of high values of Total Dissolved Solids in certain locations of the study area may be due to the influence of anthropogenic sources such as domestic sewage, solid waste dumping, agricultural activities and influence of rock-water interaction. The spatial distribution map for Total Dissolved Solids during the pre monsoon period for the study area is shown in figure 5.

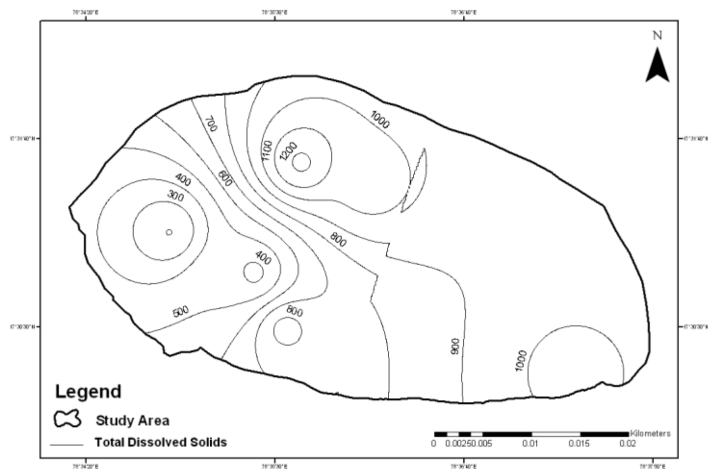

Figure 5: Spatial Distribution Map of Total Dissolved Solids in the Study Area

Total hardness is caused primarily by the presence of cations such as calcium and magnesium and anions such as carbonate, bicarbonate, chloride and sulphate in water. Water hardness has no known adverse effects; however, some evidence indicates its role in heart diseases and hardness of 150-300 mg/l and above may cause kidney problems and kidney stone formation, as it causes unpleasant taste and reduce ability of soap to produce lather. Hard water is unsuitable for domestic use. In this region, the total hardness varies between 240-652 mg/l and 230-702 mg/l during post and pre monsoons. The maximum allowable limit for drinking purpose is 600 mg/l and the most desirable limit is 300 mg/l as per BIS standards. The total hardness is relatively high in all samples due to the presence of calcium, magnesium, chloride and sulphate ions. Values are slightly higher in pre monsoon than post monsoon season. The spatial distribution of Total Hardness in groundwater of the study area is illustrated in Figure 6. Groundwater in the area exceeding the limit of 300 mg/l as CaCO3 is considered to be hard and this may be due to solid waste leachate, and geology of the rocks.

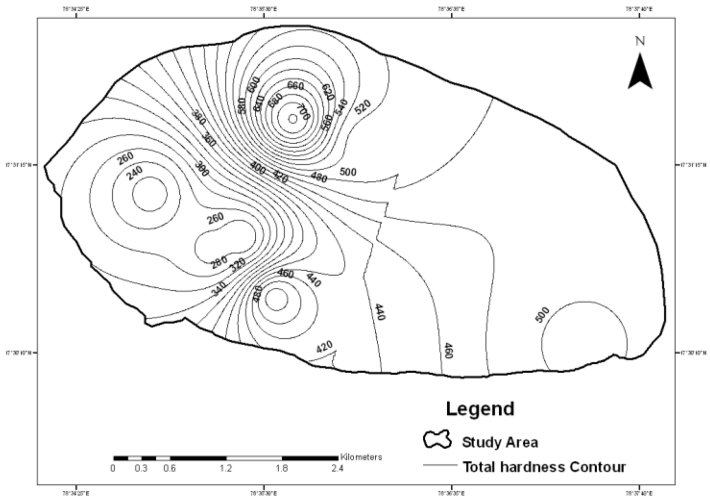

Figure 6: Spatial Distribution Map of Total Hardness in the Study Area

Calcium, magnesium and total hardness in the groundwater are inter-related. Calcium is an important element to develop proper bone growth. It is found alkaline in nature. The presence of calcium in the groundwater is from silicate mineral group, such as pyroxene and amphibole in the igneous rocks. In addition, the shales, sandstone also contain calcium in the form of carbonate. Calcium content is very common in groundwater, because they are available in most of the rocks, abundantly and also due to its higher solubility. However, the range of its availability depends on the solubility of calcium carbonate and sulphate. The permissible limit of calcium in drinking water is 75 mg/l. The calcium concentration in water samples collected from the study area ranged from 176-376 mg/l and 166-426 mg/l in post and pre monsoon seasons. So, all the samples exceeded the permissible limit. The rapid industrialization and urbanization in the area contributed to the high concentration of calcium in the groundwater of the region. The spatial distribution of Calcium Hardness in the groundwater of the study area is illustrated in Figure 7.

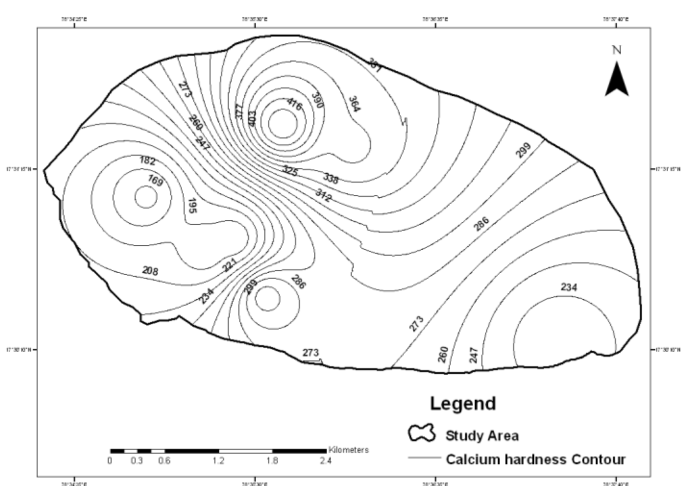

Figure 7: Spatial Distribution Map of Calcium Hardness in the Study Area

Magnesium usually occurs in lesser concentration than calcium due to the fact that the dissolution of magnesium rich minerals is slow process and that of calcium is more abundant in the earth's crust. If the concentration of magnesium in drinking water is more than the permissible limit, it causes unpleasant taste to the water. The magnesium derived from dissolution of magnesium calcite, gypsum and dolomite from source rocks. Magnesium is an essential ion for functioning of cells in enzyme activation, but at higher concentration, it is considered as laxative agent, while deficiency may cause structural and functional changes in human beings. The acceptable limit is 30 mg/l as per BIS standards. In the study area the magnesium level in the water samples ranged from 66-280 mg/l and 64-278 mg/l in post and pre monsoon seasons. Most of the locations exceeded the permissible limit. Anomalously high concentrations are observed in the groundwater samples collected very nearer to the solid waste dumping site. The spatial distribution map of the magnesium hardness is shown in figure 8.

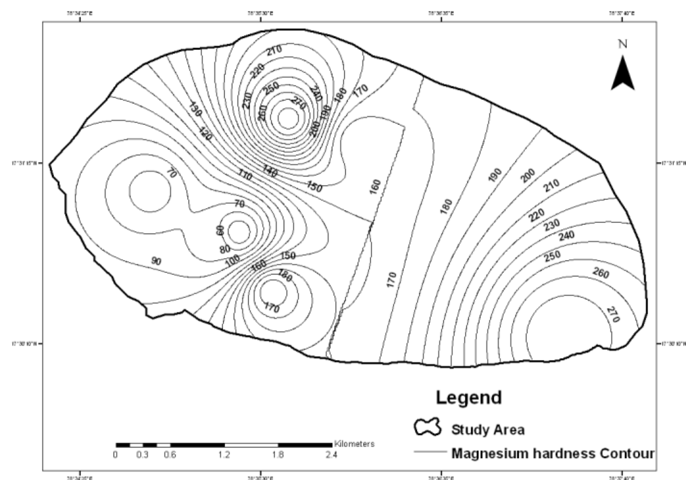

Figure 8: Spatial Distribution Map of Magnesium Hardness in the Study Area

The concentration of nitrite content in all the samples is ranging from 0.0005-0.1mg/l and 0.0005-0.15 mg/l during post and pre monsoon seasons. In some samples, nitrite content has not been traced. The results indicate that the nitrite concentration is low in all the regions of groundwater sources. The values are well below the permissible limit. The results also indicate that the distribution of nitrite is not uniform in the groundwater samples. Nitrates generally occur in trace quantities in surface water but may attain high levels in groundwater. It is well known that the nitrogenous fertilizers are one of the important sources for groundwater nitrate for the past two decades. Further, nitrogenous materials are rare in geological system. In excessive limits, it contributes to the illness known as methenglobinemia in infants. The permissible limit of nitrate is 45 mg/l prescribed by BIS standards. The nitrate concentration in groundwater collected from the study area ranged between 0.3-14.6 mg/l and 0.5-12.2 mg/l in post and pre monsoon seasons. Hence, all the groundwater samples collected in the study area are well within the permissible limit. The spatial distribution map for nitrates concentration during the premonsoon period for the study area is shown in figure 9.

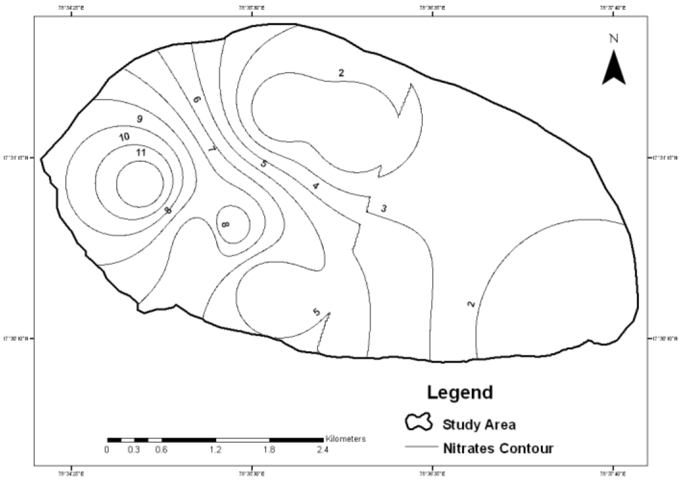

Figure 9: Spatial Distribution Map of Nitrates in the Study Area

The sulphate ion is one of the important anion present in natural water which produces catharsis, dehydration and gastrointestinal irritation effect upon human beings when it is present in excess of 150 mg/l. It is mainly derived from gypsum on oxidation of pyrites. The sulphide minerals add the soluble sulphate into the groundwater through oxidation process. In present investigation sulphate concentration was ranged from 25-100 mg/l and 23-123 mg/l during post and pre monsoon seasons. In the study area the sulphate levels are within the permissible limit of 200 mg/l. The spatial distribution map for sulphates concentration during the pre monsoon period for the study area is shown in figure 10.

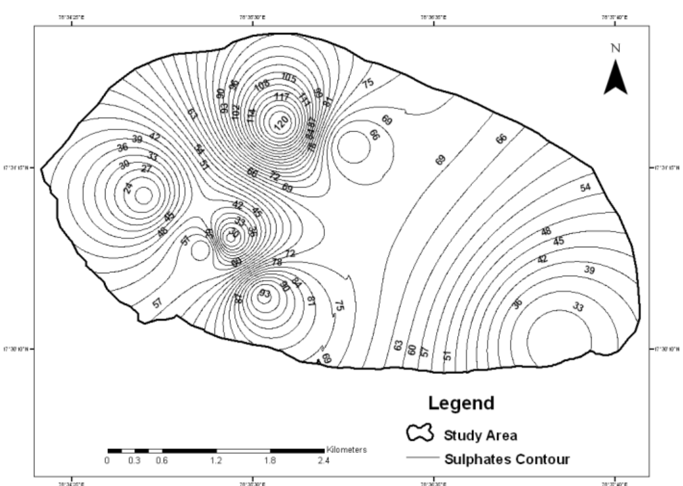

Figure 10: Spatial Distribution Map of Sulphates in the Study Area

Chloride is a widely distributed element in all types of rocks in one or the other form. Therefore, its concentration is high in groundwater, where the temperature is high and rainfall is less. Mostly, the chlorides are found in the form of sodium chloride in the groundwater. Soil porosity and permeability also has a key role in building up the chloride concentration. Chloride imparts a salty taste and some times higher consumption causes for the development of essential hypertension, risk for stroke, left ventricular hypertension, osteoporosis, renal stones and asthma in human beings. Although, the chloride plays an important role in balancing level of electrolyte in blood plasma, but higher concentration can produce some physical disorders. The chloride concentration in the study area varied from 40-230 mg/l and 38-358 mg/l during post and pre monsoon periods. In the study area the chloride concentration has exceeded the permissible limit in certain locations which could be dangerous from health point of view. The high chloride concentration may be attributed due to solid waste dumping which in turn is leaching from upper soil layers in dry climates and natural geochemical activities in the area. The spatial distribution map for chlorides concentration during the premonsoon period for the study area is shown in figure 11.

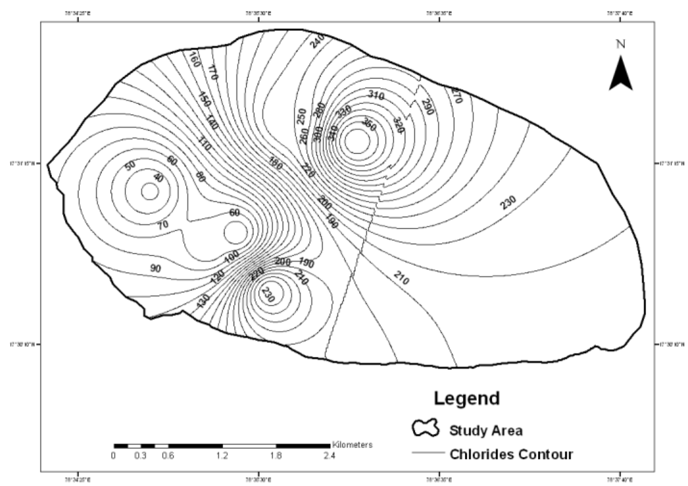

Figure 11: Spatial Distribution Map of Chlorides in the Study Area

One of the main trace elements in groundwater is fluoride which generally occurs as a natural constituent. Bedrock containing fluoride minerals is generally responsible for high concentration of this ion in groundwater. Fluoride normally accumulates in the bones, teeth and other calcified tissues of the human body. Excess of fluoride in water causes serious damage to the teeth and bones of the human body, which shows the symptoms of disintegration and decay, diseases called dental fluorosis, muscular fluorosis and skeletal fluorosis. Higher intake of fluoride may change the metabolic activities of soft tissues (brain, liver, kidney, thyroid and reproductive organs). The permissible limit of fluoride in drinking water is 1.5 mg/l as per BIS standards. The fluoride concentration in the study area varies from 1-1.8 mg/l in post monsoon and 0.8-1.4 mg/l in pre monsoon season. The concentration is higher than 1.5 mg/l in 02 locations. According to UNESCO specifications, water containing more than 1.5 mg/l of fluoride cause mottled tooth enamel in children and are not suitable for drinking purpose. Clinical report indicate that adequate calcium intake is directly associated with reduced risk of dental fluorosis. Vitamin C also safeguards against the risk. The spatial distribution map of fluoride ion concentration in groundwater for the post monsoon period is shown in Figure 12. In this area fluoride is higher due to the leaching from solid waste dumping, long term irrigation processes, semi-arid climate.

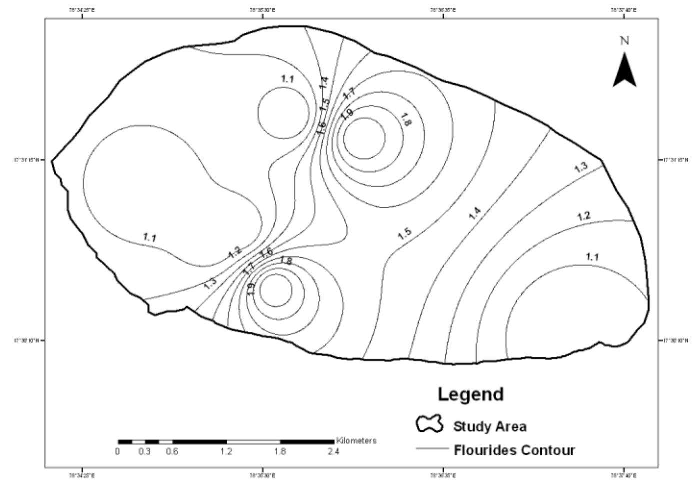

Figure 12: Spatial Distribution Map of Fluorides in the Study Area

V. CONCLUSIONS

Groundwater quality in and around Jawaharnagar, Hyderabad has been analysed in the present work. The groundwater is acidic in nature and total hardness observed in all samples fall under hard to very hard category. The total dissolved solids falls under fresh water to saline categories. The fluoride concentration in the northern and southern region exceeded the permissible limit. The concentration of physiochemical constituents in the water samples were compared with the Bureau of Indian Standards to know the suitability of water for drinking. Based on the analysis, most of the area at many locations near the solid waste dumping site falls in moderately polluted to severely polluted category indicating that the water is unsuitable for drinking purpose. The influences of solid waste dumping site, aquifer material mineralogy together with semiarid climate, other anthropogenic activities and increased human interventions have adversely affected the groundwater quality in the study area.

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