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INVESTIGATION ON WATER POLLUTANTS, THEIR CHARACTERISTICS AND EFFECTS WITH GIS-STUDY AT KURNOOL DISTRICT

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Abstract*— Groundwater quality has a major significance, being the major alternate source of domestic, industrial and drinking water supply and therefore it needs greater attention of all concerned. Contamination of ground water has been observed world-wide, and it is become self evident that concentrated human activities lead to ground water contamination. The present study focus on the spatial distribution of various chemical parameters such as pH, F, Cl, iron, nitrate, alkalinity, TDS, total hardness using GIS techniques for villages in Panyam mandals of Kurnool district, AP. The Water Quality Index (WQI) has to be calculated to find the suitability of water for drinking purpose. From the analysis we can identify the areas with poor or good water quality index. Geographical Information System (GIS) is a computer based system designed tool applied to geographical data for integration, collection, storing, retrieving, transforming and displaying spatial data required for proper planning and management of natural resources. The present study attempts to understand the spatial variation and influence of external factors and ground water composition for taking preventive measures to protect the groundwater resources in the study region. The present study was taken under the regions of Panyam mandals villages, Kurnool.

***Keywords*— GIS, Pollution, pH, Total Dissolved Solids, Total Hardness, Fluorides, Chloride.**

I INTRODUCTION

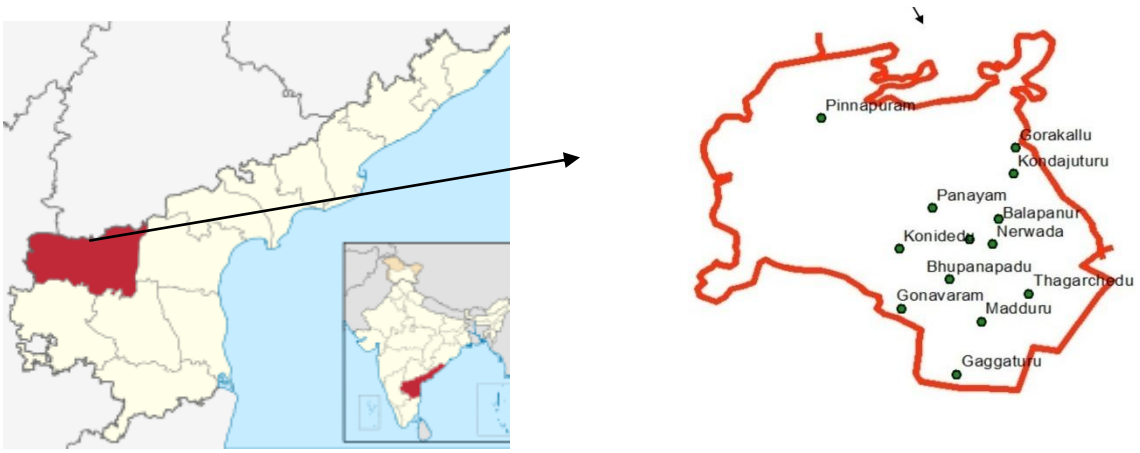
Water is the very basic requirement of every human being. Without water human survival is impossible. Water is used by humans in many ways like drinking, bathing, cleaning, waste disposal, irrigation etc.., Apart from all these, drinking water is directly related to human health. This necessary makes us to study and investigate water in many aspects. Even though the water in the rivers may be pure due to its self purification capacity but water get contaminated in its supply due to various external sources. The present paper represents various tests on water of a small town by name Panyam in Kurnool district of Andhrapradesh State and its surrounding villages from their sources of supply to their delivery place. Beyond this, Geographical Information System (GIS) is one of the revolutions in the stream of Geography. So, in this paper the test results are interconnected with the spatial data of the map using GIS Software.

i) to assess spatial distribution of various chemical parameters affecting groundwater quality
ii) to statistically correlate the concentrations of measured parameters, and
iii) to derive the water quality index to the suitability of water for drinking purpose.

A. Study Area:

The Panyam Mandal is a part of Kurnool district (AP), with geographical area of 496.08km2. It lies between longitudes 78000' to 79000' East & latitudes 15000' to 16000' North (fig1.1).The average temperature range is 19 to 440C. The average rainfall is 600 to 700mm. It consists of 18 villages. It is well connected to highways and railways. Panyam is a junction between Nandyal, Kurnool & Banganapalle. NH18 (Kurnool- Chittoor) passes through the Panyam. Its elevation is 218mts from Mean Sea Level.

B. Map View:



II GEOGRAPHICAL INFORMATION SYSTEM(GIS)

GIS implies Geographical Information System. GIS is one of the revolution in the field of geography and maps. This software is used for all types of geographical data like capturing, storing, editing, managing and analysing. Sometimes GIS is abbreviated as geospatial information studies to refer as a course in higher education or specialisation or for purpose of career working with it. GIS is one of the part and in broad it comes under the subject of Geo Informatics.

GIS refers to a number of methods, different technologies and processes. It is linked with many activities and operations. GIS is applied in the fields of Engineering, transportation, business, planning, telecommunication, management etc.., In present days geo tagging is done for plants, animals, automobiles and even for small important things and this geo tagging is derived from GIS.

A. Spatial distribution Maps in GIS:

The obtained water quality data from the attribute database which is used to generate the spatial distribution maps for the present study area. Inverse Distance Weighted (IDW) raster interpolation technique of spatial analyst module in ArcGIS (Version 10.1) software has been used for the present study to delineate the locational distribution of various water pollutants. The different locations of the sampling stations were imported into GIS software through point layer. Each sample point was assigned by a unique code and stored in the point attribute table. The data base file contains values of all the chemical parameters in separate columns along with a sample code for each sampling stations. The geo database was used to generate the spatial distribution maps of selected water quality parameters namely PH, Fluoride(F),Chlorides(CL),Iron(Fe),Nitrate, Alkalinity, Total Dissolved Solids(TDS), Total Hardness(TH) and Water Quality Index(WQI). The following steps are:

Step1: Digitization of Panyam Mandal

Step2: Creation of Excel Sheet

Step3: Add the Excel Data

Step4: Spatial Distribution by IDW Raster Interpolation

Step5: Assigning the Classifications for Spatial Distribution maps

III SAMPLE COLLECTION & TESTING

Samples from study area are collected in such a way that 3 samples from each village are taken with the co-ordinates. Sampling equipment should be constructed from relatively inert materials (e.g., Teflon, glass, stainless steel) that will not contaminate the sample. Containers used for collecting groundwater samples must not affect the integrity of the sample. As a result, certain sample containers are specified for common sample types. Additionally, there are a number of treatments that are applied to containers to further reduce the chance of sample contamination. Table 1 provides guidance for container selection by analysis type.

Table 1:Sample Containers &max time for different parameters

Determinants	**Type of container**	**Preservation Procedure**	**Max. HoldingTime**
pH, TDS	Plastic	No air gap	Within 24hrs
Alkalinity	Plastic or glass	Fill the container completely to exclude air and freeze	24 hrs
Chloride	Plastic	None required	28 days
Fluoride	Plastic	Filter on site	Within 24hrs
Nitrate	Plastic	None	28 days
Iron	Plastic	Fill completely	Within 24hrs
Total Hardness	Plastic	Fill completely and acidify with nitric acid	<6 months,Without acidification7 Days

Fig 1: Samples stored in Plastic Container.

IV WATER QUALITY INDEX (WQI)

Water Quality Index (WQI) is a very useful and efficient method for assessing the quality of water. WQI is a very useful tool for communicating the information on overall quality of water. To determine the suitability of the groundwater for drinking purposes, WQI is computed adopting the following steps (Shivasharanappa et at 2011).

1. Each of the parameters has been assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes.
2. In the second step, the relative weight (Wi) is computed from the following equation;

$$Wi = wi \div \sum wi \quad \text{----------(1)}$$

Where,

Wi is the relative weight,
(wi) is the weight of each parameter and
n is the number of parameters.

3. A quality rating scale (qi) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the guidelines laid down in BIS, and the result multiplied by 100

$$qi = (ci \div si) * 100 \quad \text{----------(2)}$$

Where ,qi is the quality rating, Ci is the concentration of each chemical parameter in each water sample in mg/l (milligram/litre),and Si is the Indian water drinking standard for each chemical parameter in mg/l according to the guidelines of the BIS(1991) .

4. For computing the WQI, the SI is first determined for each chemical parameter, which is then used to determine the WQI as per the following equations

$$SI = wi \times qi \quad \text{----------(3)}$$

$$WQI = \sum SIi \quad \text{----------(4)}$$

SI is the subindex of the i th parameter; q is the rating based on concentration of i th parameter and n is the number of parameters. The computed WQI values are classified into five types “excellent water”, “good water”, “poor water” “very poor water” and “water unsuitable for drinking” as shown in table no.2 (Shivasharanappa et al 2011). Factors which have higher permissible limits are less harmful because they can harm quality of water when they are present in very high quantity. So weightage of factor has an inverse relationship with its permissible limits. Therefore Wi α1/ Xi (Mahesh Kumar et al 2012). Sub-Index for various chemical parameters are tabulated as below in table no 2 For Example, Consider for Nerwada village and Calculate Sub-index for different parameters.

Table 2: Sub-Index for various chemical parameters

S. No	Chemical Parameters	IS Standards	Weightage (wi)	RelativeWeight (wi)	Quality Rating (qi)	Subindex (SI i)
1	pH	6.5-8.5	4	0.133	93.53	12.46
2	TDS	500-2000	4	0.133	20.34	2.711
3	Alkalinity	200-600	3	0.1	30.00	3.000
4	Chlorine	250-100	3	0.1	12.74	1.274
5	Total Hardness	300-600	3	0.1	29.72	2.972
6	Nitrate	45-100	5	0.167	5.00	0.834
7	Iron	0.3-1.0	4	0.133	10.00	1.333
8	Fluoride	1.0-1.5	4	0.133	31.33	4.150
			$\sum wi=30$	$\sum Wi=0.99$	$\sum qi=232.46$	$\sum SIi=28.73$

Calculation for sample-1 of Nerwada village:

For example take pH,

From eq 1, $Wi = wi \div \sum wi$

$= 4 \div 30 = 0.133$

From eq 2 $qi = (ci \div si) * 100$

$= (7.95 \div 8.5) * 100 = 93.53$

From eq 3 $SI = wi \times qi = 0.133 \times 93.53 = 12.46$

From eq 4 $WQI = \sum SIi = 28.73 < 50$

V RESULTS AND DISCUSSIONS

The results of chemical parameters are analysed are given in table 3. Understanding the quality of ground water is as important because it is the main factor for determining its suitability for drinking, domestic, agricultural and industrial purposes.

Table 3: Comparison of Chemical Parameter Alkalinity with Indian standards (IS) & WHO standards

S. No	Villages	Nitrates (mg/l) IS:45 WHO :50	TDS (mg/l) IS:500 WHO: 1000	Total Hardness (mg/l) IS:300 WHO: 100	Chloride (mg/l) IS:250 WHO: 250	pH IS:6.5-8.5 WHO: 7-8	Fluoride (mg/l) IS:1 WHO:1	Iron (mg/l) IS:0.3 WHO: 0.1	Alkalinity (mg/l) IS:200 WHO:200	Remarks
1	Kavuluru	8.33	934	420	214	7.44	0.64	0.20	420	Satisfactory
2	Pinnapuram	9	830	475	250	7.46	0.50	0.10	550	High Alkaline Content
3	Gorakallu	5	419	187	169	7.77	0.46	0.03	190	Safe
4	Kondaguturu	83	617	297	144	7.69	1.00	0.23	297	High Nitrates
5	Balapanur	10	1320	539	142	7.24	0.50	0.50	522	High TDS, Unssafe
6	Nerwada	5	407	178	127	7.95	0.46	0.10	180	Safe
7	Panyam	5	538	205	115	7.84	0.20	0.10	205	Satisfactory
8	Konidedu	5	937	410	133	7.18	0.50	0.10	417	Satisfactory
9	Bhupanapadu	5	528	230	141	7.18	2.50	0.06	230	Chances of getting Flourosis
10	Gonavaram	5	991	462	224	7.20	0.73	0.10	458	Satisfactroy
11	Gaggatur	15	145	524	283	7.11	0.67	0.47	519	High Chloride, Unsafe
12	Madduru	5	996	500	213	7.23	0.80	0.40	213	Hard Water
13	Thogarchedu	5	26	12	17	7.14	0.20	0.00	10	Safe

A. Effect of Nitrate on groundwater quality:

Nitrogen (N) is an essential input for the sustainability of agriculture. Contamination of groundwater by nitrate leached from agricultural land use is a problem in many countries of the world. Higher nitrate concentrations in drinking water can cause blue baby disease (Methamoglobinamia) in infants and stomach cancer in adults (Anayah and Almasri, 2009). High level may form carcinogens and can accelerate eutrophication in surface waters. Sources of nitrate will include sewage, fertilizers, air pollution, landfills and industries (CPCB, 2008). In the study area nitrate lies between 5 to 15 mg/l which is less than the value as suggested by BIS (1991). All Villages fall under only 2 categories i.e., Excellent & Good water. Gaggatur village water is classified as good and all other villages are Excellent. As shown in the Fig: All the nitrate values of all the villages are within the limits and are safe for drinking. As shown in the Fig.2

B. Effect of TDS on groundwater quality:

TDS is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. At a high TDS Concentration, water becomes saline. Water with a TDS above 500 mg/l is not recommended for use as drinking water. Water with a TDS above 1500 to 2000 mg/l is generally considered problematic even for irrigation use on crops with low or medium salt tolerance (WHO, 1996).In the study area, Konidedu, Kavuluru, Gonavaram; Gaggatur villages are affected by high TDS value this may be due to the presence of high calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulphate, and nitrate anions. As shown in the Fig: TDS Values are very high in the regions of Panyam mandal. Gorakallu, Nerwada & Thogarchedu are safe in TDS values and are suitable for Drinking. As shown in the Fig.3

C. Effect of Hardness on groundwater quality:

The principal natural sources of hardness in water are dissolved by polyvalent metallic irons from sedimentary rocks, seepage & run off from soils. Ca & Mg, the two principal ions, are present in many sedimentary rocks, the most common being limestone & chalk. They are also present in a wide variety of industrial products and are common constituents of food. As shown in the Fig: .All the villages in study area have the high total hardness value except Thogarcheedu. This is due to the presence of high amounts of calcium. Villages of Gorakallu, Kondajuturu, Nerwada, Panyam, Bhupanapadu, & Thogarchedu are safe with Total Hardness. As shown in the Fig.4

D. Effects of Chloride on groundwater quality:

Chloride concentration of the ground water sample in the study area varies from 17-284 mg/l. The acceptable limit for chloride in ground water is 250mg/l & a permissible limit is 1000mg/l (WHO, 1996). Their concentrations vary considerably according to the mineral content of the earth in any given area. In small amounts they are not significant. In large concentrations they present problems. As shown in the Fig.5

E. Effect of pH on ground water quality:

High pH causes a bitter taste, Water pipes and water using appliances becomes encrusted. It depresses the effectiveness of the disinfection of chlorine, thereby causing the need for additional chlorine when pH is high. Low pH water will corrode or dissolve metals and other substances. In the study area, pH lies between 7.09-8.3 which is approximately within the acceptable range, as suggested by BIS (1991). As shown in the Fig.6

F. Effect of Fluoride concentration on groundwater quality:

Fluoride, the most common occurring from fluorine, is the natural contaminant of water. Groundwater usually contains fluoride dissolve in geological formation (Agarwal et. Al., 2010). Fluoride has long been recognized as one of the most significant natural groundwater quality problems affecting arid & semi-arid regions of India. The occurrence of fluoride in ground water is mainly a natural phenomenon influence not only by the local, regional, geological setting and hydrological conditions but it also depends. As shown in the Fig.7

G. Effect of Iron on groundwater quality:

High concentrations are expected in anaerobic groundwater conditions and under strongly acidic conditions. In the study area, Iron concentration lies between 0-0.5 mg/l which is less than the permissible limits suggested by BIS (1991). As shown in the Fig.8

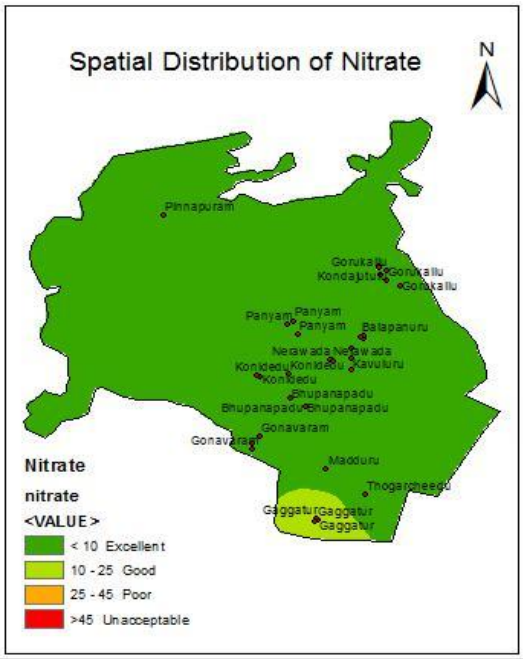


Fig 2: Spatial distribution of Nitrate

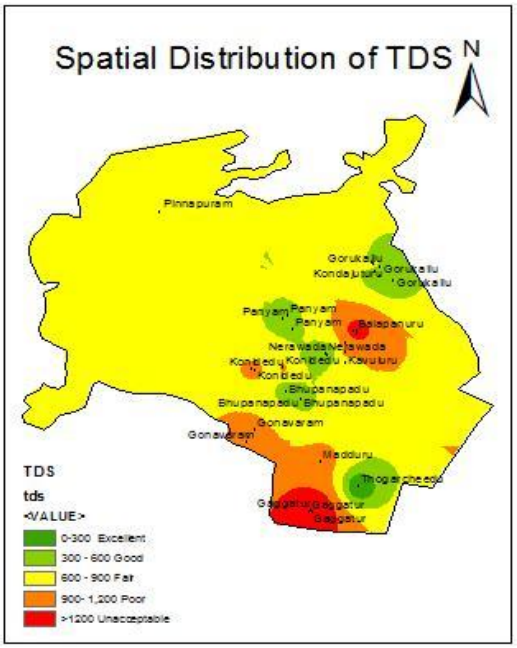


Fig 3: Spatial distribution of TDS

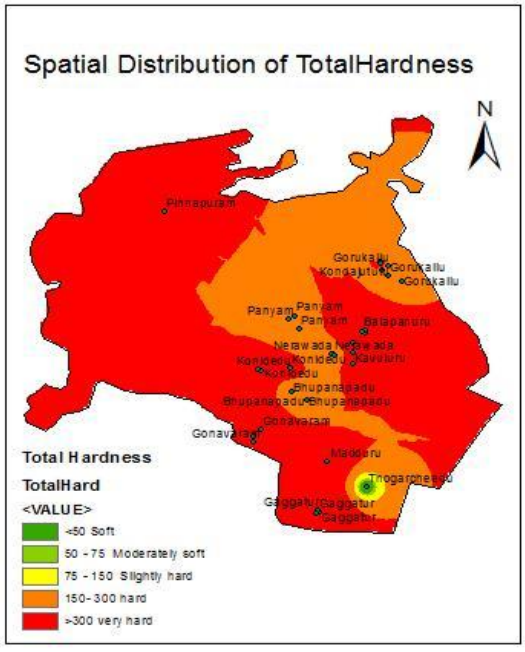


Fig 4: Spatial distribution of TH

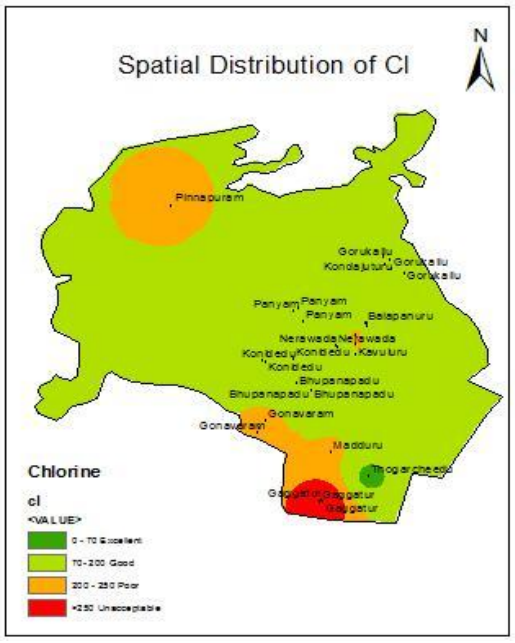


Fig 5: Spatial distribution of CL

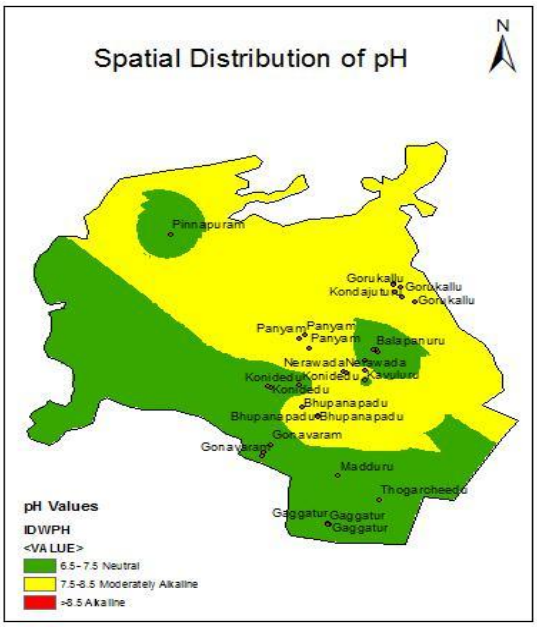


Fig.6: Spatial distribution of pH

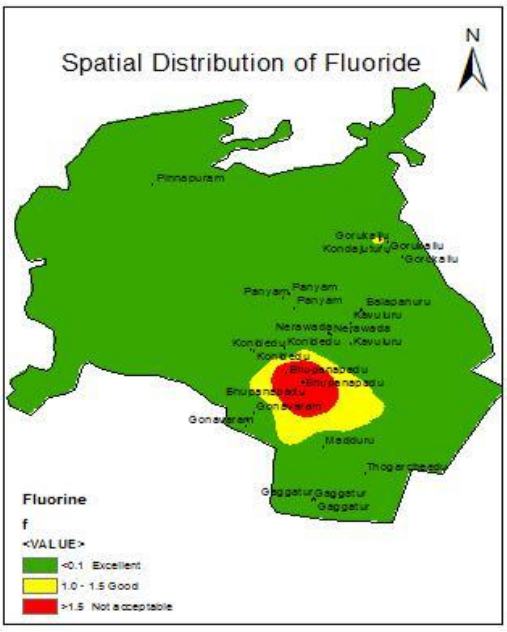


Fig.7: Spatial distribution of Fluoride

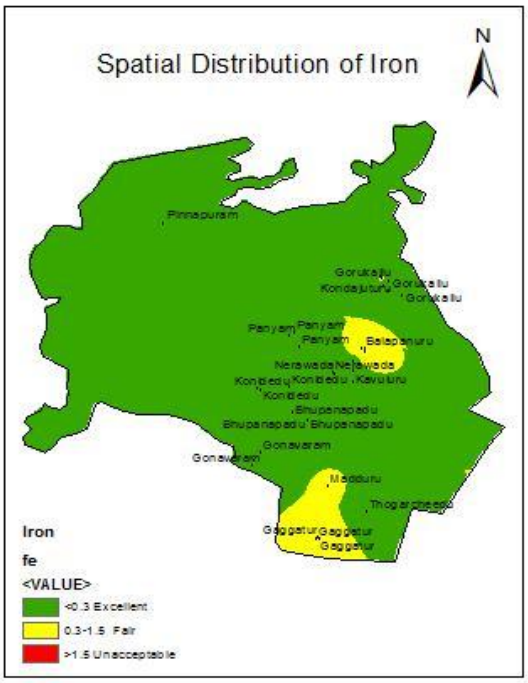


Fig.8: Spatial distribution of Iron

VI CONCLUSIONS

After conducting all tests on water samples, we can conclude

- Villages Gorakallu, Nerawada and Thogadcheru are safe in all aspects for drinking. And those three villages are getting water from the near by sources i..e, Gorakallu have a Reservoir where water is coming from River Krishna, Thogadcheru is on the banks of River Kundu and Nerawada is having a Tank near by it. And all other villages which are getting water by supply from those three Resources and those villages are having high pollution.
- So, we can conclude that the rivers due to self purification capacity are free from pollution and safe for drinking but in case of supply there are some external pollutants like Factories, Human interference, Animal cleaning & decomposition etc.., make the water polluted. Steps should be taken by the government for supply of safe drinking water to those villages.

- The village Bhupanapadu is having extreme Flourine content in water. So, if we can't control fluorine content right from now, then in future villagers may face problems of Flourosis.
- Water Quality Index (WQI) gives concentration of the all the parameters in one spatial map. By which our study area Panyam Mandal is safe for drinking. The Villages of Balapanuru & Madduru comes under Good water for drinking and remaining villages comes under excellent water category revealed by the WQI studies.
- The spatial distribution maps generated for various physicochemical parameters using GIS techniques could be useful for planners & decision makers for initiating groundwater quality development in the area.

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