Evaluation of Water Quality Index by Using GIS in Tadepalli Mandal

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Abstract - Water is a vital natural resource which forms the basis of all life. Ground water Systems are dynamic and that are not available and not suitable for drinking purpose in all regions of the world. Ground water is considered as one of the purest forms of water available in nature and meets the overall demand of rural as well as urban population and so it is very precious. The ground water samples are collecting from January 2018 to March 2018 at different locations in region (chirravuru, Gundimeda, Ippatam, Kolanukonda, Undavalli, Prathuru, penumaka), Guntur (DIST), A.P. The water samples were analysis to determine the concentration of physiochemical parameters to assess ground water quality. The samples were collecting and analysing. The analysis of different parameters such as PH, Electrical conductivity, Total dissolved solids (TDS), sodium, magnesium, nitrate, chloride, iron, alkalinity and total hardness were carried out as per standard methods in the laboratory.

Using GIS tools simulating the past and present years thematic maps of pH, Electrical conductivity, total dissolved solids (TDS), Sodium, Magnesium, Nitrate, Chlorides, Total alkalinity, total hardness and iron in ArcGIS environment. In developing countries in India around 80% of water borne diseases is directly related to drinking water quality and unhygienic condition. Assessment of water quality of drinking water supplies has always been paramount in the flied of environment quality management a study on ground water quality analysis was carried at tadepalli, Guntur district. A study on ground water quality mapping in Municipal Corporation of tadepalli using GIS technique.

***Keywords* -** pH, Electrical conductivity, Total Hardness, Nitrates

I. INTRODUCTION

WQI indicates the quality of water in terms of index number which represents overall quality of water for any intended use. It is defined as a rating reflecting the composite influence of different water quality parameters were taken into consideration for the calculation of water Quality index (WQI) The indices are among the most effective ways to communicate the information on water quality trends to the general public or to the policy makers and in water quality management. In formulation of water quality index, the relative importance of various parameters depends on intended use of water. Mostly it is done from the point of view of its suitability for human consumption.

Initially, WQI was developed by Horton (1965)[1] in United States by selecting 10 most commonly used water quality variables like dissolved, pH, specific conductance, alkalinity and chloride etc. and has been widely applied and accepted in European, African and Asian countries. The assigned weight reflected significance of a parameter for a particular use and has considerable impact on the index. Furthermore, a new WQI similar to Horton's index has also been developed by the group of Brown in 1970[1,2], which was based on weights to individual parameter. Recently, many modifications have been considered for WQI concept through various scientists and experts. A general WQI approach is based on the most common factors, which are described in the following three steps:

The calculation of WQI was made using weighed Arithmetic index method following steps:

Table 1 WQI values for human consumption

0-25	Excellent
25-50	Good
50-75	Bad
75-100	Very Bad
100 & above	Unfit

Let there be water quality parameters and quality rating (qn) corresponding to nth parameter is a number reflecting relative value of this parameter in the polluted water with respect to its standard permissible value. qn values are given by the relationship.

$$q_n = \frac{100(v_n - v_i)}{(v_s - v_i)} \qquad (1)$$

vs= Standard value, vn = observed value, vi = ideal value equation.

In most cases vi=0 except in certain parameters like pH, dissolved oxygen etc.,

Calculation of quality rating for pH &DO (vi not equal to 0)

Calculation of unit weight: The Unit weight (Wn) to various water Quality parameters are inversely proportional to the recommended standards for the corresponding parameters.

$$W_n = \frac{k}{S_n} \qquad (2)$$

Where Wn= unit weight for nth parameter

Sn = standard permissible value for nth parameter

k = proportionality constant.

The unit weight (wn) values in the present study are taken from Krishnan et al., 1995[3]

WQI is calculated by the following equation:

$$WQI = \sum n_i = q_i \times W_i \qquad (3)$$

The suitability of WQI values for human consumption according to Mishra & Patel, 2001[4] are rated as follows:

Necessity of WQI - A water quality index provides a single number (like a grade) that expresses overall water quality at a certain location and time based on several water quality parameters. However, a water quality index based on some very important parameters can provide a simple indicator of water quality.

The Water Quality Index model developed in the present study consists of 5 steps:

1. Selection of parameters for measurement of water quality.
2. Development of a rating scale to obtain the rating (Vr).
3. Estimating the unit weight of each indicator parameter (Wi) by considering the weightage of each parameter.
4. Determining the sub-index value (Wi×Vr).
5. Aggregating the sub-indices to obtain the overall WQI.

Unit weight of each parameter - The unit weight (W_i) of each parameter is proportional to the weightage of each parameter.i.e, W_i ά $1/S_i$ or $W_i = K/S_i$ where $K=1/\sum n_i=11/S_i$ $k=1/\sum i=1n1/S_i$

Where K is the constant of proportionality; W i is the unit weight of the parameter; n is the number of water quality parameters.

Table 2

Parameters	**Standards (sn &si)**	**Weightage (wn)**
pH	8.5	0.0267418
Chloride(mg/lit)	250	0.0009092
Total hardness(mg/lit as CaCO3)	300	0.0007577
Total alkalinity (mg/lit)	200	0.0011365
Fluoride(mg/lit)	1.5	0.1515369
Nitrate(mg/lit)	45	0.0050512
Calcium(mg/lit)	75	0.0030307
Magnesium(mg/lit)	30	0.0075768
Electrical conductivity	2000	0.0001137
Sulphate(mg/lit)	200	0.0004684

There are direct and indirect methods for monitoring the river bank erosion. The direct method is taking measurements from the field in terms of linear rates of erosion, volumes of erosion and channel cross section. The indirect method is by analyzing the archival sources that exist at various timescales with the sediment records.

The archive sources can be conventional survey maps, aerial photos or satellite images. In the recent years, Satellite Remote Sensing (RS) and GIS technology has been successfully proven itself as a valuable information generator for carrying out river morphological/engineering studies and creating geospatial database for analysis. Using multi-temporal high-resolution satellite data, the latest river configuration, and shift in the river courses, formation of new channels/oxbow lakes, bank erosion/deposition, drainage-congested areas, etc. can be mapped at different scales. Since accurate river configuration is obtained, it can be used for laying models for conducting river behavior studies. Information derived from remote sensing can be used for other river morphological application studies like monitoring the existing flood control works and identification of vulnerable reaches, planning bank protection works, and drainage improvement works etc.

II. STUDY AREA

Tadepalli Municipality is in Guntur district of the Indian state of Andhra Pradesh. The town lies on the south bank of the Krishna river and is the headquarters of Tadepalli Mandal of Guntur revenue division.

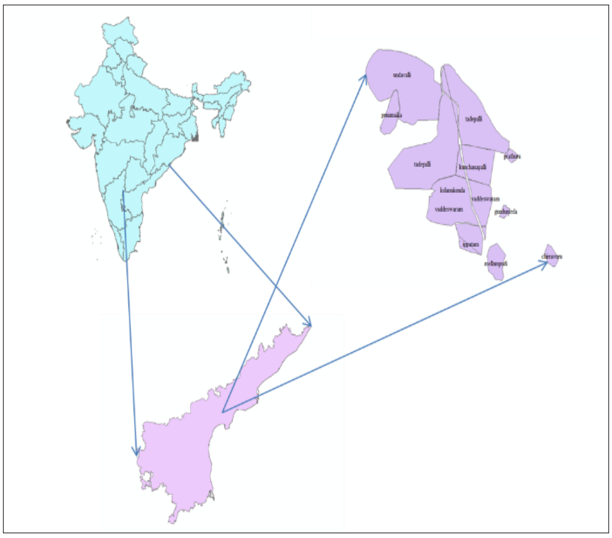

Figure 1: Study Area, Tadepalli Mandal, Guntur District, India

It lies in Andhra Pradesh Capital Region and a small portion of the town is a part of the state capital, Amaravati. Tadepalli is located at 16.4667°N 80.6000°E. It has an average elevation of 6 meters (22 feet). Total municipality contains hill area and agricultural plural and use the active voice (“I observed that ...” or “We observed that ...” instead of “It was observed that ...”). Remember to check spelling. If your native language is not English, please get a native English-speaking colleague to proofread your paper lands. Buckingham canal Flows from north to south in the region. Municipality contains old industrial lands, belongs to EID parry company and cement factory which are not being used for any purpose. As of 2011 census of India, Tadepalli had a population of 54,406. It is spread over an area of 25.45 km2 (9.83 sq mi).

Tadepalli municipality and its out growth, Undavalli, are a part of Vijayawada urban agglomeration. The town has a total road length of 107.41 km (66.74 mi).

III. METHODOLOGY

Digitalization of Tadepalli Mandal was done using online ESRI Basemap tools in ArcMap. Observed 18 partition of polygons that area is 25.45 Sq. Km

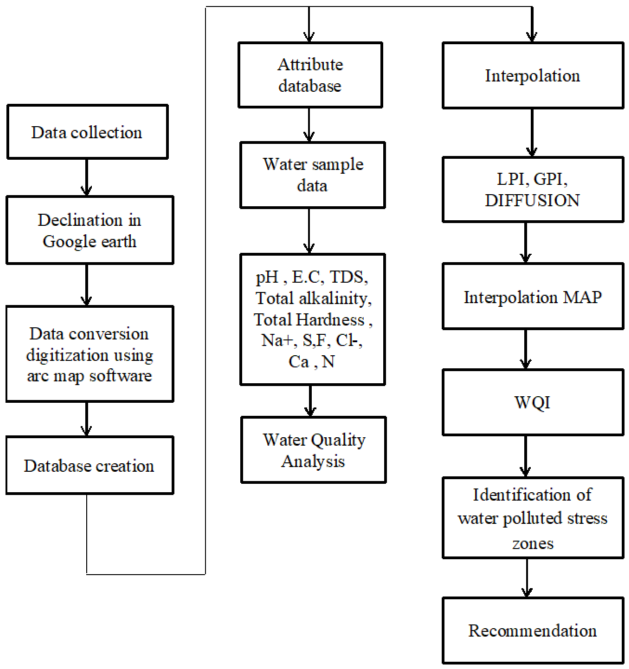

Figure 2: Methodology

For understanding non-spatial data to spatial data was done using Interpolation tools to observed in GIS environment. In Analysing the surface properties of nearby locations, interpolation that depends on distance was presented. There are other solutions for predicting the values for unmeasured locations. Another proposed site for the observation area is on the face of a gently sloping hill. The face of the hill is a sloping plane. However, the locations of the samples are in slight depressions or on small mounds (local variation). Using the local neighbours to predict a location may over- or under estimate the prediction because of the influence of depressions and mounds. Further, you might pick up the local variation and may not capture the overall sloping plane (referred to as the trend). The ability to identify and model local structures and surface trends can increase the accuracy of your predicted surface,

The study is carried out with the help of topographic sheets, Google earth and Arc Map 10.4.1. The paper map of the city has a 1:50,000 scale and was digitized to the UTM coordinate system by applying the on-screen digitizing method using Arc Map 10.4.1 software, which is shown in Figure 2. Google map is used to map the location of each sampling borehole; and finally, the results of each parameters analysed were added to the concerned boreholes. Spatial Analyst, an extended module of Arc Map 10.4.1, was used to find out the spatio-temporal behaviour of the groundwater quality parameters. The various thematic layers on hardness, pH and ionic concentrations were prepared using a spatial interpolation technique through Local Polynomial Interpolation Method (LPI). This contouring method has been used in the present study to delineate the locational distribution of water pollutants or constituents. This method uses a defined or a selected set of sample points for estimating the output grid cell value. It determines the cell values using a linearly weighted combination of a set of sample points; and, it controls the significance of known points upon the interpolated values based upon their distance from the output point, generating thereby a surface grid as well as thematic isolines. Ground water quality classification maps for pH, TH, EC, TDS, Cl, S, N, Ca, Mg, Total alkalinity and F from thematic layers, based on the WHO Standards for drinking water, have been created.

IV. RESULTS

The Electrical Conductivity of some villages like Chirravuru, Ippatam, Kunchanapalli, Prathuru, Mellampudi, Penumaka, Undavalli are low saline and the areas like Gundumeda, Kolanu konda, Vaddeswaram are having high salinity with Electrical Conductivity more than 2000 µ mhos/cm, spatial distribution show in Figure 3

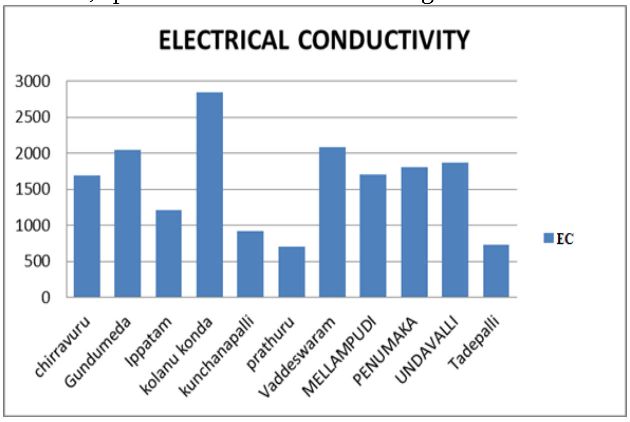

Figure 3: Electrical conductivity

The concentration of chlorides was found to be within permissible limits in all the villages expect in the villages where a high concentration within the range of 250mg/lit is found. The concentration of the low villages like Chirravuru, Ippatam, Kunchanapalli, Prathuru, Mellampudi, Penumaka, Undavalli. The high villages like Gundimeda, Kolanukonda Vaddeswaram, etc. The produces salty taste in drinking water and thus becomes objectionable for drinking. Chloride may arise as a result of various soluble salts and animal manure which is potential source of sulphate excess chloride may result to heart and kidney disease, spatial distribution of chlorides shown in figure 4.

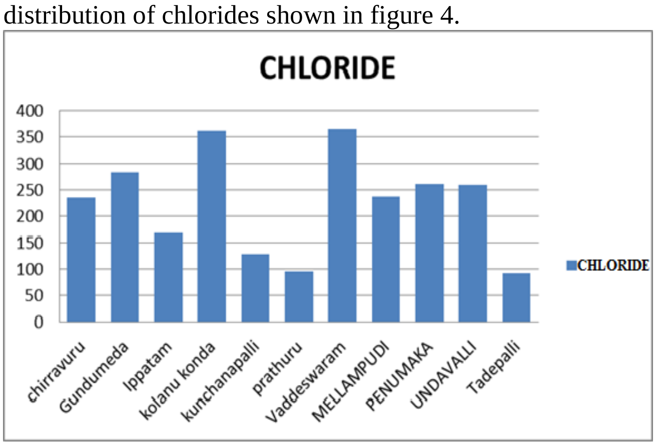

Figure 4: Chlorides

The calcium concentration was in below 75mg/lit in the villages like Kunchanapalli, Prathuru, etc. High concentration of calcium was found in the villages like Chirravuru, Gunumeda, Kolanukonda, Vaddeswaram, Mellampudi, Penumaka, and Undavalli. The standards of calcium are (75to200). The spatial distribution of calcium is shown in the figure 5.

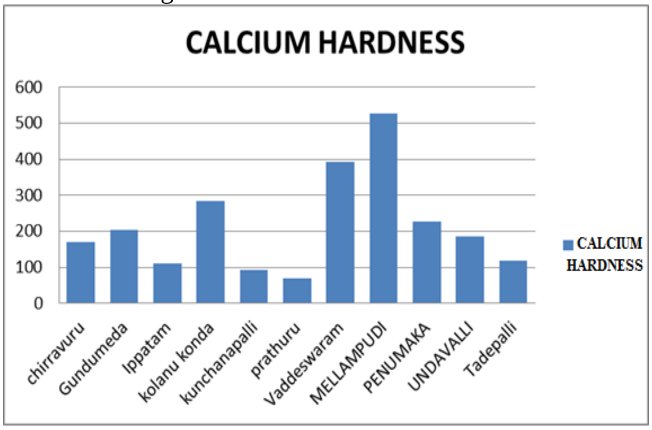

Figure 5: Calcium Hardness

Fluoride the most commonly occurring form of fluorine is the natural contaminant of water. Ground water usually contains fluoride dissolved by geological formation. The concentration of fluoride is below 1mg/lit in most of the villages like Chirravuru, Gundimeda, Ippatam, Kolanukonda, Kunchanapalli, Prathuru, Vaddeswaram, Mellampudi, Penumaka, and Undavalli. And the village Tadepalli has higher amount of fluorine this may lead to diseases like dental furious and skeletal fluorosis, the spatial distribution of magnesium is show in figure 6.

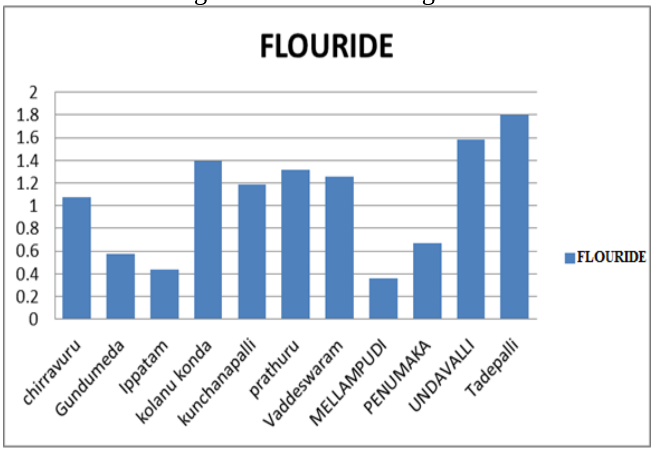

Figure 6: Fluorides

The concentration of magnesium was found to be within the permissible limits in the villages. The concentration of the low villages like kunchanapalli, prathuru. The concentration of the high villages like Chirravuru, Gundumeda, Ippatan, Kolanukonda, Vaddeswaram, Mellampudi, Penumaka, Undavalli. The spatial distribution of magnesium is show in figure 7.

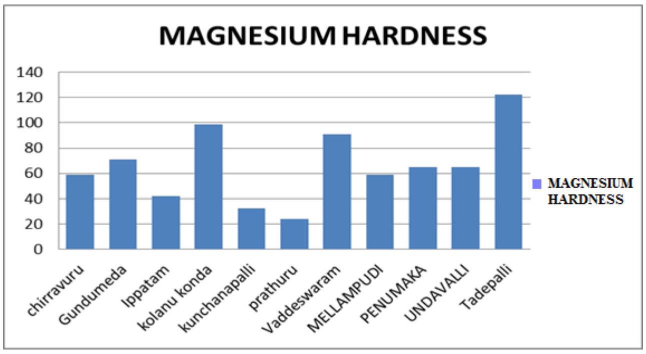

Figure 7: Magnesium Hardness

In the entire villages the nitrate concentration was below 45mg/lit. The nitrate concentration was in between 45-100mg/lit in low areas like Chirravuru, Gundumeda, Ippatam, Kolanukonda, Kunchanapalli, Prathuru, Vaddeswaram, Mellampudi, Penumaka, Undavalli. Improper manure management practices, and improper operation of landfills and open dump sites of solid wastes. The spatial distribution of Nitrate is show in the figure 8.

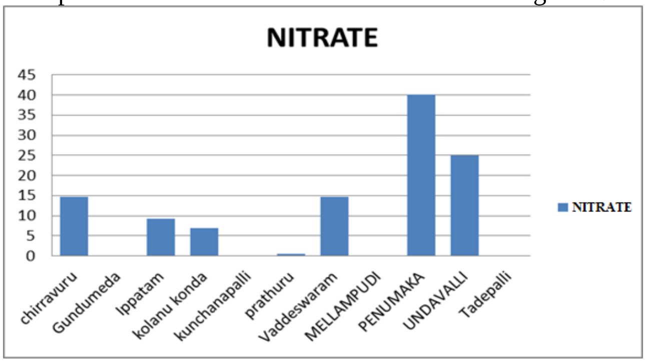

Figure 8: Nitrate

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The Water Quality Index (WQI) of major villages in Tadepalli Mandal was found to be excellent. The standard value of sulphate for drinking water is 500mg/lit. The villages likePrathuru, Kunchanapalli, Ippatam has less amount of sulphate. Water containing more than 250 mg/l in drinking water is objectionable in water. Water containing about 500 mg/l of SO4 taste bitter and water containing about 1000mg/l may be cathartic, spatial distribution of sulphate shown in figure 9

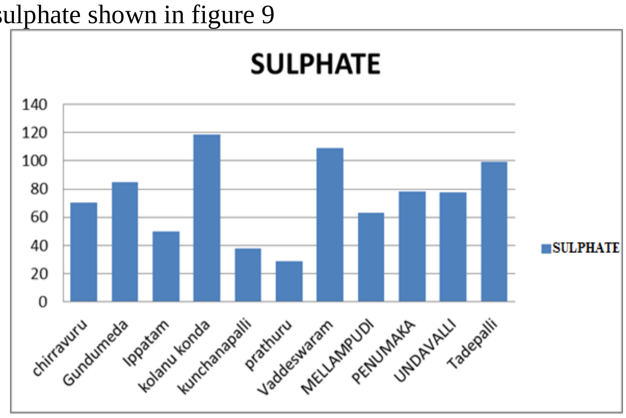

Figure 9: Sulphate

The total dissolved solids (TDS) is high in the villages like Chirravuru, Gundumeda, Ippatam, Kolanukonda, Kunchanapalli, Prathuru, Vaddeswaram, Mellampudi, Penumaka, and Undavalli. The average standard value of TDS is (500 to 2000). The spatial distribution of Total hardness shown in Figure 10.

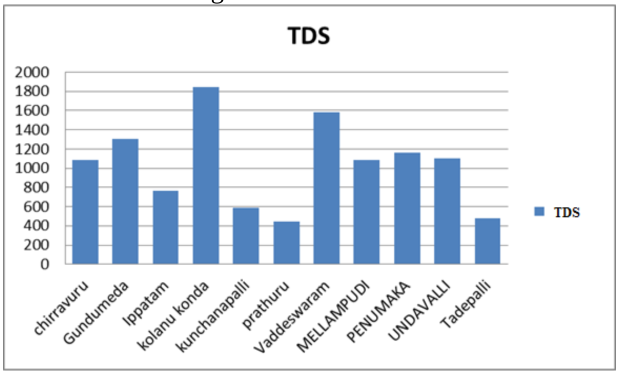

Figure 10: Total dissolved solids

The concentration of alkalinity is above 200 mg/lit in villages like Chirravuru, Gunumedmeda, Ippatam, Kolanukonda, Kunchanapalli, Prathuru, Vaddeswaram, Mellampudi, Penumaka, Undavalli i.e; where the taste of the water is very unpleasant. The spatial distribution is shown in the figure.11.

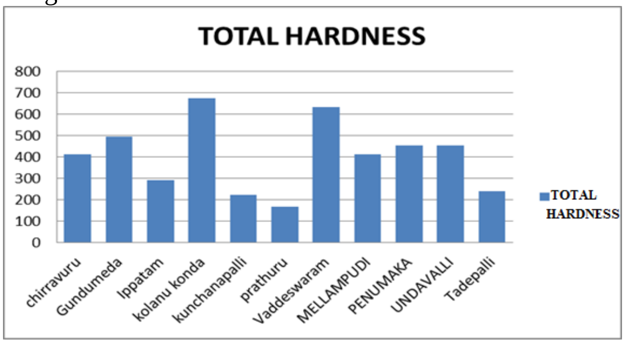

Figure 11: Total Hardness

The Hydrogen ion concentration (pH) values are one of the most important factors of ground water and in present study, the value of pH is found lower than the desired limit (8.5) prescribed by BIS in all the samples. The standard of pH is in between 6.5 to 8.5. The spatial distribution of pH shown in figure 12.

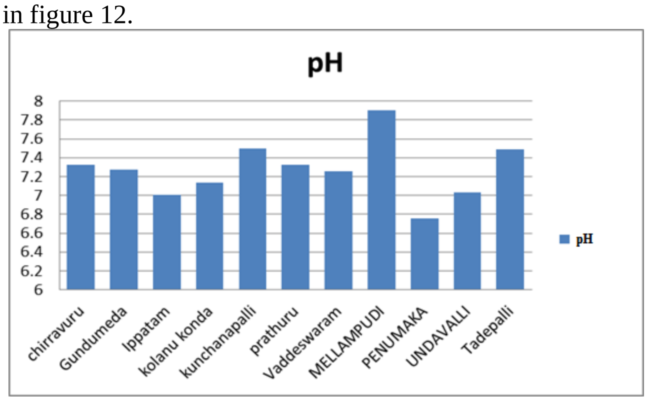

Figure 12: pH

V. CONCLUSION

WQI has been computed based on eleven different quality parameters pH, Total Dissolved Solids, total hardness, fluoride, chloride, nitrate, sulphate, calcium, magnesium, electrical conductivity and total alkalinity to assess the suitability of ground water for drinking purposes in Tadepalli Mandal, Guntur district. The WQI shows that overall ground water samples in the villages like Chirravuru, Gunumedmeda, Ippatam, Kolanukonda, Kunchanapalli, Prathuru, Vaddeswaram, Mellampudi, Penumaka, Undavalli is excellent for drinking purpose. And in tadepalli village fluoride amount is high than desirable limit so that the water in tadepalli is poor for drinking.

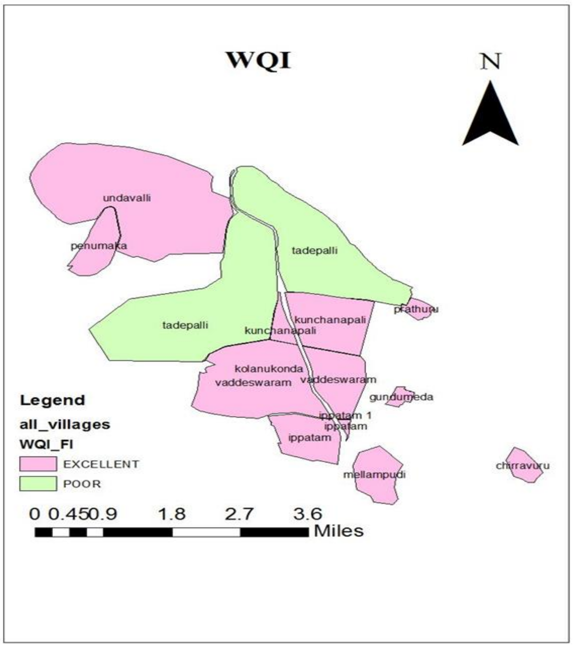

Figure 13: Water Quality Index

VI. RECOMMENDATIONS

The present work revels whether the water is suitable or unsuitable for drinking purpose in the area.

The final output has been given in the thematic represented of ground water quality. The analysis suggests that the ground water of the area need some degree of treatment before consumption. The study helps us to understand the quality of the water as well as to suitable management practice to product the ground water resource.

As we had seen the WQI results the villages like (Chirravuru, Gundimeda, Ippatam, Kolanukonda, Kunchanapalli, Prathuru, Vaddeswaram, Mellampudi, Penumaka, Undavalli, Tadepalli) has excellent drinking water and the only village tadepalli has poor level for drinking purpose. This is due to excess amount of fluoride. This must be reduced the area which live is fluoridates its water, we can avoid drinking the fluoride in one of the three ways: -

A. Water filters
B. Spring water
C. Water distillation

A. Water filters - One way for avoiding fluoride from tap water is to purchase a water filter. Not all water filters, however, remove fluoride. The three types of filters that can removed fluoride are reverse osmosis, deionizers (which use ion-exchange resins), and active alumina. Each of these filters should be able to remove about 90% of the fluoride. By contrast, "activated carbon" filters do not remove fluoride.

B. Spring water - Another way to avoid fluoride from tap water is to purchase spring water .Most brands of spring water contain very low levels of fluoride .Some brands, however ,do contain high levels (e.g., Trinity Springs).Before consuming any bottled water on a consistent basis, therefore, you should verify that the fluoride content is less than 0.2ppm, and ideally less than 0.1 ppm .You can find out the level of fluoride level in some of the popular brands .You can also find out the fluoride level by calling the number on the water label.

C. Water Distillation - A third way to avoid fluoride from the tap is to purchase a distillation unit. Water distillation will remove most, if not all, of the fluoride. The price for distillation units varies widely depending on the size.

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