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SEASONAL VARIATION OF DRINKING WATER SOURCES AND CONTOUR MAPS - IN THE UPLAND AREA OF THE WEST GODAVARI DISTRICT, AP, INDIA

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ABSTRACT

Water plays an essential role in human life. WHO reports that approximately 36% of urban and 65% of rural Indian were without access to safe drinking water. It must be noted that a regular chemical analysis must be done to ensure that the quality of water in this area is not contaminated. Ground Water quality plays an important role in groundwater protection and quality conservation; hence it is very much important to assess the groundwater quality not only for its present use but also a potential source of water for future consumption. Ground water is highly valuable source of water because of its unique properties which may not be possessed by surface water. The chemical quality tests may be difficult to interpret the groundwater quality for the whole region. Therefore, the quality tests results of groundwater can be represented by a variety of graphic techniques developed to display and detect the major chemical constituents. The contour maps are also useful to show the isograms of equally chemical, biological contaminants concentrations with physical parameters. Contour maps are extremely useful for various research areas. This technique could give a more regular gradient of the groundwater table than other methods. This research studies the distribution of chemical contaminants and their concentrations in groundwater of using contour maps interpretation with some chemical analyses and graphic techniques.

KEY WORDS : Ground water, Contaminant, Contour maps

INTRODUCTION

Water plays an essential role in human life. WHO reports that approximately 36% of urban and 65% of rural Indian were without access to safe drinking water. Fresh water is one of the most important resources crucial for the survival of all the living beings. Increase in urbanization, industrialization, agriculture activity and various human activities increase the pollution of surface water & ground water. As the safe & potable drinking water is needed, various treatment methods are adopted to raise the quality of drinking water.

Water should be free from the various contaminations viz. Organic and Inorganic pollutants, Heavy metals, as well as all its parameter like pH, Electrical Conductivity, Calcium, Magnesium, Total Hardness, Carbonate, Bicarbonate, Chloride, Fluoride, Total Dissolved Solid, Alkalinity, Sodium, Potassium, Nitrate, DO, BOD, COD should be within a permissible limit. During last decade, this is observed that ground water get polluted drastically because of increased human activities. Consequently number of cases of water borne diseases has been seen which a cause of health hazards. The quality of water is of vital concern for the mankind since it is directly linked with human welfare.

West Godavari district is one of the 13 districts in the Indian state of Andhra Pradesh. West Godavari District was divided into three natural regions (i.e,) Delta, Upland and Agency areas. The District is popularly known as "Rice bowl of Andhra pradesh. The upland and backward areas of West Godavari

Districts of Andhra Pradesh which are mainly inhibited by tribes and poor people depended mostly on bore-wells and streams for their drinking water needs. Deep tube wells, filter point wells and bore wells are the main sources for extraction of groundwater in the West Godavari district to cater the water demand of the population. Due to increased utilization of ground water for domestic, agriculture and industrial usethe bore-wells were drying up and water levels were going down year by year. Moreover, the natural stream waters had unsafe levels of bacteria and required treatment. Further, bore-well water also contained with excess iron in some pockets.

The district is underlain by Archaeancrystallines, Gondwanas, Deccan Traps, Tertiaries and alluvial sediments. About 45% of the district is underlain by Gondwana formations, 40% is underlain by Alluvium and the rest is by Archaean crystalline rocks. One of the primary goals of the World Health Organization (WHO) and its Member States is that "all people, whatever their stage of development and their social and economic conditions, have the right to have access to an adequate supply of safe drinking water". It is in this context, the ground water quality is determined in twenty four mandals in the upland area of the West Godavari district and are analyzed systematically for two seasons (pre monsoon and post monsoon) and two consecutive years for pH, Electrical Conductivity (EC), Total Dissolved Solid (TDS), Turbidity, Total Alkanity (TA), Total Hardness (TH), Sodium (Na^{+}), Potassium (K^{+}), Calcium (Ca^{+2}), Magnesium (Mg^{+2}), Iron(Fe^{+2}), Chloride (Cl^{-}), Fluoride (F^{-}), Nitrite (NO_2^{-}), Sulphate (SO_4^{-2}), Phosphate (PO_4^{-3}), DO, COD, BOD and MPN using standard techniques.

From the chemical quality tests it is difficult to interpret the groundwater quality for the whole region. Contour maps are extremely useful for various research areas. This technique could give a more regular gradient of the groundwater table than other methods. This research studies the distribution of chemical contaminants and their concentrations in groundwater of using contour maps interpretation with some chemical analyses and graphic techniques. Fig 1 represents the district and Fig 2 is the upland area i.e., study area. Fig. 3 is the Map showing the sources of drinking water in Upland areas of West Godavari District.

MATERIALS AND METHODS

The drinking water quality at the source of the upland area of the West Godavari district is determined in twenty four mandals for two seasons (pre monsoon and post monsoon) and two consecutive years.

Bottles used to collect samples for bacteria should be sterilized. A representative sample is needed while collecting samples and while sampling well

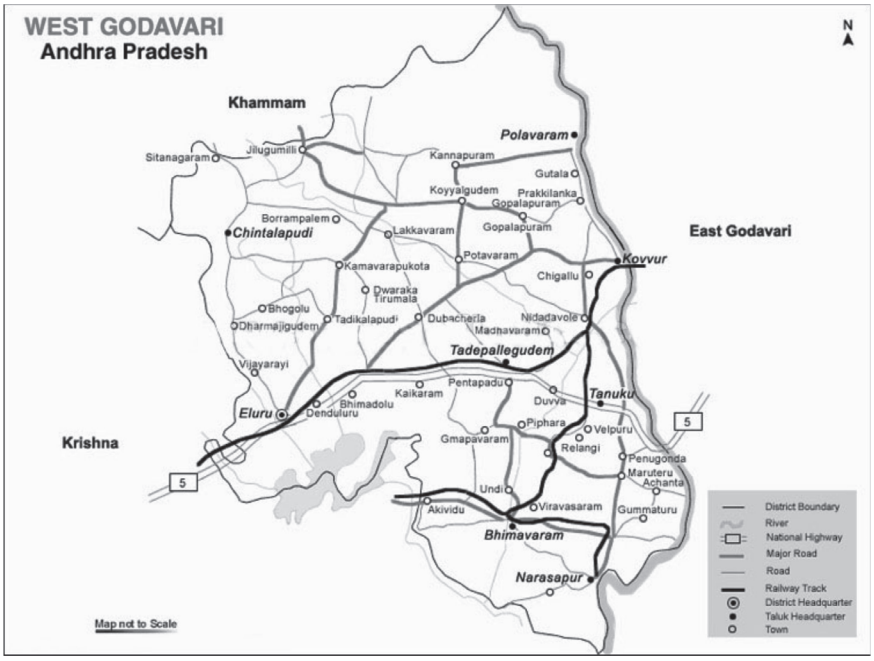

Fig. 1.

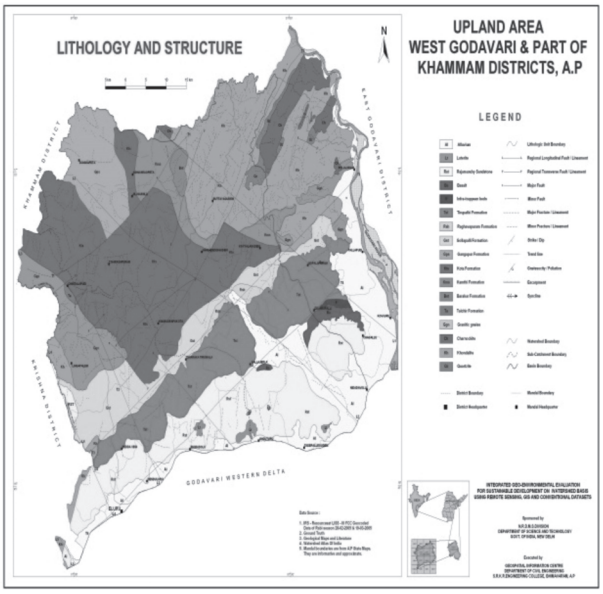

Fig. 2.

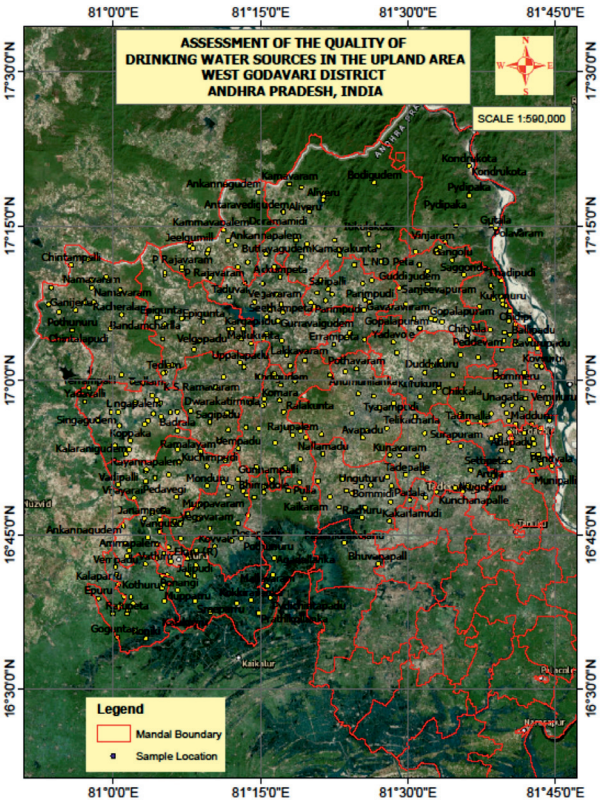

Fig. 3.

water, the water is run for several minutes so that we get water directly from the well and not from a source that has been sitting in a storage tank or pipes.

Sample Bottles are designated A & B. A is 250 mL sterile plastic bottle pre-treated with sodium thiosulfate, used for collection of treated or untreated drinking water samples for analysis for total coliform/ *E. coli* bacteria and B 250 mL plastic bottle which is cleaned with acid water followed by rinsing twice with distilled water for physicochemical analysis.

Methodology

- The pH and Turbidity was measured by using nephalometrically using Systronics.
- EC was measured by using Conductivity meter Elico.
- TDS was measured by using TDS Meter EUTECH (digital).
- Total hardness, calcium and magnesium were measured by EDTA Complexo metric titration.
- Chloride was measured volumetrically by silver nitrate (precipitation) titrimetric method.
- Iron, Fluoride, Sulphate, phosphate, Nitrite was measured by using Systronics Spectrophotometer.
- Total alkalinity is determined by Acid Base titration.
- Sodium and Potassium was measured by using Flame photometer.
- DO is measured by using Winkler's method.
- BOD is measured by using dilution method.
- COD by using Redox titration.

RESULTS AND DISCUSSION

(a) Physico-chemical parameters indicate the quality of ground water. 422 water samples are analyzed systematically for Physico- chemical and biological parameters and the results are discussed in terms of Water quality for two seasons and for two consecutive years. Most of the parameters like EC, TDS, Total alkalinity, Total hardness, Chloride and Fluoride were found to have highest concentrations but within the permissible level except few samples indicating the over exploitation of ground water. Total dissolved solids and Total alkalinity concentrations recorded exceeded the BIS standards.

(b) Water quality index is one of the most effective, simple and easily understandable tools to assess water quality for its suitability for various purposes. The computed WQI values are classified into five types, "excellent water" to "water unsuitable for drinking". In this study, the computed WQI values ranges from from 89.21 to 660.56 and Table 1 shows the percentage of water samples that falls under

different quality.

The high value of WQI at these stations has been found to be mainly from the higher values of total dissolved solids, hardness, chlorides, fluorides, bicarbonate in the groundwater. Pedavagi, Pedapadu, Eluru, Bhimadole, Unguturu, Tadepalligudem, Nidadavole, Chagallu, Tallapudi, Polavaram are the mandals where there are more water samples poor in quality.

(c) Water Quality Contour Map (WQCM) shows the water quality in different parts at a single point in time. By creating and comparing multiple contour maps, it is possible to detect patterns in water quality changes from month to month or from season to season, and to identify water quality trends over a longer period. Contour maps are extremely useful for various research areas. This technique could give a more regular gradient of the groundwater table than other methods. This research studies the distribution of chemical contaminants and their concentrations in groundwater of using contour maps interpretation with some chemical analyses and graphic techniques.

In the present study Contour maps are drawn for pH, EC, Chloride and sulphate and the results are discussed based on seasonal variation.

pH

During this period the hydrogen ion concentration (pH) is varying from 7.00 to 8.5 the pH values are generally neutral in the central part of the study area and slightly alkaline east and southern boundaries acidic pH values were recorded near korasavarigudem, ankkannagudem, kamavaram of North western margins and alkaline pH ranging from 8 and above were recorded in the western margins of the district in and around kottapalli, yadavalli, yarrampalli (shown in Fig 4a).

In the post monsoon season the Alkaline pH areas marked in the eastern and southern regions found to get diluted to neutral pH with isolated patches near kalakorru, kokkirailanka and Dosapadu (shown in Fig. 5a).

Electrical conductivity

The electrical conductivity values in the pre monsoonrange from 500 to 2500 μS/cm. In general, the central part of the study area confined to 500-1000 μS/cm EC levels. High concentrations of EC were found near Gangallu, Dommeru, Nellaturu and Arulla villages in the eastern margin whereas the EC values tend to be much higher near koppaka, yedavalli, TCh.R. palem on the western margin. The EC concentrations are predominently higher and above the permissible limit for both domestic and irrigation purpose in the south west corner of the study area in and around Vegavaram, Kovvali, Ponangi, Gogunta, Rojupeta, Epuru and Vempadu villages (shown in Fig 4b).

In the post monsoon period of the high EC concentrations in the eastern margin found to be diluted and well within the potable limits whereas the other EC concentrations in the western margins as well as south-western region remain in the same range uneffected by monsoon (shown in Fig. 5b).

Chloride

The chloride values for the period pre monsoon vary between below 100 to near 1000 mg/L level. The Higher concentrations of chloride were limited to the western margin between venkatadrigudem and singagudem from north to south. Similar high concentrations were also noticed Sagigudem to koniki from north east to south west (shown in Fig 4c & 5c).

Sulphate

The sulphate ion concentrations in the pre monsoon range below 20 to near 100 mg/L and the values are uniformly spread in the study area. Few isolated high concentrations patches were observed south east of Rajavaram and west of Gopalapuram villages. In the post monsoon the concentrations of

Table 1. Classification of water quality based on WQI value (Ramakrishnaiah *et al*., 2009)

Se. No	WQI Value	Grade	Water quality	Pre monsoon% of samples	Post monsoon % of samples
1	50 and below	A	Quality of water is excellent	0.94	0.23
2	50-100	B	Quality of water is good	25.83	26
3	100-200	C	Quality of water is poor	57.8	60.6
4	200-300	D	Quality of water is very poor	11.8	13.5
5	300 and above	E	Quality of water is unsuitable for drinking	3.55	1.89

sulphate remains the same and the high concentrations patches noticed during the pre monsoon were disappeared due to dilution effec (shown in Fig 4d & 5d).

CONCLUSION

The drinking water quality in the upland west Godavari District varies widely with the change of lithlogical formations. Among the Eight groups of rocks in the study area sandstone terrine found to be stable for monsoonal vagaries and sustained with a better quality to a major extent. In order to maintain and enhance the dilution effect of the rain fall, recharge methods need to be adopted in the sandstone terrine with sustainable scientific designs. As in majority of area the water quality is within the potable limits awareness programs need to be conducted on the use of potable ground water. The sanitation and natural drainage parameters have to be at continuous vigilance in order to maintain the present water quality level and to avoid local contaminations if any. It must be noted that a regular chemical analysis must be done to ensure that the quality of water in this area is not contaminated. Observed results shows that the technology to be applied for the treatment of ground water is source dependant and in most cases, effective and simple treatment solutions are sufficient without blindly implementing RO Technologies.

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