iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** II **Month of publication:** February 2018

DOI:

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue II, February 2018- Available at www.ijraset.com

Assessment of Fluoride Content in Groundwater of PC Palle Mandal, Prakasam District, Andhra Pradesh

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Abstract: Fluoride is a ubiquitous element in earth's crust, the limestone is the most predominant rocks of the study area these rocks have fluoride bearing minerals which are leached out and contribute high concentration in the groundwater. The Groundwater is the primary source for drinking purpose in the study area villages in P.C Palle mandal, Prkasam District, the high concentration of fluoride (>1.5 ppm) in drinking water is a serious issue not only Andhra Pradesh, but also very serious problems are faced in several parts of the world which causes dental and skeletal fluorosis to humans. As well as the physico-chemical parameters concentrations were observed in the study area such as pH-8.9, TDS-2284 mg/li, Cl-345 mg/li, Na-351ppm, Ca-201 ppm, Mg-124 ppm, F-2.4 ppm, , these are all exceeded the limits according to the WHO and BIS standards in the ground water, hence finally concluded that the study area needs Fluoride management plan and the removal of fluoride from drinking water and treatment of ground water before consumption for drinking purpose.
Key words: Ground water, Fluoride, Fluorosis, P.C Palle, Standards,

I. INTRODUCTION

Groundwater is a major source for drinking in the several regions of the India and in the world, without proper treatment of groundwater the people facing several health problems, and having excess fluoride though the origin of geological reasons. (Suresh et al., 2015), Fluoride minerals and agro-chemicals, etc., are the sources of F- in the groundwater (Ayoob and Gupta 2006; Ahmed 2014; Rao et al. 2014). and it is also found in the soil and the content of Fluorine in the lithosphere varies between 100 and 1500 g/ton (Nagarajan et al., 2004), It is estimated that around 260 million people worldwide (in 30 countries) are drinking water with Fluoride content more than 1.0 mg/L. In India alone, endemic Fluorosis is thought to affect around one million people and is a major problem in 17 of the 25 states, especially Rajasthan, Andhra Pradesh, Tamil Nadu, Gujarat and Uttar Pradesh. In India totally 25 states have been reported as fluoride affected areas but severe problem occurred in the states of Andhra Pradesh (Shukla et al., 1995 and Jamode 2005,).

Similar studies shows that approximately 62 million People including 6 million children suffer from fluorosis because of consumption of water containing high concentration of fluoride (Susheela 1999). In Rajasthan the existence of fluoride was first detected from jobner near Jaipur city (Kalsiwal 1959) later during 1964 in the villages of nagour and in 1976 high fluoride content in drinking water was observed in bhilwara district and Mathur et al reported the prevalence of fluorosis in Ajmer district (Mathur et al., 1976). Samples from 45 wells were collected once every 2 months and analyzed for fluoride concentration using an ion chromatograph (Brindha et al., 2011), Many epidemiological studies stated that possible adverse effects of the long-term ingestion of fluoride via drinking water and clearly indicated that fluoride primarily produces effects on skeletal tissues (bones and teeth) (Somboon and Chinpitak,, 2005), In India, the people suffering from two health disorders due to occurrences of fluoride (F-) in drinking water (Subba Rao et al., 2017),),

The problem of excessive fluoride in ground water in India was first reported in 1937 in the state of Andhra Pradesh (Short et al., 1937). The health implications caused by F contamination are far more wide spread and contamination in the country (Subba Rao 2011).

The severity of fluorosis depends on the concentration of fluoride in the drinking water, daily intake, continuity and duration of exposure, and climatic conditions, so it very necessary to understand the present contamination level, distribution and developing a methodology for safe drinking water source.

II. MATERIALS AND METHODS

A. *Study Area*

The fluoride-affected areas are more in prakasam district because the geologic scale having unconsolidated materials like sand, sand stone, gravel, and clay with intrusive granite and quartz shale, ancient and younger sedimentary rocks which are known to have high fluoride content.

Prakasam district is one of the Coastal Andhra districts of the Indian state of Andhra Pradesh. The headquarters is Ongole. The district has been named after the Andhra patriot Prakasam Panthulu. The Ongole district was formed in February 1970 and later in 1972 it was renamed as Prakasam. The district located on the western shore of Bay of Bengal and is bounded by Guntur district. (Fig.1), the PC Palle is one of the mandal in 56 mandals of Prakasam district, it consists of 68 Villages and 18 Panchayats, bounded by Kanigiri Mandal towards North, Ponnaluru Mandal towards East, Marripudi Mandal towards North, Pamur Mandal towards South, and the total population is 38984 according to 2011 census.

Figure 1: study area map

B. *Sampling Collection And Method Of Analysis*

The drinking water quality depends on many physico-chemical parameters and their concentrations, which are derived from laboratory tests of water samples, water samples were collected from selected regions in the study area based on the ground water use for drinking purpose. The groundwater samples were collected from 10 villages and mentioned as Sample number such as S1-PedaAlavalaPadu, S2-PedaIrlaPadu, S3-PedacherloPalle, S4-Pedavari Madugu, S5-Pothavaram, S6-Rama Govinda Puram, S7-Sankara Puram, S8-Talakondapadu,S9-Vepagum Palle, S10-Vengalayapalle (Table-1), One liter polythene bottles are used to sample collection, have been thoroughly cleaned by rinsing with 8M HNO_3 solution, followed by repeated washing with deionized distilled water and the sample bottles were tightly capped without air gap. Immediately, after collection of the water, the samples are shifted to laboratory for the chemical analysis, the pH, Total Dissolved Solids (TDS) were measured by Water Quality Analyzer. Magnesium (Mg) was determined titrimetrically using standard EDTA. Chloride (Cl^-) was determined by standard $AgNO_3$ titration, Sodium (Na^+) by flame photometry and fluoride (F^-) were analyzed by using ion-sensitive electrode, according to standard water quality procedures WHO, BIS and APHA-1999. All chemical variables (except pH) are expressed in milligrams per litre (mg/L) or parts per million (ppm).

III. RESULTS AND DISCUSSION

Water quality monitoring and assessment is the foundation of water quality management so that there is an increasing demand for monitoring the water quality in many rivers and ground water by regular measurements (Sudhakar et al., 2014), The results of the physico-chemical analysis of the groundwater, samples were taken from the study area are shown in Table 1. pH is one of the important parameter for the quality of water, in this study pH of the groundwater samples are in neutral conditions that all range from 6.9 to 8.9 and the average is 7.99, which are within the permissible limits 6.5- 8.5 given by BIS. (Fig 2) The pH was slightly alkaline in all stations except S2-Peda Irla Padu, S5-Pothavaram (6.9), and some of the samples are observed within the permissible limit as per BIS standards (Ramakrishnaiah et al, 2009), Similar studies were observed that the higher pH can be expected near certain industries in industrial area that is about 7.0 to 8.31 (Swarna Latha & Nageswara Rao, 2010). (Satish & Ravichandran, 2011). The Total Dissolved Solids is one of the important parameter for the use of drinking water, the water with high TDS value indicates that water is highly mineralized, (Sudhakar & Swarna Latha, 2013), the TDS concentrations were observed in the study

area from 1508 to 2248 and the average value is 1763.4, all sampling stations were beyond the standard limit (500 ppm) of WHO and BIS.(Table-1, fig:3&7), this indicates the ground water quality is changed by addition of dissolved particles (Swarna latha et al., 2017).

Chloride is the most abundant anion in the human body, it is present in natural waters due to the dissolution of salt deposits, Chloride concentrations were exceeding the permissible limit (250 ppm), as per WHO, BIS standards, in sampling station except S8-Talakondapadu (238 ppm), S2-Peda Irla Padu (250 ppm, (figure:4&7, table:1), Similar results were reported by Swarna latha and Narsingrao, (1998), the higher concentration of chloride is association with increased level of pollution in drinking water and the increasing chloride into ground water is likely to sea water influence salt pan deposits agricultural return flow into groundwater, The sodium concentration in the study area sampling stations observed from 162 ppm to 351 ppm , the high concentrations were recorded in S5-Pothavaram (351 ppm), and the some of the samples are within the permissible limits that are S1-Peda Alavala Padu (162 ppm), S7-Sankara Puram (198 ppm), S8-Talakondapadu (167 ppm), (Table:1, fig:4&7), the excess of Na in water is unsuitable for patients suffering from hypertension or congenital heart diseases and also from kidney problems (Rao G.T et al., 2012). It is dangerous for human health, particularly for infants causing Methaemoglobinemia. As per WHO (1993). Calcium plays an important role for proper bone growth (Dilip, 2001), The permissible limit of calcium is 75 mg/l according to WHO, the minimum amd maximum values of calcium in the study area recorded as 86 to 201 ppm, this indicates all sampling stations were beyond the standards limit, the maximum concentration is observed in S3-Pedacherlo Palle (201 ppm), the results are indicated in table 1 and figure: 4&7.the magnesium ranges from 46 to 124 ppm in the study area groundwater samples, according to standard value 30 ppm, all the sampling stations were beyond the permissible limits Fluoride contamination is mainly a natural process, i.e. leaching of fluorine-bearing minerals, since no man-made pollution has been noticed. Since fluorite, apatite, mica and various other minerals take part during rock–water interaction and liberate fluoride into the groundwater. According to ISI (2012) and WHO (2008), the desirable and permissible limits of F- in drinking water are 1.00 and 1.50 mg/L, respectively. However, the recommended limit of F- in the water depends on the climatic conditions of an area (USPHS 1987), The fluoride levels in the study area were observed from 1.8 ppm to 2.4 ppm, all the sampling stations are beyond the standard value S1-PedaAlavalaPadu (1.9 ppm), S2-PedaIrlaPadu (2.2 ppm), S3-PedacherloPalle (1.8 ppm), S4-Pedavari Madugu (2 ppm) , S5-Pothavaram (2.4ppm) , S6-Rama Govinda Puram (1.85ppm), S7-Sankara Puram(1.99 ppm), S8-Talakondapadu (2.4ppm), S9-Vepagum Palle (2.1 ppm), S10-Vengalayapalle (2.2ppm) (Table-1, figure 5&6) If the F concentration is between 0.9 to 1.2 mg/L then dental fluorosis is started and F - exceeds the level of 3 mg/L then skeletal fluorosis is started in living beings. (Kalwale & Savale 2012). Influences of saline water, chemical activity (ion exchange) and climate (evaporation) also play an important role for increasing F- content in the groundwater (Subba Rao et al., 2017), the solubility of F- increases with the increase of Na in the groundwater (Apambire et al. 1997; Gao et al. 2007, 2013; Singaraja et al. 2013; Surya Rao et al. 2015).

Table: 1. Physico-chemical parameters of groundwater samples in the study area

Sample	Name of the village	pH	TDS	Cl	Na	Ca	Mg	F
S1	Peda Alavala Padu	8.9	2248	324	162	125	98	1.9
S2	Peda Irla Padu	6.9	1648	250	245	145	76	2.2
S3	Pedacherlo Palle	7.6	1572	345	234	201	101	1.8
S4	Pedavari Madugu	8.4	1642	328	257	167	124	2
S5	Pothavaram	6.9	1508	294	351	135	86	2.4
S6	Rama Govinda Puram	8.4	1645	276	281	101	94	1.85
S7	Sankara Puram	7.8	2153	283	198	92	56	1.99
S8	Talakondapadu	8.5	1923	238	167	86	95	2.4
S9	Vepagum Palle	8.6	1647	295	243	124	68	2.1
S10	Vengalayapalle	7.9	1648	320	220	97	46	2.2
	Min	6.9	1508	238	162	86	46	1.8
	Max	8.9	2248	345	351	201	124	2.4
	Average	7.99	1763.4	295.3	235.8	127.3	84.4	2.084

Figure: 2. pH concentration in groundwater in the study area

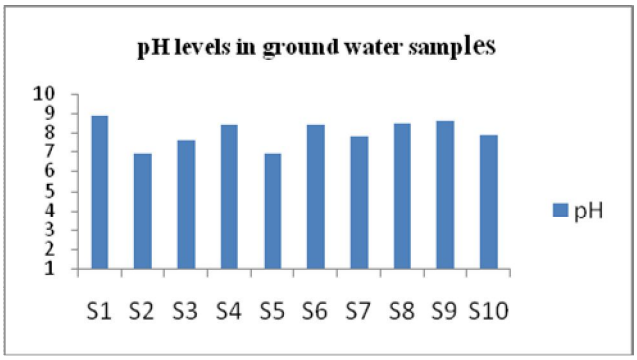


Figure 3: TDS concentration in ground water samples

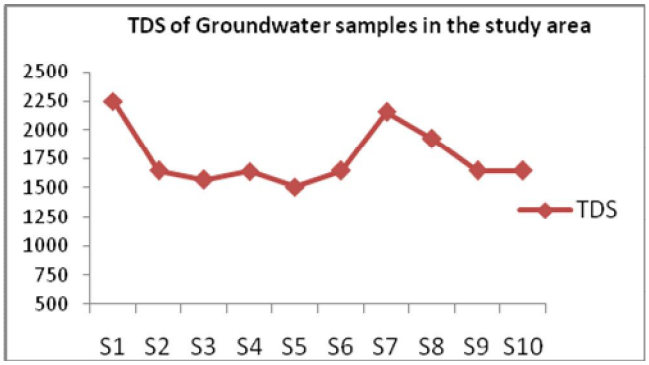


Figure 4: Cl, Na, Ca & Mg levels in the Groundwater samples

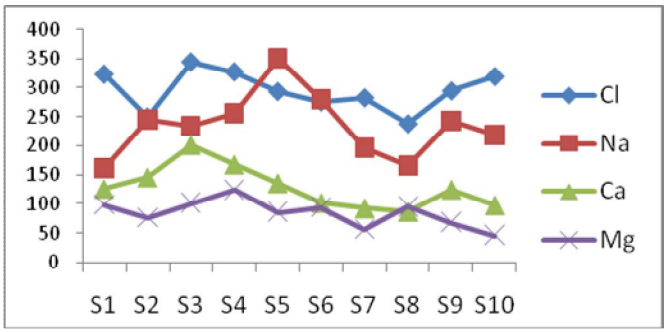


Figure 5: Fluoride concentration in the study area

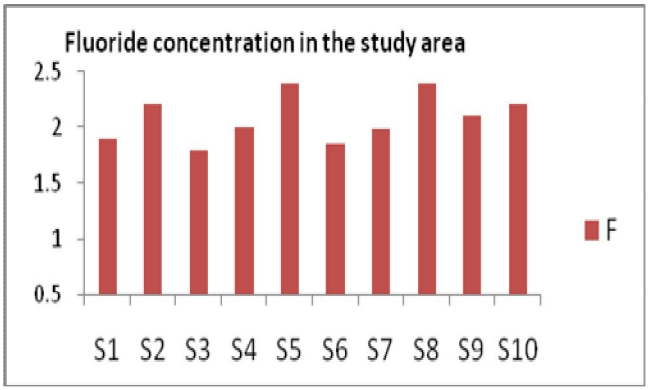


Figure 6: Min, Max & Average values of pH & F of Groundwater

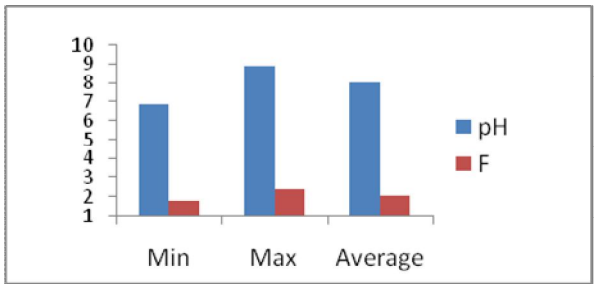
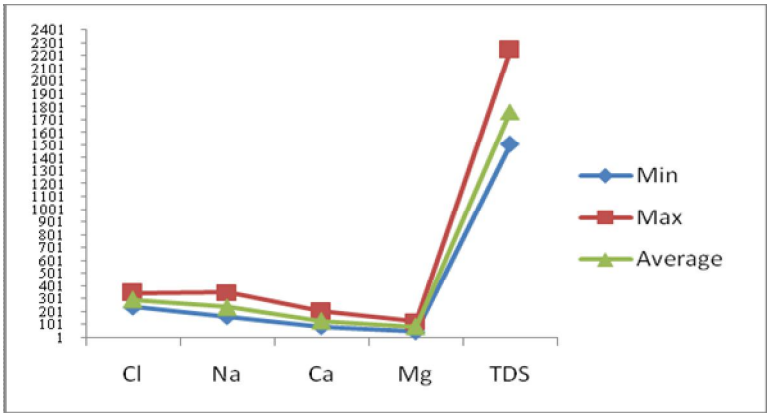


Figure 7: Min, Max & Average values of pH & F of Groundwater



IV. CONCLUSION

The results of the present study indicate that the area under study is fully affected withenemic fluorosis and the concentration of fluoride ion in all water sources derived from bore well and hand pumps, adsorbents can be used for the defluoridation of potable water at house hold level. Finally the results also suggest that the area is fully contaminated with fluoride and the ground waters are not suitable for drinking purpose unless properly treated all groundwater samples in the study area. The occurrence of F--bearing minerals in the country rocks are the main geogenic source of F- in the groundwater. F^{-} As a result, a positive correlation

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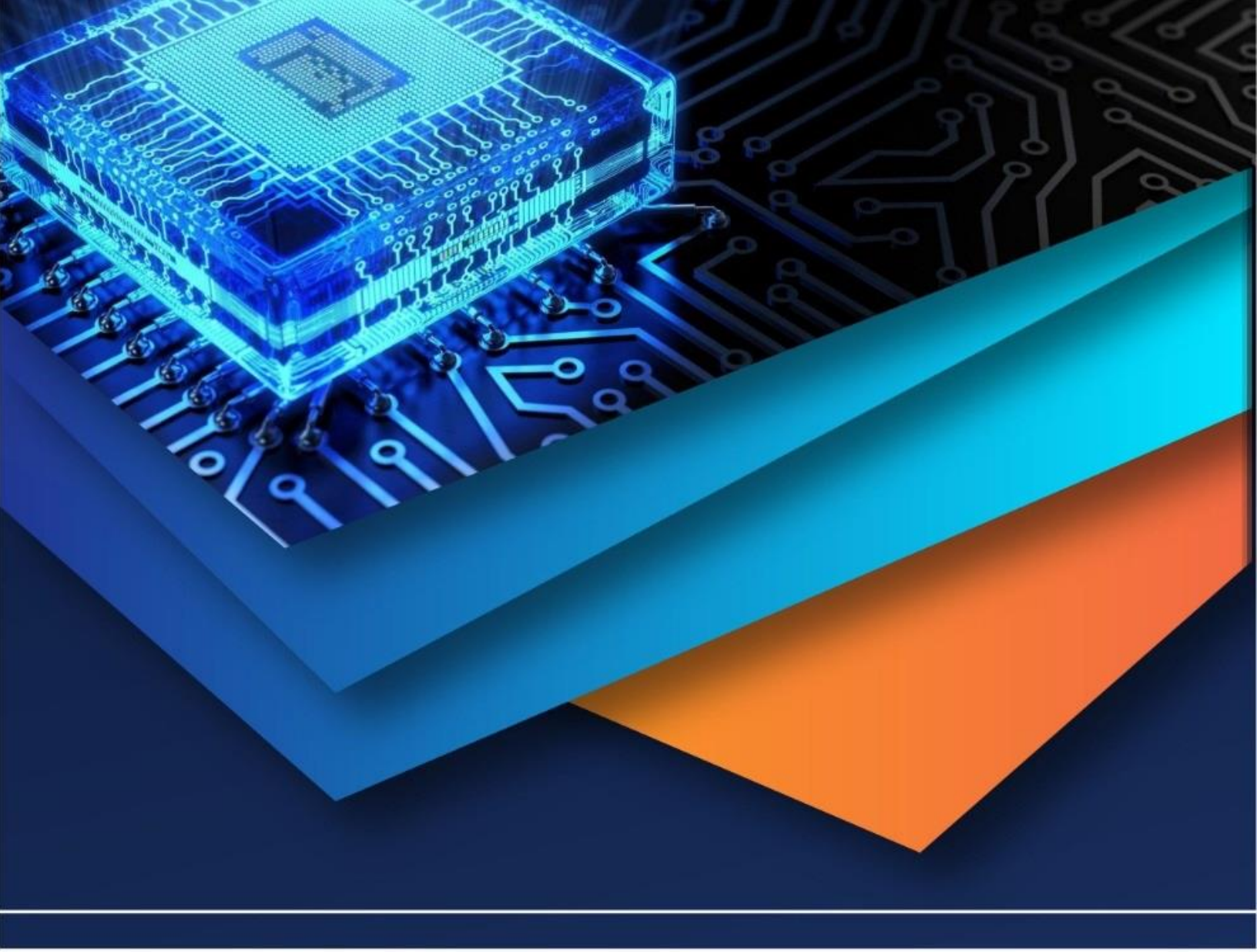

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