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Investigation On Chemical Contamination In Bore Well, Dug Well and Palar River Water Near Tannery Locality Of Vellore district, India

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Abstract: Industries, though being an integral part of an economy, have a very high impact on polluting the environment by discharging effluents. Various pollutants from different sources cause defilement of profuse resources. One of the most threatening pollutants in the recent years is heavy metals released from leather industries. This study aims at reckoning the amount of heavy metals present in the water sources in and around the most polluted tannery area in Tamil Nadu, Ranipet that lies on the banks of Palar River. Leather processing in these industries requires many chemicals which includes heavy metals such as Chromium, Zinc, Barium etc. The industrial waste that comes out after the processing contains these metals in surplus amount. The wastes from these industries are released into the nearby water source. This on sustained deposition causes befoulment of the water making it unsuitable for drinking and irrigation. Thirty Samples (ten from each) were taken from bore well, dug well and river. Standardized methods were used to scrutinize the amount of heavy metals encompassed in the samples. Comparisons were made against the permissible level in each sector. The results showed discrepancy with the standards. The health discomforts posed by the habitants due to usage of the contaminated water for the daily chores have also discussed
Key words: Leather processing, physico- chemical parameters, bore well, dug well, Ranipet.

I. INTRODUCTION

One of the major developments of the industrial era is refining of leather. Refined leather is used for suitable manufacturing of consumer products such as luggage, foot wares and like. Leather refining undergoes three main processes such as preparatory stages, tanning and crusting [1]. These processes have various other sub processes such as liming, drying etc., [2]. Chemicals used for these processing consists of heavy metals such as Chromium, Lead, Cadmium, Arsenic etc, [3]. Even small traces of these elements can pose serious hazards to the habitants. The study is confined to Ranipet which is a suburb of Vellore district. It has around 240 leather processing tanneries. Since most of them are located on the banks of Palar River, the effluents that contain traces of metals used for refining are discharged into the river. The three major sources for water in Ranipet are dug well; bore well and Palar River water. Sustained discharge leads to contamination of these sources posing health hazards to the human beings and the animals. The leather produced in India accounts to about 12 percent of the total world production [4]. According to the study, around 37 percentage is contributed by Vellore [5]. Ranipet is identified by The New York-based Blacksmith Institute (BI) as one of the top 10 dishevelled and polluted countries in the world in 2007[6]. Vellore is ranked as 6th most polluted city among the 20 polluted cities in India in 2011 [7]. In accordance by the Tamil Nadu Pollution Control Board uncovered that nearly 15 lakhs tonne of solid wastes accumulated over two decades of plant operation are dumped in an open yard on the premises where the groundwater is found at high level. The contamination causes weakening of the human health and destroys the peace of environment with respect to BI report. If the situation prevails and the pollution remains unscreened, Palar River, one of the major drinking sources for the localities in and around ranipet may suffer a huge devastation that ultimately will lead to ill effects for humans and the surroundings. One ton of hide refining produces several tons of wastes and effluents. These wastes on subsequent deposition in the water sources eventually lead to reduce the quality of water. Sustained intake of water contaminated with hazardous metals will lead to deformation in the health of the habitants and other organisms that rely on these sources for water. When this water is used for irrigation, the plants subsequently get contaminated with heavy metals and hence enter the human body. Based on the careful analysis of the literature, the present investigation aimed to attain the health hazards of the heavy metals in three different types of water collected from the Palar river.

II. MATERIALS AND METHODS

A. Study Area

Vellore, one among the 32 districts of Tamil nadu functions with Vellore city as its head quarters. As of 2016, the district had a population of 3,936,331 with a Gender ratio of 1,007 females for every 1,000 males. Vellore district lies between 12^{o} and 13^{o} 15' of Northern latitude and 78^{o} 20' and 79^{o} 50' of Eastern longitude. It slopes from East to West and the land in Eastern part is flat (Figure 1). About 3122 kilo of effluents are produced each day. Ranipet is a highly chronic polluted city [8]. Ranipet is a medium-sized municipality located along Palar River bank in the Vellore District and 120 km from Chennai [11]. Many small-scale tanneries are processing leather in the study area and discharging their effluents on the open land and surrounding water bodies. Ranipet is located on the northern bank of the Palar River. It houses nearly 400 small and medium leather units. The large number of medium-scale leather industries which make both finished leather and leather articles for export. The Indian Government has identified the Leather Sector as a Focus Sector, as it has immense potential for export growth prospects and also in employment generation. According to 2011 Census [7], Ranipet had a population of 50,764 with a Gender-ratio of 1,091 females for every 1,000 males. Palar is the predominant source of water for the villages situated in Ranipet. Palar River that has a catchment area of about 2813 sq metres, originates from Talagavara village in kolar [9]. This flows through Karnataka, Andhra Pradesh and Tamilnadu.

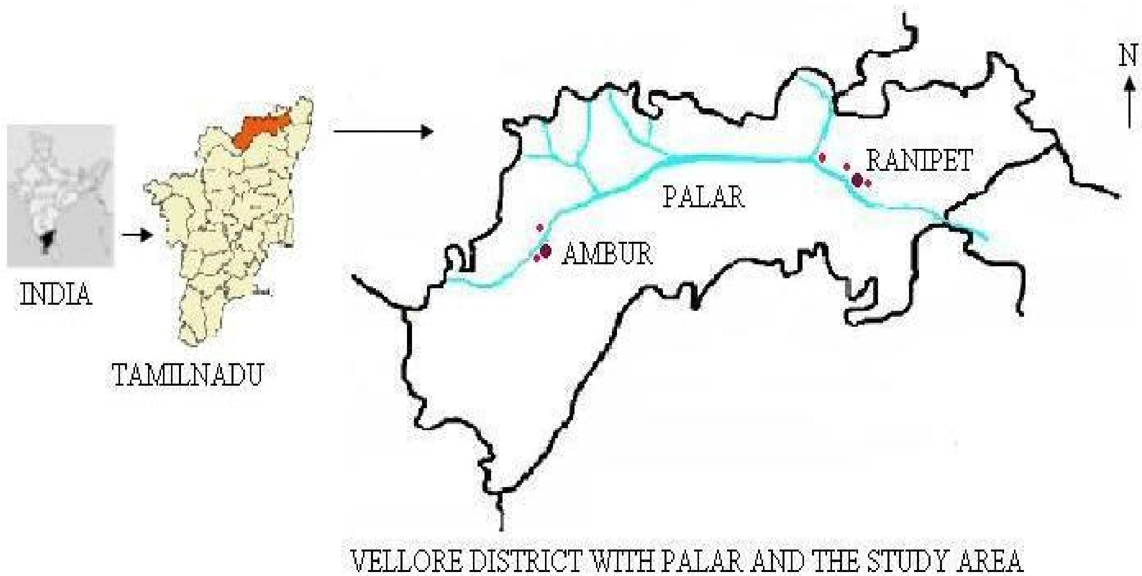

Figure 1: Vellore district with Palar river study area.

B. Geology and Hydrogeology

The study area predicts undulating topography, falling in pediment zone and structural hills in the northern side. The flat to undulating Pedi plain nature continue and extends up to the flood plain of Palar River. The Pedi plain has granites, gneisses and basic and ultra basic intrusive, which are discontinuous unconfined to semi-confined aquifers down to 150 m bal and restricted to weathered zone and fractures GSI (2000). The major dolerite dyke, striking NE–SW passes through the factory area. Quaternary sediments are restricted to the alluvial sand and clay of the Palar River and its tributaries. Sand thickness in the Palar River is hardly 10 m and the width being 2000 m along the river course. The alluvium consisting of fine to coarse sand and clay occurring in the area is of a fluviatile origin and restricted to the course of Palar River and major streams (Subramanian and Selvan 2001). Discontinuous unconfined to semi-confined aquifers down to 150 mg/l restricted to weathered zone and fracture zone have been encountered in the granite and gneissic formations in the Palar basin.

C. Sample collection and processoing:

Around 25 samples were collected from Ranipet. About 10 samples were collected each from bore well, dug well, ponds and Palar respectively (Figure 2). All these industries discharge effluents into the surrounding in various concentrations. For the assessment, water has been taken and analysed for various major physical – chemical parameters. The sampling bottles were made of plastic, usually polyethylene. The bottles were soaked with 10% HCl for 24 hours and then thoroughly cleaned, rinsed with distilled water. Water samples were collected from bore wells around the dump yard in Vellore region in high grade plastic bottles of 1 litre capacity after rinsing with distilled water and thrice with the sample water before collecting the sample for analysis(Figure 3). Data were then stored in excel format and linked. The samples were collected at regular intervals for about three-four times a month in one litre polyethylene bottles, rinsed with water sample before the sampling. The ground water samples were stored at 1 - 4°C temperature prior to analysis in the laboratory. Thus, standard method of collection, preservation and analysis were adopted

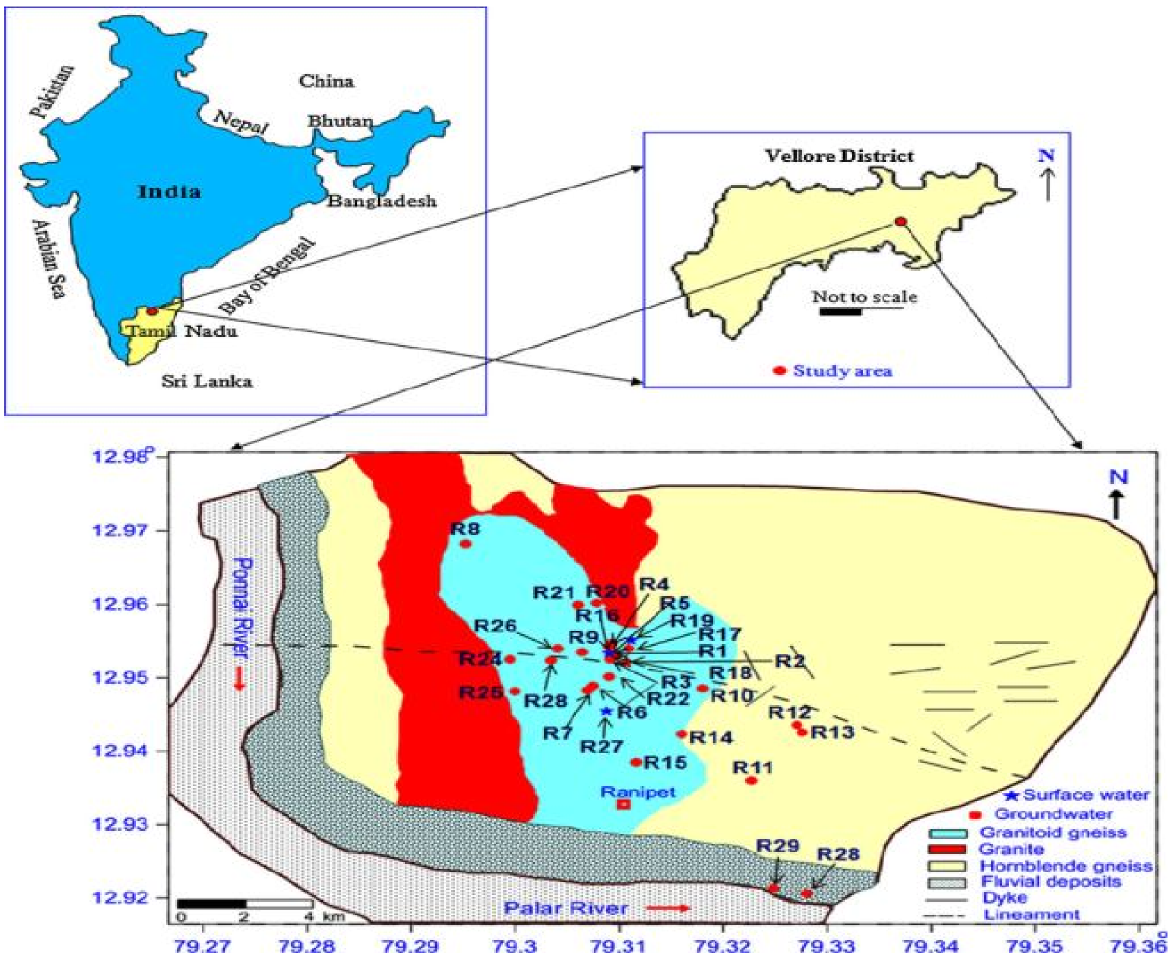

Figure: 2 sample collected area.

D. Heavy Metal Assesment Methodologies

After the collection of water samples from the sources, the samples were tested using various methods to deduce the amount of heavy metals and the other physical and chemical characteristics of the water samples. The physic-chemical parameters such as pH, TDS, turbidity, total alkalinity, Iron, Calcium, Magnesium, Zinc, Aluminium, Lead, Chromium, Sulphates, Chlorides, Fluorides, Nitrates and nitrates were determined, the chemical characteristics including heavy metals for examination of water. The physic-chemical parameters were measured at the sample site using handheld analyzing kits. Groundwater samples were collected and the samples were kept in a polythene bottle for further laboratory analysis of major ions. The extra pure analytical reagents and chemical standards were used (Figure 2: sample collected area for the groundwater quality assessment). The analytical procedures are suggested by the American Public Health Association. pH was determined by electrometric method by using pH meter. Turbidity was determined by Nephelometric Turbidity meter [10]. Carbonate (CO_3^-) and bicarbonate (HCO_3^-) were determined using acid titration method. Total alkalinity was measured by Potentiometric titration method [11].

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Figure 3: sample collected area

TDS was determined by Gravimetric method. Chloride (Cl^-) concentration was measured by $AgNO_3$ titration method, sulphate (SO_4^{2-}) measured by $BaCl_2$ method using spectrophotometer, Nitrate (NO_3^-) was analyzed using Kjeldhal flask apparatus. Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) were determined using the EDTA titration method. Zinc was determined by using Spectrophotometer (620 nm). Lead (Pb^{2+}) and Chromium (Cr^{3+}) were determined by Flame Atomic absorption spectrophotometer (VARIAN SPECTRA A240), Technology Business Incubator Lab, Department of Science and Technology, VIT, Vellore, Tamilnadu. The results obtained were tabulated and evaluated in accordance with the standards prescribed under 'Indian standard drinking water specification IS 10500: 1992' of Bureau of Indian Standards(TABLE 1).

III. RESULTS AND DISCUSSIONS

The samples were subjected to various procedures to have a clear and accurate quantity of hazardous metals present in collected sample. The analysis showed that the samples tested in the area in and around tanneries had heavy metal deposition more than the permissible levels. This section presents a detailed description of various samples and the amount of heavy metals present in them. These results were compared against the permissible standards (**Table 1**). The results were evaluated and tabulated for three sources namely dug well, bore well and river samples. Tables 2, 3 and 4, represented the bore well, dug well and river samples respectively. The results show that except a few samples had high traces of heavy metals. Certain metals such as Zinc, Calcium, Iron, Magnesium are needed to be present in our daily intake in required amount. Excess intake also has a significant effect on the health as that posed by deficient intake. Other heavy metals such as cadmium, lead, chromium, arsenic etc., have a large effect on the normal body conditions when taken even in small shreds. The samples were tested for more than thirty elements including various physical and chemical characteristics such as turbidity, alkalinity, pH etc

Table 1: Indian standard drinking water specification; IS 10500:1992. Bureau of Indian standards

S.No	Parameter	Requirement desirable limit	Remarks

1.	Colour	5	May be extended up to 50 if toxic substances are suspected
2	Turbidity	10	May be relaxed up to 25 in the absence of alternate
3.	pH	6.5 to 8.5	May be relaxed up to 9.2 in the absence
4.	Total hardness	300 mg/L	May be extended up to 600 mg/L
5.	Calcium	75 mg/L	May be extended up to 200 mg/L
6.	Magnesium	30 mg/L	May be extended up to 100 mg/L
7.	Copper	0.05 mg/L	May be relaxed up to 1.5 mg/L
8.	Iron	0.3 mg/L	May be extended up to 1 mg/L
9.	Manganese	0.1 mg/L	May be extended up to 0.5 mg/L
10.	Chloride	250 mg/L	May be extended up to 1000 mg/L
11.	Sulphates	150 mg/L	May be extended up to 400 mg/L
12.	Nitrates	45 mg/L	No relaxation
13.	Fluoride	0.6 to 1.2 mg/L	If the limit is below 0.6 mg/L water should be rejected, Max. Limit is extended to 1.5 mg/L
14.	Phenols	0.001 mg/L	May be relaxed up to 1.5 mg/L
15.	Mercury	0.001 mg/L	No relaxation
16.	Cadmium	0.01 mg/L	No relaxation
17.	Selenium	0.01 mg/L	No relaxation
18.	Arsenics	0.05 mg/L	No relaxation
19.	Cyanide	0.05 mg/L	No relaxation
20.	Lead	0.1 mg/L	No relaxation
21.	Zinc	5.0 mg/L	May be extended up to 10.0 mg/L
22.	Anionic detergents	0.2 mg/L	May be relaxed up to 1 mg/L
23.	Chromium (VI)	0.05 mg/L	No relaxation
24.	Mineral oil	0.01 mg/L	May be relaxed up to 0.03 mg/L
25.	Residual free chlorine	0.2 mg/L	Applicable only when water is Chlorinated

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A. Dug well

The traditional and most common method of obtaining groundwater in rural areas of the developing world is by means of hand-dug wells. Keep in view of the prior knowledge in groundwater, a hole is dug until the groundwater level is reached. Inflowing groundwater is collected and extracted with the help of pumps or buckets [9]. Figure 4.1,4.2,4.3. heavy metal present in dug well water with standard values given suitable geological conditions, dug wells provide a low-tech solution to the challenges of rural water supply and can be implemented with a high level of community participation and locally available material and tools [13].

The samples from dug wells in around 20 villages were collected and tested for the level of contamination. The results show that the level of pH of the sample except few is near the minimum permissible level of 6.5. The average level of pH from the samples is about 6.75 which are very closer to the minimum level. With further deposition of heavy metals leads to water with decreased values making it acidic and hence it is not preferred for drinking and irrigation purposes. Essential metals such as zinc, magnesium and calcium have the permissible level of 200, 124 and 46 **(UNIT)** respectively. The average encompassment of these metals in the dug water sample is less when compared to the maximum permissible standard whereas the heavy metals such as cadmium, chromium, lead are present in excess amount when compared with the permissible standard (Table 2). Magnesium is the only metal present above the standard. An essential metal such as calcium is present nearer to the standard. But metals like, potassium, barium is present in deficient quantity.

Table 2: Physico Chemical parameters of dug well water

S.No	Physic – chemical examinations	BIS (IS 10500: 1991)	Unit	Sample s1	Sample s2	Sample s3	Sample s4	Sample s5
1	pH	6.5 - 8.5	-	1	7.5	7.4	6.2	6.8
2	EC	1500-3000	µmho/cm	2710	2800	1750	2430	2850
3	Turbidity	01-Oct	NTU	8.1	5	6	5	6
4	TDS	500 – 2000	mg/L	2350	1960	2270	1590	2300
5	Alkalinity	200 – 600	mg/L	368	432	648	627	365
6	Total Hardness	300 – 600	mg/L	480	480	548	255	485
7	BOD	250	mg/L	140	221	147	135	142
8	COD	250	mg/L	228	285	256	278	228
9	Calcium	75 – 200	mg/L	124	104	260	330	124
10	Magnesium	30 – 100	mg/L	46	152	189	179	46
11	Sodium	50-200	mg/L	116	92	72	68	110
12	Potassium	50-200	mg/L	23.5	15.9	32.3	22.7	23.5
13	Barium	50-200	mg/L	9.63	12.74	14.68	13.59	10.63
14	Iron	0.3-1.0	mg/L	0.22	0.54	0.45	0.67	0.22
15	Manganese	0.1- 0.5	mg/L	0.16	0.242	0.436	0.318	0.174
16	Free Ammonia	5	mg/L	0.254	0.52	0.642	0.745	0.24
17	Nitrite as NO_2	0.01	mg/L	0.357	0.423	0.25	0.16	0.354
18	Nitrate as NO_3	45	mg/L	24.7	49.2	31.7	26.2	24.7
19	Chloride	250 – 1000	mg/L	475	540	938	930	475
20	Fluoride	0.6 - 1.2	mg/L	0.4	0.68	0.79	0.56	0.45
22	Sulphate as SO_4	200 – 400	mg/L	240	220	320	395	225
23	Phosphate as PO_4	-	mg/L	0.137	0.96	0.145	0.322	0.137
24	Chromium	0.05	mg/L	0.985	1.32	1.587	0.995	0.985

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25	Lead	0.01	mg/L	0.02	0.025	0.013	0.015	0.01
26	Zinc	May-15	mg/L	4.77	8.28	8.96	11.18	4.773
27	Nickel	0.02	mg/L	6.16	12.57	24.35	11.22	7.14
28	Aluminium	0.03 - 0.2	mg/L	4.55	6.8	8.37	7.4	4.75
29	Cadmium	0.003	mg/L	0.001	0.002	0.002	0.001	0.001
30	Copper	0.05 - 1.5	mg/L	4.57	5.78	4.57	3.4	4.5

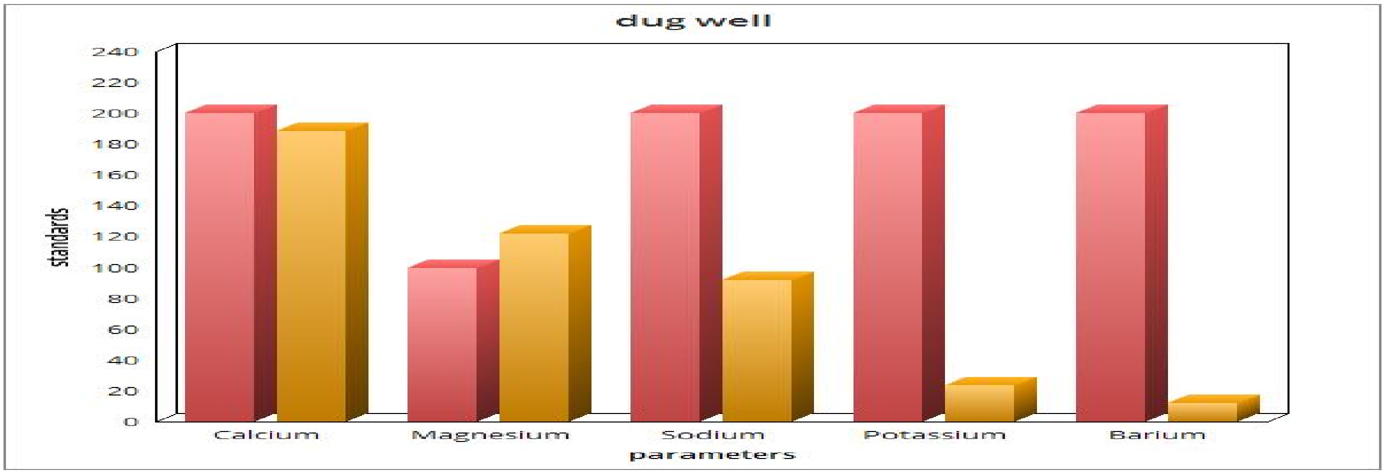

Figure 4.1. Ca, Mg, Na, K and Ba metals concentration with standards values(mg/L)

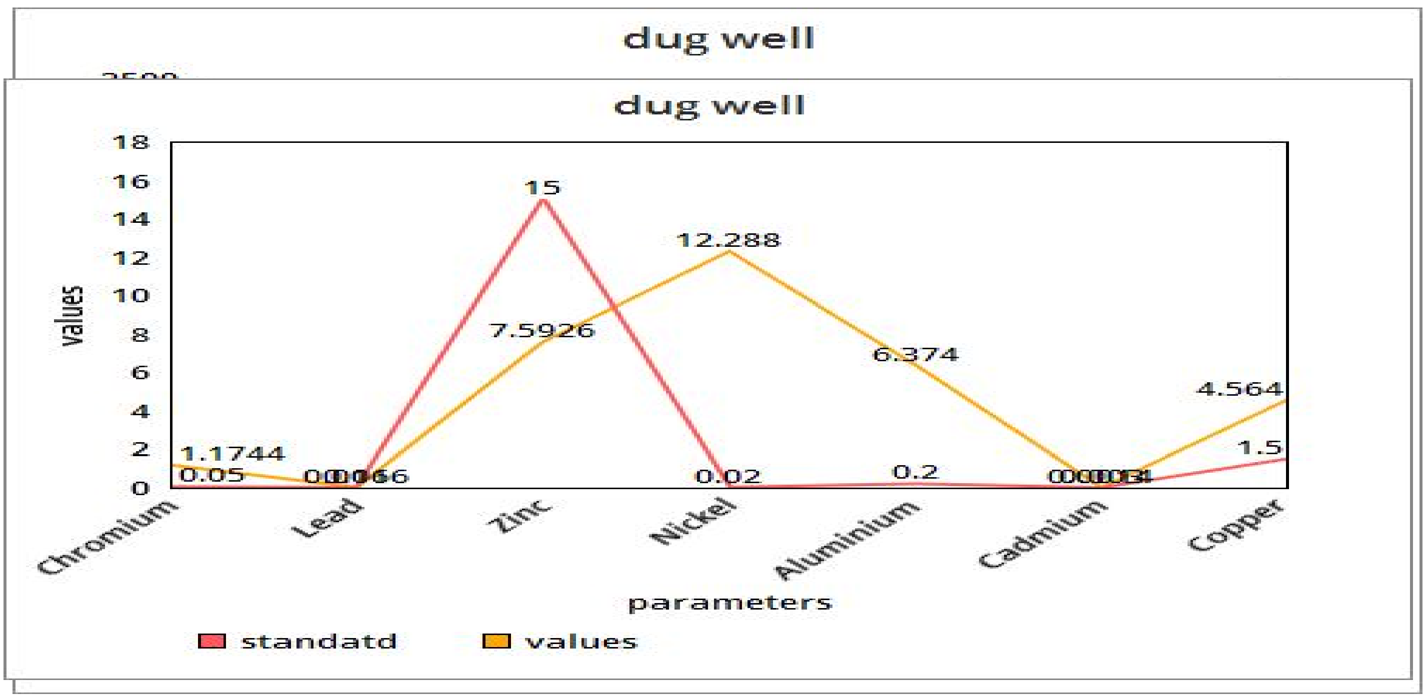

Figure 4.2: Physico Chemical parameters in Dug well water analysis result with standards values

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B. Bore well water

A bore well is cased in the region of loose subsoil **strata** open in hard rock or in crystalline rock. High grade PVC pipes are used for Casing in bore wells. The depth of a bore well can vary from 150 feet to 1500 feet [14]. The average value of chromium is about 1 mg/L but the permissible level is only 0.05. The amount of contamination was found to be 20%. Cadmium is present in an average of 0.0015 which is less than the permissible level and hence the cadmium contamination is less in bore well samples. The average value of zinc is also less than the permissible level. Zinc is an essential component for development of immune system. This is also essential for plant growth. [15]. Copper that has the average of 5.172 which is approximately 3 mg/L more than the permissible value. Lead which is another important heavy metal is present at an average of about0.0202 whereas the permissible limit is 0.01 mg/L. Therefore, the heavy metal contamination is comparatively higher than the dug well. **Figure 5.1,5.2,5.3.** calcium and magnesium were found to above the maximum level whereas the other elements such as sodium, potassium and barium are comparatively less than that of dug well.

Table 3- Bore well water samples analysis

S.No	Physico – chemical examinations	BIS (IS 10500: 1991)	Unit	Sample V1	Sample V2	Sample V3	Sample V4	Sample V5
1.	pH	6.5 - 8.5	-	6.8	7.3	7.8	7.5	8.0
2.	EC	1500-3000	µmho/cm	2850	2700	1924	2800	3000
3.	Turbidity	1 - 10	NTU	6.0	6.0	6.0	5.0	7.2
4.	TDS	500 - 2000	mg/L	2300	1910	2150	1960	1700
5.	Alkalinity	200 - 600	mg/L	365	432	612	432	435
6.	Total Hardness	300 - 600	mg/L	485	450	545	450	648
7.	BOD	250	mg/L	142	208	140	221	208
8.	COD	250	mg/L	228	285	256	285	254
9.	Calcium	75 - 200	mg/L	124	104	366	104	413
10.	Magnesium	30 - 100	mg/L	46	152	189	152	157
11.	Sodium	50-200	mg/L	110	80	74	92	45
12.	Potassium	50-200	mg/L	23.5	15.9	32.3	15.9	30.5
13.	Barium	50-200	mg/L	10.63	12.74	14.68	12.74	11.42
14.	Iron	0.3-1.0	mg/L	0.22	0.54	0.45	0.54	0.56
15.	Manganese	0.1-0.5	mg/L	0.174	0.235	0.436	0.235	0.287
16.	Free Ammonia	5.0	mg/L	0.240	0.432	0.642	0.532	0.540
17.	Nitrite as NO_2	0.01	mg/L	0.354	0.423	0.288	0.423	0.246
18.	Nitrate as NO_3	45	mg/L	24.7	49.2	31.7	49.2	57.5
19.	Chloride	250 - 1000	mg/L	475	540	938	540	843
20.	Fluoride	0.6 - 1.2	mg/L	0.45	0.78	0.51	0.68	0.62
22.	Sulphate as SO_4	200 - 400	mg/L	225	238	349	228	388
2	Phosphate as PO_4	-	mg/L	0.137	0.116	0.145	0.116	0.248

3.								
2	Chromium	0.05	mg/L	0.985	1.300	0.682	1.306	0.428
4.								
2	Lead	0.01	mg/L	0.01	0.025	0.010	0.022	0.022
5.								

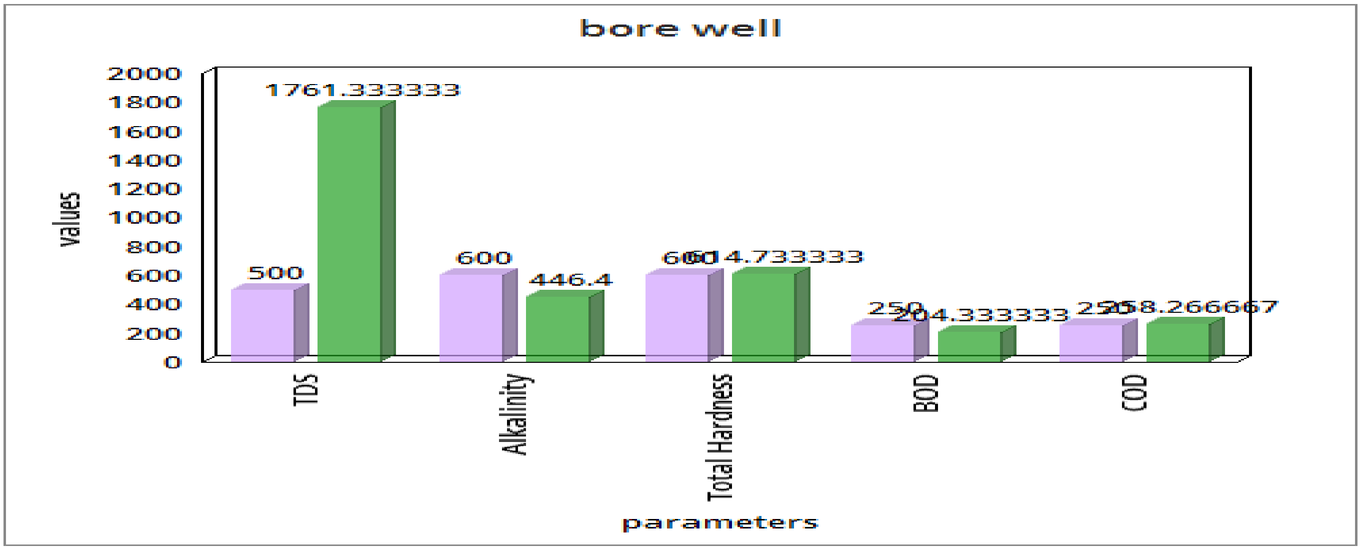

Figure 5.1. Physico Chemical parameters for bore well water

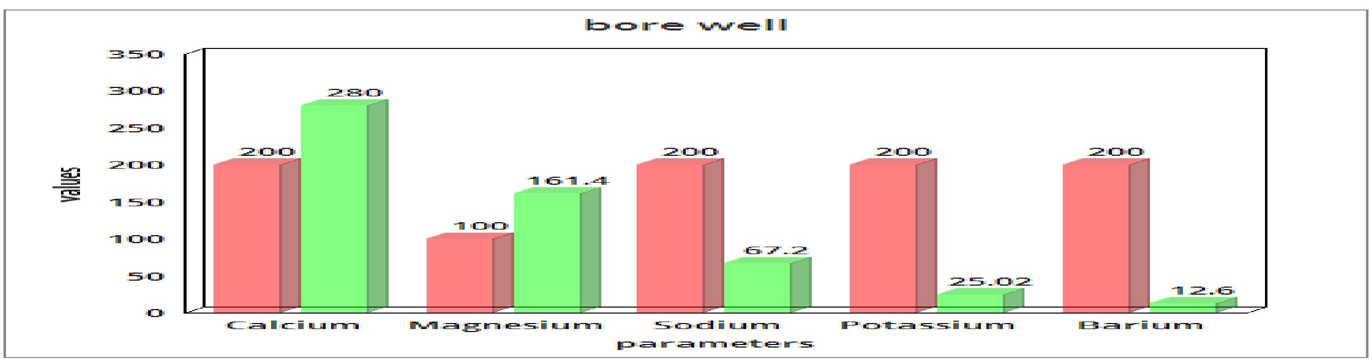

Figure 5.2. Ca, Mg, Na, K and Ba metals concentration with standards values(mg/L)

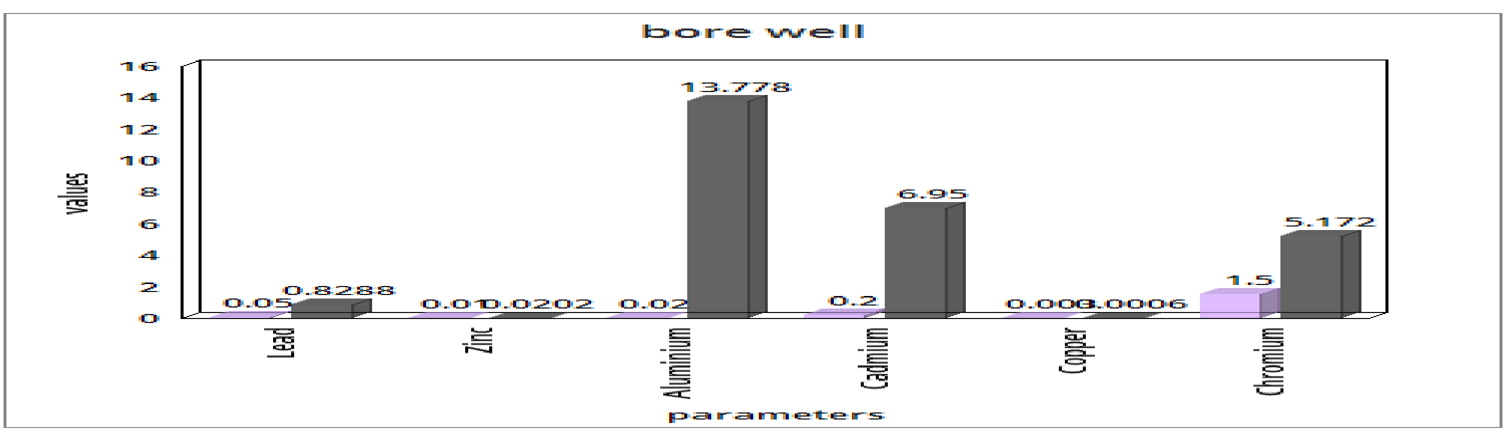

Figure 5.3. Heavy metal Concentration in Bore well water with standard values(mg/L)

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Table 4. Palar River water samples analysis

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Physico – chemical examinations	BIS (IS 10500: 1991)	Unit	Sample s6	Sample s7	Sample s8	Sample s9	Sample s10
pH	6.5 - 8.5	-	6.8	7.3	7.8	8.2	8
EC	1500-3000	µmho/cm	2850	2700	1924	3250	3000
Turbidity	01-Oct	NTU	6	6	6	7	7.2
TDS	500 - 2000	mg/L	2300	1910	2150	1710	1700
Alkalinity	200 - 600	mg/L	365	432	612	435	435
Total Hardness	300 - 600	mg/L	485	450	545	648	648
BOD	250	mg/L	142	208	140	237	208
COD	250	mg/L	228	285	256	295	254
Calcium	75 - 200	mg/L	124	104	366	413	413
Magnesium	30 - 100	mg/L	46	152	189	157	157
Sodium	50-200	mg/L	110	80	74	89	45
Potassium	50-200	mg/L	23.5	15.9	32.3	30.5	30.5
Barium	50-200	mg/L	10.63	12.74	14.68	11.42	11.42
Iron	0.3-1.0	mg/L	0.22	0.54	0.45	0.56	0.56
Manganese	0.1- 0.5	mg/L	0.174	0.235	0.436	0.287	0.287
Free Ammonia	5	mg/L	0.24	0.432	0.642	0.513	0.54
Nitrite as NO_2	0.01	mg/L	0.354	0.423	0.288	0.226	0.246
Nitrate as NO_3	45	mg/L	24.7	49.2	31.7	57.5	57.5
Chloride	250 - 1000	mg/L	475	540	938	843	843
Fluoride	0.6 - 1.2	mg/L	0.45	0.78	0.51	0.65	0.62
Sulphate as SO_4	200 - 400	mg/L	225	238	349	382	388
Phosphate as PO_4	-	mg/L	0.137	0.116	0.145	0.248	0.248
Chromium	0.05	mg/L	0.985	1.306	1.587	0.128	0.128
Lead	0.01	mg/L	0.02	0.025	0.013	0.022	0.022
Zinc	May-15	mg/L	4.773	8.204	7.145	10.132	12.152
Nickel	0.02	mg/L	7.14	12.57	24.35	9.7	9.7
Aluminium	0.03 - 0.2	mg/L	4.75	7.26	8.37	5.93	5.93
Cadmium	0.003	mg/L	0.001	0	0.001	0.001	0
Copper	0.05 - 1.5	mg/L	4.5	5.09	4.18	6.82	5.55

C. Palar river water

Palar River, which is the main source of drinking water for most of the areas in and around Vellore is also one of the major southern rivers of India. Most of the leather industries have been established on the banks of River releases effluent water in the river. The samples from the river water where the effluents from leather industries released are subjected to various tests. The results showed that heavy metals such as nickel aluminium copper and chromium have more sedimentations than the allowable limit. Intake of water with such heavy metal contamination can pose severe health hazards such as nausea, vomiting etc. The amount of essential metals such as calcium, chlorine, iron etc is moderately present but they do not meet the required standard. Usage of water for irrigation will lead to fewer nutrients to the plants because of high heavy metal contamination. Other physical parameters were also tested and results were tabulated (figure 6.1, 6.2, 6.3).

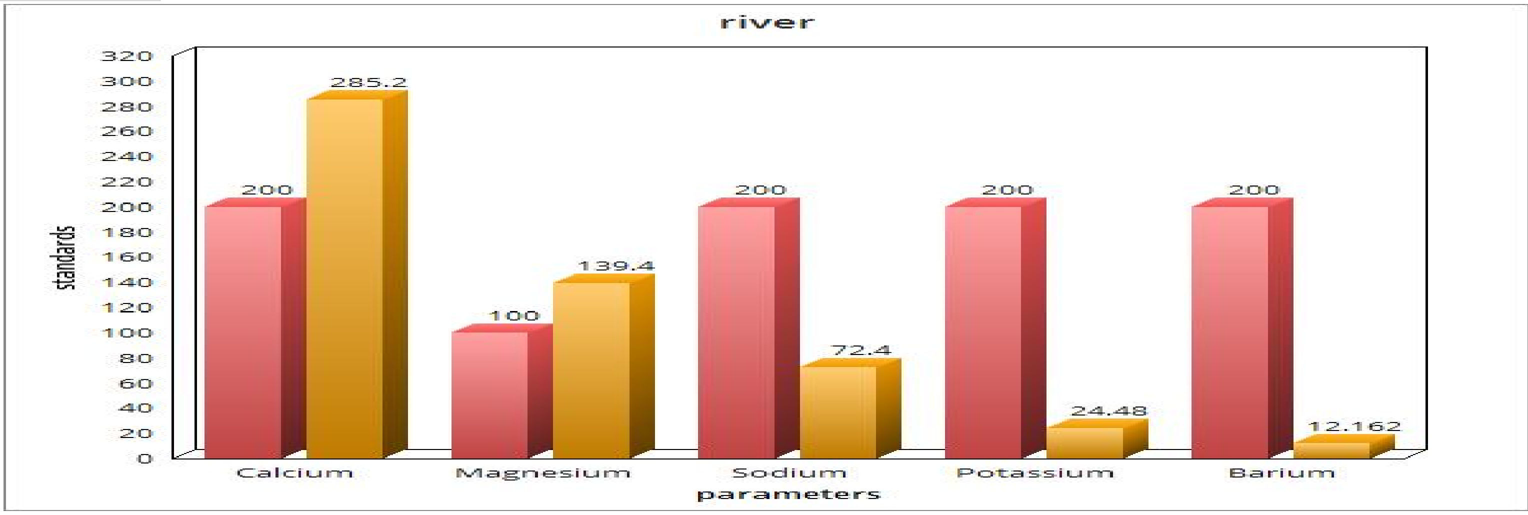

Figure 6.1: Ca, Mg, Na ,K and Ba present in Palar river water(mg/L) with standard values

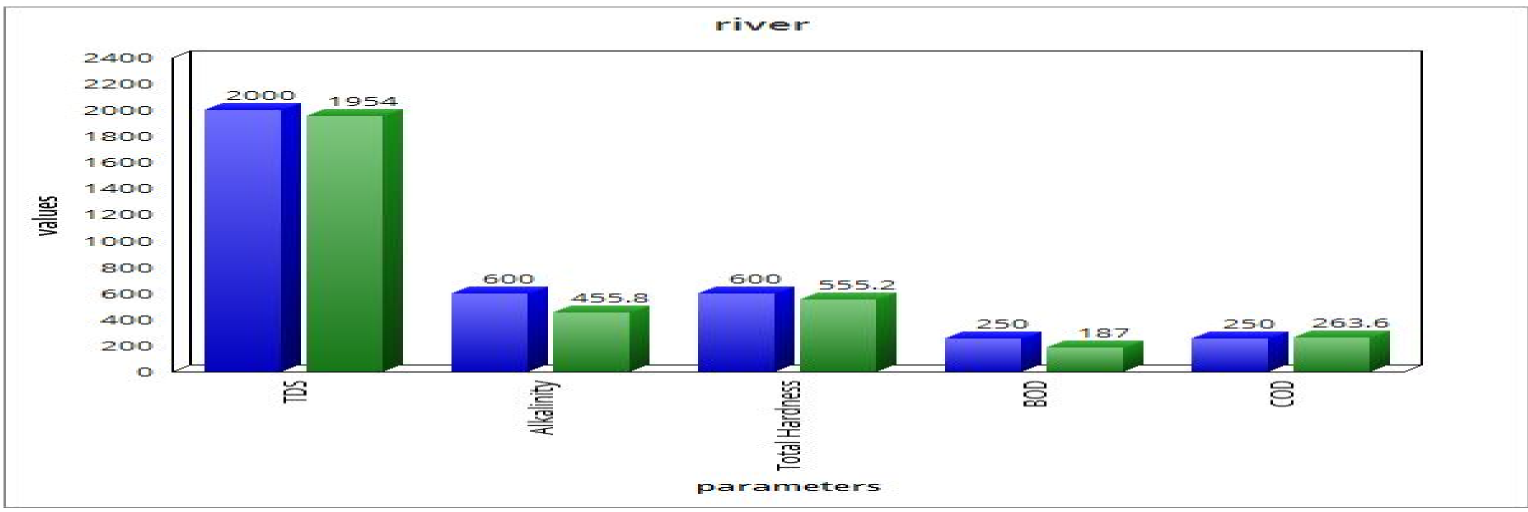

Figure 6.2. Physico- Chemical parameters of river water with standard values

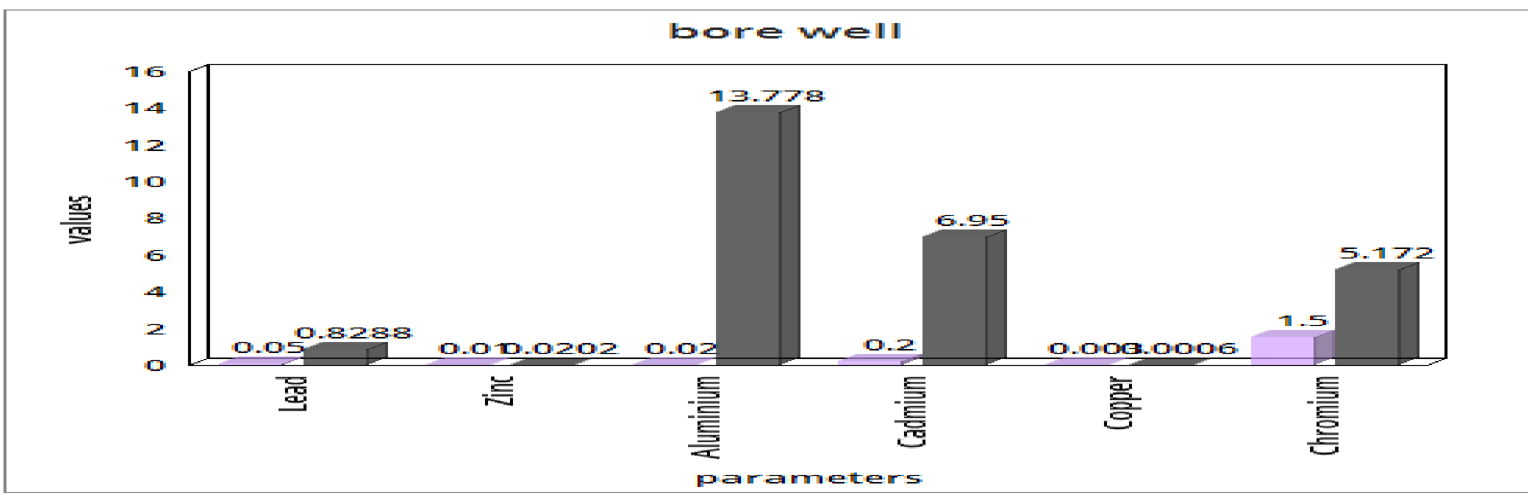

Figure 6.3. Heavy metal present Parar river water with standard values – metals(mg/L)

D. Health hazard:

Prolonged usage of heavy metal contaminated water will cause intense relapse to the human beings and the environment. The most continating heavy metal is chromium. This has been shown in high amounts in all the samples. [14, 15]. hromium is noticed at a very high level in all the three sources. Chromium VI is the most toxic form of chromium. It is absorbed by lungs at a very high rate and may affect the respiratory system at a drastic rate. Cr(VI) enters many types of cells and under physiological conditions can be reduced by hydrogen peroxide (H2O2), glutathione (GSH) reductase, ascorbic acid, and GSH to produce reactive intermediates, including Cr(V), Cr(IV), thiylradicals, hydroxyl radicals, and ultimately, Cr(III). Any of these species could attack DNA, proteins, and membrane lipids, thereby disrupting cellular integrity and functions.Cadmium is hazardous even at reduced levels. The ill effects of cadmium on the body are many and can impact nearly all systems in the body, including cardiovascular, reproductive, the kidneys, eyes, and even the brain. Cadmium affects blood pressure, prostrate function and causes drastic damage to the bone, renal and respiratory system. Children are highly prone to the ill effects of cadmium than the adults.Lead is an extremely useful metal but desperately has also proved to be a hazardous toxin, particularly for young children [23]. A small trace of lead, that would have little effect on an adult, can have a significant and remarkable effect on a child. Low levels of exposure to lead can lead to various impacts on the human health including damage to the peripheral nervous system, learning disabilities, shorter stature, impaired hearing, and impaired formation and function of blood cells.

IV. CONCLUSION

The review of the research shows that when compared with the three predominant sources of water for the locality around the tannery zone in ranipet, dug well water has less contamination when compared with the others. Essential metals such as zinc, iron etc, is present in reduced quantity. This in turn reduces the quality of the food crops and the vegetation in the zone. In all the three sources the most predominant pollutant is chromium. Glut amount of chromium in these water samples make it unfit for domestic usage and for irrigation. This study reveals that sewage and industrial effluents are the primary source of pollutions to the water containing variable amounts of metals leads to an increase in the concentration of metals in soil and the vegetable that are grown using polluted river water. There is an alarming need to check the contamination levels in the water samples and the water resources of the study area and to develop different strategies to prevent the accumulation of heavy metals in food crops that may ultimately minimize the chronic health risk to the exposed populations. The level of heavy metal should be monitored closely particularly chromium metal to reduce the contamination effects that will create the adverse effect for human and environment problems. This study reveals that sewage and industrial effluents are the primary source of pollutions to the water containing variable amounts of metals leads to an increase in the concentration of metals in soil and the vegetable that are grown using polluted river water.

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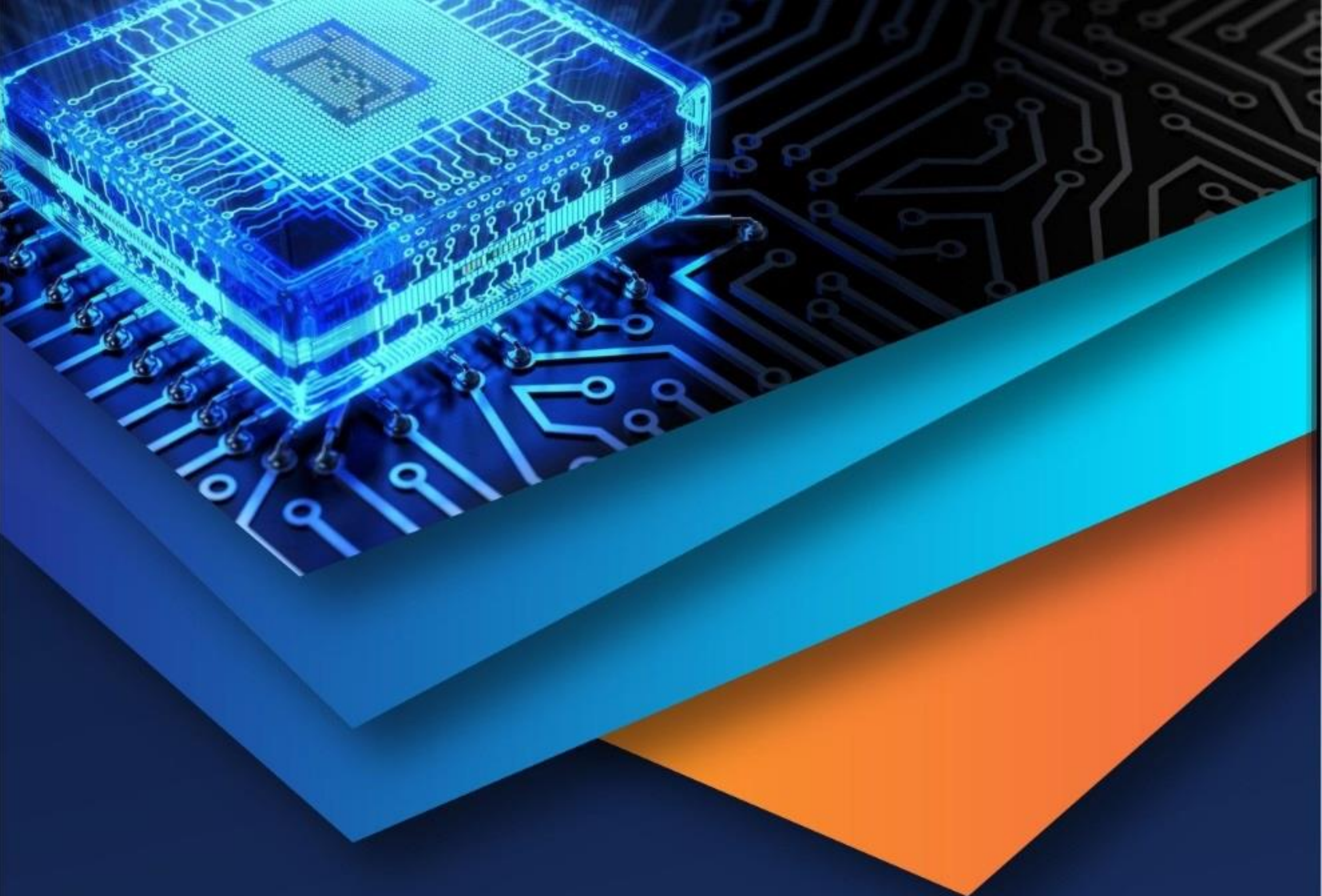

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