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PHYSICO-CHEMICAL AND TOXIC HEAVY METAL ANALYSIS OF GROUNDWATER AROUND LANCO AMARKANTAK POWER PLANT AREAS IN KORBA DISTRICT, CHHATTISGARH INDIA

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ABSTRACT

Recently on increasing the contamination of aquatic environment by domestic sewage and industrial effluents has focused attention on the behaviour and interaction of many rare and neglected elements in the biosphere. Bioaccumulation of heavy metals in living organisms occurs due to their property of persistence and non-degradability of the complex organic compounds. This paper studied the physico-chemical properties and toxic heavy metals in groundwater. The present study focuses on the characteristics of groundwater samples collected from around Lanco Amarkantak Power Plant Areas in the Korba District during the premonsoon, monsoon and postmonsoon seasons of 2023-24. A total of 16 groundwater samples were analyzed for important parameters of physico-chemical and toxic heavy metals. Comparing the findings against drinking water quality requirements set by Indian standards for maximum acceptable level of drinking water quality (BIS), ICMR, USEPA, and WHO; some samples were found not to be portable for human consumption.

Keywords: Groundwater, Contamination, Heavy Metal, Power Plant, Drinking Water

1. INTRODUCTION

Water is one of prime necessities of life. We can barely live without water for a few days. Drinking water are obtained from all short of sources, some good, some not well, some bad and some outright dangerous. These are reflected in health, vitality and longevity of people. Since one gulp water and it is taken straight into the body its cleanliness is vitally important. It should be free from pathogens, it should not contain excessive amount of salts and toxic elements. Scientifically distilled water is the cleanest, but it is not good drinking water. Water is the mostly used for industrial, municipal and agriculture purpose. The quantity and quality of the available water are very important for the purpose of industries. All industry have its Owen water requirements and sometimes adequate supply of water may be dangerous for other. It is therefore, extremely important to take into account to use of water to be carried out, its suitability based on the result of chemical analysis. The available natural fresh water resources today are threatened by hazard of pollution; particularly rivers are greatly polluted due to release of untreated effluents and waste material from agriculture practice and industries located around water bodies. Groundwater generally occurs in large quantities in river alluvial deposits, semi-consolidated sedimentary rocks like sand stones and cavernous lime stone. In igneous rocks, the water is held mainly in the zones of factures and cracks with many not be interconnected. A large quantity of groundwater occurs in geological formation called Aquifers.

Groundwater is a good source of fresh water available on the Earth. (Ghosh M.K. et al. 2013) Groundwater is used by about two billion people worldwide; making is the single most used natural resource. The estimated annual production of groundwater is between 600 and 700 cubic kilometres (billion cubic meters, or a billion tons). Groundwater is considered public property in many countries. Where it is the scare, groundwater could be considered on economic commodity, but in most cases no value is assigned to this. However, the costs of groundwater exploitation, supply and treatment need to be covered through water charges to maintain sustainable supplies. Groundwater is one of the major water resources for domestic, agricultural and industrial uses. Rapid growth of industrialization and human activities is added pollutants to the earth are affecting the human health.

Environmental Assessment in this context is concerned with groundwater concentration of cadmium, zinc, lead and arsenic, the levels of which are often increased by the effects of human activity. Heavy metals can be highly toxic and have function in the body. Through drinking, inhalation, ingestion and skin absorption, they are taken into the body (Gaur S. et al. 2012). Groundwater may also contain soluble natural substance like fluoride, nitrate, sulphate or phosphate, which restrict or even prevent its direct use because of health concerns.

Physico-chemical analysis forms the basis of interpretation of quality of water in relation to source lithology and climate. Assessment of groundwater chemical characteristics is to better predict its uses. (Ndoye S. et al. 2018) crucial Water is an excellent solvent. It has the power to dissolve the minerals constituting the rocks. The geochemistry through which groundwater circulates plays on important role in controlling the quality of groundwater. The present paper reports results of the analysis of groundwater samples in the year March 2019 – Feb. 2020 around villages Lanco Amarkantak power plant, Korba.

Study area:- Korba district is located latitude 22^{0}01’N to 23^{0}01’N and longitude 82^{0}08’E to 83^{0}09’E is closest by Korea, Janjgir-Champa, Surajpur, Sarguja, Raigarh and Bilaspur district. Korba district is a regulatory district of C.G., in India. The dist is arranged in northern stone of C.G., Korba is known for its coalmines and SECL, It additionally has power plant such as NTPC, CSPGCL-KE, CSPGCL-WE, BALCO and another private constrained power plant such as Lanco Amarkantak thermal power project and ACB India etc. Lanco Amarkantak Power Project is a coal based thermal power project at venture situated Pathadi village in Kartala Tehsil. The power plant owned and worked by Lanco Infratech. Its planned capacity is 1920 Mega Watt.

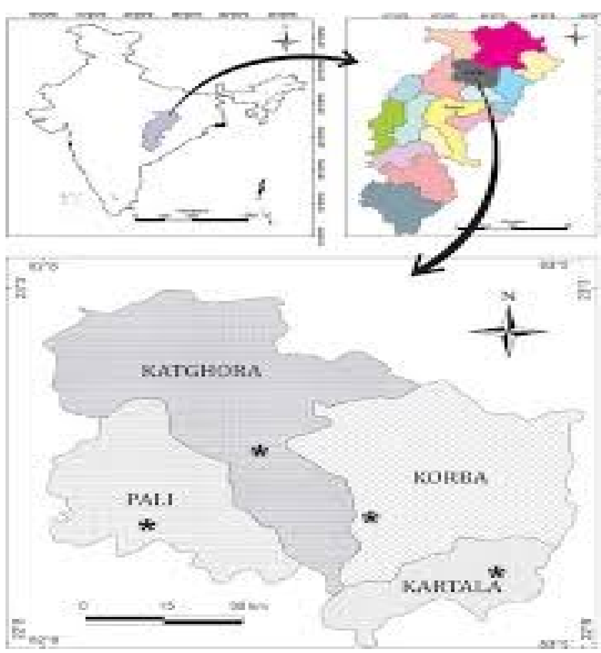

Fig1:-Korba District of chhattisagrh

Lanco power plant has been installed in the patadhi village of kartala tehsil, about 18 km from Korba city, on near of the Hasdev river. This power plant is set up on NH149 B route. There are about 118 villages in Kartala Tehsil, of which 20-22 villages are around Lanco project.

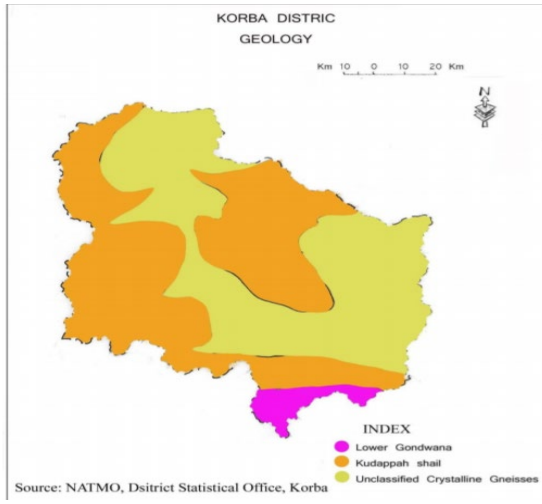

Fig 2 :- Geological structure of Korba District.

The geological formation of the Korba district is quite ancient and Complex. It covered by Unclassified Crystalline Gnessis, Gnessis Cuddapah and Lower Gondwana. The lower gondwana system is found in the northern portion and cuddapah system covered in the south-eastern part of Kartala Tehsil. The forest area of this tehsil is 35.15% and the average rainfall here is 1090.1 mm. Issue Humidity of this tehsil is the lowest 35% in April and the highest 85% in September, in this area sandly clay soil and red yellow soil are available. 100% population live in rural areas in Kartala tehsil and dependent on agriculture. The main sources of groundwater pollution are the unregulated disposal of agricultural and municipal waste and the use of chemical substances in agriculture (fertilizers, herbicides , and pesticides) (Yadav K.K. et al. 2019).

2. MATERIALS AND METHODS

Survey & Sample Collection:- Survey was conducted during month of March, April, May and June (pre-monsson), July, August, September and October (monsoon) and November, December, January and February (post-monsoon) of year 2023-24.

The 16 Groundwater samples were collected from the nearest site of power plant and incubated at 4^0C until used for analysis.

Fig 3:- Lnaco Amarkantak Power Plant & its around villages

Table- 01: Sampling sites and their sources

S.N.	Sample Code for Groundwater Samples	Name of Sampling Sites	Sources
1	Ws1	Patadhi	Handpump
2	Ws2	Saragbundia	Bore
3	Ws3	Barpali	Handpump
4	Ws4	Sandail	Well
5	Ws5	Tarda	Handpump
6	Ws6	Tilkeja	Bore
7	Ws7	Kudurmal	Handpump
8	Ws8	Bhada	Handpump
9	Ws9	Khoddal	Well
10	Ws10	Purania	Bore
11	Ws11	Pahanda	Handpump
12	Ws12	Bhaisamuda	Bore
13	Ws13	Akhrapali	Well
14	Ws14	Dhandhani	Handpump
15	Ws15	Katbitla	Bore
16	Ws16	Jhinka	Handpump

Physico-chemical analysis:- Water is like a medicine if it is uncontaminated and fresh, otherwise it may be dangerous to health. All the sample were analysed for the following physic-chemical parameters; Temperature, pH, EC, Turbidity, Total Solid (TS), Total Dissolved Solid (TDS), Total Suspended Solid (TSS), Total Hardness(TH), Total Alkalinity (TA), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^{+}), Potassium (K^{+}) Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), Chloride (Cl^{-}), Fluoride (F^{-}), Nitrate (NO^{3-}), Nitrite (NO^{2-}), Iron (Fe^{2+}/Fe^{3+}), Phosphate (PO_4^{3-}), Sulphate (SO_4^{2-}), Carbonate (CO_3^{2-}), and Bi-carbonate (HCO_3^{-}). The Physico-chemical analysis of groundwater sample were carried out in accordance to standard analytical method (APHA, 2005)

Toxic heavy metal analysis:- Heavy metals are usually present in trace amounts in naturally waters but many of them are toxic even at very low concentration. Although many of the metals are essential components of the biological system yet some of these are potentially toxic. Increasing quantity of heavy metals in aquatic resources is currently an area of greater concern especially since a large number of industries are discharging their metal containing effluents in to fresh water without any adequate treatment. All 16 sample stepwise analysed for the toxic heavy metal such as Arsenic (As), Cadmium (Cd), Lead (Pd), Zinc (Zn) and Chromium (Cr).

Most of the industries discharged their waste directly (without any treatment) into the stream, lakes and other water resources in the open land and that contaminate the groundwater. There are number of pollutants like fertilizers, pesticides, heavy metals, which seriously affect human like by entering into the system directly or indirectly through food material. Some parameter were determined immediately on sampling sites, for rest parameters and heavy metals; samples were stored in refrigerator at 4^{0}C. Heavy metal may be analyzed in the 6 months period from the preservation date. Groundwater samples were analyzed by standard methods (APHA 2005).

Table- 02: Chemical Parameters and their Methods used (APHA2005)

Parameters	Methods
Temperature	Thermometric Method
pH	pH Meter
EC	Conductivity Meter

Turbidity	Nephelometer
TS	Gravimetric Method
TDS	HM Digital meter TDS-3
TSS	TS-TDS
TA	Titration Method
TH	Titration Method
Ca^{2+}	Elico flame photometer
Mg^{2+}	Elico flame photometer
COD	Spectroquanta Merck COD Meter
BOD	BOD Merck BOD Meter
DO	Chemiline DO Meter
NO_3^-	UV Spectrophotometer
NO_2^-	UV Spectrophotometer
Cl^-	Titration against $AgNO_3$ Solution
F^-	Ion selective Electrode
Iron	ICP-AES
PO_4^{3-}	Colorimetric Test
SO_4^{2-}	Turbidimetric Method
CO_3^{2-}	Titration Method
HCO_3^-	Titration Method
Na^+	Elico flame photometer
K^+	Elico flame photometer
As	ICP-AES
Cd	ICP-AES
Pd	ICP-AES
Zn	ICP-AES

Result and Discussions:- The physicochemical characteristics and the heavy metal contamination in the collected samples depend primarily upon the waste water composition and water content of the solid waste (Kanmani S. and Gandhimathi R. 2013). Different workers from India and abroad have been discussed various aspects of water pollution in term of characteristics of water bodies time to time. This paper include some of important contribution made in the field of industrial pollution, with references to physical, chemical and biological parameters of groundwater. The present investigation of Groundwater resources, physicochemical characteristics of water directly reflects its quality for irrigation, bathing, drinking and industrial uses.

The hydrochemical evaluation is very critical for assessing the Performance of groundwater in any area where groundwater is used Irrigation and irrigation are both important. The distribution of groundwater is not uniform in a region due to the unequal utilization and exploitation rate of groundwater. In certain areas there are quite a hand pumps, bore and well. Water consumption from groundwater is negligible in some areas due to the less exploitation of groundwater resources. So, for proper monitoring of water quality random sampling is the best option for analysing the Physico-chemical parameters of water. Heavy metals And some other physic-chemical parameters of polluted water may cause many effects on environment. USEPA, BIS, ICMR and WHO declared their standards for water quality.

Table-03: Physico-chemical Parameters and their Standard limit for Drinking by following Agencies

Parameters	USEPA	BIS	ICMR	WHO
pH	6.5 -8.5	6.5-8.5	8.5	6.5-8.5
EC	-	1500	300	1500
Turbidity	5	10-25	5-25	5-25
TDS	500	500-2000	500-2000	1000
Total Alkalinity	200	75-200	75-200	75-200
Total Hardness	300	300-600	300-600	300-600
Ca^{2+}	200	75-200	75-200	75-200
Mg^{2+}	150	30-100	50-150	50-150
COD	-	-	20	-
BOD	5.0	5.0	5.0	5.0
DO	-	-	5.0	-
NO_3^-	45	45	45	45-100
Cl^-	250	250-1000	1000	250
F^-	4.0	1.0-1.5	1.5-2.0	1.5
Iron	0.3	0.3	1.0	0.1
PO_4^{3-}	-	-	-	0.3
SO_4^{2-}	500	150-400	200-400	400
Na^+	-	-	-	200
As	0.05	0.05	0.05	0.001
Cd	0.01	0.01	0.01	0.005
Pd	0.05	0.10	0.05-0.10	0.05-0.10
Zn	5.0	5.0-15	0.10	5.0
Cr	0.1	0.05	0.5	0.5

Different guideline and standards limits should be immediately applied in small scale industries for utilization of groundwater and open discharging the effluents into groundwater or land. Metals that are naturally introduced into the waterbody come primarily from such sources as rock weathering, soil erosion, or the dissolution of water- soluble salts. Naturally occurring metals move through aquatic environment independently of human activities, usually without any detrimental effects. Water used for drinking contains small amounts of heavy or trace metals that help in normal working of the human body but, in excess, can be injurious to human health (Vetrimurugan et al. 2017). Physico-chemical characteristics of water directly reflect its quality for irrigation, bathing, drinking and industrial uses. Physico-chemical parameters like total dissolved solids, pH, chloride, total alkalinity, biochemical oxygen demand, chemical oxygen demand are some important parameter for assessing the quality of water for drinking and irrigation purposes. Temperature mostly fluctuated according to climate conditions of the region and directly depends upon seasonal air temperature. Conductance is a measurement of an electrical current with increasing amount and mobility of ions. These ions which come from the breakdown of compounds, conduct electricity because they are negatively or positively charged when dissolved in water. It is not necessary that the water having high electric conductivity is not fit for irrigation. Water alkalinity is caused by strong bases and the salts of strong alkalis and weak acids. Carbonates are added to a water system if the water passes through soil and rock that contain carbonate minerals.

Table-04:- Seasonal (premonsoon) Variations of the Physico-chemical Parameters Groundwater Samples during the study period

Parameters	Total variable Sixteen sample sites
Temp.	20.37
pH	8.23
EC	467.06
Turbidity	6.38
TS	835.87
TDS	810.75
TSS	25.12
Total Alkalinity	244.87
Total Hardness	383.31
Ca^{2+}	80.96
Mg^{2+}	28.25
COD	19.50
BOD	6.26
DO	5.63
NO^{3-}	30.13
NO^{2-}	0.048
Cl^{-}	202.37
F^{-}	1.94
Fe^{2+}/Fe^{3+}	0.31
PO_4^{3-}	0.24
SO_4^{2-}	78.73
CO_3^{2-}	244.87
HCO_3^{-}	33.25
Na^{+}	18.19
K^{+}	20.25
As	0.029
Cd	0.0038
Pb	0.0175
Zn	1.475
Cr	0.0020

Table-05:- Seasonal (monsoon) Variations of the Physico-chemical Parameters Groundwater Samples during the study period

Parameters	Total variable Sixteen sample site
Temp.	18.50
pH	7.41
EC	475.81
Turbidity	7.84
TS	644.12
TDS	614.56
TSS	28.93
Total Alkalinity	213
Total Hardness	354.50
Ca^{2+}	57.30
Mg^{2+}	21.61
COD	9.68
BOD	5.67
DO	6.36
NO^{3-}	21.74
NO^{2-}	0.028
Cl^{-}	186.06
F^{-}	1.41
Fe^{2+}/Fe^{3+}	0.21
PO_4^{3-}	0.19
SO_4^{2-}	64.30
CO_3^{2-}	213
HCO_3^{-}	30.12
Na^{+}	15.11
K^{+}	1.43
As	0.023
Cd	0.0027
Pb	0.0136
Zn	1.162
Cr	0.0012

Table-06:- Seasonal (postmonsoon) Variations of the Physico-chemical Parameters Groundwater Samples during the study period

Parameters	Total variable Sixteen sample site
Temp.	12.75
pH	7.47

EC	481.68
Turbidity	6.70
TS	701.87
TDS	676.87
TSS	25
Total Alkalinity	228.06
Total Hardness	362
Ca^{2+}	70.52
Mg^{2+}	21.99
COD	13.81
BOD	7.09
DO	5.79
NO^{3-}	25.02
NO^{2-}	0.034
Cl^{-}	187.56
F^{-}	1.48
Fe^{2+}/Fe^{3+}	0.25
PO_4^{3-}	0.19
SO_4^{2-}	70.35
CO_3^{2-}	228.06
HCO_3^{-}	30.87
Na^{+}	16.25
K^{+}	1.72
As	0.024
Cd	0.0031
Pb	0.0155
Zn	1.376
Cr	0.0015

When hardness equals alkalinity, the only cations present in significant concentrations in the water are calcium and magnesium. When hardness is greater than alkalinity, the water may contain considerable amounts of other cations. Sodium salts in the water are much more objectionable than salts of calcium and magnesium because of the tendency of sodium to cause deflocculation of the colloidal fract6ion of the developed an undesirable structure water contain sufficient heavy metals to prove to toxic to continue use by plant. Chemical oxygen demand is directly proportional to biochemical oxygen demand. Dilution of effluents for biochemical oxygen demand analysis always depends upon the value of chemical oxygen demand in a waste groundwater. Chloride does not have a health based standard for drinking water. In the waste water the concentration of chloride will be high due to the use of sodium chloride in industrial area. Chloride concentration in irrigation water should be less 75 ppm, otherwise it may be harmful for soil structure. The ratio of total dissolved solids and total suspended solids with total solids was found quite similar during the study. All kinds of water including groundwater have appreciable quantities of iron. Iron has solubility at acidic pH, therefore large quantities of iron are leached out from the solid by acidic waters. In the alkaline medium iron remain comparatively low in soluble phase. Excess calcium can reduced the activity of iron in groundwater and soil. Fluoride is found practically in all sources of water but typically does not exceed 10 ppm. Sulfate is one of the most important dissolved rain ingredients. When combined with calcium and magnesium, the two most common constituents of hardness, high concentrations of sulfate in the water we drink may have a laxative effect. Hydrogen sulfide gas (H_2S) is produced by bacteria which attack and reduce sulfates. The concentration of nitrate in surface water and groundwater is usually low, but may be high due to farm runoff, refuse dump runoff or contamination of human or animal waste. The concentration also fluctuates with the season and can rise when nitrate-rich aquifers feed the river. A number of review papers have recorded human and animal exposure to arsenic . Arsenic is a potent cancer that may contribute to cancers of the skin, prostate, liver and lung. Naturally, cadmium occurs in zinc, lead and copper ores, coal and other fossil fuels, shales, and is emitted through volcanic activity. These deposits may serve as sources for groundwater and surface waters, especially when in contact with low total dissolved solids (TDS) and acidic water. Cadmium has the chronic ability to inflict harm to the lungs , liver, bone and blood from long-term exposure to amounts above the permissible amount of toxins (MCL). There is no research to say whether or not cadmium in drinking water has the ability to cause cancer from lifetime exposures. Lead appears to be volatile and precipitated by a vast number of substances. Studies suggest that virtually all the lead in the drinking water of consumers does not come from the main source of water or the wastewater treatment system, but from contamination that occurs after the water exits the treatment facility. If consumed as drinking water, hexavalent chromium (Cr-VI) is likely to be, at a certain stage, a carcinogen, but tests are still being performed to determine which amount is dangerous and if it induces cancer. Chromium-6 is better minimized by a reverse osmosis method. It's also recognized how efficient methods of distillation and anion exchange are effective.

Temperature:-The temperature of the water is Important factor in the aquatic environment as it regulates almost all physical , chemical and biological reactions (Dra A. et al. 2019).Temperature mostly fluctuates according to climatic condition of the region and directly depends upon seasonal air temperature. However, groundwater temperature remains comparatively lower due to the geothermal energy. Temperature of groundwater sample was recorded maximum 23^0C in Pre-monsoon and minimum 11^0C in Post monsoon**.**

pH:-In our study the hydrogen ion concentration which measures acid-base equilibrium in terms of pH units (Vaishnav M.M. and Dewangan S. 2011), the pH of groundwater was recorded mostly alkaline. pH of groundwater sample recorded maximum 9.4 in primonsoon and minimum 6.8 in monsoon & postmonsoon.

EC:-Pure water is just a good insulator not a good conductor of electric current. Increasing concentration of ions increases the electrical conductivity of water (Mohsin M. et al. 2013).EC is a measurement of an electrical current with increasing amount and mobility of ions. Maximum electric conductivity in groundwater was recorded 852μScm^{-1} in primonsoon and minimum 302μScm^{-1} in monsoon.

Turbidity:-Highly turbid waters cause free residual chlorine to decrease and create a high demand for chlorination for their treatment and pollution prevention (Malek A. et al. 2019). The measurement of turbidity is based on comparison of the intensity of light scattered by a sample to the light scattered by a reference suspension under the same condition. Maximum turbidity in groundwater was recorded 11.3 NTU in monsoon and minimum 4.3 NTU in postmonsoon.

Total Solid (TS):-Total solids include both organic and inorganic materials, which adversely affects the aquatic life. Total solid in groundwater samples was recorded maximum1117 mgL^{-1} in premonsoon and minimum 436 mgL^{-1} in monsoon season.

Total Dissolved Solid (TDS):- Total dissolved solids are the measure of the quantity of material dissolved in water that can pass through a filter (usually with a pore size of 0.45 micrometers). Total dissolved solid in groundwater samples was recorded maximum 1106 mgL^{-1} in premonsoon and minimum 420 mgL^{-1} in monsoon season. The TDS concentration was seen as over as far as possible might be because of the filtering of different pollutant into the ground water which can diminish the portability and may cause gastro-intestinal disturbance in human and may likewise have diuretic impact especially upon travels.

Total Suspended Solid (TSS):-Total suspended solid is calculation by TS-TDS, high total suspended solids in water body can often mean higher concentration of bacteria, nutrients, metals and pesticides in the water. Total suspended solid in groundwater samples was recorded maximum 46 mgL^{-1} in monsoon and minimum 11 mgL^{-1} in premonsoon season.

Total Alkalinity:-Alkalinity is caused by strong base and the salt of strong alkalis and weak acid. Total alkalinity in groundwater samples was recorded maximum 405 mgL^{-1} in premonsoon and minimum 130 mgL^{-1} in monsoon season.

Total Hardness:-Hardness generally represents the concentration of calcium and magnesium ions, because these are the most common polyvalent cations. Total hardness in groundwater samples was recorded maximum 564 mgL^{-1} in premonsoon and minimum 306 mgL^{-1} in monsoon season. This is further compared to the 300 mg L^{-1} standard value. Water hardness is typically due to multivalent metal ions that come from dissolved minerals in the water. However (Bundelaa P.S. et al. 2012) an inverse association between water hardness and cardiovascular disease has been identified.

Calcium and Magnesium:- Calcium and magnesium are found in groundwater that has interacted with specific rocks and minerals, particularly limestone and gypsum. At the point when these materials are broken up, they discharge calcium and magnesium. Calcium and magnesium in groundwater samples was recorded maximum 121.33 mgL^{-1} and 38.13 mgL^{-1} in premonsoon respectively and minimum 49.79 mgL^{-1} and 13.21 mgL^{-1} in monsoon season respectively.

Chemical Oxygen Demand:-Chemical oxygen demand explains the load of pollutants and degree of pollution in effluent. Chemical oxygen demand in groundwater samples was recorded maximum 26 mgL^{-1} in premonsoon and minimum 06 mgL^{-1} in monsoon season.

Biochemical Oxygen Demand:-Biochemical oxygen demand and Chemical oxygen demand are the measurement of the oxygen consuming capabilities of organic matter. Biochemical oxygen demand indicates the presence of decomposing organic matter and the subsequent high counts of bacteria which degrade its quality and potential uses. Biochemical oxygen demand in groundwater samples was recorded maximum 9.63 mgL^{-1} in postmonsoon and minimum 3.56 mgL^{-1} in monsoon season.

Dissolved Oxygen:-The dissolved oxygen is often attributed to the fact the oxygen is dissolved more during the period of active photosynthesis. Dissolved oxygen demand in groundwater samples was recorded maximum 9.24 mgL^{-1} in premonsoon and minimum 3.43 mgL^{-1} in premonsoon season.

Nitrate and Nitrite:-The main source of nitrate and nitrite pollution in water is in this way manure, creature waste, and septic tank wastes. The water supplies generally helpless against nitrate contamination are in agriculture regions and in well waters having a close or hydraulic relationship to septic tanks. Nitrate in drinking water may be responsible for a temporary blood problem in infants called methemoglobinemia..Nitrate and Nitrite in groundwater samples was recorded maximum 42.46 mgL^{-1} and 0.084 mgL^{-1} in premonsoon respectively and minimum 07.32 mgL^{-1} and 00 mgL^{-1} in monsoon & postmonsoon season respectively.

Chloride:-Chloride is one of the most conservative constitute in wastewater, being affected very little either by vegetative growth or other biological processes, or by precipitation or anion exchange reaction. Agricultural fertilizers, industrial and domestic sewage alongside chloride-rich rocks are the main sources of chloride in water (Sirajudden J. and Jameel A.A. 2006).Chloride in groundwater samples was recorded maximum 218 mgL^{-1} in premonsoon and minimum 185 mgL^{-1} in postmonsoon season.

Fluoride:-Fluoride has long been shown to have a beneficial effects on dental health, although when present in drinking water at concentrations well above the WHO guideline value (and national drinking water limit for most countries) of 1.5 mg/L, long term usage can contribute to the production of dental fluorosis or at its worst, to debilitating skeletal fluorosis. Fluoride in groundwater samples was recorded maximum 2.35 mgL^{-1} in premonsoon and minimum 0.68 mgL^{-1} in monsoon season.

Iron:- Iron is most abundant element of the rocks and soil, all kinds of waters including groundwater have appreciable quantities of iron.Iron shortage causes disease called anemia and prolonged drinking water intake with high iron content that result in liver disease called haermosiderosis. Iron in groundwater samples was recorded maximum 0.45 mgL^{-1} in premonsoon and minimum 0.0 mgL^{-1} in monsoon season.

Phosphate:-Phosphorus can be present as the orthophosphate ion (PO_4^{3-}) in water, and is also present as an essential component of cellular material in all life forms. Phosphorus is derived from rock erosion in natural ecosystems, and is preserved for plant growth. Phosphate in groundwater samples was recorded maximum 0.5 mgL^{-1} in premonsoon& monsoon and minimum 0.0 mgL^{-1} in monsoon & post monsoon season.

Sulphate:- Mineral dissolution, atmospheric deposition and other anthropogenic sources (mining, fertilizer, etc.) are sources of sulphate in groundwater. Gypsum is a major contributor to the high sulphate levels in many aquifers and groundwater sources. Sulphate in groundwater samples was recorded maximum 128.04 mgL^{-1} in premonsoon and minimum 48.73 mgL^{-1} in monsoon season.

Carbonate and Bicarbonate:-The process of raising the concentrations of carbonate and bicarbonate ions in water to produce carbonated water and other carbonated beverages – either by the addition of carbon dioxide gas under pressure, or by dissolving carbonate and bicarbonate salts.Carbonate and bicarbonate in groundwater samples was recorded maximum 378 mgL^{-1} and 56 mgL^{-1} in premonsoon and postmonsoon respectively and minimum 118 mgL^{-1} and 12 mgL^{-1} in monsoon monsoon season respectively.

Sodium:-Sodium salts in the water are much more objectionable than salts of calcium and magnesium because of the tendency of sodium to cause deflocculation of the colloidal fraction of the soil and developed an undesirable structure water contain sufficient metals to prove toxic to continue by plant. Sulphate in groundwater samples was recorded maximum 28.13 mgL^{-1} in premonsoon and minimum 09.84 mgL^{-1} in monsoon season.

Potassium:-Potassium is one of the most important element among ten chemical element required in rather large quantities fir growth all of crops. Sulphate in groundwater samples was recorded maximum 3.79 mgL^{-1} in premonsoon and minimum 0.72 mgL^{-1} in monsoon season.

Arsenic:-. A 2007 study found that more than 137 million people are likely affected by arsenic contamination in drinking water in more than 70 countries. (*USAToday.com*, 30 August 2007). Arsenic in groundwater samples was recorded maximum 0.053 mgL^{-1} in premonsoon & monsoon and minimum 0.0 mgL^{-1} in all seasons (Ws_{12}).

Cadmium:- Cadmium is used for dye and paint pigment production, batteries, ceramic industries, wooden industries and plastic production. The Cd found in a sample of calcium is likely in a inorganic from and may be relatively less toxic to plants and animals. Cadmium in groundwater samples was recorded maximum 0.0084 mgL^{-1} in premonsoon and minimum 00.00 mgL^{-1} in all seasons (Ws_5).

Lead:- It is a dance soft metal and is quite resistant to corrosion. Lead is used in industries, beverages, ointments and synthetic dyes. The chemical from of lead determines its suitability in water and biological fluids. Cadmium in groundwater samples was recorded maximum 0.032 mgL^{-1} in premonsoon and minimum 00.00 mgL^{-1} in all seasons (Ws_6).

Zinc:-Zinc is very essential micronutrient in human beings and only at very high concentration it may cause some toxic effects. Zinc salt produce an undesirable taste to the water and causes water to appear milky and on boiling. Zinc in groundwater samples was recorded maximum 3.524 mgL^{-1} in premonsoon and minimum 00.00 mgL^{-1} in monsoon season.

Chromium:-Cadmium (Cd) has long been used in industrial use. Over the middle of the last century, its significant toxicity shifted to scientific attention. Aside from water, the most important sources of Cd are food and cigarette smoking (Vaishaly A.G. et al. 2015).Hexavalent chromium (Cr(VI)) is a contaminant from groundwater which is potentially hazardous to human health. The data indicate that Cr(VI) is the predominant dissolved Cr component, and that aquifer groundwater in the Piedmont region contains substantially higher concentrations than coastal plain groundwater. Chromium in groundwater samples was recorded maximum 0.0090 mgL^{-1} in premonsoon and minimum 00.00 mgL^{-1} in all seasons (Ws_9).

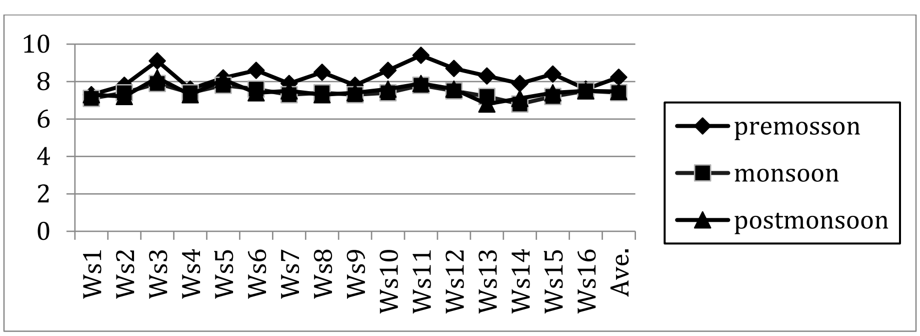

Fig4:-pH

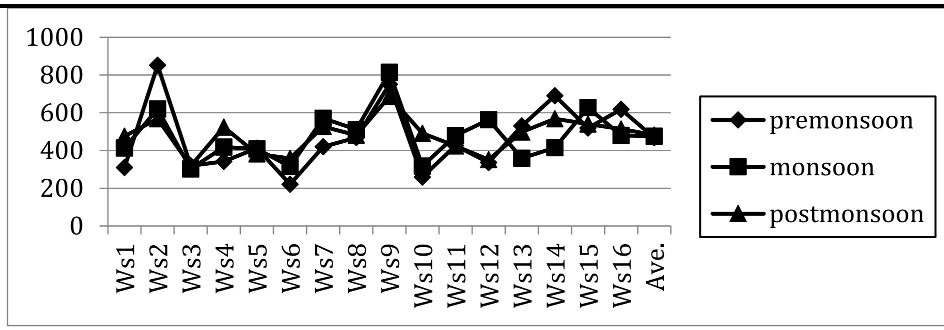

Fig5 :-EC

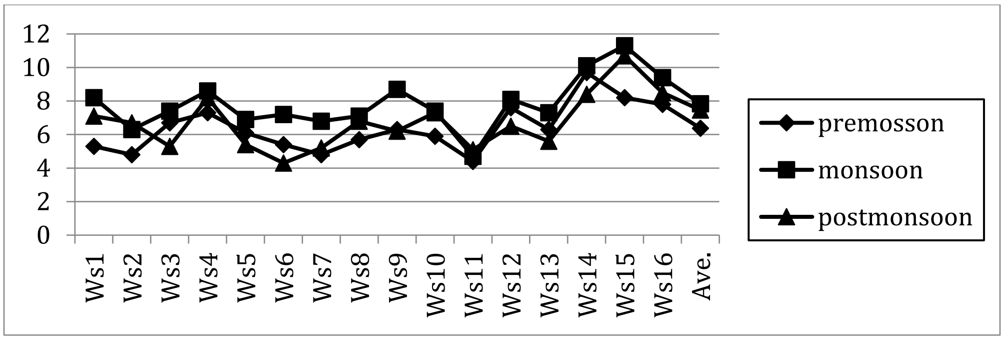

Fig 6 :-Turbidity

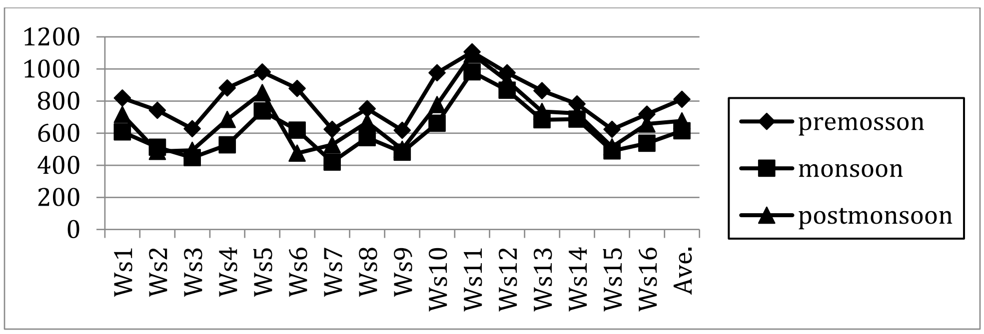

Fig7 :-TDS

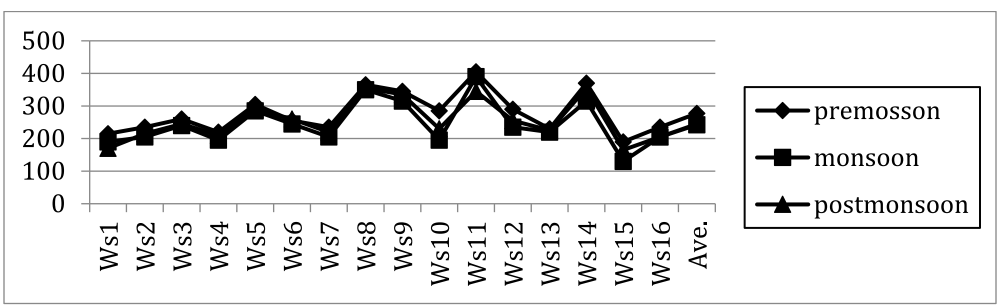

Fig 8:-TA

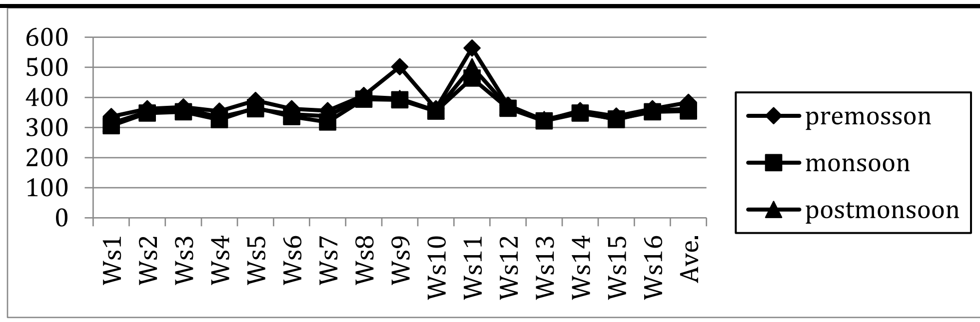

Fig 9:-TH

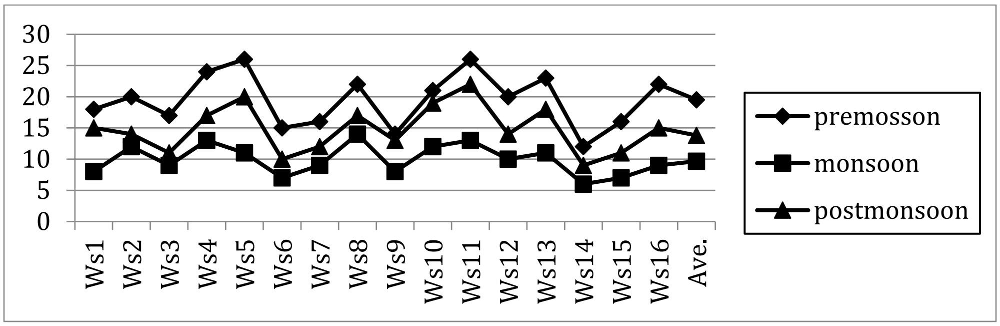

Fig 10:-COD

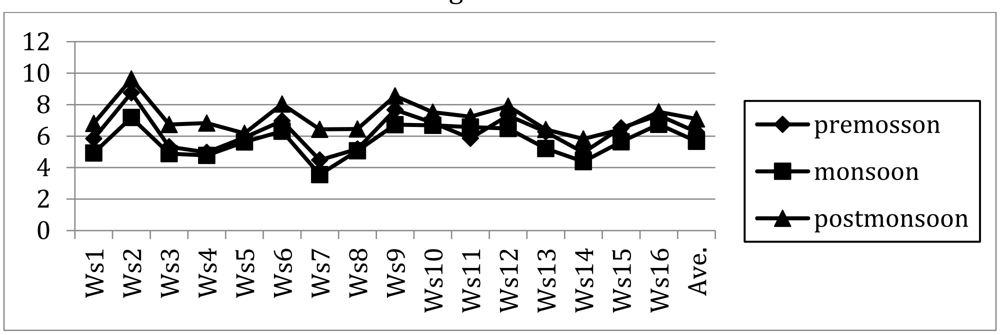

Fig 11:-BOD

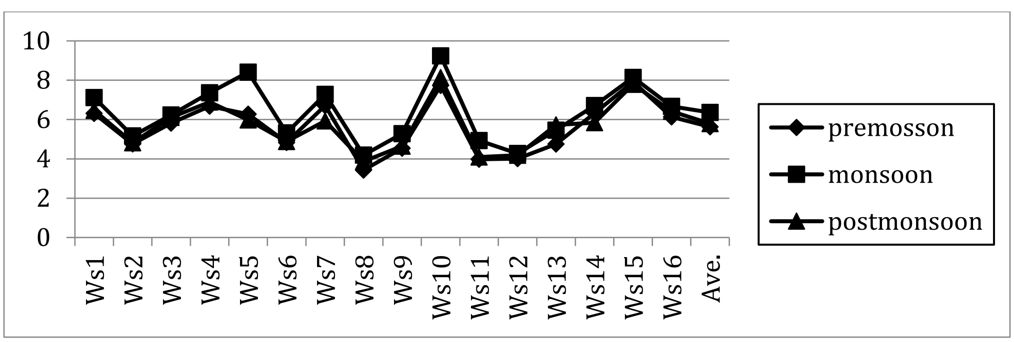

Fig 12:-DO

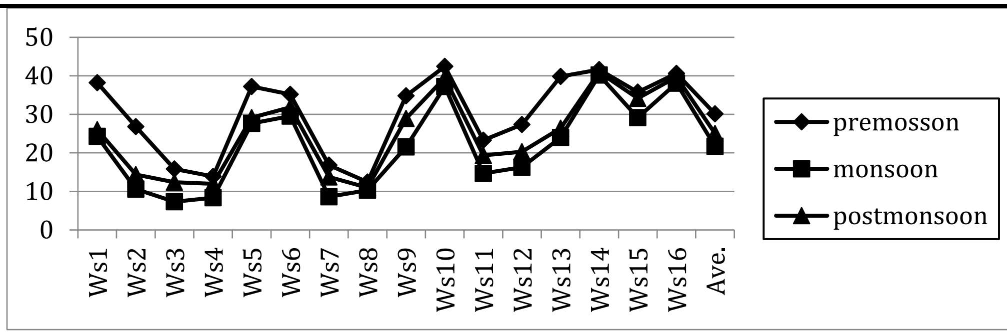

Fig 13:-Nitrate

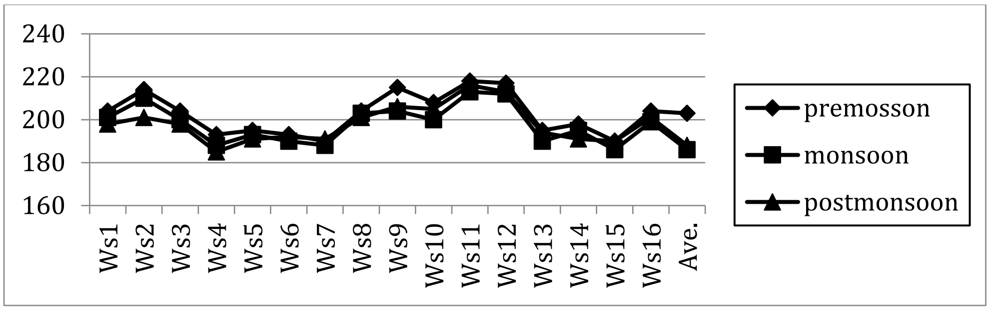

Fig 14 :-Chloride

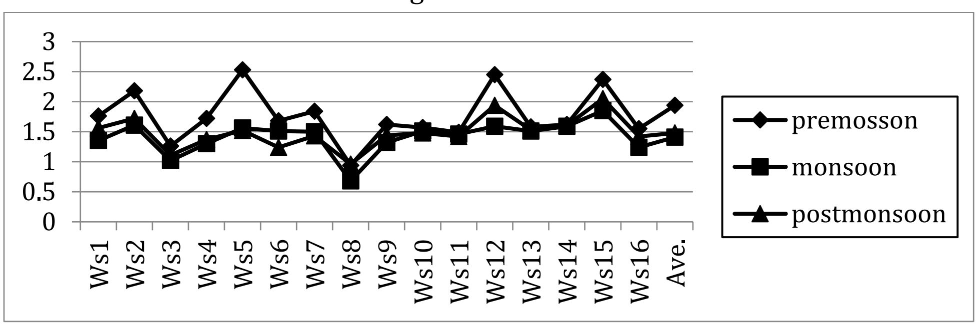

Fig 15:- Fluoride

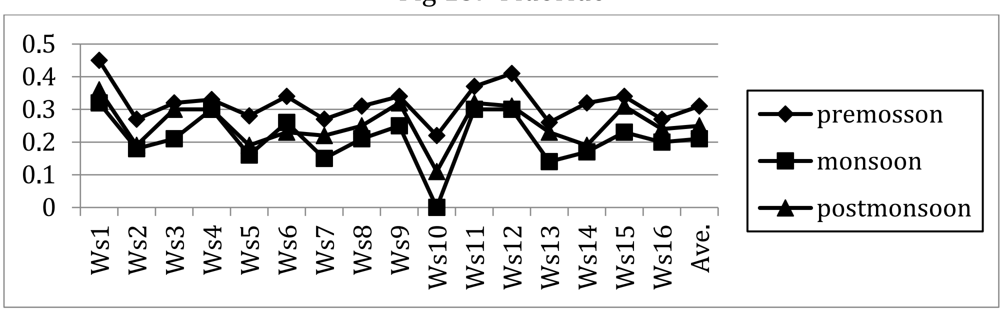

Fig 16:-Iron

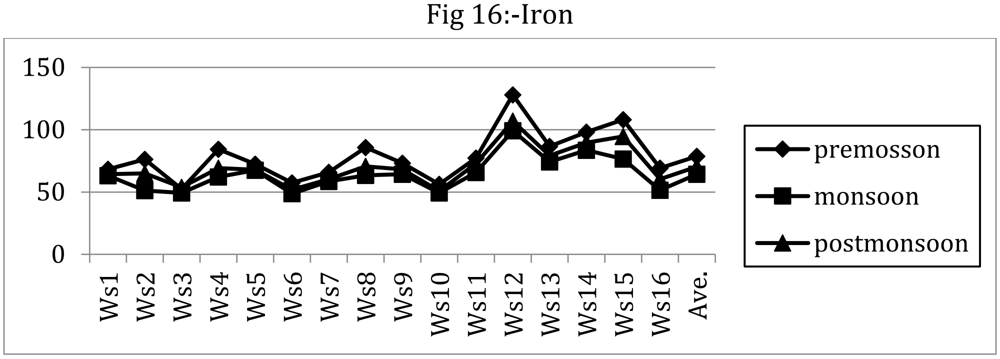

Fig 17 :-Sulphate

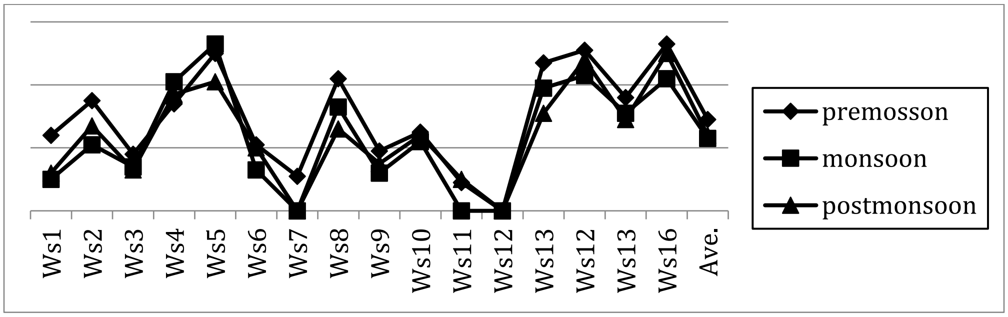

Fig 18:-As

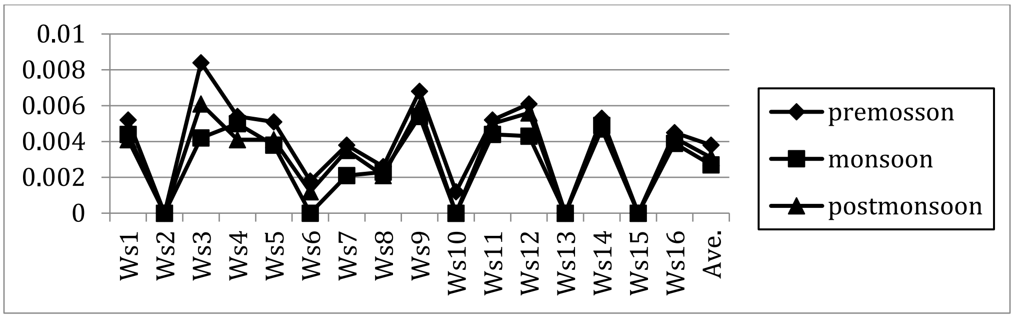

Fig19 :-Cd

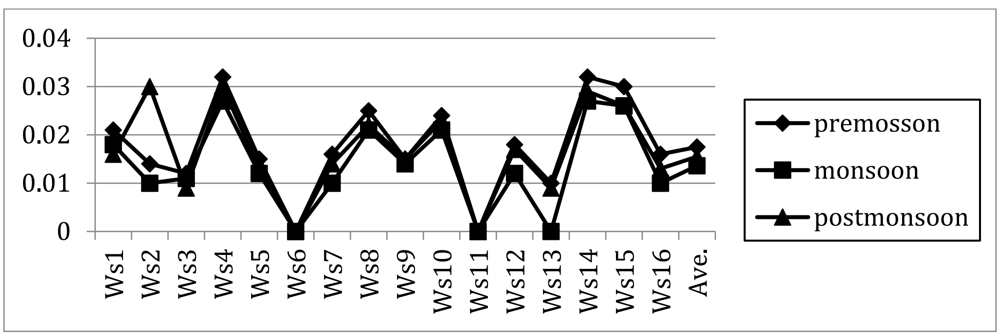

Fig 20:-Pd

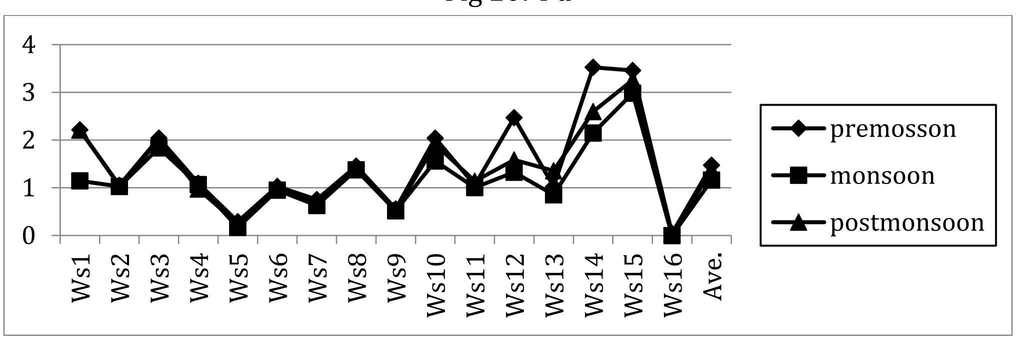

Fig 21 :-Zn

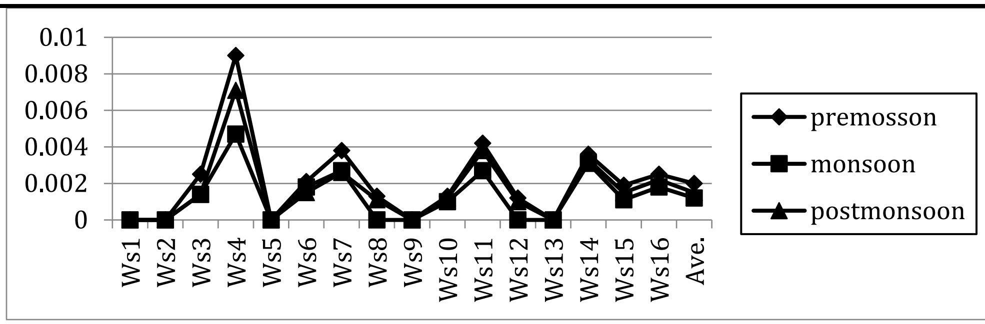

Fig 22:-chromium

3. CONCLUSION

Different guidelines and standards limits should be immediately applied in all groundwater samples. Beside this, water supply of the Lanco Amarkantak power plant industrial area should be managed and regularly analyzed the Suitability of drinking water quality. Groundwater safety measures are immediately necessary in this region. Restoration of affected agricultural soil is still an environmental aspect for Korba district. All the above observation and data indicated that the qualities of effluents sometimes do not meet the USEPA, BIS, ICMR and WHO specified norms. The effluents may also cause varies health problems among the human beings through contaminated groundwater supply by hand pump, bore and wells etc. Heavy metal contamination was found to be low in groundwater samples at control site and also in outer circle of Lanco amarkantak power plant area.

CONFLICT OF INTERESTS

None.

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