International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 04, April 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

SEASONAL VARIATION OF TOXIC METALS IN GROUNDWATER RESOURCES OF KISHANGANJ DISTRICT, BIHAR, INDIA

Nishat Anwer, Mukesh Kumar Sah, Md. Furkan Alam

Civil Engineering Department of IIMT College of Engineering, (Affiliated to AKTU) Gr.Noida,UP

ABSTRACT

For the survival of aquatic organism and other living things like as plant etc, Heavy metals within limits are essential which are toxic at higher levels. The presence of heavy metal ions in water is caused by natural and anthropogenic sources that depend on the local geology, hydrology and geochemical properties of aquifier substances and human activities. The objective of this research work is to detect the heavy metal ions distribution, their possible sources in groundwater and monitoring of health consequence on human population of Kishanganj district, Bihar, India. The heavy metal ions like Cr^{+6}, Mn^{+2}, Fe^{+3}, Cu^{+2}, Zn^{+2}, Cd^{+2} and Pb^{+2} in groundwater from different sources of five blocks of Kishanganj district, were examined during summer, rainy and winter seasons (2016-2017).The results reveal that out of 150 hand pump/tap water samples Cr^{+6}, Mn^{+2}, Fe^{+3},Cu^{+2}, Zn^{+2} , Cd^{+2} and Pb^{+2} ions concentrations varied from 0.00-0.07 mg/l, 0.10-0.53 mg/l, 0.11-0.65 mg/l, 0.03-1.55 mg/l, 0.11-2.76 mg/l, 0.000.005 mg/l and 0.00-0.04 mg/l, whereas among 150 open/ring well water samples these ions varied as 0.00-0.05 mg/l, 0.01-0.43 mg/l, 0.11-0.51 mg/l, 0.02-1.38 mg/l, 0.02-1.86 mg/l, 0.00-0.004 mg/l and 0.00-0.02 mg/l respectively during summer, rainy and winter seasons. The results of the present study have shown that all water samples contain copper and zinc ions within permissible limits of WHO (2008) standards, whereas Cr^{+6}, Mn^{+2}, Fe^{+3}, Cd^{+2} and Pb^{+2} ions crossed the maximum desirable limits as recommended by WHO (2008) at some locations of study areas.This study also indicates water pollution hazards and poor drinking water treatment plants in the areas. This research study, therefore, will be helpful for the Governmental and the non- Governmental agencies to take correct and appropriate steps by creating awareness among the people and make them free from disease caused by toxic metals.

Keywords:* *Groundwater, Chromium, Manganese, Iron, Copper, Zinc, Cadmium and Lead.

I. INTRODUCTION

Groundwater is generally considered as safe source of drinking water but due to high concentration of toxic metals, chemical substances along with bacteriological contamination, groundwater becomes unfit for drinking and other purposes . There are 50 metals that can be classified as heavy metals among them 17 are considered to be very toxic. Some metals such as Mn, Cu, Zn, Co, Mo and Fe are essential for human life in appropriate concentration as they catalyze for enzyme activities in human body, but in excess they become poisonous. Some of these heavy metals form complexes with carboxylic (-COOH), amino ($-NH_2$), imino (>NH) and thiol (-SH) groups present in the proteins and they disturb the activity of the proteins to catalyze the function of enzymes .

ISSN (O) 2454-9665
ISSN (P) 2454-0663

The new biological complex molecules thus formed lose their function which result in break down or cell damage . Three heavy metals of greatest health concern are Cd, Pb and Hg. There is no biological need of any of them. The increase in environmental pollution caused by toxic metals is of great concern because of their carcinogenic properties, their non-biodegradability and bio-accumulation .

The degree of contamination of our environment is directly or indirectly related to contamination of water bodies. Heavy metals are natural components of earth′s crust. Contamination of groundwater may occur due to its passing through rock containing heavy metals. Haphazard disposal of industrial elements, fertilizers and pesticides in farming and seepage from effluent bearing water bodies are sources of heavy metals in groundwater. Contamination of surface water with heavy metals poses a more serious threat. Metals enter into water as a result of weathering of soil and rocks from volcanic eruptions and from a variety of human activities like mining, processing of metals, automotive industry and leather tanning etc. Therefore, these chemical substances from human activities, industries and agriculture get into the rivers, ponds, lakes and underground water that may be the cause of contamination of drinking water . Drinking water, food, air, traffic, industrial activities and contaminated soil are sources of heavy metals exposure to human [8]. Among them drinking water is one of the main sources of exposure of heavy metals to humans and animals. In our country, small industrial units release their untreated effluents into the surface drains. Raw sewage is used for producing vegetables near big cities. The heavy metals present in sewage find their way into vegetables and then to the human consumer.

Cd^{2+} ion being soft acid that interacts with –SH (soft base) groups and can inactivate several S-containing enzymes and proteins by blocking the –SH groups. Due to chemical similarity with Zn^{2+} ion, Cd^{2+} ions can substitute Zn^{2+} ions in different enzymes causing renal dysfunction, bone marrow disorder, anemia and hypertension [9]. Cd^{2+} ions can interfere with Ca-metabolism and consequently decalcify bones. It can also interfere with Mg^{2+} in different enzymes to cause glaucoma and inhibit DNA ligase enzyme. Occurrence of cadmium exposure in human population is mainly through ingestion and inhalation. Inhalation of smoke of cigarette and airborne cadmium produced from industries is the cause of inhalation exposure, whereas use of drinking contaminated water followed by consumption of food through irrigation, medicine and cooking is the cause of ingestion exposure. Pb^{2+} ions interact with the enzyme, δ-aminolevulinate dehydrase (ALAD) to inhibit the formation of porphobilinogen, which is required in heme synthesis . It also interferes with native Zn^{2+}centre, which is required for the activity. Thus Pb^{2+} ions disrupt the synthesis of hemoglobin and other important proteins like cytochrome . The destruction of the mitochondria by the Pb^{2+} ions in the kidneys results in elimination of glucose, phosphate and amino acids through urine . Chromium is an essential trace metal for humans and animals but becomes toxic at higher concentration. Chromium bound β-globulins is found in lungs, heart, brain, liver, testes and spleen . It irritates the skin which causes ulceration. Long term exposure results in kidney and liver damage. The toxicity of Cr depends on the species under consideration, Cr^{3+} is nontoxic or less toxic and is required for glucose metabolism while Cr^{6+} is more toxic due to its string oxidizing nature and can induce cancer . Copper is essential trace element, not very toxic to animal, but toxic to plant at moderate levels. Excess of copper (470 mg) in human body is toxic and cause hypertension, sporadic fever, uremia, coma and even death. It also produces pathological changes in brain tissue . Zinc is essential element for many metalloenzymes , but heavy dose cause vomiting, renal damage, cramps , Manganese is relatively less toxic of

ISSN (O) 2454-9665
ISSN (P) 2454-0663

essential metals, but at higher levels (100 ppm) it becomes toxic to human body and can cause growth retardation, muscular fatigue and blindness .

Groundwater in entire northern region of Bihar is of poor quality as it possesses different types of harmful contaminations such as arsenic, fluoride and large amount of heavy metals which poses serious threat to human life . The groundwater in some villages of Kishanganj district has been reported contaminated in various newspapers. Keeping the above facts in news, we had decided to analyze the toxic metals in different groundwater sources of villages in Kishanganj district. The objective of this research work is to analyze the concentration and sources of heavy metals like Cr, Mn, Fe, Cu, Zn, Cd and Pb in groundwater of Kisanganj district, Bihar, India and on their direct or indirect toxicity on human health.

II. EXPERIMENTAL SECTION

2.1 Study Site

Kishanganj district is located in the north-east of the state of Bihar**,** at latitude of 25^0 20’ to 26^0 30’ north and longitude of 87^0 7’ to 88^0 19’ east. West Bengal, Nepal and Bangladesh are at border line of it. Mahananda, Kankai, Mechi, Ratwa, Ramzan and Donk are major rivers that flow through Kishanganj district. Two blocks Thakurganj

and Terhagachh are located in the forest area. Two types of minerals silica and iron are found around Kishanganj district. The climate of the study area was humid with maximum temperature 42^0 C in May-June.

2.2 Sample Collection

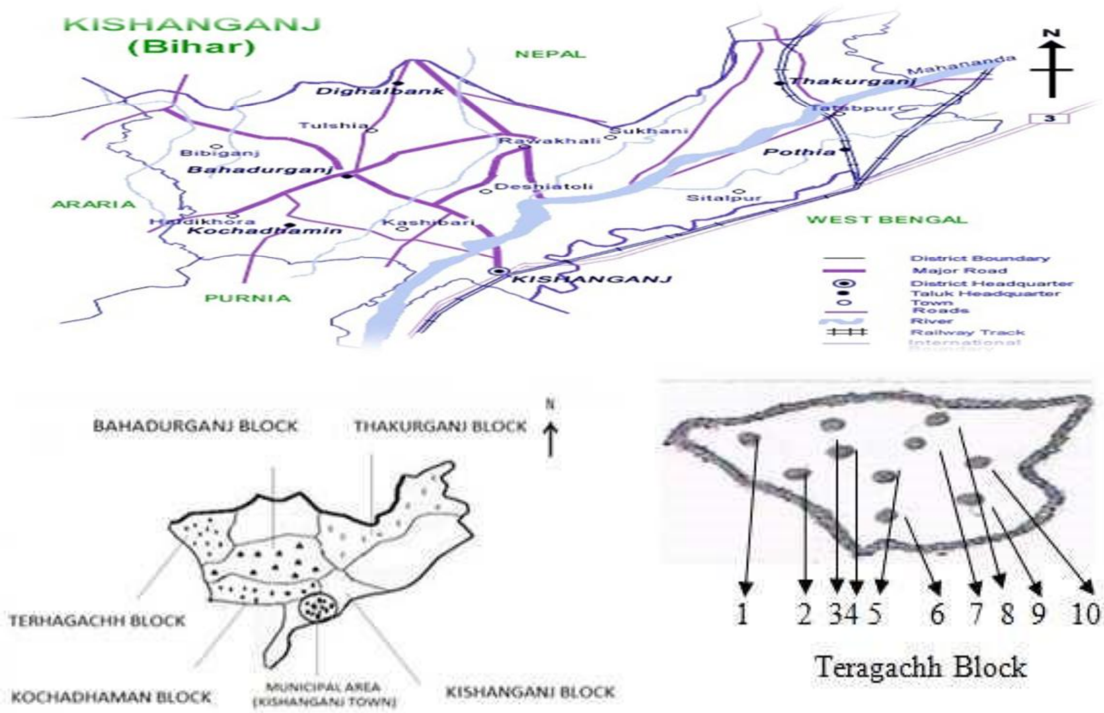
Water samples were collected fromhand pumps, tap water, open and ring wells during summer, rainy and winter seasons in the year 2016-2017 from 30 locations of municipal area of Kishanganj block, 30 villages from 10 panchayats (3 villages from each panchayat) each of four blocks namely Bahadurganj, Kochadhaman, Teragachh and Thakurganj, covering entire Kishanganj district. The research work was carried out in laboratory of Department of Chemistry, IIMT College of Engineering Gr.Noida G.B. NAGAR, (UP), Shiva Test House, Bailey Road, Patna, recognized as Environmental Laboratory by Central Govt.

2.3 Methodology

Temperature and pH were measured at the spot immediately after the collection of samples. Cr, Mn, Fe, Cu, Zn, Cd and Pb in water samples were estimated by Atomic Absorption Spectrophotometer, literature described by UNEP, 2004 earlier given by Environment Canada (1974) . The mean heavy metals content for each sampling site was compared with WHO (2008) guidelines for domestic use to assess compliance .

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 04, April 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

7 Bhur Kundi in Gunjar Mari village and at S19 Denga Tola in Bhaulmari village of Thakurganj block.



3.1 Chromium

During summer season, chromium content in hand pump/tap water samples was estimated to be maximum 0.07 mg/lat S25(Waquar Sahab)inUttrapali, at S30 (Md Kazim) in Lahra Chowk of the Kishanganj municipal area and at S25 HalimaTola in Jhiljhili village of Bhadurganj block, where as minimum 0.01mg/l at S4 Adibasti in Giddhni Kola village of Thakurganj block. During rainy season, chromium level in hand pump/tap water samples was maximum 0.05 mg/l at S24 in Chuddipatti, at S25 in Uttrapali andat S30 in Lahra chowk of municipal area of Kishanganj block, at S21 BhatiaTola in Sukhan, at S24 Saudal Tola inMurmala and at S25Halima Tola in Jhiljhili villages of Bhadurganj block, at S24 Naya Tola in Sundarbari village of Kochadhaman block and at S26 Fahim Tolain Khajuribari village of Teragachh block. The minimum 0.00 mg/l was found to be at S19 Sahu Tola in Doria villageof Teragachh block andat S1 kashi Bari in Pawakhali village, at S4 in Adibasi Basti in Giddnikola village, at S7 Bhur Kundiin Gunjar Mari village and at S19 Denga Tola in Bhaulmari villageof Thakurganj block.

ISSN (O) 2454-9665
ISSN (P) 2454-0663

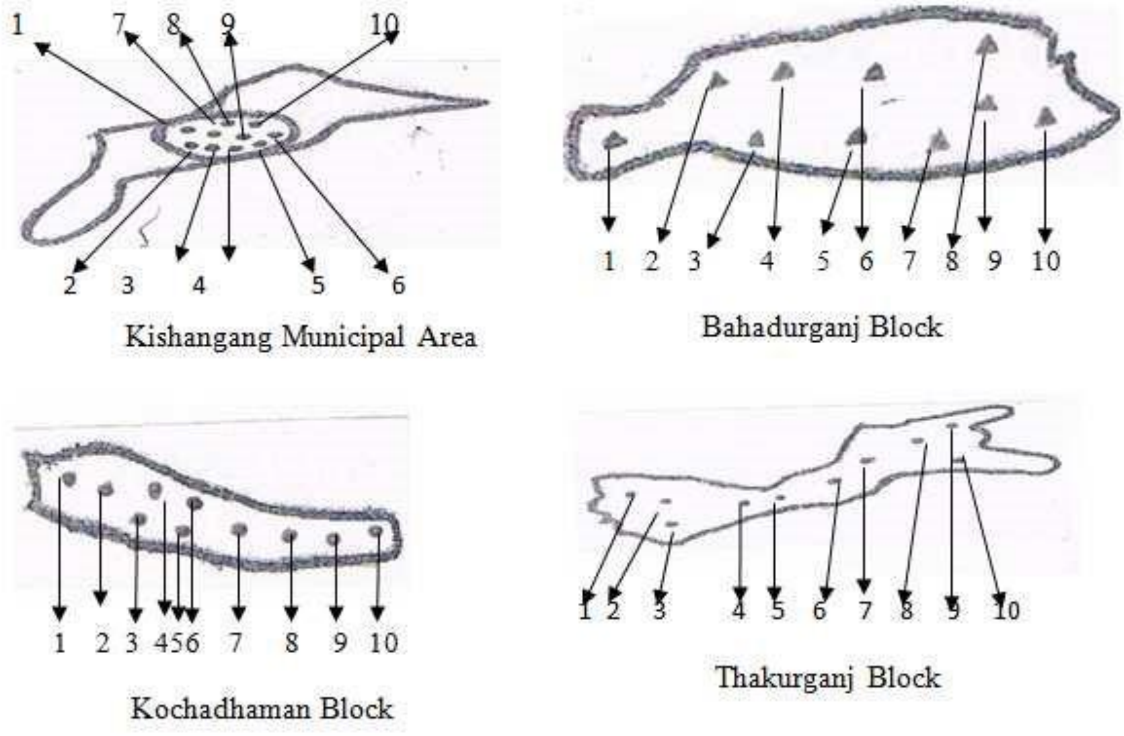


Figure 1 Sketch map of Kishanganj district showing five sampling blocks

During winter season, chromium level was 0.06 mg/l at **S12** inRailway colony, at **S24** inChudi Patti, at **S25**in Uttrapali and at **S30** Lahara chowk of municipal area of Kishanganj town, at **S12** Santhal Tolain Pulbari village, at **S24** Saudul Tola in Murmala and at **S25**Halima Tola in Jhiljhili village of Bahadurganj block, whereas minimum 0.00 mg/l at **S5** inHarijan Tola of Teragachh block and at **S5** Dhak Para village of Thakurganj block.

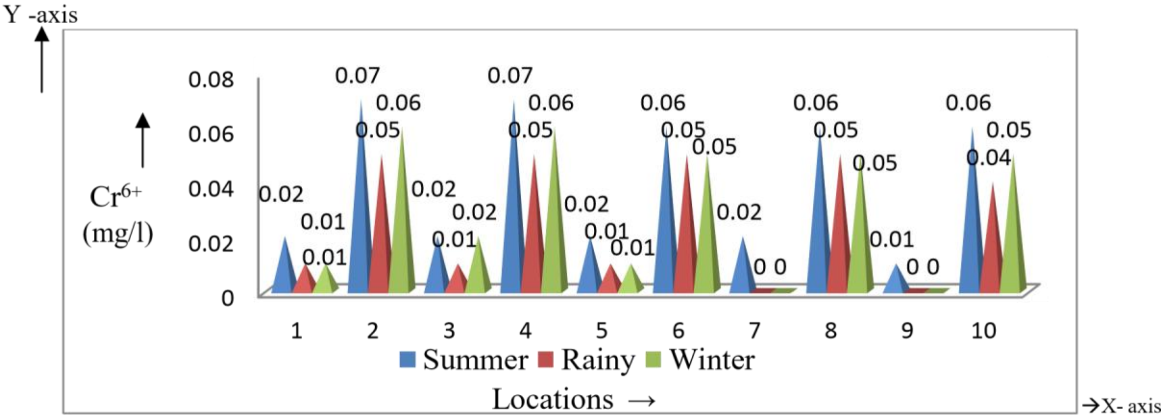


Figure-2 Seasonal variation of Cr in hand pump/tap water samples at different locations

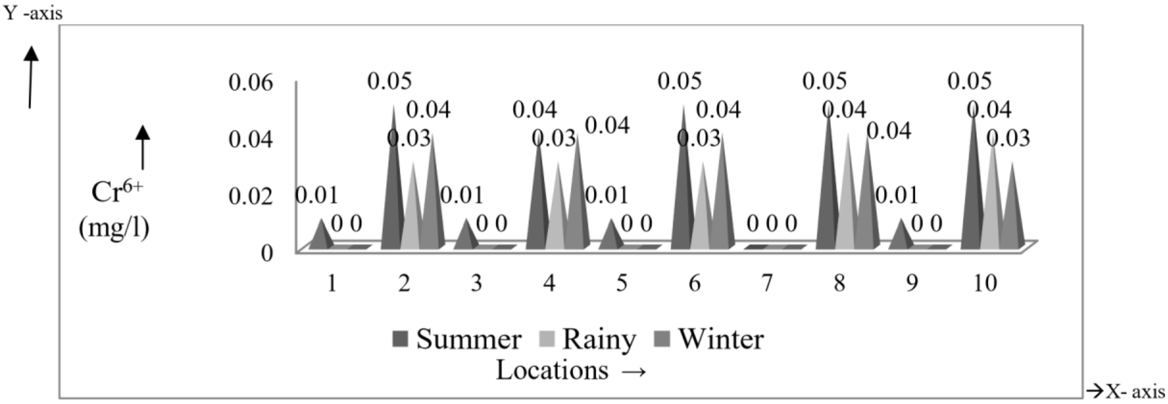


Figure-3 Seasonal variation of Cr in open/ring well water samples at different locations

In open/ring well water samples, the range of chromium content was found in between 0.01-0.04mg/l in Bahadurganj and 0.00-0.05 mg/l in Teragachh whereas 0.01-0.05 mg/l in municipal area of Kishanganj and other two blocks Thakurganj and Kochadhaman during summer season. During rainy, levels of chromium was found in between 0.00-0.03 mg/lin municipal area of Kishanganj and other two blocks Bahadurganj and Kochadhaman and 0.00-0.04 mg/l in rest two blocks Teragachh and Thakurganj. During winter the maximum concentration of chromium in open/ring water samples were similar (0.00-0.04 mg/l) at all stations of five blocks of Kishanganj district.

In nature, chromium is present in small quantities but it is maximum present in rocks of silica type. In the present study, during summer the level of chromium is slightly more (0.06-0.07 mg/l) than permissible limits of 0.05 mg/l as recommended by WHO(2008), whereas in winter and rainy seasons of study period, its level is less than the permissible limit except in some locations as shown figure- 2 and 3. Within the permissible limit in drinking water, it is essential in human nutrition to maintain the normal glucose metabolism but if higher than the 0.05 mg/l, it causes nephritis and glycosuria .The high level of chromium in these locations may be due to its presence an aquatic and terrestrial ecosystem. The contamination of groundwater with high level of Cr could be due to steel and pulp mills and erosion of natural deposit, highly used in electroplating, pigments for paints, cement, rubber, and other materials. In the township area high level of chromium could be due to the presence of chromium in soaps and detergents highly used for washing and bathing . High level of Cr (0.07mg/l) at **S12, S24**, **S25** and **S30** of municipal area and 0.06 mg/l at **S12, S24** and **S25** of Bahadurganj block could pose a threat to human health in these localities.

3.2 Copper

During summer, the concentration of copper in the hand pump/tap water samples from the Kishanganj Township was maximum 1.55 mg/l at **S3** (Mohsin Sahab)inPachimpali and minimum 0.07 mg/l at **S22** **(**S.S.Rabbani)inChuddipatti and at **S28** (Asla Sahab)in Lahra Chowk. For the Bahadurganj, Kochadhaman, Teragachh and

Thakurganj block, it was maximum 1.53 mg/l at **S20** Kalima Tola of Lohia Kadnar village, 1.51 mg/l at **S3** Dobi Tola of Bhag Baisa village, 1.53 mg/l at **S15** in Khara village and 1.48 mg/l at **S21** Purb Tolaof Malik Basti respectively.The minimum 0.09 mg/l at **S19** Amalu Tola in Kumhar village of Bahadurganj block, 0.11 mg/l at **S1** in Bhag Baisa, at **S7** in Gurgawn and at **S13** Bank Tola of Gauramari villages of Kochadhamin block, 0.08

mg/l at **S10** Khanka Tola of Dahibhat village of Teragachh block and 0.14 mg/l at **S1, S4,** and **S7** locations of Thakurganj block.

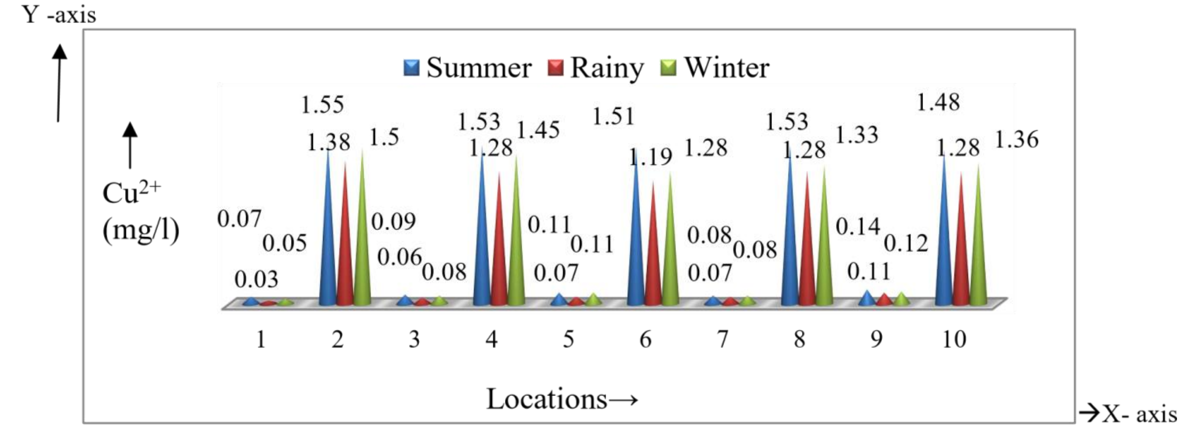


Figure-4 Seasonal variation of Cu in hand pump/tap water samples at different locations

During rainy season, the Kishanganj, Bahadurganj, Kochadhaman, Teragachh and Thakurganj water samples copper was maximum 1.38 mg/l at **S21** (Faraque Azad)in Khagra, 1.28 mg/l at **S21** Bhatia Tola inSukhani, at **S26** Harizan Tolain Saktihar and at **S29** in Massan gawn villages, 1.19 mg/l at **S2** BakhoTolain Bishanpur, 1.28 mg/l at **S12**

Mashan Tolain Dahibhat and at **S20** Dunia Tolain Lodhabari villages and 1.28 mg/l at **S20** Muslim Tolaof Saraikuri village respectively**.** The minimum copper content was found to be 0.03 mg/lat **S22** in Chuddipatti of municipal area, 0.06 mg/l at **S10** Gingai Tola of Bhatbari village in Bhadurgnj blocks, 0.07 mg/l at **S22** in Saptia village of Kochadhaman, at **S10** in Dahibhat village of Teragachh blocks and 0.11 mg/l at **S5** in Dhakpara village of Thakurganj block.

During winter, the copper content in hand pump/tap water samples was estimated to be maximum 1.50 mg/l at **S21** (Faraque Azad) in Khagra, 1.45 mg/lat **S27** in Jhiljhili, 1.28 mg/lat **S2** in Bishanpur, 1.33 mg/lat **S21** in Nankar, and 1.36 mg/l at **S20** inSaraikuri villages of the Kishanganj township, Bahadurganj, Kochadhaman, Teragachh and Thakurganj block respctivelly. The minimum 0.05 mg/l at **S2,S13**, **S22** and **S28** locationsin municipal area, 0.08 mg/l at **S19** in Kumhar village of Bahadurganj, 0.11 mg/l at **S4** Danpura,at **S7** Gargawn,at **S22 Sapita** villages of Kochadhaman, 0.08 mg/l at **S10** Khanka Tola in Teragachh and 0.12 mg/l at **S1** Kashi BariinThakurganj block as shown figure-4.

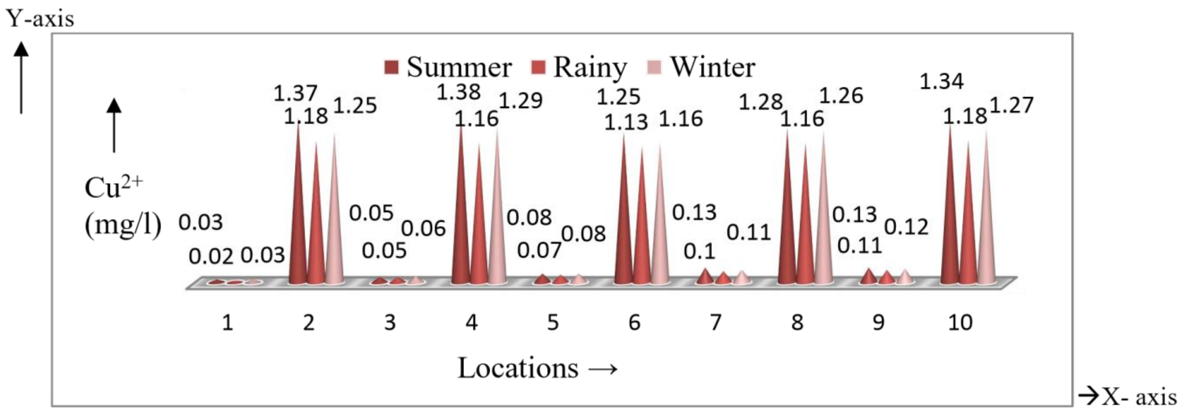


Figure-5 Seasonal variation of Cu in open/ring well water samples at different locations

In open/ring well water samples the range of copper0.03-1.37 mg/lin Kishanganj township**,** 0.05-1.38 mg/lin Bahadurganj,0.08-1.25 mg/l in Kochadhaman, 0.13-1.28 mg/l in Teragachh and 0.13-1.34 mg/l in Thakurganj block during summer, whereas during rainy 0.02-1.18 mg/l in Kishanganj township, 0.05-1.16 mg/l in Bahadurganj, 0.071.13 mg/l in Kochadhaman,0.10-1.16 mg/l in Teragachh and 0.11-1.18 mg/l in Thakurganj block. During winter, copper content varied from 0.03-1.25 mg/l, 0.06-1.29 mg/l, 0.08-1.16 mg/l, 0.11-1.26 mg/land 0.12-1.2 mg/l in Kishanganj municipal area, Bahadurganj, Kochadhaman, Teragachh, and Thakurganj block respectively as shown in figure-5.

In the groundwater (hand pump/tap and open /ring well water samples) level of copper was found to be below (0.021.55 mg/l) than permissible (2.0 mg/l) as recommended by WHO (2008). Low level of copper may be due to low copper related industries and mining activities. The high value of pH in the study area could also be responsible for low level of copper, as it forms insoluble compound in alkaline medium and is deposited as sediment . Copper is an essential micronutrient to human life, deficiency of copper can be the cause of anemia, growth inhibition, and blood circulation problems , but in high concentration it causes physiological effect in human and chronic exposure which can result in the development of anemia, liver and kidney problem . It enters into water bodies through the intrusion of industrial and domestic wastes and corrosion of brass and copper pipes which also contributes to copper level in water.

3.3 Iron

During summer, in the municipal area of Kishanganj town hand pump/tap water samples iron content was maximum 0.61mg/l at **S15 (**Babul Dey)inBus stand and at **S30** (Md Kazim)in Lahra chowk and minimum 0.31mg/l at **S20 (**Nashim Akhar)inKhagra. For other four blocks, it was found to be maximum 0.65 mg/l at **S15** Madarsa Tola in Tegharia village of Bhadurganj and at **S3** Dobi Tola in Bhag-Baisa villageof Kochadhaman, 0.63 mg/l at **S20**Muslim Tola in Saraikuri village of Thakurganj and 0.62 mg/l at **S5** Harizan Tola in Baluajagir village of Teragachh. The minimum concentration 0.32 mg/l at **S16** Musluim Tola in Kathal Bari village of Bahadurganj, at **S1** Harizan Tola in Gilni village in Teragachh and 0.31mg/l at **S19** (Ajay Jha) in Khagra of municipal area of Kishanganj, at **S1** JagirTola of Bhag-Baisa village of Kocadhaman and at **S13** Kela- Bari in Pat-Bari village in Thakurganj block.

During rainy season, iron content ranges are 0.21-0.43 mg/l, 0.21-0.58 mg/l, 0.11-0.48 mg/l, 0.18-0.46 mg/l and 0.12-0.48 mg/l in municipal area of Kishanganj, Bahdhurganj, Kocadhaman, Teragachh and Thakurganj block respectively. During winter, the range of iron concentrations was found in between 0.25-0.52 mg/l in municipal area of Kishanganj, 0.26-0.56 mg/l in Bahadhurganj, 0.22-0.56 mg/l in Kochadhaman and 0.22-0.51mg/l in Teragachh and 0.21-0.49 mg/l in Thakurganj block as shown in figure -6.

ISSN (O) 2454-9665
ISSN (P) 2454-0663

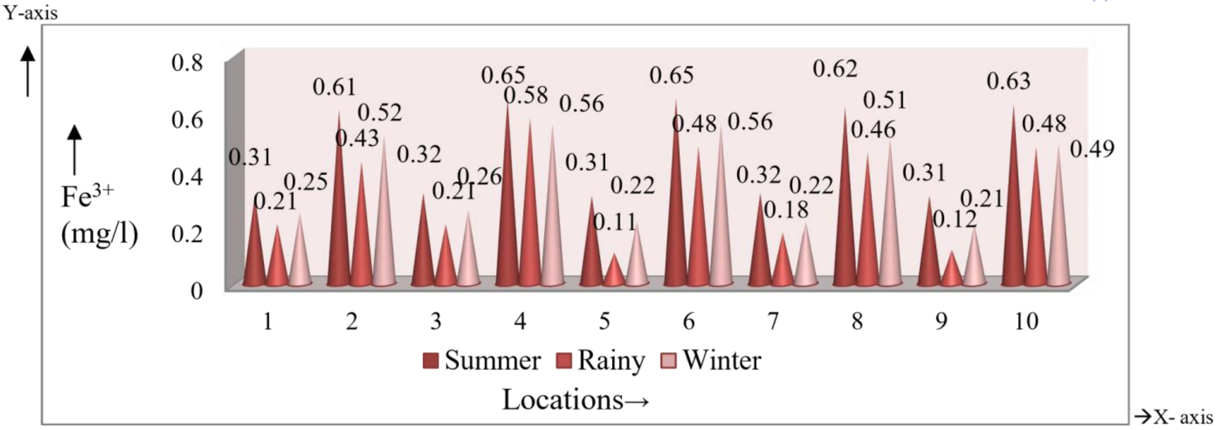


Figure-6 Seasonal variation of Fe in hand pump/tap water samples at different locations

In open/ring well water samples iron concentration varied from 0.13-0.45 mg/l in township of Kishanganj**,** 0.180.45 mg/l in Bahadurganj, 0.31-0.51mg/l in Kochadhamn, 0.14-0.33mg/l in Teragachh, 0.13-0.37 mg/l in Thakurganj block during summer season. During monsoon, only one well at **S24** Naya Tola of Sunderbari village in Kochadhaman block, iron content (0.39mg/l) was found to be above than permissible limit (0.30 mg/l) as recommended by WHO 2008 During winter iron levels in open/ring well samples was maximum 0.37 mg/l at **S30** in Lahra chowk in municipal area, 0.38 mg/l at **S27** Halima Tola in Jhiljhili village of Bahadurganj,0.49mg/lat **S24** in Sunderba**ri** village of Kocadhaman,and0.32 mg/l **at S9** Yadav Tola in Shernia village, at **S17** Munia Tola in Kalpir village of Teragachh and 0.21mg/l at **S3** Teli Bastiin Dumaria village of Thakurganj block as shown in figure -7.

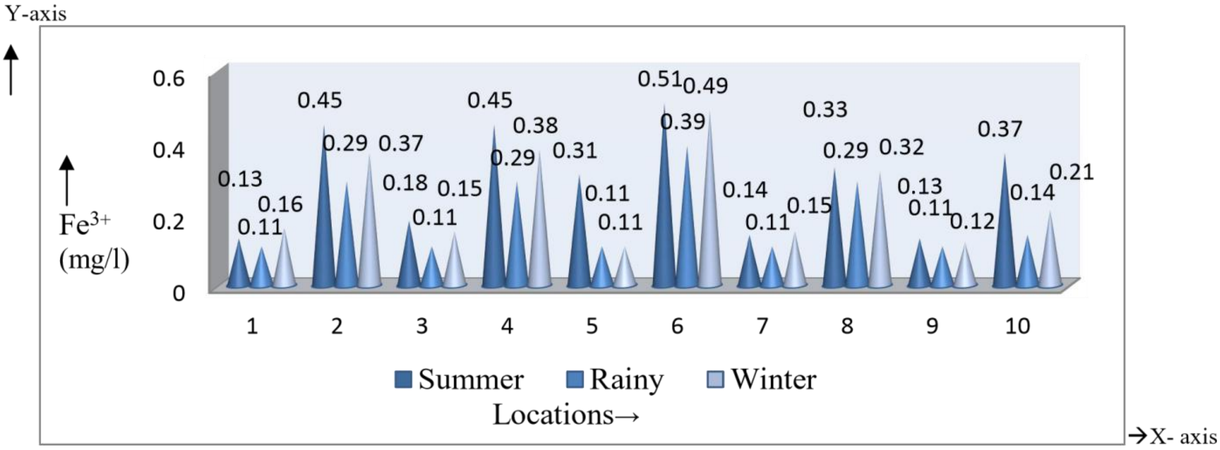


Figure-7 Seasonal variation of Fe in open/ring well water samples at different locations

Iron is naturally occurring element in earth . When water passes through rock and soil it can dissolve these minerals and carry them into water bodies. Corrosion and deterioration of old iron pipes may also be the source of iron in water. In the study area, iron content varies from 0.11 mg/l in sample taken from open well to 0.65 mg/l from hand pump water samples.About 49% of the samples have iron level below the permissible limit of 0.03 mg/l as recommended by WHO (2008), whereas 51% of the samples have shown iron concentration above the permissible limit. Iron is beneficial if it is present under desirable concentration but higher concentration lead to iron toxicity and affects organs like liver, cardiovascular system and kidneys .

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 04, April 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

3.4 Cadmium

The concentration of cadmium in the groundwater collected from hand pump/tap water samples varied from 0.002-

0.005 mg/l, 0.000-0.003 mg/l and 0.001-0.004 mg/l, whereas in open/ring well water samples it varied from 0.0010.004 mg/l, 0.00-0.002 mg/l and 0.00-0.003 mg/l during summer, rainy and winter seasons respectively in all five blocks of Kishanganj district as shown in figure-8 and 9. The results reveal that during summer and winter season cadmium content was found to be more than permissible limit of 0.003 mg/l as recommended by WHO (2008). It was found to be of maximum level of 0.005 mg/l at **S16** (Paswan Tola) of Bhelaguri village, at **S30** (Kumhar Tola) of Bhatgaon village, 0.004 mg/l at **S13** (Harendra Singh) of Bus Stand and 0.0039 mg/l at **S2** (Rasidpur) Altibari village of Teragachh, Thakurganj, municipal area of Kishanganj and Kochadhaman blocks respectively and of minimum level of 0.001 mg/l at **S23** of Khokho Basti of Bahadurganj block during summer. During winter season only two sites at **S10** (B.K.Thakur) of municipal area and at **S21** (Malik Basti) of Thakurganj block, cadmium was found to be 0.004 mg/l. During rainy season, cadmium was found to be under permissible limit of WHO (2008) at all locations of hand pump/tap water samples.

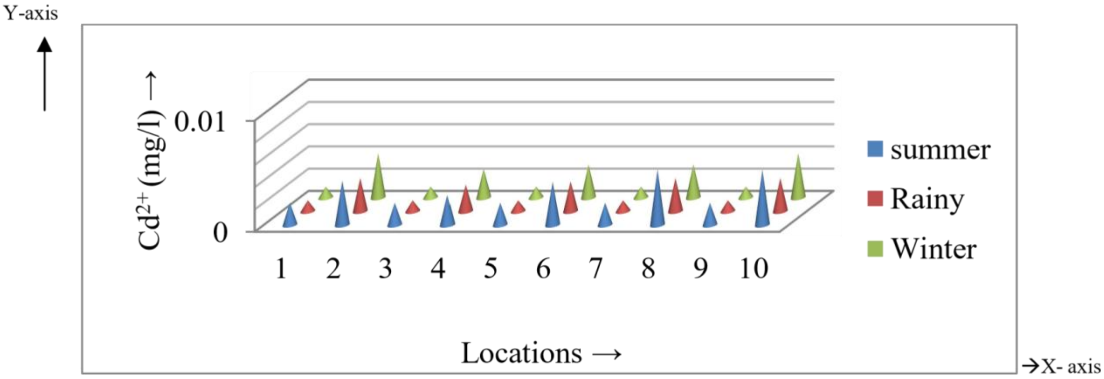


Figure-8 Seasonal variation of Cd in hand pump/tap water samples at different locations

In open/ring well water samples only one site at **S12** (Mashan Tola) of Teragachh block cadmium level was found to be 0.004 mg/l during in summer, whereas in all open/ring water samples it was found to be less than permissible limit.

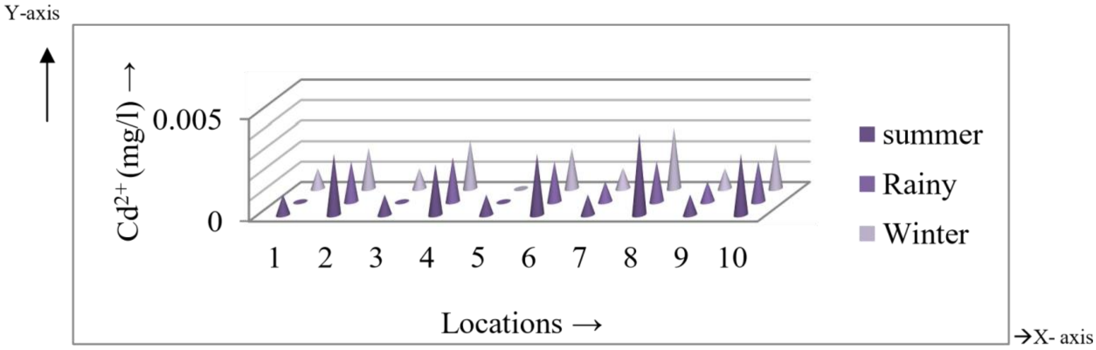


Figure-9 Seasonal variation of Cd in open/ring well water samples at different locations

Cadmium is toxic to all humans and animals and is responsible for all types of poisoning. Small amount of Cd can cause adverse effect in arteries of human kidneys .Toxicity of Cd is also the cause of vomiting, diarrhea, abdominal pains and loss of consciousness .The common clinical symptoms of Cd poisoning are growth retardation, bone deformation, impaired kidney functioning, impaired reproductive system, hypertension, tumor formation and teartogenic effects. It enters water system through industrial discharges or the deterioration of galvanized pipes.

3.5 Lead

Lead content in water samples collected from hand pump/tap water samples from different blocks of Kishanganj districts showed ranges as 0.00-0.03 mg/l, 0.00-0.03 mg/l, 0.00-0.04 mg/l, 0.00-0.03mg/l and 0.00-0.03mg/l, whereas in open/ring well water samples lead content varied from 0.01-0.02 mg/l, 0.00-0.0 2mg/l, 0.00-0.02 mg/l, 0.00.03 mg/l and 0.10-0.02 mg/l in Kishanganj municipal area, Bahadurganj, Kochadhaman, Teragachh and Thakurganj block respectively. The comparative analysis of the data as shown in figure-10 and 11, is evident that lead is the only metal that was not detected in all sampling areas in groundwater during monsoon. It has been found that a level of lead slightly increases up to 0.02 mg/lduring winter and up to 0.04 mg/l during summer at some of the sampling sites. Only one site at **S23** (Master Tola in Saptia village) of Kochadhaman block it was found to be 0.04 mg/l.

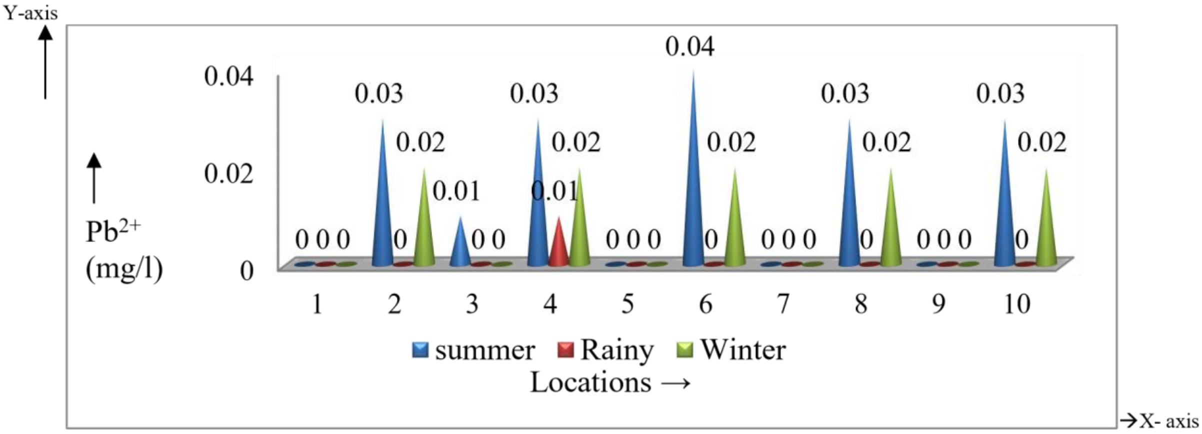


Figure-10 Seasonal variation of Pb in hand pump/tap water samples at different locations

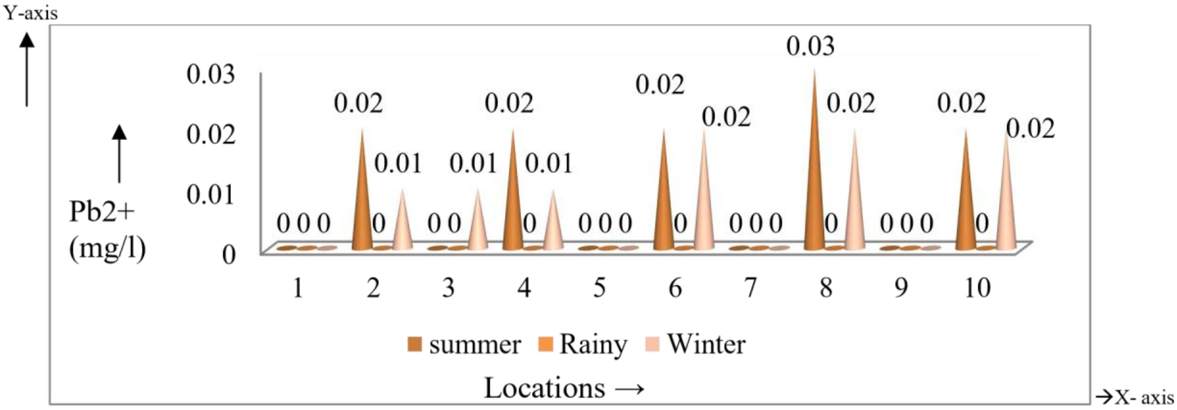


Figure-11 Seasonal variation of Pb in open/ring well water samples at different locations

The occurrence of lead content in groundwater at the study area may be due to old plumbing, household sewages, human and animal excreta, soil-water containing phosphatic fertilizers, battery chargers workshops and industrial effluents around these areas . Lead is mainly deposited in bones and some in soft tissues. It is also absorbed by liver, kidney and muscles of human beings . Its toxicity symptoms are vomiting, loss of appetite, brain damage,convulsions,uncoordinated body movements and stupor .The vital dose (above 500 mg/l) can cause of coma and death.

3.6 Manganese

It was observed that manganese content in all hand pump/tap water samples from different blocks of Kishanganj districts showed that manganese ranged from 0.10-0.52 mg/l, 0.11-0.42 mg/l, 0.11-0.45 mg/l, 0.11-0.53 mg/l and 0.11-0.53 mg/l, whereas in open/ring well water samples manganese content varied from 0.01-0.43 mg/l, 0.120.41mg/l, 0.11-0.36 mg/l, 0.08-0.35 mg/l and 0.10-0.36 mg/l in Kishanganj municipal area, Bahadurganj, Kochadhaman, Teragachh and Thakurganj block respectively.

Results revealed that during summer, the manganese content in the ground water samples recorded the highest value of 0.53 mg/l at **S24** Baisa Tola (hand pump) in Matiyari village of Teragachh and at **S23** Kalka Dunga (hand pump) in Besarbati village of Thakurganj, and minimum of 0.05 mg/l at **S25** (ring well) in Uttrapauli of municipal area. During rainy season, the highest level of manganese was found to be 0.44 mg/l at **S9** in Dharmashala Road (tap water) and minimum of 0.01mg/l at **S25** in Uttrapali (ring well), at **S15** in Bus stand (hand pump) of municipal area of kishanganj block. During winter season, the concentrations of manganese in the groundwater sample was found to be of highest value 0.45 mg/l at **S11** (B.Bhagat) in Railway Quarter at **S24** (Dr. B. Alam) in Chudipatti and at **S30** (Md. Kashim) in Lahra chock (tap water) and minimum 0.04 mg/l at **S5** in Subhaspally, at **S8** in Dharamshala Road, at **S20** in Khagra and at **S26** in Uttrapali (open well) in municipal area.

The results reveal that amount of Mn content was found be within the permissible limit of 0.5 mg/l as recommended by WHO except at few locations. In this study, during summer, the manganese content in the groundwater samples was estimated to be at the level of 0.53 mg/l at **S24** (Teragachh block) and at **S23** (Thakurganj block) and 0.52 mg/l at **S21** municipal area of Kishanganj block.

3.7 Zinc

Zinc is an essential and beneficial element for human bodies. However, concentration above 5 mg/l cause bitter taste and an opalescence and excess quantity can be harmful and cause zinc toxicity . It enters the domestic water supply from deterioration of galvanized Fe and dezincification of brass, and industrial effluents.The values of Zn in water samples were 0.11 to 2.76 mg /l in hand pump/tap water samples and 0.02 to 1.86 mg/l in open/ring wells among five blocks of Kishanganj district. The maximum level of Zn (2.76 mg/l) was detected in the sample taken from **S30** Mushari Tola of Junki -Mushara village (Hand pump) of Teragachh block, and minimum level of 0.02 mg/l was observed at the sample obtained from **S4 (**open well)inSubashpauli of municipal area of Kishanganj block. Results showed that the Zn content in groundwater was below the permissible limit of 3.0-5.0 mg/l as reported by WHO (2003).

IV. CONCLUSION

Finally, it is concluded that the aim of this research work is to assess the status of groundwater quality and to use it for drinking purpose with reference to toxic metals.150 hand pump/tap and 150 open/ring well water samples were collected from five blocks of Kishanganj district during summer, rainy and winter in year 2016-2017.The results reveal that all samples contained Zn^{2+} and Cu^{2+} under desirable limits, but some toxic metal ions such as Cr^{6+}, Cd^{2+} and Pb^{2+} were present in slightly higher than permissible limits as set by WHO (2008), at some locations only during summer and winter seasons. The concentration of Fe^{3+} ion was high at most of sampling stations as per WHO (2008) standards. Till the study period groundwater quality of Kishanganj district was not very bad with reference to heavy metals but will be worst and become unfit for drinking and other purposes if the same situations continue in future. Therefore, this study will be helpful to make the people aware and recommend the Governmental and the Non-Governmental authorities to take appropriate action that would reduce the current levels of heavy metals.

V. ACKNOWLEDGEMENTS

The authors are thankful to the Director of IIMT College of Engineering greater Noida G.B. NAGAR (UP) and The Director of Shiva Test House, Bailey Road, Patna, for carrying this research work successfully.

REFERENCES

[1] A Kumar; V Kumar, Res. J. Chem. Sci., **2015**, 5(2),76-84.

[2] AA Khan; MN Khan, Res. J. Chem. Sci., **2015**, 5(1),55-59.

[3] SS Parihar; A Kumar; A Kumar ; RN Gupta; M Pathak; A Shrivastav; AC Pandey, Res. J. Recent Sci., **2012**,1(6), 62-65.

[4] M Pirsaheb; T Khosravi; K Sharafi; L Babajani; M Rezaei, World App. Sci. J.,**2013**, 21 (3), 416-423.

[5] MA Momodu; CA Anyakora, Res. J. Environmental and Earth Sci.,**2010**, 2 (1), 39-43.

[6] A Kumar; V Kumar, J. Chem. Pharm. Res.,**2015**, 7(1), 685-697.

[7] MA Iqbal; SG Gupta, African Journal of Basic and App. Sci.,**2009**, 1 (5-6), 117-122.

[8] V Mudgal; N Modaan; A Mudgal; RB Singh; S Mishra, The Open Nutraceuticals Journal, **2010**, 3, 94-99.

[9] B Rajappa; S Manjappa; ET Puttaiah, Contemporary Engineering Sci., **2010**, 3 (4), 183-190.

[10] M Hanna; A Eweida; A Farag, International Conference on Environmental Hazard Mitigation, Cairo University, Egypt, **2000**, pp 543-556.

[11] K Mukesh; P Kumar; M Singh; A Singh, Veterinary World,**2008**, 1 (1), 28-30.

[12] AD Dayan; AJ Paine, Human and Experimental Toxicology, **2001**, 20, 439-451.

[13] HH Dieter; TA Bayer; G Multhaup, Acta Hydrchimica et Hydrobiologica, **2005**, 33, 72-78

[14] AA Adepoju-Bello; OO Ojomolade; GA Ayoola; HAB Coker, The Nig. J. Pharm., **2009**, 42 (2), 57-60.

[15] M Tuzen; M Soylak, Polish J. Environ Stud., **2006**, 15 (6), 915-919.

[16] O Kaplan; NC Yildirim; N Yildirim; N Tayhan, E-Journal of Chemistry, **2011**, 8(1), 276-280.

[17] A Kumar; M. K Singh; N Renu. National Seminar,on “The problem of Fluoride, Arsenic and Heavy Metal contamination in Drinking Water in The Ganga Plain”, Sponsored by C.S.I.R, B.C.S.T. and Co-Sponsored by Indian Chemical Society, Kolkata and conducted by G.B. College Naugachia, TMBU Bhagalpur, Bihar, on 21st to 22nd Sep. **2010,** pp- 114-124.

[18] UNEP., Analytical Method for Environment Water Quality; UNEP GEMS /Water Program & IAPE (1985), code-24002 page-79, code-24005 page-82, code -26005 page 86, code- 29106 page 95, code-30004 page 99, code- 82101 page 118 , **2004.**

[19] WHO, Guidelines for drinking water quality, World Health Organization, Geneva, **2008**.

[20] AM Sheller; EA Boyle, Geochemica et Cosmochimica Acta, **1987**, 51. 3273.

[21] LM Rao; RMS Patnaik, Poll. Res., **2000,**19 (3), 325-329.

[22] GD Jennings; RE Sneed; MB Clair, Metals in Drinking Water, North Carolina Co-operative Extension Service, Publication no.: AG-473-1. Electronic version, **1996**; 3/1996

[23] H Madsen; L Poultsen; P Grandjean, Ugeskr Laeger,**1990**, 152 (25), 1806-90041-5782.

[24] S Bent; K Bohm. Gesundheitswesen, **1995,** 57 (10), 667-669.

[25] TR Agarwal; KN Singh; AK Gupta, Poll. Res., **2000,** 13 (3), 491-494.

[26] S Moscow; K Jothivenkatachalam; P Subramani, Der Chemica Sinica, **2011**, 2(2), 199-206.

27] JD Zuane. Handbook of Drinking Water Quality Standard and Controls, Van Nostrand Reinhold, New York, **1990,** 64-69.

[28] CW Cheung; JF Porter; G Mckay, Water Res., **2001**, 605-612.

[29] AN Oniye; SJ Bararabe; MI Auta, Chem. Class Journal, **2005**, 2(1): 69-73.

[30] J Sirajudeen; A Jameel, J. Ecotoxicol. Environ. Monit., **2006**, 16(5) 443-446.

[31] D Swarup; RC Patra; R Naresh; P Kumar; P Shekhar, Science of the Total Environment, **2005**, 15(1-3), 67-71.

[32] MB Rajkovic; CM Lacnjevac: NR Ralevic; MD Stojanovic; DV Toskovic; et al., Sensors,**2008,** 8, 2199-2207. [33] CG Elinder. Handbook on the Toxicology of Metals, 2nd Amsterdam, Edition, Elsevier Science Publishers, **1986;** 664-679.