

## **IMPACTS OF INDUSTRIAL EFFLUENTS ON GROUND WATER QUALITY OF HATTAR INDUSTRIAL ESTATE AND ITS ASSOCIATED HEALTH RISKS**

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**Abstract:** Current study was under taken to analyze underground water of the Hattar Industrial Estate (HIE) and that of reference areas for physio-chemical and biological parameters and to determine health impacts associated with the contamination of the water bodies. For this purpose, random sampling technique is used. A total of thirty-five samples of underground water were collected from the source and user points, and were analyzed for physio-chemical i.e. Temperature, pH, Electric Conductivity (EC), Total Dissolved Solids (TDS), Total Alkalinity, Ca-hardness, Mg-hardness, Total Hardness (TH), Chlorine (Cl), Nitrates (NO<sub>3</sub>). The results were compared with World Health Organization (WHO) standards and National Environmental Quality Standards (NEQS) that showed that most of the parameters were within the prescribed limits. It is concluded that water quality of industrial area is as good as the control site because there is no significance difference in the water quality of industrial area as compared with that of control site.

**Keywords:** Industrial Effluents, Urbanization, Water Quality, Contamination, Total Dissolved Solids.

### **Introduction**

Water is not only a precious natural source but a basic necessity of life. It is the most essential part of almost 50-97% of animals and plants (Buchholz, 1998). Recently due to uncontrolled increase in population, urbanization and industrial activities its availability and quality is badly affected. According to WHO estimates about 1.1 billion individuals don't have approach to hygienic and clean drinking water globally (McMichael and Butler, 2006). Fresh water is a limited reserve of earth, it is essential for the survival of industry agriculture and for the existence of human. Without satisfactory quantity and quality of clean water sustainable development is hard to materialize and achieve. The resources of fresh water are deteriorating at rapid rate day by day.

A study conducted in Lahore evaluated water quality parameters i.e. pH, TH, turbidity, TDS, TC and FC of drinking and compared there results with WHO guidelines showed within the permissible limits (Haydar et al., 2009). The Physio-chemical parameters such as pH, conductivity, TDS, DO, COD, BOD total hardness, chlorides and sulphates of wastewater of HIE were found well above the maximum safe limits. The Na and Ca contents with an average of about 256.3 Mg/L Na and 122.7 Mg/L Ca were found. The pH values of some soil extracts in water were found to be highly acidic, indicating a direct adverse impact of the effluents on the local soil, expected to ultimately pollute local vegetation (Manzoor, 2006). However, quite limited data was available in the underground water quality of the HIE that was why the proposed study was designed to analyze underground water of the HIE and to correlate physico-chemical

parameters of both underground waters of the selected area and also to determine associated health impacts.

## **Material and Methods**

### ***Study area description***

The HIE is one of the biggest industrial estates of Pakistan that lies near district Haripur. This area has diversified agriculture resulting from the variety of climates and land forms. The estate is located at 33.9059° N and 72.8575° E. Due increasing population of the district Haripur especially and that of the country in general, demand for goods is increasing. In order to cope with the increasing demand new industrial setups are constructed. According to the Hattar Chamber of Commerce & Industry (HCCI) currently 215 units are operational and 79 are in pipeline.

### ***Sample collection and analysis***

A total of thirty-five samples of underground water were collected from both industrial area and that of the reference site randomly. All samples were collected in clean dry plastic bottles of 1-liter capacity. Each bottle is marked and labeled in which sample number, date, time and site of collection were included. The collected samples were brought to the laboratory for the complete analysis of physio-chemical parameters namely Turbidity, Electric Conductivity (EC), pH, Total Dissolved Solvents (TDS), Carbonates, Bicarbonates, Total Hardness (TH), Calcium Hardness, Magnesium Hardness, Chloride by using US salinity laboratory staff (1954) method (Malik *et al.*, 1984).

### ***Statistical Analysis***

All the data gathered were subjected to the statistical analysis. The mean values of the

readings were marked to show the significance of the treatments. These values had depicted in tabular forms. The collected data was analyzed for descriptive statistics and correlation by using SPSS and Microsoft excel.

## **Results and Discussions**

### ***pH***

The pH value for all the water samples from industrial area was ranged from 6.8 to 7.1 with mean value 6.8. while the pH value for all the water samples collected control site was ranged from 6.8 to 7.0 with mean value 6.9 (figure 1). WHO range is 7.0 to 8.5, and NEQS value is 6.5 to 8.5. So the pH was not out of specs but the trend was towards acidic side. At exceedingly high or low pH levels for e.g. 9.6 or 4.5, the water becomes totally improper for most of the organisms. Low pH badly damages the aquatic life and crops if it was regularly used for irrigation, and produce acidity in stomach if use for the drinking purpose regularly. The extreme levels of the pH are also not suitable for human being's eyes and skin (Khan *et al.*, 2005).. pH values for water sample were found slightly alkaline then those reported (Khan *et al.*, 1999; Jamal and Jameroz, 2006). For some water samples in the study area where similar pH values were reported in Peshawar by (Bacha *et al.*, 2010).

### ***Electrical Conductivity***

The EC of water samples collected from industrial area was ranged from 326  $\mu\text{S}/\text{cm}$  to 431  $\mu\text{S}/\text{cm}$  with mean value 365  $\mu\text{S}/\text{cm}$ . While that of control site was ranged from 335  $\mu\text{S}/\text{cm}$  to 403  $\mu\text{S}/\text{cm}$  with mean value 357  $\mu\text{S}/\text{cm}$  (figure 3). Although the mean value of EC of industrial area was higher than control site but insignificant difference in the EC was found. EC of

drinking water samples of the study were similar as reported by (Jamal and Jamroz, 2006). Lower values than our results were reported in Skardu by (Lodhi et al., 2003) for urban area of Peshawar by (Khan et al., 2005) and in Rawalpindi by (Farooq et al., 2008). Whereas high values EC was reported for ground water samples of Sialkot city by (Ullah et al., 2009) and in AndraPerdesh India by (Venkateswarlu et al., 2011).

### **Total Dissolved Solids**

The TDS of water samples collected from industrial premises was ranged from 205 mg/L to 261 mg/L with mean value 233 mg/L. While that of control site was ranged from 211 mg/L to 218 mg/L with mean value 214 mg/L (figure 5). Although the mean values of both the industrial and control site water were within the permissible limits but significant deference was found at  $p \leq 0.05$  by using one-way ANOVA.

Water with the high concentration of the TDS cause aesthetic problem. Additionally, it makes water having undesirable taste i.e. salty bitter. Some minerals are also hazardous for the health. The most hazardous are the nitrates barium, sodium, copper, sulfates and fluorides. High TDS water have bitter taste and have also unpleasant smell. It was also less thirst quenching. This water interferes with the taste of food and beverages and makes them less desirable to consume. High TDS pose variety of health dangers some other individuals. Copper, cadmium, barium, nitrates, sodium, fluorides and sulfates are especially most problematic (Azizullah et al., 2011).

TDS in water is an indirect measure of soluble salts in water that contribute in both temporary and permanent hardness (Khan et

al., 2005). Large quantity of TDS in water may cause cardiac disease and toxemia, in women during pregnancy (Azizullah et al., 2011). So higher concentration of TDS make water unfit for drinking and also cause harness, corrosion and incrustation. Extremely low quantity of TDS is also unacceptable due to its flat and insipid taste (PCRWR, 2005).

### **Total Hardness**

The total hardness (TH) of the samples of industrial area was ranged from 243 mg/L to 322 mg/L with mean value 261 mg/L. While that of the control site was ranged from 238 mg/L to 241 mg/L with mean value 240 mg/L. Although the mean values of the TH were within the permissible limits of NEQS and WHO but significant difference in the TH of industrial and control site was found (figure 7). TH value for all water samples were found within the recommended standard of WHO (500 mg per litre). Similar TH for drinking water samples was reported by (Khan et al., 1999, Jamal and jameroz, 2006) and (khan et al., 2008) in Kohat division. Lower TH value of drinking water was reported by (Lodhi et al., 2003) in Sikardhu then present study. Positive correlation of total hardness with cation and anions in the study area reveals that drinking water shows both type of hardness, temporary as well as permanent (Sen et al., 2011; Daragen et al., 2011; Majidano et al., 2010).

### **Calcium and Magnesium Hardness**

The Ca-hardness for industrial area was ranged from 151 mg/L to 187 mg/L with mean value 170 mg/L. While that of control site was ranged from 151 mg/L to 166 mg/L with mean value 159 mg/L. Next, the Mg-hardness for industrial area was ranged from 73 mg/L to 132 mg/L with mean value 91 mg/L. while that of control site was ranged

from 78 mg/L to 83 mg/L with mean value 88 mg/L (figure 9).

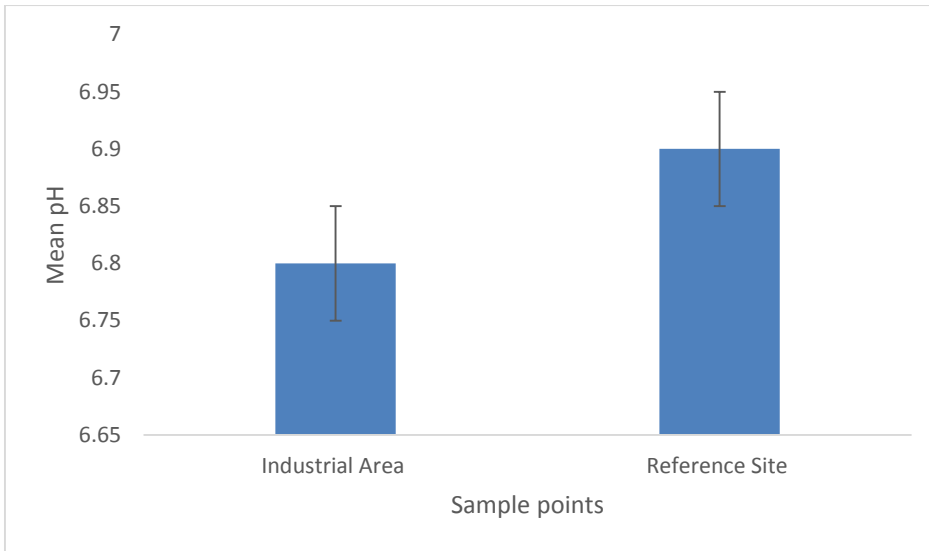


Fig. 1. Mean pH of the collected water samples from various sample points and bar shows standard deviation

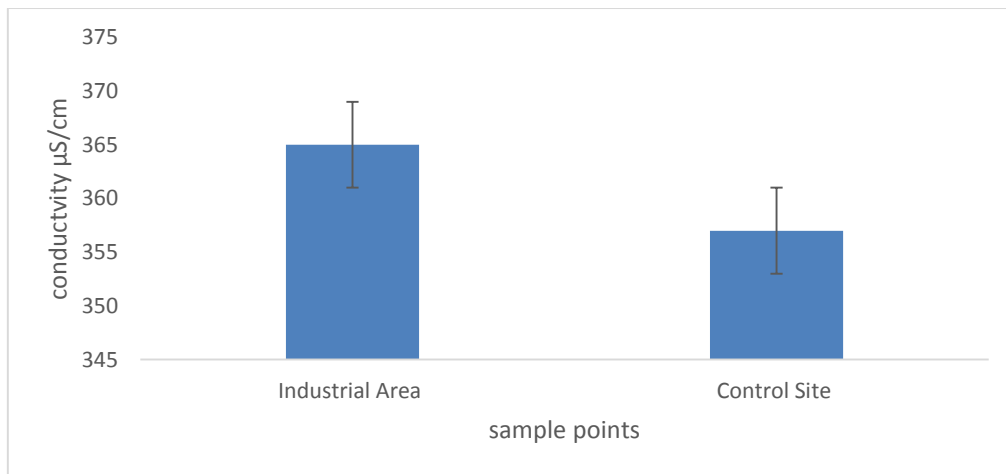


Fig. 2. Comparison of mean value of electric conductivity of various sample points

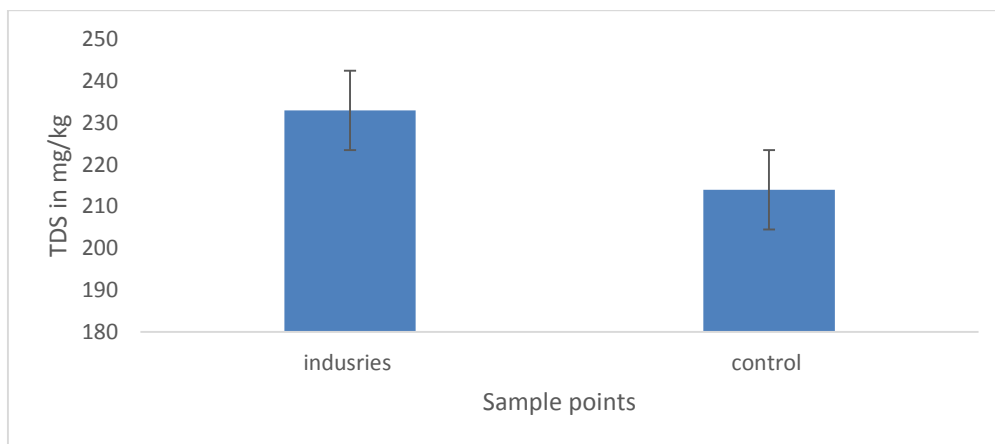


Fig. 3. Comparison of mean value of Total Dissolved Solids (TDS) of various sample points

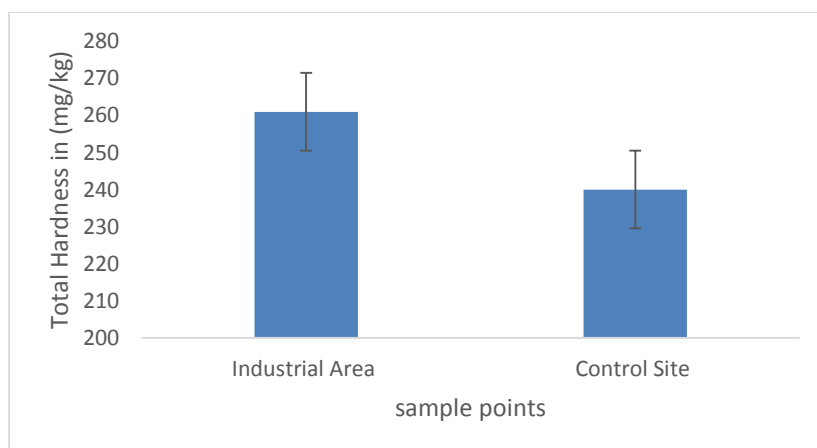


Fig. 4. Comparison of total hardness of water of various sample points

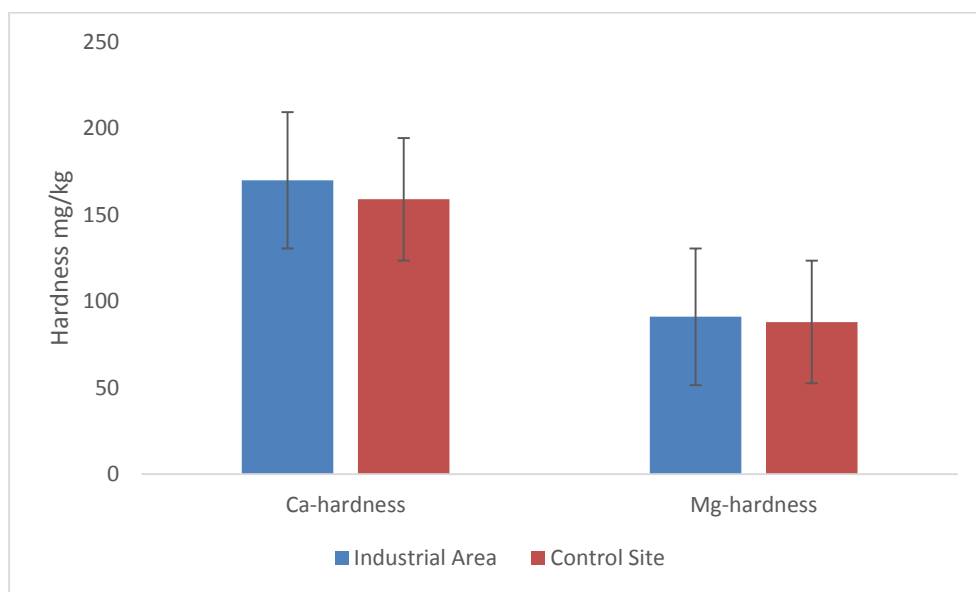


Fig. 5. Comparison of Caanf Mg Harness of water of various sample points

WHO standard was 75 and NEQS was 200, so the calcium hardness was within the permissible limits. Magnesium was also analyzed exceed the WHO (50 mg/kg) standard but it was within the Pakistan standard i.e. (100 mg/kg). Concentration of Mg reported in the present study was similar as reported (Bacha et al., 2010) in drinking water of Peshawar and (Jamal and Jamroz, 2006) in the study area whereas low Mg concentration was reported by (Khan et al., 2008) in Kohat division and Ghana by (Esumang et al., 2011).

Due to scale formation the presence of Mg in drinking water in higher concentration is considered as hazardous. However, it normal concentration play a very important role as co-factor in enzymes, hormonal and cardiovascular functions (Bacha et al., 2010). It was estimated that 40g of magnesium present in human body half of it is in the

bones and approximately 3% in serum (Armstrong, 2002).

Similar concentration of Ca was reported by (Khan et al., 1999, Jamal and Jamerroz, 2006) in study area and (Rehman and Khan 2000, Khan et al., 2005) in urban area of Peshawar where high concentration of Ca was reported for ground water samples of Andhra Perdesh India by (Venkateswarlu et al., 2011). Exposure to high concentration of Ca in potable water for short time cause no problem except long time exposure. Long time exposure may cause elevated Hypocalceemia and other side effects i.e. calculi, calcification, urinary tract and kidney soft tissues problems (Azzizullah et al., 2011). In addition, high concentration of Ca can also cause gastro diseases and stone formation (Yang et al., 1998; Vankateswarlu et al., 2 011).

### **Chlorides**

The chloride for industrial area was ranged from 12 mg/L to 20 mg/L with mean value 17 mg/L. While that of control site was ranged from 12 mg/L to 20 mg/L with mean value 19.3 mg/L (figure 12). The chlorides in the samples were analyzed by the titration technique and it was seen the chlorides amount was well within specs. It has no adequate effect on the health, but imparts the bad taste to the drinking water with increase in

the level of chloride in water. Corrosiveness of the metal also increases. Chloride was the major anion in the potable and industrial waste. But it was medically reported that to take in more than 400mg/l as chloride ions are harmful to the heart and kidney disease patient (GOP, 2004). The presence of chlorides in drinking water might be due to dissolution of salt deposits, salting of roads and highways to control ice and snow, discharge from chemical industries, oil exploration and volcanic eruptions etc.

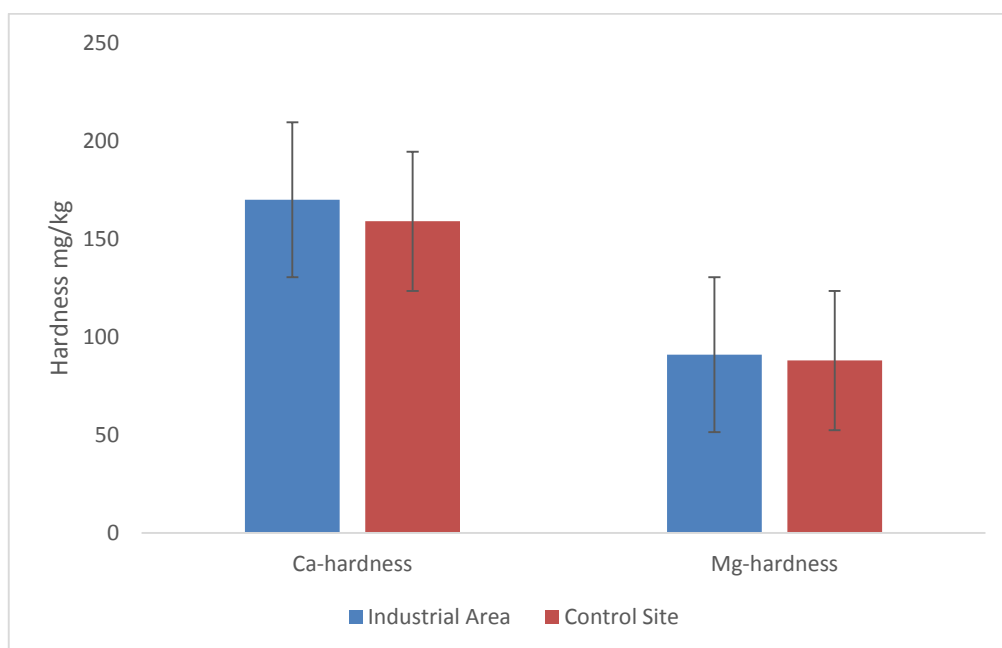


Fig. 6. Comparison of Caanf Mg Harness of water of various sample points

All of these are considered the main sources that contribute the contamination of chloride contamination in surface and underground water. The mobility of chloride ions is higher as compare to other ions that are usually found in water the availability of the ions in water is essential. It can move across the cell membrane that helps in maintaining osmotic pressure (Singh, 2014). It also helps

in balancing the acid and base rations in the cell. At the beginning the ions were considered very important but after numerous studies conducted suggested that these ions may have some malfunctions in neuro-physiology and renal activities. The high concentration of sodium and chloride ion in water not only pose threat to human beings but it may also effect wild and aquatic life. The

presence of high concentration of chloride (above 20 mg/l) in water cause odor and taste problems in drinking water (US EPA, 2005).

Similar Cl concentrations were reported by (Khan et al., 1999; Jamal and Jamroz, 2006) as reported in our study. Whoever higher concentration Cl concentration reported by (Farid et al., 2012) in Faisalabad and (Ullah et al., 2009) in Sialkot Pakistan then present study? A survey conducted suggested that that the Cl availability in water was mainly due to the geological formation and incorporation of sewage pollutants and industrial waste (PCRWR, 2005).

### ***Nitrates***

The nitrate mean value for industrial area was ranged from 0.48 t mg/L 0.72 mg/L with mean value 0.61 mg/L. While that of

control site was ranged from 0.60 mg/L to 0.66 mg/L with mean value 0.63 mg/L (figure 14).The nitrate level was within the specs and not hazardous for the health in these water samples. The specs of nitrates in the drinking water are 10 to 50 mg/L.

Industrial wastewater and surface runoff from agriculture fields is considered one of the main sources underground water contaminations of nitrate. The presence of nitrate in drinking water is important because it may cause a number of diseases in children as well as in adults. The most common disease that is caused by nitrate is blood disorder called as “Methemoglobinemia” or blue baby syndrome. In addition, its high concentration in water can cause goiter and respiratory problems. Recently linkages between nitrate and bladder and, ovarian cancer has also been found (Coren et al., 2001).

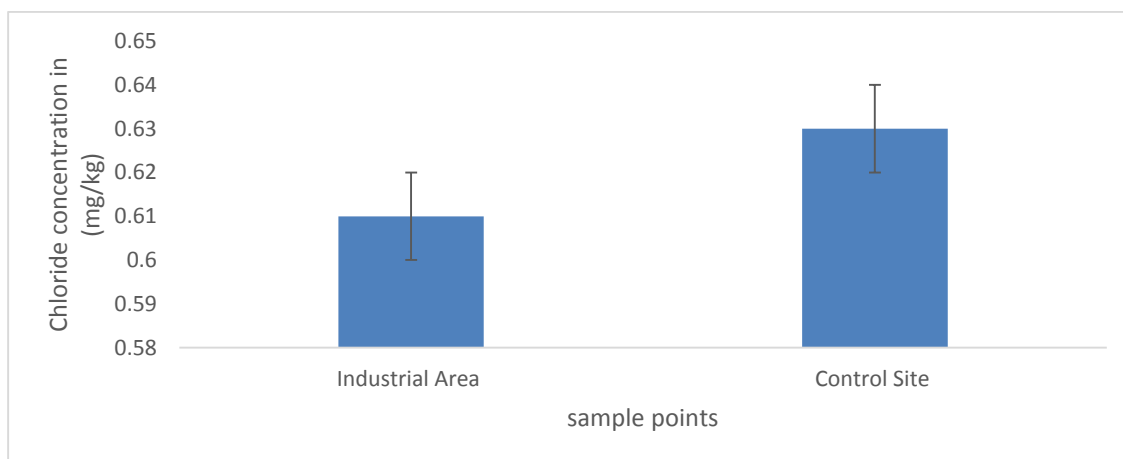


Fig. 7. Comparison of chloride concentration of water of various sample points

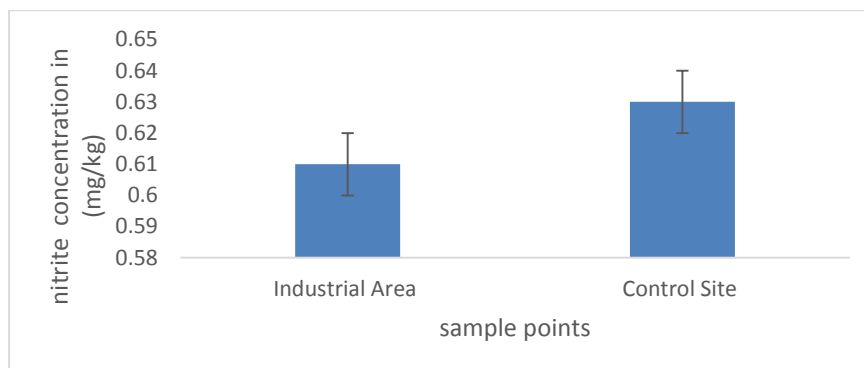


Fig. 8. Comparison of chloride concentration of water of various sample points

It was thought that nitrate reduction to nitrite caused toxicity problems in human body (Guli et al., 2002). Both the nitrates and nitrite were also considered as indicator of remote and recent faecal pollution in water subsequently. That is why, its monitoring in water is very important.

### **People Response of Industrial Area**

#### ***Sources of Drinking Water***

Results of our questionnaire survey indicated that about 90 % people were using municipal water. While approximately 10% of People were using well water for drinking purposes. The bottle and rain water were used negligibly (figure 16). It showed that a large amount of people was using municipally

supplied water for drinking purpose. This means the good the water quality of the municipal water the less the health related issues.

#### ***Water Treatment***

Our result related water treatment in the study area showed that about 2, 3 and 95% of the population were using drinking water after boiling, other treatment and without treatment respectively (figure 17). The results indicated that maximum numbers of peoples were using water without treatment. Only those were using boiling water for drinking which were patients and advised by the doctor.

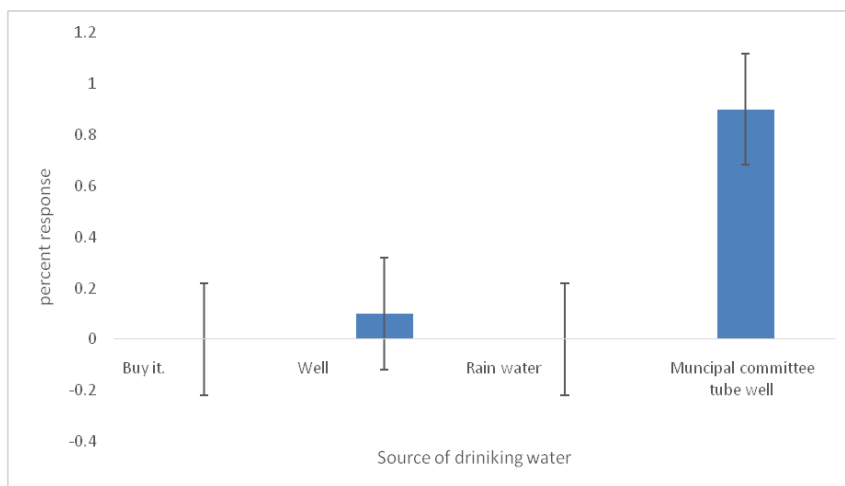


Fig. 9. Showing source of drinking water of the study area

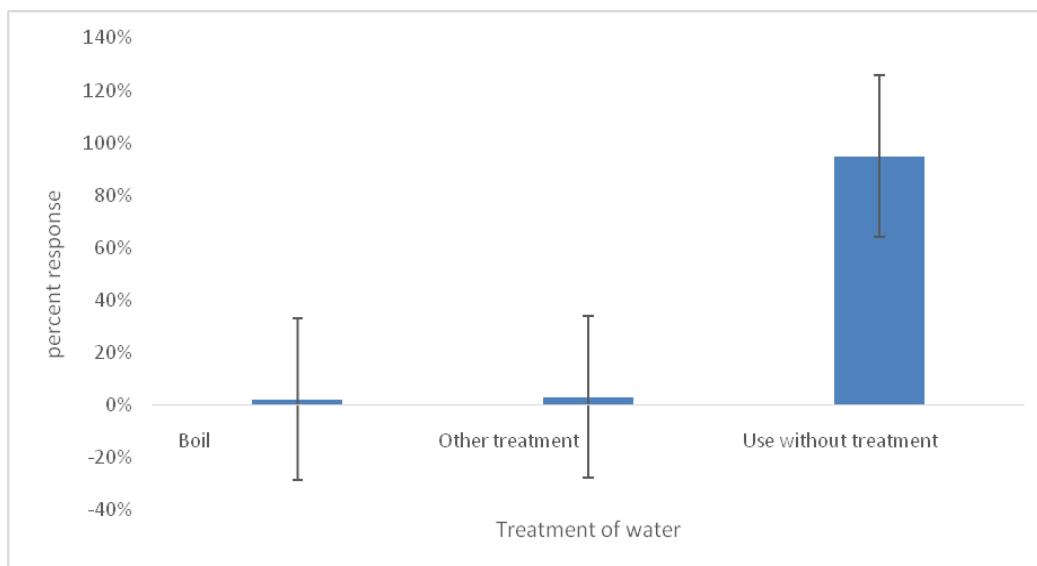


Fig. 10. Showing different treatment of drinking water of the study area

**Daily Consumption**

Our results revealed that about 45, 45 and 10 % peoples were using 8, 10 and more than 10 liters of water per day for drinking (figure 18). It showed that a large number of populations of the study area were using 8 to 10 liters of potable water per day.

**Quality of drinking water**

Many peoples in the area thinks that water is of good quality but some have not accepted the good quality and about 30% peoples have no knowledge about water quality (figure 19).

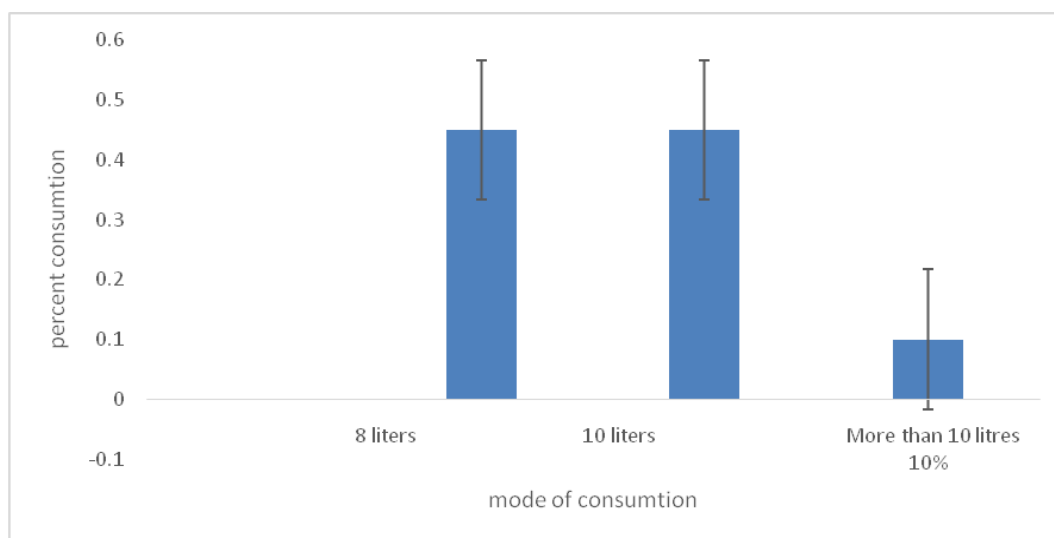


Fig. 11. Showing modes daily consumption of drinking water of the study area

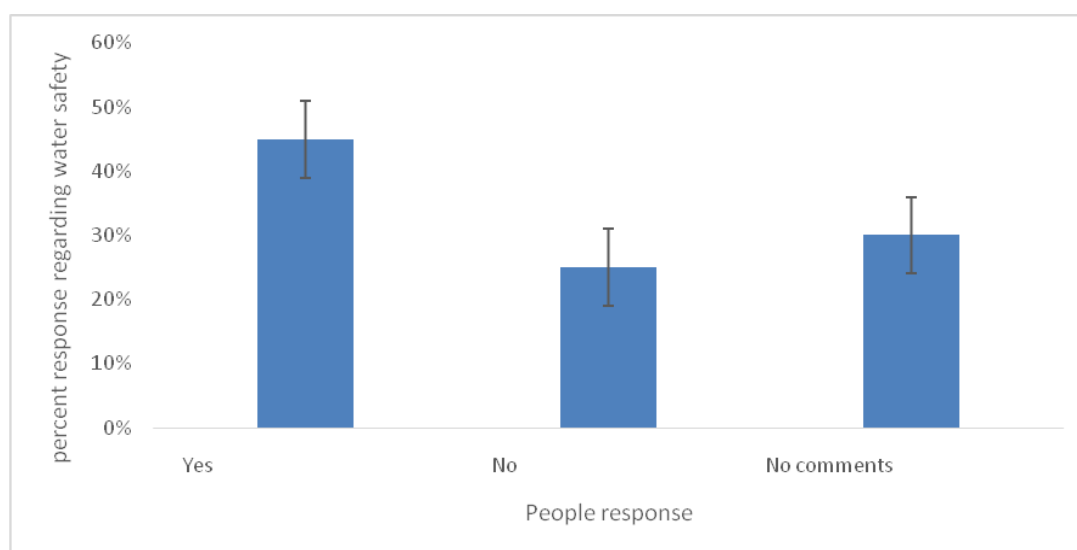


Fig. 12. Showing people response regarding quality of drinking water of the study area

***Causes of water quality degradation***

About 60% peoples think that Quality of water is degrading by the effluents but some peoples are thinking that other sources are responsible for water quality degradation.

***Associated Health Issues***

Through questionnaire survey responses of the targeted population was calculated. About 30, 20, 5, 40 and 42 % of the targeted population responded positive

regarding gastric issues, kidney diseases, stomach ulcer, depression and diarrhea (figure 16).

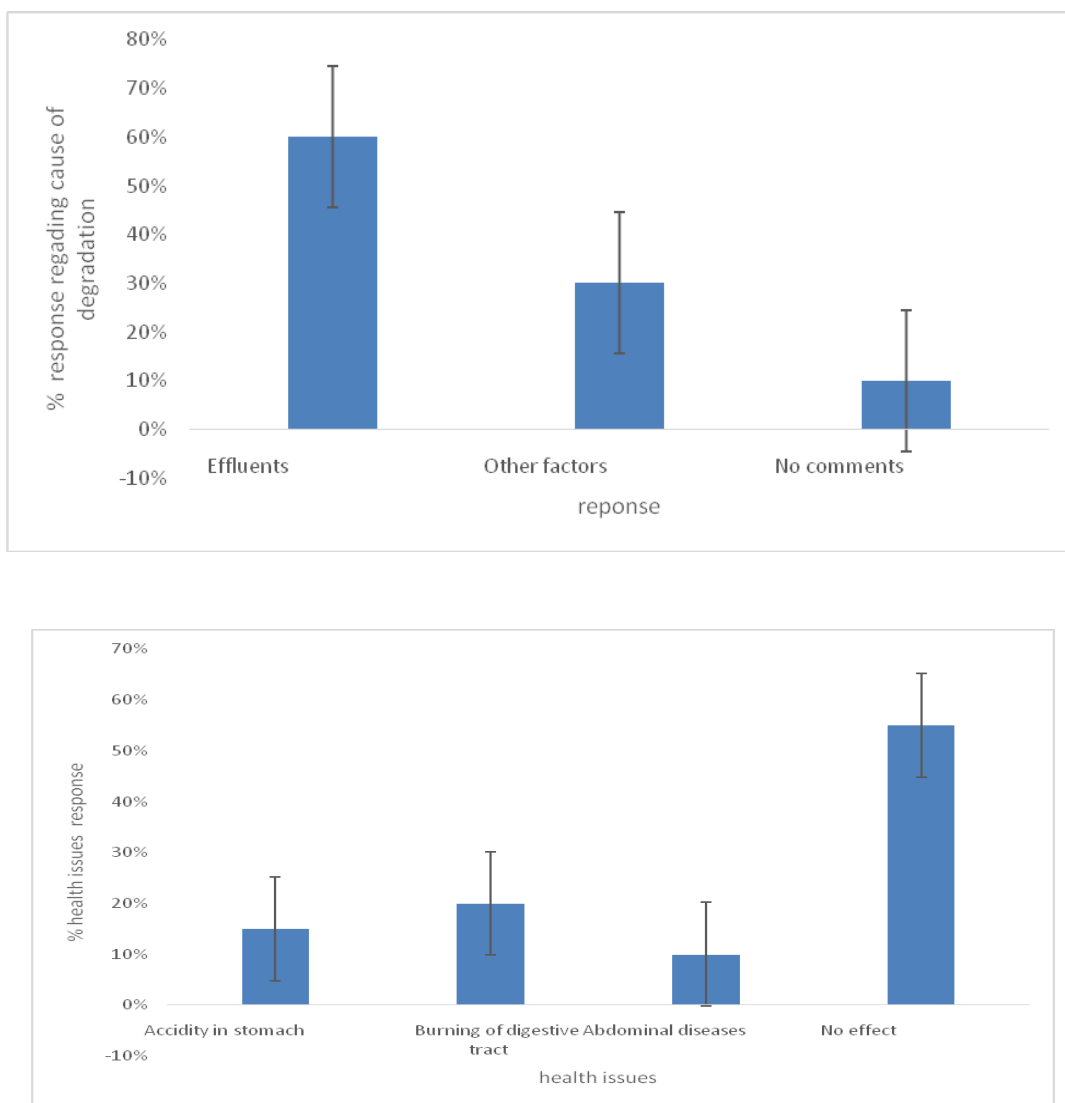


Fig. 14. Response of local population regarding health issue related to waster

### Conclusion

After comparing with World Health Organization (WHO) standards and National Environmental Quality Standards (NEQS), it was found that almost all the parameters were within the permissible limits. It was concluded

from the study that water quality of industrial area was as good as the control site because there was no significance difference in the water quality of industrial area as compared with that of control site. The health impacts identified might be due to some other reasons

and not exclusively due to drinking water of the study area.

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