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Impact of municipal solid waste (MSW) dumping on ground water quality at Muthi Jammu -A Case Study

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Abstract

The present paper deals with the physico -chemical analysis of ground water quality near a municipal solid waste dumping site at Muthi, Jammu. The impact of MSW dumping on ground water quality varies in different seasons and at different distances from the waste dumping sites .The depth of ground water also indicates the level of ground water contamination. Ground water analysis was carried for a period of seven months during (June to Dec. 2007) and thirteen parameters viz., pH, Turbidity, EC, TDS, DO, Free CO_2 , HCO_3, Total hardness,Ca^{++}, Mg^{2+} , NO_3^-, SO_4^{2-}, Cl^- were analysed for present studies. Results revealed that in some samples pH, turbidity, DO , HCO_3, total hardness, Ca^{++}, Mg^{2+}, NO_3^- were not within the standards prescribed by WHO, 1993 and BIS, 1992.

Keywords: *Physico-chemical, dumping Site, contamination, groundwater, quality*

Introduction

Water, the priceless gift of nature, vital for the existence of all life forms and hence the life line on planet Earth. Ground water accounts for more than 90% of water supply resources for many developing countries (Kolaja *et al.* 1986) and this is true for India .Rapid growth of urban areas has affected the ground water quality due to over exploitation and improper waste disposal. According to WHO, about 80% water pollution in developing countries, like India is caused by domestic waste. Ranga Raj (1996) and Indra Raj *et al.* (2000) have indicated that the ground water crosses the limits of health criteria due to anthropogenic factors like disposal of domestic waste, sewage, industrial waste and septic tanks. Auragabadkar (2000) carried out ground water quality monitoring around a municipal waste dumping site at Chennai and reported that concentration of iron and manganese were exceeding the permissible limits for drinking water. The surface runoff samples collected around the dumpsite show high organic and inorganic pollution. Lechate of soil samples also showed higher concentration of chromium, zinc, lead, iron and manganese.

Chandrasekar and Ayyappan (2006) studied impact of municipal solid waste dumping on ground water quality and results shows higher amount of contamination in the water samples which are taken within 500 meters from the dumping site which is not suitable for drinking purpose and the parameters are within the permissible limits for the remaining water samples which are suitable for drinking purposes. Ravinder *et al.* (2005) studied the impact on ground water quality due to leachate caused by solid waste.

The solid waste in Muthi is dumped in open, one of the dumping site is adjacent to a community hand pump. To study the effect of this solid waste dumping on the ground water quality, present study has been envisaged.

Materials and Methods

The contamination level of ground water has been evaluated by collecting the water samples from hand pumps located at various distances from the waste dump site. One situated near the

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MSW dumping site station(a) and the other 2.5km away station (b). The physico-chemical parameters were studied in monsoon and post monsoon season. Nearly 14 representative water samples were analysed for 13 parameters pH, Turbidity, EC, TDS, DO, Free CO_2 , HCO_3, Total hardness, Ca^{++}, Mg^{2+} , NO_3^-, SO_4^{2-} and Cl^- were selected to asses the ground water quality and samples were analysed as per standard methods of APHA, 1998.TDS was determined from electrical conductivity using the equation TDS (ppm) = 0.64 × EC (David, 1980).

Results and discussion

Results of various physico-chemical parameters of groundwater have been depicted in table–1 and figure-1.

pH

At station (a), the ground water near the waste dumping site recorded maximum pH of 9.4 in December followed by November which recorded a pH of 9.2 while the minimum pH of 5.9 was observed in October followed by 7.9 in September. The pH values of six study water samples are not within limits of standard values prescribed by WHO, 1993(6.5 to 8.5); Bureau of Indian Standards 1992 (7.0 to 8.3). Analysis of water samples have revealed that five water samples have values higher than the prescribed limits and one sample have value lower than prescribed values. A lower pH value below 4 will produce sour taste and high value above 8.5 gives bitter taste thus rendering it unsuitable for human consumption. Higher values induces the formation of trihalomethanes, which may induce cancer in human beings (Shivakumar *et al*., 2004).

At station (b), the ground water 2.5 km away from the waste dumping site recorded maximum pH of 8.8 in December followed by November which recorded pH of 8.7 while the minimum pH of 7 was observed in October followed by 7.4 in September. All water Samples are well within the limits prescribed by WHO, 1993(6.5 to 8.5); Bureau of Indian Standards, 1992 (7.0 to 8.3). pH of water samples indicates the neutral to alkaline nature which may be due to the presence of bicarbonates which undergoes hydrolysis in solution (Bindiya Langer *et al*., 2003).

Turbidity

At station (a), the ground water near the waste dump site recorded maximum turbidity of 20 NTU in June. The month of July recorded turbidity of 18 NTU while the minimum turbidity of 5.7 NTU was observed in December followed by 5.8 NTU in November. The turbidity values of all water samples are observed to be higher than the limits of International standard prescribed by WHO, 1993(5NTU); Bureau of Indian Standards, 1992 (5 NTU).

At station (b), the ground water 2.5km away from the waste dump site recorded maximum turbidity of 6 NTU in June. The month of July recorded turbidity of 5NTU while the minimum turbidity of 1.7NTU was observed in December followed by 2NTU in November. Turbidity values of all water samples are within the limits of standard prescribed by WHO, 1993 (5 NTU); Bureau of Indian Standards, 1992 (5 NTU).

Electrical Conductivity (EC)

At station (a), the ground water near the waste dumping site recorded maximum electrical conductivity of 73µsiemens/cm in October. The month of November recorded electrical conductivity of 50µsiemens/cm while a minimum of 8µsiemens/cm electrical conductivity was observed in August followed 9µsiemens/cm in July. The EC values of all water samples studied during the present investigations are within the limits of standard prescribed by WHO, 1993 (600µmhos/cm).

At station (b), the ground water 2.5km away from the waste dumping site recorded maximum electrical conductivity of 69µsiemens/cm in October, the month of November recorded electrical conductivity of 47µsiemens/cm while the minimum electrical conductivity of 4µsiemens/cm was observed in September followed by 5µsiemens/cm in July. The electrical conductivity values of all samples of present studies are within the limits of standard prescribed by WHO, 1993 (600µmhos/cm).

The EC decreased with the increase in distance of water sample from the waste dumping site, which indicates leaching effect in ground water adjacent to the waste dumping site as addition of contaminants increase EC.

Total dissolved solids (TDS)

At station (a), he ground water near the waste dumping site recorded maximum TDS of 46.72 mg/l in October, the month of December recorded TDS of 33.92 mg/l while the minimum TDS of 5.12mg/l was observed in August followed by 5.76mg/l in July. Concentration of TDS in all water samples studied during present investigations were within the limits prescribed by WHO, 1993(75mg/l); Bureau of Indian Standards, 1992 (75mg/l).

At station (b), the ground water 2.5km away from the waste dumping site recorded maximum TDS of 44mg/l in October, the month of December recorded TDS 31.36mg/l while the minimum TDS 2.56 mg/l was observed in September followed by 4.48mg/l in August. Concentration of TDS in all water samples studied during present investigations were within the limits prescribed by WHO, 1993 (75mg/l); Bureau of Indian Standards, 1992 (75mg/l).

Total hardness (TH)

At station (a), the ground water near the waste dumping site recorded maximum total hardness of 627.9mg/l in October the month of July recorded total hardness of 508.87mg/l while the minimum total hardness of 442mg/l was observed in July followed by 462mg/l in November. The total hardness values of all water samples of present studies exceeded the limits prescribed by WHO, 1993 (300mg/l); Bureau of Indian Standards, 1992 (200mg/l). Hardness of water mainly depends upon the amounts of calcium or magnesium salts or both.

Hardness is an important property of ground water from its utility point of view. The water containing excess hardness is not desirable for potable purpose. It forms scales on water heaters and utensils when used for cooking, and consumes more soap during washing of cloth. Higher values of TH may be due to leaching from solid waste dumping site.

At station (b), the ground water 2.5km away from the waste dumping site recorded maximum total hardness of 502.89mg/l in October, the month of September recorded total hardness of 496.23mg/l while the minimum total hardness of 404.786mg/l was observed in June followed by433.52mg/l in November.

Though the value for total hardness in all two stations is not within the limits prescribed by WHO, 1993 (300mg/l); Bureau of Indian Standards, 1992 (200mg/l) but comparative study reveals higher values of total hardness at station (a) located near the waste dumping site than station (b) located 2.5km from the waste dumping site.

Bicarbonate (HCO_3)

At station (a), the ground water near the waste dumping site recorded maximum bicarbonate content of 674.9mg/l in December, the month of November recorded bicarbonate content of 670.89mg/l while the minimum bicarbonate content of 320.24mg/l was observed in October followed by 386.33mg/l in July. Four water samples of present studies were found to posses' values higher than limits prescribed by WHO, 1993(500mg/l). High concentration of bicarbonate is due to the presence of humic acid which comes from decaying of organic substances present in soil and solid waste. The leachate generated from the waste dumping site might have percolated through the soil and combined with ground water.

At station (b), the ground water samples 2.5km away from the waste dump site recorded maximum bicarbonate content of 570mg/l in December. The month of November recorded Bicarbonate content of 559.16mg/l while the minimum bicarbonate content of 279.58mg/l was observed in October followed by 318.5mg/l in July. Three samples of present studies were found to posse's values higher than limits prescribed by WHO, 1993 (500mg/l)

Bicarbonate alkalinity showed a direct positive correlation with pH as they mostly tend to rise and fall together. This observation is similar to that of Zafar (1964), Sinha (1969), Singh and Sahai (1979) and Prakash (1996) who reported a direct positive correlation between Bicarbonate alkalinity and pH.

The concentration of bicarbonate decreases as we move away from the waste dumping site as the leaching effect decreases with increasing distance from the waste dumping site.

Free CO_2

At station (a), the ground water near the waste dumping site recorded maximum CO_2 content of

37.64mg/l in June, the month of July recorded CO_2 content of 32.52mg/l while the minimum CO_2 content of 8.6mg/l was observed in December followed by 9.1mg/l in November. Ground water is extra rich in CO_2 because precipitated water percolates through the soil and dissolves CO_2 from soil air and carries it into ground water, moreover decomposition of organic waste is an important source of CO_2 in water.

At station (b), the ground water samples 2.5km away from the waste dump site recorded maximum CO_2 content of 28.09mg/l in June, the month of July recorded CO_2 content of 26.47 mg/l while the minimum CO_2 content of 7.92mg/l was observed in December followed by 8.4mg/l in November.

Ground water contains considerable amount of carbon-di-oxide. The concentration of carbon-di-oxide in the water samples near waste dumpsite was found to be higher compared to water samples away from waste dumping site.

Dissolved Oxygen (DO)

At station (a), the ground water near the waste dumping site recorded maximum DO content of 5.6mg/l in December, the month of November recorded DO content of 4.9mg/l while the minimum DO content of 2.02mg/l was observed in June followed by 2.7mg/l in October. Concentration of DO in all water samples was much below the standard prescribed by WHO, 1993 (6 mg/l). Concentration of DO in four water samples was below the standard prescribed by WHO, 1993(6 mg/l).

At station (b), the ground water 2.5km away from the waste dump site recorded maximum DO content of 6.4 mg/l in December, the month of November recorded DO content of 6 mg/l while the minimum DO content of 3.7mg/l was observed in October followed by 3.9mg/l in September.

Calcium (Ca^{++})

At station (a), the ground water near the waste dump site recorded maximum calcium content of 168.46mg/l in August. The month of September recorded calcium content of 159.72mg/l while the minimum calcium content of 135.24mg/l was observed in July followed by 140.23mg/l in June. Concentration of calcium in all water samples exceeded the limits prescribed by WHO, 1993 (75mg/l); Bureau of Indian Standards, 1992 (75mg/l).

At station (b), the ground water 2.5km away from the waste dump site recorded calcium content of 133.28mg/l in October. The month of August recorded calcium content of 116mg/l while the minimum calcium content of 104.40mg/l was observed in July followed by 105mg/l in September. Concentration of calcium in all water samples exceeded the limits prescribed by WHO, 1993 (75mg/l); Bureau of Indian Standards, 1992 (75mg/l).

While comparing the concentration of calcium at all three sites, it was found that though most samples exceeded the prescribed limit but the calcium concentration was found to be much higher at site (a) located near the waste dumping site.

Minimum calcium concentration was found during monsoon season and maximum concentration was found during post monsoon season. Generally groundwater contains Ca^{2+} contents less than 100ppm and Mg^{2+} contents 50ppm (Todd and Keith, 1995). Calcium and magnesium ions in greater quantities may be present in groundwater either by leaching of soil deposits (lime stone, dolomite, gypsum, granite, siliceous, sand, serpentine etc.) or through seepage of ions from domestic waste water. The hard water causes ill effects on digestive system and moreover, the possibilities of forming calcium oxalate crystals (leading to stone formations) in the urinary tracts.

Magnesium (Mg^{2+})

At station (a), the ground water near the waste dump site recorded maximum magnesium content of 84.5 mg/l in September, the month of October recorded magnesium content of 71mg/l while the minimum magnesium content of 19.7 mg/l in December followed by 20.36mg/l in November . Concentration of magnesium in all water samples exceeded the limits prescribed by WHO, 1993 (75mg/l); Bureau of Indian Standards, 1992 (75mg/l). At station (b), the ground water 2.5km away from the waste dump site recorded maximum magnesium content of 37.9mg/l in September, the month of October recorded magnesium content of 30.90mg/l while the minimum magnesium content of 7.37mg/l was observed in November followed by 8.6mg/l in December. Concentration of magnesium in all water samples were well within the limits

prescribed by WHO, 1993 (75mg/l); Bureau of Indian Standards, 1992 (75mg/l).

Nitrate (NO_3^-)

At station (a), the ground water near the waste dumping site recorded maximum nitrate concentration of 23mg/l in July, the month of June recorded nitrate concentration of 20mg/l while the minimum nitrate concentration of 1.5mg/l was observed in October followed by 2.5mg/l in September. The concentration of nitrate in the three water samples of present studies exceeded the limits prescribed by WHO, 1993 (10mg/l).At station (b), the ground water sample 2.5km away from the waste dump site recorded maximum nitrate concentration of 4mg/l in July. The month of June recorded nitrate concentration of 3.5mg/l while the minimum nitrate concentration of 1.2mg/l was observed in October followed by 1.4mg/l in August. The concentration of nitrate in all water samples presently studied were within the limits prescribed by WHO, 1993 (10mg/l) ;Bureau of Indian Standards ,1992 (45 mg/l) .Nitrate is a poisonous component of groundwater which is natural as well as of anthropogenic origin. This is the highest oxidized form of nitrogen. Biological oxidation of nitrogenous substances from sewage is the main source of nitrate (Suresh *et al.* 1993). Shrivastva *et al.* (1998) and Olaniya and Saxena (1997) has reported the leaching of nitrate ions from soil to ground water. Excessive nitrate concentrations in drinking water pose an immediate and serious health threat to infants under three months of age the nitrate ions react with blood hemoglobin, reducing bloods capacity to carry oxygen. This produces a disease called blue baby or methemoglobinemia.

Sulphate (SO_4^{2-})

At station (a), the ground water near the waste dumping site recorded maximum sulphate concentration of 45mg/l in July. The month of June recorded sulphate concentration of 41.5mg/l while the minimum sulphate concentration of 21.5mg/l was observed in December followed by 24mg/l in November. The concentration of sulphate in all water samples were within the limits prescribed by WHO, 1993 (150mg/l); Bureau of Indian Standards 1992, (200 mg/l).At station (b), the ground water 2.5km away from the waste dumping site recorded maximum sulphate concentration of 32mg/l in July.The month of June recorded sulphate concentration of 30mg/l while the minimum sulphate concentration of 3.4mg/l was observed in December followed by 4 mg/l in November. The concentration of sulphate in all water samples were within the limits prescribed by WHO, 1993 (150mg/l); Bureau of Indian Standards 1992, (200 mg/l).However it was higher at station (a) in comparison to station (b). Sulphate is a naturally occurring anion found almost in all types of water. Sulphate salts are mostly soluble in water and impart hardness. The variation of sulphate content mainly depends on the decomposition of organic matter present in the solid waste. In anaerobic decomposition of waste, Sulphates are reduced to hydrogen sulphide causing obnoxious odours and promote corrosion. Waters with about 500mg/l sulphate have a bitter taste and those with 1000mg/l or more sulphate may cause intestinal disorders.

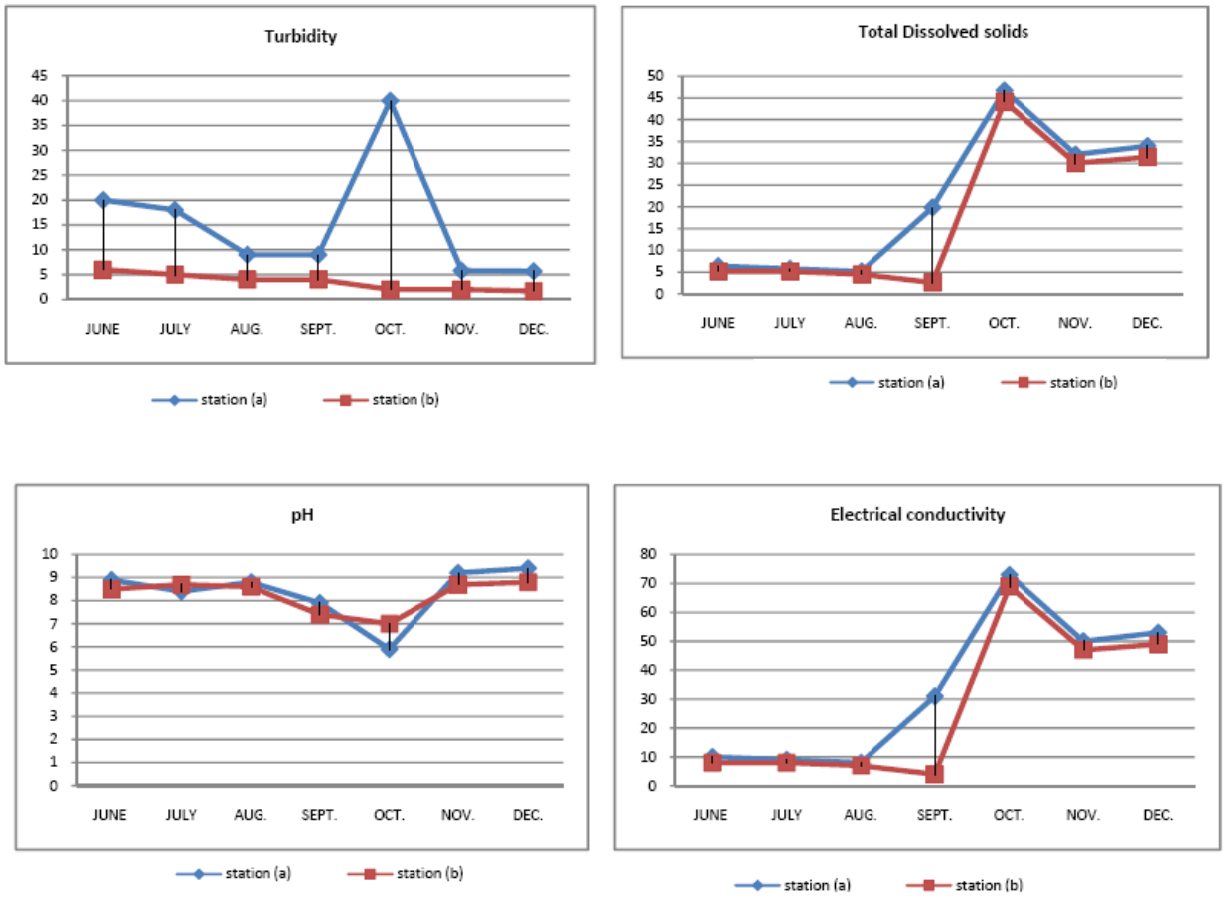
Chloride (Cl^-)

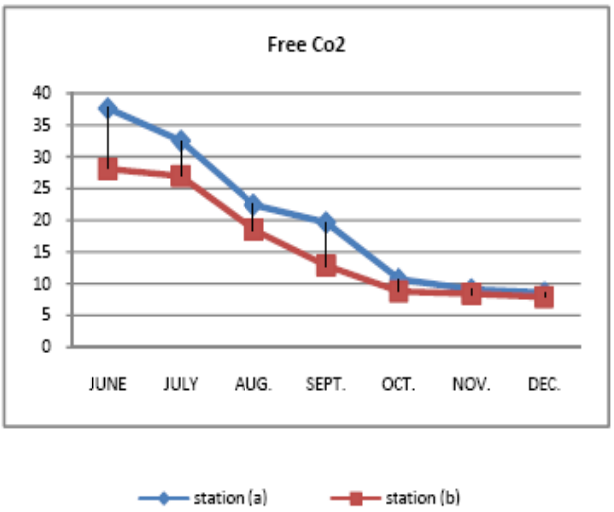
At station (a), the ground water near the waste dumping site recorded maximum chloride concentration of 103.74mg/l in October, the month of November recorded chloride concentration of 101.4mg/l while the minimum chloride concentration of 41.2mg/l was observed in July followed by 40mg/l in August. The concentration of chloride in all water samples studied during present investigations were within the limits prescribed by WHO, 1993 (200mg/l); Bureau of Indian Standards, 1992 (250 mg/l).High content of Cl^- in natural waters is regarded as pollutant from organic waste of animal origin. At station (b), the ground water 2.5km away from the waste dump site recorded maximum chloride concentration of 81.12mg/l in December, the month of November recorded chloride concentration of 76.94mg/l while the minimum chloride concentration of 18.2mg/l was observed in August followed by 26.09mg/l in July. The concentration of chloride in all samples studied were within the limits prescribed by WHO, 1993 (200mg/l); Bureau of Indian Standards, 1992 (250mg/l). However chloride concentration was higher at station (a) than station (b).Chloride is a very important parameter of detecting the contamination of groundwater by waste water. Chloride imparts bad taste to water when present at higher level than prescribed limit of 250mg/l.

Table 1: Showing physico-chemical parameters of ground water at station (a) and (b) near the municipal solid waste dumping sites

Parameters	Station (a)	Station (b)	BIS (1992)	WHO(1993)
pH	5.9-9.4	7-8.8	7.0-8.3	6.5-8.5
Turbidity	5.7-2 0	1.7-6	5.0	5.0
Electrical conductivity	8-73	4-69	-	600
Total dissolved solids	5.12-46.72	2.5-44	500	500
Total hardness	442-627.9	404.78-502	200	150
Bicabonate	320-674.9	279-570	-	500
Free CO_2	8.6-37.6	7.92-28.09	-	-
Dissolved O_2	2.02-5.6	3.7-6.4	---	6
Calcium	135.4-168.46	104.40-135.28	75	75
Magnesium	20.36-84.5	7.37-37	-	30
Nitrate	1.5-23	1.2-4	45	10
Sulphate	3-45	1-32	200	150
Chloride	35.43-103.74	26.09-81.12	250	200

Fig. 1: Showing physico-chemical parameters of ground water at station (a) and (b) near the municipal solid waste dumping sites




Free Co2
40
35
30
25
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JUNE
JULY
AUG.
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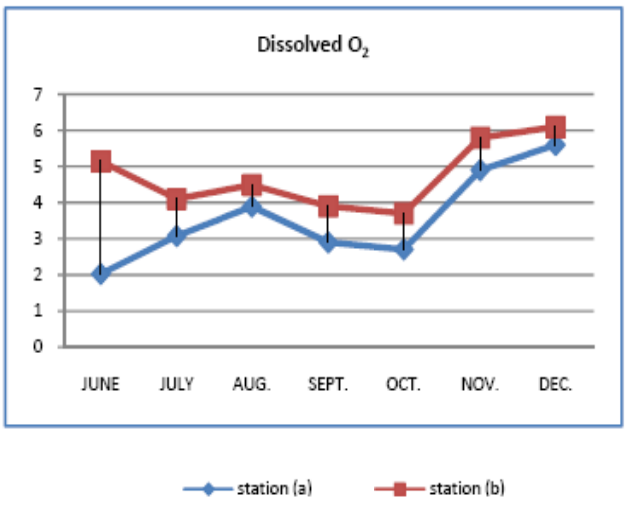
station (a)
station (b)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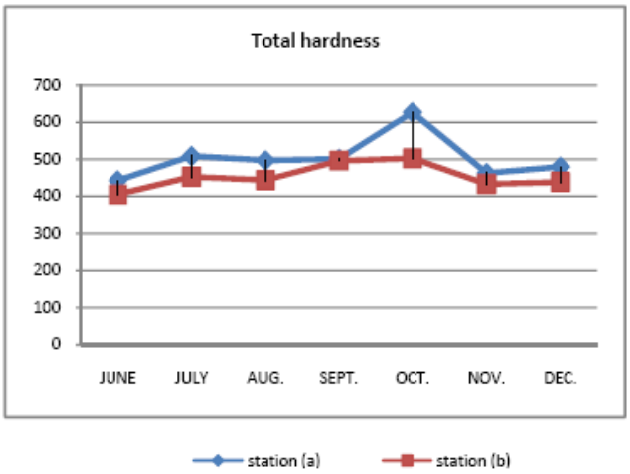
station (a)
station (b)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AUG.
SEPT.
OCT.
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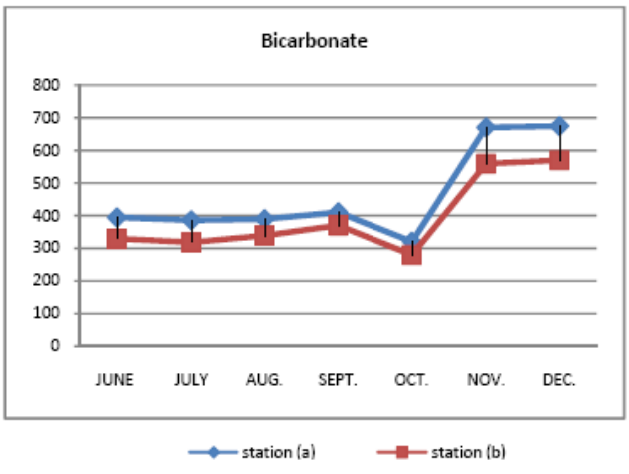
DEC.
station (a)
station (b)


Bicarbonate
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OCT.
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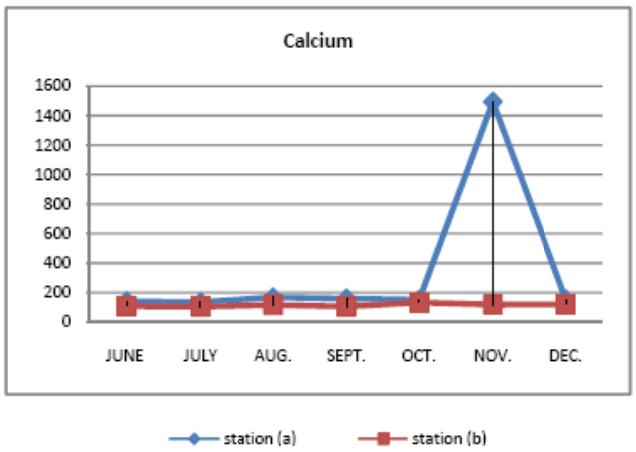
station (a)
station (b)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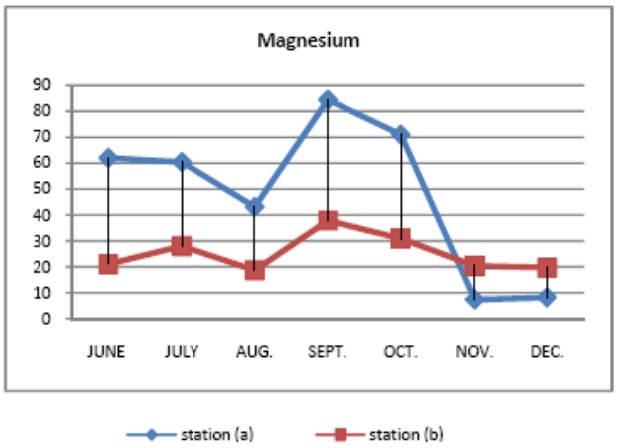
station (a)
station (b)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station (a)
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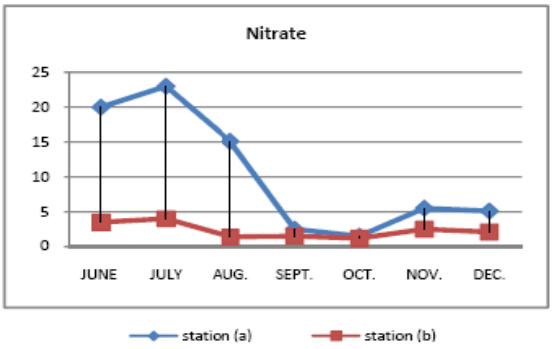

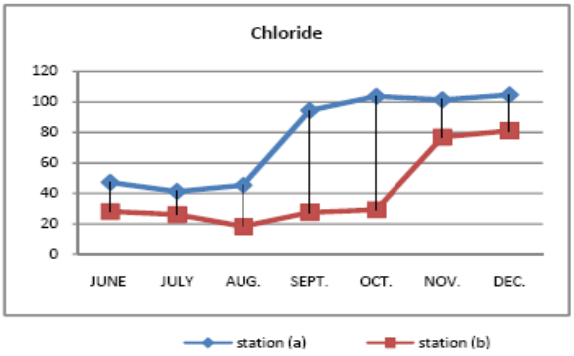

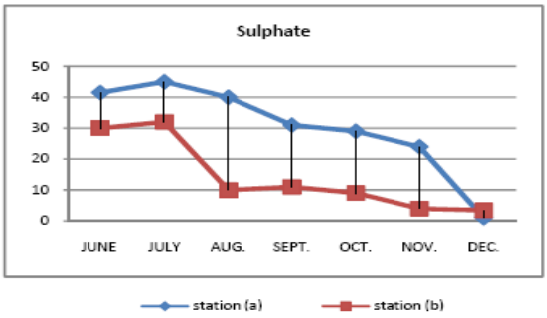

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