CHARACTERIZATION OF GROUNDWATER IN RELATION TO DOMESTIC AND AGRICULTURAL PURPOSES, SOLAPUR INDUSTRIAL BELT, MAHARASHTRA, INDIA

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Received November 14, 2013

Accepted July 22, 2014

ABSTRACT

The Solapur Industrial Belt in Maharashtra (India) is situated in the northern side of the city. The textile mills are the major industries in this belt. The hydrochemical study was undertaken by collecting 50 representative groundwater samples from dug wells and bore wells covering the entire belt. The 14 physico-chemical parameters were determined. Majority of the groundwater samples represent Na + K > Ca + Mg (alkalies exceed alkaline earths) while other groundwater samples represent Ca + Mg > Na + K (alkaline earth exceeds alkalides) hydrochemical facies. The groundwater from the study area have been classified for domestic and irrigation purpose on the basis of Sodium Absorption Ratio (SAR), Kelly’s Ratio (KR), Soluble Sodium Percentage (SSP), Residual Sodium Carbonate (RSC), Percent Sodium (% Na), Magnesium Hazard (MH), Magnesium Ratio (MR) and Permeability Index (PI). The values of majority of groundwater samples for SAR, KR, SSP, RSC, % Na, MH, MR and PI are within permissible limit indicating excellent quality for irrigation purpose. The Nitrate contents are more than the permissible limit, which is unfit for the human consumption. The textile mills, sugar industry and nitrogenous fertilizers are mainly responsible for the deterioration of the groundwater quality of the study area.

Key Words: Groundwater quality, Industrial belt, Textile mill, Domestic, Irrigation purpose

INTRODUCTION

The wastewater discharges are unavoidable in the process of industrial developments, which lead to water pollution. The inland water bodies including groundwater are becoming a sink for industrial pollutants. The impact of industrial development is varied and highly complex and many time unintentional. The establishment of industries or any manufacturing unit accelerates the development and helps to increase employment opportunities but unintentionally pollute the environment, especially through the release of effluent and emissions.

The casual attitude between the employer and industrialist also leads to this type of problem including release of toxic waste. The industrial discharges may contain pollutants like oils, plastics, phenols, suspended solids, traces of pesticides or heavy metals etc. These pollutants are generally released from various units like manufacturing, processing, cooling, desizing, bleaching, dying and treatment of materials at various stages. Such effluent containing pollutants are generally released by industries which leads to pollution of surface water and groundwater directly or indirectly. This problem arises because of inadequate measures taken by industries for the treatment of effluents. Such water polluting industries include tanning and leather industry, food industry, dairy, paper and pulp, chemical, pharmaceutical, distilleries, sugar mills and textile mills etc.

MATERIAL AND METHODS

Study area

The study area is located between 17° 36′ to 17° 42′ N latitude and 75° 55′ to 75° 58′ E longitude (Fig. 1). The Solapur is situated on
the South East fringe of Maharashtra state and lies entirely in the Bhima river basin and Seena river basin. Major part of the district is spread in either Bhima river basin or its tributaries. Solapur is one of the major cities in the state of Maharashtra, India. It is located on the borders of the states of Karnataka and Andhra Pradesh, India. The temperature of the study area widely varies in the range of maximum up to 46 °C and minimum up to 9 °C. The average rainfall of the study area is about 545 mm. Solapur stands last in the list of cities in the state of Maharashtra, India. The soil of the area can be broadly classified into three types i.e. black, coarse gray and reddish. The major crops in the study area are mainly sugarcane, jawar, wheat, chana, tur and groundnut etc.

Fig. 1: Location map of Solapur Industrial Belt, Maharashtra, India

The study was conducted in the post monsoon season of the year 2008. A grid sampling method was employed to collect the groundwater samples. Total 50 samples were collected in selected dug wells and bore wells for assessing the groundwater quality. Groundwater samples for physico-chemical analysis were collected directly into pre-cleaned polyethylene container of 1 liter capacity. The collected samples were immediately brought to the laboratory analyses. The physico-chemical analysis of groundwater samples were carried out by adopting standard methods given by APHA. All field meters and equipment such as pH meter, conductivity meter, flame photometer, UV-VIS spectrophotometer and electronic balance were calibrated and checked according to the manufacturer specifications. The pH meter was calibrated using buffers of pH 4.0, 7.0 and 9.2, conductivity was calibrated using the potassium chloride (KCl) solution provided by the manufacturer, the flame photometer was checked for malfunctioning by passing standard solutions of the sodium and potassium to be measured, the spectrophotometer was checked for malfunctioning by plotting graph of absorbance Vs standard solutions of the sulphate...
to be measured, the another parameters were measured by the titration method by using standard methods given by APHA.²⁻⁵

RESULTS AND DISCUSSION

The quality of groundwater is very important because it is the main factor which decides its suitability for domestic, industrial and agricultural purpose. Industrial effluent is the most common source of water pollution in the present day and it increases yearly due to the fact that industries are increasing because most countries are getting industrialized.⁶⁻⁷ Results of the groundwater samples (Table 1) are compared with the World Health Organization (WHO) guidelines for drinking water (WHO, 2002)⁸⁻⁹ and Bureau of Indian Standards⁹ (BIS, 1991). The concentrations that are above the guideline values are identified and discussed.

Table 1: Physico-chemical analysis of groundwater of the Solapur Industrial Belt

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>Min</th>
<th>Max</th>
<th>Average</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>-</td>
<td>7.1</td>
<td>9.2</td>
<td>7.96</td>
<td>0.45</td>
</tr>
<tr>
<td>EC</td>
<td>µS/cm</td>
<td>760</td>
<td>94300</td>
<td>20893.28</td>
<td>26789</td>
</tr>
<tr>
<td>TDS</td>
<td>-</td>
<td>486.4</td>
<td>60352</td>
<td>13371.7</td>
<td>17144.96</td>
</tr>
<tr>
<td>TH</td>
<td>-</td>
<td>160</td>
<td>1646</td>
<td>757.8</td>
<td>418.6</td>
</tr>
<tr>
<td>Ca</td>
<td>mg/l</td>
<td>40.08</td>
<td>533.06</td>
<td>212.58</td>
<td>116.39</td>
</tr>
<tr>
<td>Mg</td>
<td>mg/l</td>
<td>0.9</td>
<td>186.73</td>
<td>60.34</td>
<td>49.13</td>
</tr>
<tr>
<td>Na</td>
<td>mg/l</td>
<td>25.7</td>
<td>300.9</td>
<td>101.7</td>
<td>52.68</td>
</tr>
<tr>
<td>K</td>
<td>mg/l</td>
<td>0.1</td>
<td>58.3</td>
<td>3.21</td>
<td>8.83</td>
</tr>
<tr>
<td>CO₃⁻</td>
<td>-</td>
<td>17.5</td>
<td>20</td>
<td>18.75</td>
<td>-</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>-</td>
<td>75</td>
<td>2200</td>
<td>453</td>
<td>282.06</td>
</tr>
<tr>
<td>Cl</td>
<td>mg/l</td>
<td>26.98</td>
<td>1118.9</td>
<td>389.47</td>
<td>259.14</td>
</tr>
<tr>
<td>SO₄²⁻</td>
<td>-</td>
<td>3</td>
<td>150</td>
<td>65.84</td>
<td>37.82</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>-</td>
<td>9</td>
<td>86</td>
<td>52.1</td>
<td>19.34</td>
</tr>
<tr>
<td>Acidity</td>
<td>-</td>
<td>27.5</td>
<td>350</td>
<td>118.85</td>
<td>61.38</td>
</tr>
</tbody>
</table>

Classification of groundwater for domestic purposes

pH, EC and TDS

A list of some physico-chemical assessment of groundwater of the Solapur industrial belt is given in Table 1. It can be seen that pH of the groundwater has remained alkaline in the study area. The minimum pH value of the groundwater is 7.1 (sample no. 16, 32) and maximum value is 9.1 (Sample no.12). The average pH of the groundwater is 7.96. According to BIS (Bureau of Indian Standard),¹⁰ the desirable limit for pH in drinking water is 6.5 to 8.5. Most of the groundwater samples from the study area fall under the desirable limit during the investigation. Hence groundwater is suitable for drinking purposes in the study area and pH of groundwater samples does not cause any severe health hazard.¹¹ Conductivity reflects the concentration of dissolved solids in water mainly contributed by inorganic ions. Solids in water mainly refer to suspended or dissolved matter. Solids may affect water or effluent quality adversely in a number of ways. Water with high dissolved solids is not suitable for drinking and may induce physiological reactions in the consumer.¹² The EC values of the groundwater samples ranges from 760 to 94300 µS/cm. The average EC value of the groundwater is 20893.28 µS/cm. 50% of samples (25 samples) show EC values above 4000 µS/cm representing very poor/bad water class and very highly saline nature of water. Twelve (24%) groundwater samples show EC values above 2250 µS/cm representing poor/bad water class and highly saline water. The TDS values of the groundwater samples ranges from 486.4 to 60352 mg/l. The average TDS value of the groundwater is 13371.7 mg/l. Majority of the groundwater samples (74%) show high TDS values than maximum desirable limit given by WHO. indicating mixing of effluent water in the aquifer
and thereby contaminating the groundwater. According to the Fetter’s\(^{13}\) classification of waters based on the TDS, majority of the groundwater samples (84%) come under brackish water (TDS >1000 mg/l) and few samples (16%) come under fresh water (TDS <1000 mg/l) categories. According to APHA the maximum permissible level of dissolved solids is 500 mg/l for drinking water. Majority (98%) of the groundwater samples above the maximum permissible level from the study area.

**Hardness, calcium and magnesium**

Water hardness is an important property, which determines its utility for domestic and industrial activities. Hardness may vary over a wide range.\(^{14}\) The hardness values of the groundwater samples range from 160 to 1646 mg/l. The average hardness value of the groundwater is 757.84 mg/l. Majority of the groundwater samples (90%) represent very hard water while few samples (10%) represent hard water (Fig. 2(a)). Calcium is one of the most abundant substances of natural water being present in high quantities in the rocks. Like calcium, magnesium is also occurs in natural water and is derived from the same sources as those of calcium. Contribution of magnesium is always somewhat less than calcium. Magnesium arises principally from the weathering of rocks containing ferro-magnesium minerals and from some carbonate rocks. Mg occurs in many organometallic compounds and in organic matter, since it is an essential element for living organisms.\(^{14}\) The Calcium values of the groundwater samples range from 40.08 to 533.06 mg/l. The average calcium value of the groundwater is 212.58 mg/l. Twenty two groundwater samples (44%) show calcium content higher than the maximum desirable limit. Higher calcium concentration in groundwater shows the indication of dissolution of calcite mineral samples in the study area. The magnesium values of the groundwater samples range from 0.9 to 186.73 mg/l. The average magnesium value of the groundwater is 60.34 mg/l. Few groundwater samples (18%) show magnesium content higher than the maximum permissible limit.

**Sodium and potassium**

All natural waters contain some sodium since sodium salts are highly water-soluble and sodium is one of the most abundant elements on earth. Concentrations of sodium in natural water vary considerably depending on local geological conditions and wastewater discharges.\(^{14}\) The sodium values of the groundwater samples range from 25.7 to 300.9 mg/l. The average sodium value of the groundwater is 101.72 mg/l. Majority of the groundwater samples (98%) show sodium content below the highest desirable limit. The potassium values of the groundwater samples range from 0.1 to 58.3 mg/l. The average potassium value of the groundwater is 3.21 mg/l. A minimum concentration of potassium in groundwater samples is found during the investigation, due to most of the source rocks contain approximately equal amounts of sodium and potassium and both are released during weathering. A part of potassium goes into the clay structure and thereby its concentration gets reduced in water.\(^{15-17}\) In few samples the concentration of potassium in groundwater is high due to the natural leaching of salts.

**Alkalinity, chloride and sulphate**

Alkalinity of natural waters is its quantitative capacity to neutralize strong acid to a designated pH. An even neutral water sample shows considerable alkalinity, because it is a capacity function, different from intensity function.\(^{18}\) Carbonate, bicarbonate and hydroxide salts of calcium, magnesium and other elements contribute for the total alkalinity of groundwater samples.\(^{19,20}\) The total alkalinity values of the groundwater samples range from 75 to 2200 mg/l. The average total alkalinity value of the groundwater is 453 mg/l. Chlorides occur naturally in surface and groundwater. The main sources of chlorides are atmospheric precipitation, sedimentary rocks, domestic and industrial sewages. The chloride values of the groundwater samples range from 26.98 to 1118.96 mg/l. The average chloride value of the groundwater is 389.47 mg/l. Few groundwater samples (22%) show chloride content above maximum desirable limit (Fig. 2(b)), which indicates that the mixing of sewage waste and industrial waste in the groundwater. Sulphate is found naturally in various minerals. It is used in various chemical industries. It is the important anion in
groundwater. It reaches to groundwater from industrial waste, atmospheric deposition and natural mineral sources such as gypsum and oxidation of pyrites. The sulphate values of the groundwater samples range from 9 to 86 mg/l. The average sulphate value of the groundwater is 52.1 mg/l. Higher concentration of sulphates in drinking water imparts bitter taste to it. Sulphates in association with magnesium cause laxative particularly in children in hot climate.

Nitrate and acidity

Nitrate enter in human body through the use of ground water for drinking and cause a number of health disorders via methemoglobinemia, gastric cancer, goiter, birth malformation, hypertension, when present in higher concentration in drinking water. The nitrate values of the groundwater samples range from 3 to 150 mg/l. The average nitrate value of the groundwater is 65.84 mg/l. Majority of the groundwater samples (68%) show nitrate content above maximum desirable limit (Fig. 2(c)). The higher content of nitrates may be attributed to the anthropogenic sources like nitrogenous fertilizers, industrial effluents, human and animal wastes. Nitrate in groundwater has been linked to agricultural activities due to excessive use of nitrate fertilizers and sources related to urban development can also increase nitrate concentrations in groundwater causing an environmental hazard. The primary health effect from high nitrate levels is methemoglobinemia which affects infants up to 6 months of age and can ultimately result in death. The acidity values of the groundwater samples range from 27.5 to 350 mg/l. The average acidity value of the groundwater is 118.85 mg/l. Water pollution due to industrial processes has attained serious dimensions in India. Both, the quality and quantity of ground water is severely threatened by industrial sewage.

Classification of groundwater for irrigation purposes

The characteristic ratios of the groundwater in the Solapur industrial belt are shown in the Table 2. These ratios like Sodium Absorption Ratio (SAR), Kelly’s Ratio (KR), Soluble Sodium Percentage (SSP), Residual Sodium Carbonate (RSC), Percent Sodium (%Na), Permeability Index (PI), Magnesium Hazard (MH) and Mg/Ca ratio evaluate the groundwater quality for the irrigation purposes.
Table 2: Characteristic ratio of groundwater of the study area for the irrigation purpose

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Min.</th>
<th>Max.</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAR</td>
<td>0.54</td>
<td>4.78</td>
<td>1.71</td>
</tr>
<tr>
<td>KR</td>
<td>0.07</td>
<td>1.69</td>
<td>0.36</td>
</tr>
<tr>
<td>SSP</td>
<td>7.04</td>
<td>62.84</td>
<td>23.99</td>
</tr>
<tr>
<td>RSC</td>
<td>-25.32</td>
<td>12.86</td>
<td>-8.13</td>
</tr>
<tr>
<td>%Na</td>
<td>7.11</td>
<td>62.99</td>
<td>24.34</td>
</tr>
<tr>
<td>PI</td>
<td>13.66</td>
<td>82.02</td>
<td>40.1</td>
</tr>
<tr>
<td>MH</td>
<td>0.9594</td>
<td>74.02</td>
<td>29.53</td>
</tr>
<tr>
<td>MR</td>
<td>0.0096</td>
<td>2.8500</td>
<td>0.5241</td>
</tr>
</tbody>
</table>

**Sodium Absorption Ratio (SAR)**
The SAR values of the groundwater samples range from 0.54 to 4.78. The average SAR value of the groundwater is 1.71. The water having SAR ≤ 10 are excellent quality, 10 to 18 are good, 18 to 26 are fair and above 26 are unsuitable for irrigation purpose. The SAR values for groundwater of the study area are less than 10 and therefore indicate excellent quality for irrigation purpose.

**Kelly’s Ratio (KR)**
The KR values of the groundwater samples range from 0.07 to 1.69. The average KR value of the groundwater is 0.36. The water having KR ≤ 1 is considered to be of good quality for irrigation, on the other hand KR of more than 1 is considered to be unsuitable for irrigation and it causes alkali hazards to the soil. The KR values of most of the groundwater samples (96%) of the study area are less than 1, which considered as good quality for irrigation purpose and few groundwater samples (04%) indicate the unsuitable water quality for irrigation purpose.

**Soluble Sodium Percentage (SSP)**
The SSP values of the groundwater samples range from 7.04 to 62.84. The average SSP value of the groundwater is 23.99. The SSP values of ≤ 50 indicate good quality and if it is more than 50 it indicates the unsuitable water quality for irrigation purpose. The SSP values of most of the groundwater samples (96%) of the study area are less than 50, which indicate good quality for irrigation purpose and few groundwater samples (04%) indicate the unsuitable water quality for irrigation purpose.

**Residual Sodium Carbonate (RSC)**
The RSC values of the groundwater samples range from -25.32 to 12.86. The average RSC value of the groundwater is -8.13. If the RSC values are ≤ 1.25 indicates safe water quality, 1.25 to 2.5 indicates marginally suitable and if it is more than 2.5 then it is unsuitable for irrigation purpose. The RSC values of most of the groundwater samples (96%) of the study area are less than 1.25, which indicate good quality for irrigation purpose and few groundwater samples (04%) indicate unsuitable for irrigation purpose.

**Percent sodium**
Sodium content is usually expressed in terms of percent sodium (% Na). The calculated value of percent sodium ranges from 7.11 to 62.99. The average %Na value of the groundwater is 24.34. A maximum of 60% sodium in water is allowed for agricultural purposes. The % Na of most of the samples (88%) is below 60%, therefore the groundwater is suitable for irrigation purposes and only few groundwater samples (12%) show %Na above 60% indicate the unsuitable water quality for irrigation purpose.

**Permeability index**
According to permeability indices the waters may be divided into Class I, Class II and Class III types. Class I and Class II water types are suitable for irrigation with 75 percent or more of maximum permeability and Class III type water with 25 percent maximum permeability. The PI values for the groundwater samples range from 13.66 to 82.02. Based on the Doneens chart few groundwater samples (18%) in the study area are Class III type water.
Magnesium Hazard (MH)
Calcium and magnesium ions are essential for the plant growth but they may be associated with soil aggregation and friability. Excess of magnesium affects the quality of soils which is the cause of poor yield of crops. Szabolcs and Darab proposed the formula to specify the Magnesium Hazard (MH) for the irrigation water as follows,
\[
MH = \frac{(Mg\times100)}{(Ca+Mg)}
\]
The water having magnesium hazard < 50 are safe and suitable for irrigation. The majority (92%) of groundwater samples MH value is less than 50 and can be classified as safe and suitable for irrigation purposes.

Magnesium ratio (Mg/Ca ratio)
The concentration of magnesium ion is more important than that of calcium ion for irrigation water and their ratio serves as an index for irrigation water quality. The Mg/Ca ratio divided in three groups. The ratio below 1.5 is desirable limit (suitable for irrigation), 1.5 to 3 is moderate and above 3 is maximum permissible limit (unsuitable for irrigation). The Mg/Ca ratio of the groundwater samples ranges from 0.0096 to 2.85 (Table 2). The average value is 0.5241. The majority of groundwater samples (94%) fall in below the desirable limit while few groundwater samples (6%) fall in above desirable limit but below the maximum permissible limit.

Salinity
The EC and Na concentrations are important in classifying irrigation water. The electrical conductivity values ranges from 760 to 94300 µS/cm. The high salt content in irrigation water leads to formation of saline soil. This affects the salt intake capacity of the plants through their roots. On the basis of electrical conductivity values, Richards has classified irrigation water into five groups (Table 3). As per Richards’s classification the 25 groundwater samples (50%) falls in very poor/bad water class, 12 groundwater samples (24%) falls in poor/bad water class and 13 groundwater samples (26%) falls in fair/medium water class (Table 3). Excess salinity reduces the osmotic activity of plants and thus interferes with the absorption of the water and nutrients from the soil.

Table 3 : Irrigation water quality classification (after Richard, 1954)

<table>
<thead>
<tr>
<th>Water class</th>
<th>Salinity hazard</th>
<th>Alkali hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC µS/cm</td>
<td>No. of samples</td>
</tr>
<tr>
<td>Excellent</td>
<td>Up to 250</td>
<td>-</td>
</tr>
<tr>
<td>Good</td>
<td>250-750</td>
<td>-</td>
</tr>
<tr>
<td>Fair/Medium</td>
<td>750-2250</td>
<td>13</td>
</tr>
<tr>
<td>Poor/Bad</td>
<td>2250-4000</td>
<td>12</td>
</tr>
<tr>
<td>Very Poor/Bad</td>
<td>&gt;4000</td>
<td>25</td>
</tr>
</tbody>
</table>

Piper’s Trilinear diagram
Among the various trilinear methods of plotting, Piper’s diagram has been extensively used to understand problems about the geochemical evolution of groundwater. From the Fig. 3, it is seen that majority of the groundwater samples (29) represent Na + K > Ca + Mg (Alkalies exceed alkaline earths) while few groundwater samples (21) represent Ca + Mg > Na + K (alkaline earth exceeds alkalides) hydrochemical facies. Majority of the groundwater samples (32) represent CO₃⁺ + HCO₃⁻ > Cl⁻ + SO₄²⁻ (weak acids exceed strong acids) while few samples (18) represent Cl⁻ + SO₄²⁻ > CO₃⁺ + HCO₃⁻ (strong acids exceed weak acids) hydrochemical facies (Table 4). It is also seen that chemical properties of the groundwater from study area are dominated by alkalies and weak acids.
Fig. 3: Piper diagram showing ionic composition of groundwater samples of post-monsoon season

Table 4: Distribution of groundwater samples in the Piper’s Trilinear diagram

<table>
<thead>
<tr>
<th>Area</th>
<th>Criteria</th>
<th>Sample number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alkaline earths exceed alkalies</td>
<td>1,2,3,4,5,6,13,15,17,18,22,27,34,35,36,37,40,43,44,50,51 = 21</td>
</tr>
<tr>
<td>2</td>
<td>Alkalies exceed alkaline earths</td>
<td>7,8,9,10,11,12,14,16,19,21,23,24,25,26,28,29,30,31,32,33,38,39,41,42,45,46,47,48,49,50,51 = 29</td>
</tr>
<tr>
<td>3</td>
<td>Weak acids exceed strong acids</td>
<td>1,2,3,4,5,6,7,8,9,12,13,14,15,16,17,22,24,25,32,36,38,39,41,42,43,44,45,47,48,49,50,51 = 32</td>
</tr>
<tr>
<td>4</td>
<td>Strong acids exceed weak acids</td>
<td>10,11,18,19,21,23,26,27,28,29,30,31,33,34,35,37,40,46 = 18</td>
</tr>
</tbody>
</table>

Pollution source
The study area is divided by four regions viz textile industrial area, north effluent channel, south effluent channel and remaining all groundwater samples for the detection of pollution source. When the average values for different parameters are seen it is observed that the groundwater in the vicinity of textile mill and stream carrying textile mill effluent (North and South) are highly polluted as compare to the groundwater from other areas indicating the interaction of industrial effluent with the groundwater. From the Fig. 4, it is concluded that the main source of pollution in study area is untreated industrial effluent discharging in to the environment.
CONCLUSION

From the detailed, hydrochemical study of the groundwater it is observed that the pH of the groundwater has remained alkaline in the study area. On the basis of electrical conductivity the majority of the groundwater samples represent bad water class. This is an alarming situation and requires interventions. Majority of the groundwater samples (74%) show high TDS values than maximum desirable limit indicating mixing of effluent water in the aquifer and thereby contaminating the groundwater. According to APHA, majority (98%) of the groundwater samples above the maximum permissible level from the study area. Majority of the groundwater samples (90%) represent very hard water while few samples (10%) represent hard water. Majority of the groundwater samples (68%) show nitrate content above maximum desirable limit, which indicates that the mixing of sewage waste and industrial waste in the groundwater. The higher content of nitrates may be attributed to the anthropogenic sources like nitrogenous fertilizers, industrial effluents, human and animal wastes. The groundwater from the study area have been classified for domestic and irrigation purpose on the basis of Sodium Absorption Ratio, Kelly’s Ratio, soluble sodium percentage, residual sodium carbonate, percent sodium, permeability index and magnesium hazard. The values of majority of groundwater samples SAR, KR, SSP, RSC, % Na, PI and MH for the groundwater are within permissible limit indicating excellent for irrigation purpose. As per salinity classification the 37 groundwater samples (74%) falls in poor/bad water class. When the data was plotted on Piper’s Trilinear diagram, it is seen that majority of the groundwater samples from study area are dominated by alkalies and week acids hydrochemical facies. The main source of pollution is industrial effluent.

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**SAVE TREES FOR SAVE LIFE**