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# Physicochemical Analysis of Selected Groundwater Samples of Amalner Town in Jalgaon District, Maharashtra, India

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**Abstract:** Physicochemical characteristics of groundwater and municipal water in Amalner town by taking water samples from five different stations. The study was carried out by collecting four groundwater samples (Two open well, two bore well) and one municipal water sample during November 2007-February 2008. The results were compared with standards prescribed by WHO and ISI 10500-91. Total 15 parameters were analysed. It was found that the underground water was contaminated at few sampling sites namely Shirud Naka, Cotton Market and Shivaji Nagar. The sampling sites Dekhu road showed physicochemical parameters within the water quality standards and the quality of water is good and it is fit for drinking purpose. The correlation coefficients were calculated for water quality assessment.

**Keywords:** Groundwater, Physicochemical characteristics, Municipal water, Drinking water.

## Introduction

Water is extremely essential for survival of all living organisms. The quality of water is vital concern for mankind since it is directly linked with human welfare. In India, most of the population is dependent on groundwater as the only source of drinking water supply. The groundwater is believed to be comparatively much clean and free from pollution than surface water. But prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the groundwater to become polluted and created health problems[1]. The problems of groundwater quality are much more acute in the areas which are densely populated, thickly industrialized and have shallow groundwater tables. The rapid growth of urban areas has further affected groundwater quality due to overexploitation of resources

and improper waste disposal practices. Hence, there is always a need for and concern over the protection and management of groundwater quality[2] Considering the above aspects of groundwater contamination, the present study was undertaken to investigate the possible impact of the groundwater quality of some open wells and one municipal water sample in Amalner town of Jalgaon district of North Maharashtra region. Thus, in this paper an attempt has been made to assess the physical and chemical properties of groundwater (open well, tube well) and comparing it with municipal water.

## Experimental

Amalner town in Jalgaon district is situated at northern region of Maharashtra state lying between latitude $21^0$ 2' 30" North and longitude 75 $^0$ 4' East. The people are using open well water, tube well water as well as municipal water for their daily need. The literature survey reveals that no water quality management studies are made in this region so far. Hence the present study was planned and undertaken. Two open wells, two tube wells and one municipal water sample site selected were from different localities in Amalner town.

### *Preparation of water samples*

The samples were collected in plastic canes of three liter capacity without any air bubbles as per standard procedure. The temperatures of the samples were measured in the field itself at the time of sample collection. The samples were kept in refrigerator maintained at 4$^o$C. Water samples from five sampling points situated at different places were collected during a post monsoon period of four months (November 2007 to February 2008).The sampling locations is given in Table 1.

**Table 1.** Sampling locations.

| Sample No. | Sampling locations | Source |
|---|---|---|
| S1 | Shivaji Nagar | Tube well |
| S2 | Shirud Naka | Tube well |
| S3 | Cotton Market | Open well |
| S4 | Dheku Road | Open well |
| S5 | Weekly Market | Municipal supply water |

### *Physicochemical analysis*

Analysis was carried out for various water quality parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, dissolved oxygen (DO), total alkalinity (TA), total hardness (TH), calcium ($Ca^{2+}$) magnesium ($Mg^{2+}$), sodium ($Na^+$), potassium ($K^+$), chloride ($Cl^-$), nitrate ($NO_3^-$) sulphate ($SO_4^{2-}$), phosphate ($PO_4^{3-}$) using standard method[3-5]. The reagents used for the analysis were AR grade and double distilled water was used for preparation of solutions.

### *Statistical analysis*

The simple linear correlation analysis has been carried out to find out correlation between two tested parameters

## Results and Discussion

The average results of the physicochemical parameters for water samples are presented in Table 2.

### *pH*

pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. Most of the waters are slightly alkaline due to presence of carbonates and bicarbonates. The pH values of water samples varied between 7.1 to 8.0 and were found within the limit prescribed by WHO.

**Table 2.** Average results of the physicochemical parameters.

| S.No. | Parameter | Sampling points | | | | | WHO (1973) | ISI 10500-91 |
|---|---|---|---|---|---|---|---|---|
| | | S1 | S2 | S3 | S4 | S5 | | |
| 1 | pH | 7.1 | 7.1 | 7.1 | 8.0 | 7.9 | 7-8.5 | 6.5-8.5 |
| 2 | EC | 1052 | 2827 | 2441 | 388.9 | 386 | 1400 | - |
| 3 | TDS | 520 | 1760 | 1480 | 240 | 80 | 1000 | 500 |
| 4 | Turbidity | 0.1 | 0.1 | 0.4 | 0.4 | 2.3 | 5.0 | 10 |
| 5 | DO | 5.3 | 2.2 | 2.6 | 8.3 | 8.1 | - | 5.0 |
| 6 | TA | 300 | 604 | 647.4 | 216 | 160 | 120 | 200 |
| 7 | TH | 264 | 870 | 514 | 190 | 170 | 500 | 300 |
| 8 | $Ca^{2+}$ | 36.87 | 114.6 | 27.25 | 41.68 | 29.66 | 100 | 75 |
| 9 | $Mg^{2+}$ | 41.91 | 142.3 | 108.7 | 20.95 | 23.39 | 150 | 30 |
| 10 | $Na^{+}$ | 255.7 | 233.2 | 372.3 | 37.61 | 53.59 | 200 | 200 |
| 11 | $K^{+}$ | 0.804 | 1.005 | 2.011 | 0.402 | 4.626 | - | - |
| 12 | $Cl^{-}$ | 123.9 | 447.9 | 311.3 | 16.9 | 35.22 | 250 | 250 |
| 13 | $NO_3^{-}$ | 0.451 | 0.765 | 1.271 | 0.191 | 0.041 | 5 | 45 |
| 14 | $SO_4^{2-}$ | 21.35 | 62.92 | 89.89 | 15.73 | 21.35 | 250 | 200 |
| 15 | $PO_4^{3-}$ | 0.155 | 0.155 | 0.233 | 0.155 | 0.155 | - | - |

*All parameters are in mg/L except pH, EC and Turbidity. EC in micromho /cm, Turbidity in NTU*

### *Electrical conductivity (EC)*

Electrical conductivity is a measure of water capacity to convey electric current. It signifies the amount of total dissolved salts[6]. EC values were in the range of 386 micromhos/cm to 2827 micromhos/cm High EC values were observed for two sampling points S2 and S3 (One open well, one tube well) indicating the presence of high amount of dissolved inorganic substances in ionized form.

### *Total dissolved solids (TDS)*

Total dissolved solids indicate the salinity behavior of groundwater. Water containing more than 500 mg/L of TDS is not considered desirable for drinking water supplies, but in unavoidable cases 1500 mg/L is also allowed[7]. TDS values varied from 80 mg/L to 1760 mg/L. The sampling points S1, S2 and S3 showed higher TDS values than the prescribed limit given by ISI 10500-91.

### *Turbidity*

In most waters, turbidity is due to colloidal and extremely fine dispersions. The turbidity values varied between 0.1 to 2.3 NTU and found within the limits prescribed by ISI 10500-91.

### *Dissolved oxygen (DO)*

Dissolved oxygen is important parameter in water quality assessment and reflects the physical and biological processes prevailing in the water. The DO values indicate the degree of pollution in water bodies. DO values varied from 2.2 to 8.3. The sampling points S2 and S3 showed low DO values indicating heavy contamination by organic matter.

### *Alkalinity*

Alkalinity of water is its capacity to neutralize a strong acid and it is normally due to the presence of bicarbonate, carbonate and hydroxide compound of calcium, sodium and potassium. Total alkalinity values for all the investigated samples were found to be greater than the value prescribed by WHO.

*Total hardness (TH)*

Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water[4]. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. The hardness values shown range from 170 mg/L to 870 mg/L. The values for tube well sample from point S2 and open well sample from point S3 were higher than the prescribed limit.

*Calcium and magnesium ($Ca^{2+}$, $Mg^{2+}$)*

Calcium and Magnesium are directly related to hardness. Calcium concentration ranged between 27.25 mg/L to 114.6 mg/L and found below permissible limit, except tube well sample from sampling point S2. Magnesium content in the investigated water samples was ranging from 20.95 mg/L to 142.3 mg/L which were found within WHO limit.

*Sodium ($Na^{+}$)*

Sodium concentrations were found in between 37.61 mg/L to 372.3 mg/L. Two tube well sampling sites S1 and S2 and one open well sampling site S3 showed higher sodium concentration than the prescribed limit.

*Potassium ($K^{+}$)*

The major source of potassium in natural fresh water is weathering of rocks but the quantities increase in the polluted water due to disposal of waste water[4]. Potassium content in the water samples varied from 0.402 mg/L to 4.626 mg/L.

*Chloride ($Cl^{-}$)*

The chloride concentration serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to laxative effects[6] In the present analysis, chloride concentration was found in the range of 16.9 mg/L to 447.9 mg/L. The values are within the limit except water sample collected from sites S2 and S3. Higher chloride concentration in samples from sites S2 and S3 may be due to big discharge of sewage near the sampling sites.

*Nitrate ($NO_3^{-}$)*

Groundwater contains nitrate due to leaching of nitrate with the percolating water. Groundwater can also be contaminated by sewage and other wastes rich in nitrates. The nitrate content in the study area varied in the range 0.041 mg/L to 1.271 mg/L and found within the prescribed limit.

*Sulphate ($SO_4^{2-}$)*

Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals[5]. Discharge of industrial wastes and domestic sewage tends to increase its concentration. The sulphate concentration varied between 15.73 mg/L and 89.89 mg/L. and found within the prescribed limit.

*Phosphate ($PO_4^{3-}$)*

Phosphate may occur in groundwater as a result of domestic sewage, detergents, agricultural effluents with fertilizers and industrial waste water. The phosphate content in the study area was found in the range of 0.155 mg/L to 0.233 mg/L.

*Statistical analysis*

Interrelationship studies between different variables are very helpful tools in promoting research and opening new frontiers of knowledge. The study of correlation reduces the range

of uncertainty associated with decision making. The correlation co-efficient 'r' was calculated using the equation[8].

$$r = \frac{N\sum(X_i Y_i) - (\sum X_i).(\sum Y_i)}{\sqrt{[N\sum X_i^2 - (\sum X_i)^2][N\sum Y_i^2 - (\sum Y_i)^2]}}$$

Where, $X_i$ and $Y_i$ represents two different parameters. N = Number of total observations. The numerical values of correlation coefficient (r) for 15 parameters are tabulated in Table 3. The high positively correlated values were found between TDS and EC (0.996), DO and pH (0.911), TA and EC (0.978), TA and TDS (0.980), TH and EC (0.943), $Mg^{2+}$ and EC (0.991), $Mg^{2+}$ and TDS (0.991), $Mg^{2+}$ and TA (0.953), $Mg^{2+}$ and TH (0.974), $K^+$ and Turb. (0.940), $Cl^-$ and EC (0.989), $Cl^-$ and TDS (0.985), $Cl^-$and TA (0.939), $Cl^-$ and TH (0.979), $Cl^-$ and $Mg^{2+}$ (0.996), $NO_3^-$and TA (0.949), $NO_3^-$and $Na^+$ (0.923), $SO_4^{2-}$ and TA (0.950), $SO_4^{2-}$ and $NO_3^-$ (0.951).

**Table 3.** Correlation matrix for different water quality parameters.

| Parameter | pH | EC | TDS | Turb. | DO | TA | TH | $Ca^{2+}$ |
|---|---|---|---|---|---|---|---|---|
| pH | 1 | | | | | | | |
| EC | -0.816 | 1 | | | | | | |
| TDS | -0.783 | 0.996* | 1 | | | | | |
| Turb. | 0.621 | -0.532 | -0.566 | 1 | | | | |
| DO | 0.911* | -0.981 | -0.967 | 0.579 | 1 | | | |
| TA | -0.791 | 0.978* | 0.980* | -0.559 | -0.964 | 1 | | |
| TH | -0.681 | 0.943* | 0.950* | -0.491 | -0.885 | 0.869 | 1 | |
| $Ca^{2+}$ | -0.348 | 0.607 | 0.628 | -0.398 | -0.520 | 0.463 | 0.832 | 1 |
| $Mg^{2+}$ | -0.752 | 0.991* | 0.991* | -0.483 | -0.950 | 0.953* | 0.974* | 0.687 |
| $Na^+$ | -0.928 | 0.795 | 0.766 | -0.552 | -0.885 | 0.841 | 0.567 | 0.088 |
| $K^+$ | 0.331 | -0.257 | -0.308 | 0.940* | 0.284 | -0.282 | -0.283 | -0.357 |
| $Cl^-$ | -0.787 | 0.989* | 0.985* | -0.501 | -0.959 | 0.939* | 0.979* | 0.709 |
| $NO_3^-$ | -0.785 | 0.873 | 0.869 | -0.545 | -0.897 | 0.949* | 0.671 | 0.169 |
| $SO_4^{2-}$ | -0.665 | 0.894 | 0.889 | -0.326 | -0.871 | 0.950* | 0.734 | 0.245 |
| $PO_4^{3-}$ | -0.407 | 0.497 | 0.490 | -0.156 | 0.520 | 0.650 | 0.213 | -0.348 |

| Parameter | $Ca^{2+}$ | $Mg^{2+}$ | $Na^+$ | $K^+$ | $Cl^-$ | $NO_3^-$ | $SO_4^{2-}$ | $PO_4^{3-}$ |
|---|---|---|---|---|---|---|---|---|
| $Ca^{2+}$ | 1 | | | | | | | |
| $Mg^{2+}$ | 0.687 | 1 | | | | | | |
| $Na^+$ | 0.088 | 0.708 | 1 | | | | | |
| $K^+$ | -0.357 | -0.227 | -0.241 | 1 | | | | |
| $Cl^-$ | 0.709 | 0.996* | 0.718 | -0.243 | 1 | | | |
| $NO_3^-$ | 0.169 | 0.812 | 0.923* | -0.256 | 0.792 | 1 | | |
| $SO_4^{2-}$ | 0.245 | 0.864 | 0.810 | -0.034 | 0.832 | 0.951* | 1 | |
| $PO_4^{3-}$ | -0.348 | 0.420 | 0.713 | 0.079 | 0.732 | 0.828 | 0.815 | 1 |

*However some weak correlation were observed between $Na^+$ and $Ca^{2+}$ (0.088) so that $Na^+$ is weakly depend on $Ca^{2+}$ While low negatively correlation observed between $SO_4^{2-}$ and $K^+$ (-0.034). pH, Turbidity and DO are negatively correlated with most of the parameters, *-.*

## Conclusion

Deviations were observed by groundwater samples from municipal water and water quality standards indicating groundwater pollution. Municipal water was found to be fit for drinking purpose than groundwater.

The water samples from sites S2 (Tube well) and S3 (Open well) showed poor water quality as compared to other water samples, probably due to sewage pond close to site S2 and large sewage flowing near the site S3. The water samples from sites S2 and S3 are highly polluted and unfit for drinking purpose. The sampling point S1 (Tube well water) showed high TDS, Alkalinity and sodium content indicating the need of some treatment for minimization of the parameters. The sampling site S4 (Open well) showed physicochemical parameters within the water quality standards and the quality of water is good and it is fit for drinking purpose. The values of correlation coefficients will help in selecting proper treatment to minimize groundwater pollution.

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