ABSTRACT OF THE THESIS

“IMPACT OF URBAN SEWAGE AND INDUSTRIAL EFFLUENT ON THE GROUND WATER QUALITY IN THE VICINITY OF AHMEDNAGAR CITY.”

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ABSTRACT OF THE THESIS

Ground water is precious natural resource for several important functions such as for public, agricultural, domestic and industrial water supply. It is the surface water that seeps into the ground. This ground water act as reservoir by virtue of large pore spaces in the earth material. Due to increasing demand of water in domestic, agricultural and industrial sector, there is more exploitation of ground water. It is recognized that water is prime natural resource, a basic need and a precious national asset. The planning, development and management of resources need to be governed by national perspectives. The use of water resources over the last fifty five years have led to declining per capita availability of water, falling ground water tables and wasteful and inefficient use of water. While pressure have built up on the water resources from wide range of economic and development activities, present policy and institutional frame work has also failed to ensure equity and sustainability in the use of water. Increased industrialization, urbanization and agricultural activities during the last few decades have deteriorated the groundwater quality. Groundwater constitutes one of the principal sources of fresh water. Hence, it assumes enormous importance in domestic as well as Industrial activities. In view of the groundwater being used for potable purpose, its quality remains one
of the issues of concern. The leaching of heavy metal contaminants into the groundwater is a realistic and significant environmental hazard because of their ecotoxicological potential, non biodegradable and accumulative nature, pollute the local ecosystems and affect much larger systems. Within industrial estates, vastly accelerated emission of heavy metal pollutants inevitably renders the local ecosystems susceptible to irreversible degradation and contamination. The Ahmednagar urban agglomeration during the last three decades has emerged as a major Industrial sector, the heavy industrialization and the incasing urbanization are responsible for the rapidly increasing stress on the groundwater of the area. The enormous quantity of wastewater generated from domestic, commercial, industrial and other sources, has led to the problems of groundwater in and around Ahmednagar city. Therefore considering this serious aspect the studies carried out on seasonal groundwater quality to evaluate the impact of industrialization, urbanization and agricultural activities on environment. Both spatial and temporal variation of groundwater has been studied.

**Ground water quality studies:**

The quality of ground water is the resultant of all the processes and reactions that have acted on the water from the moment it condensed in the atmosphere to the time it is discharged by a well. Therefore, the ground
water varies from place to place, with the depth of water table and from season to season and is primarily governed by the extent and composition of dissolved solids present in it. A majority of ground water quality problems are caused by contamination and over exploitation which are difficult to detect and hard to resolve. The quality of ground water depends on a large number of individual hydrological, physical, chemical and biological factors.

Physiochemical characteristics of ground water have been studied and it is found that ground water quality deteriorated day by day.

It was observed that ground water in the area occurs under water table condition in the weathered preamble and porous zeolitic basalt. The ground water in the basaltic aquifers was predominantly topped by dug wells in the study area at a distance varying from 50 to 400 meters. The dugs wells in the study area were ranged in the depth from 30 to 60 feet. The diameter of the wells varied from 5 to 12 meters. Most of the wells were lined indicating higher thickness of alluvial and weathered basaltic aquifers. The depth of the water table was varied from 1 to 12 meters in the area. The results on water and soil summarized as.
**Physico-chemical Properties of water:**

**Temperature:** In the present study during the study period i.e. from 2009-2011 the water temperature of the well water was higher in summer and lower in winter seasons. However, during the year 2009-2010 the water temperature was higher at well number (5) 31.56°C ± 0.66 in summer season, and lower in well number (5) 19.56°C ± 0.92 in winter season. While, in the year 2010-2011 it was high in well number (3) 32.15°C ±0.56 in summer and lower in well number (9) 19.89°C± 0.56 in winter season. In Rainy season during the study period for both the years the water temperature was moderate. From the detailed study of the ground water of study area it is observed that the spatial and temporal variations of temperature is not much. The little higher temperature in pre monsoon season is recorded, because of the summer season.

**pH:** In the study during the year 2009-10 the pH values ranged from 6.78± 0.38 (well No 10) to 8.59 ± 0.08 (well no. 7). In the year 2010-11 it ranged 6.15 ± 0.89 (well no. 10) to 7.98 ± 0.58 (well no.2). The slight increase of pH can be attributed to discontinued supply of CO₂ due to cessation of rain fed charge of the aquifer (Deshmukh and Pawar, 2000).
Generally, the pH of water varies due to changes in temperature, biological activities, disposal of industrial wastes and photosynthetic activities.

**Electrical Conductivity:** The electrical conductivity (EC) vary from 194.8 ± 28.89 (W3) mmhos/cm to 399.93±36.36 mmhos/cm (W6) in summer, from 254.6 ± 55.6 (W3) to 394.3 ± 19.5 mmhos/cm (W4) in rainy season and from 188.0 ± 25.45 (W3) to 399.15 ± 20.58 mmhos/cm (W4) in winter season of the year 2009-10. During the year 2010-11 it varied from 183.2 ± 32.33 (W3) to 449.95 ± 45.56 mmhos/cm (W6) in summer, from 258.85 ± 17.88 mmhos/cm (W3) to 457.4 ± 15.89 mmhos/cm (W4) in rainy season and from 264.1 ± 21.34 (W7) to 387.95 ± 14.35 mmhos/cm (W6) in winter season. The low values of EC observed in the study area may be due to lower temperature and stabilization of water due to sedimentation (Parvateesam and Gupta, 1994; Pejaver *et al.*, 2002). The electrical conductivity is a result of electrolyte present in water is generally low in inland waters. Total dissolved solid showed a positive relationship with electrical conductance (Kumar and Paul, 1990).

**Total Dissolved Solids:** The total dissolved solids vary from 2010.57 ± 28.6 mg/l (W8) to 3099.26±30.71 mg/l (W3) in summer, from 1414.31±10.91 mg/l (W6) to 3692.41±73.35 (W2) mg/l in rainy and from 1089.11±
7.33 mg/l (W6) to 2591.44± 5.59 mg/l (W2) in winter season for the year 2009-10. During the year 2010-11 it varied from 2249.51±15.2 mg/l (W8) to 3625.42±21.2 mg/l (W3) in summer, from 21.97± 34.1 mg/l (W6) to 3942.13±47.2 mg/l (W2) in rainy season and from 1627.3±11.95 mg/l (W10) to 2714.07±10.56 mg/l (W2) in winter season. High level of dissolved solids observed in all the water samples analyzed in the present study may be attributed for their higher electrical conductivity (EC) values. The high total solids, dissolved solids and high concentration for sodium and chloride in the effluent might influence toxicity of the effluents (Ramasubramanian et.al., 1988, 2006; Mariappan et.al., 2002).

**Total Hardness:** The total hardness (TH) varied from 139.5±9.73 (W9) to 475.35±8.20 mg/l (W1) in summer, from 132.05±8.4 (W8) to 469.75± 9.6 mg/l (W7) in rainy season and from 137.8±6.47 (W9) to 416.55± 9.37 mg/l (W7) in winter season for the year 2009-10. During the year 2010-11 it varied from 189.5±9.66 (W9) to 486.53± 5.9 mg/l (W1) in summer, from 156.45± 9.35 (W8) to 479.91± 6.68 mg/l (W7) in rainy and from 156.8± 7.61 (W9) to 436.25±10.26 mg/l (W7) in winter season. Total hardness in ground water of the study area exceeded in almost all the seasons from all the sampling sites in the study area which is mainly due to increasing the solubility of calcium and magnesium salts (Garg, 2003).
The higher values may be due to use of HCL and CaCo3 in industries. The maximum level of total hardness is due to the presence of carbonate and non-carbonate hardness (Manimegalai and Muthulakshmi, 2006) which may be due to the natural accumulation of lime by rock-soil interaction kinetics or direct pollution by the industrial and domestic waste water (Murugesan et.al., 2007).

**Dissolved Oxygen (DO):** The dissolved oxygen (DO), value in the study area varied from 6.23 mg/l (W10) to 7.56 mg/l (W9) in summer, from 7.33 mg/l (W5) to 7.88 mg/l (W5) in rainy and from 7.36 mg/l (W4) to 7.68 mg/l (W7) in winter season for the year 2009-10. During the year 2010-11 it varied from 6.52 mg/l (W3) to 7.89 mg/l (W2) in summer, from 7.12 mg/l (W4) to 7.89 mg/l (W5) in rainy and from 7.19 mg/l (W9) to 7.89 mg/l (W8) in winter season. The minimum level of dissolved oxygen required for fresh water is 5.0mg/lit. It is well known fact that the oxygen balance of water is tagged with chemical oxidation on one hand and the prevailing physico-chemical conditions on the other (Mazher Sultana and Dawood Sharif, 2004).

**Biological Oxygen Demand (BOD):** The BOD values varied from 5.81 (W10) to 14.69 mg/l (W1) in summer, from 4.28 (W4) to 6.89(W3) mg/l in rainy and from 3.59 (W3) to 6.32 mg/l (W4) in winter season for the year
2009-10. During the year 2010-11 it varied from 6.89 (W9) to 13.46 mg/l (W2) in summer, from 4.22 mg/l (W10) to 6.56 mg/l (W1) in rainy and from 3.91 mg/l (W2) to 5.69 mg/l (W4) in winter season. The BOD values in the present study reveals that all the sample waters at all the sites ranging from 3.59 to 14.69 mg/l in all the samples values of BOD are beyond permissible limits. The maximum limit of BOD is 2.0 mg/l as stated by ISI (1983). This clearly indicates that the water sources are getting more polluted which are close to dumping sites.

**Chemical Oxygen Demand (COD):** The variations in the COD values during the study period in 2009-10 observed from 21.19 (W1) to 26.23 mg/l (W6) in summer, from 19.29 (W5) to 28.59 mg/l (W4) in rainy and from 22.98 (W5) to 33.26 mg/l (W2) in winter season, During the year 2010-11 it varied from 22.27 (W4) to 26.89 mg/l (W9) in summer, from 19.00 (W5) to 23.25 mg/l (W6) in rainy and from 25.45 (W6) to 30.56 mg/l (W2) in winter season. The high value of COD was obtained in nearest wells at most of the sampling sites indicating contamination of well water with relatively oxidizable organic matter. The leachate generated due to dumping up of wastes from the industries might have percolated the waste water through the soil and combined with ground water.
**Alkalinity:** The total alkalinity in the study area varied from 147.6±2.83 (W8) to 199.04± 4.42 mg/l (W1) in summer, from 98.89± 2.85(W9) to 236.24± 2.24 mg/l (W8) in rainy and from 156.04±4.36 (W3) to 193.04±3.24 mg/l (W5) in winter season for the year 2009-10. During the year 2010-11 it varied from 150.04±3.65 mg/l (W4) to 195.68±4.75 mg/l (W10) in summer, from 148.05±2.69 (W6) to 258.05± 2.64 mg/l (W3) in rainy and from 132.61±2.87 (W10) to 191.95±3.78 mg/l (W5) in winter season. The high alkalinity of water in the present study may be due to the carbonates and bicarbonates (Nayak *et al.*, 1982). Oomachan and Belsare (1986), Ghosh and George (1989) pointed out that high alkalinity indicates pollution of water and is harmful for domestic purpose, irrigation which leads to the soil damage and crop yield and imparts bitter taste to the water (Daji, 1985; Sivagurunthan and Dhinakaran, 2005).

**Chloride:** The chloride concentration in 2009-10 varied from the range of 225.24±13.92 (W87) to 497.63±9.35 mg/l (W9) in summer, from 181.31±26.5 (W1) to 366.67±9.75 mg/l (W9) in rainy and from 194.53±15.8 (W1) to 391.76±8.97 mg/l (W3) in winter season. During the year 2010-11 the chloride content varied from 189.50±27.74 (W1) to 465.66±16.35 mg/l (W10) in summer, from 151.88±18.61 (W1) to 363.92±22.46 mg/l
(W3) in rainy and from 158.30±22.21 (W1) to 363.78±9.15 mg/l (W3) in winter season. Chloride content, which was high during the present study, may be due to anthropogenic activities and addition of chloride rich fertilizers and chemicals in the area. Similarly, high chloride may be due to the high temperature during summer and addition of chloride rich chemical and fertilizers throughout the year for rising crop yield in the area (Mishra and Patel, 2007; Machale, 2010; Jadhavar, 2012; Ghorade, 2013).

**Sulphate**: The seasonal variations of sulphate (in mg/l) in the study area vary from 24.06±0.46 (W4) to 227.29±0.67 (W1) in summer, from 26.54±0.25 (W7) to 221.68±4.4 (W1) in rainy and from 18.84±0.29 (W9) to 223.65±0.88 (W1) in winter season during the year 2009-10. During the year 2010-11 it varied from 23.43±0.45 (W9) to 445.02±0.16 (W8) in summer, from 24.78±0.44 (W4) to 199.15±0.86 (W6) in rainy and from 24.55±0.26 (W9) to 229.76±0.28 (W1) in winter season. From the above study it is observed that sulphate content in all the sampling sites from all the seasons of the study period fall within the prescribed limit. The sulphate concentration of water may change with time during infiltration of rainfall and ground water recharge (Ramesh and Elango, 2006).
**Phosphate:** The phosphate content in summer from most of the wells during the study period 2009-10 to 2010-11 was observed more than 1.0mg/l (Well no. 1, 2, 3,4,5,6 and 7). However, during the rainy and winter season it was below 1mg/l in all the wells. The average concentration of phosphate in summer season is more than 1mg/l and below in rainy and winter season. Low values of phosphate observed in the study area may be due to the fact that as tropical water always possess low concentration of phosphate (Dasgupta and Purohit, 2001). The maximum concentration of phosphate in the study area is $1.95 \pm 0.65$ mg/l (W3).

**Nitrates:** The nitrate content varied from $6.25 \pm 0.16$ mg/l (W5) to $30.88 \pm 0.43$ mg/l (W1) in summer, from $2.13 \pm 0.26$ (W8) to $29.48 \pm 0.58$ mg/l (W2) in rainy and from $3.97 \pm 0.19$ (W7) to $29.48 \pm 1.19$ mg/l (W2) in winter season during the year 2009-10. During the year 2010-11 it varied from $4.82 \pm 0.23$ (W5) to $39.75 \pm 0.80$ mg/l (W2) in summer, from $2.58 \pm 0.44$ (W7) to $39.4 \pm 1.34$ mg/l (W2) in rainy and from $2.8 \pm 0.19$ (W3) to $29.72 \pm 2.48$ mg/l (W2) in winter season. Kasturi., *et. al.* (2005) stated that the major contribution to nitrate concentration is given by biological oxidation of organic nitrogenous substances from sewage and industrial wastes and the higher concentration of nitrogen may be due to the scanty flow of water and percolation of water. The lower values of nitrate in some of the sampling wells in the study area
may be due to relatively stable thermal stratification and incomplete circulation of water (Suresh et.al., 1992).

**Calcium:** It is observed that the values of calcium are as high as $1999 \pm 11.86$ in (W4) in summer season for the year 2009-10. The lowest values of calcium were observed in the well number 2 with values of $218.4 \pm 11.57$ mg/l (W2) in rainy season for the year 2009-10. The high calcium content in the ground water can be related to oxidation of organic matter releasing free calcium in the solution in the acidic pH (Goel and Jadhav, 1983).

**Magnesium:** The average concentration of magnesium for ground water in the study area is found to be low i.e. $12.97 \pm 10.15$ mg/l (W10) in summer season for the year 2009-10. The maximum concentration of magnesium is found in well no. 6 i.e. $497.6 \pm 8.45$ mg/l (W6) in winter season (W6) for the year 2009-10 which may increases hardness of water which involve in scale formation in the boilers. The higher values of magnesium reflect the contamination of ground water due to industrial effluents. (Rajmohan et.al., 1997)

**Sodium:** It is observed that the seasonal variations of sodium in the study area varied from season to season. Sodium concentration varied from $85.18 \pm 1.84$ (W6) to $386.88 \pm 3.64$ mg/l (W3) in summer, from $354.67 \pm 3.67$
to 1879.8±12.54 mg/l (W7) in rainy and from 94.65±8.24 mg/l (W6) to 348.99±4.67 mg/l (W3) in winter season for the year 2009-10. During the year 2010-11 it varied from 98.47±1.24 (W6) to 451.77±5.84 mg/l (W3) in summer, from 495.95±5.68 (W6) to 1992.61±12.6 mg/l (W3) in rainy and from 92.75±1.13 (W6) to 339.87±3.39 mg/l (W7) in winter season. It is further interesting to note that the average value of sodium for the ground water in the study area is higher than that of concentration of effluent which is due to the fact that apart from the contamination of ground water from the effluent, the natural process which increases the sodium concentration in water are more important.

**Potassium:** The potassium in the ground water in the present study shows seasonal variation ranging from 3.89±0.98 (W10) to 8.62±1.77 mg/l (W3) in summer, from 2.58±0.95 (W4) to 5.39±1.19 mg/l (W8) in rainy and from 3.77±1.09 (W2) to 8.12±1.39 mg/l (W8) in winter season for the year 2009-10. During the year 2010-11 it varied from 5.79±2.06 (W3) to 9.72±1.24 mg/l (W7) in summer, from 2.68±0.97 (W10) to 5.98±0.57 mg/l (W2) in rainy and from 3.33±1.51 (W3) to 9.66±1.19 mg/l (W9) in winter season. The lower values of potassium are particularly due to the absence of potential source in the soil but reflected the use of potash fertilizers in the area. Like sodium weathering of rocks is the major source in
natural water and waste disposal from the industrial clusters increases its concentration.

**Physico-chemical Properties of Soil Samples**

**pH:**

In summer, during the present of study period (2009-10) the pH level in soil was ranged between 6.64 to 7.92. The lower level of pH was recorded in (S1) and higher level was recorded in (S5). During second year (2010-11) it was ranged between 6.65 to 7.89. The minimum level of pH was recorded in (S3) and higher level was in (S10).

In rainy, pH level in soil was ranged between 6.15 to 6.90. The lower level of pH was recorded in (S5) and higher level was recorded in (S3) in the year (2009-10). During second year (2010-11) it was ranged between 6.20 to 6.75. The minimum level of pH was recorded in (S3) and the maximum level was recorded in (S12).

In winter (2009-10), pH was ranged between 7.15 to 7.98. The lower level of pH was recorded in (S1) and higher level was observed in (S9). During second year (2010-11) it was ranged between 7.11 to 7.94. The minimum level of pH was observed in (S1) and maximum level of pH was recorded in (S9).

In the present study in both the years (2009-11) pH level was recorded lower in rainy and higher in summer compared to two other seasons. The successive effluent in river affected the pH of irrigated soil and lead to
accumulation of salts in the soil. Increase in soil pH has significant effect on seed germination (Reddy, 1991).

**Alkalinity (mg/l):**

In summer, during the present of study period (2009-10) the alkalinity level in soil was ranged between 139.86 to 195.29 mg/l. The lower level of alkalinity was recorded in (S4) and higher level was recorded in (S8). During second year (2010-11) it was ranged between 122.56 to 198.52 mg/l. The minimum level of alkalinity was recorded in (S10) and maximum level was recorded in (S5).

In rainy, alkalinity level in soil was ranged between 124.24 to 198.18 mg/l. The lower level of alkalinity was recorded in (S2) but in (S6) it was reported to be at higher level. During second year (2010-11) it was ranged between 111.53 to 198.52 mg/l. The minimum level of alkalinity was recorded in (S5) but in (S1) it was reported to be at maximum level.

In winter (2009-10), alkalinity level was ranged between 225.14 to 267.75 mg/l. The lower level of alkalinity was reported in (S5) but in (S10) it was reported to be at higher level. During second year (2010-11) it was ranged between 230.23 to 298.45 mg/l. The minimum level of alkalinity was reported in (S2) and maximum level was recorded in (S3).

In the present study in both the year (2009-11) alkalinity level was recorded lower in summer and higher
in winter compared to two other seasons. High value of alkalinity was observed in winter due to the anaerobic sediments, bacteria reduce nitrate to ammonium and NP; phosphorus remains soluble because it does not form insoluble compounds with metals under these conditions (Libes, 1992; Ingall and Jahnke, 1997; Auti, 2002; Matkar, 2008; Machale, 2010; Wagh, 2013; Jadhavar, 2013; Ghorade, 2013).

**Sodium (mg/l):**

In summer, during the present of study period (2009-10) the sodium content in soil was ranged between 135.65 to 199.16 mg/l. The lower level of sodium was recorded in (S6) and higher level was recorded in (S2). During second year (2010-11) it was ranged between 121.56 to 168.54 mg/l. The minimum level of sodium was recorded in (S3) and maximum level was recorded in (S8).

In rainy, sodium content in soil was ranged between 88.14 to 125.37 mg/l. The lower level of sodium was recorded in (S1) and higher level was recorded in (S4). During second year (2010-11) it was ranged between 87.16 to 123.54 mg/l. The minimum level of sodium was recorded in (S6) and maximum level was recorded in (S9).

In winter (2009-10), sodium content was ranged between 82.22 to 98.48 mg/l. The lower level of sodium
was reported in (S1) and higher level in (S7). During second year (2010-11) it was ranged between 83.22 to 99.54 mg/l. The minimum level of sodium content was recorded in (S2) and maximum level was recorded in (S6).

In the present study period of (2009-11) sodium level was recorded lower in winter and higher in summer compared to two other seasons. The ratio of sodium to total cations is important in agriculture and human pathology. Soil permeability can be harmed by a high sodium concentration (APHA, 1995). There are no health based drinking water standards for sodium and potassium.

**Potassium (mg/l):**

In summer (2009-10), potassium content was ranged between 62.15 to 74.13 mg/l. The lower level of potassium was reported in (S3) but in (S10) it was reported to be at higher level. During second year (2011-12) it was ranged between 65.25 to 78.14 mg/l. The minimum level of potassium content was reported in (S3) but in (S8) it was reported to be at maximum level.

In rainy, during the present of study period (2009-10) the potassium content in soil was ranged between 63.23 to 69.89 mg/l. The lower level of potassium was recorded in (S6) and higher level was reported in (S10). During second year (2010-11) it was ranged between 62.51 to 69.53 mg/l. The minimum level of potassium
was recorded in (S5) and maximum level was reported in (S9).

In winter, potassium content in soil was ranged between 63.22 to 69.15 mg/l. The lower level of potassium was recorded in (S1) but in (S3) it was reported to be at higher level. During second year (2010-11) it was ranged between 62.82 to 69.24 mg/l. The minimum level of potassium was recorded in (S5) and maximum level was reported in (S9).

In the present study in the year (2009-10) potassium content was recorded lower in summer and higher in rainy. During (2010-11) higher in summer and lower in rainy season. The major source of potassium in natural water is weathering of the rocks but the quantities increases in the polluted water due to disposal of waste water. It has a similar chemistry like sodim and remains mostly in solution without undergoing any precipitation.

**Sulphate (mg/l):**

In summer, during the present of study period (2009-10) the sulphate content in soil was ranged between 131.21 to 193.42 mg/l. The lower level of sulphate was recorded in (S1) and higher level was reported in (S2). During second year (2010-11) it was ranged between 118.55 to 198.59 mg/l. The minimum level of sulphate was recorded in (S10) and maximum level was reported in (S6).
In rainy, (2009-10) sulphate content in soil was ranged between 235.46 to 294.69 mg/l. The lower level of sulphate was recorded in (S5) and higher level of sulphate was recorded in (S4). During second year (2010-11) it was ranged between 295.87 to 245.18 mg/l. The minimum level of sulphate was recorded in (S5) and maximum level was reported in (S4).

In winter (2009-10), sulphate content was ranged between 181.36 to 189.92 mg/l. The lower level of sulphate was reported in (S9) and higher level in (S4). During second year (2010-11) it was ranged between 117.64 to 198.81 mg/l. The minimum level of sulphate content was reported in (S10) but in (S9) it was reported to be at maximum level.

In the present study in both the year (2009-11) sulphate content in was recorded lower in summer and higher in rainy compared to two other seasons. Sulphate ions usually occur in natural water. Many sulphate compounds are readily soluble in water. Most of them originate from the oxidation of sulphide ores, the solution of gypsum and anhydrite, the presence of shales, particularly those rich in organic compounds and the existence of industrial wastes.

Phosphate (mg/l):

In summer, during the present of study period (2009-10) the phosphate content in soil was ranged between 131.21 to 193.42 mg/l. The lower level of
phosphate was recorded in (S1) and higher level was reported in (S2). During second year (2010-11) it was ranged between 2.58 to 3.91 mg/l. The minimum level of phosphate was recorded in (S2) and maximum level was reported in (S10).

In rainy, phosphate content in soil was ranged between 1.52 to 3.64 mg/l. The lower level of phosphate was recorded in (S2) and higher level of phosphate was recorded in (S8). During second year (2010-11) it was ranged between 1.18 to 3.93 mg/l. The minimum level of phosphate was recorded in (S1) and maximum level was reported in (S10).

In winter (2009-10), phosphate content was ranged between 3.34 to 4.62 mg/l. The lower level of phosphate was reported in (S2) but in (S10) it was reported to be higher level. During second year (2010-11) it was ranged between 3.16 to 4.56 mg/l. The minimum level of phosphate content was reported in (S1) but in (S10) it was reported to be at maximum level.

The phosphate content was recorded lower in rainy and higher in winter compared to two other seasons. Phosphates and nitrates are the main nutrients responsible for the process of eutrophication that leads to ultimate environmental degradation (Reynolds, 1991; Kodarkar et.al., 1991; Kodarkar and Chandrasekhar, 1995). Phosphate in the nature present mostly in inorganic forms. The major sources of phosphate are
domestic sewage, detergents, agricultural effluents with fertilizers and industrial wastewaters.

**Nitrate (mg/l):**

In summer, during the present of study period (2009-10) the nitrate content in soil was ranged between 2.13 to 2.41 mg/l. The lower level of nitrate was recorded in (S8) but in (S5) it was reported to be at higher level. During second year (2010-11) it was ranged between 2.18 to 2.48 mg/l. The minimum level of nitrate was recorded in (S1) but in (S10) it was reported to be at maximum level.

In rainy, nitrate content in soil was ranged between 2.42 to 3.89 mg/l. The lower level of nitrate was recorded in (S6) and higher level of nitrate was reported in (S8). During second year (2010-11) it was ranged between 2.37 to 3.76 mg/l. The minimum level of nitrate was recorded in (S1) and maximum level was reported in (S10).

In winter (2009-10), nitrate content was ranged between 2.30 to 2.69 mg/l. The lower level of nitrate was reported in (S3) The higher level reported in (S4). During second year (2010-11) it was ranged between 2.32 to 2.98 mg/l. The minimum level of nitrate content was reported in (S8) but in (S10) it was reported to be at maximum level.

In the present study period of (2009-10) nitrate content in soil was recorded lower in summer and higher
in rainy compared to two other seasons while in second year (2010-11) the nitrate content was lower in summer and higher in rainy compared to two other seasons. Nitrate is a problem as a contaminant in surface water and (primarily from groundwater and wells) due to its harmful biological effects. High concentrations can cause methemoglobinemia, and have been cited as a risk factor in developing gastric intestinal cancer (Pondhe, 2005).

**Trace Elements:**

**Iron (Fe):** The concentration of iron in ground water of study area varies from 0.14±0.084 (W3) to 0.96±0.238 mg/l (W4) in summer, from 0.35±0.144 (W3) to 0.74±0.138 mg/l (W4) in rainy and from 0.15±0.123 (W3) to 0.67±0.185 mg/l (W4) in winter season for the year 2009-10. During the year 2010-11 it varies from 0.25±0.063 to 0.96±0.136 (W4) in summer, from 0.23±0.162 (W5) to 0.79±0.184 mg/l (W4) in rainy and from 0.14±0.084 (W3) to 0.64±0.156 mg/l (W6) in winter season. The Bureau of Indian standards has recommended 0.3 mg/l as the desirable limits and 1.0 mg/l as the maximum permissible limit for drinking water (BIS, 1991). High concentrations of iron generally cause inky flavour, bitter and astringent taste. It can also discolour clothes, plumbing fixtures and cause scaling which encrusts pipes.
**Copper (Cu):** In the present study the Copper concentration varies from 0.237±0.014 (W5) to 0.496±0.011 mg/l (W2) in summer, from 0.236±0.054 (W4) to 0.393±0.213 mg/l (W9) in rainy, and from 0.254±0.03 (W5) to 0.463±0.15 mg/l (W9) in winter season for the year 2009-10. During the year 2010-11 it varied from 0.348±0.014 (W6) to 0.522±0.09 mg/l (W1) in summer, from 0.248±0.016 mg/l (W8) to 0.368±0.63 mg/l (W9) rainy, and from 0.269±0.0.011 (W5) to 0.461±0.015 mg/l (W3) in winter season. The toxicity of copper to aquatic life is dependent on the alkalinity of water, as copper is generally more toxic to aquatic fauna at lower alkalinitities (Train, 1979). Over doses of copper may also lead to neurological complications, hypertension, liver and kidney dysfunctions (Rao., *et al.*, 2001, Krishna and Govil, 2004).

**Manganese (Mn):** In the present study the Manganese concentration varies from 0.032±0.011 (W3) to 0.451±0.024 mg/l (W1) in summer, from 0.096±0.004 (W3) to 0.361±0.028 mg/l (W2) in rainy, and from 0.043±0.006 (W4) to 0.193±0.015 mg/l (W6) in winter season for the year 2009-10. During the year 2010-11 it varied from 0.057±0.015 (W7) to 0.455±0.039 mg/l (W2) in summer, from 0.062±0.012 (W3) to 0.346±0.014 mg/l (W1) rainy, and from 0.033±0.0088 (W7) to 0.119±0.014 mg/l (W9) in winter season. Manganese is an essential
element, which does not occur naturally as a metal but is found in various salts and minerals frequently in association with iron compounds. In general, concentration of manganese in ground water is low due to geochemical control.

**Lead (Pb):** In the present study the Lead concentration varies from $0.027 \pm 0.082$ (W6) to $0.947 \pm 0.0124$ mg/l (W8) in summer, from $0.028 \pm 0.004$ (W4) to $0.64 \pm 0.06$ mg/l (W2) in rainy, and from $0.023 \pm 0.003$ (W9) to $0.756 \pm 0.011$ mg/l (W8) in winter season for the year 2009-10. During the year 2010-11 it varied from $0.023 \pm 0.035$ (W9) to $1.234 \pm 0.014$ mg/l (W8) in summer, from $0.037 \pm 0.095$ (W10) to $0.73 \pm 0.0082$ mg/l (W8) rainy, and from $0.026 \pm 0.005$ (W10) to $0.88 \pm 0.017$ mg/l (W8) in winter season. The presence of lead in drinking water occurs primarily due to corrosion of lead pipes and solders, especially in areas of soft water. Since dissolution of lead requires an extended contact time, lead is most likely to be present in tap water after being in the service connection piping and plumbing overnight.

**Cadmium (Cd):** In the present study the Cadmium concentration varies from $0.034 \pm 0.0083$ (W2) to $0.085 \pm 0.0027$ mg/l (W8) in summer, from $0.026 \pm 0.0014$ (W2) to $0.076 \pm 0.0027$ mg/l (W8) in rainy, and from $0.025 \pm 0.0001$ (W2) to $0.066 \pm 0.0017$ mg/l (W8) mg/l in winter season for the year 2009-10. During the
year 2010-11 it varied from 0.035±0.0003 (W3) to 0.094±0.0024 mg/l (W8) in summer, from 0.036±0.0012 (W2) to 0.078±0.0019 mg/l (W8) rainy, and from 0.021±0.008 (W2) to 0.064±0.0017 mg/l (W8) in winter season. Cadmium is a nonessential non-beneficial element known to have a high toxic potential. The Bureau of Indian Standards has prescribed 0.01 mg/l as the desirable limit for drinking water (BIS 1991). Beyond this limit, the water becomes toxic. WHO has also prescribed the same guideline value for drinking water (WHO 1993).

**Zinc (Zn):** In the present study the Zinc concentration varies from 0.43±0.121 (W7) to 0.98±0.192 mg/l (W4) in summer, from 0.38±0.184 (W6) to 0.86±0.235 mg/l (W9) in rainy, and from 0.32±0.113 (W7) to 0.96±0.224 mg/l (W8) in winter season for the year 2009-10. During the year 2010-11 it varied from 0.22±0.35 (W7) to 1.25±0.45 mg/l (W8) mg/l in summer, from 0.35±0.29(W7) to 0.994±0.26 mg/l (W8) in rainy season, and from 0.27±0.18 (W2) to 1.15±0.135 mg/l (W9) in winter season. The Bureau of Indian Standards has prescribed 5 mg/l zinc as the desirable limit and 15 mg/l as the permissible limit for drinking, water (BIS, 1991). WHO has also prescribed the same guideline value for drinking water (WHO, 1993).
**Fluoride:** The fluoride concentration varies from 0.229±0.074 (W10) to 0.492±0.025 mg/l (W7) in summer, from 0.156±0.023 (W1) to 0.535±0.026 mg/l (W8) in rainy, and from 0.174±0.034 (W1) to 0.451±0.056 mg/l (W9) mg/l in winter season for the year 2009-10. During the year 2010-11 it varied from 0.255±0.061 (W1) to 0.585±0.069 mg/l (W5) in summer, from 0.166±0.041 (W2) to 0.469±0.046 mg/l (W9) in rainy season, and from 0.149±0.026 (W1) to 0.429± 0.044 mg/l (W9) in winter season. As fluoride is naturally present in water it becomes toxic to animal and human being when present at more than 1.0 mg/l concentration in drinking water. At the level of 1.5 mg/l, molting of teeth and bones has been reported very occasionally and above 3.0 mg/l skeleton flourisis may be observed when a concentration of 10 mg/l is exceeded it may cause crippling problem (Goyal et.al., 2006).

The results obtained in the present study are significant because the earth crust in which contains granite, which is a major fluoride source. Use of fluoride containing fertilizers in these areas is another contaminant of ground water with fluoride.

In the present study more than 80% of the well samples not suitable for drinking purpose.

Presumptive test shows positive in near all the sampling stations for the study period indicated that the ground water is not suitable for drinking purpose.
At last, it is well known that India becomes not amonges the third world but within short period of time it will be among the few top countries in the world having strong, stable economy according to the latest economic international reports but there are big challenges will be faced by India to achieve this goal. Some of those challenges are.

- Rapidly increasing of population and all needs and requirement.
- The huge investment in industrialization is required for many things and increasing industrialization impact on the environment on the natural resourceces (water, air, and soil pollution),
- The ignorance of environmental laws and its implementation in every state and the timely need of amendments of these laws as and when it is nesscessary,
- The irregular monitoring of the status of the water quality and quantity and also the quality of soil and air. These natural sources can be considerd as the central nervous system of positive development.
- The high percentage of uneducated people scattered specially between the poors in urban and rural areas which is considerd as a big threat for developing the country.

The global warming phenomenon and its impact on the rainfall percentage which start its negative impact.
**Suggestion:-**

**Industrial Suggestion:**

1. Strict implementation of environmental laws.
2. The process of discharging the effluents, from Ahmednagar industrial area has been going on for the last 30 years and the adversely effect on ground water is a consequence of accumulated effect over such a long period of time. If the effluent treatment plants are not installed properly and the process of discharging untreated effluents goes on for some more time, the problem will be more and deeper to a larger area of ground water sources (basins).
3. Regulation of pollutional lead to minimize the waste and certain utility aspects. The volume of waste may be reduced within the factory if the factory authorities pay proper attention for the proper maintenance of the units.
4. Percolation of effluents through soil sand should be tried for removing the toxic wastes. The accumulated debris may be mechanically removed or may even be reused after purification.
5. A proper treatment of effluent and sewage needed at the earliest.
6. The installment of effluent treatment plants in every industry or by the group of Match industries is the only remedial measure which could solve the problem. The improvements anticipated are:
(i) Further pollution of ground water sources will be stopped;
(ii) There will be conservation of the water because of reuse of the pollutants and the waste water after treatment;
(iii) Water used by the Match industries will cause little problem to the equipments;
(iv) Pollution of agricultural land due to effluents will be prevented.

7. Development of greenery in and around industrial zones

8. The disposal sites for industrial and urban wastes should be away from residential and agricultural areas.

**Agricultural Suggestions:-**

1. Spreading the education between the farmers or at least timely awareness for them through the suitable media that can easily reach and touch and settle down their minds e.i. excessive use of chemical fertilizers should be avoided, otherwise they will lost the fertility of their fields and in the same time they may deteriorate the quality of both surface water and groundwater.

2. Providing free electricity to the farmers will encourage them to withdrawal of water more than the need.
**General Suggestion:-**

The domestic waste water which is passing through Ahmednagar city and need some attention from the concern authorities to achieve the goals in the regard of environment, health, economic. etc. those goals can be detected as:

1. Cover the dometic effluent (of the above rivers which recently becomes due to huge population and industrialization as nalas) though installing a big pipes and need to install many waste water treatment plant (for recycling the wastewater in different location of its cross so that from this point we can achieve the following sub-points (from a to j) :

   a) Protect the ground water basins which lay down these nalas from contamination by sewage and industrial waste.

   b) By covering these nalas we can also avoid the people from Malaria, biological diseases and other related diseases.

   c) Resulting of previous point (b) the Government financial responsibilities through the free medication in Government hospitals will be minimized and that huge amount can be saved and reused for other investments which are useful for human welfare.

   d) The recycled water from treatment plant (under above point no. 6) can be used for
agriculture purpose and the abstracted fertilizers will be used as organic fertilizers so as to avoid using the chemical fertilizers.

e) Using the recycled water (under point no 1) for many purpose will decrease the using of ground water for the same purpose and also the healthy ground water can be saved for the next generation.

f) The city and surrounding areas will be looking as a beautiful areas in Aurangabad and this new look will play very important role in developing the National and International tourism industry.

g) Covering these nalas will provide us with big areas can be used as bridges, gardens, hospitals ....etc

h) Planning and installing scientifically drainage network joint to this underground sewage big pipes so that can avoid the people from using the drainage basin which lay under the societies according to the geographical features of the areas (as it is famous for them a poring wells water.

i) Now a days people need awareness to not make boring wells mostly near 1-3 houses without consulting the concern authorities that is very important for their health (because
in most of the cases it is percolating drainage water) and for groundwater management.

j) The pipes carrying waste waters (effluents must not be lay beside the Municipal Corporation pipes) which should not carry water for drinking or domestic purpose.

2. The regular groundwater and surface water monitoring is very necessary to assess the extent pollution from time to time for taking appropriate management measures to mitigate its intensity.

3. The people should not make bore wells beside their houses without permission from the concern authorities and this should be strictly prohibited.

4. Limited withdrawal of groundwater should be done by the people and the farmers only under the supervision of the Government.

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