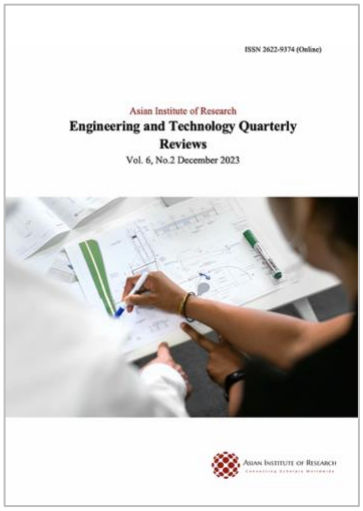

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Groundwater Nitrate Pollution Assessment in Warangal

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Abstract
Due to nitrogen fertilizers consumption and unsafe wastewater networks of cities, now nitrate pollution is one of the challenging issues of surface and groundwater pollution. In case of this contaminant present in drinking water causes 'Blue Baby' disease for infants, cancers, and harmful for pregnant women. So, it is very important to assess nitrate concentration for maintaining better health precaution. Nitrate concentration, dispersion and its distribution status were evaluated in Warangal District, India. The samples show that nitrate concentration in Warangal is very high in both urban and agriculture area which have maximum level of 49.5 & 83.3 mg/ liter as (NO3 – N); average value of 40.3 and 69 mg/l respectively. Even though in urban area the amount of concentration is somehow low, but it also is in harmful level. Nitrate dispersion could be observable from the high standard deviations which are 7.4 for urban area and 12.065 for agriculture area, it means nitrate dispersion in agriculture area is more than urban area's groundwater and it is clearly observed from normal distribution curves. This high spread out on nitrate concentration shows many variations of nitrate sources from many different locations that various amount of nitrate pollutions is infiltrated into groundwater.

Keywords: Nitrate Assessment, Groundwater, Warangal, Urban, Agriculture, Dispersion and Normal Distribution

1. Introduction

One of the worldwide big concern is the water pollution, many people are there in developing country which is suffering from un-safe water. Recently, due to improper uses from N- fertilizers for agriculture and inappropriate urban plans to manage the wastewater collection and management properly, large scale of nitrogen as nitrate pollution have been infiltrated into groundwater. Since, water is the most primary need for mankind, unsafe drinking water would cause irreparable crisis. More than one billion people in developing countries don't have clean water for drinking (Gosling and Arnell, 2016). The reason which groundwater nitrate pollution is increasing very fast in China is using large quantity of N – fertilizers in agriculture area (W.L. Zhang *, 1996) . In Japan, during the last two decades researchers shows that many areas have high nitrate pollution in groundwater which some of them are used for drinking water (Kumazawa, 2002). Kumazawa says in his research that among 1362 wells, 64 wells are used for drinking water which their standard limits are more than

acceptable amount. 76% of world population are living in developing countries, as well as use of N-fertilizers are more than developed countries (Bijay-Singh *, 1995).

Most of people who don't have access to safe drinking water are living in developing countries (Gosling and Arnell, 2016), and According to UNICIF and WHO (2015), majority of the people who have not access to safe potable water are living in Asia and sub-Saharan Africa. Meanwhile, United Nations organizes several targets in the Agenda 2030 for Sustainable Development the major source of water is supplied for people is groundwater which is used as private wells. In many places, because of urbanization, industrials and agriculture activities water is polluted with pathogenic and anthropogenic pollutants. From inorganic or anthropogenic pollutants, we can mention nitrate and nitrite pollution in water.

Water nitrate pollution has different sources like agriculture area, industrial, urban area (wastewater and solid waste) which are in filtered into groundwater table. Nitrate is the stable form of nitrogen in the nitrogen cycle and has an unreactive character. Methaemoglobenia disease is the major health risk of nitrate exposure through drinking water that is called "blue baby syndrome," especially it is a big threat for infants as well as for pregnant women. Due to the nature of the infant digestive system, nitrate is reduced to nitrite which can render hemoglobin and causes that oxygen cannot reach to body cells (SWRCB 2010). Small rural communities are particularly impacted by nitrate (Pacific Institute 2011), recent studies have suggested that it can cause cancer in humans as well (Chiu et al., 2007; Kumar et al., 2009; Meenakshi and Viswanathan, 2007). In nitrate concentration be higher thang 300 mg/liter, it can be problematic for animals also (Islam and Patel, 2010).

In Warangal district less researches was done related to groundwater nitrate pollution. (Narsimha. A1, 2012), studied on groundwater nitrate pollution and the results what they got are between 6 mg/l to 100 mg/l as nitrate with mean value of 39.44 mg/l. meanwhile they say that among the all samples 61% of samples were suitable for drinking purpose, it means that 61% of samples had concentration less than standard limit (50 mg/l). In 2013 Central Groundwater Board, Groundwater Brochure, Warangal District, Andhra Pradesh have done a research on Warangal district groundwater quality, nitrate concentration which is got in this research is equal to mean value of 150 mg/liter and maximum value of 850 mg/liter as nitrate.

Again Central Groundwater Board, ground water year book 2016-17 Telangana State, have done a research on Telangana State groundwater quality. In this research the nitrate concentration which they obtained is in the range of (0 - 506 mg/liter), the maximum concentration was detected in Ippagudem well (Warangal district) among the 392 samples. What we obtained from aforesaid paragraph, nitrate concentration in Warangal district is increasing. Increasing nitrate pollution in groundwater is due to different sources raise the groundwater risk day by day and world widely is spread (Mattern, Fasbender, & Vanclooster, 2009); (Simpkins S. , 2001); (BUROW, 2010) . Over last decades the because of using much N-fertilizers for crops yield are increasing.
The objective of this study is to evaluate the nitrate concentration of particular areas in Warangal district, Telangana state, India and also study of dispersion and distribution situation of groundwater nitrate in the area with the connection to sources of nitrate which agricultural and urban was considered significant source of nitrate here. So this study covers which groundwater nitrate should be concern about agriculture or urban, and how is the distribution status in both areas and how much we should be concern about the groundwater nitrate situation in Warangal district.

2. Materials and Method

Totally 20 groundwater samples were collected from two different nitrate pollution sources agriculture (Paindipaly village) and urban (around thousand Pillar; Hanamkunda) areas, 10 samples from each one. The water samples collection was done using plastic bottles, and within 3 hours the samples were reached to laboratory and tested after passing Whatman No 40 filter paper.

The test was done by Microprocessor UV-VIS Double Beam Spectrophotometer (Model: LI-2800) using Standard Method (Arnold, 1992) for nitrate determination which using 275 nm and 220 nm wavelength absorbance are determined and then for correction of absorbance the absorbance of 275 nm was subtracted from 220 nm. Nitrate has more absorbance in the presence of 220 nm, and more absorbance shows more

concentration. First of all, using KNO_3 salt stock solution was prepared, and using stock solution standard solution was provided, and then using Absorbance against Nitrate concentration which was already known the standard curve was drawn (4500-NO_3– B. Ultraviolet Spectrophotometric Screening Method**)**. The samples unknown concentrations were determined, after finding their absorbance were determined via standard curve (figure 1.1).

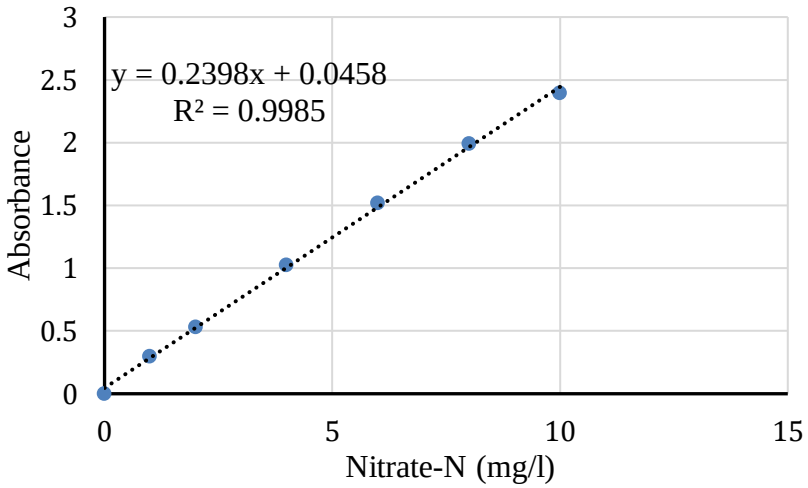

Figure 1.1: Nitrate determination standard curve (Arnold et al, 1992).

In order to know how the pollution is distributed normally and find the variation of dispersion status of nitrate pollution in mentioned areas, parameters like standard deviation, mean values, median, skewness and kurtosis was needed. Therefore, for these purposes SPSS software was used for statistical analysis to predict how is the situation of nitrate pollution dispersion in study area. By calculation and prediction of groundwater samples using SPSS probability density of nitrate was calculated in groundwater which standard deviation and mean values are the significant indicators, and good determiner for dispersion and have important role for normal distribution shape.

3. Results and Discussion

3.1. Nitrate determination

Based on objective of the study, groundwater nitrate concentration was determined, and the dispersion situation was statistically analyzed in both areas. For more or better accuracy nitrate determination was done five times (n=5) for each samples and then mean values are calculated. Table 1.1 & 1.2 show the results of nitrate concentration in both sources of nitrate pollution. It is noticeable that nitrate concentration expressed in the form of nitrate- nitrogen (NO_3 – N).

Table 1.1: Nitrate concentration in groundwater of agriculture area (n=5).

No	Area Name	Depth of the well (m)	Mean (n=5) (mg/l) as NO_3-N
1	Kokthepet	50	56
2	Kokthepet road	44	69.6
3	NSR School	67	78
4	Arpally	40	81.2
5	Arpally, North side 1 km farther	34	82.9
6	Bacharlagadda	83.3	68.8
7	Near agriculture college (1)	83.3	83.3
8	Near agriculture college(2)	135	59.6

9	Arithral village (1)	130	60.2
10	Arithral village (2)	150	49.9

Table 1.1 represent that nitrate maximum concentration is 82.9 and the minimum value is 49.9 mg/ liter as (NO_3 – N), and among these ten samples which were collected from different agriculture area in Paidipally village are not in acceptable limit as per WHO drinking water norms. Compare to standard limit which WHO is determined for nitrate in drinking water is equal to 11.3 mg/l as (NO_3 – N), whereas the minimum concentration in mentioned area is 49.9 mg/l which is almost five times more than acceptable level. when we attend on results from urban area, nitrate concentration in urban area is low compare to agriculture area, but it is also more than standard limit see Table 1.2.

Table 1.2: Nitrate concentration in groundwater of Urban area (n=5).

No	**Area Name**	**Depth of the well (m)**	**Mean(n=5) (mg/l) as NO3-N**
1	Thousand Pillar Temples	37	42.1
2	Mahli Bazar (1)	42	40.5
3	Mahli Bazar (2)	43.3	39.1
4	Mahli Bazar (3)	47	37.23
5	Reddy Colony urban area (1)	67	32
6	Reddy Colony urban area (2)	55	48.7
7	Padmakshi, Vivekananda High school	83.3	35
8	Padmakshi	57	49.5
9	1.8K hostel back side bore well (NITW)	67	36.54
10	Thousand Pillar temples (2)	41	40.23

As it is seen, nitrate concentration in urban area is very low compare to what has been fallen in agriculture area. The maximum and minimum values are 49.5 and 32 mg/l respectively in urban area. By observing the results of nitrate concentration in two different groundwater nitrate pollution source, eventually we could write that agricultural nitrate pollution source are significantly release pollution more than urban nitrate pollution source in groundwater. The reason for agricultural area would be much overuse of Nitrogen- fertilizers for increasing of crop yielding, and from other hand most of farmer may without technical training use extra fertilizers which the crop or plants roots are not able to catch that much nitrogen, so the additional nitrogen after long time reach to groundwater in the form of nitrate.

3.2 Nitrate Dispersion and Distribution Analysis

In order generalize the results what are obtained above, some statistical calculation was done using SPSS, and the probability density was determined in each area which represent how the nitrate pollution is distributed in both area and how much difference are between? Probability density shows dispersion situation and normal curve distribution. The dispersion situation and normal curve shape and status depend on two very important indicator factors which call standard deviation and mean. Here the analysis was done in two phase. Once, each one area was studied individually and then considered the results of both areas in combination to have larger scale of study area.

3.2.1. Phase 1 (Individual Analysis)

In this phase each nitrate pollution source was analyzed individually, two Nitrate concentration and source of nitrate were variables of the analysis. According to these two variables, dispersion was evaluated standard deviation and mean value which are the significant indicators of dispersion were calculated, and simultaneously the curve of normal distribution was drawn as well to figured out a clear picture from nitrate dispersion in the mentioned area, see (Figure 2.1) which represent the nitrate status in urban area groundwater.

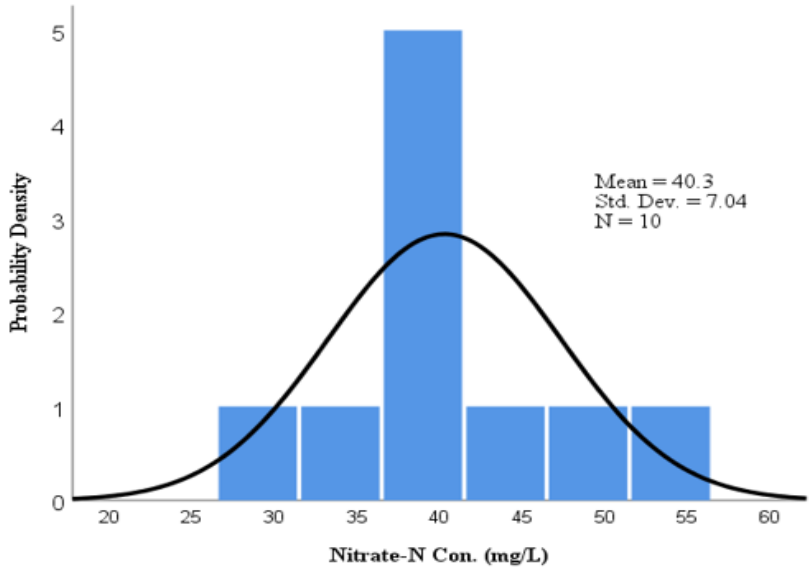

Figure 2.1: Histogram graph of groundwater nitrate concentration in urban area (Thousand Pillar), Warangal City.

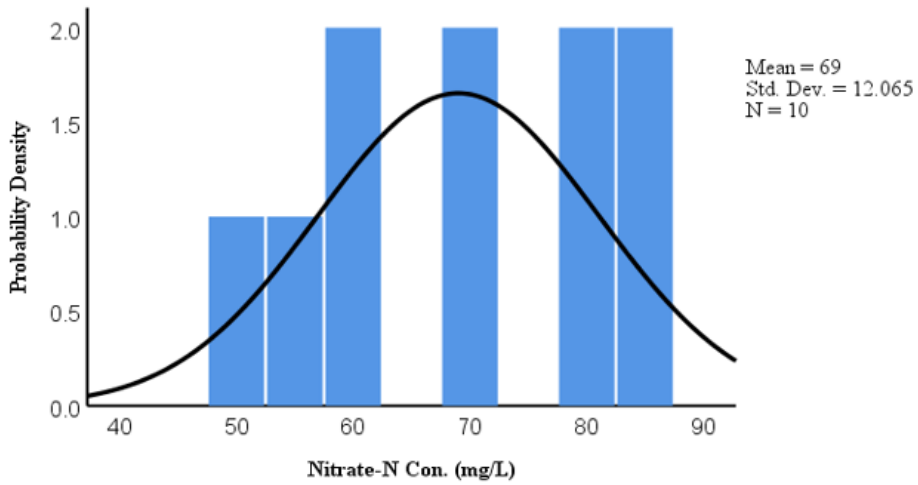

Figure 2.2: Histogram graph of groundwater nitrate concentration in agriculture area (Paid paly), Warangal District.

From figure 2.1 & 2.2, it is obviously observed that standard deviation and mean values in urban nitrate source is significantly low compare to agricultural area, even though, 7.04 standard deviation is a big value, and shows high dispersion of nitrate pollution in urban area. According to three Standard Deviation Rule (68%, 95%. 99.7%), which is started with 68% from mean point and spread out through 99.7%. It is spread both side based on standard deviation valu. As much as standard deviation and mean value are less, accordingly dispersion is less, and vis versa as much as standard deviation and mean values are high, in same proportion, dispersion is more. Therefore, since standard deviation and mean values in urban area are low against agriculture area, we infer that groundwater nitrate dispersion in urban area is lower than agriculture area which has standard

deviation equal to 12.065 and mean value of 69 mg/l. it means, agriculture area has larger interval of SD which shows more dispersion (figure 2.3)

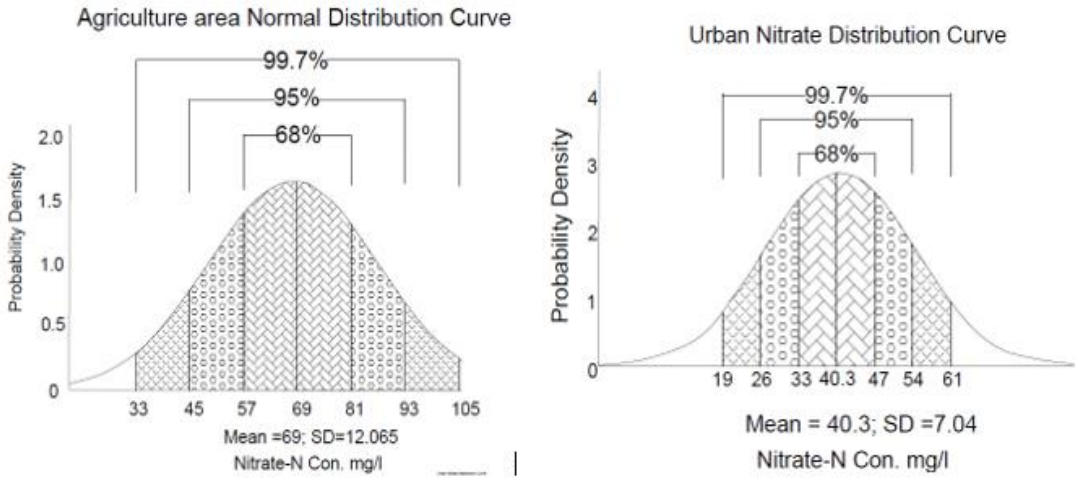

Figure 2.3: Nitrate Normal Distribution Curve and dispersion situation of both study areas.

Eventually, everything is clear form figure 2.3 that more dispersion was happened in agriculture area than urban area, and have more mean value also which expresses its concentration is also more than urban area as well. It is clearly visible that the amount nitrate concentration in agriculture area which include 68% is from 57 to 81 mg/li, whereas in urban area 68% is including of 33 to 47 mg/l of nitrate concentration, dispersion is almost two times more than urban area. The reason that agricultural nitrate source is more dispersed than urban areas are would be depend on the amount on nitrogen which release in groundwater. In agriculture area from everywhere of agriculture land the extra nitrogen is infiltrated into groundwater without any slightest control, but vis versa in urban area as much as possible people are trying to prevent the nitrogen infiltration into groundwater by providing wastewater networks or individual prevention.

3.2.2. Phase 2 (Combined Analysis)

The reason of considering as combine was to see the nitrate dispersion and distribution in a larger scale area of groundwater which include both urban and agriculture sources, Figure 2.4 shows the result of combine areas.

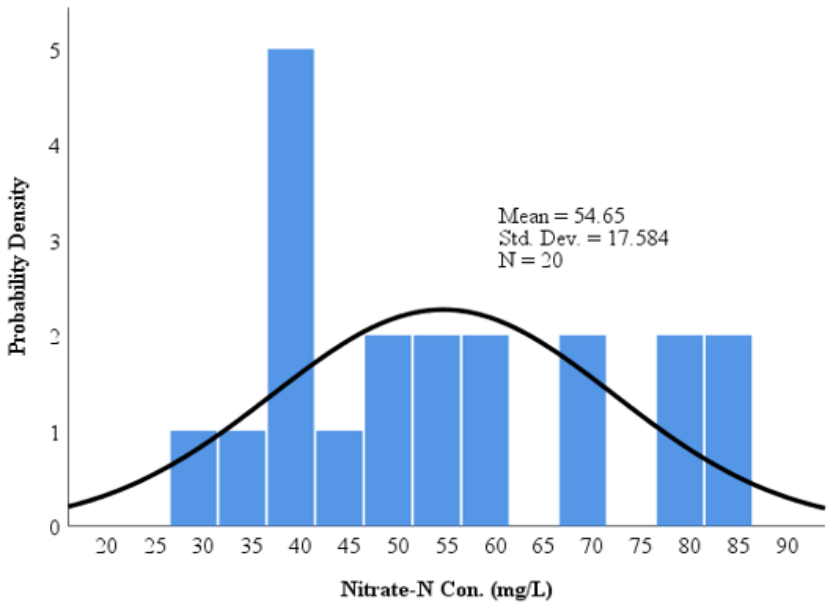

Figure 2.4: Nitrate concentration Probability density distribution and combine normal curve in Paid paly and Thousand pillar.

When the results of both sources were analyzed as one source, the obtained result is totally different compare to individual analysis, because here large area was investigated and from other hand two different source was considered as one object. Here probability density lower than urban area and higher than agriculture area and also the mean value, but standard deviation is very high. I might be due to increasing the number of samples and also combination causes. Since the number of sample were less, may be the analysis have its error, but should not forget that can give a very good perspective about the nitrate situation and its distribution in the to us. Finally, it is concluded that high standard deviation in agriculture area is due to nonhomogeneous of nitrate in groundwater because each crop land has its own infiltration which is dramatically high, so it could be one of the reason that in agriculture area much difference be between one point to other point. But in urban area since the nitrate source is poor and also is tried to prevent from infiltration using different way, it is caused homogenously. When it is considered as combine, the mean valued was reformed a bit, but standard deviation was increased, so the nitrate concentration in urban areas was low and in agriculture area was high and in increased the standard deviation which shows high dispersion.

4. Conclusion

This study shows that the groundwater in Warangal district from nitrate pollution point of view is in critical situation. Although, this study was done in small scale area, but it could be a good instance to show for us what is the state of nitrate pollution of groundwater in the area. From previous research it is known that nitrate pollution is increasing when it is compared with this study. The reason for high dispersion is might be overuses of N-Fertilizers and beside this unsuitable wastewater network would be there, which have remarkable infiltration into groundwater from each different points. So generally it concluded that both urban and agriculture areas are the sources of nitrate which can pollute considerably the groundwater, and it suggested to prevention should be taken, otherwise it might be cause a large problem for drinking water and water treatment technologies

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