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Nitrate pollution of ground water in Lalithanagar of 32nd ward and Kunchamma colony of 46th ward , Janatha colony of 48thward in Visakhapatnam

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Abstract: *Water is life and sanitation is the way of life .Both are critical for leading a quality life. A colossal 80% of the diseases stem from consumption of unsafe water and of poor sanitation conditions .The most notable cause for the nitrate contamination of ground water is the release of waste waters at or near the ground water. In the field of agriculture the retention of nitrogen in the surface soils is of vital concern is the application of plant fertilizers. Nitrate enters the ground water system and reduce in concentration down slope from the source due to the dilution offered by the ground water flow*

Areas like Janathacolony, Lalithanagar and Kunchamma colony was selected and a survey was conducted to know about sanitation drinking water resources and their management. Seven samples from lalithanagar, five samples from Kunchamma colony and five samples from Janatha colony are collected..Nitrate values in study areas varying from2.2 to 38.84mg/lt This paper explains how the nitrate penetrate into the ground water and causes the effect and also to find the correlation between nitrate and chlorides of ground water in study area and to identify whether the ground water pollution in study area is due to single dominant source or not.

Keywords:
1) Nitrate contamination of ground waters
2) Impacts of nitrate pollution
3)Analysis of chlorides and nitrates
4)Results and discussions

I. Introduction

The highest available sources of freshwater lies beneath the ground. Even today more than 90% of our population is primarily dependent on ground water .

Nitrate can enter the ground water from the following sources like land fills .industrial hazards municipal sanitary, open dumps,.residential or local disposal, irrigation return flows, pesticide applications. fertilizer applications.urban run off etc. Recent studies have shown that nitrates in drinking water besides causing Methaemoglobinemia can result in various other clinical manifestations like recurrent stomatitis, Recurrent respiratory tract infections etc.Some areas in Visakhapatnam district are studied about the nitrate and its contamination. Samples are collected and analyzed the presence of nitrates and chlorides as per standard methods(APHA1995) This study helps how the nitrate enters into the ground water and long term impacts of deteriorating ground water quality can be studied.

Objectives of the Project work

1. To study nitrate pollution of groundwater in study area
2. To find the correlation between nitrate and chlorides of groundwater in study area and for verifying weather the groundwater pollution in study area is due to single dominant source or not

Causes of nitrate pollution

The most notable cause for nitrate contamination of groundwater is the release of waste waters at or near the ground surface. In the field of agriculture, the retention of nitrogen in surface soils is of vital concern in the application of plant fertilizers. Number of physical, chemical and biological interactions of nitrogen compounds with the soil takes place during the movement through soils. Most of the nitrogen in the septic tank effluent is in the form of ammonia. Normal effluent pH of less than 8.5 is quickly oxidized in the aerobic soil zone (Unsaturated zone) and converted to nitrate nitrogen. The mobile nitrate enters the groundwater system and reduces in concentration down slope from the source due to the dilution offered by the groundwater flow.

Chlorides and nitrates are essentially unaffected by their movement through soils. Most of the nitrogen from septic tank effluent occurring in organic and ammonia form is readily adsorbed to soil particles within

short distances. If anaerobic conditions are maintained in the soils, there will be little nitrogen movement. However, under favorable moisture levels, temperature, and oxygen content, occurring generally in well drained soils, soil-bacteria will oxidize the nitrogen compounds to more mobile nitrates

The chemical reactions in ammonia release, nitrification, and de-nitrification are detailed: -

i) Ammonia release

Urea CO (NH^+_3) + H_20 $\rightarrow 2NH^+_4 + C0_2$

Amino acids + $H_2 0$ $\rightarrow NH^+_4 + Organic$ compounds

ii) NH^+_4+$2O_2$ nitrification $\rightarrow NO^-_3 + 2H^+ + H_2O$

iii) De-nitrification

$4NO^-_3$+$5CH_2O$+$4H^+$ $\rightarrow 2N_2 + 5CO_2 + 7H_2O$

The conversion of ammonia in the septic tank effluent to nitrates occurring in the aerobic zone in the soil could pose public health problems when groundwater in the vicinity is used for drinking purpose. However, under anaerobic conditions, some bacteria could utilize nitrates along with organic carbon compounds as a source of energy. The end products of the reactions are molecular nitrogen, nitric oxide and nitrous oxide. Under optimum conditions, considerable amount of nitrates may be removed from the percolating water through this process. However, the amount of organic carbon reaching beyond the nitrification zone in the soil would normally be insufficient to support the effluent, which can be achieved under controlled conditions in the ground below a conventional leaching field using methanol as a carbon source.

Thus it is understood that nitrogen compounds undergo a series of reactions within the soil profile resulting in removal of nitrogen from the soil system, storage of nitrogen in the soil, or transformation of nitrogen into another form. Storage of nitrogen is credited to the adsorption of the ammonium ion at soil cation sites, fixation by clay minerals, adsorption by organic matter. The transformation of nitrogen by the nitrification of ammonia into nitrate is the most significant reaction in a well-aerated unsaturated zone
(Vadose zone)

It is reported that at a depth of 0.6 meters, 80% of total nitrogen was in the form of nitrate Hence, for proper treatment of septic tank effluent, sufficient depth of unsaturated zone is required. Generally, 10 $mg1^{-1}$of nitrate - N is considered to have a reasonable margin of safety level in drinking water and Food sources of nitrates include certain vegetables and meat products. Higher levels have been found in spinach and carrots. The nitrate contents in the crops are influenced by plant species and genetic and environmental factors such as heavy use of N fertilizers. The levels of nitrate in baby foods are of special concern.

Recommended Nitrate Limits in Several Countries

Country	mg 1^{-1}**
USA (USPHS)* 1962	10
USA (NAS) 1972	10
USA (EPA) 1975	10
Japan 1968	10
SABS 1971	10
Australia1973	10
WHO European 1970	<11.5
WHO International1971	10
Britain	20
Russia	9.0
West Germany	11.3
Israel	10.2
Austria	9.0
East Germany	6.8
Denmark	5.7
Switzerland	4.5
Czechoslovakia	3.4
India (IS!) 1983	45
India (ICMR) 1975	50

NAS=National Academy of Science

EPA= U.S Environmental Protection Agency

SABS = South Africa Bureau of Standards

WHO = World Health Organization

** To convert the nitrate (as N) value to a nitrate (as $N0_3$) value, multiply by 4.43

The ICMR (1975) guidelines suggested that If no other water supply is available $N0_3$ Content may be 100 mg / $N0_3$.

Health Aspects of Nitrate pollution

The diseases are related to high nitrate intake and they are Methaemoglobinaemia (infantile cyanosis) and cancer.

Methaemoglobinaemia

Under specific conditions, nitrate is reduced to nitrate in the stomach and saliva. The nitrite oxidizes ferrous (Fe^{21}) ions in hemoglobin molecules to (Fe^{3}) ions. This results in methaemoglobin, which is incapable of binding and transporting oxygen. The consequence would be anoxia, which could lead to death if left untreated. Methaemoglobinaemia is a disease primarily affecting infants, especially if the diet lacks of vitamin C. Adults normally have the enzyme methaemoglobin reductase, which transforms methamoglobin back to haemoglobin.

Cancer

Nitrites, formed from nitrates, can react with amines and amides to form nitrosamines and nitrosamides and nitrosamides. N - nitro so compounds have proved to be carcinogenic in animal tests and nitrate ingestion may be a contributing factor in gastric cancer. However, too little information is available to draw specific conclusion about the relationship between high nitrate levels and cancer in humans.

Other potential health effects linked with high intake of nitrate have been identified and include increased infant mortality, birth defects and hypertension

II. Methodology

STUDY AREA:

The areas selected for study are Lalitha Nagar of 32ndward Kunchamma Colony of 48ward Janatha Colony of 46th Ward of Visakhapatnam.

Drinking water facility is provided by constructing bore wells and open wells, as the groundwater is the main source of drinking water.

In Lalitha Nagar there are about 50 bore wells and about 2 open wells which are dry. In Janatha Colony there are about 80 'bore wells and only one open well at Sivalayam temple. In Kunchamma Colony there are about 50 bore wells and about 3 open wells.

SAMPLING

A preliminary survey was conducted to know about sanitation and drinking water resources and their management in the particular study area. The samples are collected from these areas and then analysed for the presence of Chlorides and Nitrates as per standard methods. (APHA, 1995). The samples collected from Lalitha Nagar, Kunchamma Colony, and Janatha Colony are 7, 5 and 5 respectively.

ANALYSIS

Determination of Chlorides (mg/I) Procedure

1. 10 ml of water sample is transformed into a clean conical flask with the help of measuring cylinder.
2. One or Two drops of Potassium Chromate is added to the sample.
3. Then the burette is filled with the given silver nitrate solution and initial reading was noted down
4. Then the water sample is titrated against silver nitrate solutions till a drop of silver nitrate changes the color from yellow to red.
5. The final readings of the burette were noted.
6. The same experiment is repeated till 2 or 3 consecutive values are obtained.

Amount of Chlorides (mg/I)

$$= \frac{\text{vol. of Ag No] consumed x 0.0141 x Eg. Wt of chlorine x 1000)}}{\text{Vol. of sample taken in ml}}$$

Determination of nitrates (mg/l) :

1. 50ml of water sample is taken into a dish and evaporated to dryness.
2. Now the residue is dissolved in 2 ml of phenol di-sulfonic acid.
3. Then this solution is taken into 100 ml of volumetric flask.
4. To this sample containing flask 20 ml distilled water is added and then 3 ml of ammonia solution is added and then make up to the mark with distilled water.
5. The sample is subjected to spectrophotometer analysis then the reading was observed at the wavelength of 410 nm.
6. 0.5 ml, 1 ml, 1.5 ml, 2 ml standard nitrate solutions are taken in separate volumetric flask.

7. To each of the volumetric flask 1 ml of PDA, 3 ml of ammonia solution are added and made up to the mark with distilled water and left for color development.
8. After color development absorbance of each standard is measured at 410 nm.
9. The standard curve is plotted with the concentration of nitrate on its x-axis and optical density on y-axis.

4:4. THEORITICAL BASIS OF CORRELATION COEFFICIENT

Correlation coefficient determines the relationship between 2 parameters. If X and Y were any two variables and let (Xi, Yi) be n pairs of observed variables (I = I, 2, 3 and……..n)

Then the correlation coefficient 'r' in between variables X and Y is given by the relation (Sarangi et al).

$$\sum_{i=1}^{n} x_i y_i \Big/ [\sum_{i=1}^{n} x_i^2 \sum_{i=1}^{n} y_i^2]^{1/2}$$

Where,x1=$\left(\overline{xi - x}\right)$

y1=$\left(\overline{yi - y}\right)$

$\bar{x}$ **=(**$\sum^{n}$**X$_i$)/n,**
i=1

$\bar{y}$= ($\sum^{n}$**y$_i$)/n**
i=1

fairly high, it indicates the two variables are highly correlated. In such cases, one may obtain a linear relation of the form,

$$Y=AX+B$$

Where A and B are constants to be determined by fitting the experimental data to the above equation. According to least square method of straight lint fitting the values of the constants A and B are given by the relations.

$$A= \frac{n\Sigma(X.Y) - (\Sigma X).(\Sigma y)}{n.\Sigma(X - X)^2}$$

$$B= \overline{Y} - a.\overline{Xi} \text{ ……..}$$

The results of analysis are presented in table

LALITHA NAGAR

Sl. No.	Sample No.	D.No. of the Near by House	Type of the Well	Depth of the Well	Chlorides (mg/I.)	Nitrates (mg//l.)
01.	S-1	49-7-6	Bore Well	70 feet	149.995	13.48
02.	S-2	49-7-7	Bore Well	80 feet	99.997	5.28
03.	S-3	49-7-17	Bore Well	120 feet	149.995	4.60
04.	S-4-	49-7-9	Bore Well	135 feet	144.995	21.20
05.	S-5	49-7-15	Bore Well	100 feet	149.995	10.00
06.	S-6	49-7-12	Bore Well	100 feet	134.996	2.80
07.	S-7	49-7-10	Bore Well	110 feet	169.995	22.00

KUNCHAMMA COLONY

Sl. No.	Sample No.	D.No. of the Near by House	Type of the Well	Depth of the Well	Chlorides (mg/I.)	Nitrates (mg./l .)
08.	S-1	Public Bore well	Bore Well	100 feet	259.9	6.00
09.	S-2	Public Bore well	Bore Well	90 feet	249.9	12.00
10	S-3	Public Bore well	Bore Well	95 feet	159.9	4.10
11.	S--I-	Public Bore well	Bore Well	100 feet	309.9	30.00
]2.	S-5	Public Bore well	Bore Well	100 feet	209.9	21.00

JANATHA COLONY

Sl. No.	Sample No.	D.No. of the Near by House	Type of the Well	Depth of the Well	Chlorides (mg/I.)	Nitrates (mg//l.)
13.	S-1	Public Bore well	Bore Well	100 feet	154.995	6.20
14.	S-2	Public Bore well	Bore Well	100 feet	159.995	l6.20
15.	S-3	Public Bore well	Bore Well	105 feet	l29.996	0.60
16.	S-4	Public Bore well	Bore Well	100 feet	104.997	0.60

1 . Chloride values in study area are varying from 99.997 to 209.9 mg.!l. ion concentration is found to be within standard limits (IS:10.500:1991) drinking water.
2 .Nitrate values in study area are varymg from 2.2 to 38.84 mg.!\. Nitrate ion concentration is found to be within standard limits (IS: 10:500: 1991) for drinking water.

3 .Chloride Levels are high in ground water exceeding 250 mg/l m I sample indicating little suitability for drinking from chloride point of view.
4.Considerable concentration of Nitrate (more than10mg/l) is found in most of the samples. Most related cases of methamoglobineamia and gastric cancel have been associated with the used of water containing nitrate.
5. Movement of pollutants like nitrate & chlorides is much more quicker in sandy soils than in clayey and silty soils because of its low water holding capacity & high permeability (Moha Patra et., aI, 2001). Considerable Nitrate concentration is found in some well waters. It may be due the fact that the soils of the study area are sandy.
6. Organic nitrogen from on site disposal system of human excreta oxidizes into nitrates in soil (Ramaraju et., aI, 1998). Considerable concentration of nitrate in study area may be due to on site disposal systems of human excreta.
7. A significant correlation is observed between nitrate and chloride. This is suggestion on single dominant source such as on - site disposal systems of wastes.

correlation coefficients:
Lalitha nagar-0.6324
Kunchamma colony-0.626604
Janatha colony – 0.654264s

III. Conclusion

The high Nitrate to chloride ratio is a standard pollution indicator. The result indicate a close relationship between chloride and nitrate suggesting a single dominant source. The high ratio of nitrate chloride is indication of faecal origin leaching of faecal nitrogen to ground water (Ramaraju et al.,1998).The most likely source of this inorganic faecal contamination in multi point loading from septic tank..

Community on site waste disposal system which could be well managed may be provided for minimizing ground water pollution in peri-urban human settlements otherwise the ground water& health of the people will be highly vulnerable.It is also likely that if deep rooted vegetation such as shrubs & trees could be

introduced into the areas, the situation could be improved. Long term impacts of deteriorating ground water quality must be studied.

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