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Nitrate Pollution and Fecal Coliform Contamination in Domestic Wells in the Vavuniya District Sri Lanka with Special Reference to Hospital Area

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Abstract

Ground water is generally polluted by leachates from sewage and agricultural lands. The main pollutants from sewages are nitrate nitrogen and fecal coliform. Both are hazardous when its level at high concentration in drinking water. The objectives of the study were to evaluate the nitrate nitrogen and fecal coliform count in wells and identify the wells that are not suitable for drinking purpose in Vavuniya District, Sri Lanka. Thirty three dug wells and three tube wells were selected around the general hospital Vavuniya to measure the Nitrate Nitrogen ($N0_3$-N), and fecal coliform count from March 2008 to February 2009. Mean NO_3- N ranged from 0.40 to 16.2 mg/l over a twelve months period and 30.5 % of the wells were above the permissible limit of 10mg/l (well No11,12,13, 17,18,20,21,23, 25, 29 & 33) and these wells are not suitable for drinking purpose in almost all the months. Nitrate nitrogen in wet season was significantly higher than dry season (p= 0.072). The depth of wells varied from 4m to 8m and most of these wells were shallow wells. Shallow wells are very vulnerability to nitrate pollution in permeable soil. Almost all the wells were contaminated with fecal coliform. Wells closer to sand beds were contaminated with very high amount (more than 500) of fecal coliform. Improper sewage disposal system could be the reason for high nitrate nitrogen and fecal coliform contamination in wells around the hospital area.

Key Words: Dug wells, Nitrate pollution, Sewage, Fecal coliform

Introduction

The Vavuniya District is situated in the agro ecological region of low country dry zone with a mean annual rainfall of 1400mm and an average temperature of 28° C. From early October to late January is the Maha rainy season and from late April to late May is the Yala rainy season. The soil in this area is Reddish Brown Earth with Low Humic Gley soil occurring in the lower part of the undulating landscape. It is an agricultural area and people use surface and ground water for their irrigation and domestic needs. Nitrate is an essential source of nitrogen for plants. When nitrogen fertilizers are used to enrich the soils, nitrates may be carried down through the soil into ground water by rain, irrigation and other surface water sources. Improper disposal of sewage can also contribute to nitrate contamination as well as fecal coliform contamination in ground water.

According to the WHO standards, the maximum allowable contaminant level of Nitrate Nitrogen in drinking water is 10mg/l (10ppm). It has been reported that if the drinking water contain more than 10 ppm nitrate-nitrogen, it could affect the health of infants, giving rise to blue babies (WHO, 1971). In addition, Studies in Sri Lanka revealed that there is positive correlation to nitrate concentration in drinking water and various types of human cancer such as stomach, small intestine, esophagus and liver cancers (Dissanayake 1998). Some strains of fecal coliform are produces a powerful toxin and can causes severe illness. Infection causes diarrhea and bloody diarrhea. In some people, particularly children under 5 years of age and elderly, the infection can also causes a complication called hemolytic uremic syndrome, in which the red blood cells are destroyed and kidneys fail.

Vavuniya hospital is located in the heart of the city and which is a densely populated residential area as well. People in this areas are depending on ground water for their domestic and agricultural purpose. There are possibilities of contamination of ground water by Nitrate Nitrogen and fecal coliform coming from improper functioning sand beds. The objectives of the study were to measure levels of Nitrate Nitrogen and obtain the fecal coliform counts in wells around the hospital area and select the wells that are not suitable for drinking purpose.

Material and Methods

Thirty three dug wells and three tube wells were selected around the hospital area which has been utilized for domestic purpose. The depth of dug wells varied from 4 m to 8m.

Monthly water samples were collected from March 2008 to February 2009 to analysis Nitrate Nitrogen (NO_3- N), Electrical Conductivity (EC), pH and fecal coliform count. Samples were drawn from the wells approximately at the levels of 30cm depth below the free water surface and each sample was poured into a bottle after rinsing it twice with the same sample and covered with a lid and transported to the laboratory at the Department of Biological Science of the Vavuniya Campus for chemical analysis. Sterilized polythene bags were used to collect water sample for fecal coliform count and transported to laboratory and stored in the refrigerator.

Electrical conductivity and pH were measured by environmental prop (YSI model 556). Fecal coliform test was performed same day by membrane filter methods using the water quality kit. A measured volume of water sample was filtered through a sterile cellulose ester membrane where the pore size is small enough (0.45µm). The membrane was placed on an absorbent pad saturated with membrane lauryl sulphate (containing lactose and phenol red as indicator of acidity) and incubated for 18 hours at 44^o C. The yellow colour colonies were counted after 18 hours and results were expressed in number of colonies per 100ml of water sample. Nitrate-N analysis was done within twenty four hours after collection of sample and determined by Brucine method (Taras, 1958). t test was performed to observe the significant differences among nitrate nitrogen with spatial and temporal variation.

Results and Discussion

pH

The pH of the wells varied from 6.8 to 7.9 over a period of twelve months from March 2008 to February 2009 (Figure 1). All the wells showed pH within the WHO permissible limit of 6.5–9.0 respective of the months.

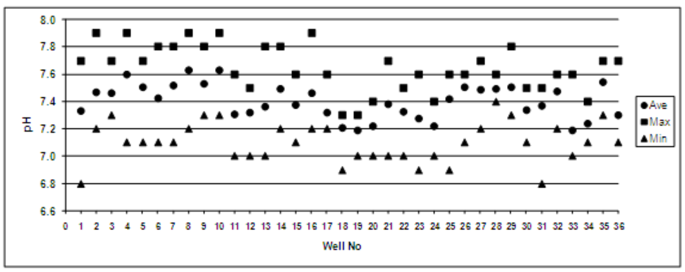

Figure 1: Spatial variation of pH in the study area.

Electrical Conductivity (EC)

The EC of the wells ranged from 0.68 to 2.15 dsm^{-1} and it was within the WHO permissible limit of 3.5 dsm^{-1} for drinking water (Figure 2). Therefore water could be used for drinking purpose with out any health hazards in relation to dissolved salts. Twenty five percentage of wells (well No: 4,8,9,11,13, 24, 28,33 & 35) had average EC more than 1.5 dsm^{-1} and these values too were below the WHO standards for drinking purpose.

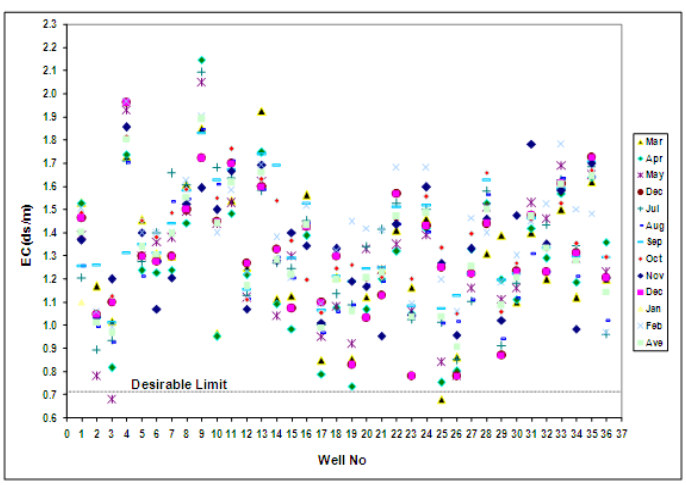

Figure 2 : Spatial and temporal variation of EC in the study area.

Nitrate Nitrogen (NO_3- N)

Mean NO_3- N ranged from 0.40 to 16.2 mg/l over a twelve months period (Figure 3) and 30.5 % of the wells were above the permissible limit of 10mg/l (well No11,12,13, 17,18,20,21,23, 25, 29 & 33). These wells are not suitable for drinking purpose in almost all the months. Nitrate nitrogen ranged from 0.3 to 24.8 mg./l (Figure 4) in November 2008 and it was higher than other months in most of the wells due to leaching of Nitrate - Nitrogen after heavy rain (298 mm rain fall) and 47.2 %. of the wells were above permissible limits during this period. Nitrate nitrogen in wet season was significantly higher than dry season (p= 0.072). Amount of nitrate nitrogen in well water decreased in dry period and increased with rain fall after the dry period (Figure 4). Nadesena & et al (2005) reported that easy migration of nitrate nitrogen from top layer to ground water table occur raining just after well aerated soil condition. Mean NO_3- N of Well No 14,19, 22, 24, 28 & 35 were above 5 mg/l and less than 10 mg/l and it goes more than 10 mg/l during raining season. Therefore these well are not suitable for drinking purpose during rainy season.

Well No 16, & 19 showed low nitrate levels with less fluctuation from March 2008 to February 2009 even though these wells were located in high land. There was a rocky layer in the well No 16 & 19 below 4 meter from ground level. This could be the reason for low nitrate nitrogen in these well due to poor permeability of rock. But during November 2008 (298mm rain fall) NO_3- N level of these wells was above 10mg/l. This may due to entering of nitrate nitrogen through permeable well wall from elevated water level during heavy raining period. These wells could be utilized through out the year by proper ceiling of well wall to prevent entering of nitrate nitrogen during rainy season. There is no severe fluctuation in nitrate nitrogen level in well No 26 and 34 and it also less than 4.8 mg/l. These well are suitable for drinking purpose through out the year. These types of wells should be marked and used for drinking purpose.

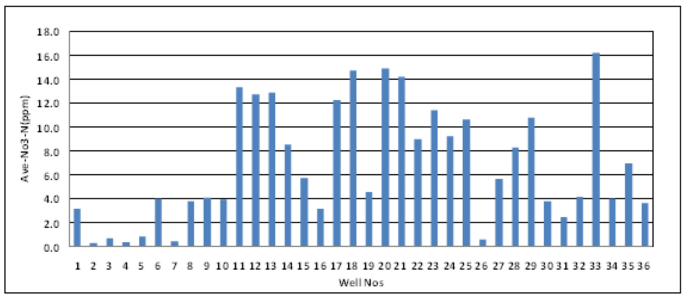

Figure : 3 Average Nitrate Nitrogen in selected wells from March 2008 to February 2009

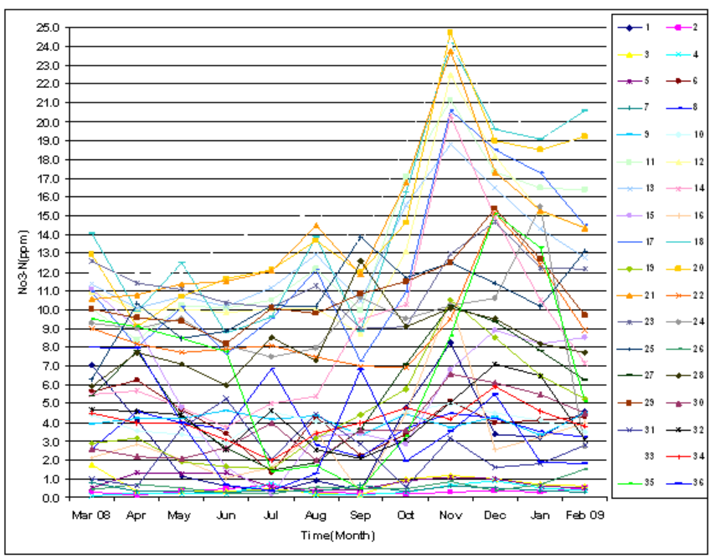

Figure 4 : Spatial and temporal variation of NO_3- N in the study area.

Nitrate nitrogen in high lands was significantly higher than low land (wells closed to the paddy fields) (P=0.00). This could be due to easy migration of NO_3- N in permeable soils as high land soil is Reddish Brown Earth soil. Low land soils are Low Humic Gley (LHG) soils with high amount of clay and poor drainage. The nitrate pollution was low in low land wells since the migration of nitrate nitrogen is low. The depth of wells varied from 4m to 8m and most of these wells were shallow wells. Panapokke (2005) identified 6 types of ground water aquifers in Sri Lanka and out of this shallow Regolith aquifer of hard rock region is available in Vavuniya district. Amarasinghe & De Silva (2006) stated shallow wells are very vulnerable to ground water pollution.

Nitrate nitrogen in tube well also above permissible level in one tube well and other two were 8 and 9mg/l. Even though tube wells were dug up to 50m, PVC pipe was inserted up to 12m. Therefore water may be contaminated with nitrate nitrogen through permeable layer. Distance between toilets and wells were maintained properly in almost all the houses. Therefore the improper functioning of sand beds could be one of the reason for high nitrate nitrogen levels in ground water around the hospital area.

Fecal coliform

Almost all the wells were contaminated with fecal coliform from selected wells and it was higher than WHO standard of zero. Fecal coliform counts were very high in rainy period (March and September 2008) than dry period (July 2008) due to contamination of surface runoff water during rainy period. For example coliform count in well No 01 was 3921 and 3500 in March and September 2008 respectively but 850 in July 2008. Wells closer to sand beds (well No 01 to 06 except 04) were contaminated with very high amount (more than 500) of fecal coliform (Table No1.0).

Fecal coilform count in tube well and water supply were zero and some closed dug wells (well No 10) also showed less number of count. Protective P V C pipe prevent the contamination of fecal coliform in tube wells from sand bed by seepage. Contamination of closed dug wells may be due to the seepage from sand bed through permeable well wall and open well through seepage as well as direct contact by birds and others contaminated carries. Results reveal that all the wells except tube well are not suitable for drinking purpose and it could be utilized after proper treatments such as boiling of water or chlorination. Presence of fecal coliform in drinking water is a strong indication of contamination of sewage in ground water.

Table :1.0 Fecal coliform count in wells in March, July and September 2008

	Fecal coliform count in selected wells (No of colony/100ml)					
	>1000	1000-501	500-100	99-10	09-01	Nil
March	1 , 3	2,5,6,12	7,9,11,13,14,15,17,18,19 ,20	4, 8, 16	10,21	22,23,24
July		1,2,3,5,6	9,12,13,17	7,11,14,15, 16,18,19,20	4,8,10,21	22,23,24
September	1 ,9	13	2,3,5,6,7,11,12, 15,17,18,19	4,8,14,16,20	10	21,22,23,24

Conclusion

Electrical Conductivity (EC) and pH of all wells were below the WHO permissible limits of 3.5 dsm^{-1} and 6.5 to 9.0 respectively and Nitrate Nitrogen was higher than permissible limit of 10 mg/l in some wells (well No11,12,13, 17, 18, 20, 21, 23 (tube well), 25, 29 & 33) during the twelve months study period from March 2008 to February 2009. These wells are not suitable for drinking purpose according to Nitrate Nitrogen in almost of all the months. There were few wells showing mean NO_3-N values above 5mg/l which may become unsuitable for drinking purpose in the near future as well as not suitable during rainy season since nitrate levels goes above permissible limits of 10mg/l during rainy season. Wells located in low lands were suitable for drinking purpose in almost all the months after treatment for fecal coliform. Nitrate contamination in ground water is high in permeable soil. There is no simple ways to remove all nitrates from contaminated water. Finding and correcting the source of nitrate contamination is the best course of action. All the wells were contaminated with fecal coliform and it is not suitable for drinking purpose unless the water is treated. High nitrate nitrogen and high fecal coliform count in wells around the hospital area may be due to the improper functioning of sand beds. Therefore sewage should be disposed in proper manner with out contaminating the ground water to provide safe drinking water.

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