TEMPORAL VARIATION OF NITRATE POLLUTION IN AGRO WELLS IN VAVUNIYA DISTRICT, SRI LANKA WITH SPECIAL REFERENCE TO KANTHAPURAM

P.Loganathan

Head, Department of Biological Science, Faculty of Applied Science,
Vavuniya Campus of the University of Jaffna, Sri Lanka
puvanalogan@gmail.com

Abstract

Management of good quality ground water is a prime factor for sustenance of life. Use of nitrate contaminated drinking water is well known risk factor for infant methemoglobinemia and various types of human cancer. There is a possibility of contamination of nitrate nitrogen in agro wells due to intensive use of inorganic fertilizer in permeable soil with shallow ground water. Objective of the study was to measure the nitrate nitrogen in selected agro wells and observe the temporal variation. Twenty wells were selected randomly from the Kanthapuram areas who have been cultivating vegetable crops for long period of time. Monthly water samples were collected from December 2008 to February 2010 to analysis Nitrate Nitrogen. Samples were drawn from the wells approximately at the levels of 30cm depth below the free water surface. Nitrate nitrogen was determined by colorimetric method (Brucine method). Mean Nitrate nitrogen in the study area was 12.2mg/l from December 2008 to June 2009 and 95 % of the wells were above WHO permissible limit of 10mg/l. The depth of the well varied from 6 m to 12 m and around 70% of the farmers apply the inorganic fertilizer above the recommended level. Intensive use of fertilizer and shallow ground water in permissible soil could be the reason for high nitrate nitrogen in agro wells. But mean nitrate nitrogen from August 2009 to February 2010 was 1.2 mg/l. Phyto remediation of nitrate nitrogen in shallow agro wells by available perennial plants around the wells during severe drought period from May 2009 to September 2009 could be the reason for low nitrate nitrogen. Mean nitrate nitrogen from December 2008 to June 2009 was significantly higher than mean nitrate nitrogen from August 2009 to February 2010 after severe drought (p= 0.000).

Keywords: Nitrate pollution, agrowells, phyto remediation, intensive use of fertilizer

1.0 Introduction

The Vavuniya district is located in the low country dry zone with the mean temperature of 28 ° C and annual rainfall of 1400mm. It is an agricultural area and people use surface and ground water for irrigation purpose. In Kanthapuram area, people have been engaged in cultivation of vegetable crops for more than 30 years using inorganic fertilizer. There is a possibilities of contamination of nitrate nitrogen in agro wells due to intensive use of inorganic fertilizer for vegetable cultivation in permeable soil with shallow ground water. Nitrate contamination of ground water has become a serious problem in northern part of Sri Lanka where intensified agriculture is being practiced (Nagarajah *et al*., 1988). A study of the incidence of various types of human cancer in relation to nitrate concentrations in Sri Lanka revealed a significant positive correlation for stomach, small intestine, oesophagus and liver cancers (Dissanayake and Weerasooriya 1987). In human body, nitrate is turned into nitrite. Nitrite then reacts with certain substrates such as amines, amides and amino acids to produce nitroso compounds, which have been found in numerous animal studies to carcinogenic (U. S. Dept of Health and Human services 1998). Preliminary study shows nitrate nitrogen in this area was high than WHO standard of 10mg/l. Therefore objective of the study was to measure the nitrate nitrogen of the agro wells with temporal variation.

2.0 Material and Methods

2.1 Collection of water samples from agro wells

Twenty agrowells were selected from Kanthapuram area who has been cultivating agricultural crops for long period and water samples were collected once in two months from December 2008 to February 2010 to analysis Nitrate Nitrogen (NO_3- N), Electrical Conductivity (EC), and pH. 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. The depth and diameter of wells were measured.

2.2 Analysis of Water

Electrical conductivity and pH were measured by environmental prop and NO_3- N was determined by colorimetric method using Brucine method (Taras, 1958). Nitrate-N analysis was done within twenty four hours after collection of sample. Total hardness was determined by titrimeric method using Ethylene Diaminete Tera Acetic Acid (EDTA method). Pair wise t test was performed to observe the significant difference between nitrate nitrogen in two seasons from December 2008 to June 2009 and August 2009 to February 2010.

3.0 Results

3.1 General characteristics of agro well

The depth of wells varied from 6m to 12m with the mean value of 8.6m and diameter of wells varied from 3.5m to 7.6m with the mean value of 5.3m. There was a rocky layer in the well No 18 below 6 meter from ground level.

3.2 General characteristics of soil

The texture of the soil was sandy loam with 72% sand , 4 % silt and 24 % clay . The bulk density and the particle density of the soil were 1.66 and 2.7 g/cm3 respectively. The soil of the experimental site was classified as Reddish Brown Earth.

3.3 pH of agro well water

The pH of the wells varied from 6.7 to 7.9 from with the mean value of 7.1 from December 2008 to February 2010 (Figure 1).

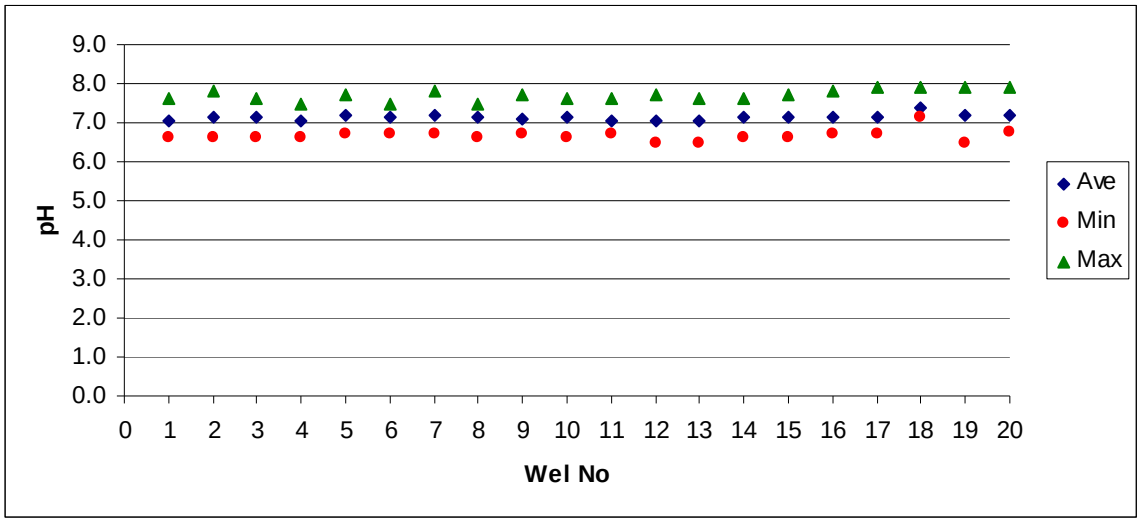

Figure 1 : Temporal variation of pH in agro wells

3.4 Electrical Conductivity(EC) of agro well water

The EC of the wells ranged from 0.65to 1.56 dsm^{-1} with the mean value of 1.00 dsm^{-1} and 60% of the wells' EC were above 1 dsm^{-1} (Figure 2). Low EC was observed in Well No 3, 11 and 17.

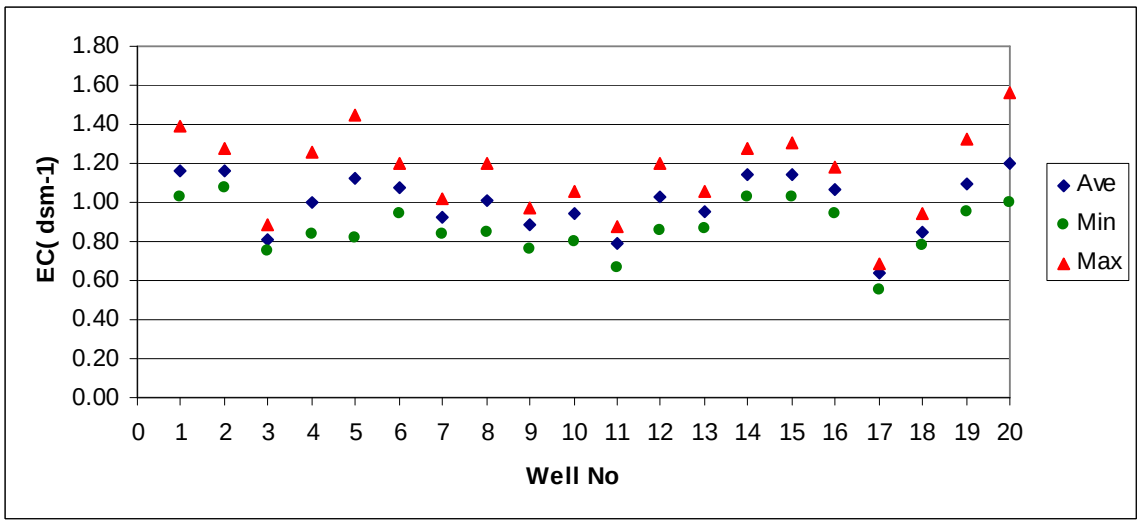

Figure 2 : Temporal variation of EC in agro wells

3.5 Nitrate Nitrogen in agro well water

Mean Nitrate nitrogen in agro wells varied from 4.5 to 15.1 with the mean of 12.2mg/l from December 2008 to June 2009 and 95 % of the wells were above WHO permissible limit of 10mg/l (Figure 3). Nitrate nitrogen in well No 18 varied from 3.5 to 5.9 with the mean of 4.5 mg/l during this period. But it was varied from 0.5 to 2.3 mg/l from August 2009 to February 2010 with the mean of 1.2 mg/l.

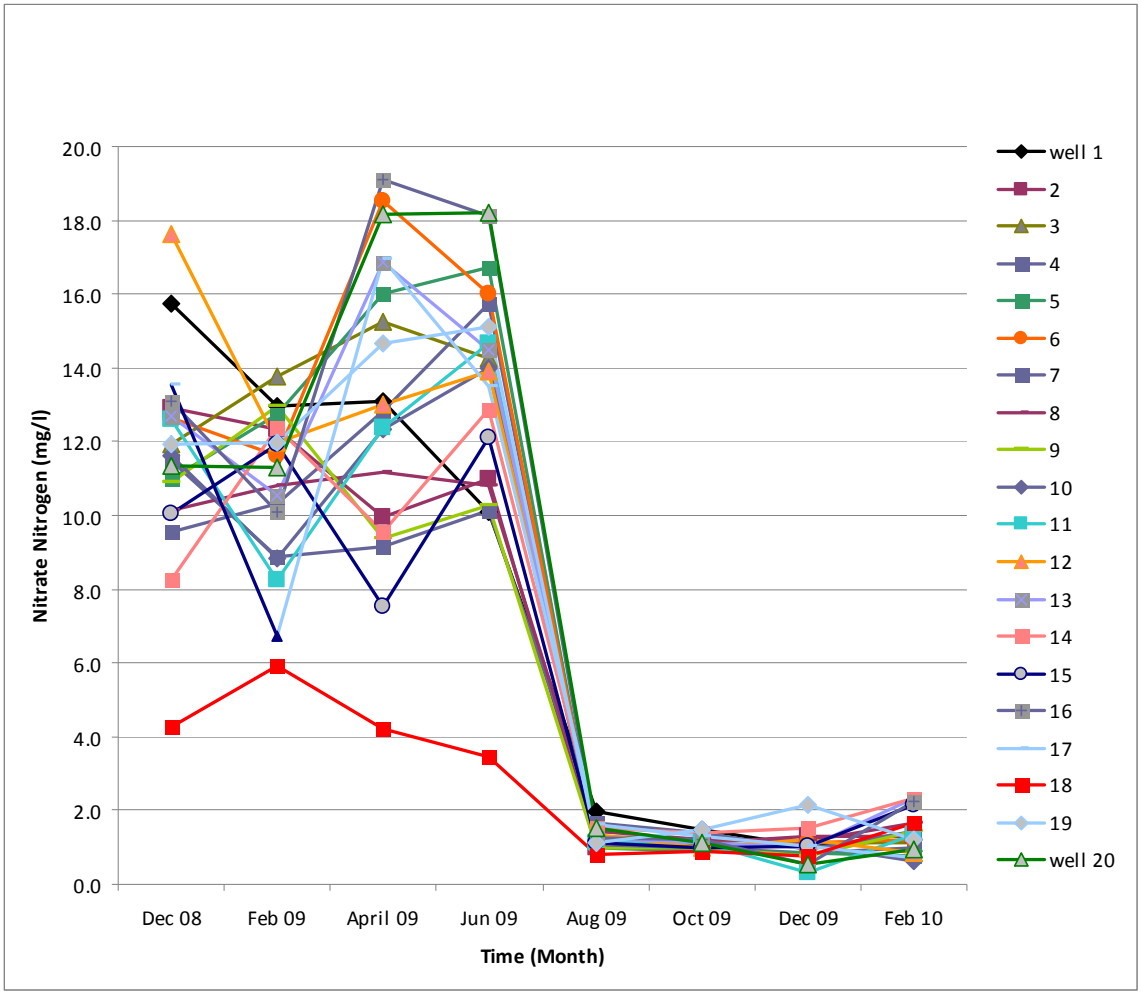

Figure 3 : Temporal variation of NO_3- N in agro wells

Mean nitrate nitrogen from December 2008 to June 2009 was significantly higher than mean nitrate nitrogen from August 2009 to February 2010 after severe drought (p= 0.000) (Figure 4).

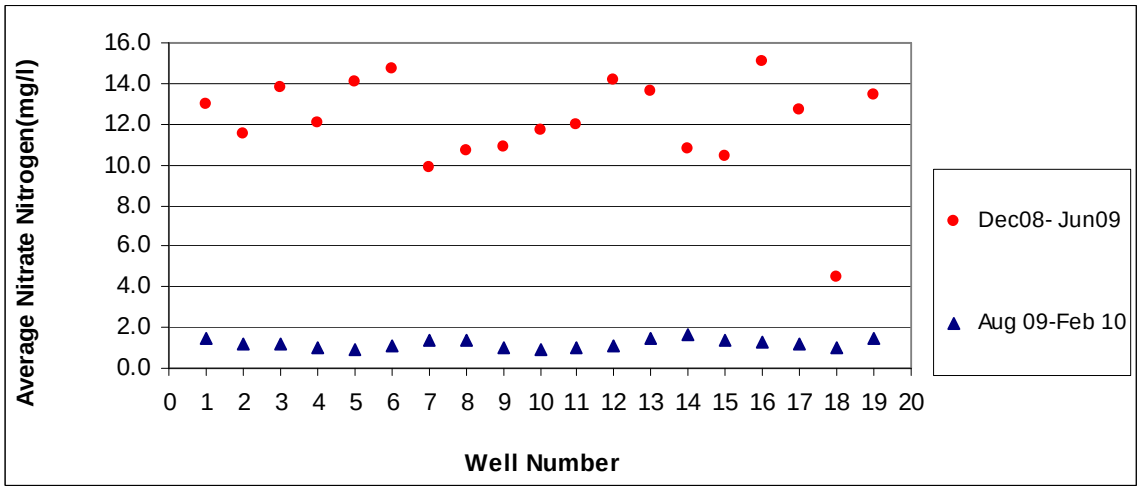

Figure 4 : Average nitrate nitrogen in agro well water from Dec 08 to June 09 and Aug 09 to Feb 2010

4.0 Discussion

4.1 pH and EC of agro well water

The neural nature was observed in almost all the well water through out the period and all the wells show pH within the WHO permissible limit of 6.5 – 9.0 irrespective of the months. Therefore water could be used for domestic and agricultural purpose. Electrical Conductivity of water was within the WHO permissible limit of 3.5 dsm^{-1} for drinking water. No significant temporal variation was observed in pH and EC. Therefore water could be used for drinking purpose with out any health hazards in relation to dissolved salts.

4.2 Nitrate Nitrogen in agro well water

The depth of the well varied from 6 m to 12 m and around 70% of the farmers apply the inorganic fertilizer above the recommended level in addition to organic fertilizer. Intensive use of fertilizer and shallow ground water in permissible soil (sandy loam) could be the reason for high nitrate nitrogen in 95% of agro wells. Nagarajah and *et al* (1988) also identified the same problems in agrowells in Jaffna district. 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.

The sudden decreased in nitrate nitrogen was observed from August 2009 to February 2010 in all the wells. During these periods there was severe drought and shortage of ground water occurred due to sudden fluctuation of population in Vavuniya district after arrival of internal displaced people. Water level of the wells varied from 1-2 feet in almost all the wells during severe drought period and household members said that once they extracted available water they have wait for next day. There was no water to remove the nitrate ions by leachate from top soil to bottom. Phyto remediation of nitrate nitrogen in shallow agro wells by available deep rooted perennial plants around the wells during severe drought period from May 2009 to September 2009 could be the reason for low nitrate nitrogen. Ground water quality improvement through ecosystem management research by Melvani (2008) in Kalpitiya, Sri Lanka noticed that nitrate nitrogen in water from experimental well decreased from 58.5 mg/l to 12.1 mg/l in four years.

5.0 Conclusions

Results of the experiment indicate that there is high nitrate pollution in agro well waters in the study area from December 2008 to June 2009 due to high and continuous chemical and organic fertilizer application, frequent irrigation, soil type (Sandy loam) and shallow ground water. But it was less during severe drought period due to lack of water to remove nitrate ions by leachate in the soil and phytoremediation of nitrate nitrogen in well water by perennial plants. Management of fertilizer and cropping system are prime factor that determine the ground water pollution.

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References

Amarasinghe.S.R and C.S De Silva., 2006. "Water quality assessment of agro wells in Vavuniya District for the use of Agricultural and Domestic purposes". Water Professional Day symposium. October 2006.

Dissanayake.C.B.1998. "Nitrates in ground water in Sri Lanka"- implications fro community health. Journal of the Geological Society of Sri Lanka, Vol 1 1998 p,80-84.

Melvani.K 2008. Bioremediation ensure clean water. NEO synthesis research centre, Sri Lanka.

Nagarajah, S., N. Emerson, and S.Yogalingam, S. 1988. "Water quality of some wells in Jaffna and Kilinochchi with special reference to nitrate pollution". *Tropical Agriculturist*. 144:15-20

Panabokke, C.R., and A.P.G.R.L.Perera. 2005. "Ground water resources of Sri Lanka". Water Resources Board , Sri Lanka.

Taras, M.J.,1958. "Nitrogen. In: chemical analysis. Vol. VIII. Calorimetric determination of non-metals", Ed. D. F. Bolts, 75-160. New York: Inter Science publishers Inc.

U. S Dept. of Health and human services, Public Health Service. 1998. National Toxicology Program, 8th Report on Carcinogens.

USEPA (US Environmental Protection Agency), 2000. "Drinking water standards and Health advisories", Office of water U S .Environmental Protection Agency Washington, D.C., EPA 822-B-00-001.
114:61-79.

WHO (World Health Organization), 1971. "International Standard for Drinking water". WHO Geneva, Switzerland. 70pp.