

## Ground Water Quality in Mahakanumulla and Thirappane Tank Cascades in the Dry Zone of Sri Lanka

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### Abstract

Many people in the world are depending on the ground water as their source for domestic and agricultural activities. Ground water is an extremely valuable resource and pollution of ground water resources is a matter of serious concern. Twelve dug wells under six tanks (*Siwalagala, Amanakkatuwa, Mahakanumulla* in *Mahakanumulla cascade* and *Meegasagama, Alisthana and Thirappane* in *Thirappane cascade*) were selected for this study. Sampling had been carried out for two years from February 2010 to January 2012. Water samples were collected at monthly intervals from dug wells. In all water samples, major plant nutrients *viz.* dissolved nitrate ( $\text{NO}_3^-$ ), phosphate ( $\text{PO}_4^{3-}$ ), potassium ( $\text{K}^+$ ) and toxic elements; cadmium ( $\text{Cd}^{2+}$ ), and fluoride ( $\text{F}^-$ ) were determined using standard laboratory techniques.  $\text{NO}_3^-$  concentration of dug wells varied from 2.10 – 10.51 mg/L and in this study, There is a moderate positive correlation between tank water  $\text{NO}_3^-$  and dug well  $\text{NO}_3^-$  ( $r = 0.536$ ).  $\text{PO}_4^{3-}$  concentration ranged from 0.003 – 0.46 mg/L and  $\text{K}^+$  concentration varies from 1.03 – 8.50 mg/L. The most health detrimental element  $\text{Cd}^{2+}$  which enters to water through phosphate fertilizer and organic manure also showed the significant temporal variation throughout study period. It varies from 0.001- 0.02 mg/L and exceeded the permissible level of drinking water which is 0.003 mg/L (WHO, 2004). Fluoride which has both beneficial and detrimental effect on human health varies from 0.49-2.39 mg/L. In this analysis, all major nutrients and toxic elements (Cd and F) showed relatively high concentrations during the rainy season where the low concentrations were recorded in dry season. The highest concentration of plant nutrients and toxic elements occurred in ground water during the months of October, November, April, May and June, which are the months that farmers apply chemical fertilizers to croplands. It is evident from the results that major plant nutrients and toxic elements in ground water varied significantly with the bimodal rainfall, cropping seasons and fertilizer use. None of the nutrients exceeded permissible level for drinking water except Cadmium.

**Key words:** Ground water, Plant nutrients, Toxic elements, Tank cascade system.

### Introduction

Many people in the world are depending on the ground water as their main source for domestic and agricultural activities. Ground water is an extremely valuable resource and pollution of ground water resources is a matter of serious concern. It becomes contaminated when anthropogenic or people related substances are dissolved or mixed in waters recharging the aquifer (Jeyaruba and Thushyanthy, 2009). Ground water contamination is extremely difficult and sometimes impossible to clean up. Poor water quality results in health hazards to humans and animals. Nearly 75 % of Sri Lankan population still depends on dug wells and deep wells for their water requirements (Nandasena et al., 2005). By far the majority of this 75% is the middle and low income groups and their general health is bound to be influenced by the quality of water that they drink. It would have had health subjective either beneficially or detrimentally depending on chemical and biological quality of water source. In the

dry zone, major ground water recharging source is village tanks and the quality of water in most areas in dry zone is questionable. Therefore the objective of this study is to assess the chemical quality of waters of dug wells under some selected tanks.

### Materials and Methods

Field work has been carried out in the *Thirappane* area located about 30 km south from *Anuradhapura* city in the North Central Province. Twelve dug wells under six tanks (*Siwalagala, Amakkatuwa, Mahakanumulla* in *Mahakanumulla cascade* and *Meegasagama, Alisthana and Thirappane* in *Thirappane cascade*) were selected for this study. Sampling was carried out for two years from February 2010 to January 2012. Water samples were collected monthly intervals from dug wells. There were three replicates for each analysis. In all water samples, dissolved nitrate ( $\text{NO}_3^-$ ), phosphate ( $\text{PO}_4^{3-}$ ), potassium ( $\text{K}^+$ ), cadmium ( $\text{Cd}^{2+}$ ), and fluoride

(F), were determined using standard laboratory techniques. Electrical conductivity (Ec) and pH of the water samples were also measured. The data were analyzed statistically with turkey's Student zed Range test comparison using SAS software package.

### Results and Discussion

According to the results, major plant nutrients and two toxic elements showed significant temporal and spatial variations over the study period. Concentration of major plant nutrients ( $\text{NO}_3^-$ ,  $\text{PO}_4^{3-}$ ,  $\text{K}^+$ ) and toxic elements ( $\text{Cd}^{2+}$ , and  $\text{F}^-$ ) in the twelve dug wells showed a similar trend with significant temporal variation during the two years period. In the dry zone, there are two distinct seasons namely *yala* and *maha* based on the rainfall distribution. *Yala* and *maha* season falls in the months of April to September and October to March, respectively. In this analysis all major nutrients and toxic elements showed relatively high concentrations during the rainy season where as the low concentrations were recorded in dry season (Fig 01).

The highest concentration of all nutrients and toxic elements occurred during the October, November, April, May and June months which are the months that farmers apply chemical fertilizers to croplands and subsequently the nutrients and toxic elements along with the water reach to the ground water. After that the concentration was reduced during January because of high recharge to the well which dilutes the concentration of plant nutrients.

Nitrate ( $\text{NO}_3^-$ ) concentrations of dug wells varied from 2.10 – 10.51 mg/L and in this study, there is a moderate positive correlation between tank water  $\text{NO}_3^-$  concentration and dug well  $\text{NO}_3^-$  concentration ( $r = 0.536$ ).

Phosphate ( $\text{PO}_4^{3-}$ ) concentration ranged from 0.003 – 0.46 mg/L and  $\text{K}^+$  concentration varies from 1.03 – 8.50 mg/L. Nitrate concentration in only one well under *Thirappne tank* exceeded the permissible level for drinking water quality which is 10 mg/L according to WHO standards. However according to drinking water standards of European community, the recommended  $\text{PO}_4^{3-}$  is 5 mg/L Present study also showed that  $\text{PO}_4^{3-}$  was not much higher in well waters in the investigated area. Also none of the dug wells exceeded the permissible level for drinking water quality which is 2 mg/L according to WHO standards. The most health detrimental element  $\text{Cd}^{2+}$  which get there through phosphate fertilizer and organic manure also showed a significant variation throughout study period. It varies from 0.001- 0.02 mg/L. All the wells sampled exceeded the permissible level for drinking water which is 0.003 mg/L (WHO, 2004) especially during cultivation periods. The levels of fluoride which has both beneficial and detrimental effect on human health, varied from 0.49-2.39 mg/L. None of the dug wells except one in *Thirappane* area exceeded the permissible level of drinking water which 1.5 mg/L. Waters of other wells are in conformity with drinking water quality standards.

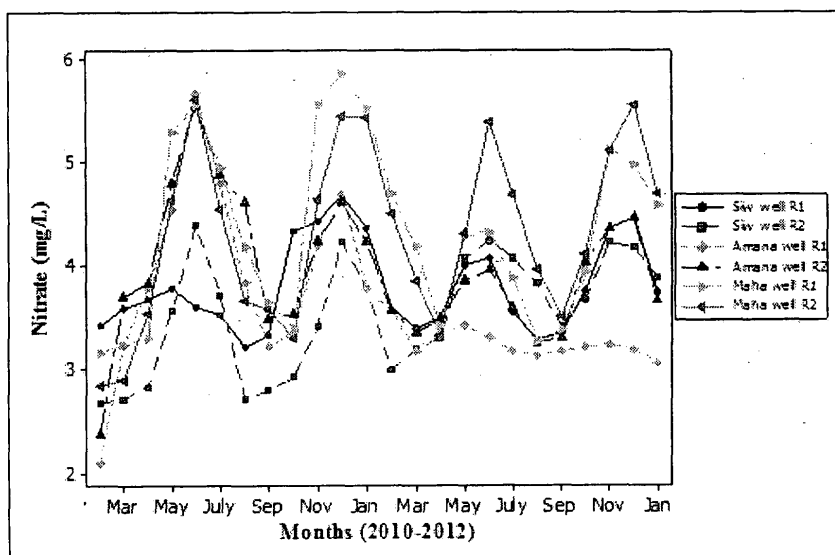


Figure 1: Nitrate fluctuation in six selected wells during Feb 2010- Jan 2012 period

The normal recommended pH range for drinking waters is from 6.5- 8.5. All the tested dug wells were within the range and there were no influence of cropping system on pH. Since the measured Ec values of dug wells were less than Sri Lankan permissible level of 3.5 dS/m, all the wells were suited for drinking.

### Conclusion

It is evident from the results that major plant nutrients and toxic elements in ground water varied significantly with the bimodal rainfall, cropping seasons and fertilizer use. None of the nutrients and toxic elements exceeded permissible level for drinking water except Cadmium. Therefore, no serious threats were observed so far in relation to the water quality deterioration in dug wells in *Mahakanumulla* and *Thirappane* tank

cascades. But the caution must be taken regarding Cadmium.

### References

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