*Proceedings of the Peradeniya University Research Sessions, Sri Lanka, Vol.12, Part II, 30th November 2007*

# Deterioration of Groundwater Quality in Tsunami Affected Coastal Aquifers in Sri Lanka and Complexities in Natural Recovery

H.A. Dharmagunawardana[1*], A. Welagedara[1], A. Pitawala[1] and M.N.A. Mubarak[2]

[1]*Department of Geology, Faculty of Science, University of Peradeniya*
[2]*Industrial Technology Institute, Colombo 07*

## Introduction

In December 2004, tsunami inundated and thereby contaminated about 40,000 dug wells and a considerable number of surface water bodies. Therefore, potable water supply systems that were based on groundwater became unusable. Contamination of groundwater became a massive problem to be solved in the affected areas. In general, deep sea sediments contain a large variety of organic and inorganic chemical compounds including heavy metals, some of which can be toxic (Jacobs *et al.*, 1987).

The present study was carried out in the west coast of Sri Lanka, between Ambalangoda and Rathgama towns in the Galle district (Figure 1). This highly variable nature of geology and environmental conditions within short distance makes groundwater quality highly variable. The purpose of the present study is to understand the natural processes of ground and surface water quality improvements with time, under the influence of prevailing environmental conditions.

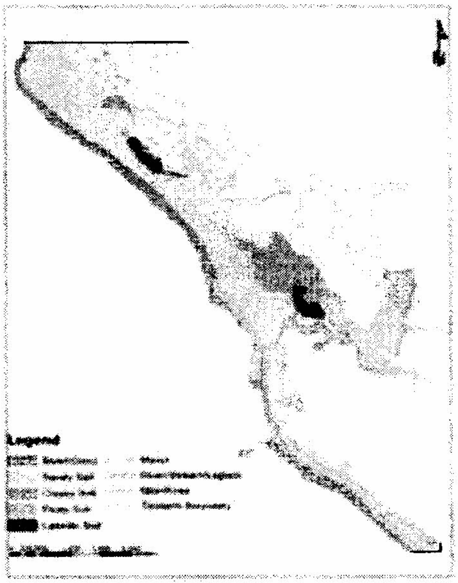


Figure 1. The study area showing the soil types and surface environmental conditions

## Materials and methods

Sixty five sampling points, including dug wells, tube wells and surface water bodies were selected, and sampling was done at four occasions during the period between December, 2005 and December, 2006. Water samples were analyzed for heavy metals, nutrients. pH, electrical conductivity (EC), salinity, total dissolved solids (TDS), dissolved oxygen (DO) and temperature. A portable multi-parameter meter and ELE portable turbidity meter were used for determining general chemical parameters. Heavy metals (Hg, As, Cd and Pb) were analyzed using Varian atomic absorption spectrophotometer (AAS) while phosphate and nitrate levels were determined using standard methods (APHA, 20th edition).

## Results and discussion

The concentrations of the heavy (trace) metals appear to be significantly low and are mostly below the detection limits. This indicates that the possible effect on water quality by the (analyzed) heavy metals that were brought by tsunami water or the agitated sediments, is not significant at most places. One out of five tube wells sampled showed contamination by nutrients. The dug wells in marshy environment where the water table was very shallow were also showed contamination by nutrients.

Based on the groundwater salinity levels observed in December, 2005, the dug wells could be arranged in the order from low to high salinity (Figure 2). When comparing the results of subsequent salinity measurements in the same wells, interesting behavioral patterns can be seen (Figure 2). The wells with high salinity as seen in Figure 2 have shown rapid decrease with time. Majority of these wells were situated close to the coast and had inundated by the tsunami water. Wells with originally moderate and low salinity on the other hand (Figure 2) do not show a fast or a significant change with time. These wells thus could be assumed to be saline even prior to tsunami.

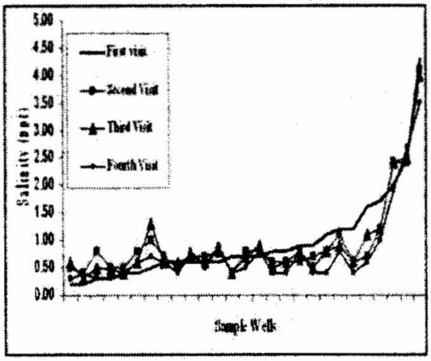



Figure 2. Salinity variation in dug wells

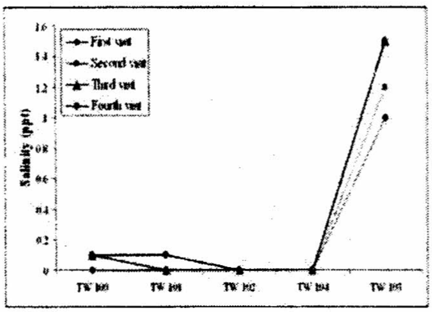


Figure 3. Salinity variation in tube wells

The salinity levels of the tube wells have shown an increasing trend with time (Figure 3). Of these tube wells, TW100 is located near the tsunami boundary, TW 101 and 103 within the tsunami flood zone and TW102 and 104 outside the tsunami zone.

The area wise distribution of the salinity of groundwater at different times is shown in Figure 4. It is seen from the salinity maps of Figure 4 that there is no definite trend of temporal or spatial salinity variation other than slight shrinking of the high salinity zones with time. This situation can be attributed to the previously mentioned diversified geological and environmental conditions of the area. Water quality also appears to be dependent on recharge conditions, sandy, peaty, or lateritic soil compositions, local morphology and presence of marshy conditions of the area. This can be seen when compared to the geographic distribution of salinity with the surface geological and environmental conditions (Figure 1) of the area. High evaporation associated with shallow groundwater level in the vicinity of marshes can retard the rate of decrease of salinity created by the tsunami. In addition, intrusion of saline water from brackish water streams and other surface water bodies can further complicate and mask the natural salinity decreasing processes.

## Conclusions

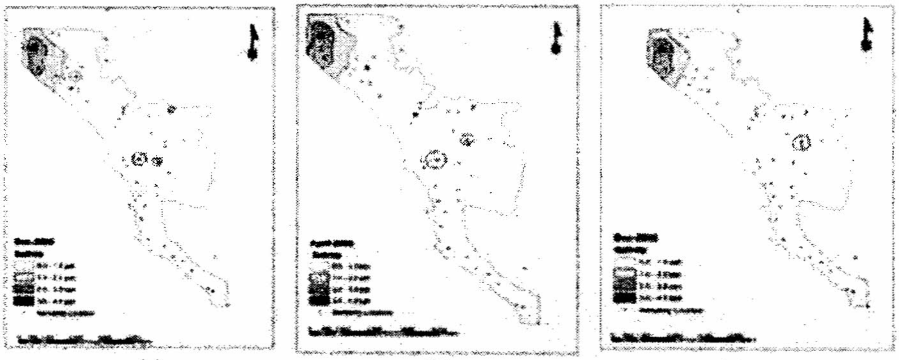
Ground waters in the tsunami affected coastal areas have been faced quality problems of diversified nature. Increase in salinity has become the most significant problem while contamination with respect to nutrients has been evident mostly in marshy areas with shallow groundwater table. Heavy metal contamination however, is not significant. Groundwater quality has shown a slow recovery with respect to salinity. Complex geological and environmental conditions in the area however, complicate and mask the natural rates of recovery.

## Acknowledgements

Financial support from NSF research grant RG/05/DMM/03 is acknowledged.

## References

Jacobs, L., Emberson, S. and Huested, S.S. (1987) *Trace Metal Geochemistry in the Cariaco, Trench, Deep-sea Research,* Royaume University, Oxford: Pergamon. 265-284.



(a) (b) (c)

Figure 4. Variation of Salinity of ground water with time (a) December 2005, (b) August 2006 and (c) December 2006