Salinity Distribution of Groundwater in Trincomalee Coastal Region

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Introduction

Groundwater is the prime source for people living in dry zone of Sri Lanka, especially duringdry season for their drinking, domestic and agricultural activities. Groundwater has been exploited from earliest times in Sri Lanka mainly for domestic use and where readily available for irrigation as well. Almost 80% of the rural population in Sri Lanka relies on groundwater for their domestic needs today, because of its excellent natural quality and sustained availability throughout the year (Panabokke, 2007). Groundwater is frequently contaminated due to anthropogenic activities. However, some natural phenomena too are responsible for making groundwater unsuitable for drinking. Seawater intrusion is one such prominent process of groundwater contamination.

This study focuses on seawater intrusion of groundwater regime along a 22 km long coastal region of Trincomalee, fromKinniya to Nilaweli by evaluating the salinity distribution of groundwater. Groundwater plays a significant role as the major source of freshwater for Trincomalee district during the dry season. The main aquifer type in Trincomalee coastal region is called 'shallow aquifer in coastal sand'. This aquifer is well marked in Nilaweliarea (Water Resources Board 1999-2001). People consuming water from the wells near the sea are highly affected by the salt (saline) water and undesirable properties of the water. Seawater intrusion has not only been affecting the groundwater, but also has changed the soil condition making it unsuitable for agricultural uses. Therefore, most of the farming lands are converted into fallow lands. After the tsunami in 2004 seawater intrusion has exacerbated more than the past. Therefore, seawater intrusion becomes a serious issue and has to be controlled for the future demands both water and land resources. Seawater mainly consists of cations like sodium, magnesium, calcium and major anion known chloride, which induce salinity and high el ectrical conductivity.Therefore, measuring the conductivity of groundwater may help identify any saltwater intrusion.

Methodology

Initially, existing data including aquifer types, geology and topography were studied with the help of previous researches and monitoring carried out in the area. Wells were selected along a profile perpendicular to the coastal region until the electric conductivity (EC) value became very low close to the drinking water standards. Water samples were collected in plastic bottles and capped tightly for subsequent laboratory analysis. Finally, 32 shallow well samples were selected for chemical analysis from the area of 22 km coastal belt from Kinniya to Nilaweli. Well locations were identified using GPS. On the spot measurement for EC of the water samples was carried out with Orion 3 Star EC meter. Water samples were analysed for Cl by using Silver Nitrate Titration method. Na^+ was determined by Varian SpectrAA AAS facility available at the Uva Wellassa University. Spatial distribution of the chemical and physical parameters in the groundwater was plotted and interpolated using Inverse Distance Weighted method aided by ArcGIS 9.3 software to visualize the data.

Results and Discussion

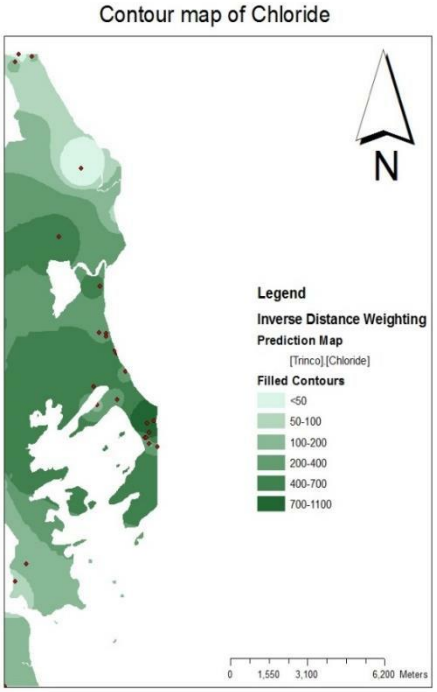

Figure 1. Chloride distribution in the study area.

Groundwater consumption is vital in Trincomalee district because piped water supplied percentage is below 35 %. The district is located in dry zone of the country experiencing low rainfall except in September to January when north east monsoon occurs. Dry season is highly experienced from February to June. Below the discharging freshwater in coastal aquifers, there exists a saltwater wedge formed by recirculating sea water. This wedge develops due to both density driven flow and hydrodynamic dispersion. Intensive groundwater abstraction alters the equilibrium between freshwater and saltwater with the result of an inland movement of the wedge and upward movement of saltwater below partially penetrating pumping wells.

The electrical conductivity of well water is within normal range, except in areas close to the sea (Figure 1). This is due to the seawater intrusion, especially in dry season when the water from the wells is intensively pumped for the use of agriculture and other domestic needs. Highest value is obtained from the well at 6 th mile post (1394µs/cm) and low value from Nilaweli (391µs/cm). The total groundwater flow in southern (Nilaweli) and Northern (Kumburuppiddi) segments, the average recharge of this aquifer shows a value of 4.05mcm for the Nilaweli segment, a 2.36 mcm for the Kumburuppiddi segment. Low recharging level may enhance the effect of seawater intrusion when well water is extracted over its safe yield. The safe yield for the Nilaweli segment is 2.43 mcm and kumburuppiddi 1.42 mcm.

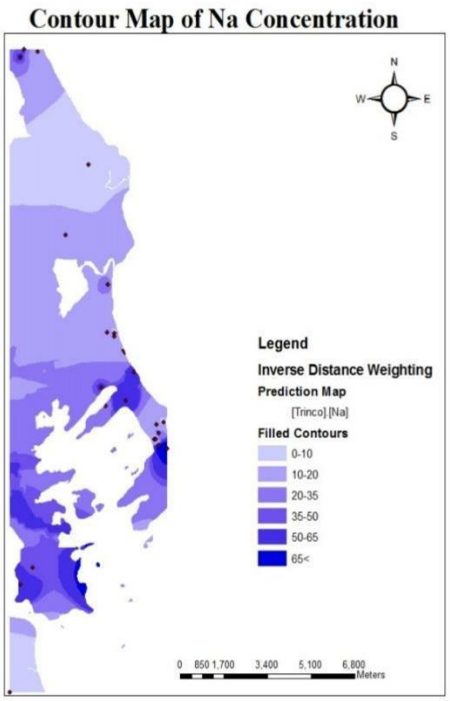

Figure 2. EC distribution in the study area

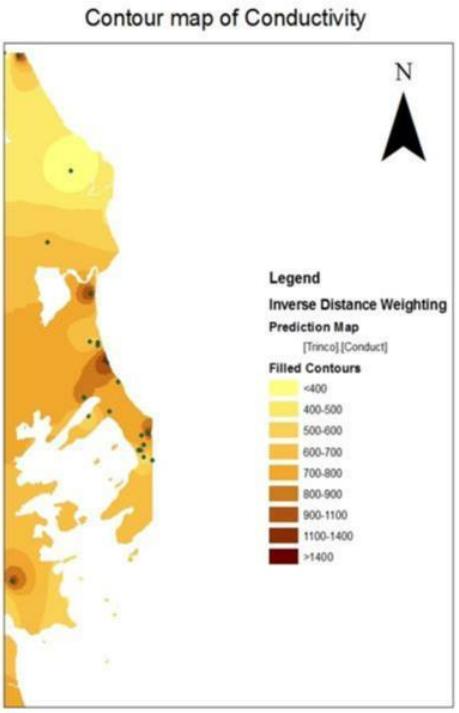

Figure 3. Sodium distribution in the study area

Sodium concentrations variation change with the distance to the sea. The wells closer to the sea are higher than the wells far from the sea in sodium content. Wells from Nilaweli, Kumburppiddi, Saampaltheevu, 6 th mile post and Uppuweli had shown both higher sodium and chloride values (Figures 2 and 3) because they are closer to the sea. In some areas the saltwater front has moved about 1 km in to the land (Figure 3).

Conclusions

Conductivity, sodium and chloride concentrations clearly indicate that the groundwater close in the coastal area has been contaminated with the seawater. Presently, the seawater front can be identified in the extent of about 1 km into the land during dry season. In order to observe the in and away movement of the saltwater front, groundwater analysis should be carried out during the wet season.

References

Panabokke, C.R., 2007. Groundwater conditions in Sri Lanka: a geomorphic perspective, Journal of the National Science Foundation of Sri Lanka, 36, 18-26.