Assessment of Groundwater Quality Status in Puttalam and Chillaw Area to Demonstrate its Suitability as a Source of Potable Water

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ABSTRACT

Ground water is an important source for domestic, industrial and agricultural use in the whole world. In Puttalam and Chilaw areas 20% of the domestic water requirement is mainly fulfilled by the ground water. Exponential population growth, development pressures and the use of water resources for multiple competing uses have led to fast depletion of the groundwater aquifers in the area resulting salinity intrusion and quality deterioration. Use of groundwater as a potable water source has a limited opportunity due to over extraction, pollution by agriculture, industries, and prawn farming. Most water sources show quality deterioration showing water quality parameters exceeding the Desirable level according to the Sri Lankan standards for water quality. Content of Manganese, Electrical conductivity and Total Dissolved Solids concentrations are reported to be very high in groundwater in Puttalam area and high iron concentrations are common in Chilaw area constraining their suitability as a potable water source. The research was conducted to establish present status of groundwater quality deterioration and to Screen suitable groundwater sources in Puttalam and Chilaw Municipal Council areas for domestic purposes.

Samples were collected randomly from existing dug wells in the area and tube wells about three times over a one month duration interval. The monitoring parameters included Ground Water Table, Electrical Conductivity, Temperature and Total Dissolved Solids as on-site measurements and Total Iron, Manganese, Fluoride, and Total Hardness as parameters measured at the laboratory. The Concentration of water quality parameters and its distribution were graphically plotted using GIS software. The results show high concentration of Electrical conductivity, Total Hardness, Total Dissolved Solids closer to the sea and mouth of Deduruoya area and comparatively poor water quality in Puttalam compared to Chilaw marginalizing its suitability as a potable source.

The study led to several valuable recommendations to improve present water quality status and continue areas needing further investigations on screened locations.

Key Words: Aquifer, Quality deterioration, Screened locations, Quality parameters

INTRODUCTION

Ground water is a valuable resource. It can be found beneath most land and most of the available fresh water on the earth is ground water. Because it is hidden from our view it tends to be somewhat mysterious. Despite abundance of available information, the knowledge of the bordering community on ground water existence, ground water movement, quality, and quantity is very low.

Groundwater has been an important natural resource of the Puttalam and Chilaw area throughout the ages. The population of Chilaw and Puttalam depends mostly on the limited groundwater resources to meet all of their water requirements. In recent times concern has been expressed about the increase in salinity and poor quality of water due to sea water intrusion, organic

pollution through continuous and liberal use of organic manure and inorganic fertilizer. Over extraction or rapid rate of extraction is practiced using mechanical and electrical pump for intensive agriculture practices. Majority of the wells of two areas contain highly saline water.

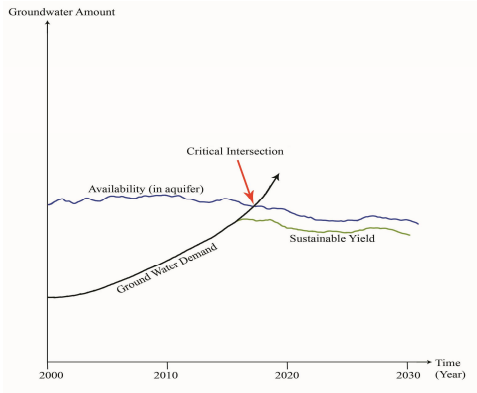

Fig. 1 Ground water demand curve in future

A water supply system with good quality water is essential for these identified areas at least to satisfy their requirements especially for domestic drinking purposes. Water quality is an important parameter used to identify and locate suitable source of ground water which can be used for supplying potable water to the community. Another important aspect of determining the water quality is, it helps for monitoring additional parameters. Further information on water quality of a source of ground water also helps to identify possible pattern of underground movements of water. Water quality monitoring helps to identify combinations of various parameters of which the unacceptable levels of any constituent can render any water source unusable. Certain constituent can make water unwholesome and even hazardous for human consumption. In Chilaw and Puttalam area only a few number of wells are used for pumping water for several human activities resulting in quality deterioration. In this study sample locations were selected to represent the city area of Puttalam and Chilaw. Mainly in Puttalam water requirement depend on Mi oya well field. Therefore it is better to find new potential ground water locations to sustain fulfillment of future water demand.

MATERIALS AND METHODS

Reagents were used with Spectrophotometer (DDR 2700), SPAND Reagent (Fluoride), Pan Indicator solution (Mn), Alkaline Cyanide Reagent (Mn), Ascorbic Acid pillows (Mn), Ferrous Iron pillows (for 25 ml), Ferro Ver Iron pillows (for 10 ml), Nitra Ver 5 Nitrate pillows (for 10 ml), EDTA Solution (hardness- 50 ml)

Topography of the area with particular reference to the main existing pumping station, distribution tank and its locations were carefully studied. The general topography and the other geological features of area such as water bodies, feasible dug wells, were also identified.

The groundwater catchment was demarcated with reference to the existing dug wells, tube wells and well fields situated in the study area. Therefore the sampling locations were spread out to represent the whole catchment. Representing all the decided locations samples were collected three times with one month interval. Polythene bottles were used to store ground water samples for analyzing ground water parameters. Sample bottles were prepared to collect the water samples to meet prerequisites of chemical analysis.

Distributions of Chemical parameters of the study area are graphically represented by using of GIS software.

RESULTS AND DISCUSSION

Rainfall in Puttalam(2011)

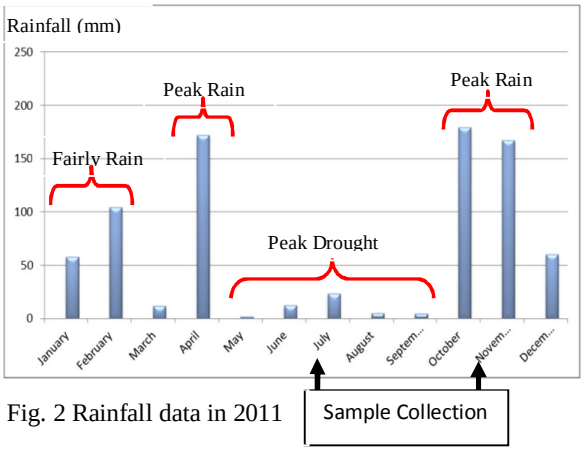

Fig. 2 Rainfall data in 2011

Electrical Conductivity (EC) Distribution in Puttalam

July (Dry Period)

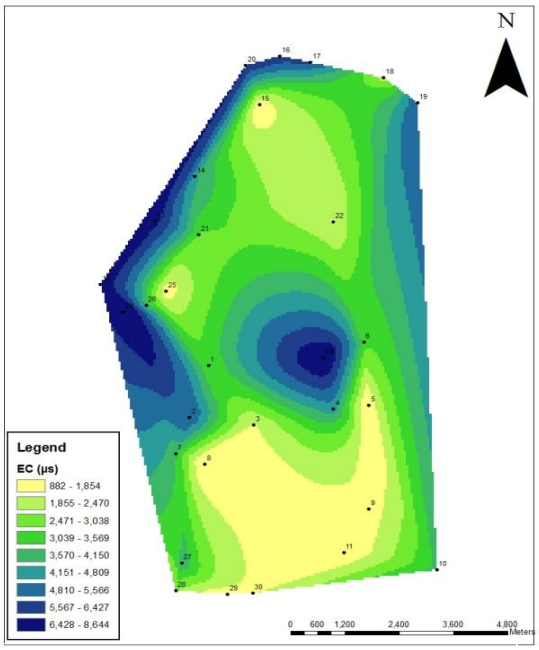

Fig. 3 EC Distribution in July

November (Rainy Period)

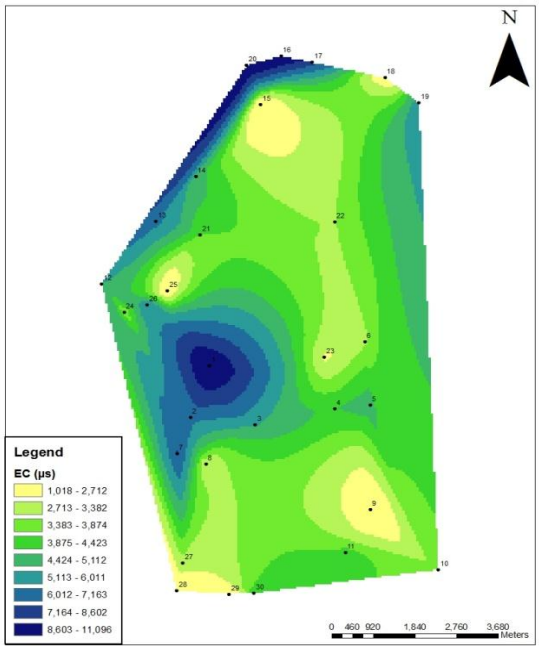

Fig. 4 EC Distribution in November

Total Dissolved Solids (TDS) distribution in Puttalam study area

July (Dry Period)

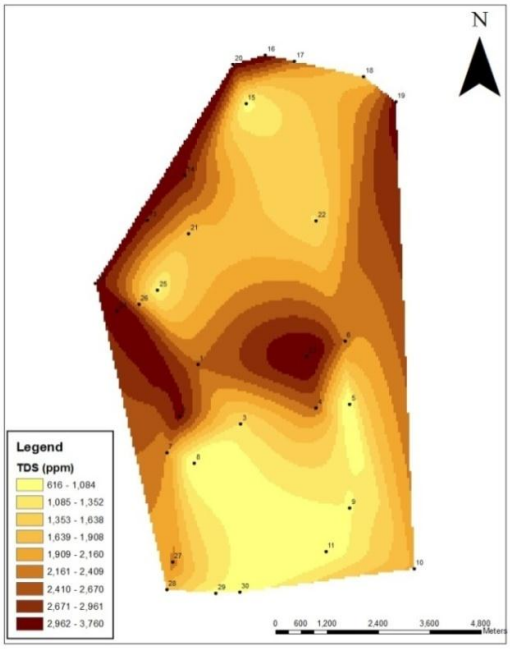

Fig. 5 TDS distribution in July

November (Rainy Period)

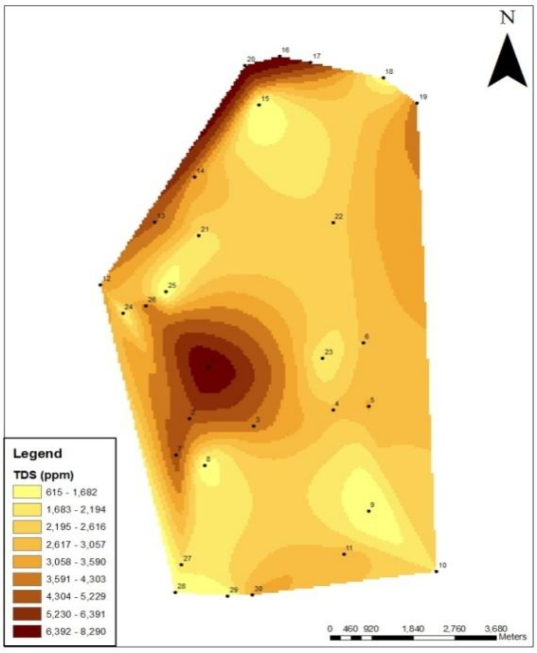

Fig. 6 TDS distribution in November

A variation in EC can be clearly observed during the rainy season and drought conditions. However the increase in EC is not severe, during drought, where most EC values remain below maximum permissible levels as per Sri Lanka standards for drinking water. This indicates that from the rainy period up to drought there is no major concentration of ions due to transpiration. Indirectly this also suggest that there could be a dilution input during drought, perhaps from base flows of Deduru Oya, and from major Tank System flows, below tank beds closer to the negombo lagoon, Deduru oya mouth and closer to the sea can be clearly seen through EC incensement. In the dry period with the lowering of Ground Water Table, saline water intrusion become a common phenomena

In groundwater of Sri Lanka from past records it has been generally accepted that a correlation exists between EC and TDS as follows:

EC µ mhos/cm x 0.7 = TDS ppm

Therefore a similar trend exists for TDS, and the comments made for EC is valid for TDS also

Manganese Distribution in Chilaw Area
Jully(Rainy Period)

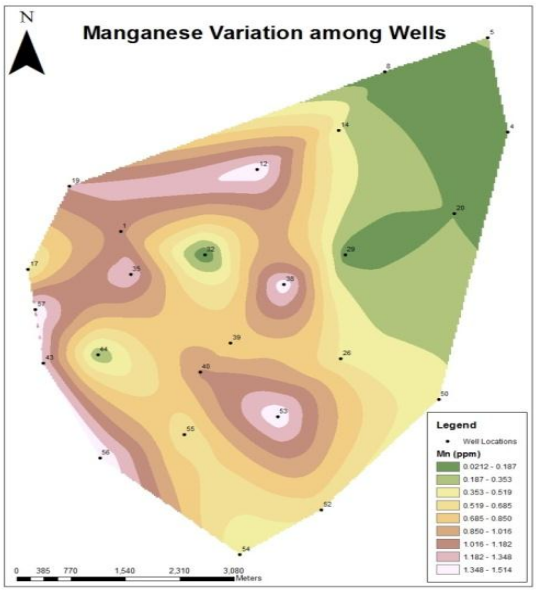

Fig. 7 Manganese Distribution in July

October (Dry Period)

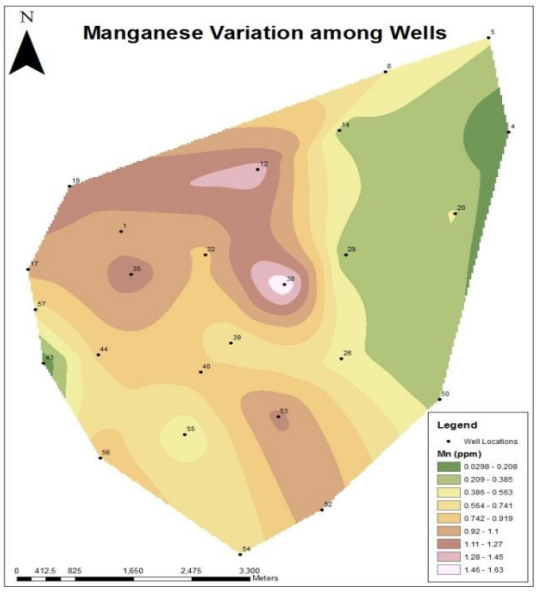

Fig. 8 Manganese Distribution in October

The concentration of Manganese exceeds even the maximum permissible limit in the areas of Munneswarama,Tissogama,Mungandaluwa, Maikkulama and Merawala areas. This may affect for the community health, and it is difficult to treat by traditional treatment methods.

Concentration of total Iron exceed the desirable limit in few locations, those locations falls in to the Munneswarama kovil, Tissogama and Karawita south areas but they do not exceed the maximum permissible limit. It is easy to reduce the concentration of total Iron mainly by the methods of aeration and filtration processes in the treatment plant. However this precipitated Iron may severely affect by clogging and damaging the water pumps and other water supply water treatment facilities. Hence it is very essential to exclude the areas with high Iron concentration for construction of tube wells. Panirendawa Iron ore deposit increase Iron availability concentration in water

Fluoride Distribution in Chilaw Area

Jully(Rainy Period)

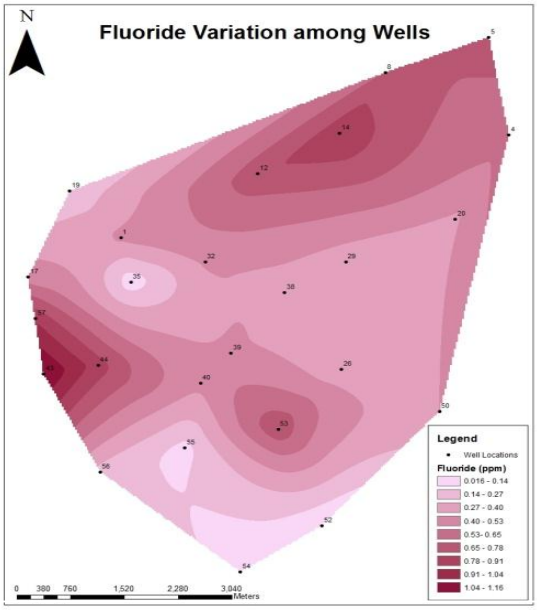

Fig. 9 Fluoride distribution in October

October (Dry Period)

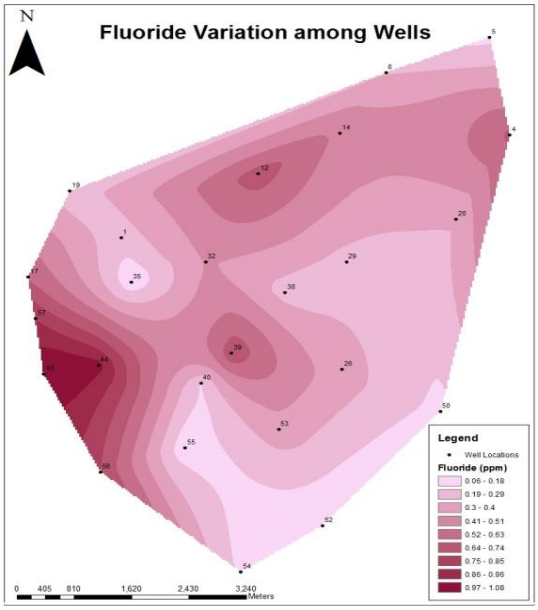

Fig. 9 Fluoride distribution in July

CONCLUSIONS (Chilaw Study Area)

Total Dissolved Solids in 84% of the locations are below permissible level of (200mg/l), 16% of the selected locations exceed the permissible level of (2000mg/l), and during the dry period increase of the TDS concentration in many locations is observed than during the rainy season. This situation is caused by concentration, saline water intrusion and transpiration. Water available in16% of the studied locations are not suitable for drinking.

Concentration of total hardness at all locations (100%) is below the permissible level of 600 mg/l. water tested at a few locations exceed the desirable level (300mg/l) of hardness at most of locations tested water samples are even below the desirable level.

High concentration of manganese could be monitored in most locations.100% of the locations exceeds the desirable level of 0.05 mg/l. Samples tested at only three locations are below the permissible level of 0.5mg/l. At 88% the studied locations water is not suitable for drinking purpose.

Comparatively high concentration and distribution of Iron were monitored in Chilaw area than in Puttalam. But all the locations are below the permissible level of (1.0mg/l) and at 56% of the studied locations, Iron content exceeds the desirable level of 0.3mg/l.

Electrical conductivity of water at all locations except at three locations exceeds the desirable level of 750mg/l. Water tested at 24% of locations are not suitable for drinking purpose too (3500mg/l).

Water found at 24% of the selected locations exceeds the desirable level of fluoride content in drinking water (0.6mg/l). But water at all the locations is found below the permissible level. In all locations pH range vary between (5.2-7.8)

When considering all the monitored parameters in the area water found in Munneswaram, Maanuwangama, Malwaththa, Nariyagama, Kanjukkuliya, Thitta Kade are suitable for drinking

CONCLUSIONS (Puttalam Study Area)

80% of the studied locations in the area have concentration of total dissolved solids below the desirable level (500mg/l) 20% of the locations exceed this desirable level. Concentrations of TDS in all locations are acceptable for drinking. Water in most of the locations exceed the desirable level of Total Hardness (300mg/l) and at 16% of the locations water was found as suitable for drinking purpose.

Concentration of Manganese exceeds the permissible level at 8% of the studied locations and therefore is not suitable for drinking. Water at 100% of the selected locations was with high Manganese concentration exceeding the desirable level At about 76% of locations Electrical Conductivity in water exceed the permissible level of Electrical Conductivity and is not suitable for drinking purpose 100% locations exceed the desirable level of 750mg/l. And range in the Puttalam area vary within 6.3- 8.2 as well.

When consider all the monitored parameters, water found at Mi Oya, Thabbowa area, Sirambi adi can be recommended as best sources of water areas for drinking purpose and further quantitative studies have to be performed in studied areas.

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