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## Seasonal changes of ground water table and its usages; a study based on Kuchchaveli area in Trincomalee district

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### ABSTRACT

Groundwater by the domestic wells has been used in Kuchchaveli area of Trincomalee district for the use of domestic purpose, home gardening and cultivation. The demand for the ground water has been increased rapidly due to intensive high population growth and more industrialization. The main purpose of this study is to identify the seasonal changes of groundwater quantity and quality from the domestic wells. The study was carried out by using primary and secondary data. Primary data has been gathered through the sampling of 50 users and the water level changes for 50 domestic wells from 24 GN divisions. Meteorological and irrigation department's reports, images were utilized for this study, published reports and statistical records were employed to collect as secondary data. In addition, rainfall data of 143 years from the meteorological department was used for the analysis. MS Excel, SPSS, GIS software were used for data analysis. The water level was observed during the dry and rainy seasons, the ground water level in this area decreases due to over use of ground water. Run-off has increased due to low infiltration, which leads to low ground water storage. The following recommendations could be made from the results of study. Rainfall water should be saved for future use. Optimum use of rainfall, the re-use of irrigated water and avoiding the construction of deep wells help to prevent salinity.

**Keywords:** Cultivation, Domestic, Run-off, Salinity, Pollution, Kuchchaveli area, Trincomalee district

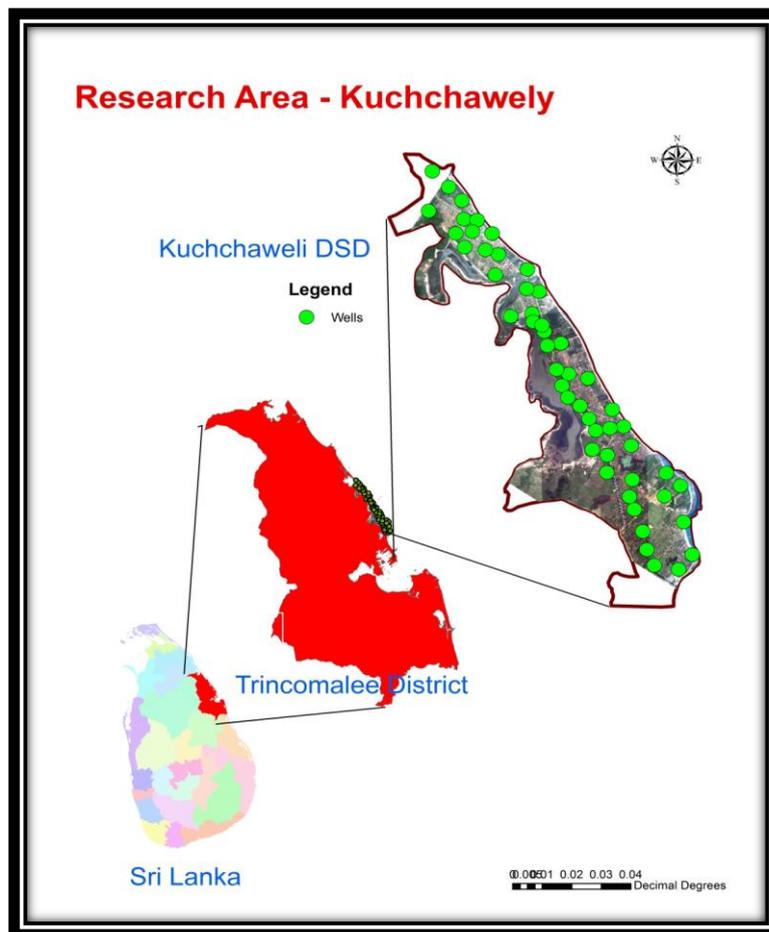
### 1. INTRODUCTION

Water being a precious resource for domestic use comes directly by the rainfall in monsoon period, stored on the surface or into the ground. Utilizing the ground water for

domestic wells used for several domestic activities. The water availability of shallow wells relies on the perpendicular and horizontal movement of the water. Removal of domestic and other wastages, removal of sewage water, the condition of wastages, agricultural practices and sea water intrusion such activities may lead to the shallow wells' water contamination and degrade the portable water quality [1] and [2]. In addition, meaning of ground water, importance of ground water, the troubles during the seasonal changes of ground water table and the solutions are the essential on the survey. At present, the demand of water is increased in the world, when compare with earliest times and insufficient storage of reservoirs caused to the less irrigation activities to the nearest area of Kuchchaveli.

Some factors determine the nature and scale of land, beside the rock structure is one of the significant feature. The study area contains Pre-Cambrian crystalline rocks, oldest sixty million years. Although, this provide less amount of ground water, metamorphosed rock which contains the sediment on top, infiltrate the water around 0.2% - 0.8% and the average 0.2% for sedimentary rocks. Ground water is inconstant for place to place. Therefore, ground water takes more important at present in study area [3, 7-9].

## 2. STUDY AREA



(Source: Retrieved on GIS, 2014)

Trincomalee is an extent of 350Km being almost coastal lowland has paddy cultivation lands in Nilaveli and Pulmottai. However, due to the increased amount of settlement, the paddy lands in Kuchchaveli fewer amounts relatively. Presently, there are 1108 domestic wells, 932 agro-wells and 303 abandoned wells available. Quite a lot of domestic wells are available in highly populated areas.

### **3. OBJECTIVES**

To Identify the changes of ground water table by the domestic wells

- To Improve the ground water quality and quantity of domestic usage by the changes of ground water table
- To Manage the options for the high wastages of domestic water for future generation

### **4. MATERIALS AND METHODS**

#### **4. 1. Primary Data**

The Samplings of 50 households from 24 GN Divisions were analyzed on the study. Based on this, questionnaire survey has been done for 50 households and direct personal observation. These 100 households' data were used to the study.

Further, the water level for January, April, August and December has been measured in a particular order, of these, the water level has been measured in the mid of these months to identify the changes of ground water table. Monthly and annual rainfall changes and the trends of water vapour and vaporization were calculated on the research that depending on rainfall.

#### **4. 2. Secondary Data**

The reports of meteorology, images, published research reports and statistical records were the secondary data of the study.

#### **4. 3. Data collection and Analysis**

According to the extent of Kuchchaveli and its physical features, the samplings of 50 wells were selected through the location of wells, rock types and water level changes. The water level measurement tool were used to measure the water level of selected wells and observed the seasonal changes that used the formula is,

$$\mathbf{W = (B + G) - L}$$

W – Water level from sea level

L – Water level from well top

B – Well height from surface

G – Elevation of particular area.

The numbers have been assigned to the selected wells in a particular order to identify them. The GPS locations are set in order to identify the exact place and get the accurate elevation of the area.

The groundwater levels of January were filed in the mid of month and, depth of wells, water level and sea level elevation were considered on the measurement, as same as, April, August and December water level were measured. The average consumption of drinking water was calculated from 50 users. To investigate the ground water changes due to the trend of rainfall variation for the period of 143 years, obtained from Trincomalee meteorological station were analyzed using the moving average and average deviation techniques. MS Excel, SPSS, GIS software were used for the study.

## **5. RESULT AND RECOMMENDATION**

### **5. 1. Types of wells and its distribution**

Landscape gets more important when illustrate the types of wells in Kuchchaveli, the land getting up from the sea level to the Northern part and the undulating land from the Northern part to South, due to this, the rocks differ. However, the ground water table has getting possibility to differentiate the well types due to the nature and importance of location, according to this, the wells divided as follow;

1. Seasonal wells
2. Permanent wells
3. Tube wells

Surface water has been decreasing due to the dry season at the same time water demand is increasing to meet the needs of people. Thus, people extract the water from ground water by wells and tube wells. On the other hand, the water extracted from tube wells, coming from the precipitation. The precipitation is a part of water cycle after the evaporation and following process, the water is coming to the earth.

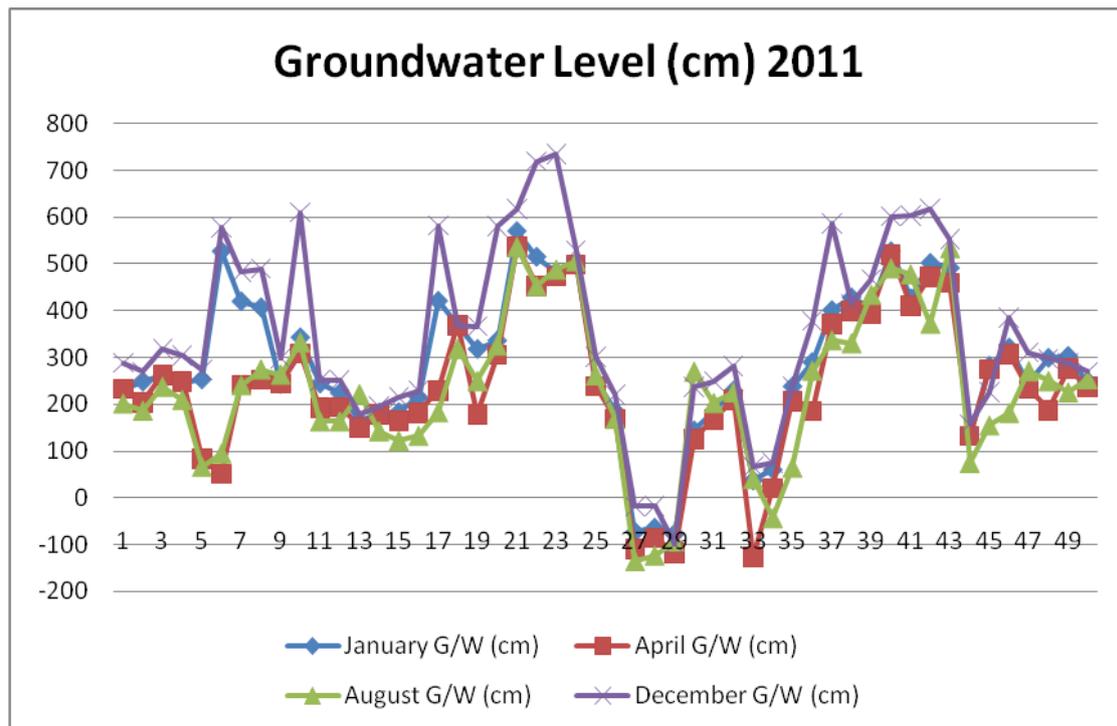
Some part reached the ocean rest remains as surface water. The plants absorb some of water by absorbed water of soil. While some parts infiltrate through the pore of soil into the earth, the water infiltrated into the rock joints, stored in the craters of the rocks as ground water. To get this water, tube wells are drilled with the force of machinery [4].

The resulting loss of ground water has high by the water vapor and vaporization of study area, high vaporization is July and August in a year, wells are getting dry during this period and some wells in May. Around 75% of wells are seasonal wells, whatever, 25% of wells are permanent wells.

### **5. 2. Seasonal changes of ground water table**

The seasonal rainfall determines the ground water quantity and changes of the study area, during the Northeast monsoon; the ground water level has very high. Nevertheless, after few months of the monsoon, the ground water level suddenly decreased especially in the dry season of May to August, during this period, the wells were not contained the water that is called temporary wells, identified in crystalline landscape area of Kuchchaveli.

**Chart 1.1.** Groundwater Level 2011.



(Source: Field observation, 2011)

The Chart 1.1 shows, the ground water level of NW2 calculated in January as 249 cm, but this was decreased in April as 205 m, in August as 186 m and then increased as 269 cm in December. NW7, NW11, NW12, NW15, NW16, NW17, NW35, NW37, NW38, NW40, NW42, NW45, NW46, NW49 numbered wells were seen as same as NW2, cause to the Northeast monsoon.

In addition, the ground water level of the well NW35 were 236cm in January, 208 cm in April, 64 cm in August and 237 cm in December, the changes of season caused to the water level of these months.

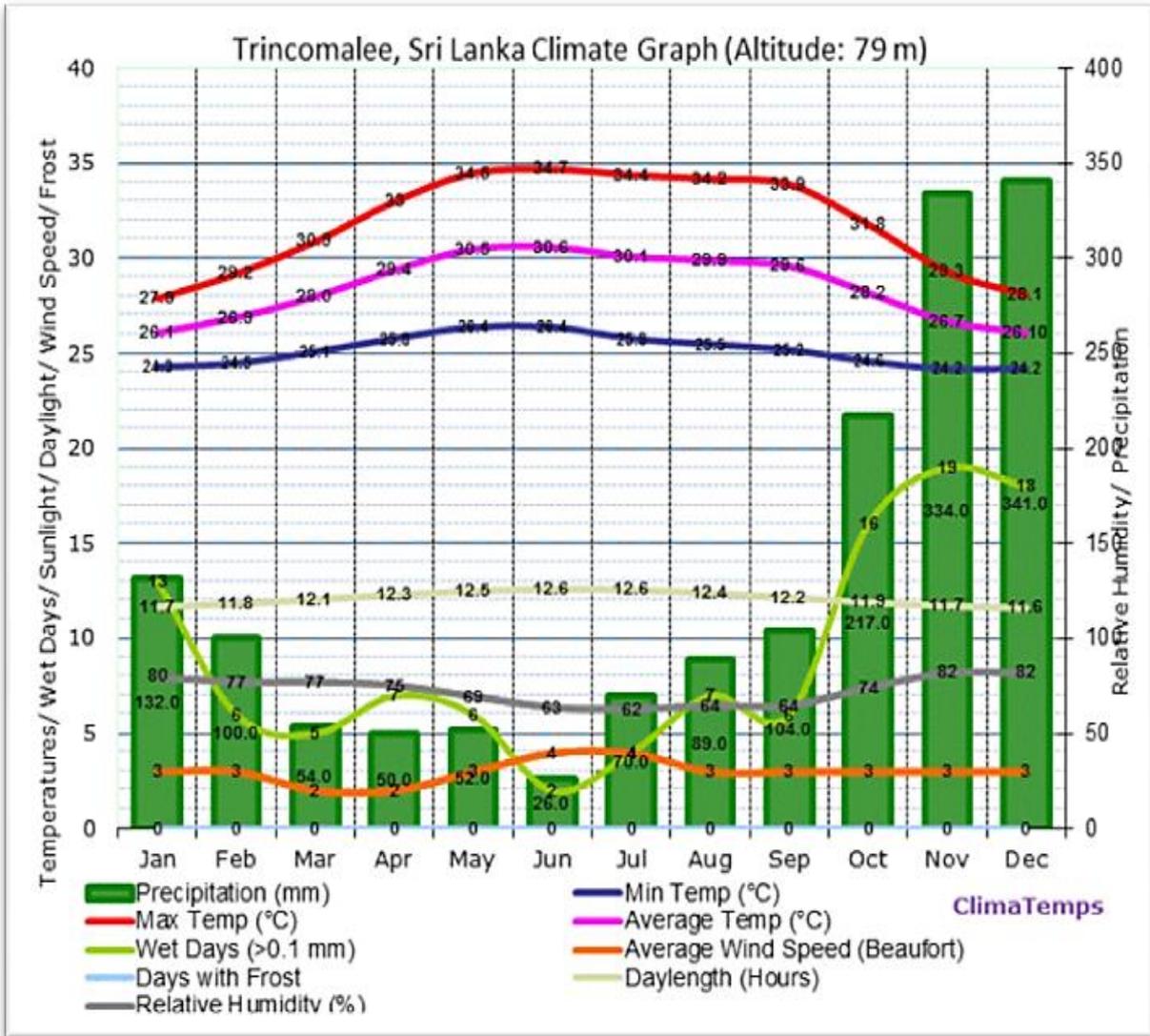
Around 99% of wells' water level located above the sea level and 85% of wells' water level fell around 2-3 m. The resulting of loss of the storage of ground water decreased by the vaporization, cause to the seasonal changes of ground water level.

### 5. 3. Temperature

Sri Lanka has two main climatic seasons, wet zone and dry zone, of these, the study area has been the dry zone. The annual average temperature of this area is 28.7 °C that changes due to the seasons.

The seasons of Trincomalee divided into two types, winter and summer, the four months from November to February has winter season and the eight months from March to October has summer season. The average temperature of Trincomalee is shown on the chart 1.2 [5].

Chart 1.2. Temperature and Rainfall 2011.



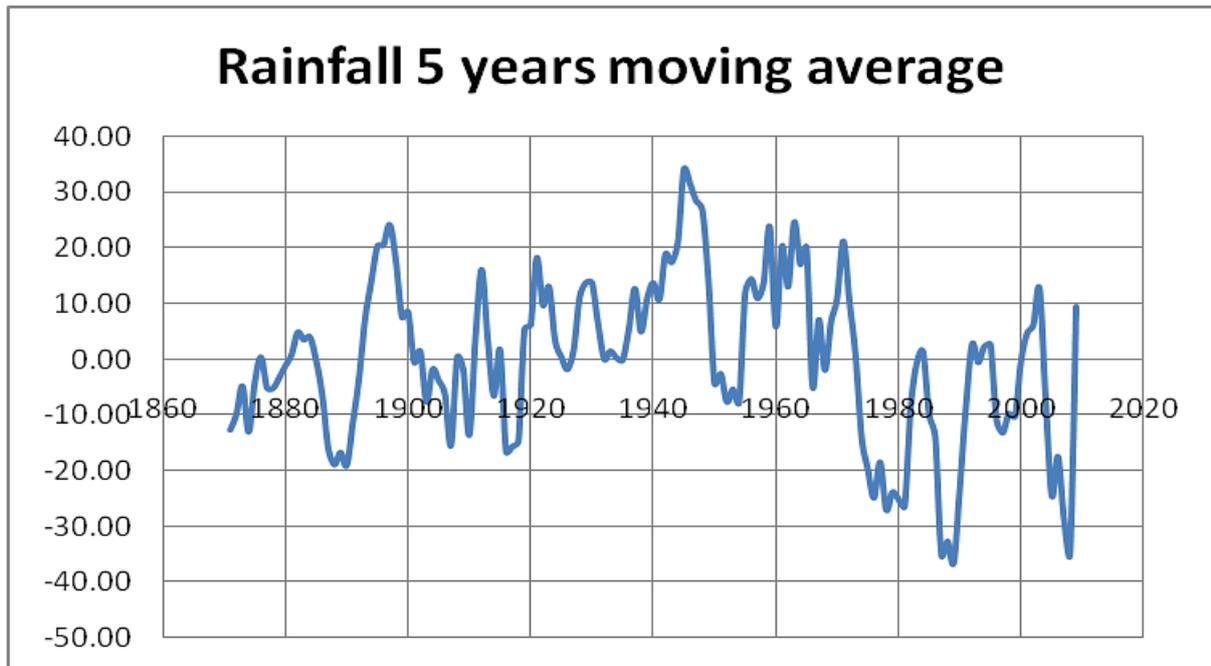
(Source: Retrieved on GIS, 2014)

The temperature is 24.5 °C during the winter, by the influence of Northeast monsoon; it is 24-28 °C from November to February. This period favors to recharge the water in domestic wells and it uses during the dry season [1] and [5].

#### 5. 4. Rainfall

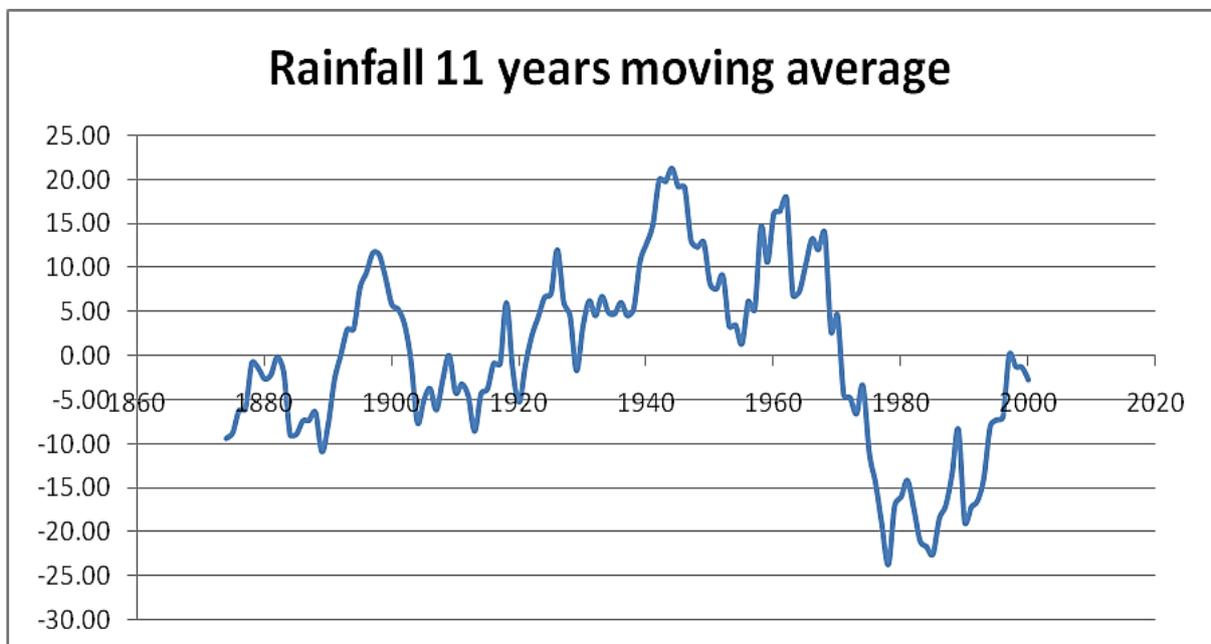
Trincomalee is an extent of 350Km being almost coastal lowland has paddy cultivation lands in Nilaveli and Pulmottai. However, due to the increased amount of settlement, the paddy lands in Kuchchaveli fewer amounts relatively. Presently, there are 1108 domestic wells, 932 agro-wells and 303 abandoned wells available. Quite a lot of domestic wells are available in highly populated areas.

Chart 1.3. Rainfall 5 years moving average 2011.



(Source: Retrieved on MS Excel, 2015)

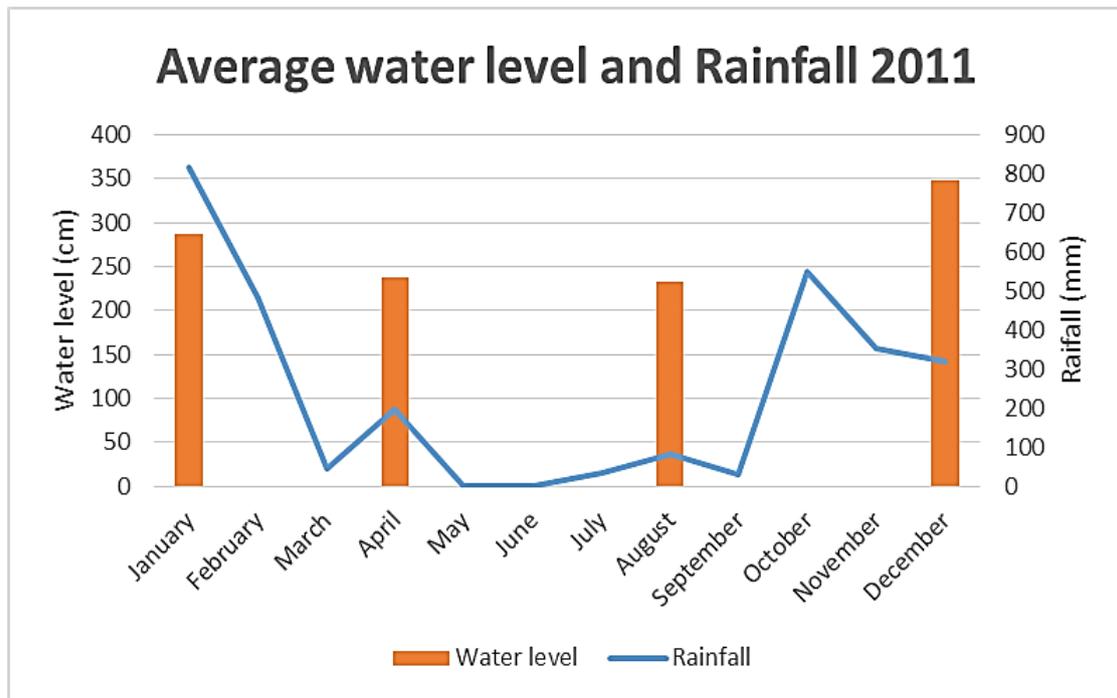
Chart 1.4. Rainfall 11 years moving average 2011.



(Source: Retrieved on MS Excel, 2015)

According to the chart 1.4, the selected 143 years, there were 7 dry season and 6 wet season. The first wet season was being of 11 years, in between 14 years of dry season, in 1909 was wet season and again 1918 was wet season. Thereafter, experienced 3 years dry season, 7 years wet season and then, the long term of 41 years were being wet season. Further, in between 29 years of dry season, in 1997 were being a wet season.

**Chart 1.5.** Average water level and Rainfall 2011.



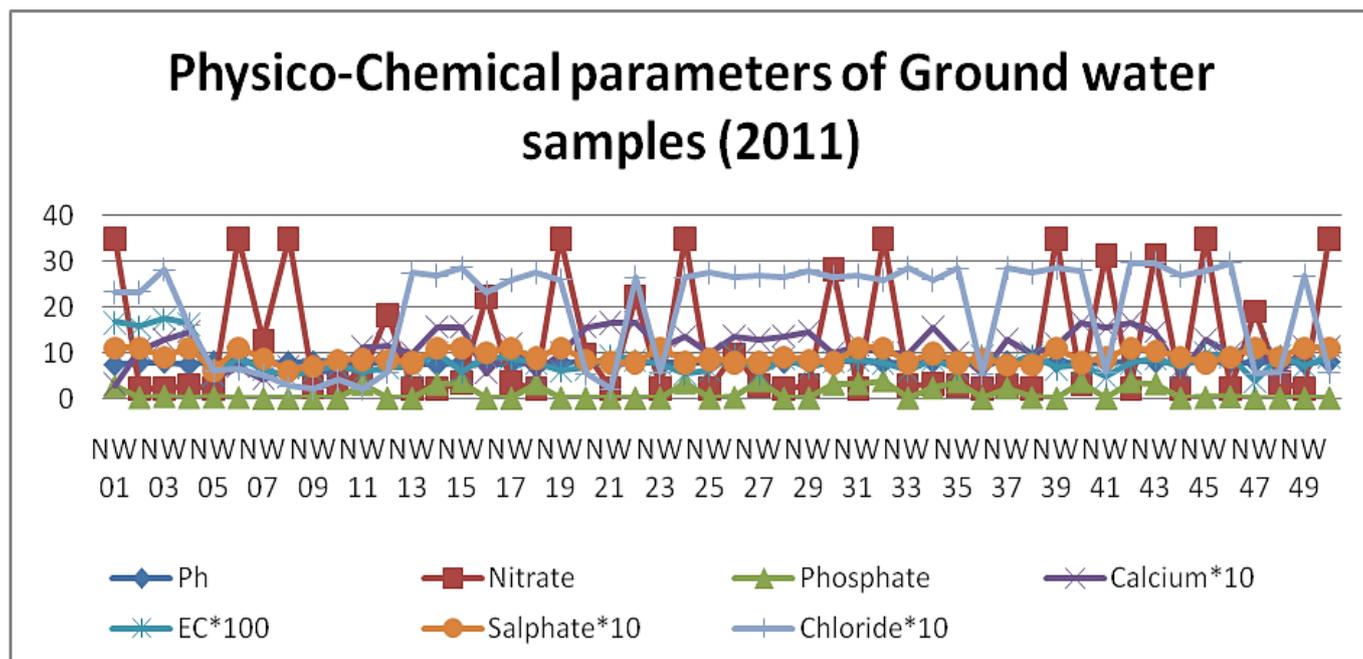
(Source: Retrieved on MS Excel, 2015)

According to the chart 1.5, the average amounts of water level were observed in April and August. The main reason for this, very less mm rainfall were recorded in March (43.6 mm), May (0.9 mm), June (0.5 mm), July (34 mm), August (80.4 mm) and September (31.8 mm). Very high rainfall was registered in January (817 mm). The water level is also very high in this period. Nevertheless, March, May, June, July, August and September were got the very low rainfall but seem the water level was above the rainfall. The possibility of this, the irrigation tank may get the role to produce the water. Otherwise, there were no another source for the water.

### 5. 5. Water Vapors and vaporization

The annual rainfall of Trincomalee is 1589 mm but, the annual water vapour and vaporization is higher than the rainfall. As per that, water shortage and access water storage are remained here. The annual water shortage is 510 mm (10.9%) and the annual access water storage is 304 mm (9.9%), according to this, the net water of 208 mm is the shortage of the year that occurs from February to September as per 8 months and the water level balanced during October, access water availability is during November, December and January.

## 5. 6. Ground water quality



### pH level

In the study area, all the wells' water pH level is  $>7$ . The wells, having pH 7-8 are, NW1, NW13, NW16, NW19, NW24, NW26, NW35, NW38. NW10, NW12 numbered wells have  $\text{pH} > 8$ .

### Electrical conductivity (EC)

The water with  $\text{EC} > 2.25 \mu\text{S}/\text{CM}$ , is saline. (Sarath Amarasiri, 2015). In the study area, NW05, NW07, NW08, NW09, NW10, NW18, NW23, NW27, NW29, NW33, NW35, NW39, NW41, NW47, NW49 numbered wells have  $\text{EC} > 800 \mu\text{S}/\text{CM}$ . And, NW01, NW02, NW03, NW04 numbered wells have the  $\text{EC} > 1000 \mu\text{S}/\text{CM}$ . Due to the fact that, the wells water in the study area is in contaminated condition.

### Nitrate

NW02, NW03, NW04, NW05, NW10, NW17 numbered well's water have  $< 5 \text{Mg}/\text{L}$  nitrate concentration. NW01, NW06, NW08, NW19, NW24, NW32, NW39, NW39, NW45, NW50 numbered wells' water nitrate concentration is  $> 35 \text{Mg}/\text{L}$ .

### Phosphate

NW02, NW03, NW04, NW05, NW06, NW07, NW08, NW09, NW10, NW23, NW25, NW41, NW44, NW46 numbered wells' water phosphate concentration is  $< 1 \text{Mg}/\text{L}$ . And, NW01, NW30 numbered well's water phosphate concentration is very high level.

### **Shalphate**

NW05, NW50 numbered wells' water shalphate concentration is  $< 60\text{Mg/L}$ . And, NW01, NW02, NW04, NW06, NW15, NW23, NW32, NW39, NW47, NW50 numbered wells' water have the high level shalphate concentration.

### **Calcium**

NW01, NW05, NW06, NW07, NW08, NW09, NW10 numbered wells' water calcium concentration is  $< 100\text{Mg/L}$ . And, NW04, NW14, NW21, NW22, NW39, NW40, NW42, NW43, NW47, NW49 numbered wells' water calcium concentration is  $> 100$ .

### **Chloride**

NW05, NW06, NW07, NW08, NW09, NW10, NW11 numbered wells' water chloride concentration is  $< 200\text{Mg/L}$ . And NW01, NW02, NW14, NW28, NW29, NW31, NW32, NW34, NW37, NW42, NW49 numbered wells' water chloride concentration is  $> 200\text{Mg/L}$ .

Therefore, some suggestions proposed to eliminate the problems. While store much floodwater at home, get much fresh water that gradually reduce the size if the wells are being salinity.

Furthermore, the restoration of wells water increased by the machine hole, the irrigation tank replaced the wells' water level of surrounded area, the wells near the big tanks give much water for us, refine the tanks increase the water storage [3].

Temporary water retaining structures should be constructed to facilitate the infiltration. Optimum use of rainfall, the re-use of irrigated water and avoiding the construction of deep wells help to prevent salinity. Controlling the intensive use of water pumps for drainage and making the farmers aware about the water wastage and pollution is also important.

Further, the wells should make according to the law without the personal idea, as the size of wells, distance between them that will reduce the amount of wells. While clean the wells' water of usual activities, should make the proper ways to send it into ground without waste, storage of rainwater in the small tanks at home can be used in dry seasons.

Therefore, the government should concentrate the water problem as well as the public should participate with government to eliminate the ground water problems.

## **6. CONCLUSIONS**

Water availability differs from place to place that is depending on bedrock and landscape. Tricomalee has been located in dry zone of Sri Lanka, thanks of this many wells are being as seasonal well. These people mostly depend on seasonal monsoon for the water storage.

The selected 50 wells in Kuchchaveli were the most suitable, that was selected in different locations and the each wells contained different water level. Nevertheless, the water level was high during the rainy season but some wells contained the water during the dry season and some are not.

The past 143 years' rainfall showed, the dry and wet season through the chart 1.3, 1.4 and, 5, 11 years moving average and standard deviation for it are more helpful to experience the rainfall fluctuation. According to 11 years standard deviation, the people experienced of 7 dry seasons and 6 wet seasons, of these, the highest wet season occurred for 41 years and the

highest dry season experienced for 26 years. Therefore, the people in every period experienced the different season in their life.

During the dry season, due to the excessive usage of the domestic wells for every activity, water became as brackish water. The people who live in the coastal and lagoons nearby areas said that identifying the chemical variation of water is rather difficult due to the continuous usage. Significantly, in the coastal and lagoon area such intrusions high level in relatively.

Further, during the rainy season, rainwater balances the salinity of this water. In the analytical view using the data derived by the field survey, show that the ecological problems higher than 80 per cent triggered by the domestic well chemical contamination.

Thus, to increase the water level, every people should take the responsibility to store the wastewater and reduce the useless wastages and should do the awareness program to each level as students, societies and clubs.

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