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ANALYSIS ON DRINKING WATER QUALITY IN THE VAVUNIYA DIVISIONAL SECRETARY DIVISION USING GIS

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ABSTRACT

Poor drinking water quality in the Vavuniya discourages people to drink ground water and to use bottled water or boiled the water instead in recent years due to the health issues such as Chronic Kidney Diseases. There is no comprehensive data on water quality in the district. The objectives of this study were to analysis the drinking water quality and preparing spatial maps on the drinking water quality in the study area. This study was carried out with secondary data. Main water quality parameters of the study was namely EC, pH, Fluoride and Hardness. Data was analysis using Arc GIS 10 package and Micro soft Excel. An interpolation technique was used to analysis the spatial patterns of drinking water quality. All the data were represented by using maps and graphs. The analysis of the pH values indicate that all water samples of this study area were less than 7.0/ 8.5 desirable limit in Sri Lanka. Average Electrical Conductivity/Temp ℃ (EC) values was recorded range 400 $\mu S/cm$ to 2050 $\mu S/cm$ in Katharsinnakulam and Kanthapuram GN divisions respectively. Nearly 81% GN divisions' EC values were above 750$\mu S/cm$ SLS desirable limit. The result of Fluoride (F) obtained from the range between 0.26mg/l to 2.23mg/l. approximately 64% of the study area have Fluoride concentration above 0.6 mg/l SLS desirable limit. The Total Harness ($CaCO_3$) concentration in the study area were average from 106 mg/l to 1036 mg/l. This study reveals that the some drinking water sources of the study area were not fit for human drinking purposes as a result of high concentration of some water quality parameters. The Spatial analysis revealed that agricultural and industrial activities might be influence on the quality of the drinking water in the Vavuniya Divisional Secretary. Thus most of drinking water sources of the study area are not suitable for drinking consumption without water pre-treatment. Therefore as a part of the sustainable development' goal ground water quality should protected by relevant stakeholders.

Key words: Drinking water quality, Electrical Conductivity, Fluoride, GIS, pH, Total Hardness

INTRODUCTION

Good quality of drinking water is essential resource for the survival of human beings. Contaminated water can be negatively affect oh human health. Also water is one of the key elements for the development activities. Proper ground water quality is needed to ensure the sustainable development goals and fulfill the demand for drinking water. The whole Vavuniya district is dependent on ground water for drinking,

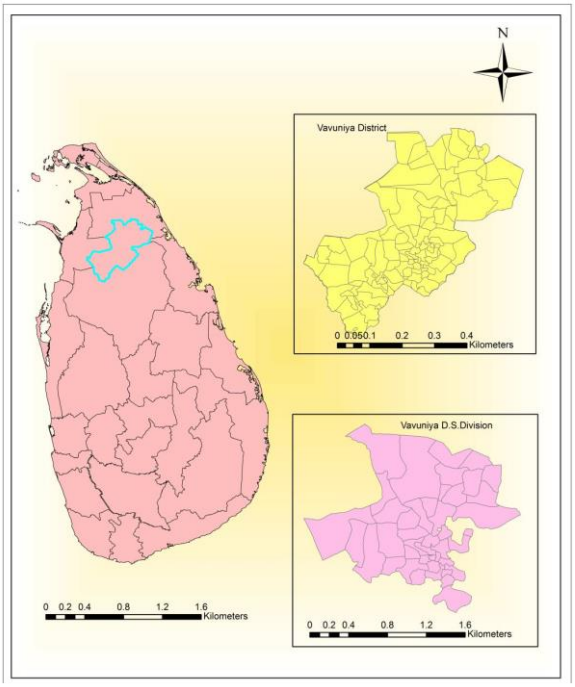
mainly shallow dug wells and deep tube wells. Population growth, rapid urbanization, unplanned constructions (houses, commercial places, and roads), encroachment of water bodies, industrial and agriculture waste runoff are the major reasons for the contaminants of the ground water in Vavuniya. There are some studies have identified that the drinking water quality of the Vavuniya district especially in the urban area becoming polluted in the recent years. Mean Nitrate nitrogen in the study area (Kanthapuram) was 12.2mg/l from December 2008 to June 2009 and 95 % of the wells were above WHO permissible limit of 10mg/l (Loganathan.p, 2010). According to the study of Amarasinghe.S. R., (2006) the feacal coliform (thermoresistant *e.coli*) was much higher in wells near residential areas of the Vavuniya DS Division. Poor ground water quality in the Vavuniya discourages people to drink ground water and to use bottled water or boiled the water instead. There is no comprehensive data on water quality in the district. Therefore the objectives of this study were to analysis the drinking water quality and preparing spatial maps on the drinking water quality in the study area.

MATERIALS AND METHODS

Study Area

This district has 4 Divisional Secretary divisions. Located is in internal pen plain area with 90 meters of height. The study was carried out in Vavuniya Divisional Secretary Division (The study area is shown in the figure 1) which is around 590.30sqkm. Vavuniya D.S area consists with 42 GN divisions. The average is 28.7C and it is low during the periods of October to January. The average rainfall of the districts is 1310mm. the terrain of Vavuniya is rather flat and located 100‟ to 300‟ about mean sea level. (Divisional Profile, 2013). The total mean annual rainfall ranges from 1,250mm to 1,720mm out of which 65% to 75% is received during October to January period (Maha season) and the rest during April to September period (Yala season). The dominant groups of soil in Vavuniya are Reddish Brown Earth (RBE). The association with the low humid clay (LHG) with RBE soil (92%) is well suited for paddy cultivation. There are about 2718 open dug wells in this division. Provide ground water for domestic as well as agriculture purpose the irrigation of subsidy food crops, vegetable, and horticultural crops. There are 333 tube wells in this division. These tube wells provide drinking water facilities to the rural people welfare center (Divisional Profile, 2013). In 2011 nearly 129,021 people live in this DS

Figure 1: Location Map of the Study Area



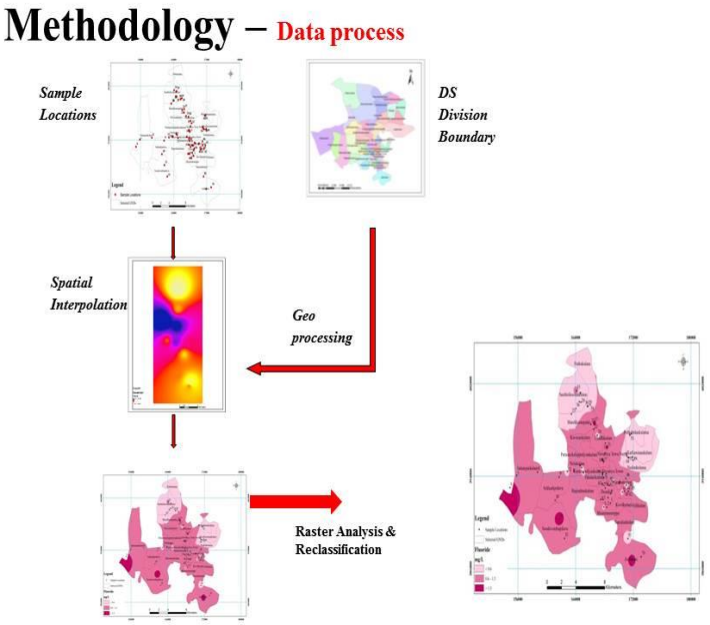
Source: Survey General Department of Sri Lanka, 2005

division (Divisional Profile, 2013). Almost total population of this area depends on ground water for domestic, irrigation and commercial activities.

Data Collection and Data Analysis

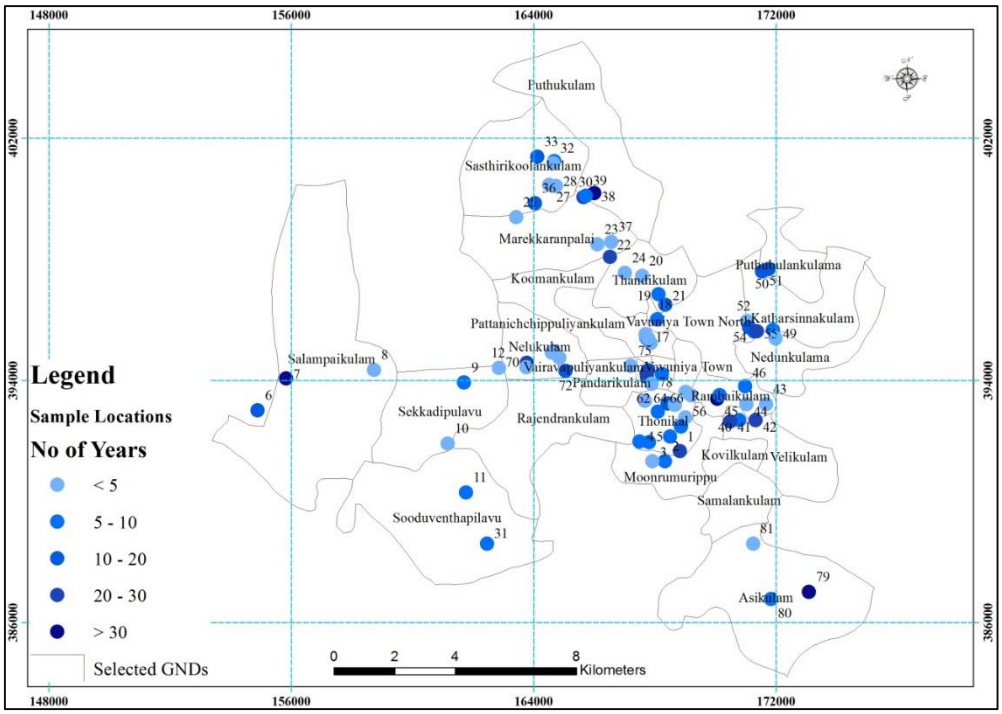
This study was carried out with secondary data, which were mainly obtained from Oxfam in Vavuniya. All the data were collected in 2008. We have used that data for this study purpose. Main water quality parameters of the study was namely EC, pH, Fluoride and Hardness. Data was analysis using ArcGIS 10 package and Micro soft Excel. An interpolation technique (Inverse Distance Weighted (IDW) was used to analysis the spatial patterns of drinking water quality parameters. All the data were represented by using maps and graphs. Figure 2 shows the overall research methodology.

Figure 2: Research methodology



RESULTS

According to the results, selected water samples were used averagely 13 years for the drinking purposes. 31 drinking water sources have been used more than 10 years while 45 were used for less than 10years. The figure no 1 shows the years of the use of the water sources.



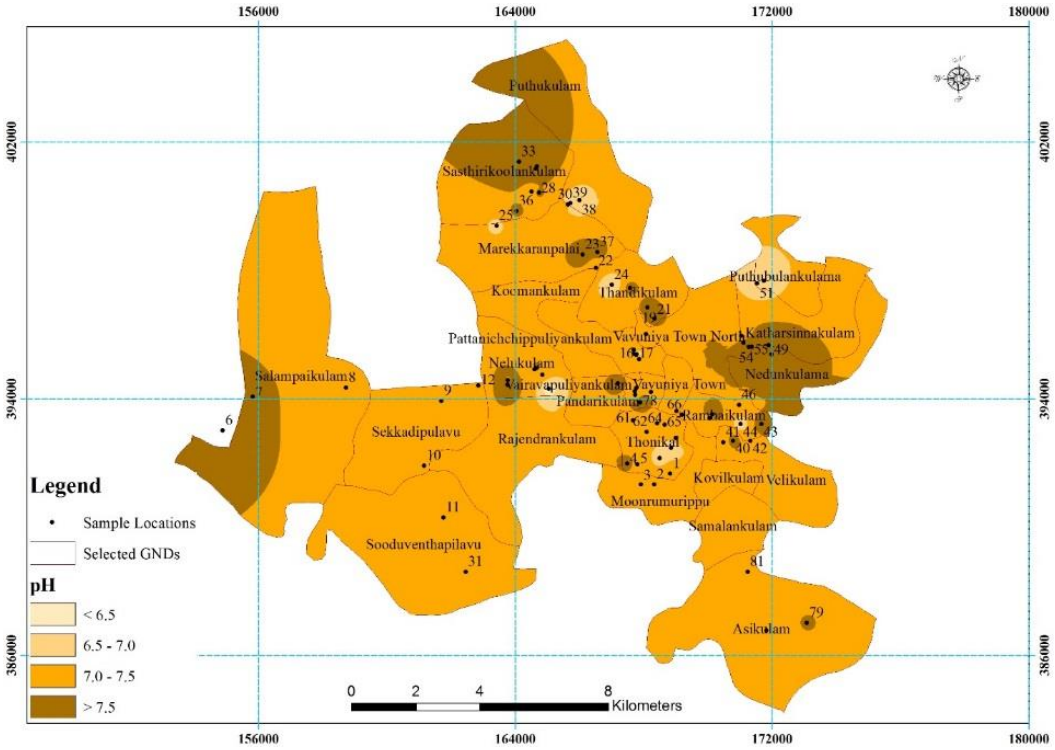
Source: Prepared by authors based on secondary data, 2016.

Analysis of Water Quality Parameters

pH

Generally, the pH value is a good indicator of whether water is hard or soft. According to the Sri Lankan drinking water standards Act the maximum desirable level of pH range was between 6.5 to 9. In this area the pH of the water samples varied from 6.2 to 8.3 from with the mean value of 7.3 in the study. pH values indicate that all water samples of this study area were less than 7.0/ 8.5 desirable limit in Sri Lanka. Similar results were found in the study of Amarasinghe.S. R., (2006) where all the wells were in the range of 6.7-7.3 which is within the standard limit of drinking water. This study indicate that only two samples (S24 and S68) were less than 6.5, which were considered as acidic water. Thus, revealed that the pH levels of the most water samples are desirable for drinking purposes. Figure 2 shows the spatial distribution of pH of the study areas.

Figure 2: Spatial distribution of pH in the study area.

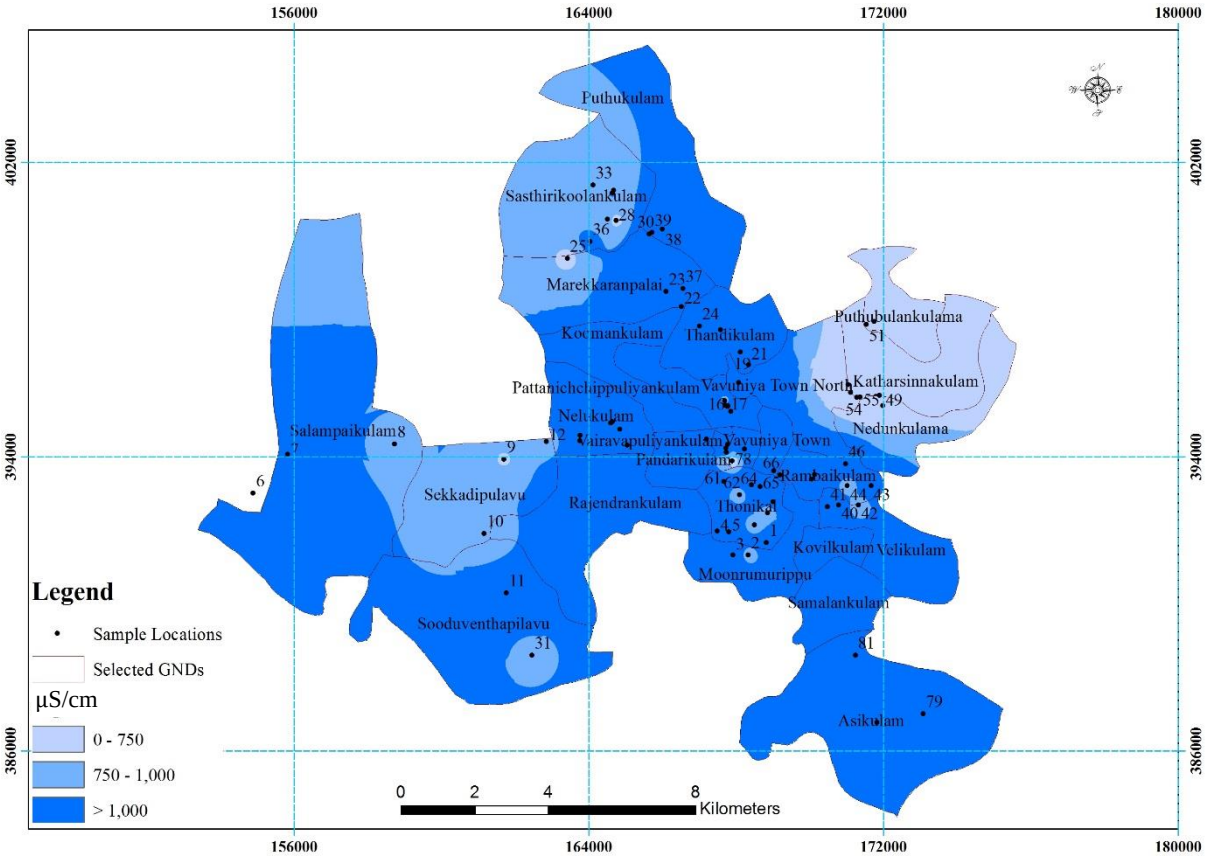


Source: Prepared by authors based on secondary data, 2016.

Electrical Conductivity (EC)

Electrical conductivity (EC) estimates the amount water's capability to pass electrical flow, or the total amount of dissolved ions in the water. The EC of samples ranged from 400 - 2050µS/cm with the mean value of 1118.2µS/cm. The highest and lowest Electrical Conductivity (EC) values were recorded in Katharsinnakulam and Kanthapuram GN divisions respectively. Nearly 82% of water samples' EC were above SLS desirable limit 750µS/cm. Low EC was observed in samples No 9, 17,25,27,41, 45, 46, 47, 48, 49, 50, 51, 52 and 73. Figure 3 shows the spatial trend of the EC.

Figure 3: Spatial distribution of Electrical Conductivity (EC*)* in the study area.

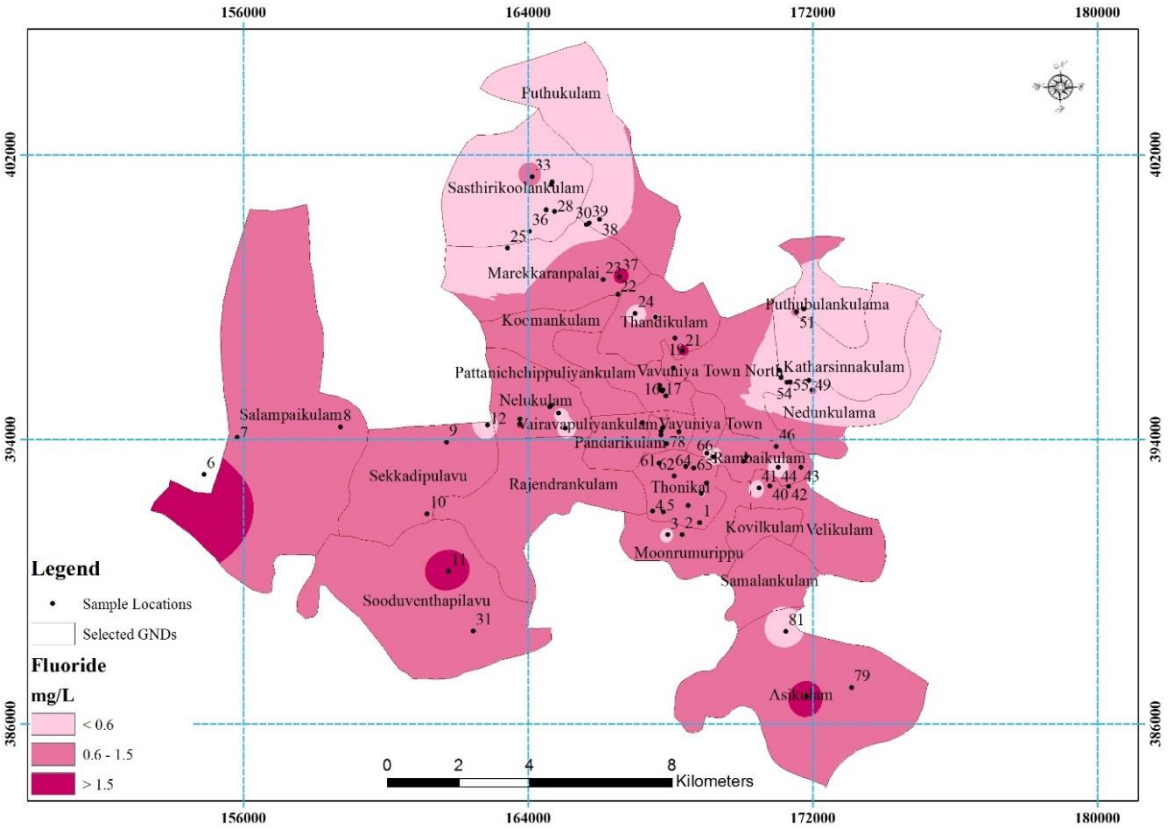


Source: Prepared by authors based on secondary data, 2016.

Fluoride (F)

Fluorine is a common element that does not occur in the elemental state in nature because of its high reactivity. The result of Fluoride (F) obtained from the range between 0.26mg/l to 2.23mg/l in Chekkaddipulavu and Poovarasankulam namely. The mean level of fluoride was 0.83 mg/l. Approximately 57% of samples were between 0.6 - 1.5 mg/l. The fluoride of 34% water samples were less than 0.6 mg/l while only 9% were above 1.5mg/l of the SLS permissible limit, which were observed in sample no 6,11, 21, 34, 65 and 75. Some studies have indicated that high level of fluoride may affect human kidney. The Following figure 4 shows the spatial distribution of Fluoride in the study area.

Figure 4: Spatial distribution of Fluoride in the study area



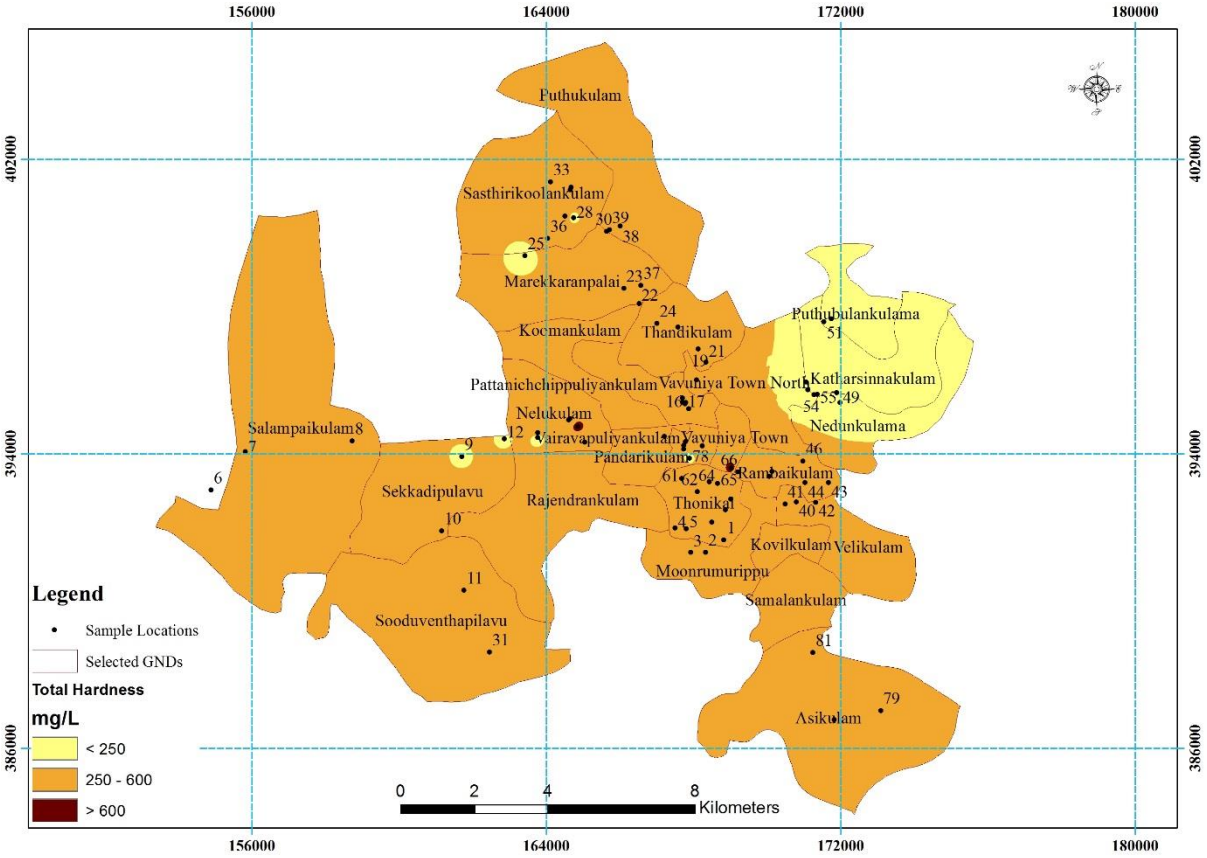
Source: Prepared by authors based on secondary data, 2016.

This spatial map shows that high level of Fluoride was recorded in Asikalam, sooduvanthapilavu, thandikulam and marekarampalai GN divisions.

Total Harness ($CaCO_3$)

The Total Harness ($CaCO_3$) concentration in the study area were range from 106 mg/l to 746 mg/l in namely Katharsinnakulam (sample no 46) and Paddanichchipuliyankulam (sample no 16) DN division. Only 15 samples (20%) were less than 250 mg/l SLS desirable level while nearly 80% of water samples were above 250mg/l SLS desirable level. It may affect peoples' health. Thus this study indicated that total hardness of drinking water is not suitable for drinking purposes in the most GN divisions of the study area. Sample no 16, 65 and 75 were above the SLS permissible limit of 600 mg/l. So they are not recommended for drinking. Figure no 5: shows the spatial distribution of the total hardness.

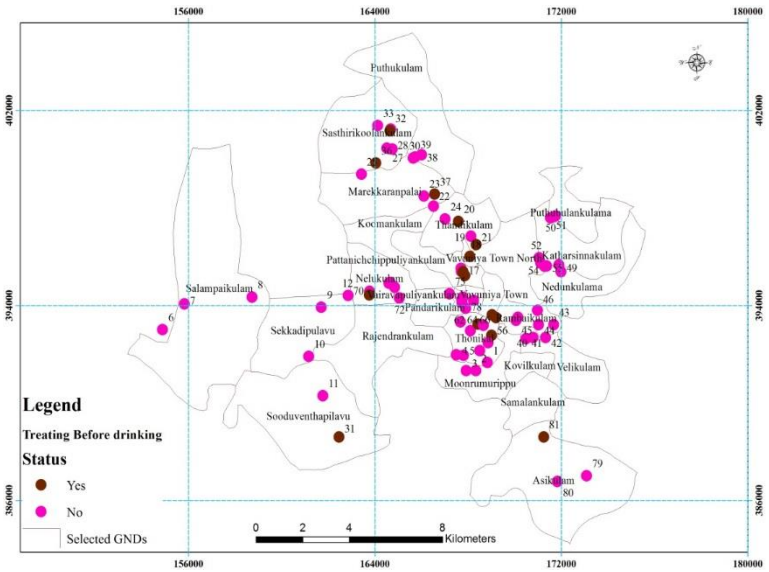
Figure no 5: spatial distribution of the total hardness



Source: Prepared by authors based on secondary data, 2016.

Water Treatment

In the study area most of the water samples were used for drinking purpose without pretreatment. This study indicates that nearly 80% of water samples were drink without treatment while only 20% (16 samples) were treated before drinking. The figure no 6 shows the spatial variation of water treatment before used.



Source: Prepared by authors based on secondary data, 2016.

CONCLUSION

The study has found that the higher concentration of the Total Harness was observed on 80% of the drinking water sources, which were above 250mg/l SLS desirable limit. The study indicate that in some water samples were not fit for human drinking purposes due to high concentration of some water quality parameters namely Total Harness, Fluoride and EC. Thus most of drinking water sources of the study area are not suitable for drinking consumption without water pre-treatment. Vavuniya Divisional Secretary is the urban area of the Vavuniya district with the high population density, many industrial activities and build environment. As the results of these the ground water becomes polluted and vulnerable for drinking. After the end of war there are many development projects are implementing in the study area without proper environment consent. Currently so part of the study area such as Thonikal, katkuli, Kurumankadu, Poonthoddam and Maharambaikulam are severely faced drinking water problems drinking the summer seasons. To achieve the goals of sustainable development, need to protect and maintain good ground water quality to ensure the socio economic and environmental sustainable.

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