Evaluation of Seasonal Groundwater Quantity and Quality Variation in Malwathu Oya Basin

Rohanson Kulas R, Rahulan Y, Thavaganesh S, *Chaminda SP, Abeysinghe AMKB and Jayawardena CL

Department of Earth Resources Engineering, University of Moratuwa, Sri Lanka

*Corresponding author – chamindaspc@yahoo.com

Abstract

Malwathu Oya is located in Anuradhapura district which has water quality and scarcity problem for drinking purpose. Samples were collected from selected locations which included upstream and downstream of Malwathu Oya basin. The samples were analyzed for conductivity, pH, turbidity, calcium, magnesium, fluoride, chloride and arsenic. Only shallow regolith aquifers are considered for the study. The quality variation of the area shows a considerable variation from south-west monsoon to second inter monsoon period. In general, water quality of the area is in acceptable limit of drinking water for most of the basic parameters. With the seasonal changes, fluoride and chloride content is higher than permissible limits in some areas.

Keywords: Monsoon, Permissible limit, Parameters, Variations

1. Introduction

Groundwater is the prominent water resource for drinking water. In Anuradhapura district groundwater contains pollution, and therefore Anuradhapura district has a problem of scarcity of drinking water in dry seasons and poor water quality [1]. According to climatic zone classification, Anuradhapura district belongs to dry zone of Sri Lanka. In Sri Lanka, seasonal variations analyzable in four different monsoons, in this study considered north-east, south-west monsoon and second inter monsoon. In this study, shallow regolith aquifer is only considered [2], and shallow regolith aquifers are the most easily accessible source of groundwater available since this regolith zone is now polluted with ions and the usage of groundwater resource is getting low by the day, and over extraction of water with deep well construction leads to higher the water depletion in those areas. Groundwater pollution leads to water hardness problem and kidney related health issues in Anuradhapura district. Main reason for this health issues are caused by ion concentration excessive than permissible limits. Therefore, in this research calcium, magnesium, fluoride, chloride and arsenic ion concentration are analyzed. People currently use water filters to purify well water and there is no permanent water supply available for houses.The primary objective of this research is to verify and understand the seasonal

groundwater quality and quantity variations.

Figure 1 - Sample collection locations in the Malwathu Oya basin

2. Methodology

2.1 Identification of Sample Locations

The sampling locations are selected from upstream, middle stream and downstream of Malwathu Oya river basin.

The general sampling locations are given in Figure 1 and exact sampling identified on the field, its selection based on availability of water near the access of road. To collect the water sample for next season the Global Position System (GPS) coordinates were recorded for every location. Sampling was done at 28 locations.

2.2 Sample Collection and Testing

In every sampling location two sets of samples were collected for analysis. One sample is acidified to prevent disturbance. Second set of samples were kept without any additions to be used for measuring the pH value. All the samples were transported in airtight bottles under controlled environment.

As soon as the samples were taken back to laboratory, the testing was carried out for selected water quality parameters such as pH, conductivity, turbidity, calcium, magnesium, chloride, fluoride and arsenic. All the testings were conducted according to standard procedure for water quality testing [3].

2.3 Analysis of Results

The results for the water quantity were taken as variation of depth of groundwater relative to the depth measurement made with previous season. Groundwater quality results were taken from sample analysis and interpolated using "Arc Map" software to plot the variations of different parameters throughout the basin for each season. The parameters were compared with World Health Organization and Sri Lankan standards to verify the quality.

3. Results and Discussion

The maps and graphs show the variation of parameters with seasonal changes in the Malwathu Oya basin.

This research is continuation of a past research [4]. In that research, analyzed samples which had been collected in south-west monsoon, second inter monsoon and north-east monsoon period were tested based on water samples collected from 11 locations. Findings from Both researches are compared to analyze the seasonal variations. In the graphs, independent axis represents water level increment, and dependent axis represents parameter changes.

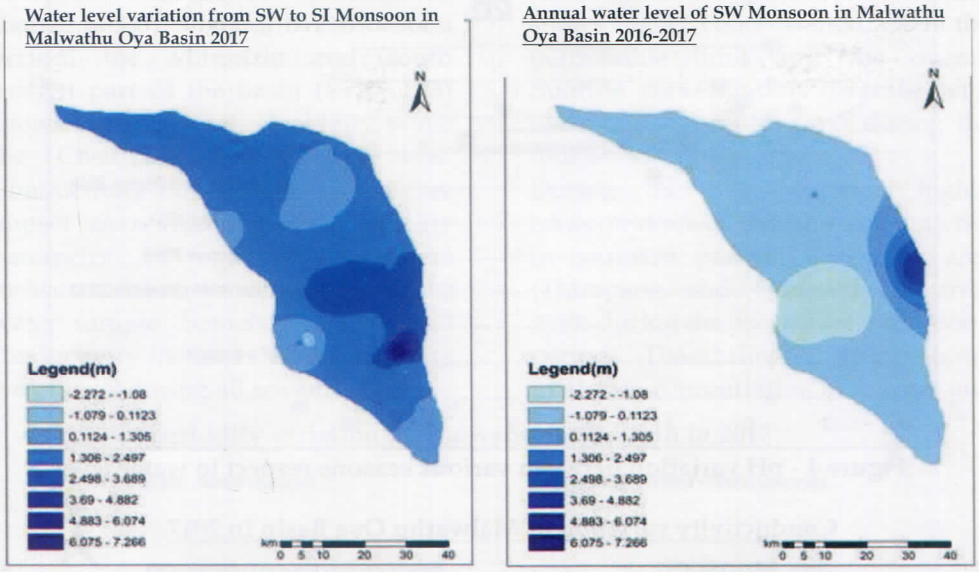

Figure 2 – Groundwater level variation in Malwathu Oya basin

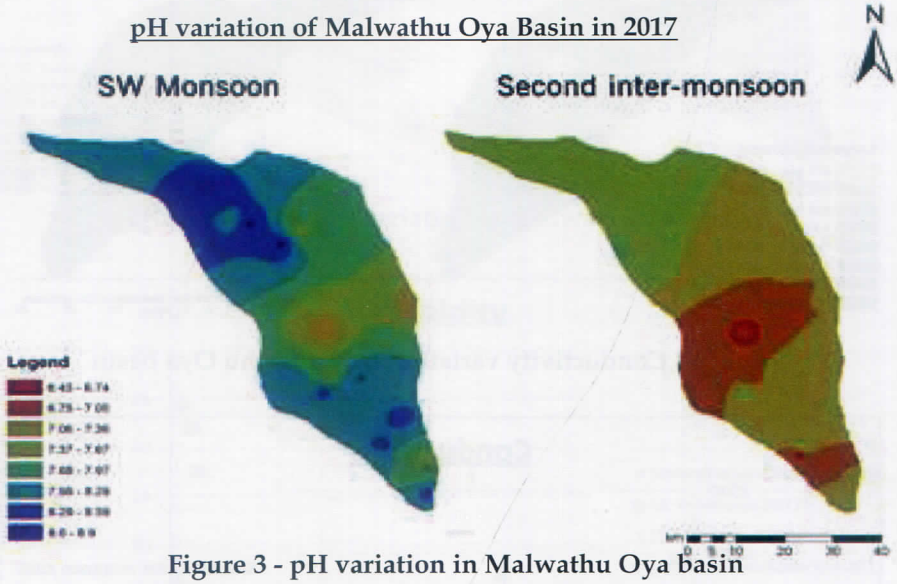

Figure 3 - pH variation in Malwathu Oya basin

During SW Monsoon period, the Madawachiya and Thanthirimale area shows higher pH values while the Mihintale and Kahatagasdigiliya show moderate values. Since with the seasonal change of SI Monsoon leads to higher precipitation and the groundwater recharge over the basin which make significant reduction on pH value over the whole basin, specially on the upstream of the basin. Also the pH values over the basin falls between 6.5 – 8.5.

During SW Monsoon period the Thirappane area shows a higher conductivity value, which moves towards the Ganewalpola, Maradankadawala area with the second inter monsoon period. Since the overall change in conductivity

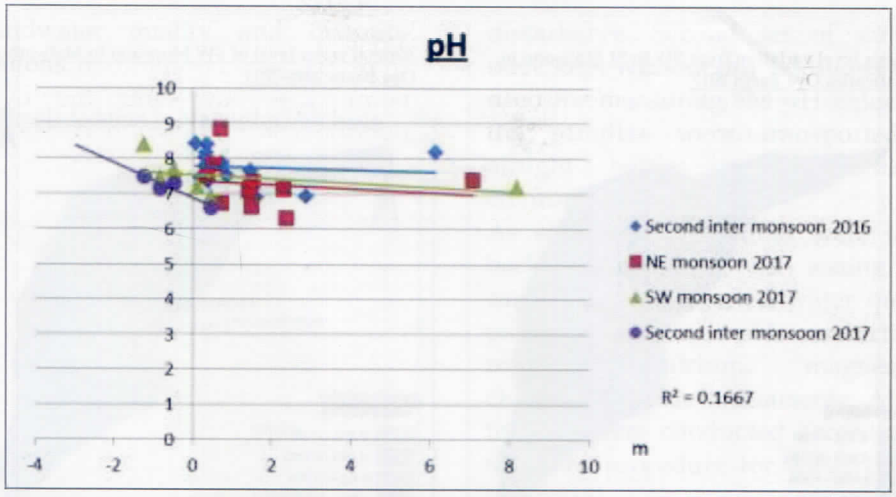

Figure 4 - pH variation between various seasons respect to water level

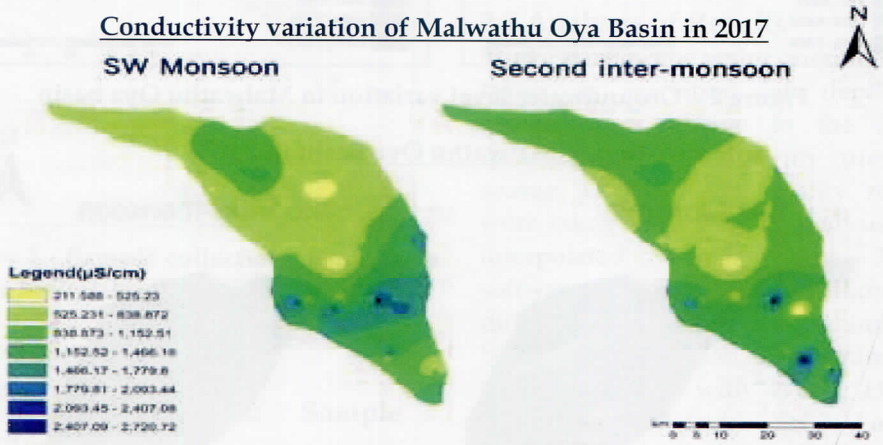

Figure 5 - Conductivity variation in Malwathu Oya basin

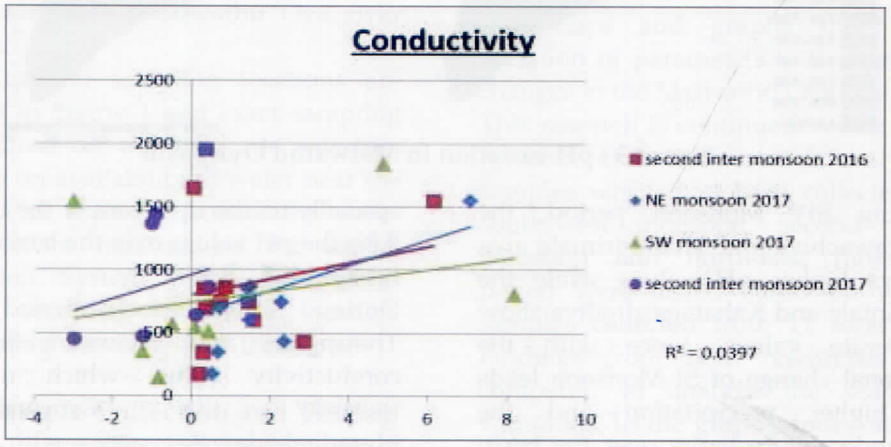

Figure 6- Conductivity variation between various seasons respect to water level variations

over the basin with the seasonal change is low. Overall SW Monsoon period, the Mihintale and south eastern part of the basin (L 20, L25) shows that higher the turbidity while the Chedikulam area have low. Conductivity doesn't have higher impact as a drinking water quality parameter but means the direct measurement of the ion content in the water sample. Somehow the overall conductivity increases with increasing water level during all seasons.

inter monsoon, Medawachiya area shows higher concentration above the permissible limit and the overall fluoride concentration decrease with the increasing water level during the four seasons mentioned.

During the SW Monsoon higher concentration of calcium encountered in southern part of the study area (Thirapane and Ganewalpola area) since during the Second inter monsoon period Thanthrimale area shows moderate concentration in calcium and

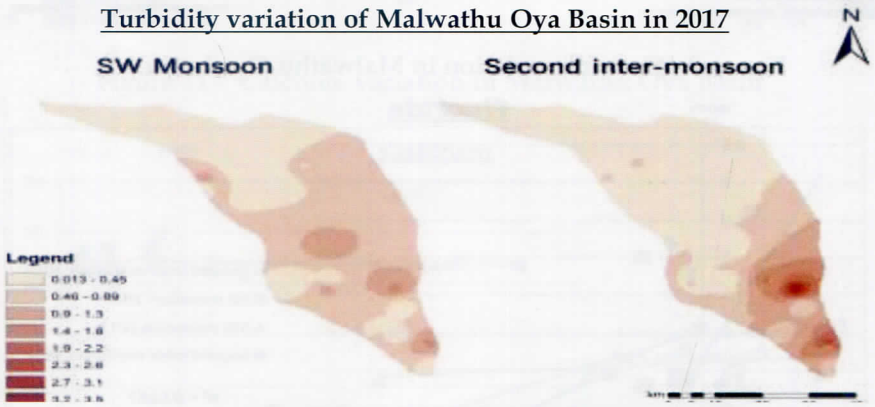

Figure 7 - Turbidity variation in Malwathu Oya basin

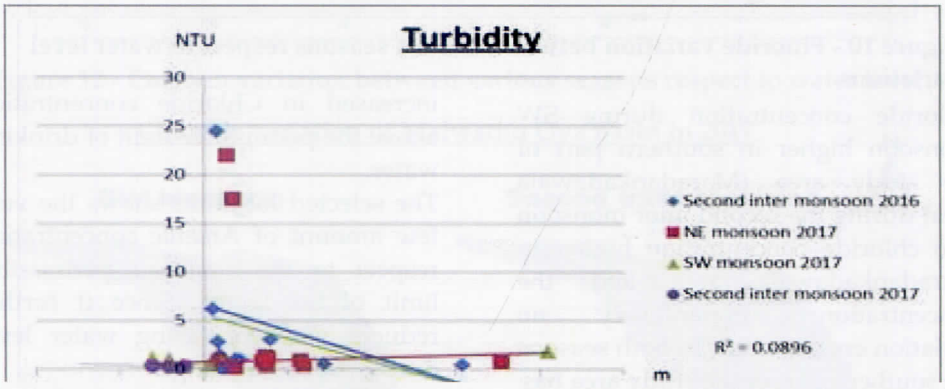

Figure 8 - Turbidity variation between various seasons respect to water level variations

Since the over all turbidity distribution decreased with increasing water level in SW and SI Monsoon period.

Fluoride concentration during SW Monsoon higher and above the permissible limit in Medawachiya and Ganewalpola area and during second

comparatively reduced overall calcium concentration in the study area. (All the study area is below the permissible limit). The overall calcium concentration reduces with increasing water lever through the basin.

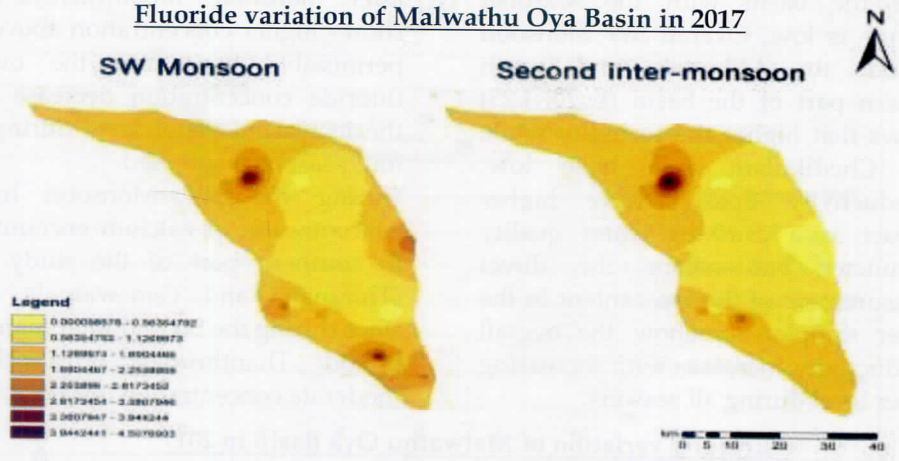

Figure 9 - Fluoride variation in Malwathu Oya basin

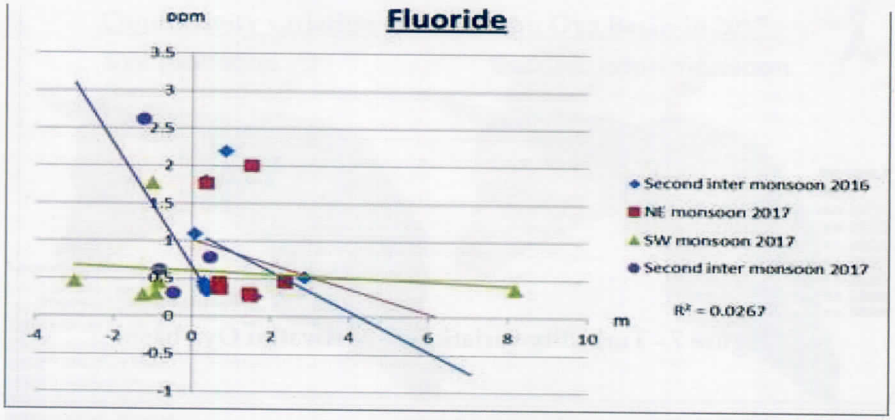

Figure 10 - Fluoride variation between various seasons respect to water level variations

Chloride concentration during SW Monsoon higher in southern part of the study area (Maradankadawala area) during the second inter monsoon also chloride concentration higher in Maradankadawala area and the concentration comparatively no variation encountered. In both seasons the southern part of the study area has increased in Chloride concentration above the permissible limit of drinking water.

The selected locations shows the very few amount of Arsenic concentration respect to the standard permissible limit of Sri Lanka. Since it further reduces with increasing water level during seasonal change.

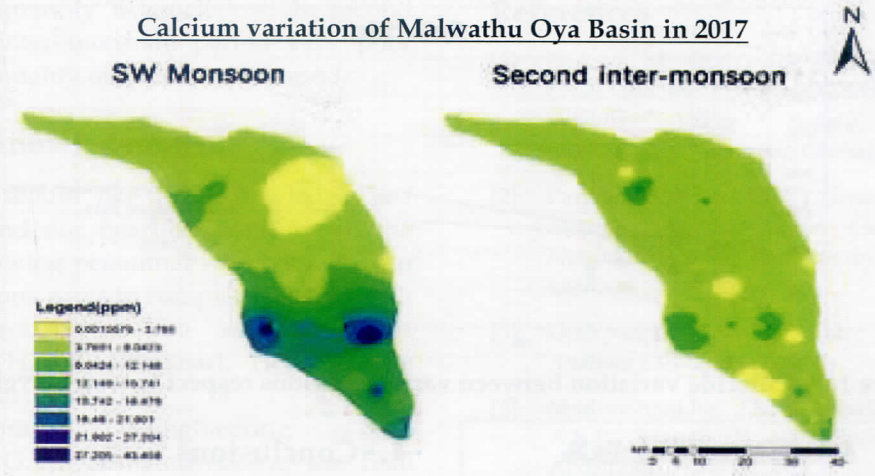

Figure 11 - Calcium variation in Malwathu Oya basin

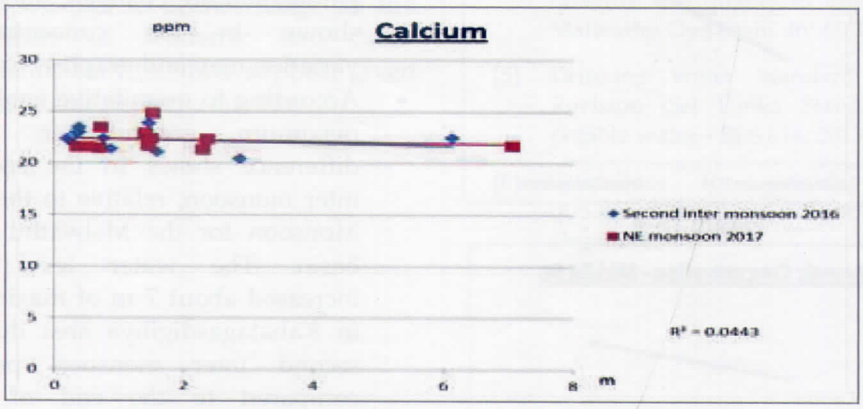

Figure 12 - Calcium variation between various seasons respect to water level

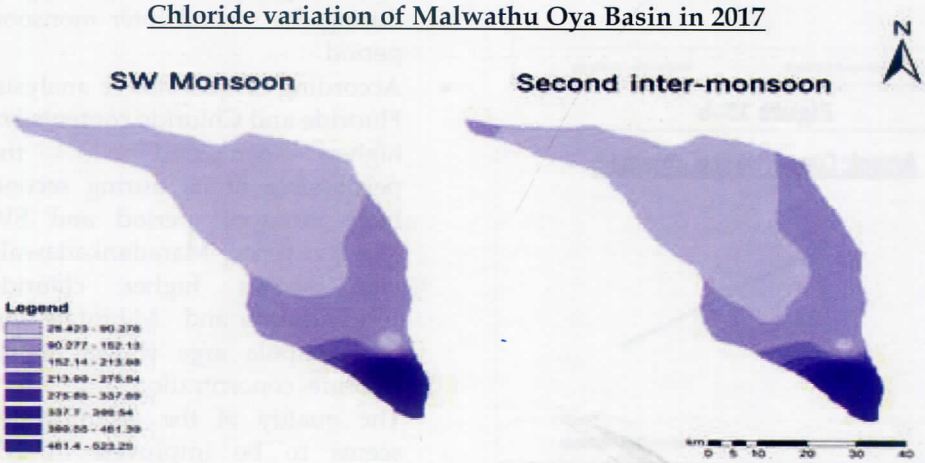

Figure 13 - Chloride variation in Malwathu Oya basin

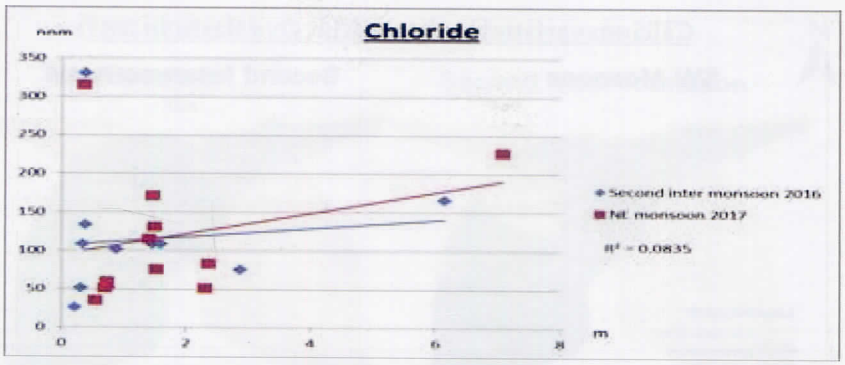

Figure 14 - Chloride variation between various seasons respect to water level variations

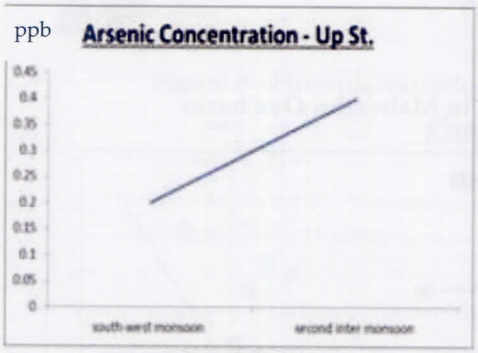

Figure 15–a

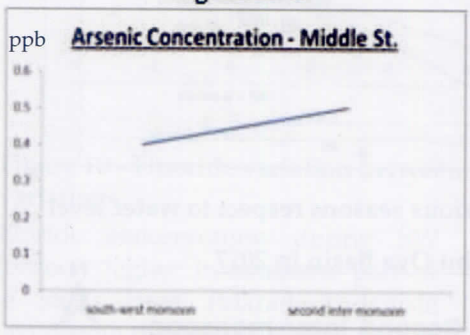

Figure 15–b

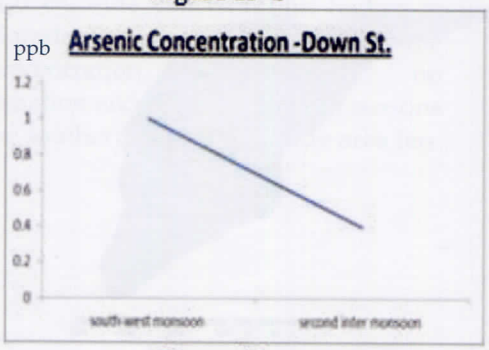

Figure 15–c

Figure 15- a, 15-b and 15-c - Arsenic variation in Malwathu Oya basin

4. Conclusions

- The seasonal analysis showed that groundwater quantity and quality parameters are changed, and was shown in ion concentration variation map and graphs.
- According to quanitative analysis, maximum groundwater level difference shows in the second inter monsoon, relative to the SW Monsoon for the Malwathu Oya basin. The water level has increased about 7 m of maximum in Kahatagasdigiliya area during second inter monsoon period compared to the end of SW Monsoon period. This is due to increasing the rate of recharging during the second inter monsoon period.
- According to quanitative analysis, Fluoride and Chloride contents are higher compared to the permissible limits during second Inter monsoon period and SW Monsoon period. Maradankadawala area shows higher chloride concentration and Mihintale and Ganewalpola area shows higher fluoride concentration.

The quality of the groundwater seems to be improved in NE Monsoon than in the SW Monsoon period and the Second Inter monsoon period where water

quantity is much low. In second inter monsoon period very poor quality of water encountered.

Acknowledgements

We would like to acknowledge and extend our heartfelt gratitude to the following personnel who helped us in various ways to complete this research project.
Dr. H.M.R. Premasiri, Head of the Department of Earth Resources Engineering and Dr. G.V.I. Samaradivakara, the final year research project coordinator for their guidance.
Also we like to acknowledge all the members of academic and Non-academic staff for their support given to make this project a success.

References

[1] Barlow, M. (2001). *The Global Water Crisis and the Commodification of the World's Water Supply*. The International Forum on Globalization.

[2] Panabokke, C. (2007). *Groundwater conditions in Sri Lanka*. Colombo: National Science Foundation of Sri Lanka.

[3] Deshpande, L. (2005). *Water Quality Analysis Laboratory Methods*.

[4] Madhushankha, J.M.L., Madhuwan, A.R.B., Menan, P., Chaminda, S.P., Abesinghe, A.M.K.B. and Jayawardena, C.L. (2017). Assessment of seasonal impact on Ground water quantity and quality in upstream of Malwathu Oya basin. In: *ISERME*.

[5] Drinking Water Standard - First Revision (Sri Lanka Standards for potable water – SLS 614: 2013). (n.d.).

[6] Guidelines for drinking water quality. (2006). Geneva: World Health Organization.