

Seasonal Variation of Groundwater Hardness in Polonnaruwa District, Sri Lanka.

L.J.M.U.S.K. Jayasundara (Hydrogeologist, Water Resources Board)

Groundwater usage is rapidly increasing in dry zone areas of Sri Lanka for domestic, agricultural, and industrial needs. Many people in dry zone areas use the dug wells and tube well as their main drinking water source. Agricultural usage is the major usage apart from drinking purpose of groundwater. Groundwater quality management in the dry zone is a more important factor for future sustainability of water. It minimizes the impact of water shortages that occur during the long dry period of dry zone.

Generally, the water quality and quantity of groundwater in dry zone areas vary from place to place due to factors such as climatic changes, the influence of mineralogy weathering and the structure of the underlying rocks. It also noted that water quality and quantity of shallow aquifer systems associated in reservoir areas will change rapidly due to seepage and percolation from the reservoirs.

Polonnaruwa district is situated in a plain valley of Mahaweli river in North Central Province in dry zone of Sri Lanka. The district is mainly an agriculture-based district. Well planned tank cascade system in this area can observed and those were built by ancient kings as a solution to the water scarcity in the dry zone, over 2,000 years ago. Demand for freshwater resources within the area has resulted of increased agricultural practices, economic development, and increased population. Therefore, there is a shortage of water during the dry seasons in many parts of the Polonnaruwa district. In this setup, the groundwater resources are in ever increased demand since the surface water resources are limited and not sustained in the events of long dry spells.

Chronic Kidney Disease unknown etiology (CKDu) was reported in some parts of Polonnaruwa district. It is believed that the application of agrochemicals and fertilizer in excess amounts would be one of the reasons for the CKDu. The hardness and the presence of fluorides in groundwater are also considered as some other reasons for CKD. Therefore, the water quality monitoring of CKD prevailing areas is very much important at this stage.

In this study, Total Hardness of water was focused. Total Hardness is the sum of the Calcium and Magnesium concentrations expressed as CaCO_3 in milligrams per liter. Under this assessment, it was identified the locations where the groundwater hardness is to be monitored on a Seasonal Variation (pre and post monsoon of a year) with the represent of the aquifer systems of the study area in year 2022. In this context, shallow and deep groundwater sources were assessed and the study was taken into account for measure 75 representative groundwater samples for analyze the spatial variation of hard waters in the Polonnaruwa District. 54 water samples were taken from existing shallow wells and 21 water samples were taken from existing tube wells constructed by Water Resources Board. Water sample collection was conducted in 1st Quarter (post monsoon) and 3rd Quarters (pre monsoon) in year 2022.

Based on CaCO₃ hardness, four categories of water can be identified as following according to the World Health Organization (WHO) drinking water standard 2009:

Table 01: Four categories of water based on hardness.

Category	Description	Range (mg/L)
01	Soft water	< 60
02	Moderately hard water	60 – 120
03	Hard water	120 – 180
04	Very hard water	180 <

Figure 1 and 2 are indicates the spatial distribution of Hardness in Polonnaruwa District in post and pre monsoon respectively.

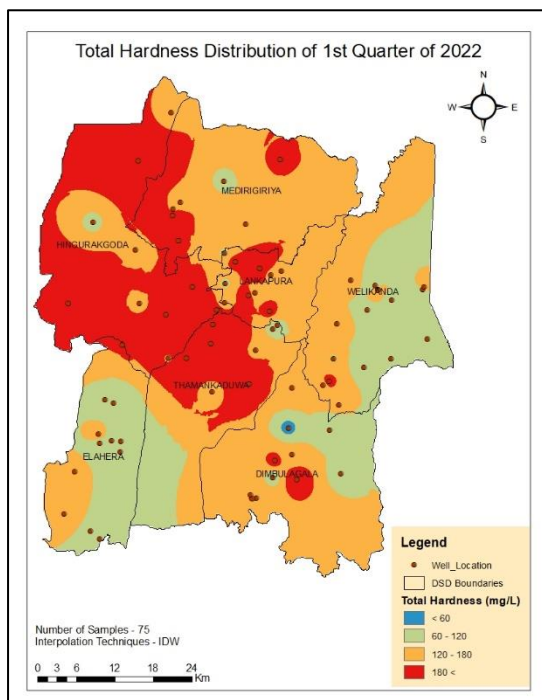


Figure 01: Total Hardness distribution map of 1st quarter of 2022

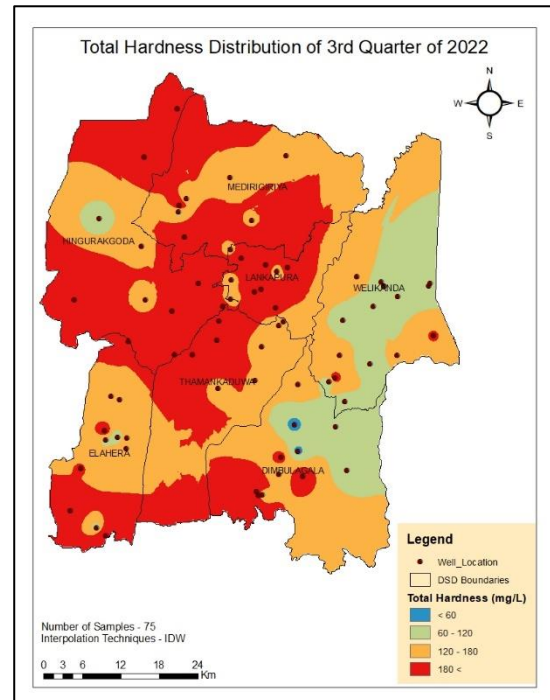


Figure 02: Total Hardness distribution map of 3rd quarter of 2022.

According to the numbers of wells representing each hardness levels in the study area, there are different kinds of water could be identified and the percentage of each level of water sources are illustrating in figure 3 and 4 by pie charts for post and pre monsoon in year 2022.

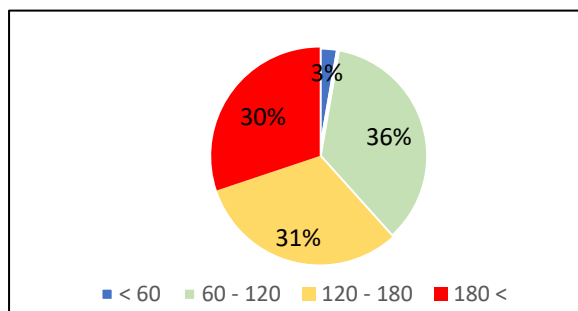


Figure 03: % of groundwater sources of Total Hardness in 1st quarter 2022

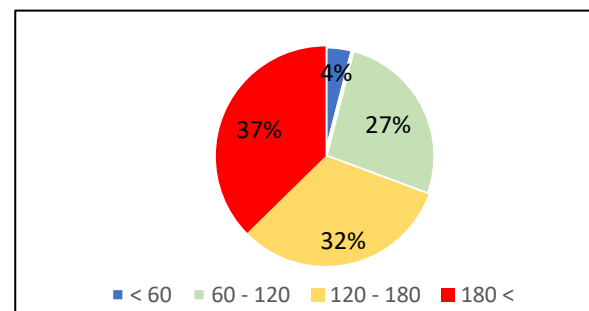


Figure 04: % of groundwater sources of Total Hardness in 3rd quarter 2022.

According to the results, the majority of the areas in the Polonnaruwa District were reported as very hard water or hard water throughout the year 2022 (in both post and pre monsoon periods.) 3%, 36%, 31%, and 30% of well water are soft, moderately hard, hard, and very hard, respectively in first quarter (Figure 01 and 03). Within third quarter 4%, 27%, 32%, and 37% of well water were soft, moderately hard, hard, and very hard, respectively. (Figure 02 and 04). In this setup, it is noted that the distribution of hardness of water is changing based on the seasonal changes of climate of the district.

But respectively 35% and 60 % of wells in Thamankaduwa and Higurakgoda Divisional secretariats have very hard water in both two climatic seasons of the year 2022. No significant variation of distribution of hardness based on the seasonal changes in Thamankaduwa and Higurakgoda Divisional secretariats

Figure 5 and 6 are illustrating the percentages of water sources in respect to the hardness limits in and out of the SLS portable drinking water standards.

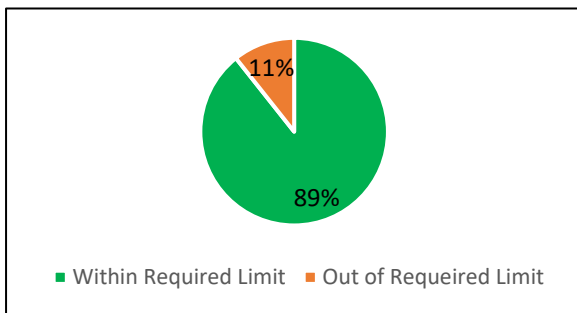


Figure 05: Pi diagram for indicating the water suitability for drinking based on total hardness in 1st quarter 2022.

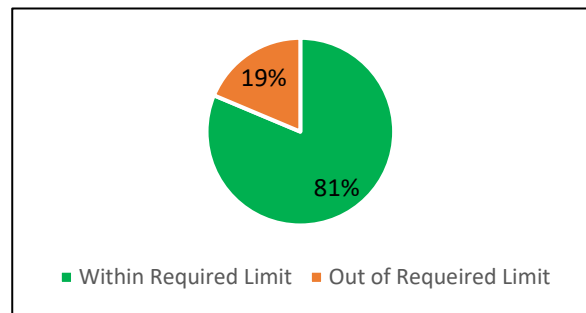


Figure 06: Pi diagram for indicating the water suitability for drinking based on total hardness in 3rd quarter 2022.

According to the above analysis, it is indicating the changes of Total Hardness with climatic variation of the district. During the dry spell of the area, the Hardness affected water sources were increased than the wet season of the area. With the precipitation, groundwater in the area is mixed with rain water and those are faced to dilution process. In this setup, hardness of the water of the area is decreased and some of them are comes under safety limit of SLS.

With the evaporation and depletion of groundwater level of the area, hardness value is increasing of groundwater in the district and it is therefore, the number of affected water sources are increased as shown by figure 6.

According to the analytical results of groundwater in Polonnaruwa district, it was noted that the high values of Total Hardness is the major issue on the groundwater in the district. It is therefore, it is needed to keep continuous monitoring on groundwater quality in the area and applying purification strategies to ensure good water quality. Rainwater harvesting for drinking purposes may be an immediate measure in addressing this issue and increase the rate of groundwater recharge by rainwater is more important to solve this issue in the district.