



6 CLEAN WATER AND SANITATION

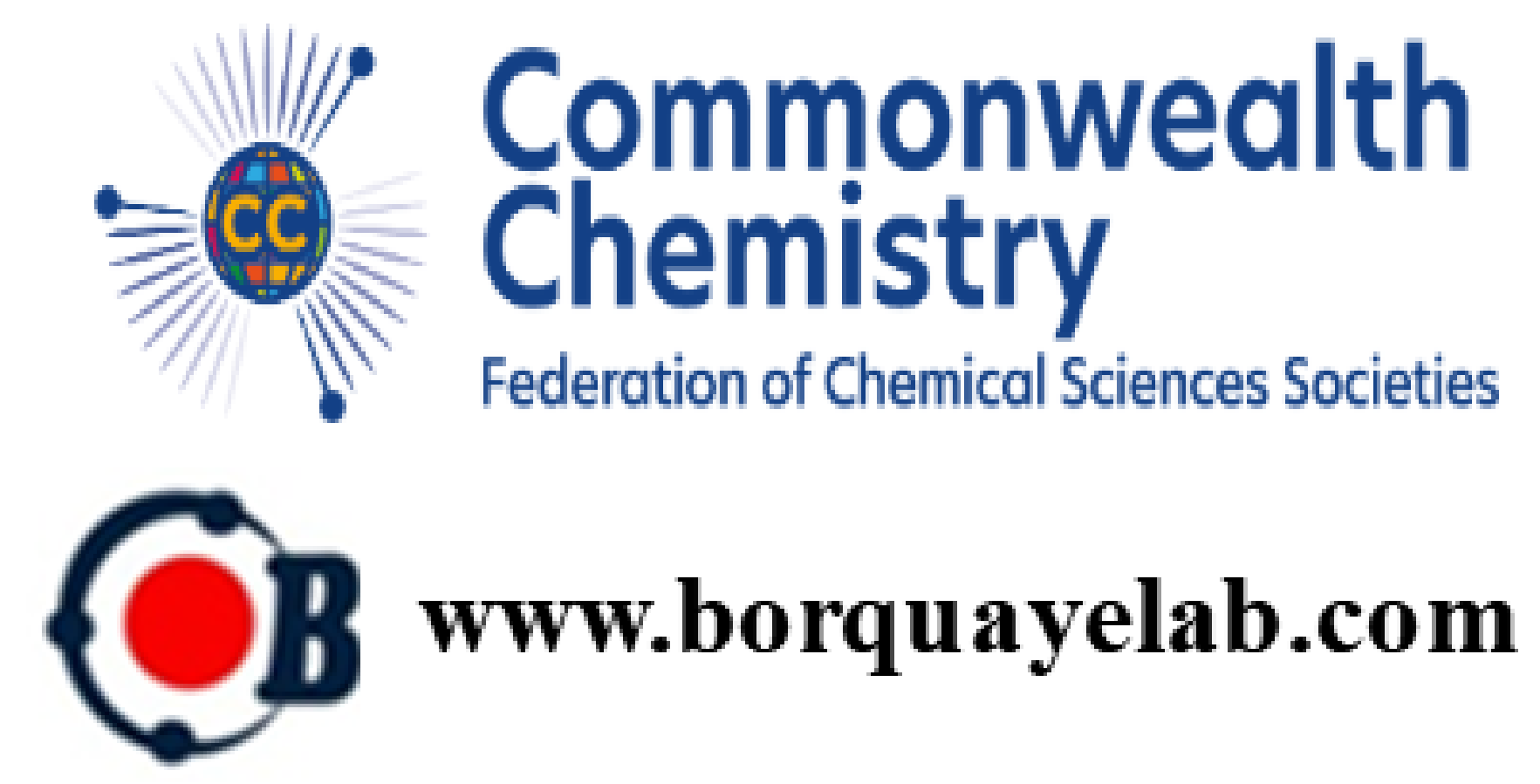


Hydrogeochemical Characterization and Health Risk Assessment of Borehole Water in Peri-Urban Kumasi, Ghana

Solomon Bomiane, Godfred Darko, Michael K.Laryea, Lawrence S.Borquaye

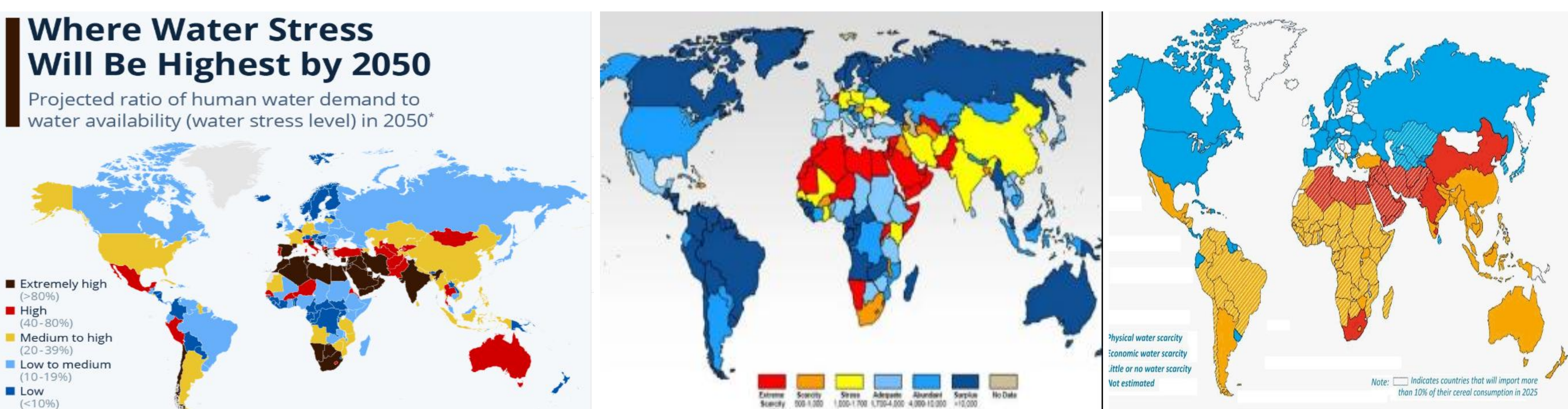
Department of Chemistry, Faculty of Physical and Computational Sciences, College of Science,

Kwame Nkrumah University of Science and Technology, Ghana



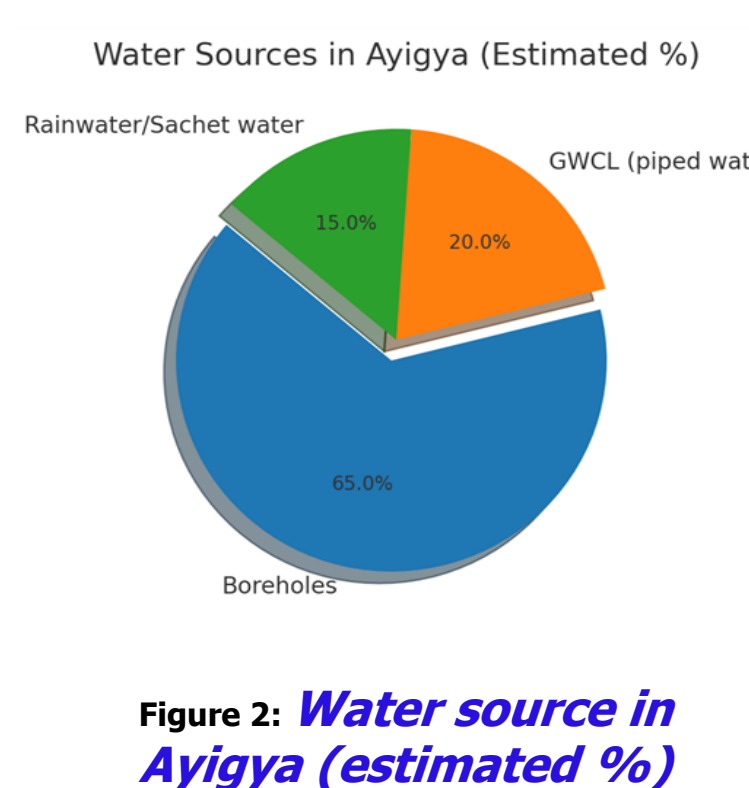
1. Background

Due to overexploitation, as well as anthropogenic and geogenic interferences, access to freshwater in Kumasi has become increasingly difficult [1], making groundwater a critical source of domestic supply [2]. Suburbs such as Oforikrom, Ejisu-Juaben, Ayeduase, Kotei, Atonsu, and Ayigya are among the fastest-growing areas in Kumasi [3]. Several water quality studies conducted in these communities have raised concerns about groundwater safety and public health; however, Ayigya remains relatively underexplored [4]. Given its proximity to these rapidly developing suburbs, groundwater in Ayigya is likely to experience similar challenges [5]. Therefore, this study seeks to conduct a hydrogeochemical evaluation and health risk assessment of groundwater from mechanized boreholes in Ayigya, Kumasi.



2. Problem Statement and Justification

About 65% of the Ayigya population relies on groundwater for domestic use due to the inadequate supply from the Ghana Water Company Limited[4]. However, despite this heavy dependence, limited research has been conducted on the quality of the groundwater in the area. Continued reliance on this resource without adequate monitoring may increase the risk of emerging contaminants, thereby compromising water safety [5]. This study aligns with Sustainable Development Goal 6.1 by assessing the quality of groundwater, which serves as a primary drinking water source for many households in Ayigya.



3. Methodology

Study Area

Ayigya is a suburb in the Oforikrom Sub-Metro of the Kumasi Metropolis and is the most densely populated community in the area. It is located in the eastern part of Kumasi along the 24th February Road and shares boundaries with the Kwame Nkrumah University of Science and Technology (KNUST). The community comprises two electoral areas: Ahenebronu and Zongo. According to the Ghana Statistical Service, the population of Ayigya increased from 30,283 in 2000 to 67,604 in 2021.

4. Results and Discussion

Descriptive analysis of the groundwater in Ayigya

Most of the physicochemical parameters and major ions were found to be within the permissible limits set by WHO and GWCL standards. However, elevated levels of pH, Pb, Cd, and Hg were detected in several borehole samples.

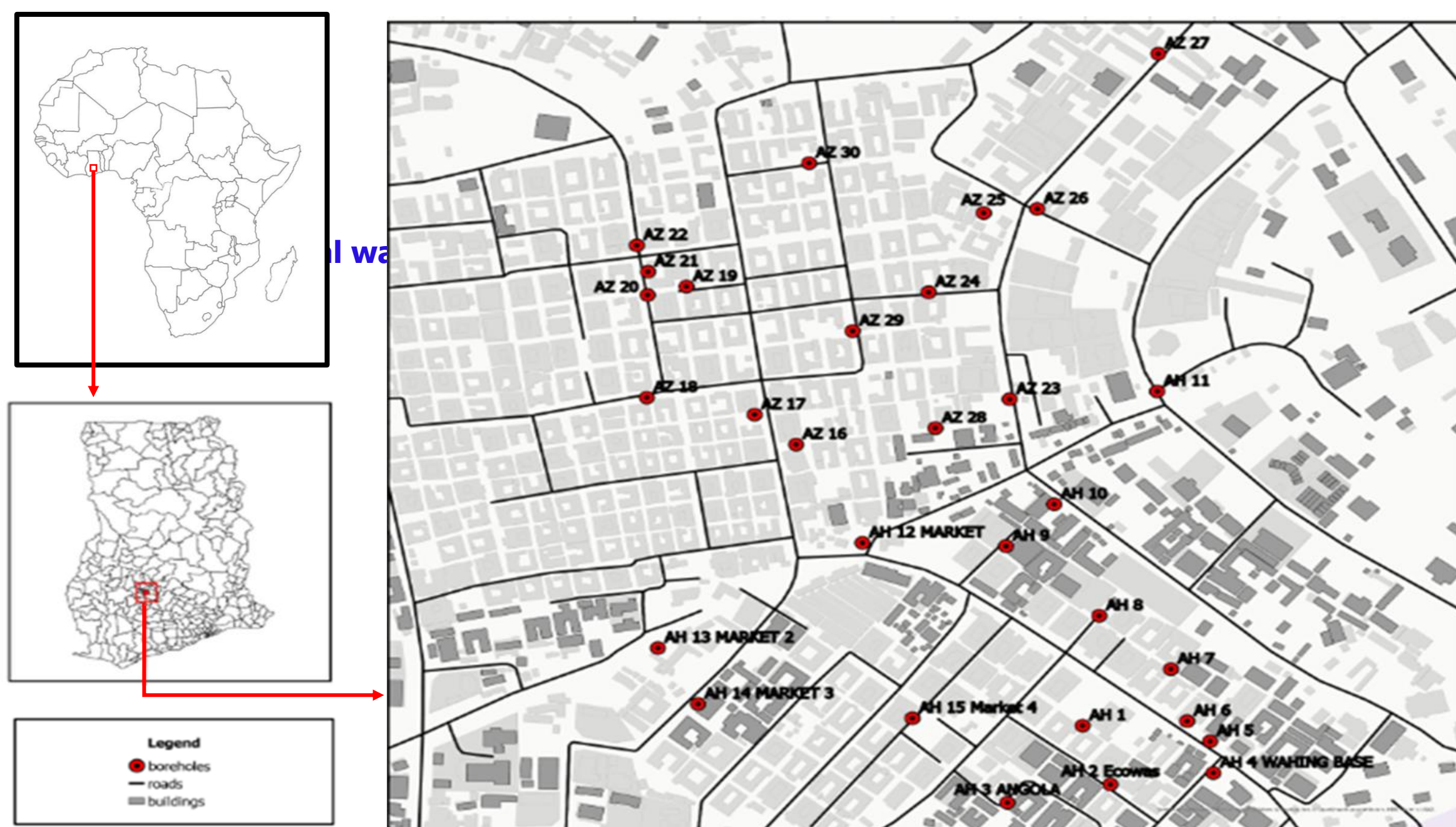


Figure 3: Map of the study area showing sampling locations

Sampling and Sample Collection

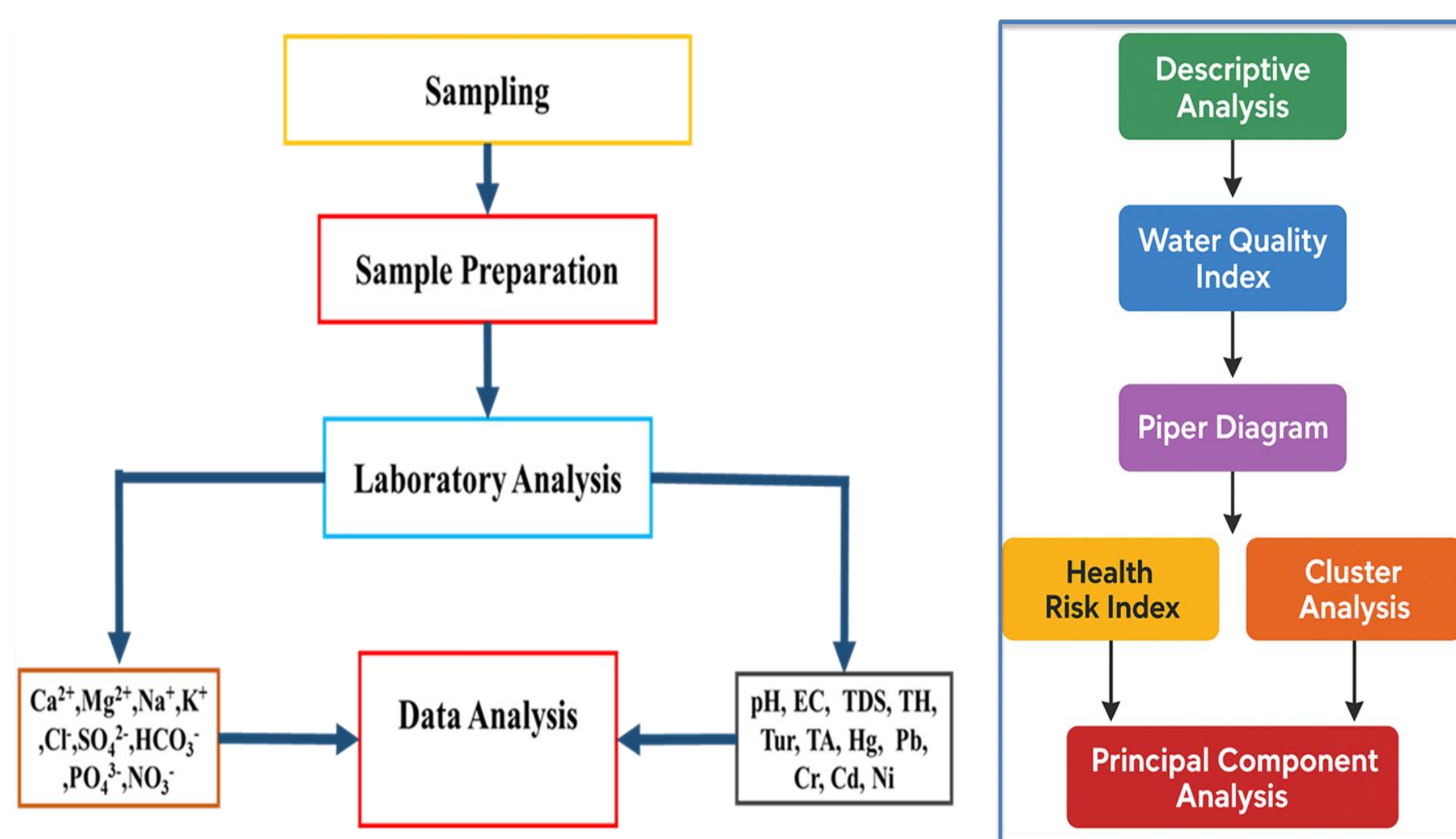


Figure 4: Schematic diagram of groundwater quality in Ayigya Community

Table 1: Statistical analysis of physicochemical and heavy metal parameters

Parameter	min	max	range	mean	Std.D	WHO (2022)
pH	3.7	6.4	2.7	4.867	0.6597	6.5 - 8.5
EC	150	932	782	536.4	256.4	1500
TDS	125	598	473	262.2	115.6	1000
Tur	0.01	0.81	0.8	0.192	0.2313	-
TA	0.08	1.6	1.3	0.8467	0.3357	500
TH	0.3	0.38	0.3	0.2187	0.0719	-
Na ⁺	10.49	48.28	37.79	29.39	10.91	50
K ⁺	13.44	171.5	158.1	73.63	42.81	1200
Ca ²⁺	0.24	0.96	0.72	0.5213	0.219	300
Mg ²⁺	0.2	0.9	0.7	0.4933	0.2086	50
SO ₄ ²⁻	4	19	15	11.6	4.641	500
Cl ⁻	63.9	923	859.1	173.7	208.7	250
NO ₃ ⁻	1.84	3.09	1.25	2.429	0.393	50
HCO ₃ ⁻	0.6	3.6	3	1.64	0.7139	500
PO ₄ ³⁻	0.025	1.95	1.925	0.2867	0.4774	0.7
Cd	0.059	0.000	0.059	0.007	0.017	0.003
Ni	0.511	0.005	0.516	0.054	0.129	3.00
Pb	0.049	0.025	0.073	0.042	0.012	0.01
Cr	0.024	0.003	0.026	0.010	0.006	0.05
Hg	0.000	0.001	0.001	0.001	0.000	0.001

Water Quality Index in the Groundwater

Groundwater quality assessment classified eight samples as "good" for drinking purposes, two as "very good," and five as "poor." This indicates that groundwater in the study area can meet the majority of drinking water demands, although some sources may require treatment before

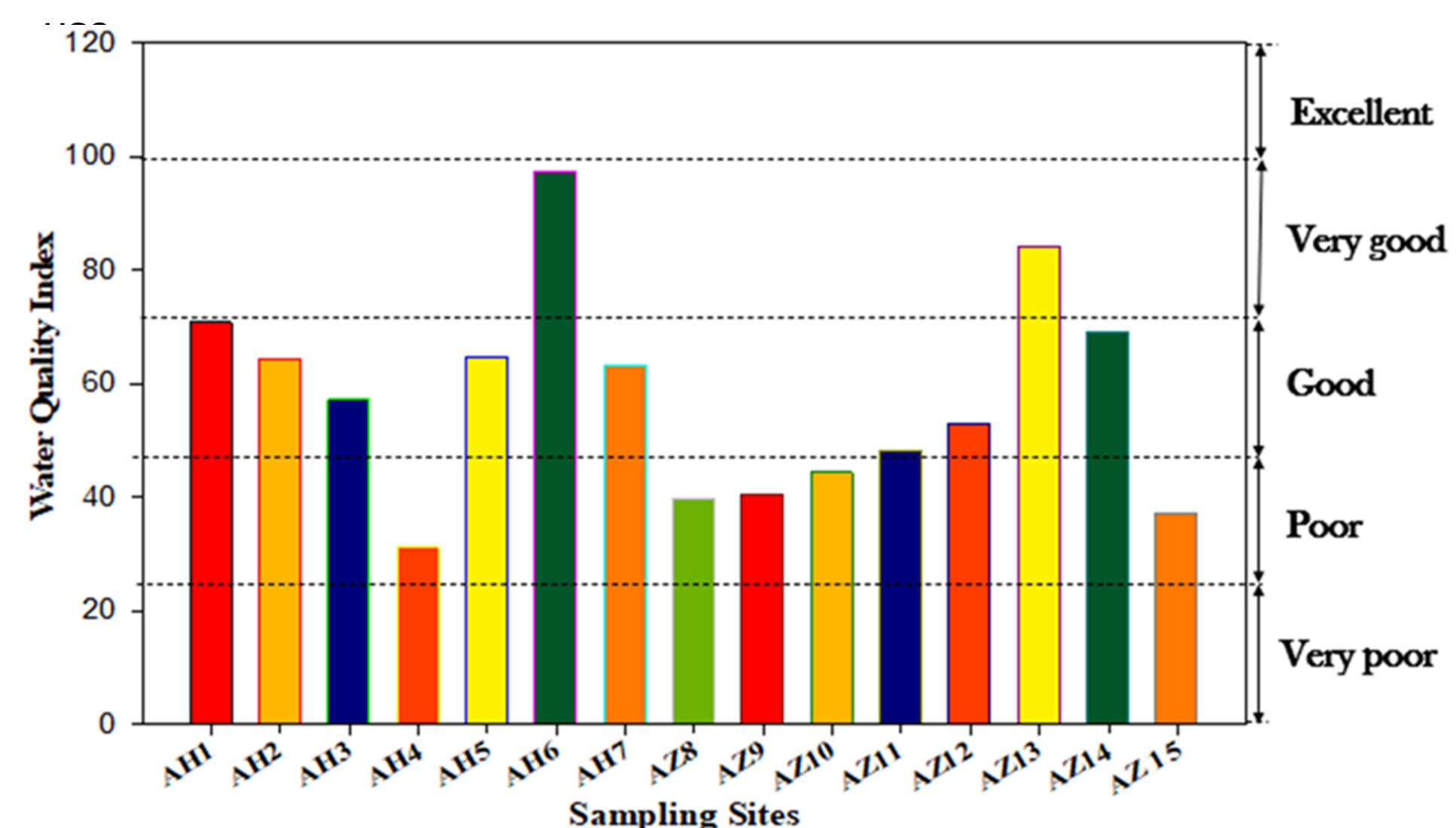


Figure 5: The Water Quality Index Score Range is Calculated for each Mechanized Borehole

Hydrochemical Facies of Groundwater

Hydrochemical facies analysis revealed that nine borehole samples fall within the Ca-HCO₃ type, reflecting fresh water. Four borehole samples were classified as the Na-Cl type, suggesting possible saline intrusion, ion exchange processes, or anthropogenic influence. In addition, two borehole samples exhibited a mixed Ca-Na-Cl-SO₄ type, reflecting the impact of multiple geochemical processes and indicating relatively good groundwater quality.

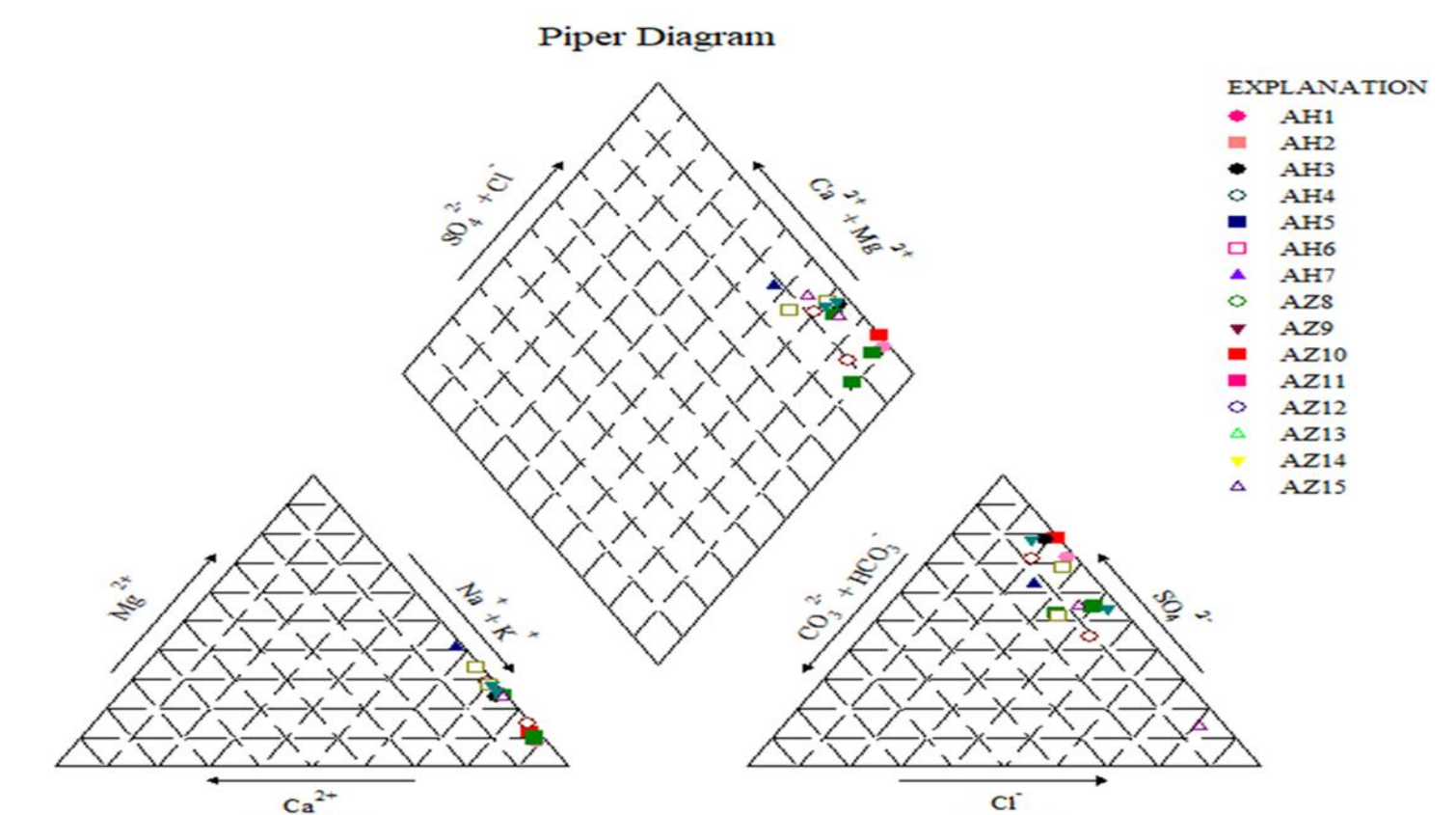


Figure 6: The Piper Diagram Illustrates the Hydrochemical Facies

Health Risk Assessment

Children were found to be more vulnerable, facing unacceptable carcinogenic and non-carcinogenic health risks, while adults exhibited comparatively lower risk levels.

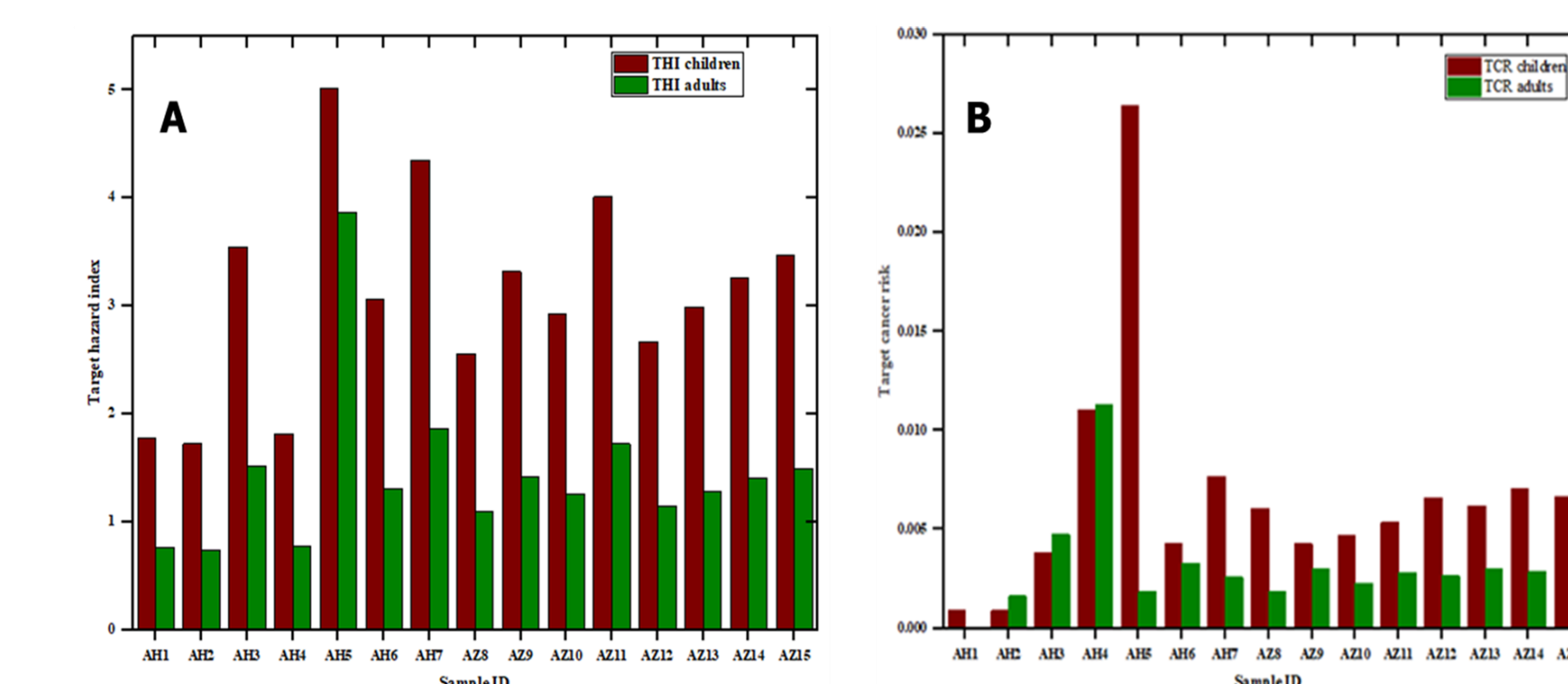


Figure 7: Health Risk Assessment of Groundwater Samples for Adults and Children in Ayigya

5. Conclusion

This study revealed that while most groundwater samples in Ayigya met WHO and GWCL standards for major ions and physicochemical parameters, elevated levels of pH, Pb and Cd in some boreholes pose potential health risks. Hydrogeochemical analyses indicated both natural and anthropogenic influences on groundwater quality. Health risk assessment further showed that children are more vulnerable, facing higher non-carcinogenic and carcinogenic risks compared to adults. These findings underscore the need for continuous monitoring, mitigation of contamination sources, and appropriate treatment measures to ensure safe and sustainable groundwater use in support of SDG 6.

6. References

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