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SEASONAL VARIABILITY OF GROUND WATER QUALITY IN HAWELLA TULLA, HAWASSA

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Abstract
The urban development in line with a population of mixed socio-economic status and intensive agriculture practice pollutes the water resource in developing countries. Water quality is vital determinant of availability because water that is not fit for use is in effect unavailable. It is clear, that decision-makers require scientifically sound information with which to base their priorities. So, the aim this work is to assess the present status of the groundwater quality on the basis of seasonal variation in Hawella Tulla sub-city, Hawassa. Groundwater samples were collected during the wet and dry seasons of August 2014 and February 2015 from boreholes (n=7). Fluoride, pH, alkalinity, total dissolved solids, nitrate, phosphate, chloride and chromium were assessed. Moreover, metal concentrations (Fe, Cr, Mn) were also determined using atomic absorption spectrophotometer. Fluoride, chloride, sulphate, nitrate and phosphate were measured by colorimeter apparatus using standard solutions. The acquired results imply ground water samples were generally of good quality. The result presents that, virtually all the parameters lies within the maximum permissible limit prescribed by WHO and Ethiopian drinking water standard except, alkalinity, but this value has less impression for the water to use for drinking. Statistical analyses indicate easy going differences among all parameters tested for in the samples at 95% confidence level. However, it is highly essential to examine the quality of potable purpose to grant the health of large community.

Key Words: *Hawella Tulla, Physico-chemical, Fluoride, Water quality*

Introduction

The global water community continues to highlight good water quality as vital for securing the future of human and aquatic ecosystem health. Widespread poverty and the dramatic impacts of demographic change, growing urbanization and the effects of globalization aggravates the water quality problem than ever (MoWR, 2011). Ethiopia has also set ambitious goals for improving access to basic services and to reach domestic water supply 70% of the populations by 2015 (MoWE, 2011), yet the truth on the ground is different and the water quality problem is still left behind without attaining the goal. Currently, in Sidama Province, Southern Nations and Nationalities Peoples Region (SNNPR) there are more than 3,313 boreholes which serve as water supply in which, Hawassa city the capital of this province has obtained water supply primarily from boreholes majorly from Tulla sub-citywhere a population of mixed socio-economic status and intensive agriculture practice is more prevalent (Thiede, 2014).

The quality of public water supply essential service is critical to community health but it also has the potential to deliver harmful substances and microorganisms if not properly maintained (USEPA, 2000). Anthropogenic activities takes the leading position in contributing contaminants to both the surface and ground water sources (*Prabu et al*., 2011). Protection of water supplies from contamination is the first line of defense than treatment in ensuring safe drinking-water (Berhanu and Hailu, 2015).

Globally around 1.2 billion people in the world who lack access to sufficient quantities of safe water and 2.6 billion people without adequate sanitation (Holmberg and Rothstein, 2011). In most developing countries, there is growing dissatisfaction with the public quality service specially accessibility of drinking water for all not yet solved (WHO/UNICEF, 2010). Moreover, deficiencies in the coverage, access and quality of water supply services are common for most marginalized community (UNICEF, 2010) which escorts to take life of the children and women.

In Ethiopia, more than 80% of deaths are caused due to water borne diseases (MoH, 2011). There is a need for reliable, surveillance data and information about water resources and quality at the national and regional level for the water and sanitation targets to be measured (Ethiopia MDGs report, 2012). So, recurrent physicochemical and biological water quality determination activities are vital to ensure the consistency of water quality. Moreover, the uncontrolled expansion of this kind of housing, together with increasing sewage and effluent leakage, indiscriminate waste disposal and increased industrial and commercial activities result in seepage of harmful compounds into the ground water (WHO/UNICEF, 2010). In HawellaTulla, water treatment and monitoring was not utterly followed with the rapid sprawl and ever booming of Hawassa city, led to the growth of large areas of unplanned sub-standard housing, and agricultural practices in most areas, which directly or indirectly compromise the water quality.

The undulating terrain of Hawassa catchment is largely being converted into built-up zone and other allied activities. The problem entirely affects the ecological health, which nurtures life. Inappropriate dumping of solid and liquid wastes, lack of strict enforcement of law and loose governance, agricultural practice and open defecation are the cause of deterioration of surface and ground water quality. The aim of this study is to assess the present water quality status of Hawassa city during dry and summer seasons, and the study would also try to highlight the current concentration of pollutants and their influence on environment in general and water quality in particular.

Study Area

This study was conducted in Hawassa City, Southern Nations Nationalities and Peoples Region (SNNPR) located 275 km south of Addis Ababa. Water samples were collected from the seven functional public borehole (Fig. 1) water supply sources in the study area, Hawella Tulla sub-city (table 1) in 2014/2015 G.C.

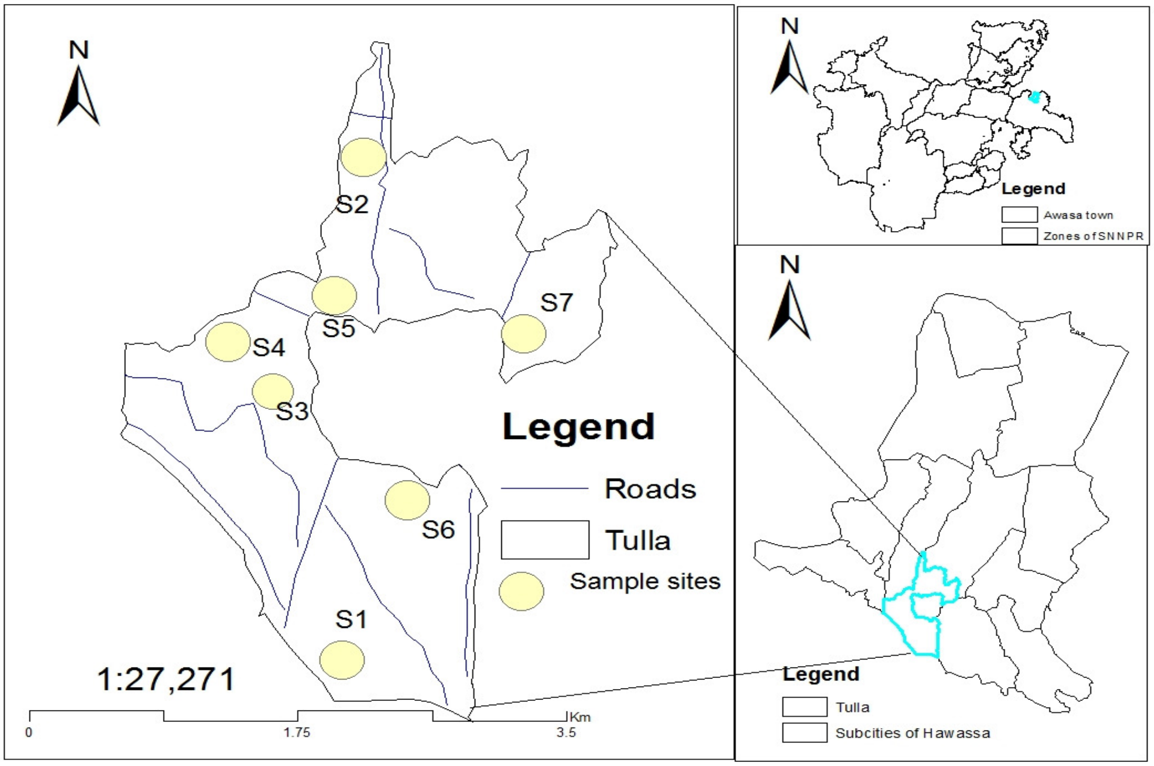

Fig. 1: Map of the study area and sampling locations

Study Design

Cross sectional study, for laboratory investigation to determine physico-chemical quality of ground water samples in Hawassa city based seasonal variation. A total of fourteen water samples from seven sites.

Collection of Water Samples

Water samples collected two times during wet and dry season with pre-cleaned polyethylene bottles after flashing the water until it maintains constant temperature and conductivity, to attain its representatives and minimize bias. Preservation and transportation to the laboratory were done as per standard methods provided by the American Public Health Association (APHA, 1998). The variations in concentration of the chemical components were studied in the perspective ofpermissible limit of drinking water following Ethiopian standards (MoWR, 2002) and World Health Organization standards (WHO, 2010).

Total dissolved solids (TDS), pH and alkalinity were measured *in-situ* using a Troll-9500 multi-parameter metre. Total hardness, magnesium (Mg) and calcium (Ca) hardness were determined by ethylenedi-amine tetra acetic acid (analytical grade) and total alkalinity by titrimetric method. Magnesium was estimated as difference in total hardness and calcium. Fluoride, chloride, sulphate, nitrate and phosphate were measured by colorimeter apparatus using certified standard solutions (APHA, 1998). To prevent cross-contamination, all materials associated with trace metal sampling and analyses were thoroughly acid cleaned before use.

Iron (Fe), chromium (Cr) and manganese (Mn) in water samples were determined using atomic absorption spectrophotometer (Wagtech AA-6800, serial no 3400-008, America) adjusting wavelength between 410-640.The wavelength adjustments were done depending on the interest of metal or ions to find out. All analytical grade reagents were used for calibrations and preparation of the standards and deionized water was used for dilution and reagent preparation. The analytical procedures and instrument sensitivity were checked by analysis of standard reference materials.

Table 1: Well water sampling coordinates within the study area

Sample Code	Sampling Location	UTM E	UTM N
D_nS_1	Qarara borehole water	447455	768682
D_nS_2	Bashema Protected spring	445303	770648
D_nS_3	Meti-2 borehole water	445303	770493
D_nS_4	Meti-1 borehole water	445607	770648
D_nS_5	Treatment borehole water	447465	768772
D_nS_6	Habela-1 borehole water	446393	770925
D_nS_7	Gara Riketa-1 borehole water	447761	771220

**n-can be '1' for wet season and '2' for dry season*

All data of the water quality determinants were analyzed using descriptive and relational statistical techniques. Means were calculated together with standard error to indicate reliability of measurements between duplicates. The correlation between pairs of variables were used to analyze the significance of spatial difference in distribution of the physicochemical parameters of the ground water samples, the level of significance was set at α =0.05(95% confidence interval) throughout the study.

Results and Discussion

Physico-chemical Characteristics of Borehole Water

The present study presents the water samples had pH values which ranges 7.3 - 7.9 for dry and wet seasons. The high pH value might be due to the high levels of bicarbonates of the soil mainly as result geological formation rather than human activities practiced in and around the catchment. However, the pH values of all the samples were within the pH range assigned by WHO and Ethiopian guidelines as the standard for drinking water which ranges 6.5 -8.5. The pH values of the water sample were much higher during the dry season in comparison to the wet time; this decrease in pH might be resulted from the fact that solubility of free carbon dioxide in water increases with decrease in temperature which can be evacuated while the temperature elevates during the dry season where as the decrease in pH leads a risk factor for leaching of essential nutrients, and other heavy metals into the water.

The soluble ion concentration is generally measured by determining the total dissolved solids (TDS) of water. For all the analyzed samples, the measured total dissolved solids values are given in table (2). Out of the analyzed seven groundwater samples, two samples have TDS values below 120 mg/l during the wet time and the remaining six samples have TDS value ranging from 122 to 180 mg/l. The TDS values during the wet season were much lower than the dry season. This is an indication that the geological formation of the area is mostly made off insoluble minerals and other finding also reported low concentration of TDS (<500 mg/l) (BGS, 2010), for drinking water which was 259 - 500 mg/l.

Hardness and total alkalinity of drinking water are said to be acceptable at 500 mg/l and 200 mg/l respectively according to the WHO standard for drinking water. It depends mainly upon the amount of calcium and magnesium salts. Water hardness in the wet season varied widely with the mean values ranging from 48-109 mg/l while in the dry season had hardness values ranging from 45-114 mg/l. Hardness has actually no health impact rather it has an economic impact if available at high concentration by consuming more soap and consuming more energy during boiling of water in addition it is the cause of corrosion.

The values obtained for total hardness, calcium and magnesium hardness in this study were within the WHO standard guidelines in which 35.71% were soft water class (<75 mg/l as $CaCO_3$) and 64.29% of samples were belongs to moderately hard (75-150 mg/l as $CaCO_3$), and therefore the water samples are suitable for domestic as well as industrial uses.

Soluble Ions in the Water Sample

The land uses of the catchment were majorly agricultural activities with significant animal husbandry. However, nitrate concentrations in all the samples were within the WHO standard. Even though, nitrate concentration shows significant variation between the dry and wet seasons where lower values were recorded during the wet season, this probably as a result dilution. High nitrate content in water is known to cause disease in fact called methemoglobinemia.

It was realized that (table 2), that levels of chloride were so high in the samples of D_1S_1 and D_1S_2 in wet season and D_2S_1 in dry season where as sulphate concentration were maximum in D_1S_6, D_1S_7, and D_1S_5 in wet season and D_2S_5, D_2S_6 and D_2S_7 in dry season. Phosphatewere maximum at (D_1S_5, D_1S_3 in wet season; D_2S_1 and D_2S_5in dry season) and nitrate concentration were much more at (D_1S_5, D_1S_1 and D_1S_2 in wet season; D_2S_6, D_2S_5 and D_2S_1 in wet season). This pollutants were appears in regions with highly vulnerable animal dug and intensive fertilizer application were expected however, it was found in rare amount which might be as a result geological formation the area. Phosphate and sulphate concentrations in water tend to show insignificant however these values were inconsiderable it could be natural causes rather than anthropogenic activities.

Fluoride appears as a secondary contaminant of concern sporadically throughout the boreholes sampled. Bedrock containing fluoride minerals is generally responsible for high concentration of this ion in groundwater and from the fact fluoride prevalent in rift valley area where the study area is parts of it which were distinguished as water related health concern (Survey, 2010). The concentration of fluoride in groundwater of the study area varies and with an average value of 0.58 mg/l and 0.42-1.07 mg/l during the dry season with an average value 0.70 mg/l where the overall groundwater samples in study area are suitability for drinking where the concentration of fluoride less than the WHO guideline value 1.5 mg/l but needs continuous monitoring since the area history well known in geothermal water.

Table 2: Mean Concentration (Mean ± SE mg/l, n=5) of groundwater samples collected during 2014/15

Season	Site	F^-	NO_3^-	PO_4^{3-}	SO_4^{2-}	Cl^-	Total Alkalinity	TDS	pH	Total hardness	Ca-hardness	Mg-hardness
Wet season	D_1S_1	0.22± 0.003	5.67± 0.019	1.09± 0.019	4.00± 0.020	1.90± 0.003	144± 0.005	95± 0.19	7.2± 0.48	64.5± 0.139	41± 0.034	23.5± 0.005
	D_1S_2	0.87± 0.012	5.03± 0.018	1.19± 0.27	2.00± 0.036	1.00± 0.013	154± 0.015	122± 0.012	7.2± 0.012	48± 0.005	21± 0.012	27± 0.120
	D_1S_3	0.59± 0.20	1.10± 0.036	1.38± 0.015	1.67± 0.003	0.10± 0.012	150± 0.12	127± 0.019	6.6± 0.016	77± 0.036	44± 0.020	33± 0.012
	D_1S_4	0.51± 0.103	3.43± 0.014	1.17± 0.012	1.00± 0.012	0.10± 0.010	166± 0.003	123± 0.003	6.8± 0.003	93± 0.012	51± 0.045	42± 0.036
	D_1S_5	0.39± 0.006	7.60± 0.003	1.33± 0.003	2.27± 0.005	0.10± 0.016	123± 0.012	117± 0.042	6.7± 0.020	96± 0.027	61± 0.036	35± 0.045
	D_1S_6	0.72± 0.019	3.30± 0.012	1.01± 0.005	7.00± 0.007	0.10± 0.010	162± 0.027	101± 0.005	6.8± 0.013	109± 0.003	66± 0.003	43± 0.003
	D_1S_7	0.78± 0.001	3.50± 0.005	0.07± 0.036	5.67± 1.009	0.10± 0.005	158± 0.019	144± 0.056	7.0± 0.005	105± 0.057	57± 0.005	48± 0.044
Dry season	D_2S_1	1.07± 0.005	13.2± 0.025	1.04± 0.034	1.5± 0.003	1.65± 0.005	154± 0.025	180± 0.012	7.8± 0.025	45± 0.012	21± 0.001	24± 0.012
	D_2S_2	1.05± 0.004	6.2± 0.012	1.08± 0.004	1.5± 0.001	0.4± 0.011	101± 0.004	147± 0.004	7.4± 0.001	57± 0.012	31± 0.004	26± 0.025
	D_2S_3	0.67± 0.012	3.8± 0.001	1.39± 0.005	1.5± 0.002	0.4± 0.012	126± 0.012	166± 0.001	7.5± 0.012	67± 0.004	34± 0.005	33± 0.005
	D_2S_4	0.55± 0.012	7.10± 0.004	0.51± 0.012	2.00± 0.025	0.10± 0.001	154± 0.001	183± 0.025	7.9± 0.005	89± 0.005	44± 0.025	45± 0.004
	D_2S_5	0.42± 0.025	8.25± 0.005	0.58± 0.012	4.50± 0.005	0.75± 0.004	134± 0.034	180± 0.005	7.4± 0.004	93± 0.001	54± 0.012	39± 0.012
	D_2S_6	0.60± 0.001	11.2± 0.012	1.05± 0.025	24.5± 0.012	0.60± 0.025	169± 0.005	271.5± 0.01	7.3± 0.012	114± 0.025	60± 0.012	54± 0.001
	D_2S_7	0.56± 0.20	7.65± 0.12	2.15± 0.029	4.50± 0.34	0.55± 0.034	157± 0.019	227± 0.19	7.5± 0.013	103± 0.017	50± 0.48	53± 0.20

The study presents the total alkalinity values among the seven sampling sites and the seasons show slight variation. It is caused by the presence of HCO_3^-, CO_3^{2-} or OH^-. In this study, the value of alkalinity obtained during the wet season was much higher than the dry season this might be because of solubility salts increase with increasing temperature activities around the area and the dissolution of natural minerals contained in the rocks.

The high value of alkalinity value obtained vivid that it has to cause corrosion in plumb and other utensils which further aggravates to contribute other heavy metals which possibly leached as a results and affects the health of the community particularly child and pregnant women. Alkalinity of 500 mg/l is however also acceptable by the Ethiopian Ministry of Energy and Water Resources standard (MoWR, 2002) and USEPA standards. Based on these guidelines, the levels of alkalinity and total hardness recorded for all the samples can be said to be within safe limits.

Metal Concentrations

Chromium is an essential micronutrient for animals and plants, and is considered as a biological and pollution significant element. In this study the concentration of hexavalent chromium were in the range of 0.01 - 0.03 mg/l to <0.01 - 0.02 mg/l during the wet and dry seasons respectively. It is more dominant during wet season vis-à-vis dry season.

The maximum value obtained in the wet season might be resulted from the dissolution of mineral rocks in the geographic area or anthropogenic source and the corresponding high solubility of chromium which might be a risky for human consumption. As per WHO (2011) guidelines and in perspective of Ethiopian drinking water standard prescribed permissible limit for drinking water, chromium concentration in all the samples were well within the prescribed permissible limit of 0.1 mg/l.

Iron is not hazardous to health, but it is considered a secondary or aesthetic contaminant. Essential for good health, iron helps transport oxygen in the blood. Iron is usually occurring in ground water is in the form of ferric hydroxide, in concentration less than 500 µg/l. It is an essential and non-conservative trace element found in significant concentration in drinking water because of its abundance in the earth's crust. Even though the WHO limit of iron in water is 1 mg/l, sample D_1S_1during dry time and samples D_1S_1 and D_2S_2 (wet season) have more than 1 mg/l which is acceptable as per Ethiopian drinking water standards as far they do not pose any health hazards. Iron show a highly significant increase during both seasons with higher average value during summer than that in dry; whereas, maximum concentration recorded at D_1S_1 and D_2S_2 at both seasons and minimum at D_1S_5 in the wet season.

Table 3: Mean concentration of heavy metals (Mean ± SE mg/l, n=5) in borehole water in comparison to depth during dry and wet season.

Season	Site	Fe	Mn	Cr^{+6}	Depth of Borehole (m)
Wet season	D_1S_1	1.397± 0.003	0.97± 0.006	0.03± 0.020	107
	D_1S_2	0.87± 0.008	0.73± 0.002	0.01± 0.001	70
	D_1S_3	0.59± 0.64	0.13	0.02± 0.005	70
	D_1S_4	0.51± 0.01	2.6± 0.005	0.01± 0.003	70
	D_1S_5	0.38± 0.003	1.00± 0.003	0.01± 0.001	102
	D_1S_6	0.72± 0.008	1.13± 0.009	0.01± 0.003	107
	D_1S_7	0.78± 0.001	1.10± 0.005	0.01± 0.001	102
Dry season	D_2S_1	0.21± 0.011	1.35± 0.002	nd	107
	D_2S_2	0.28± 0.013	0.88± 0.004	0.01± 0.001	70
	D_2S_3	0.05± 0.005	1.00± 0.006	0.01± 0.001	70
	D_2S_4	0.01± 0. 002	0.80± 0.002	0.02± 0.001	70
	D_2S_5	0.03± 0.001	0.20± 0.006	0.01	102
	D_2S_6	0.03± 0.001	1.00± 0.008	0.01± 0.001	107
	D_2S_7	0.04± 0.009	0.60± 0.010	nd	102

**nd-Not detected*

In the present study level manganese varies significant across the sampling sites and seasons.WHOs' (2010) MAL for manganese is 400 µg/l and none of the drinking water samples analyzed show above the limit. So, from this finding the concentration level was within the WHO standard guidelines.

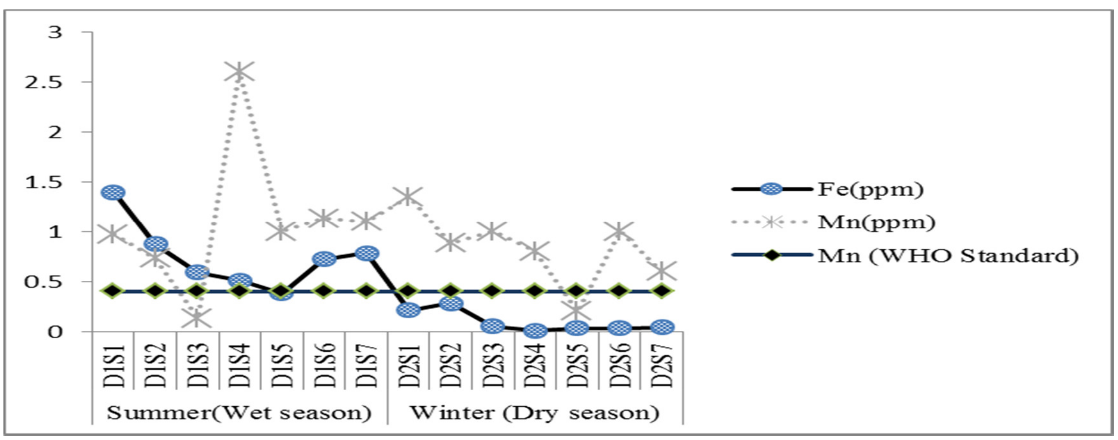

Fig. 2: Line plots showing spatial variation in Iron (Fe) and manganese (Mn) in mg/l

It must be mentioned that (WHO, 2010) gives no specific guidelines for permissible limit of iron and manganese in drinking water whereas, the concentrations of chromium in the water samples were generally low compared with the WHO standards.

The health effects from over-exposure of manganese are dependent on the route of exposure, the chemical form, the age at exposure, and an individual's nutritional status. This result did not show any evidence of the heavy metal pollution as their concentrations were low. The concentration heavy metals have no relation with the depth of the well.

The concentration of chemical constituents such as iron and manganese during wet and dry seasons in groundwater samples when plotted with respect to the sampling location showed roughly cyclic behavior (figure 2).

The spatial variation in the above-mentioned chemical constituents in the groundwater samples was prominent. These cyclic patterns may be on account of numerous subsidiary anthropogenic activities reach the ground water either through infiltration and mostly expected to be sourced from geological soluble rock formations containing iron and manganese where this is evidenced with the maximum concentration which was obtained during the wet season versus the dry season, accelerating its enrichment in groundwater.

These plots are useful in assessing spatial variation in concentration of different groundwater contaminants but they are not enough to relate the similarity/dissimilarity among chemical contaminants. Hence, a correlation coefficient matrix were prepared for wet and dry seasons samples and sampling locations, which provided sufficient information for all analysed chemical constituents (table 4) and (table 5).

Table 4: Correlation matrix for the groundwater quality data in summer season (concentrations were expressed in mg/l)

	TDS	F^-	NO_3^-	PO_4^{3-}	SO_4^{2-}	Cl^-	Total Alkalinity	pH	Total Hardness	Ca-Hardness	Mg-Hardness	Fe	Mn	Cr^{+6}
TDS	1													
F^-	0.541	1												
NO_3^-	-0.336	-0.413	1											
PO_4^{3-}	-0.499	-0.383	0.133	1										
SO_4^{2-}	-0.216	0.227	-0.062	-0.620	1									
Cl^-	-0.559	-.406	0.374	0.127	-0.011	1								
Total Alkalinity	0.185	0.537	-0.705	-0.354	0.229	-0.162	1							
pH	-0.188	0.083	0.349	-0.326	0.190	0.801*	0.136	1						
Total Hardness	0.178	0.042	-.144	-0.422	0.506	-0.727	0.133	-0.570	1					
Ca-Hardness	-0.037	-0.179	-0.006	-0.269	0.508	-.604	-0.066	-0.592	0.961*	1				
Mg-Hardness	0.512	0.410	-0.353	-0.605	0.411	-0.803*	0.446	-0.428	0.883*	0.719	1			
Fe	-0.473	-0.244	0.116	-0.194	0.325	0.907*	0.092	0.810*	-0.507	-0.431	-0.544	1		
Mn	-0.002	-0.148	0.106	-0.114	-0.125	-0.174	0.410	0.007	0.355	0.273	0.430	-0.201	1	
Cr	-0.467	-0.639	-0.066	-0.043	0.076	0.714	-0.179	0.326	-0.401	-0.238	-0.664	0.761	-0.353	1

*. Correlation is significant at the 0.05 level; **. Correlation is significant at the 0.01 level.

Table 5: Correlation matrix for the groundwater quality data in dry season (concentrations were expressed in mg/l)

	TDS	F-	NO_3^-	PO_4^{3-}	SO_4^{2-}	Cl^-	Total Alkalinity	pH	Total Hardness	Ca Hardness	Mg Hardness	Fe	Mn	Cr^{+6}
TDS	1													
F^-	-.429	1												
NO_3^-	.472	.252	1											
PO_4^{3-}	.276	.064	-.159	1										
SO_4^{2-}	.873**	-.289	.424	-.010	1									
Cl^-	.018	.484	.770*	.027	-.041	1								
Total Alkalinity	.814*	-.387	.621	.090	.550	.234	1							
pH	-.318	.185	.157	-.265	-.532	.167	.253	1						
Total Hardness	.791*	-.831*	.017	.108	.675*	-.449	.565	-.386	1					
Ca Hardness	.713*	-.843**	.001	-.017	.678*	-.435	.444	-.495	.975**	1				
Mg Hardness	.831*	-.767*	.035	.245	.630	-.438	.670*	-.237	.967**	.887**	1			
Iron	-.523	.943**	.164	.017	-.342	.410	-.576	.015	-.788*	-.747*	-.786*	1		
Mn	.004	.725*	.352	.094	.068	.407	.145	.347	-.539	-.638	-.392	.462	1	
Cr	-.076	-.254	-.043	-.623	-.269	-.799	.367	.953**	.124	-.027	.290	-.347	.040	1

*. Correlation is significant at the 0.05 level.

**. Correlation is significant at the 0.01 level

Correlation matrix was prepared within the studied parameters in summer and dry seasons in table 4 and 5 respectively. The high correlation coefficient value of magnesium hardness with total hardness, calcium hardness with total hardness pointed to the fact that magnesium hardness was more dominant in the study area than calcium hardness which might be as a result of volcanic activity. The higher positive correlation coefficient of iron with chloride, chloride with pH and negative correlation coefficient with total hardness, calcium hardness and magnesium hardness presents minimum chloride content in groundwater is attributed to longer retention time of groundwater and lack of chloride rich rocks.

The insignificant positive correlation coefficient value between nitrate and iron, nitrate and manganese, nitrate and magnesium, nitrate and chloride established there were low anthropogenic impacts on the degradation in groundwater quality as a result of infiltration. This can be further evidenced by relatively high negative correlation coefficient value between chloride and sulphate. The significant positive correlation coefficient value between fluoride and total alkalinity, total hardness, calcium hardness, magnesium hardness, iron and manganese coupled with high level of fluoride in a few locations suggests contamination of the groundwater at a few locations by geological formations rich in mineral and volcanic activities.

In two sampling locations during dry season, chromium was absent in the groundwater. However, in places where traces of chromium were found, it showed good correlation with pH and negatively correlated with total dissolved solids, chloride and phosphorus. This indicates that the high solubility of chromium at lower pH.It is possible that the trace heavy metals in groundwater were introduced as a natural contamination from the catchment area where the water samples were taken. The correlation matrix could be an effective tool to understand the relationship among different major physiochemical parameters and trace elements. The correlation coefficient value among parameters of both wet and dry seasons has shown analogous trends of seasonal variation, it may be due to the weathering and heavy rain in the study area.

Conclusion and Recommendations

The ground water which were taken from the different places of HawellaTulla were studied and the analysis reports presents that, virtually all the parameters lies within the maximum permissible limit prescribed by WHO except, alkalinity which above the permissible level, but this value does not have any impression for the water to use for drinking and industrial purpose. The physico-chemical characteristic further reveals that, there were significant variations in most of the physicochemical parameters for both seasons for all seven sites. The ground water quality during the dry season was better with respect to the wet season. According the current water quality status of ground water it is suitable for any domestic purpose and is does not contain any toxic chemical species which is harmful to human health.

On the other hand, there is need of an increasing awareness among the people to maintain the groundwater at their highest qualityand purity levels and the present study may prove to be useful in achieving the same.At the same time regulation should be introduced to prevent contamination-particularly irreversible contamination -around Ethiopia's fast growing cities, because if not in the long run water security of an increasing urban population is jeopardized.

Acknowledgements

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