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Assessment of Water Quality in The University of The Gambia Environs for Environmental and Human Health

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The study deals with a limited look at thirteen water quality parameters. They were measured in groundwater of Faraba Banta and some other areas of The Gambia. The water quality parameters measured were: pH, conductivity, temperature, acidity, alkalinity, iron, nitrate, nitrite, sulphate, nitrogen in the form of ammonia, true colour, suspended solids, turbidity and in few select cases: iron, chromium, and copper. On average, nearly all parameters conformed to World Health Organization, National Environment Agency (of The Gambia) (NEA), and the European Union standards. Final evaluation showed that with few exceptions, the groundwater is safe *vis-a-vis* environment and human health. Copper and chromium were detected in an unexpected location.

Key words: Faraba Banta Campus; The Gambia; Brikama; water quality parameters; groundwater

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Water has numerous uses, and its quality is essential when it comes to human health and the environment. The University of The Gambia is the only public university in The Gambia; established in 1999 by an Act of Parliament [1], it did not and still does not have a campus of its own. About two years ago, construction of a permanent campus commenced with the help of four donor agencies. The campus is being constructed at Faraba Banta. Many members of staff and students live around Faraba Banta and its environs, and the population in these areas is expected to increase once the campus becomes fully operational. This study aims to assess the quality of water in Faraba Banta and areas close to it. Directly, what is the quality of water in the University and its environs? The water quality parameters of interest pertain to human health and the environment. This study was limited in its approach due to the following reasons: firstly, The Gambia is not an industrialised country, and this implies that parameters that are of concern in industrial countries would not be of concern. Secondly, the laboratory in which this study took place is under-resourced; not all parameters could be measured due to the non-availability of certain chemicals and equipment; this work is an undergraduate research project.

The water quality parameters that were measured were: pH, conductivity, temperature, acidity, alkalinity, iron, nitrate, nitrite, sulphate, nitrogen in the form of ammonia (henceforth referred to as ammonia), true colour, suspended solids, turbidity and in few select cases: iron, chromium, and copper.

There are two primary sources of water within The Gambia: surface water and groundwater. Surface water includes lakes, rivers, oceans or streams; in The Gambia it comes from the Gambia River and its surrounding tributaries. Due to the salinisation and contamination of surface waters, groundwater and bottled water have become the primary sources of drinking water in The Gambia. Groundwater is water which is extracted from underneath the earth's surface or borehole [2]. This study focussed on groundwater, (specifically well water) because this is the type of water that is mostly in use in the areas sampled. Further to this, and in keeping with the school of thought that water quality depends on its intended, the researchers in this study compared some parameters with the use of water at some sampling sites.

Measured parameters were compared with World Health Organization (WHO), National Environment Agency (of The Gambia) (NEA), and the European Union (EU) standards.

Materials and Methods

All procedures used in this study were according to the standard protocols outlined by Hach in its water analysis protocols for each measured parameter. Further to this, all field equipment used were provided by Hach.

Samples and Sample Selection

Each sample area was sampled between two and three times. The sampled sites were households that used well water. Adjacent homes were not sampled to avoid apparent duplication of results. All water samples were collected in plastic water bottles that had not been used for sample collection. Each water bottle was rinsed with the water sample of interest before water collection. Water quality parameters that are time-bound were measured on-site, while those that were not time bound were measured in the laboratory. Each parameter was measured thrice and an average reading recorded.

Calibration and Standardization

All instrument calibration and standardization were carried out according to Hach protocols.

RESULTS AND DISCUSSION

The following locations were sampled (Table 1).

Sampling was carried out during a time when there was no rain; rainy season in The Gambia generally runs from June till mid-October; this study took place in November.

Thirteen water quality parameters were measured. In discussion the obtained values, reference is made to WHO, NEA and EU parameters [2,3,4]. Czech Republic uses EU parameters by being a member of the EU.

Table 1. Sampling Locations with corresponding GPS co-ordinates**.**

Site code	Name	Latitude	Longitude
1	Faraba Banta	13.252713	-16.522537
2	Faraba Banta	13.256196	-16.519459
3	Faraba Banta	13.248148	-16.520135
4	Nyambai	13.211446	-16.659713
5	Nyambai	13.280690	-16.663667
6	Nyambai	13.277351	-16.661447
8	Dasilam	13.175251	-16.656370
9	Dasilam	13.174868	-16.652522
11	Darusalam	13.445994	-16.665576
12	Darusalam	13.441497	-16.669884
13	Darusalam	13.442961	-16.662904
14	Kartong	13.090900	-16.759807
15	Kartong	13.089812	-16.757742
16	Gunjur	13.167580	-16.759721
17	Gunjur	13.178303	-16.777700
19	Kerewan	13.676762	-15.156810
21	Kerewan	13.496869	-15.091157

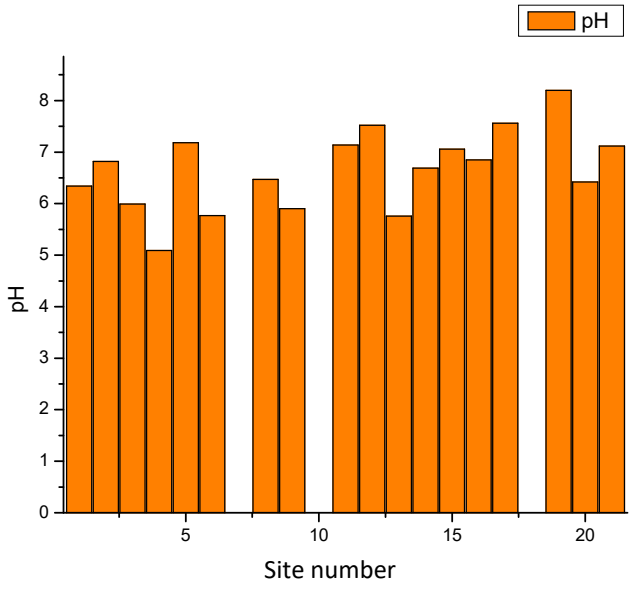

Figure 1. pH values obtained at sampling locations.

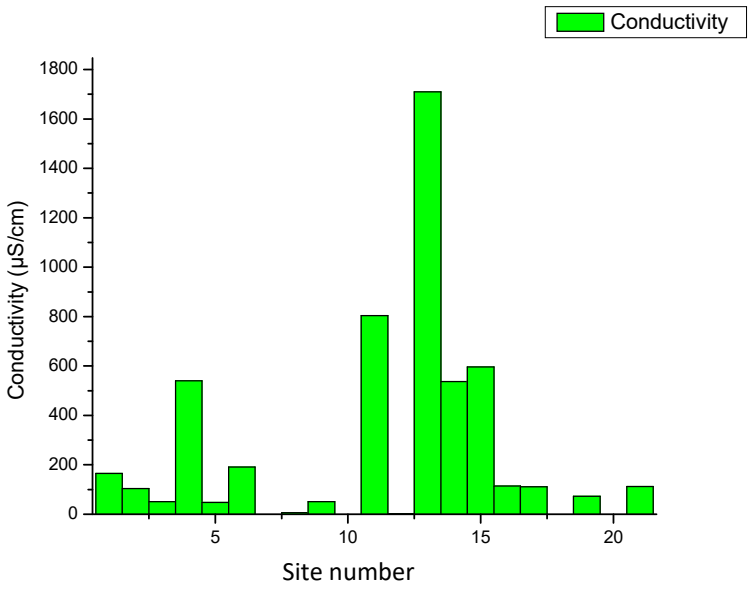

Figure 2. Conductivity values obtained at sampling locations**.**

pH

All pH measurements took place on-site. The pH measurements ranged from 5.09 to 8.20; Nyambai had the lowest reading while Kerewan had the highest reading (Figue 1). Kerewan is very far from Faraba Banta. According to the WHO, 2011, pH for water should be between 6.5 and 8.5. This implies that seven of the readings shown above are out of range. The anomaly could be attributed to geology and human activities. NEA pH values range from 5.5 to 8.5 and this means less number of readings are out of range [3]. According to EU standards, pH should be between 6.5 and 9.5 [4].

Conductivity

Conductivity measurements (Figure 2) were made on-site. WHO gives values of 50 to 500 µS/cm in freshwater environments while NEA gives a value of 1300 µS/cm. 2500 µS/cm is the EU standard.

Temperature

Although there are no set guidelines about water temperature set by the World Health Organization, it is important to monitor water temperatures as biological and chemical processes depend on temperature for reactions to occur [2]. The temperature was measured on-site since storage would change it. The following readings were taken, as shown in Figure 3:

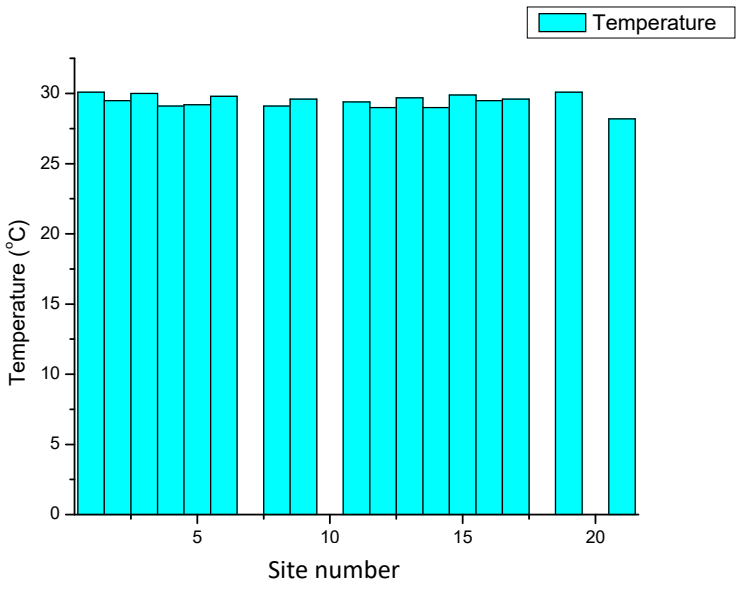

Figure 3. Measured temperature values obtained at sampling locations.

As can be seen from the chart, the temperature difference was very low; 28.2°C to 30.6°C was the temperature range observed. WHO recommends that human influence should not alter the temperature more plus-or-minus 1°C. EU has nothing on temperature.

Acidity and Alkalinity

Figure 4, shows acidity and alkalinity values obtained at sampling locations.

Acidity, as applied to water, is the capacity of the water to neutralize hydroxide ions and alkalinity is the capacity to neutralize hydrogen ions. Although virtually all water has some alkalinity and acidic water is not frequently encountered, except in cases of severe pollution [5].

True Colour and Suspended Solids

True colour was measured using units in PtCo, (platinum-cobalt). (This is also called Alpha-Hazen scale). This is a colour scale developed as a way of evaluating pollution levels in wastewater. It is specific to the colour yellow.

A value of zero indicates no colour and the highest on the Pt-Co scale is 500; meaning that the higher values indicate nearness to colour yellow. It is interesting to note that the sample with the highest value also had the highest amount of suspended solids (Figure 5).

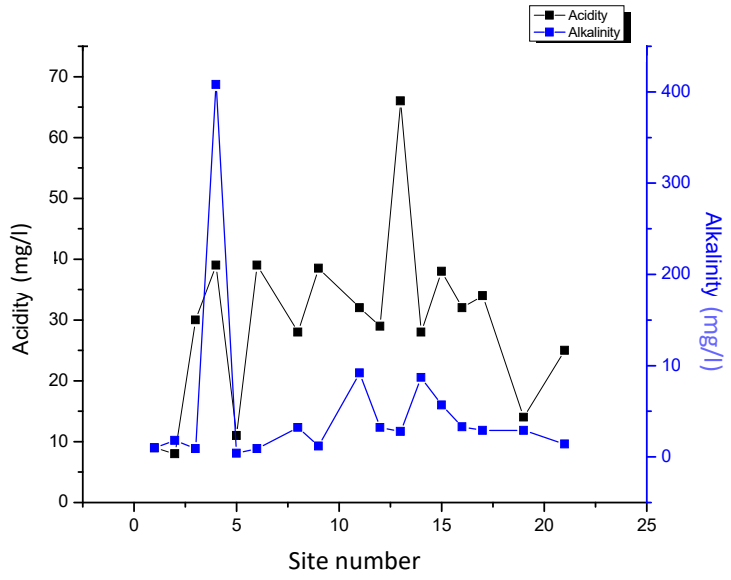

Figure 4. Acidity and Alkalinity values obtained at sampling locations.

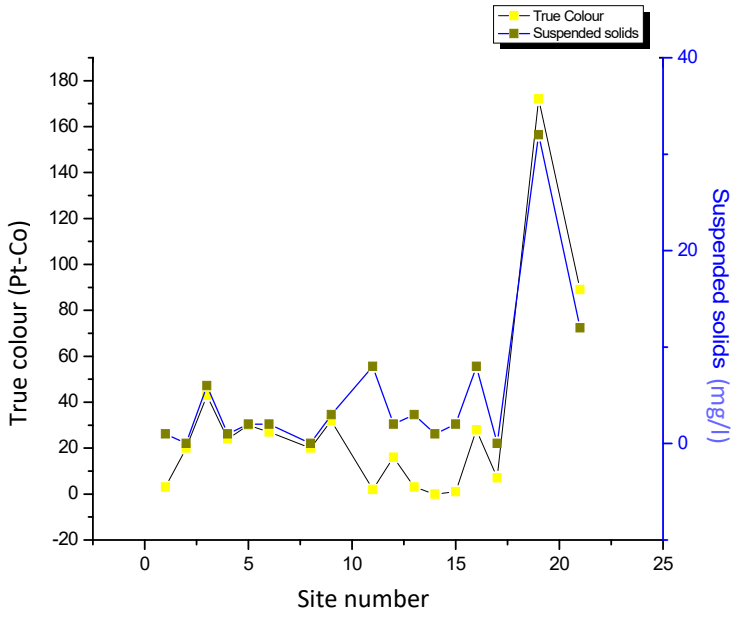

Figure 5. True Colour and Suspended solids values obtained at sampling locations.

Iron, Nitrite, Nitrate, Sulphate and Ammonia

EU has a value of 200 µg/l as a standard for iron; 0.5 mg/l for nitrite, 50 mg/l for nitrate; 250 mg/l for sulphate. NEA has the following values: 0.3 mg/l for iron; 0.03 mg/l for nitrite; 10 mg/l for nitrate; 25 mg/l for sulphate. Presence of ammonia in water indicates pollution; 0.5 mg/l is the value for ammonia, according to EU standard; as can be seen from Table 2, sites 4 and 11 are polluted. A high level of iron in water implies that the water has a somewhat bitter taste and it would have colour. Significantly high levels of nitrite mean formation of nitrosamines, and this makes the water carcinogenic. The Blue Baby disease results from high nitrate levels. As for sulphate, the taste of the water is affected by significant levels; and there is also the added laxative effect and gastro intestinal irritation [7].

Turbidity

Figure 6 depicts turbidity values obtained at sampling locations.

Sample number 4 was interesting for the following reasons: it had the lowest pH, highest amount of ammonia and nitrate; it was interesting because the inhabitants of the compound where the sample was taken said that they did not drink the water; according to them, they drank tap water. NEA has a value of 10 mg/l for nitrate.

Table 2. Iron, Nitrite, nitrate, sulphate and ammonia values obtained at sampling locations.

Site Number	Iron (mg/l)	Nitrite (mg/l)	Nitrate (mg/l)	Sulphate (mg/l)	Ammonia (mg/l)
1	0.06	0.013	4.3	0.00	0.11
2	0.08	0.002	2.0	0.00	0.07
3	0.50	0.000	0.6	0.00	0.02
4	0.04	0.30	12.6	0.00	0.50
5	0.00	0.00	1.4	0.00	0.08
6	0.01	0.007	2.9	0.00	0.07
8	0.04	0.177	3.0	0.00	0.08
9	0.25	0.006	0.9	0.00	0.06
11	0.72	0.045	1.8	24.0	0.45
12	0.03	0.043	2.8	70.0	0.06
13	0.08	0.041	12.8	14.0	0.50
14	0.00	0.006	5.1	21.0	0.21
15	0.02	0.006	1.6	0.40	0.05
16	0.06	0.011	0.9	0.00	0.06
17	0.17	0.007	0.7	0.00	0.28
19	0.98	0.004	1.3	0.02	0.08
21	0.14	0.007	0.9	0.00	0.07

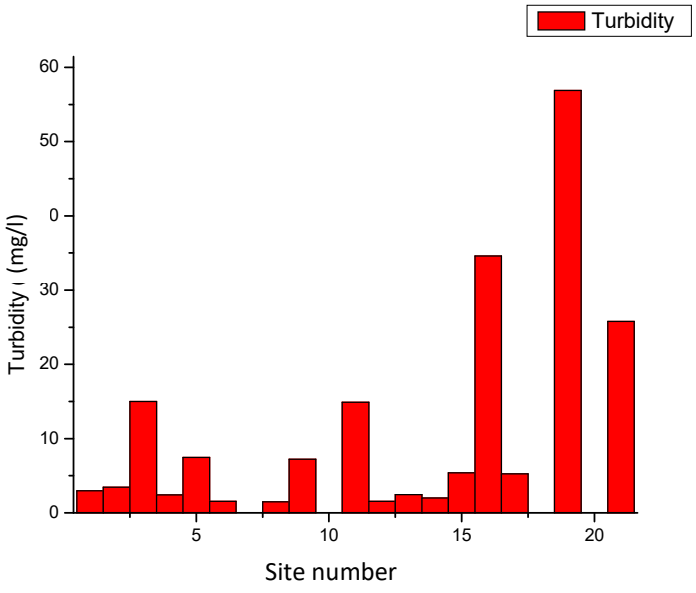

Figure 6. Turbidity values obtained at sampling locations.

Samples 4 and 13 exceed this value. The high values for nitrate indicated that there was a source of waste close to the groundwater; it might be a toilet or pit latrine.

In sample 8, the inhabitants complained that there were some problems with some wells in the neighbourhood. Sample 13 was interesting; it had the highest value of conductivity and the inhabitants complained that they experience stomach aches and they attributed it to drinking the water. The researchers in this study believed that the River Gambia was responsible because it was very close by and flooded from time to time.

As shown in Table 3**,** Sample 19 had the highest level of iron; this was probably due to the soil. All water samples were analysed for chromium and copper. This was done out of interest and curiosity. Nothing was found. However, at a village, Chamen, 0.22 mg/l of chromium and 0.17 mg/l copper were found; these were not displayed because only one site was sampled. The presence of these heavy metals was attributed to the geology of the area [6]. The values confirmed one suspicion: that the heavy metals were present in the soil. The suspicion was fuelled by the fact that there were no industries in the area in question. The under-resourced nature of the laboratory in the University of The Gambia makes testing and analysis of some other heavy metals of special interest concerning environment and health, impossible to carry out; some of these were: lead and mercury.

CONCLUSIONS

Water quality changes as population increases because the use of water becomes more varied, land use expands as does other anthropogenic activities [2]. It is recommended that this study be repeated out about three to five years after the Faraba Banta Campus becomes fully operational. It could evaluate the impact of the increase in population on water quality.

On average, the quality of groundwater in Faraba Banta and the areas sampled in this study was satisfactory; it conformed to WHO, NEA and EU standards. The levels of nitrate, ammonia, chromium, and copper were not alarming and not in any way suggestive of any form of pollution. So, with special reference to the environment and human health water quality parameters, the groundwater of Faraba Banta and other places sampled were safe, except the samples that had abnormal pH value and ammonia values.

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Table 3. Comparative Assessment of Some Water Quality Standards of NEA, WHO and EU and Values obtained**.**

Water quality parameter	NEA	WHO	EU	Range of values obtained
Iron	0.3 mg/l	0.2 mg/l	200 µg/l	0.00 – 0.98
Nitrite	0.03	3 mg/l	0.5 mg/l	0.00 – 0.30 mg/l
Nitrate	10 mg/l	50 mg/l	50 mg/l	0.6 – 12.8 mg/l
Sulphate	25 mg/l	50 mg/l	250 mg/l	0.00 – 70.0 mg/l
Conductivity	1300 µS/cm	50 – 500 µS/cm	2500 µS/cm	2.24 – 1710 µS/cm
pH	5.5 – 8.5	6.5 – 8.5	6.5 – 9.5	5.09 – 8.20
Ammonia	0.5 mg/l	1.5 mg/l*****	0.5 mg/l	0.02 – 0.50 mg/l

***** This value is for the threshold odour concentration of ammonia at alkaline pH. Ammonia is not of direct relevance to health at this level [8].

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