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*Full Length Research Paper*

# Physicochemical Assessment of a Hand-dug Well and the Kamakubuna Stream in the Sella Limba Chiefdom, Kamakwie, Northern, Sierra Leone

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**This research accesses the physical and chemical parameters of Ministry of Agriculture, Forestry and Food Security (MAFFS) hand dug well and the Kamakubuna Stream in the Sella Limba Chiefdom, Kamakwie Town. The physical parameters such as total dissolved solid (TDS), turbidity, pH, temperature, conductivity; and the chemical parameters such as residual chlorine, ammonium, ammonia, bromine, copper, fluoride, iron, nitrite, potassium, phosphate, sulphate, nitrogen-nitrate and bicarbonate. The samples were collected from the MAFFS hand dug well and the Kamakubuna stream, and transported to the water quality laboratory within thirty minutes. A physicochemical analysis was done on the water samples. The results analysed shown that the parameters were within the WHO accepted guidelines, except for low pH values and high mean value in turbidity for the MAFFS hand dug well.**

**Key words:** Hand dug well, WHO, parameters, samples and stream.

## INTRODUCTION

Worldwide, three in ten people, or 2.1 billion, lack access to safe, readily available water at home, and six in ten, or 4.5 billion, lack safely managed sanitation, according to a new report by WHO and UNICEF (2017). According to the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, at least 1.2 billion people worldwide are estimated to drink water that is not protected against contamination from faeces. Even more drink water, which is delivered through a system without adequate protection against sanitary hazards. A similar report published by WHO/UNICEF 2017, estimated that, over half of the global population or 4.2 billion people lack safely managed sanitation services. According to WHO, safely managed drinking water and sanitation services means drinking water free of contamination, that is available at home when needed, and toilets whereby excreta are treated and disposed of safely. In many developing countries, the availability of quality water has become a crucial and urgent problem and a matter of concern to families and communities (Maduka et al., 2014).

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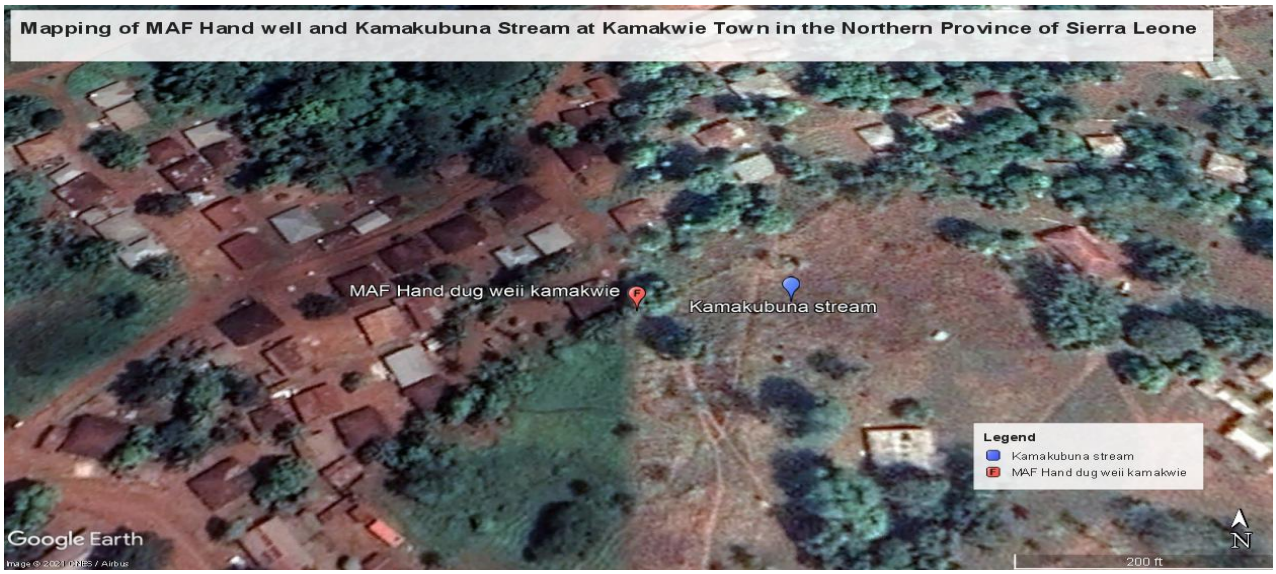


**Figure 1.** Mapping of MAFFS hand dug well and the Kamakubuna Stream, in the Sella Limba Chiefdom, Kamakwie Town.

In 1961, the Sierra Leone Guma Valley Company was established to provide safe drinking water to inhabitants in greater Freetown. In 1981, a rural water supply unit was established within the division. This division was later transformed into the Sierra Leone Water Company (SALWACO) in 2001. The main objective was to provide safe and affordable water to principal towns, such as Bo, Kenema, Koidu, Kabba, and Makeni and all urban areas except Freetown.

In Sierra Leone only 2% of the population has access to clean, readily available drinking water, and most households lack basic sanitation (https://ww.cdc.gov). Access to safe and clean drinking water remains a challenge for the past and present government. At Sella Limba, the primary sources of drinking water are; hand dug wells, rivers, streams and swamp water which are most times unprotected. A reliable supply of clean wholesome water is highly essential in a bid to promote healthy living among the inhabitants of a defined geological region in addition to being key to sustainable development, health, food production and poverty reduction (Balogun et al., 2014). Unhygienic water is a global public health concern, putting people at risk for a host of diarrheal diseases and chemical intoxication (Emenike et al., 2017).

The poor and marginalized people living in rural and peri-urban settlements are most in need of improved and safe drinking water, appropriate forms of sanitation and access to water for other domestic purposes (Crow, 2001).

According to WHO/UNICEF 2017 report, every year, 361 000 children under 5 years of age die due to diarrhoea. Poor sanitation and contaminated water are also linked to transmission of diseases such as cholera, dysentery, hepatitis A, and typhoid.

A recent report published by Statistics Sierra Leone (WHO/UNICEF 2017), with the technical support of UNICEF, conducted a Multiple Indicator Cluster Survey (MICS) to collect internationally comparable data on a wide range of indicators. The survey revealed that almost 90% of the drinking water at household level contained *Escherichia.coli* bacteria, presenting a serious health threat to citizens.

The objective of this study is to determine, the physicochemical properties of MAFFS hand dug well and the Kamakubuna Stream in the Sella Limba chiefdom, Kamakwie, and hence find suitable solutions to help improved the quality of these waters.

## MATERIALS AND METHODS

### Description of study area

Sella Limba is a chiefdom within the Bombali District in the Northern Province of Sierra Leone. It has its principal town located in Kamakwie Town. It is located on Latitude 9.5013º or 9º 30' 4.6" north and Longitude -12.2227º or 12º 13' 21.8" west; it is situated at an elevation of 117 m (384 feet). Salla Limba has a population of 58,401 (SSL, 2015).

The MAFFS hand dug well and the Kamakubuna Stream used to collect samples for this study is located at the Sella Limba chiefdom in Kamakwie Town, Karena district of Sierra Leone. The MAFFS hand dug well, and the Kamakubuna stream is utilised by the locals, inhabiting that environment. Sella Limba is a densely populated area. The main activity of the locals in that environment is agricultural activities (Figure 1).

### Sampling

Eleven (11) cleaned and sterilized plastic bottles were used to carried out this research. These sterilised plastic bottles were

carefully labelled to easy identification. The volume for each plastic bottle is 500 ml. The plastic bottle was rinsed three times with the water sample, before the sample was collected. The samples were collected for three months (October, November and December). The sample was placed in an icebox and transported to the water directorate of the Ministry of Water Resources for quality analysis.

**Procedure for sample analysis**

***Physical analysis***

**Temperature examination:** A clean plastic bottle was rinsed three times with the water sample, and filled to 500ml mark, a digital thermometer with electrode was placed in the beaker, and the electrode button turned on. The temperature was read and recorded in duplicate and the mean temperature taken in ºC. This method was used to examine the remaining samples.

**pH determination:** A digital pH meter with electrode was gently inserted into the plastic bottle containing 500ml of the water sample, and the electrode switched on. The concentration of the pH was recorded in duplicates and the averaged mean value taken.

**Total dissolved solid (TDS) and Electrical conductivity (EC):** A digital conductivity meter with electrode was used to examine the level of total dissolved solid (mg/L) and electrical conductivity (µS/cm). The electrode was inserted into the beaker containing the water sample, and the electrode turned on. The values were read and recorded.

**Turbidity:** A Photometer 7100 was used to assess the turbidity level of the water sample. The Photometer was calibration using a blank solution. A test tube filled with 10ml water sample was placed in the cuvette and then covered with light black shield cap. The button was turned on and the readings recorded in nephelometric turbidity unit (NTU).

**Analysis of chemical parameters:** WAGTECH PHOTOMETER 7100 was used to examine the Chemical quantity of the water sample. Each sample was analysed according to instructional manual for excellent quality result. A blank sample was first prepared as a reference (0.00mg/L) for each of the sample to be analysed. The test tube was filled with 10ml water sample, and one tablet (chemical) dropped into the test tube, it was then crushed and stirred to dissolve in the 10ml of the water sample, and allowed to stand for 10 minutes. The test tube was placed in the cell container and lid closed. The appropriate wavelength was turned on; the concentration level of each chemical was recorded in mg/L.

## RESULTS AND DISCUSSION

### Physical parameters

***Temperature***

From Table 1, the mean temperature recorded for all the water samples are within the World Health Organisation (WHO) acceptable standards for safe drinking water. WHO has no value for temperature of drinking water, however, WHO recommends that safe drinking water must have a temperature of 25.00ºC at the pH of 7.00. Temperature played a fundamental role in water quality analysis, since it influences both the physicochemical and bacteriological processes, such as absorption of chemicals and microbial growth.

***pH***

From Table 1, the mean pH values for all the water samples analysed fell below the WHO standard for drinking water. WHO permissible pH ranges for safe drinking water is 6, 5-8, 5. The low pH value of the water could be associated with the presence of $CO_2$. An increased carbon dioxide concentration will therefore lower pH, whereas a decrease will cause it to rise. Temperature will also affect the equilibria and the pH, in pure water, a decrease in pH of about 0.45 occurs as the temperature is raised by 25ºC, (WHO, 2003). The pH of water is mostly being influenced by environmental conditions. Careful assessment of pH control system is fundamental at all levels of water treatment plants, to ensured disinfection and clarification, and also to minimize low pH of water entering water producing machines in other to help control or minimize corrosion of pipes (WHO, 2003).

***Turbidity***

From Table 1, the mean turbidity concentration recorded for the hand dug well fell outside the WHO accepted range that is $< 5.00$ (NTU).The high value in turbidity for the MAFFS hand dug well could be as a result of low water table (aquifer), with little volume of water in the well, which might have been widely opened and exposed to contamination. However, the Turbidity value for Kamakubuna Stream is within the WHO permissible range$(< 5\ \mathrm{NTU})$. Materials that sometimes encourage turbid in water include dead organic matter and clay particles.

**Electrical conductivity (EC) and Total dissolved solid (TDS)**

From Table 1, the electrical conductivity and the total dissolved solid for all the samples analysed fell within the WHO acceptable range for safe drinking water. WHO recommended standard for E.C and TDS is $< 450\mathrm{mg/L}$ and $< 248\mathrm{mg/L}$ respectively. Conductivity values are influenced by temperature (the cooler the water, the lower the conductivity, and the warmer the water, the higher the conductivity value)

### Chemical parameters

The results of this research showed that, the chemical concentration of all the water samples analysed fell within the WHO acceptable range for safe drinking water. The

**Table 1.** Shows the physicochemical mean values obtained from the MAFFS hand dug well and the Kamakubuna Stream.

| Parameter | Hand dug well | | | Mean | Variance | SD | Kamakugbuna stream | | | Mean | Variance | SD | WHO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct. | Nov | Dec. | | | | Oct. | Nov. | Dec. | | | | |
| Temperature ($^0$C) | 25.00 | 26.00 | 25.00 | 25.33 | 0.33 | 0.58 | 25.00 | 27.00 | 23.00 | 25.00 | 4.00 | 2.00 | No Value |
| pH | 5.85 | 5.85 | 5.85 | 5.85 | 0.00 | 0.00 | 5.98 | 5.45 | 6.10 | 5.84 | 0.12 | 0.35 | 6.50-8.50 |
| Turbidity (NTU) | 1.18 | 1.18 | 50.00 | 17.45 | 807.63 | 28.42 | 3.80 | 4.80 | 3.80 | 4.13 | 0.33 | 0.57 | $< 5$NTU |
| Conductivity (µS/Cm) | 241.00 | 241.00 | 242.00 | 241.33 | 0.33 | 0.58 | 28.10 | 70.10 | 28.10 | 42.10 | 588.00 | 24.24 | $< 450\mu S/cm$ |
| TDS (ppm) | 121.00 | 121.00 | 123.00 | 121.67 | 1.33 | 1.15 | 14.00 | 100.00 | 14.00 | 42.67 | 2465.32 | 49.65 | $< 248.00$ppm |
| R. Chlorine (mg/L) | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.09 | 0.00 | 0.09 | 0.09 | 0.00 | 0.00 | 0.30-0.50 |
| Ammonia (mg/L) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | No value |
| Bromine (mg/L) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | No value |
| Total hardness (mg/L) | 121.00 | 121.00 | 121.00 | 121.00 | 0.00 | 0.00 | 60.00 | 100.00 | 60.0 | 73.33 | 533.33 | 23.09 | $< 500.00$ mg/$L$ |
| Copper (mg/L) | 0.19 | 0.19 | 0.19 | 0.19 | 0.00 | 0.00 | 0.08 | 0.08 | 0.08 | 0.08 | 0.00 | 0.00 | $< 1.00$ mg/$L$ |
| Fluoride (mg/L) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | $< 1.50$ mg/L |
| Magnesium (mg/L) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.00 | 4.00 | 4.00 | 4.00 | 0.00 | 0.00 | $< 200.00$mg/L |
| Nitrite (mg/L) | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.00 | 0.00 | <3.00 mg/L |
| Nitrate- nitrogen (mg/L | 2.40 | 2.40 | 2.40 | 2.40 | 0.00 | 0.00 | 0.08 | 0.08 | 0.08 | 0.08 | 0.00 | 0.00 | $< 10.00$ mg/L |
| Potassium (mg/L) | 1.80 | 1.80 | 1.80 | 1.80 | 0.00 | 0.00 | 3.50 | 3.50 | 3.50 | 3.50 | 0.00 | 0.00 | $< 6.00$ mg/L |
| Phosphate (mg/L) | 0.15 | 0.15 | 0.15 | 0.15 | 0.00 | 0.00 | 0.15 | 0.15 | 0.15 | 0.15 | 0.00 | 0.00 | $< 20.00$ mg/L |
| Sulphate (mg/L) | 10.00 | 10.00 | 10.00 | 10.00 | 0.00 | 0.00 | 9.00 | 9.00 | 9.00 | 9.00 | 0.00 | 0.00 | $< 400.00$ mg/L |
| Arsenic (mg/L) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | <0.01 mg/L |
| Sulphide (mg/L) | 0.17 | 0.17 | 0.17 | 0.17 | 0.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.00 | 0.00 | $< 0.50$ mg/L |
| Chlorine (mg/L) | 0.05 | 0.05 | 0.05 | 0.05 | 0.00 | 0.00 | 0.20 | 0.20 | 0.20 | 0.20 | 0.00 | 0.00 | $< 250$ mg/L |
| Bicarbonate (mg/L) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | No value |
| Chromium (mg/L) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | $< 0.05$ mg/L |

following are the results obtained for the MAFFS hand dug well and the Kamakubuna stream respectively; Residual Chlorine (0.01 mg/L, 0.09 mg/L), Ammonia (0.00 mg/L, 0.00 mg/L), Bromine (0.00 mg/L, 0.00 mg/L), total hardness (121.00 mg/L, 73.3 mg/L), Copper (0.19 mg/L, 0.08 mg/L), Fluoride (0.00 mg/L, 0.00 mg/L), Magnesium (0.00 mg/L, 0.00mg/L,), Nitrite (0.01 mg/L, 0.02 mg/L ), Nitrate- Nitrogen (2.40 mg/L, 0.08 mg/L), Potassium (1.80 mg/L, 3.50 mg/L), Phosphate (0.15 mg/L, 0.15 mg/L), Sulphate (10.00 mg/L, 9.00 mg/L,), Arsenic (0.00 mg/L, 0.00 Mg/L), Sulphide (0.17 mg/L, 0.03 mg/L), Chlorine (0.05 mg/L, 0.20 mg/L), Bicarbonate (0.00 mg/L, 0.00 mg/L) and Chromium (0.00 mg/L, 0.00 mg/L).

## Conclusion

Water plays a vital role in the development of all living organisms on earth, as it is needed by all organisms for normal functioning of the body. However, consuming contaminated water can be detrimental to human health. A sample of water collected from the MAFFS hand dug well and the Kamakubuna stream was analysed and results compared to the World Health Organisation guidelines. The results for all the chemical parameter analysed fell within the WHO acceptable range. However, a low pH value was recorded in all the water samples analysed, with a high mean turbidity concentration for the MAFFS hand dug well. It can therefore be concluded that

water is safe for drinking. It is however, recommended that the surrounding of the well be kept clean, cover and locked after use and sample tested periodically to enhance quality assurance.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

### REFERENCES

Balogun SA, Akingbade AO, Oyekunle MA, Okerentugba PO (2014). Physiochemical and Microbiological profile of drinking water sold in Abeokuta, Ogun State, Nigeria. Nature and Science 12(3):103-105.

Crow B (2001). Water: gender and material inequalities in the global south. University of California, Santa Cruz.

Emenike PC, Tenebe TI, Omeje M, Osinubi DS (2017). Health risk assessment of heavy metal variability in sachet water sold in Ado-Odo Ota, South-Western Nigeria. Environmental Monitoring and Assessment 189(9):1-16.

Maduka HCC, Chukwu NC, Ugwu CE, Dike CC, Okpogba AN, Ogueche PN, Maduka AA (2014). Assessment of commercial bottled table and sachet water commonly consumed in Federal University of Technology, Owerri (FUTO), Imo State, Nigeria using Microbiological indices. Journal of Dental and Medical Sciences 13(1):86-89.

World Health Organization (WHO) (2003). Guidelines for drinking-water quality, 2nd ed. Vol. 2. Health criteria and other supporting information. World Health Organization, Geneva, 1996.

WHO/UNICEF Joint Monitoring Programme (2017). Report Sierra Leone Multiple Indicator Cluster Survey 2017.