

Assessment of Water Quality in Kuntaur, Central River Region, The Gambia

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ABSTRACT

The study deals with twelve water quality parameters on twenty-four sampling locations in Kuntaur. Samples were collected from the both surface water and groundwater. Twelve parameters were: temperature, pH, conductivity, acidity, alkalinity, total dissolved solids, turbidity, iron, nitrite, nitrate, sulphate and phosphorus (orthophosphate). Nearly all the measured parameters fell within the standard reference of the various parameters. The standards were: National Environment Agency, NEA, (The Gambia), World Health Organization, WHO and European Union, EU, Standards.

Keywords: Water quality, Kuntaur, The Gambia, surface water, groundwater, Central River Region.

INTRODUCTION

Kuntaur is located in Central River Region, in the district of Niani, on the North Bank of The Gambia River which is about three kilometres south of Wassu and 13 kilometres north of Janjanbureh. There are two primary sources of water in Kuntaur: surface water and groundwater. Surface water in Kuntaur includes: The river, streams (including the tidal irrigation canals) and fish ponds. Groundwater is the primary source of drinking water in Kuntaur. Due to its location, rice cultivation is the primary agricultural activity all year round. With the help of the tidal irrigation system established by The Taiwanese Technical Mission, canals are inter-connected and the source is the river. The river water is allowed to flow into the system at flood tide, and the outlet valve is shut as the tide ebbs to keep the water on the fields. Closeness to the river implies that fishing is frequent, for it is a source of food and income. The health centre, agricultural camp, Rice Mill, Gambia Groundnut Company, Kairo Garden Hotel and a nursery school are the places closest to the river. The other side of the river comprises the vegetation.

Water is essential for life. Safe, abundant water is vital to one's ability to stay healthy. Across Africa, one third of the population have no access to clean water, and almost two thirds have no access to clean sanitation, causing widespread suffering from malaria, typhoid, dysentery and many other diseases. Surface water is rarely used as a source of potable water in The Gambia, because of the continuously saline conditions, which exists in the lower reaches of the River Gambia and its tributaries, where the population centres and tourism facilities are located [1]. As human population

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continues to grow and land use expands, the capacity to negatively impact surface waters and watersheds throughout the world, through contamination and human disturbances, likewise increases. This potential for adverse effects on water often results in reduced water quality [1].

Research Rationale

Water quality is a great concern in The Gambia particularly in the rural areas which may be affected by climate change and certain environmental factors. There are knowledge gaps in literature relating water quality, health and ecosystem in The Gambia. This study intends to provide information on water quality parameters in Kuntaur, Central River Region of The Gambia. The Water Resources, Fisheries and Environment Department of The Gambia does routine water analysis of several water quality parameters. However, the frequency with which it is done depends on funding by the Public Utilities Regulatory Authority, (PURA) of The Gambia. Funding by PURA is irregular. Furthermore, data obtained from the exercise is never published; it is only kept. Other objectives of this research include: to find out the values of the water quality parameters of Kuntaur and compare the values to that of WHO standards, which will be obtained from the internet. This study is an undergraduate thesis. Thesis questions include: Which samples may cause health complications in Kuntaur? What is the spatial variations in water quality in Kuntaur? What are the factors responsible for the spatial variations in water quality in Kuntaur?

Water quality parameters measured in this study were: pH, temperature, conductivity, turbidity, total dissolved solids, acidity, alkalinity, iron, nitrite, nitrate, sulphate and phosphorus.

EXPERIMENT

Chemicals and instrumentation

Chemicals used for research should contain description brand or manufacturer for example: ethyl acetate (Merck), dioctyloxalate (Sigma). To make it consistent, we prefer mention the chemicals in word rather than chemical formula. Meanwhile, sample of research such as plant, animal or microorganism should declare the origin of the sample or method to prepare it.

Instrumentation applied for analysis should be written all tools are used during research. They can contain instrumentation specification or operational conditions include brand manufacturer. For example: FTIR spectrophotometer (Shimadzu FTIR QP89500, sample was analyzed using NaCl plate or thin film).

Procedure reaction

Sample and Sample Selections

Water samples were collected from various sources: river, well, streams, rice fields, tidal irrigation systems, fish ponds and boreholes.

River

Kuntaur is found just beside the River Gambia, therefore it was deemed necessary to assess its quality. The water is used for various purposes, both consumptive uses (such as drinking, gardening) and non-consumptive uses (washing, bathing, fishing, religious and recreational uses). It is also the source of the tidal irrigation system in Kuntaur. Eight samples were collected from the river (sample 1, 2, 3, 4, 5, 6, 7 and 8).

Well

The fact that Kuntaur is very close to the river means that people consider it unnecessary to establish a well water system. Only two wells were discovered and assessed (samples 19 and 20). The water from these sources are only used for gardening.

Stream

The stream is another source of water in Kuntaur. The stream runs through the town. Two samples were collected; one from the opening/mouth from the river (sample 13) and the other from the middle of the town where the stream runs through (sample 14). Natives do not drink from the water, however, they use it for other domestic purposes like fishing, bathing and washing.

Rice Fields

There are two types of rice fields in Kuntaur: The ones with an irrigation system (samples 9 and 10) and the other without an irrigation system (samples 15 and 16).

Irrigation Systems

The Tidal Irrigation System was established by The Taiwanese Technical Mission. The source of canal is from the river and runs between rice fields. The primary use of the water is for irrigation however, farmers wash, bath and consume the water after working on their fields. Due to distance from school to Kuntaur, students sometimes drink from the water as well. Two samples were collected from the system (samples 15 and 16).

A small local irrigation system was discovered in the agricultural camp, an opening was created from the river and runs through the garden in the camp. The water is only used for gardening. A sample was collected, sample 21.

Fish Ponds

Two local fish ponds were initiated adjacent to each other by the community in 2016. A sample was collected from each pond (sample 17 and 18).

Borehole

There are two borehole systems in Kuntaur: One in the health centre that supplies water through taps to various houses (samples 23 and 24) and the other in the agricultural camp which provides water for only settlements inside the camp (sample 22).

All the procedures followed during the research were strictly according to the standard protocols outlined by Hach for each measured parameter. All the field equipment used were provided by Hach.

Calibration and Standardization

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

Sampling

Sampling was carried out in month of November to ensure there is no interference of rain during the analysis (duration of the rainy season in The Gambia is from June to early October).

Twenty-four samples were collected in plastic bottles (labelled number 1 to 24) from the various sources, (as earlier outlined) in Kuntaur and their GPS-co-ordinates recorded as shown in table 1. Parameters like temperature, conductivity and pH were measured in the field because storage might affect the reading.

RESULT AND DISCUSSION

Table 1. Sample number, source and GPS co-ordinates.

Sample Number	Source	Latitude	Longitude
1	River	13.6800	-14.8841
2	River	13.6702	-14.8911
3	River	13.6714	-14.8905
4	River	13.6725	-14.8907
5	River	13.6736	-14.8905
6	River	13.6746	-14.8901
7	River	13.6647	-14.8916
8	River	13.6654	-14.8925
9	Rice field	13.6646	-14.8922
10	Rice field	13.6645	-14.8890
11	Irrigation canal	13.6615	-14.8826
12	Irrigation canal	13.6599	-14.8788
13	Stream	13.6689	-14.8915
14	Stream	13.6683	-14.8889
15	Rice field	13.6684	-14.8865
16	Rice field	13.6682	-14.8858
17	Fish pond	13.6678	-14.8881
18	Fish pond	13.6677	-14.8880
19	Well	13.6671	-14.8898
20	Well	13.6668	-14.8910
21	Irrigation canal	13.6663	-14.8915
22	Borehole	13.6656	-14.8914
23	Borehole	13.6694	-14.8893
24	Borehole	13.667134	-14.8902

After measurements, the obtained values were compared with the reference standards of WHO and EU for each parameter.

Temperature (°C)

With regards to temperature of water no set of guidelines are set by the WHO however, it is important to monitor water temperatures as biological and chemical processes depends on temperature. [2] Furthermore, temperature in The Gambia, is for the most part, warm. The following readings were obtained:

Table 2. Water temperature in Kuntaur

Sample Number	Temperature (°C)
1	28.8
2	28.0
3	28.3
4	28.0
5	28.6
6	28.9
7	29.4
8	29.4
9	27.5
10	28.1
11	25.7
12	25.9
13	27.7
14	27.2
15	23.9
16	23.8
17	26.6
18	25.2
19	26.3
20	26.9
21	26.8
22	28.9
23	27.7
24	27.9

It can be seen from the Table 2, the highest temperatures were recorded from the river (sample 7 and 8) and the lowest temperature was from the rice field (sample 16). WHO recommendation is that temperature should not be altered by human influence even it is as small as plus or minus 1°C. The EU has neither a range nor any recommendation. However, the variation may be due to the time of collections and the environment where the sample was collected.

pH

Like temperature all pH measurements took place on-site. The following readings were obtained:-

Table 3. pH values of water obtained in Kuntaur.

Sample Number	pH
1	8.21
2	8.30
3	7.67
4	8.31
5	8.26
6	8.41
7	8.40
8	7.91
9	6.94
10	6.79
11	7.19
12	6.84
13	8.43
14	8.17
15	6.74
16	6.77
17	7.62
18	7.11
19	6.66
20	6.36
21	7.21
22	6.00
23	6.21
24	6.21

From the Table 3, the pH measurements ranged from 6.00 to 8.43. Sample 22 (borehole in the agricultural camp) had the lowest reading while sample 13 (stream) had the highest reading. There are less human activities at this part of stream and various plants were found around it. The borehole that recorded the lowest pH value was established in 2017. The WHO standards for pH of water should be between 6.5 and 8.5. [3]. The EU standards range from 6.5 to 9.5.[6]. From the standards of both WHO and EU only three samples (22, 23 and 24) are out of range. All these three samples were collected from the borehole and they are the primary source of drinking water in Kuntaur.

Conductivity

Conductivity measurements were also conducted on-site. The WHO guideline for conductivity ranges from 50 to 500 $\mu\text{S}/\text{cm}$ in freshwater bodies while the EU standards extend to 2500 $\mu\text{S}/\text{cm}$.

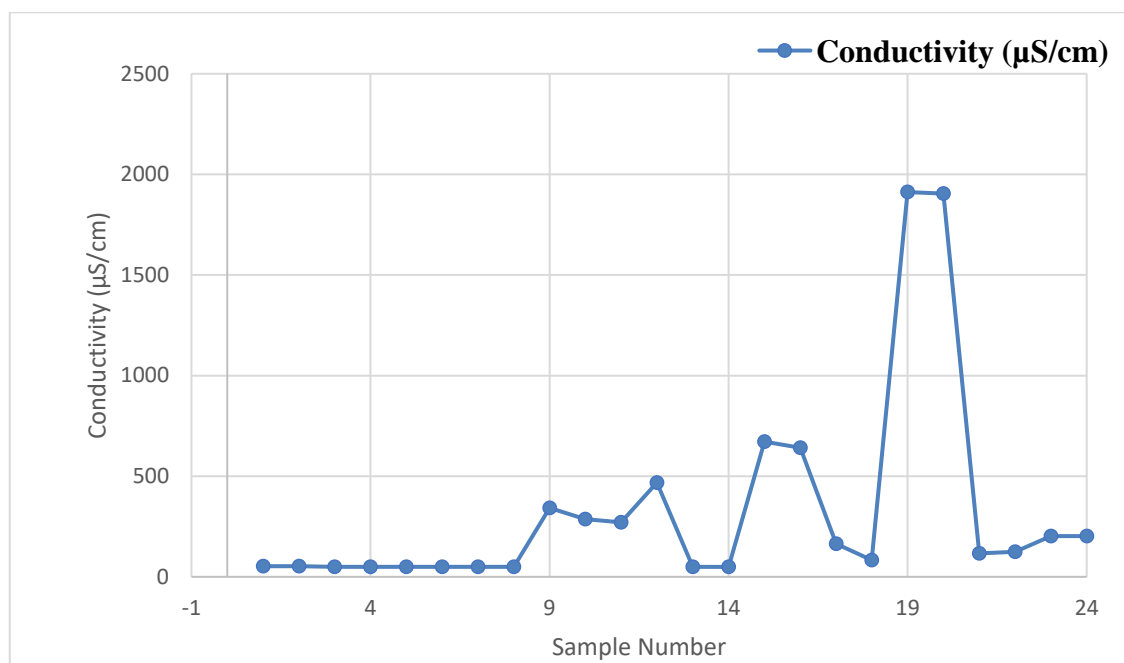


Figure 1: Conductivity values obtained at the various sampling locations.

From **figure 1**, the highest conductivity value was obtained from the well (sample 19) and the lowest at the stream (sample 14).

Turbidity

Turbidity was measured on-site and the following readings were obtained.

Table 4. Turbidity Readings

Sample Number	Turbidity (NTU)
1	48.8
2	59.7
3	49.7
4	40.5
5	52.5
6	53.6
7	41.5
8	25.6
9	9.42
10	9.91
11	6.78
12	15.1
13	42.6
14	42.2
15	25.6
16	6.34
17	4.80
18	4.82
19	2.14
20	3.40
21	35.3
22	1.07
23	1.17
24	1.15

The highest turbidity was recorded at the river (sample 2) and the lowest was recorded at the borehole (sample 22), these variation may be due to human activities.

Total Dissolved Solids

The following readings were obtained:

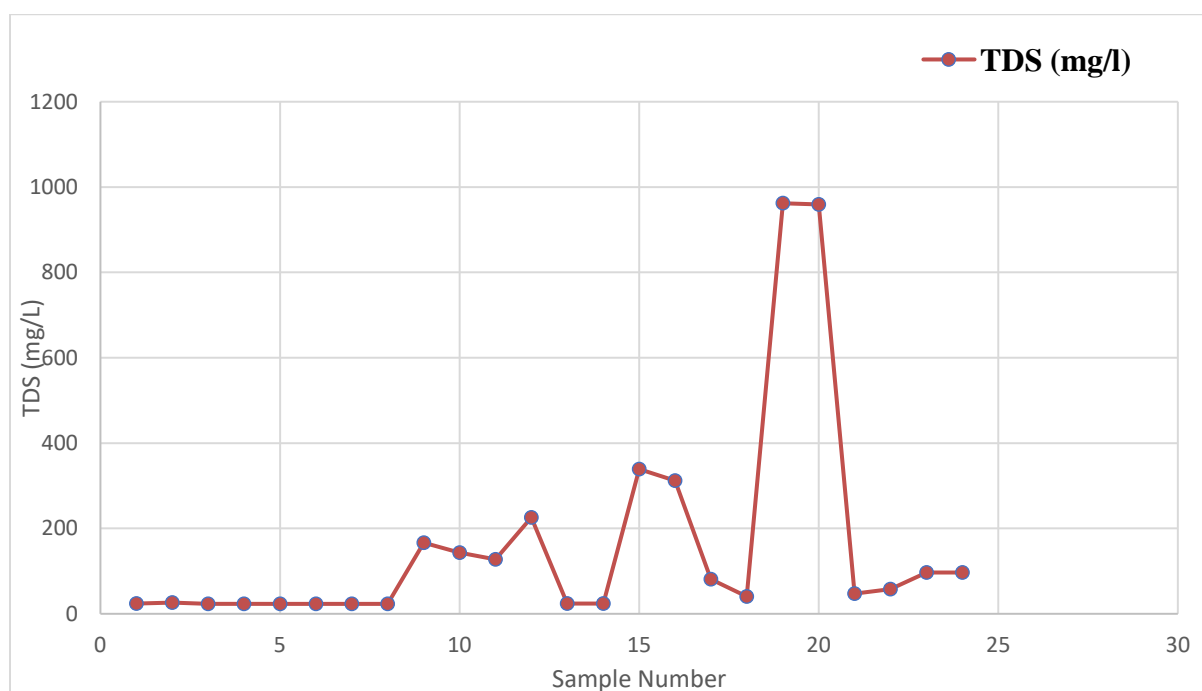


Figure 2. TDS values obtained at the various sampling locations.

Sample 19 and 20 recorded the highest level of TDS and low levels of TDS were obtained at sample 3 and 4. TDS however, does not pose any threat to human health.[2] From the above figure, one can see a similar pattern or relationship between TDS and conductivity[4].

Acidity and Alkalinity

Table 5. Acidity and Alkalinity measurements obtained.

Sample Number	Acidity (mg/L)	Alkalinity (mg/L)
1	5.00	26.00
2	20.00	18.00
3	7.00	24.00
4	7.00	26.00
5	6.00	22.00
6	7.00	22.00
7	6.00	25.00
8	6.00	24.00
9	13.00	68.00
10	19.00	34.00
11	11.00	58.00
12	10.00	84.00
13	7.00	30.00
14	9.00	32.00
15	23.00	86.00
16	20.00	80.00
17	6.00	28.00
18	7.00	28.00
19	20.00	272.40
20	22.00	272.20
21	11.00	30.00
22	15.00	12.00
23	8.00	4.00
24	8.00	4.00

From the above table (table 7) the highest acidity level was obtained for sample 15 (rice field) and the lowest level was obtained at sample for sample 1 (river). The sample with the highest level of alkalinity is sample 19 (well water) and the lowest level was obtained at sample 23 and 24. The water is mostly alkaline in Kuntaur.

Iron, Nitrite, Nitrite, Sulphate and Phosphorus (orthophosphorus)

The EU standard value for iron is 200µg/l, 0.5 mg/L for nitrite, 50mg/L for nitrate, 250 mg/L sulphate. There is no reference for phosphorus in the EU Directive. Water with a high level of iron results in a bitter taste, laundry becomes stained, vegetables become discoloured on cooking and it is quite harmful to aquatic life[2]. Nitrite can reach both surface and groundwater as a consequence of agricultural activity, from waste water treatment and from the oxidation of nitrogenous waste product in both human and animal excreta. Nitrite reacts with nitrostable compounds in human stomach to form N-nitroso compounds, which is found to be carcinogenic in all animal species. Inorganic nitrate in drinking water is associated with endemic goitre.

Certain studies reveal that the high level of nitrate in drinking water could lead to gastric cancer. Excess sulphate has laxative effect and will also attack the fabric of concrete sewer pipes. [2]

Table 6. Iron, Nitrite, Nitrate, Sulphate and Phosphorus readings.

Sample Number	Iron (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Sulphate (mg/L)	Phosphorus (mg/L)
1	1.64	0.02	0.2	2.00	3.9
2	1.18	0.034	0.5	3.00	2.2
3	1.07	0.005	0.3	0.00	3.8
4	0.98	0.006	0.3	1.00	1.6
5	1.28	0.02	0.2	1.00	1.3
6	1.03	0.009	0.3	0.00	1.5
7	0.86	0.009	0.3	2.00	3.8
8	0.81	0.006	0.4	2.00	3.8
9	1.08	0.005	0.6	1.00	4.6
10	2.03	0.002	0.2	2.00	4.8
11	0.81	0.007	0.3	2.00	1.5
12	1.33	0.03	0.3	4.00	1.8
13	1.07	0.003	0.3	1.00	2.1
14	1.03	0.008	0.3	1.00	2.2
15	3.94	0.002	0.1	2.00	4.1
16	2.41	0.008	0.2	2.00	4.2
17	1.18	0.145	0.9	2.00	2.5
18	2.20	0.130	0.9	1.00	2.3
19	0.13	0.008	0.9	42.00	7.3
20	0.13	0.007	0.7	46.00	7.4
21	1.20	0.007	0.5	1.00	1.9
22	0.86	0.005	0.8	0.00	1.6
23	0.05	0.034	0.4	1.00	2.8
24	0.05	0.034	0.3	1.00	2.8

Table 7. NEA, WHO and EU Standards for some water quality parameters.

Parameter	NEA	WHO	EU	Range of values obtained
Iron	0.3 mg/L	0.2 mg/L	200 µg/l	0.05-3.94 mg/L
Nitrite	0.03 mg/L	3 mg/L	0.5 mg/L	0.002-0.145 mg/L
Nitrate	10 mg/L	50 mg/L	50 mg/L	0.1-0.9 mg/L
Sulphate	25 mg/L	50 mg/L	250 mg/L	0.00-46.00 mg/L
Conductivity	1300 µS/cm	50-500 µS/cm	2500 µS/cm	49.3-1912 µS/cm

Samples 17 and 18 recorded the highest level of conductivity, turbidity and they are also found to contain the largest amount of both nitrite and nitrate which may be due to the feeds provided to fishes in these ponds. Animal waste can be used as feed in fish ponds.

According to the NEA the amount of nitrite and nitrate in water should not exceed 0.03 mg/L and 10 mg/L respectively. [5]

Samples 19 and 20, inhabitants considered it unfit to drink water from these sources and from the analysis, it is observed that both samples 19 and 20 have exceeded the NEA standard value for sulphate.

Samples 9, 10, 15 and 16 (samples from the rice fields) had the highest level of iron, this was probably due to the soil (clay particles).

CONCLUSION

River

All the samples collected from the river (1-8) exceeded the level of iron according to the standards of NEA, WHO and EU. There are few or no harmful effects on persons consuming waters with significant amount of iron. [6]

Both the nitrite and nitrate levels do not exceed the WHO standard as well as the sulphate level. In conclusion, all the samples that were collected from the various sampling locations are found to be fit for consumption with no significant health impact however, the level of iron could have an effect on the ecosystem once the metal is converted to an insoluble form, then the iron deposits will interfere with fish food and spawning. [6]

Well

The highest level of conductivity, TDS, sulphate and phosphate were detected in the samples collected from the wells (sample 19 and 20). A significant amount of nitrate was also detected. Therefore, the inhabitants were right not consume the water.

Stream

There are many similarities between the stream and the river (its source). The values obtained from samples 13 and 14 were very close to that of the river.

Rice fields

The samples from the rice fields (samples 9, 10, 15 and 16) were found to contain the highest level of iron and also exceeds the standards of NEA, WHO and EU. The level of iron will have a negative impact on rice cultivation. Reported yield losses in farmers' fields usually range between 15% and 30%, but can also reach the level of complete failure.[5]

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