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Quality of Well Water Used for Market Gardening from Lendeng Area Located in Common of Rufisque (Senegal)

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Abstract

This study analysis was conducted to know the quality of well water around the market gardening area of Lendeng located in the common of Rufisque Est (Senegal). In this study, six groundwater samples were taken near the Lendeng market gardening area. The physicochemical parameters of water such as pH, temperature, electrical conductivity (EC), calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^{+}), iron (Fe^{2+}), chloride (Cl^{-}), sulfate (SO_4^{3-}) and phosphate (PO_4^{3-}) were measured. The analysis results obtained show sulphate and phosphate have the highest levels. These results were compared to drinking water standards from the World Health Organization (WHO). The correlation coefficient ANOVA was applied to the test result of the samples. The statistical study showed that the well water in the market gardening area of Lendeng is not polluted.

Keywords

Physicochemical Parameters, Well Water, Lendeng Market Gardening, Rufisque

1. Introduction

The rapid growth of the world population and the development of industrial and agricultural activities cause significant environmental contamination. And all of them negatively affect the world's limited freshwater resources. It is known that one of the best techniques for protecting freshwater resources is the permanent monitoring of these systems [1] [2] [3].

Lendeng area contains some important surface water resources (ecosystems). It is located in the city of Rufisque in the Dakar region (Senegal). Freshwater resources in the Rufisque area are negatively affected by the agricultural application carried out around the system. The water may look clean but there are huge physicochemical elements that contaminate its natural eminence. The deterioration of the quality of water resources through the proliferation of different sources of pollution (fertilizers and pesticides, discharges of untreated wastewater, discharges of uncontrolled solid waste, mining, urbanization, etc.) constitutes a threat as important as that linked to the quantitative imbalance. Poor water quality negatively affects human health [4] [5]. It is essential to analyze, characterize and monitor the ecological state of these systems.

In this study, the surface water quality of Lendeng located in the common of Rufisque-Est was studied. The measured data was assessed in accordance with international surface water quality standards. This study on Lendeng well water is part of the improvement of water quality in Senegal.

2. Description of Study Area

Common Rufisque is part of the Dakar region (Senegal). Rufisque is located 25 km southeast of Dakar. Its area is 42 km^2. The population is estimated at around 300,000. SOCOCIM factory is located in Rufisque. Since 1996, Rufisque has been divided into three Boroughs: Borough of Rufisque West, Borough of Rufisque North, and Borough of Rufisque east. **Figure 1** shows the Lendeng sampling area in the Rufisque locality.

The Town of Rufisque is home to the Cap des Biches thermal power station, which produces most of the country's electricity. Economic activities currently revolve around: SOCOCIM cement factory, a small shoe factory, VALDA factory, the tertiary sector, especially artisanal fishing. The Lendeng area is located on the southern fringe of the Niayes area, in the district municipality of Rufisque east. The market gardening perimeter of Lendeng occupies a total area of 56.83 hectares, 70% of which is intended for market gardening and a plateau area (5.40 hectares) reserved for rainfed agriculture. This site has long been one of the major supply sites for vegetables in Dakar and Rufisque.

Agricultural activities carried out on the Lendeng site constitute a source of permanent and temporary employment. They contribute to the development of many economic activities (crafts, transport, trade) which constitute a network of interdependent actors.

3. Material and Methods

All chemicals used were of analytical-reagent grade from Merck (Darmstadt, Germany). Ultrapure water (Millipore Milli-Q System) was used throughout all of the work [6]. The calibration standards were prepared from the stock solution. All glass and plastic containers and materials were soaked in a 1.5% w/v HNO_3 solution for 48 h and rinsed with ultrapure water three times before use.

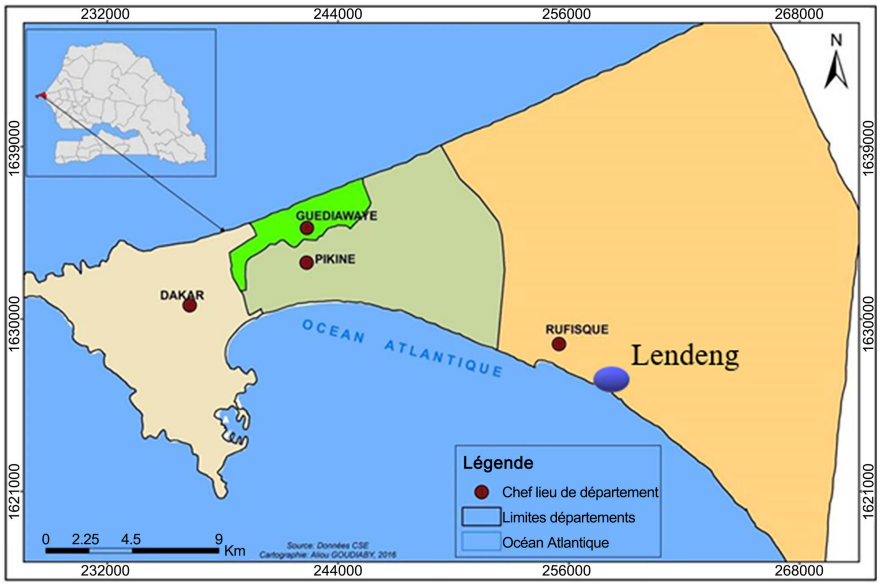

Figure 1. Location of Lendeng area in the Rufisque area (Senegal).

Sampled well water points were chosen in such a way as to cover the entire market gardening area of Lendeng. Groundwater samples were taken from six boreholes in the vicinity of the Lendeng market gardening area located in the commune of Rufisque east to understand the water quality strategy. Groundwater samples were collected using a sterilized 1-liter plastic container according to standard procedure. Physicochemical parameters (pH, temperature, electrical conductivity) were measured in situ using a multi-parameter probe.

Samples were collected and stored at low temperatures in 1liter polyethylene bottles and transported. In the Laboratory, they were kept in the refrigerator at 4˚C until the analyzes were carried out [7]. To determine sulfate, nitrate, phosphate, alkalinity and chloride, the samples, with a volume of 1 Liter, were filtered at the sampling point using a manual vacuum pump and a 0.45 µm Millipore membrane [8] [9]. Chemical parameters such as calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^{+}), chloride (Cl^{-}), sulfate (SO_4^{3-}) and phosphate (PO_4^{3-}) were measured in the samples of water, using a "HANNA instruments pH/conductivity HI98129" model pH meter.

4. Results and Discussion

The results of the analysis of physicochemical parameters obtained from the groundwater are presented in **Table 1**, which shows the average values obtained for a series of four measurements and their standard deviation (σ).

The pH of water indicates its acidity and alkalinity. The pH measurements showed an average value of 6.6, characterizing the waters as slightly acidic. The pH values measured at the points studied varied between 6.0 and 7.3. These values deviate slightly from the local model, indicating that the waters studied are slightly alkaline, with the presence of bicarbonates which control the pH of the water by its chemical reactions of neutralization of acids, suggesting a different

Table 1. Physical and Chemical parameters related to the well water samples from Lendeng.

Parameters	Water 1	Water 2	Water 3	Water 4	Water 5	Water 6
pH	6.4 ± 0.2	6.0 ± 0.5	7.1 ± 0.3	6.9 ± 0.4	7.3 ± 0.7	6.1 ± 0.5
T°	30.1 ± 1.1	29.4 ± 0.9	27.8 ± 1.6	25.7 ± 2.1	28.3 ± 0.8	29.6 ± 1.2
EC	112 ± 1.5	232 ± 12.4	226 ± 15.5	204 ± 21.3	148 ± 17.9	221 ± 20.4
SO_4^{2-}	24 ± 0.9	37 ± 1.2	16.2 ± 2.5	30.1 ± 2.1	22.2 ± 1.3	4.6 ± 0.9
PO_4^{3-}	15.5 ± 1.5	20.1 ± 1.1	17.3 ± 0.9	22.6 ± 1.3	14.2 ± 0.7	25.4 ± 2.1
NO_3^-	0.3 ± 0.1	0.2 ± 0.1	0.4 ± 0.2	0.3 ± 0.1	0.4 ± 0.1	0.2 ± 0.1
Cl^-	0.2 ± 0.1	0.5 ± 0.2	0.6 ± 0.2	0.7 ± 0.3	0.5 ± 0.1	0.3 ± 0.1
K^+	3.1 ± 0.9	4.3 ± 0.3	2.2 ± 0.8	5.7 ± 1.1	4.3 ± 0.9	6.5 ± 0.5
Fe^{2+}	0.4 ± 0.1	0.7 ± 0.1	0.5 ± 0.1	0.7 ± 0.1	0.5 ± 0.1	0.9 ± 0.2
Ca^{2+}	0.7 ± 0.2	0.3 ± 0.1	0.5 ± 0.2	0.4 ± 0.2	0.8 ± 0.1	0.9 ± 0.2
Mg^{2+}	0.3 ± 0.1	0.2 ± 0.1	0.4 ± 0.1	0.6 ± 0.3	0.5 ± 0.1	0.6 ± 0.1

typology of the geology of the limestone rocks rich in calcite and dolomite minerals [10] [11]. He clearly indicated that the waters analyzed are within the allowable limit, which is 6.5 to 8.5 [12] [13].

Water temperature is an important factor in the aquatic environment because it governs almost all physical, chemical and biological reactions. The average value recorded for the temperature (T˚) of the water was 28.5˚C, varying between 25.7˚C and 30.1˚C. This variation may be due to the different depths, static levels and elevations of the sampled wells. However, the temperature values recorded during the study are within the limits recommended by the FEPA and the WHO, which are between 29.4˚C and 30.3˚C [14].

Electrical Conductivity refers to the ability of water to conduct an electric current. Electrical conductivity is also an important factor reflecting the changes caused by the mixing of fresh water, drainage water and sea water; it is directly linked to the concentration of ions in the water [15] [16]. The average electrical conductivity (EC) was 191 µS/cm, with values varying between 112 and 148 µS/cm. This oscillation of the conductivity can be explained by the effect of the lithology on the local hydrogeology. Electrical conductivity showed a significant correlation with parameters such as temperature and pH [17].

Phosphate was present in the water samples studied. The highest value was obtained in water samples from station 6 (25.4 mg/L). The probable origin of phosphate is related to agricultural activities that use fertilizers containing phosphorus in the form of orthophosphate. The values obtained from the points studied were below the detection limit of the analytical method used [18].

Sulphate is the dominant anion in more than half of the points sampled (37 mg/L). Figure 2 illustrates the distribution of the sulphate element according to the sites studied. All the points studied have levels below the maximum authorized value for sulphate established by the World Health Organization (WHO),

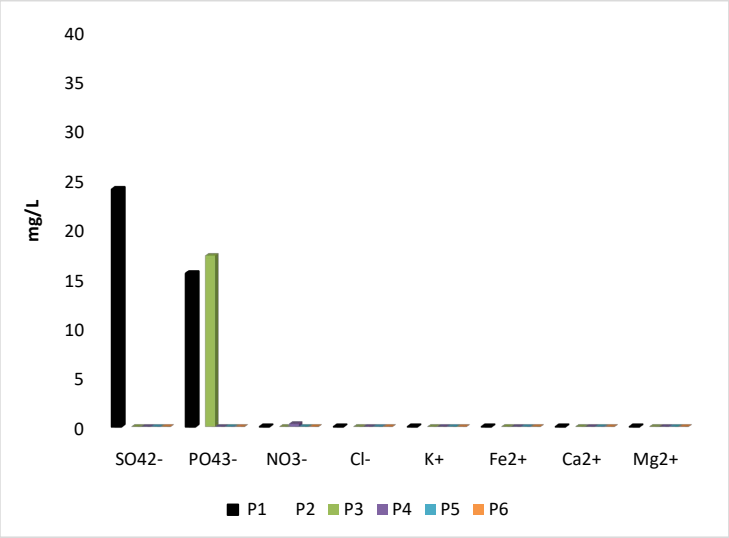

Figure 2. Distribution of chemical elements according to the sites studied.

which is 250 mg/L. Excess sulphate in groundwater can cause laxative problems and, in combination with sodium and magnesium ions, can cause serious gastrointestinal upset. The probable origin of this sulphate is associated with deposits of gypsum and pyrite minerals contained in soils and underground rocks, in the flow of water to the aquifer, as well as contamination by sewage and urban wastewater [19].

For chloride, the analytical results indicated an average value of 3.1 mg/L, well below the value set by the World Health Organization (WHO) which is 250 mg/L. Magnesium has a similar geochemical behavior as chloride. Nitrate is one of the most common constituents in groundwater contaminated by land use practices such as urbanization and agriculture. At concentrations above 10 mg/L, nitrate can cause serious health problems such as methemoglobinemia and cancer. All the water samples studied had values below the standard. This indicates the waters studied have no risk to the surrounding population. However, these points should be monitored annually.

Calcium measured in the water samples showed a marked asymmetry with a minimum value of 0.3 mg/L (Water 3) and a maximum value of 0.9 mg/L (Water 6). The average values of iron and potassium are respectively 0.6 and 4.4 mg/L. Iron overload in the human body can cause gastrointestinal and neurological problems and diseases such as hemochromatosis which can damage the liver, pancreas and heart, in addition to diabetes.

Groundwater samples (Water 6) are more contaminated than the others. This contamination could probably be due to discharges of raw wastewater effluent from pesticide-rich discharges (**Figure 3**).

With the values of electrical conductivity (112 - 148 µS/cm), all groundwater samples from the Lendeng area were classified as fresh water (EC < 1500 µS/cm) according to the classification proposed by the Organization World Health Organization (WHO). Lendeng well water designated as fresh, in addition to being

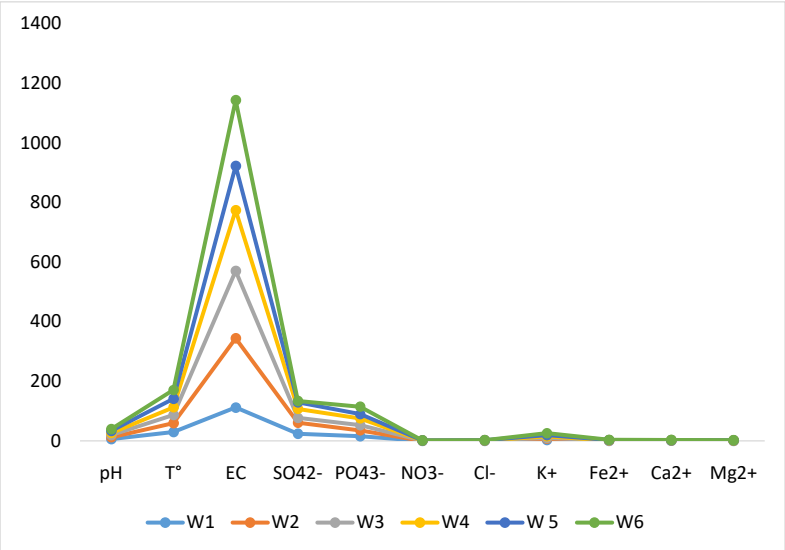

Figure 3. Comparative study of physicochemical parameters in waters studied.

qualified for human consumption, is also suitable for the protection of aquatic communities, and irrigation of vegetables and fruits [20] [21].

5. Conclusion

The well water analyzed in the market gardening area of Lendeng is characterized as soft, with very low conductivities and slightly acidic. They are mostly soft, with occasional occurrences of hard water. The concentration of anions and cations in water is low and these can be classified as sodium sulphate and calcium and sodium chlorites. It is important to emphasize that in climatic periods of drought, without water flow to recharge, it is likely that this classification may be modified, with fluctuations mainly of anionic concentrations. In general, the nitrate, phosphate and sulphate present in these waters have low levels. The test results were compared to World Health Organization (WHO) drinking water standards. The study concludes that the groundwater located near the market gardening area of Lendeng (Rufisque) is not polluted. It is, therefore, necessary to make an appropriate treatment before consuming groundwater.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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