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Evaluation of the Physicochemical Quality of Irrigation Water from the Wells of Laya Doula, CR of Nialia, Prefecture of Faranah, Republic of Guinea

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ABSTRACT

This research aims to evaluate the physicochemical quality of well irrigation water, used by market gardening groups in the District of Laya Doula, CR Nialia, Faranah prefecture, Republic of Guinea. Direct observation and analyses are carried out, direct observation consists of taking stock of the situation and identifying sampling points. The pH, temperature, turbidity, nitrite and nitrate are determined according to standard standards. A mapping of water sources is carried out. Water samples were taken from four (4) wells. The results show that the pH of the wells (PLD1, PLD2, PLD3 and PLD4) comply with WHO standards, and the temperatures are well below 35°C as the upper indicative limit value for water intended for irrigation according to BELGYTI (2009). From the point of view of turbidity, three wells (PLD1, PLD3 and PLD4) out of four are turbid because their turbidity exceeds the limit value defined by the WHO which is (5 NTU). The water samples are not polluted with Nitrite and Nitrate. In short, the results of analyses of the water samples showed that the majority of the physicochemical parameters meet the WHO standards.

Keywords: Physicochemical parameters, water, wells, irrigation, Guinea.

1. INTRODUCTION

Water is an important element for life and for truly sustainable socio-economic development of a country, so it is necessary to have a better understanding of existing water resources, including reliable information on :

- Vulnerability of resources to possible factors :
- Necessary measures for the development, management and protection of resources.

Irrigated agriculture depends on a good supply of water, both in quality and quantity. The latter aspect is of little concern because, by far, we have abundant and quality water. However, the situation is changing in many areas. Given the intensive development of almost all these resources, irrigation projects, old and new, must now move towards less attractive and lower quality water resources. To avoid the problems associated with the use of this water, proper planning is necessary to take full advantage of it (AYERS and WESTCOT, 1988)

Rapid population growth and improvement in the standard of living of the population have promoted economic and social development, consequently requiring increased demand for water. However, successive years of drought and scarce and irregular annual supplies of surface and groundwater have hampered the development of these resources and created serious management problems. Water has become a global strategic issue and its management must be integrated into the policy perspective of sustainable development. However, competition between farmers for limited water resources has affected the development efforts of many countries GARCIA (2006).

According to BERROUCH (2011), agriculture is very water-intensive, consuming 70% of the water available on the planet. Providing the right dosage of water is not the only factor to consider; the different components that water brings must also be considered. In arid and semi-arid conditions, farmers must use different water sources to irrigate their crops.

The quality of irrigation water can vary depending on the nature and quality of dissolved salts. The concentrations of these substances in irrigation water are rather low, but decisive. Furthermore, the problems related to salinity are numerous and vary in nature and intensity; they depend on the tolerance of soils, climate and plants, as well as the skills and knowledge of water users. The most common problems encountered when assessing water quality concern toxicity, water permeability and a series of other factors.

Therefore, irrigation water must be of adequate physicochemical and bacteriological quality. (AYERS and WESTCOT 1988)

Ideally, it should also be free of products that can have harmful effects on crops. However, agricultural intensification is accompanied by massive use of agrochemical inputs and random extraction of groundwater. Groundwater resources are increasingly scarce and water quality is deteriorating. However, overexploitation of these resources, coupled with drought phenomena, inevitably leads to the degradation of soils and water bodies, leading to problems such as salinization, amelioration, deterioration of soil structure, waterlogging and nitrate pollution. Laya Doula District, Nialia CR, Faranah Prefecture is not isolated from agricultural activities that feed a large number of poor people. Due to the continuous demand for market garden produce, this event is held all year round. However, if this type of agriculture is carried out without problems in winter, this is not the case during the dry season. In fact, dry season agriculture faces serious water shortage problems because it mainly relies on irrigation of water using traditional wells (Laya Doula). These waters are of varying depth and can contain large quantities of natural organic matter such as humus, but also organic compounds from various pollutant discharges or intensive agricultural practices, insoluble minerals, silt, clay, sand, gravel, fertilizer dirt and household waste.

In Layadoula, CR Nialia, Faranah Prefecture, dry season vegetables are rare and expensive. This is why some women in the district have created market gardening groups, such as: kankelin, sabougnouma, (Laya Doula); on the one hand to meet the needs of the population during this period and on the other hand for collective development. The market garden crops grown on the site include: onions, tomatoes, cabbages, salads, carrots, eggplants, sweet potato leaves and peppers. Water from a set of different wells is used, but from a quality point of view, it is not clear. No study has been conducted on the quality or adequacy of irrigation water in Laya Doula, in the District of Layadoula, CR Nialia, Faranah Prefecture. However, this water can become a source of infection and contamination for populations and crops. This is why it is necessary to carry out research work to verify the physicochemical quality of this irrigation water.

2. MATERIAL AND METHODS

2.1. Material

2.1.1. Presentation of the study area

The Faranah prefecture is located between 10°02’ and 10°10’ North latitude and between 10°42’ and 11°50’ West longitude with an average altitude of 340 m.

It covers an area of 13,000 km² for a population of 211,115 inhabitants, i.e. a density of 16 inhabitants per km² (DPS/F April 2010) and is limited:

- to the North by the Dabola prefecture;
- to the South by the Kissidougou and Guéckédou prefectures;
- to the East by the Kouroussa prefecture;
- to the West by the Mamou prefecture and the Republic of Sierra Leone.

It has 11 rural communes, namely: Banian, Bendou, Hèrèmakono, Nialya, Songoya, Tindö, Marella, Passaya, Sandénia, Kobikörö, Tiro and the urban commune.

The Laya Doula CR district of Nialia is located on the National Road N1 Faranah-Kissidougou, 25 km from the urban commune of Faranah.

2.1.2. Technical equipment

Materials for the analyses are listed in Table 1.

Table 1 : List of analysis materials

N°	Designation	Parameters
1	Photometer 7500	To determine Nitrates and Nitrites
2	Compact turbidimeter	Determination of turbidity
3	1.5 Liter Bottle	Sample collection
4	Cooler	Sample storage
5	Waterproof multi-parameter HI 98194, version 2015	Determination of pH; Temperature,

A GARMIN Etrex 30x GPS was used to record the geographical coordinates of the wells.

Waterproof multi-parameter HI 99121 was used to determine the pH and temperature of the water in situ.

2.2. Methods :

2.2.1. Sampling

A direct observation of the environment is made which consists of taking stock of the situation and identifying the sampling points. The wells for collecting water samples were chosen according to their environment predisposing to water pollution, their frequency of use by the populations and their position in relation to the crop.

Thus, the water samples were taken from four wells and the data collection took place from May to April 2023. All the packaging was carefully rinsed with tap water and then at the sampling areas by the water to be analyzed, before sampling. The samples will be hermetically sealed. These sampling procedures are of the same order as those recommended by GUILLERET (1997).

These samples were transported to the Analytical Chemistry Laboratory of the University of N'Nzérékoré.

Where the analyses of the physicochemical parameters of the water samples will be carried out. The analyses of the water samples were carried out only in the dry season because it is during this period that water is intensively used for irrigation).

2.2.2 Sample analysis

2.2.2.1. In situ analysis

We determined the physical parameters namely (pH ; Temperature,) by electrometry using a HANNA instruments device (Multi waterproof parameter HI 98194, version 2015).

2.2.2.2. Laboratory analysis

The samples taken were analyzed at the Analytical laboratory of the University of N'Zérékoré.

Turbidity by turbidimetry

Nitrites, and Nitrates are determined by the photometric method using the 7500 photometer.

Table 2 : Level of development and geographical coordinates of the sampled water sources

Source of water	Levels of development	Coordinates (X, Y)
PLD1	Presence of cover, coping and casing	(-10.6378424298662, 9.84695244821933)
PLD2	Presence of cover, coping and casing	(-10.6383485296491, 9.84682878633173)
PLD3	Presence of cover, coping and casing	(-10.6387665590692, 9.8466976601729)
PLD4	Presence of cover, coping and casing	(-10.6393365898108, 9.84700149808006)

Legend : PLD1 : Laya-Doula Well 1 ; PLD2 : Laya-Doula Well 2 ; PLD3 : Laya-Doula Well 3 ; PLD4 Laya-Doula Well 4.

3. RESULTS AND DISCUSSIONS

3.1. Physicochemical quality of well water.

3.1.1. pH

According to WHO (1994), pH is a measure of the concentration of hydrogen ions (H+) in a solution. It is expressed in logarithmic form, meaning that the concentration of H+ ions at pH 6.0 is 10 times higher than pH 7.0 and 100 times higher than pH 8.0. The higher the concentration of hydrogen ions, the lower the pH and the more acidic it is. pH affects the form and availability of nutrients in irrigation water. The pH of irrigation water should be between 5.5 and 6.5. At these values, the solubility of most trace elements is optimal.

Figure 1 illustrates the graphical representation of the pH of the Laya Doula wells. In this figure, we note that the pH values of the irrigation water show significant variations, with a minimum of 5.9 at well PLD3 and a maximum of 6.51 at PLD1 and PLD4. The acidity of wells PLD1, PLD2, PLD3, and PLD4 could be explained by a deficit in base saturation caused by the action of the bedrock, vegetation and clearing BANSEPT (2013). Indeed, the Laya Doula soils are weakly ferralitic on granites and schists, therefore of acidic pH.

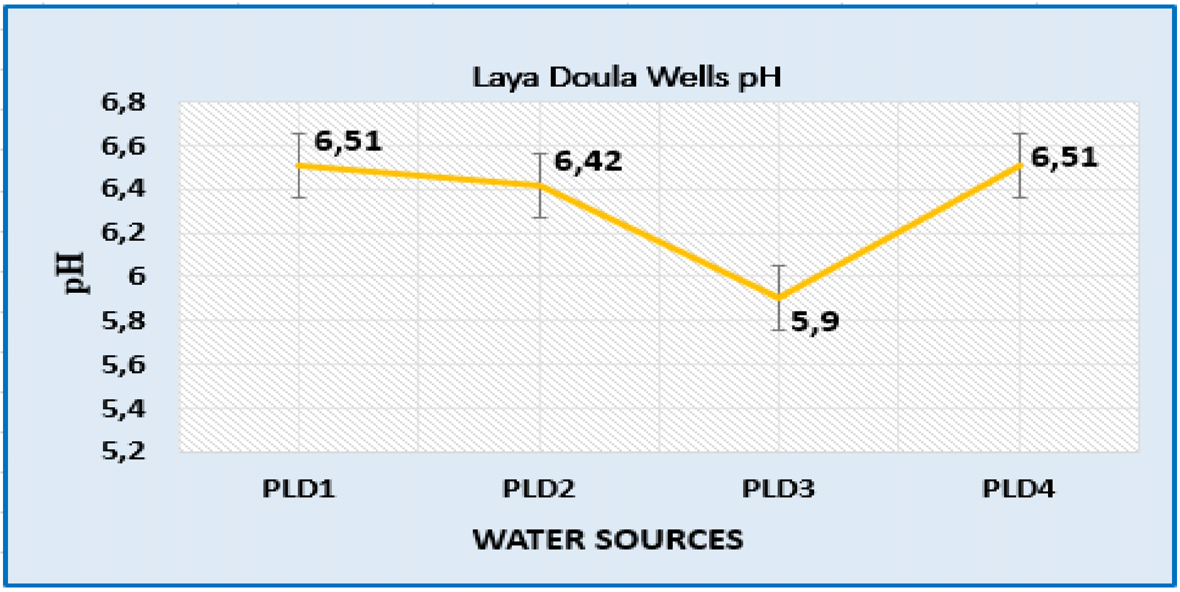

Figure 1 : pH of Laya Doula wells

Legend : PLD1 : Puit Laya Doula 1 ; PLD2 : Laya Doula 2 well ; PLD3 : Laya Doula Well 3 ; PLD4 : Laya Doula Well 4.

3.1.2. Temperature

Temperature regulates the physicochemical and bacterial reactions that occur in water (ADAMOU et al. 2015). It can also correct analytical parameters whose values depend on temperature (notably conductivity).

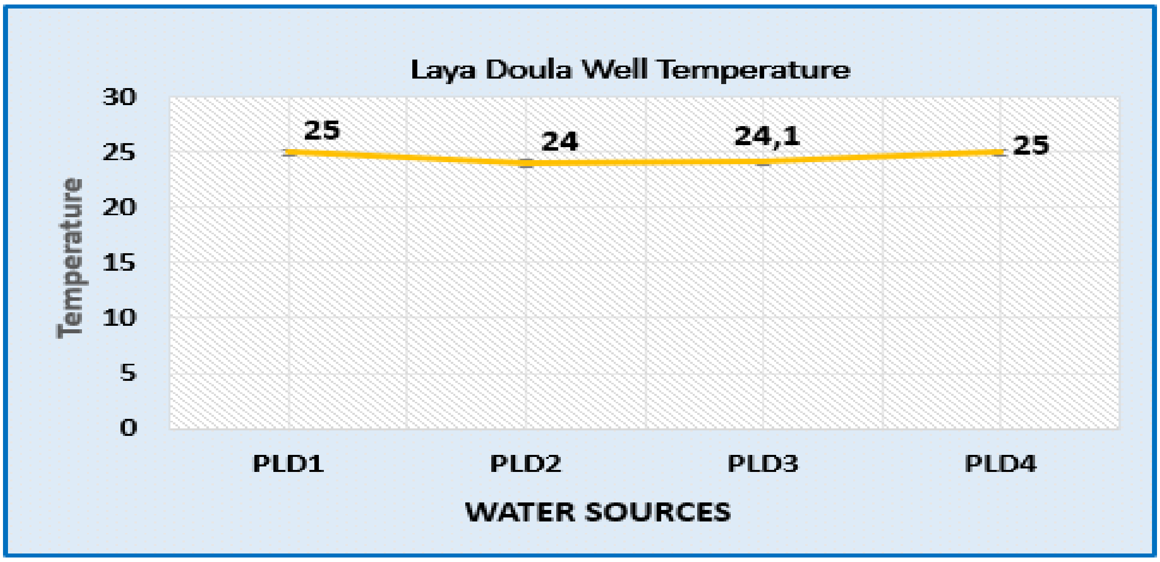

Figure 2 : Temperature of the Laya Doula wells

Legend : PLD1 : Puit Laya Doula 1 ; PLD2 : Laya Doula 2 well ; PLD3 : Laya Doula Well 3 ; PLD4 : Laya Doula Well 4.

The graph indicates that the results of this temperature do not present large variations from one water source to another (Figure 2), with a minimum of 24 °C at well PLD2 and a maximum of 25 °C at well PLD1 and well PLD4. It should be noted that the water sources have temperatures that are well below 35 °C as the upper indicative limit value for water intended for irrigation according to BELGYTI (2009). This allows us to deduce that these waters are acceptable for watering the crops considered.

3.1. 3. Turbidity

According to GUILLERET (1997) turbidity defines the more or less cloudy appearance of water. It is directly linked to MES, which causes the diffusion of light thanks to the Tyndall effect. Very turbid water can cause gastrointestinal disorders TINKER ET AL. (2010) High concentrations of MES in well water promote the proliferation of pathogenic microorganisms N'DIAYE et al. (2013). The more efficiently the water is treated, the lower the turbidity of the water.

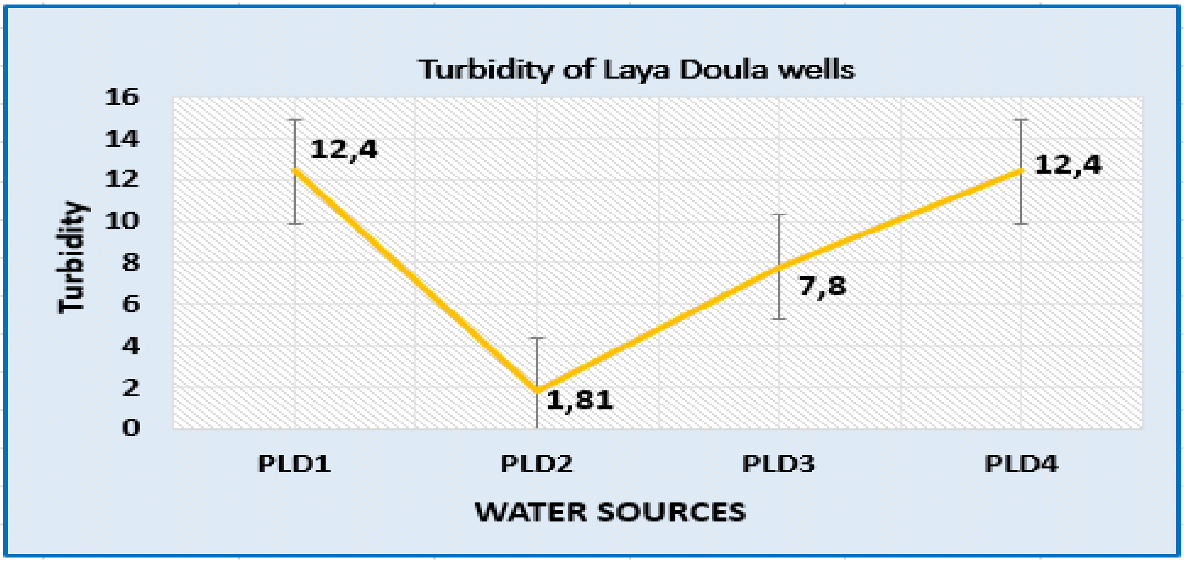

Figure 3 : Turbidity of the Laya Doula wells

Legend : PLD1 : Puit Laya Doula 1 ; PLD2 : Laya Doula 2 well ; PLD3 : Laya Doula Well 3 ; PLD4 : Laya Doula Well 4.

According to this graph, high values are found in the waters of the PLD1 and PDL4 wells with (12.4 NTU) which would have originated from a massive intrusion of organic matter (OROU and his collaborators 2016). This organic matter could come from a runoff of rainwater or human activities such as agriculture and construction, etc. Monitoring the waters of the PLD3 (7.80 NTU) and PLD2 (1.81 NTU) sources. It should be noted that the turbidity values are low at the LD2 well (1.81 NTU). The waters of the PLD2, respect the threshold value (5 NTU) of the WHO and are called clear waters ROBERT (2014). Unlike the turbidities of the waters of the PLD1, PLD3 and PLD4 sources, which are called cloudy because they exceed the said standard. Indeed, the particles suspended in this water allow the fixation of microorganisms. These can then proliferate. Thus, the consumption of raw vegetables that have been watered by these murky waters would cause these diseases.

3.1.4 Nitrite (NO 2 -)

BLARD (2005) demonstrates that nitrites are sources of incomplete oxidation of ammonia, nitrification not being carried out to the end, or a reduction of nitrates under the influence of a denitrifying action. Water containing nitrites should be considered suspect. If the levels remain at very low levels (of the order of 0.01 mg/l), the water can be considered pure or under the action of active self-purification.

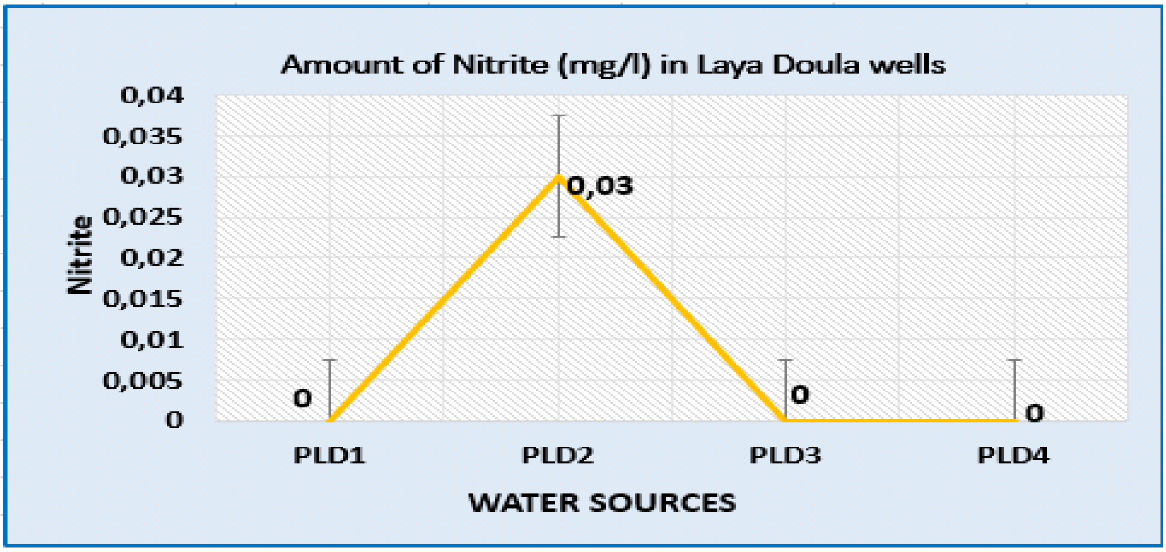

Figure 4 : Amount of Nitrite (mg/l) in the Laya Doula wells
Legend : PLD1 : Puit Laya Doula 1 ; PLD2 : Laya Doula 2 well ; PLD3 : Laya Doula Well 3 ; PLD4 : Laya Doula Well 4.

It follows from this graph that the Nitrite concentrations fluctuate between 0 and 0.03 mg/L. The highest concentration was observed in the PLD2 well (0.03 mg/L), while the other sources do not present any Nitrite concentration (PLD1, PLD3, PLD4). It should be noted that all the samples have an acceptable nitrite concentration with regard to the standard (0.1 mg/L) of the WHO and BARHÉ et al. (2013).

3.1.5. Nitrates (NO 3 -)

REMINI (2010), states that nitrates are not toxic but if the nitrate levels are high it would cause an algal proliferation which contributes to the eutrophication of the environment.

Their potential danger nevertheless remains relative to their reduction in nitrites. For the quality of irrigation water, the maximum authorized concentration of nitrates is 50 mg/l for surface water and 100 mg/l for groundwater, beyond these limits the water is Subject to a risk of pollution by nitrates.

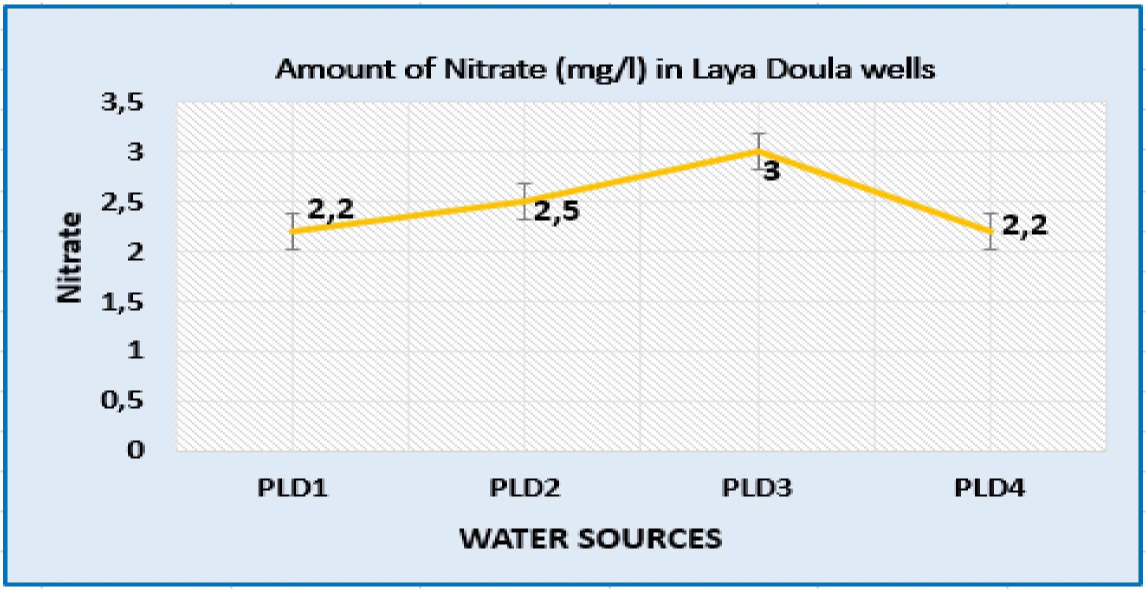

Figure 5 : Amount of Nitrate (mg/l) in the Laya Doula wells
Legend : PLD1 : Puit Laya Doula 1 ; PLD2 : Laya Doula 2 well ; PLD3 : Laya Doula Well 3 ; PLD4 : Laya Doula Well 4.

Looking at this graph, we notice a slight variation in these contents which oscillate between 2.2 mg/l (PLD1 and PLD4) and 3.00 mg/l (PLD3) but which remain lower than the value admissible by the WHO (50mg/L).
As a result, the waters studied are not subject to a risk of pollution by nitrates.

CONCLUSION AND RECOMMENDATIONS

The physicochemical quality of the well waters of the market gardening estate of Laya Doula CR of Nialia, Faranah prefecture is known, the analysis results of almost all the parameters studied meet the standards of the World Health Organization (WHO).
For the wells that presented turbid samples we recommend their dredging, the collection of garbage around the wells and the protection of the catchments.

Declaration by Authors

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