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COMPARATIVE PHYSICO-CHEMICAL CHARACTERIZATION OF MODERN WELLS AND BOREHOLES WATER IN THE COTTON ZONE OF KÉROU

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ABSTRACT

Groundwater accessible through hydraulic structures, modern wells and boreholes are the main sources of drinking water for the population of the cotton zone of Kérou. Boreholes, although are quite significant in the region but the new strategies adopted by Benin in the field of hydraulic structures are oriented towards reducing costs to the likelihood of achieving the priority of lots wells at the expense of boreholes. To highlight the non-adapting wells to people's needs and current hydro climatic context, this study has considered making a comparative physicochemical characterization of well and borehole water. The analysis of a number of parameters indicative of water pollution (T°C, pH, electrical conductivity, orthophosphate and nitrogen components) revealed that the levels of these elements remain high and show, for the most part, a major risk of pollution of well water as opposed to the boreholes water. Thus, although the cost of boreholes is high, it is advantageous for the safety of people, to foster this type of hydraulic structure.

Keywords: Drilling, wells, contamination, groundwater quality.

RESUME

Les eaux souterraines accessibles grâce aux ouvrages hydrauliques, puits modernes et forages sont les principales ressources en eau de boisson de la population de zone cotonnière de Kérou. Les forages, certes sont en nombre assez importants dans la région mais les nouvelles stratégies adoptées par le Bénin en matière d'ouvrages hydrauliques sont orientées vers la réduction des coûts avec le risque de privilégier la réalisation des puits au détriment des forages. Pour mettre en évidence la non adaptation des puits aux besoins des populations et au contexte hydroclimatique actuels, cette étude a envisagé de faire une caractérisation physicochimique comparée des eaux de puits et de forage. L'analyse d'un certain nombre de paramètres indicateurs de la pollution des eaux (T°C, pH, conductivité électrique, orthophosphates et les composés azotés) a révélé que les teneurs en ces éléments restent élevées et indiquent pour la plupart, un risque de pollution majeure des eaux de puits contrairement à celles des forages. Ainsi, bien que le coût lié à la réalisation des forages soit élevé, il est plu avantageux, pour la sécurité sanitaire des populations, de privilégier ce type d'ouvrage hydraulique.

Mots-clés : Forage, puits, contamination, eaux souterraines, qualité.

INTRODUCTION

Drinking water is considered as an undeniable factor in maintaining health and harmony of body functions (Dubois, 1992). Groundwaters are the main resources in drinking water from the infiltration of rainwater into the ground Boukari (1995). They insinuate themselves by gravity into the pores, cracks and crevices of rocks, wetting layers deeper and deeper until it meets an impermeable layer to form the sheet (Benaabidate, 2000). Access to it, is by building the infrastructures of all kinds. The Government of Benin, in 1992 ratified international agreements that require it to provide drinking water to its entire population. For this purpose, over two decades, extensive campaigns in drinking water supply from groundwater have been launched with the support of technical and financial partners (TFP). This led to the creation of modern wells and boreholes (DGH, 2005). Unfortunately, these wells since their implementation are not subject to quality monitoring, yet their water continues to serve the communities. Moreover, there is a resurgence of waterborne diseases in communities that consume water from these infrastructures yet considered safe (Djafarou, 2004). But the poor quality of drinking water is the leading cause of morbidity and mortality among the poorest populations (World Water Council, 2005). Each year, five hundred million people suffer from waterborne disease. More than thirteen million people die each year from diseases linked to water unfit for consumption (Vermeylen, 2006). This requires some attention to be given. This study has therefore proposed to compare the physicochemical characteristics of water from wells known to those of modern water boreholes type UPM or VERGNET in the cotton zone of Kérou in Atacora in northern Benin. The objective is to verify whether the physicochemical quality of the supposedly modern wells do not endanger the health of consumers. Should we not focus on water from wells to boreholes water?

MATERIAL AND METHODS

Framework Study

Kérou municipality is limited to North-West by the Municipality of Tanguieta with whom it shares Pendjari Park and North-East by the Municipality of Banikoara largest producer of cotton at the national level. In the South, it shares its borders with the cotton belt of Péhonco, Kouande and Gogounou. It is divided into four Districts that are: Brignamaro, Kérou Center, Kaobagou and Firou. Figure 1 shows the location of water points in these four districts.

The climate of the region is governed by the North Sudanian regime characterized by two distinct seasons: a dry season from October to April and rainy season from May to September. This system strongly influences the flow of water in the wells.

Sampling and analysis

Thirty (30) wells against fourteen (14) boreholes were selected for the study and whose waters were collected and analyzed. The samples were taken per water point during the months of July-August, which corresponds to the rainy season.

The table 1 shows the distribution of wells (S1 to S30) and boreholes (F1 to F14) in the districts of the town.

Table I: Distribution of wells (S) and boreholes (F) in the districts of Kérou

Wells	Boreholes	Districts
S1-S7	F1-F4	Brignamaro
S8-S14 + S27	F5-F8	Firou
S15-S26 + S28-S29	F9-F12	Kérou
S30	F13-F14	Kaobagou
30	14	4

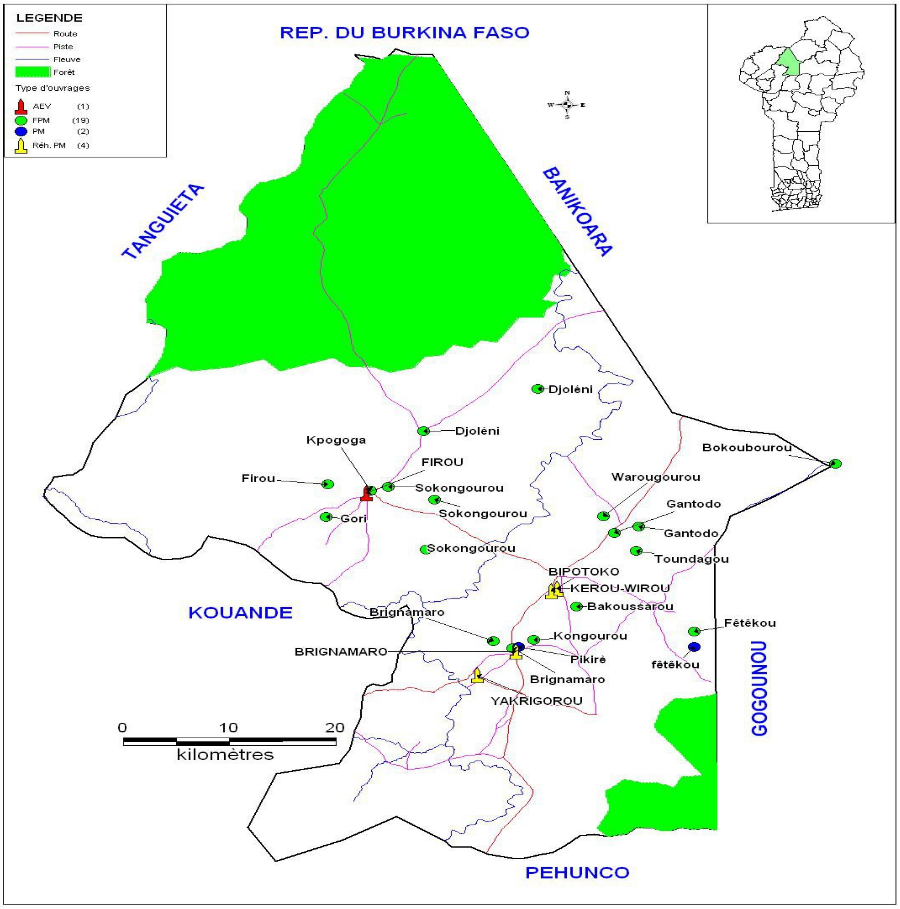

Figure 1: Kérou municipality showing the water points

The temperature, the pH, the conductivity are determined in situ using a pH meter WTWLF 340 and a conduct meter of the same brand. The ammonium (NH4 +), the nitrate (NO3-), the phosphates were analyzed by the laboratory spectrophotometer DR/2000 Hach to 425 Dm in the range from 0 to 2.5 mg / L. The data were coded, entered and analyzed using software Excel, Epi Info and SPPS.

RESULTS AND DISCUSSION

The figure 2 shows the comparison of the variation of some physical parameter (temperature, pH, electrical conductivity) of the wells and boreholes water.

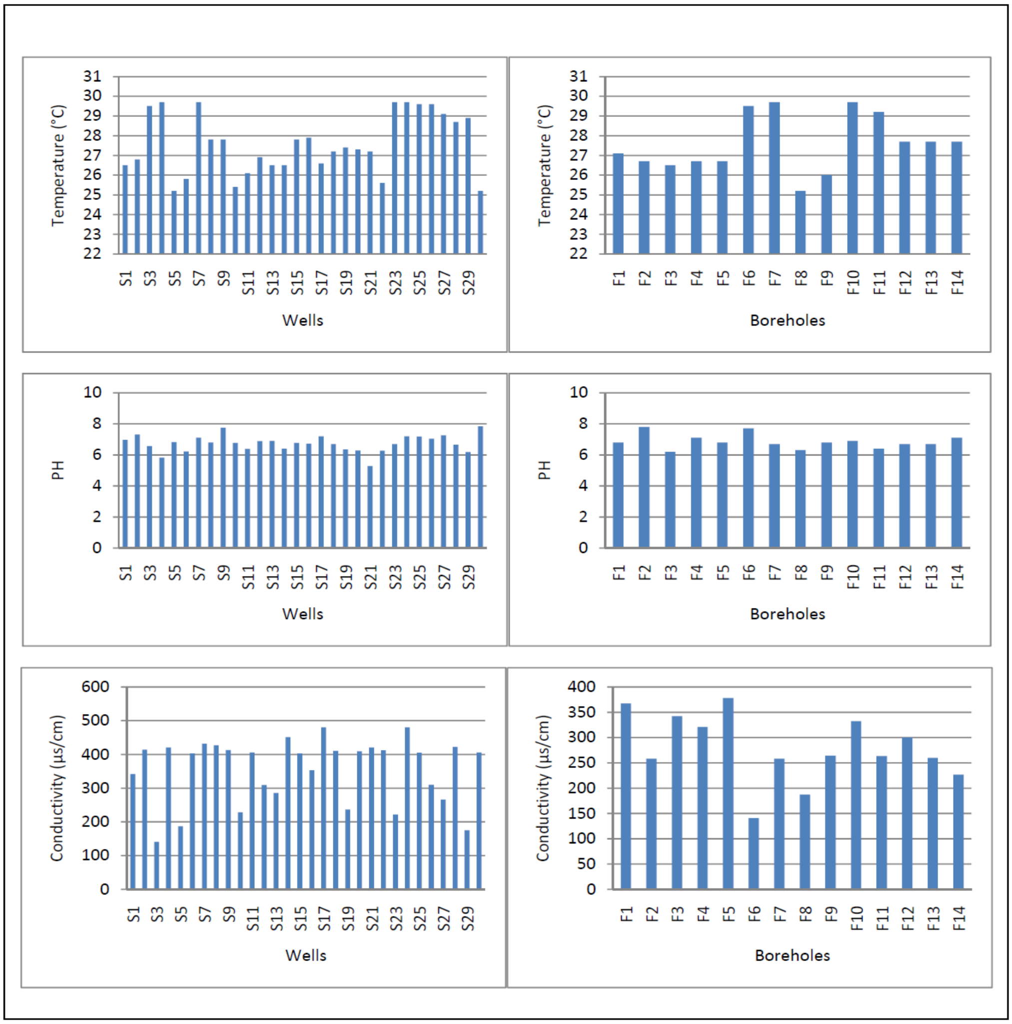

Figure 2: Comparison of the variation of some physical parameter (temperature, pH, electrical conductivity) of the wells and boreholes water.

The water temperature

The water temperature is an important factor because it governs almost all physical, chemical and biological reactions (Chapman et *al.*, 1996). Temperature is one of the important parameters on which depend physical, chemical and biological balances. From the analysis of Figure 2, it appears that the temperatures of the wells are between 25.2 °C and 29.7 °C with an average of about 28. These results are similar to those of Aissi (1992), Comlanvi (1994) in Cotonou and Assane (1995) in Grand-Popo, who find temperatures between 25 C and 30 °C. The ground water is shallow for some and average for others wells. This temperature rise may be due to the static level of water in the well, to the covering or not of the wells and / or crossed geological layers. By cons, although four boreholes have recorded temperatures up to 29 ° C, the average is 27 ° C but this figure is greater than the standard WHO (T <25 ° C). But we must recognize that in the tropical countries, temperatures of groundwater are more or less higher. Indeed, temperatures of about 29°C are also observed in Brazzaville by Moukolo (1993) and Djafarou (2004) in Kandi. According to Butterfield et al (1943) the rise of water temperatures in the tropical environment, create favorable conditions for microbial activities, which increase the costs of disinfection.

The pH

This parameter measures the concentration of protons H+ in the water, and therefore the acidity or alkalinity on a logarithmic scale of 0 to 14. It influences most chemical and biological mechanisms in the water. Usually, the pH values are between 6 and 8.5 in natural water (Chapman et al., 1996). It decreases in the presence of high levels of organic products and increases in low water period, when evaporation is high (Meybeck et al., 1996). The pH of the wells water as well as those of boreholes (Figure 2) showed no significant changes. On both sides, the average is around 6.8 for boreholes and 6.7 for wells. This slight acidity a bit sharper at the well may be due to the sampling period or fertilizer inputs used in the fields.

The electrical conductivity

The electrical conductivity is the ability of water to run an electric current and is determined by the content of dissolved substances, the ionic charge, and the ability of ionization, mobility and water temperature. Therefore, it provides information on the level of mineralization of water. Kérou wells water is highly mineralized (Figure 2), always with several values above 400 µS/cm. These values appear to result from a significant share of inputs from drainage runoff that washed cotton fields contaminated by fertilizers and / or leaching of the reservoir where the water stays in the aquifer. By cons no water sample has conductivity > 400 µS/cm. The wells S17 to S24 rich in electrolytes belong to the district of Kérou, cotton-growing area.

The figure 3 shows the comparison of the variation of some chemical parameters (phosphate ions, ammonium ions and nitrates) of the wells and boreholes water.

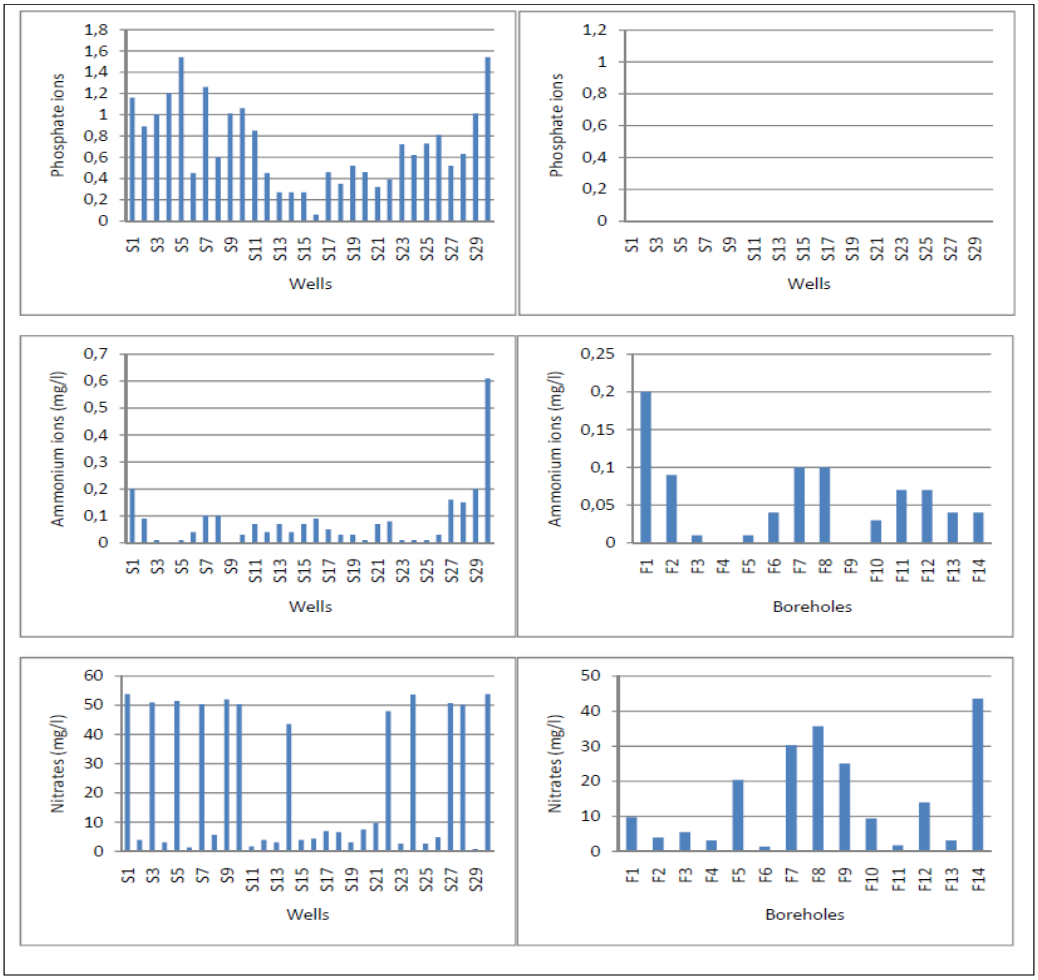

Figure 3: Comparison of the variation of some chemical parameters (phosphate, ammonium and nitrates) of the wells and boreholes water

Orthophosphates

Orthophosphate concentrations recorded in studied wells are between 0.06 and 1.54 mg/l (Figure 3). However, they remain well below the allowable limit of orthophosphate (5 mg/ l). The detection limit of the spectrophotometer does not identify phosphate ions in boreholes water.

Ammonium

Ammonium is the product of the final reduction of organic and nitrous substances and inorganic products in water and soils. It also comes from the excretion of organisms, reduction and biodegradation of waste, without neglecting domestic, industrial and agricultural inputs. This element exists in a small proportion of less than 0.1 mg/l of ammonia nitrogen in natural waters. In surface waters, it comes from the nitrogenous organic substances, and gas exchange between water and the atmosphere (Chapman et al., 1996). It is thus a good indicator of water pollution from urban sewage. The wells water S1, S27, S28, S29 are more concentrated in NH^{4+}, but the levels of these do not exceed the standards (0.2 mg/l). However, given the results of Figure 3, the water of Kaobagou village (S30) is not good for consumption. By cons, for that purpose the quality of boreholes water meets the allowed standards.

Nitrates

Nitrate is the most dominant nitrogen form in the ground water. They generally come from the decomposition of organic substances by bacterial oxidation of nitrites and thus constitute the final product of nitrification. In natural environment, its concentration rarely exceeds 45-50 mg / l. Higher levels indicate releases of wastewater that will contaminate surface and groundwater, especially the excessive use of fertilizers used in agriculture (Chapman et *al*., 1996). The organic materials of animal origin while decomposing lead to the formation of ammonia, which under the influence of air and bacteria, oxidizes and becomes first the nitrite, then nitrate. In Figure 3 above, it appears that 10/32 or 31% of wells have a nitrate content that exceeds the standards of 50 mg /L recommended by WHO for drinking water. The histogram of nitrate in boreholes shows a slight variation of these levels that range between 1.32 mg/l (well F6) and 43.5 mg / l (well F14), but remain below the permissible value by standards (50 mg/l). Thus, water boreholes studied are not subject to the risk of nitrate pollution. However, higher concentration of nitrogen compounds observed at the wells, especially in the boroughs of Brignamaro and Kérou to suspect organic pollution likely caused by animals and humans' wastes, or effluents containing fertilizers. It is just said that Kérou grow cotton probably by the intensive and uncontrolled use of agricultural inputs; it may be suspected as the mismanagement of domestic wastes and wastewater, soil contamination from feces or human excreta, particularly Kérou is the largest district of the municipality alone accounts 14 of the 30 wells of the town. However, the high percentage of nitrogen compounds obtained at some wells outside the cotton fields such as Borough Firou wells (S9 and S10) leads us to favor the hypothesis of domestic pressure as to origin of the high rate of nitrate. Indeed, these results can be interpreted in this context because they are identical to those obtained by Djafarou (2004) on the impact of household on water in the municipality of Kandi, municipality near Kérou. But we can not rule out the farm reason as Ndong (1999) obtained similar results in the cotton zone of Senegal. We can therefore conclude with these authors that agricultural inputs provide additionally nitrogen contents to groundwater already prone to household pollution.

CONCLUSION

Various tests on water samples from wells and boreholes of the cotton zone of Kérou allow us to show how some parameters describe the physicochemical quality of the water. A comparison of measured concentrations of major elements in groundwater of this area for the different sampling sites indicates a difference in concentration between the wells and boreholes. This difference is characterized by high rates in wells water. The levels of dissolved phosphate ions increase gradually from well S16 to a maximum level of well S30. It is also noticed a decrease from S5 to S16. The increase involves upstream discharges that contaminate groundwater and the decline suggests a self-purification. However, orthophosphate concentrations are very low, leaving predict that this does not constitute a pollution risk for wells water. The diagnosis of these parameters combined with the study of nitrogen compounds have shown that the wells water, after all, is heavily influenced by domestic sewage or agricultural activities.

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