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Quality of Drilling well water: Case of six drilling wells in the municipality of sapone, Burkina Faso

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Abstract

Access to drinking water is a major challenge for contemporary societies characterized by a high growth of needs. In Burkina Faso, most populations in rural and semi urban areas as well as peripheral areas of urban cities use drilling water which is supposed to be of drinking water quality, although they are often polluted. Drillings are the primary source of drinking water supply in Burkina Faso; however, no study on the quality of this water is often conducted after their implementation although most of these wells are more than twenty (20) years old and are often in the middle of fields. Therefore, these wells are likely to pollution, not only by the corrosion of equipment in their facilities, but also through agriculture of which fertilizers and pesticides filter into the ground. Our research aims to study on the one hand the impact of drilling equipment on the physicochemical quality of water from wells in the long term and on the other hand to check the possible presence of pollution related to agricultural activities. Therefore we conducted our study on six (6) drillings established since 1989 in Sapone, a village about thirty miles south of Ouagadougou located in table-1 in annex. Water samples from these wells were collected and the following physicochemical parameters were analyzed: pH, electrical conductivity, temperature, dissolved oxygen, total hardness, alkalinity, calcium, magnesium, nitrates, nitrites, orthophosphates, sulfates, chlorides, iron and arsenic. We then compared our results with analyzes of the water of these drillings during their implantation in 1989. We also analyzed the waters of other wells drilled in 2002 in the same area to compare these results with those of the previous drillings. It appears from this study that the waters of all these drillings are of good quality and are safe for consumption. Their contents in calcium and magnesium are quite low. Nitrate and orthophosphate found in these waters are due to agricultural and domestic activities and their concentrations do not exceed the standards set. The impact of their equipments on the physicochemical quality of their waters in the long term is negligible.

Keywords: Pollution, drinking water, quality, physicochemical parameters.

Introduction

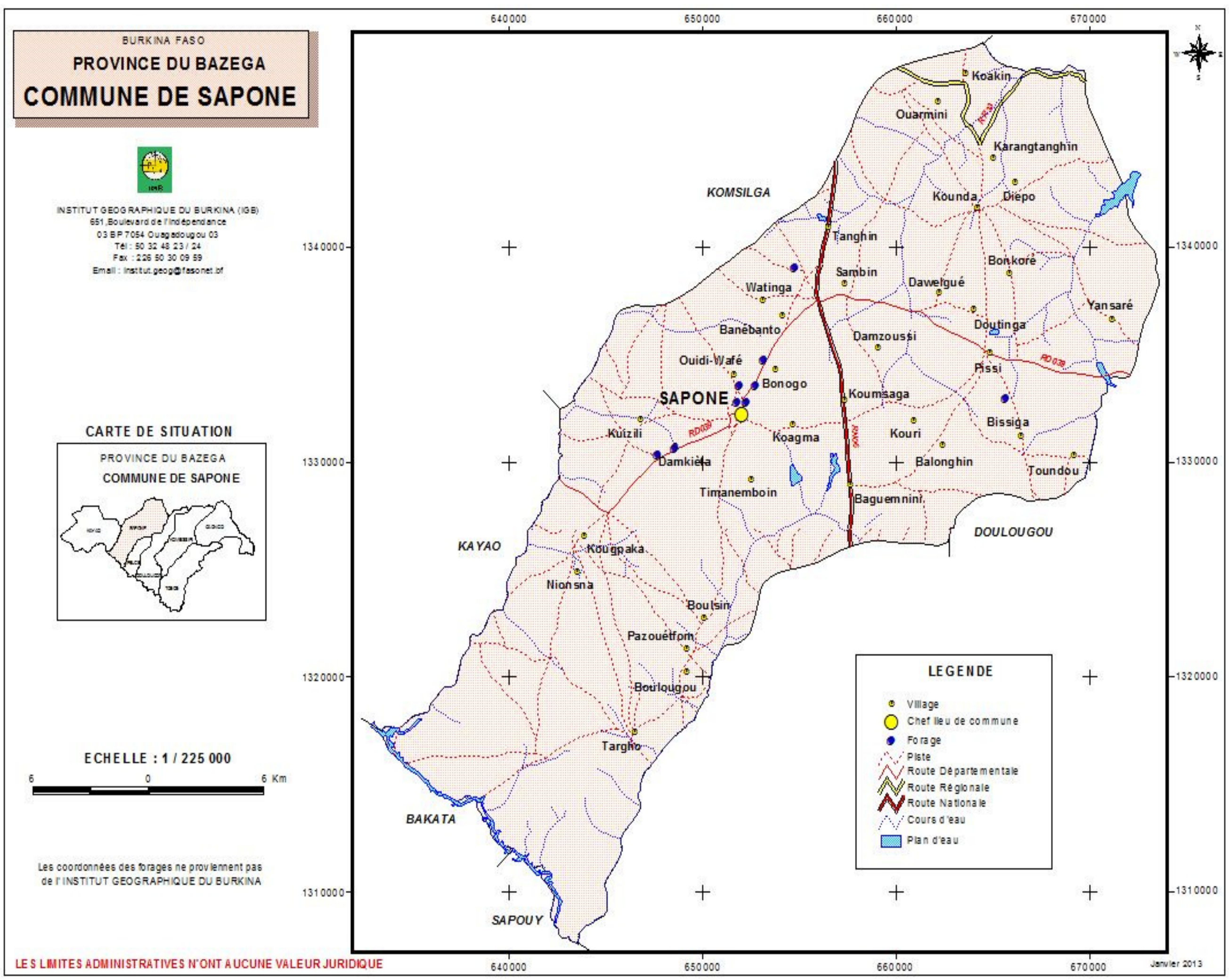
The access to potable water is nowadays a major challenge for our communities due to the high growth of their needs. Faced with a world population that has quadrupled during the twentieth century, the demand for water has increased sevenfold. The acuity of this issue nevertheless varies with the geographical areas. On the one hand, Western countries meet their needs at the cost of financial investments to access, distribute and treat fresh water. The other countries of the Southern part of the world are facing significant challenges whose intensity depends on physical, demographic, economic and political variables[1]. In this regard, the Sub-Saharan Africa ranks among the most disadvantaged regions. It faces a strong "water stress", that is to say, a significant part of the population faces a looming shortage of water. South of the Sahara, nearly 300 million people lack access to safe drinking water (over a third of the continent's population), and one out of two inhabitants suffers from diseases subsequent to shortage or poor quality of this essential raw material for human survival[1]. A worsening of the situation is now expected given the rising temperatures generated by climate change. This implies the need to protect water and treat it to produce water for human consumption or for specific industrial uses, or to limit pollution discharges into the natural environment. In rural and semi urban areas, to have drinking water supply is an obstacle course for residents. Indeed, the experiences of previous decades indicate that improving access to safe drinking water remains precarious if it is not integrated into an effective organization, management and service development.

Access to drinking water is a real need for a large part of the population of Burkina Faso. Despite significant progress in this area, these needs will require sustained efforts for the next decade. It should be noted that most of the semi urban and rural drinking water supply is through boreholes. Similarly, in the outskirts of urban centers, drinking water is primarily based also on drilling. Thus, the boreholes are the main source of drinking water across the country. Specifically, the problem of drinking water in semi urban and rural centers arises in terms of supply and quality. However, little research work has dealt with the issue of water quality in Burkina Faso[2]. No studies on the water quality are conducted subsequent to the implantation of the drilled wells because their waters are expected to be potable. However, analyzes of the water of 198 wells in BURKINA FASO done in 1984 showed that the waters are often polluted[3,4,5]. This can be explained by the fact that most of the wells are located in the middle of fields and thus are exposed to agricultural pollution by fertilizers or pesticides through their infiltration into the ground[6,7]. This pollution can also be caused by corrosion of the equipments of these facilities most of which are over twenty (20) year old. It is therefore necessary to ensure that the groundwater is not polluted[2]. It is in this context that we undertook to determine the water quality of six (6) wells drilled since 1989 (23 years old) in the Municipality of Sapone, located in table-1, in the Central Region of Burkina Faso. We compare these results not only with those of the same wells gathered during their implantation, but also with those of wells newly established in 2002 in the same area.

Material and Methods

Characteristics of the drillings: All six (6) boreholes were drilled in 1989 (23 years old)[8]. They are equipped with pumps of KARDIA type and are human powered. They are fitted with tubes and rods made of galvanized iron. The boreholes drilled in 2002 have equipments similar to the previous ones. Geographical positions and characteristics of these wells are shown in table-2 in annex.

Table-1
Map of the zone of study



Sampling: Water samples from all wells were collected in plastic bottles, previously washed with distilled water and rinsed with sample of water from the wells. These bottles are filled, sealed, placed in a cooler and transported to the laboratory where the samples were stored in a refrigerator at 4°C to avoid contamination and ensure proper conservation.

Instrumentation and methodology: Methods of analysis of physicochemical parameters:- i. Nitrates, nitrites, calcium, magnesium, sulfates, orthophosphates, total hardness, alkalinity (TA) and total alkalinity (TH) were measured with Multi Tests Orchi 1 which is a device equipped with a digital 20 MHz microprocessor. ii. Nitrites, iron and arsenic have been measured with the spectrophotometer DR3800 which provides the concentration of compounds ranging from trace to high concentrations. iii. pH, electrical conductivity, dissolved oxygen and temperature were measured using the Multitests HQ40d.

Physicochemical parameters analyzed: We have grouped them into three (3) classes: i. Major parameters: pH, electrical conductivity, temperature, dissolved oxygen, total harness, calcium, magnesium, total alkalinity (TH), alkalinity (TA); ii. Undesirable elements: nitrates, nitrites, orthophosphates; iii. Toxic substances: arsenic.

Results and Discussion

Results of analyzes: i. Results of analyzes of water of the boreholes drilled in 1989[9], Table-3 and table-4 show the results of analyzes of the parameters of the six (6) wells F1 to F6 implanted in 1989. Regarding toxic substances (arsenic), no analysis was done in 1989. ii. Results of analyzes of water from wells F1 to F6 done in 2012: Table-5 to table-7 show respectively the results of current analyzes done in 2012 of the parameters of the six (6) wells F1 to F6 drilled in 1989 and the four wells FR1, FR2, P1, P2 implanted in 2002[10,11].

Table-2
GPS positions and characteristics of drillings

Drilling	Village name	Position (GPS)	Depth (m)	Date of commissioning
F1	Pissi	N12°03’17.4’’W001°28’41.4’’	34	1989
F2	Bonkoré	N12°06’38.4’’ W001°34’40.3’’	43	1989
F3	Koagma	N12°02’21.2’’ W001°34’40.3’’	28	1989
F4	Damkiéta	N12°02’03.7’’ W001°38’07.7’’	25	1989
F5	Karkuidgin	N12°03’15.3’’ W001°36’21.0’’	40	1989
F6	Bonogo	N12°04’18.4’’ W001°35’35.2’’	40	1989
FR1	Karkuidgin 01	N12°03’39.8’’ W001°36’15.7’’	20	2002
FR2	Karkuidgin 02	N12°03’39.7’’ W001°35’47.7’’	19	2002
Well	**Name of village**	**Position (GPS)**	**Depth (m)**	**Date of commissioning**
P1	Karkuidgin 03	N12°03’13.9’’ W001°36’04.1’’	17	2002
P2	Damkiéta	N12°01’55.9’’ W001°38’37.4’’	15	2002

Table-3
Results of analyzes of major elements of the six (6) wells F1 to F6 in 1989[9]

Forages	F1	F2	F3	F4	F5	F6
Parameter						
Temperature (°C)	22	22	21	22	21	21
pH	6.32	6.23	6.38	-	-	-
Conductivity (µS/cm)	180	170	-	-	-	-
TH (meq/l)	1.63	1.20	9.08	9.8	12.98	7.56
Magnesium (mg/l)	9.84	4.9	8.2	11.0	12.98	6.51
Calcium (mg/l)	16.4	15.1	22.3	21	29.8	-
Chlorides (mg/l)	7.45	-	2.84	22	15.98	7.10
Sulfates (mg/l)	0	0	0	4		0

Table-4
Results of analyzes of undesirable substances in 1989[9]

Drilling	F1	F2	F3	F4	F5	F6
Parameters						
Iron (mg/l)	0	0	0.08	traces	0	0
Nitrates (NO_3^-) (mg/l)	17.6	0	-	5	0	6.52
Nitrites (NO_2^-) (mg/l)	0	0	0	0	0	0

Table-5
Results of the current analyzes of the major parameters of boreholes F1 to F6, FR1, FR2, P1 and P2 in 2012[10]:

Drilling / Parameters	F1	F2	F3	F4	F5	F6	FR1	FR2	P1	P2
Temperature (°C)	27	22.3	25.2	26.8	30.4	28.3	20.8	21.8	22.8	27.6
pH	6.39	6.22	6.63	6.58	6.36	6.43	6.22	6.24	6.30	6.42
Conductivity (µS/cm)	234	115.2	203.2	199.1	198.1	178	111.7	169.8	78.9	75.0
Dissolved oxygen (mg/l)	5.83	8.61	7.11	4.86	4.29	3.15	6.39	5.12	5.28	5.79
TH (°F)	10	6	10	10	10	10	6	10	4	4
Magnesium (mg/l)	4.8	9.6	9.6	9.6	9.6	9.6	9.6	14.4	4.8	4.8
Calcium (mg/l)	32	8	24	24	24	24	8	16	8	8
TA (°F)	0	0	0	0	0	0	0	0	0	0
TAC (°F)	7	5	10	9	10	9	5	9	4	3
Sulfates (mg/l)	3	1	1	1	0	2	0	0	0	1

Table-6
Results of the current analyzes of undesirable substances of the six (6) wells F1 to F6 drilled in 1989[9] and four (4) wells FR1, FR2, P1 and P2 of 2002[11]

Forages / Parameters	F1	F2	F3	F4	F5	F6	FR1	FR2	P1	P2
Iron (mg/l)	0.00	0.01	0.01	0.25	0.02	0.02	0.34	0.44	0.17	0.41
Phosphates (PO_4^{3-}) (mg/l)	5.8	6.0	6.5	4.8	6.2	5.6	4.3	6.4	4.0	4.3
Nitrates NO_3^- (mg/l)	8.1	0.3	1.8	1.8	0.8	0.2	1.1	1.3	0.1	1.0
Nitrites NO_2^- (mg/l)	0.003	0.003	0.005	0.004	0.003	0.005	0.003	0.003	0.003	0.003

Table-7
Results of the current analyzes of toxics substances of the six (6) wells F1 to F6 of 1989 and four (4) holes FR1, FR2, P1 and P2 of 2002[6].

Parameter	F1	F2	F3	F4	F5	F6	FR1	FR2	P1	P2
Arsenic (mg/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Interpretation of results: We interpret below parameter by parameter, after drawing the curves representing the evolution of the values of these parameters, the dependence on time and sampling site.

Temperature: The temperature of water is a parameter which varies according to the ambient temperature and season. It has influence on other parameters such as dissolved oxygen, pH and water density. It is an important ecological parameter because its elevation may cause the death of some aquatic species. Figure-1 gives the evolution of temperature with time and sampling sites. The data range from 21°C to 30.4°C, but we observe that the values obtained in 2012 (R2012) are higher than those of 1989 (R1989). This could be explained by the periods of sample analysis which are February-March for R1989 and May-June for R2012. There is no guideline value of temperature, but the rates of chemical reactions depend on temperature and typically double for every increase of 10°. This would increase the rate of corrosion of these metallic equipments in the presence of chloride ions[12].

pH: Figure-2 gives the evolution of pH with time and sampling sites. Healthy and good drinking water should have a pH between 6.5 and 9.5; such water would also be good for the water conduct and facilities[13]. We note that only wells F3 and F4 have current pH values that meet this standard. The waters of the wells FR1, FR2, P1 and P2 are slightly acidic and therefore can cause, in the long term, corrosion of the equipments of the wells (pipes made of galvanized steel) as well as those used for storing water (usually barrels and buckets made of iron). The acidity of these waters may be related to the acidity of the granite rock. Indeed, the various lithological sections of these wells show that granite is the largest layer of the rock before the water table[14]. It may also be caused by dissolved CO_2 present in the atmosphere.

The electrical conductivity: Conductivity is a measure of the ability of water to conduct an electric current, so it indirectly gives an indication of the content of ions in the water. Thus, the more water contains ions such as calcium (Ca^{++}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), bicarbonate ions (HCO_3^-), sulfate ions (SO_4^{2-}) and chloride ions (Cl^-), the more it conducts electrical current and the measured conductivity is high. Conductivity values are generally stable and depend mainly on the local geology. When significant changes are observed, it is a sign of increased inputs of dissolved substances.

However, it is unclear whether the substances that cause a change in conductivity come from natural minerals or pollutants. A water analysis in a laboratory indicates precisely the nature of the dissolved minerals. Conductivity is influenced by various natural and anthropogenic factors including: i. Watershed geology (rock composition), ii. the contribution of groundwater, iii. the temperature of the water, iii. the evaporation of the water (which increases or decreases the concentration of ions in water), iv. the variations in water flow rate of streams and rivers that feed the water table (conductivity increases when the flow rate is low because there is a higher concentration of ions, and decreases when the flow is high); v. the supplies of water contaminated with pollutants from human activities (agriculture, urban development, industrial). The characteristics of water from boreholes and wells according to the conductivity are shown in table-8 in annex[15].

Table-8
characteristics of drinking water[15]

Type of water	Conductivity (µS/cm)
Soft water	less than 200
Mineralized water	between 200 and 1000
Saltwater	more than 2000

Figure-3 in annex gives the evolution of the conductivity of the water of the wells with time and site of collection. We draw the following observations: i. only drillings F1 and F3 have conductivity values slightly above 200 µS /cm. They contain mineralized water while other holes (F2, F4, F5, F6) and wells (P1, P2) have soft water; ii. the conductivity of two wells P1 and P2 are the lowest. These results could be explained by the fact that these wells are shallow (respectively 17 m and 15 m depth). Indeed the lithology of the different boreholes show that at a depth less than 20 m, there is clay and at deeper than 20 m granite. Therefore the water of the wells passes through less geological phases than for the drillings and therefore has a lower mineral content than the latter. It is obvious from this analysis that except for F1, the water from the boreholes and wells analyzed in the municipality of Sapone is soft.

The dissolved oxygen: Dissolved oxygen is the amount of oxygen dissolved in water at a given temperature. In water, the solubility of oxygen varies with the temperature, altitude, depth and time of day. On earth as in water, oxygen is essential for the vast majority of living organisms. The solubility of oxygen is a function of the temperature, its partial pressure in the atmosphere and of the salinity of the water[16]. Due to its dependence on several factors, dissolved oxygen has no guided value[13]. However, water is not suitable for aquatic life if it has a dissolved oxygen content less than 3 mg/l, according to previous authors[17].
The results of our analysis are shown in figure-4 in annex (dissolved oxygen has not been subject to analysis in 1989).

A high value of dissolved oxygen can be a factor that increases the corrosion of iron by acting as depolarizer towards hydrogen[12]. Hence its high amount (concentration greater than 6 mg/l) in the waters of drillings F2, F3 and FR1 may cause corrosion of materials made of iron (screens, pipes).

Hardness: The quality of the water does not always retain attention, except in cases of extreme pollution. Yet source water may also contain various types of ions of high concentrations. In general, the most annoying solutes are calcium and magnesium bicarbonates (Ca^{2+}, $2HCO_3^-$) and (Mg^{2+}, $2HCO_3^-$).

The hardness of water is the concentration of dissolved calcium or magnesium salts and these are bicarbonates or sulfates to which one sometimes adds chlorides. There are several types of hardness: i. temporary hardness: this is due to calcium bicarbonate and magnesium bicarbonate; ii. permanent hardness: it is due to calcium and magnesium sulfates, and sometimes chlorides; iii. calcium hardness: it is related to the concentration of calcium ions; iv. magnesium hardness: it is related to the concentration of magnesium ions ; v. total hardness: it is related to the sum of the two previous levels.

The hardness of water is expressed in F (French degree) or TH (degree of hardness or total hardness). These values can be expressed in mg/l. To determine the concentration of calcium and magnesium ions in water, reactions of formation of complexes with the ethylenediaminetetraacetate (EDTA) ion is used.

Figure-5 in annex shows the evolution of the calcium ion concentration with time and the sampling sites, while figure-6 shows the evolution of the concentration of magnesium ions in the same conditions.

Waters can be classified into families of hardness[18]. Table-9 in annex shows the characteristics of water depending on the hardness. The results of our analyzes show that except drilling F1 which water is soft, the other boreholes and wells have very soft water. The lithology of the soil (clay and granite) in the study area and the equipments used (galvanized iron) do not have an impact on the content of calcium and magnesium in the waters studied.

Table-9
Characteristics of water depending on the hardness[18]

Hardness (°F)	Calcium hardness (mg/l)	Classification of water
0-3	0-30	very soft
3-6	31-60	soft
6-12	61-120	moderately soft
12-18	121-180	hard
≥18	>180	very hard

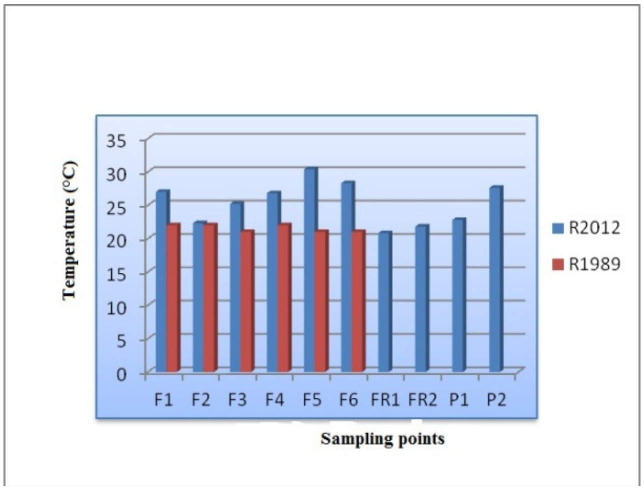


Figure-1
Histogram of evolution of temperature with time and sampling sites

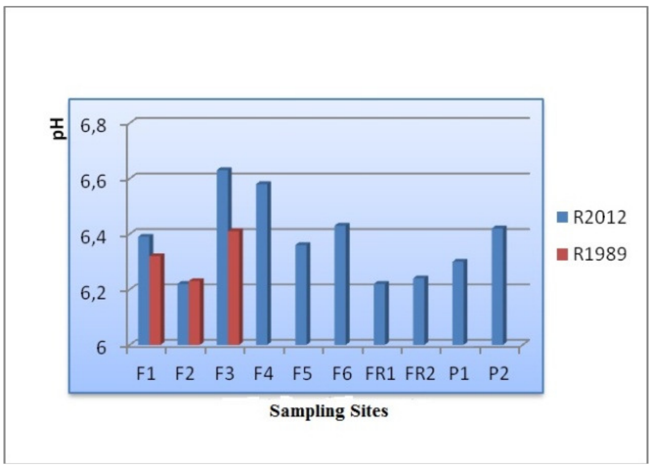


Figure-2
Histogram of changes of pH with time and place of sampling

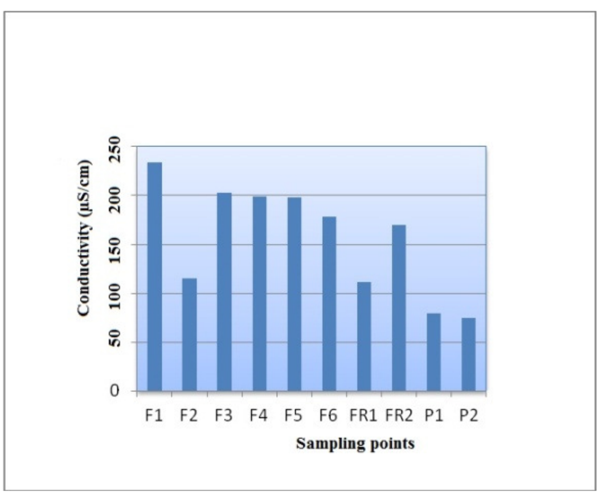


Figure-3
Histogram of the evolution of the conductivity with the sampling location

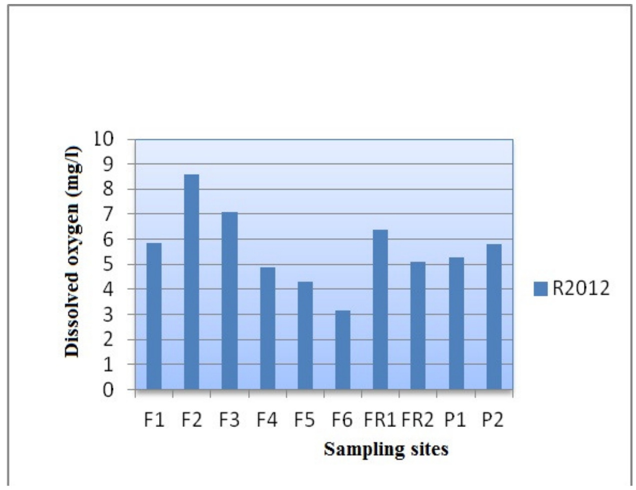


Figure-4
Histogram of evolution of dissolved oxygen with the sampling location

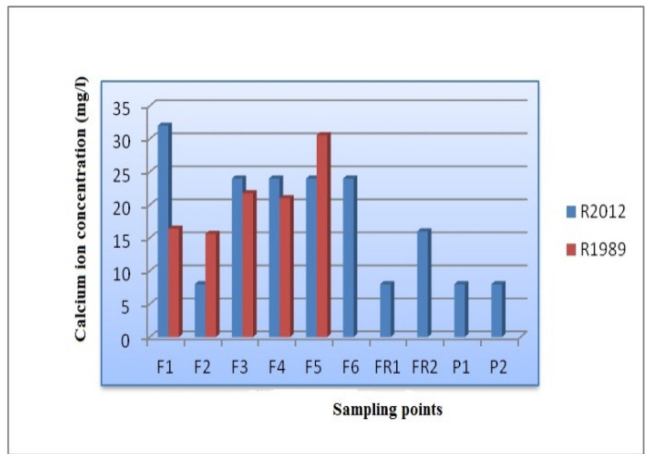


Figure-5
Histogram of the evolution of the calcium ion concentration with time and the place of sampling

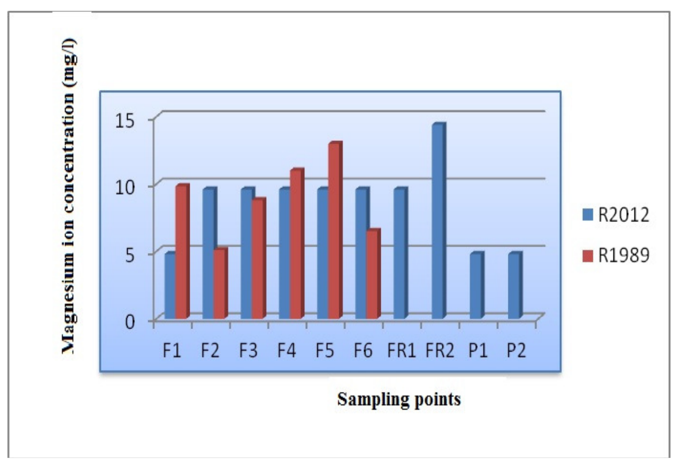


Figure-6
Histogram of the evolution of the magnesium ion concentration with time and the place of sampling

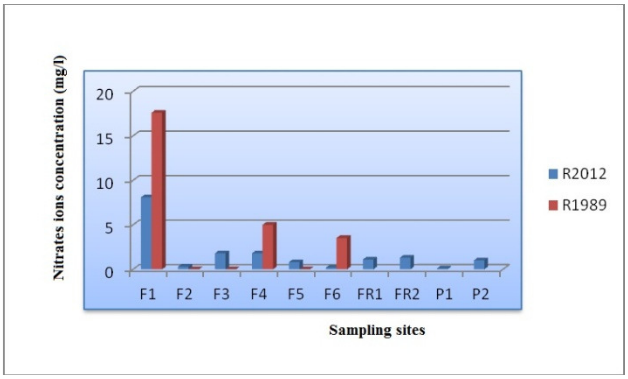


Figure-7
Histogram of the evolution of the concentration of nitrates ions over time and the place of sampling

The alkalinity: By convention, the alkalinity (TA) of a solution is expressed by the volume of hydrochloric acid 0.02 mol.l^{-1} required to titrate 100 ml of solution using phenolphthalein as an indicator of the end of reaction. The TA corresponds to the titration of OH^- and CO_3^{2-} in water. By convention, the total alkalinity (TAC) of a solution is expressed by the volume of hydrochloric acid 0.02 mol·l^{-1} required for 100 ml of solution in the presence of bromocresol green as an indicator of the end of reaction. The TAC corresponds to the determination of the OH^-, HCO_3^- and CO_3^{2-} in water, that is, all the basic species present.
TA is measured in French degrees (° F): 1 °F is equivalent to 3.4 mg / l of hydroxide ions (OH^-) or 6 mg/l of carbonate ions CO_3^{2-}, or to 12.2 mg / l of bicarbonate ions (HCO_3^{2-}). The alkalinity of water is closely linked to its hardness and thus its corrosive nature and scaling capacity. Our results show that the alkalinity is zero for all sampling points, so there is no OH^- and CO_3^{2-} in the waters analyzed. However, only bicarbonate ions (HCO_3^{2-}) are present in the water collected.

Undesirable substances: Nitrates and nitrites: Nitrate ions (NO_3^-) exist naturally in soil and water in the form of salts. They occur naturally in the nitrogen cycle, especially when organic matter decomposes by the action of soil bacteria. Organic nitrogen is converted by oxidation into nitrate and ammonium compounds. Nitrates are also manufactured as fertilizer by using nitrogen from air and natural gas. Very soluble in water, they are not retained by the soil. The presence of nitrate (NO_3^-) in drinking water is primarily due to human activities[19,20]. The use of synthetic fertilizers and manures associated with crops and intensive farming, favors the occurrence of nitrates in water. Faulty septic systems, as well as the decomposition of plant and animal matter, can also be a source of nitrates in water[21]. The risk of contamination is greater if the soil covering the groundwater is vulnerable (e.g. sand) and if the water table is shallow (shallow wells). Nitrates are not really toxic to human health, but there are only two conditions in which nitrate can be toxic: in case of massive ingestion of these compounds or if they are transformed into nitrites by digestive micro flora in the body.

Nitrites (NO_2^-) however, are very unstable salts of nitrous acid (HNO_2). When nitrites enter the bloodstream, they react with hemoglobin to form methemoglobin, a compound that reduces the blood's ability to carry oxygen. The oxygen level decreases and babies show signs of the disease called methemoglobinemia, also known as "blue baby"[14]. Figure-7 in annex shows the evolution of the concentration of nitrates ions with time and site of sampling. These curves show that nitrate concentrations are below the accepted standards which are 50 mg/l for nitrates and 3mg/l for nitrites[13]. But they are greater than the amount normally found in groundwater that is less than 1 mg/l nitrates[16,22]. The results collected in 1989 showed a total absence of nitrates for drilling F2, F3 and F5, and therefore an absence of nitrites for these wells. Current analyzes (R2012) show the presence of nitrates in all holes with values greater than 1 mg/l for wells F1, F3, F4, FR1 and FR2. There is a total absence of nitrite. The presence of nitrates in the waters analyzed (> 1 mg/l) may be due to fertilizers used in agricultural activities around boreholes. Photo-1, photo-2, photo-3 and photo-4 in the figure-8 to figure-11 show such activities.

Phosphates: Phosphorus is a nutrient essential to natural life! In animals, it is a component of DNA, bone and nerve tissue. In plants, phosphorus is essential for plant development, including root growth and maturation of fruits and seeds. In aquatic environments, it comes in different forms, including phosphate (PO_4^{3-}), directly assimilated by the vegetation. Thus, excessive intake of phosphorus and phosphates by water causes a significant growth of vegetation. A great part of the phosphorus present in the aquatic environment is not from the natural supply. Indeed, the widespread use of phosphorus in detergents and fertilizers has led to major mining of phosphate rock. By runoff or percolation into the soil, phosphorus introduced into the environment is found in rivers and by infiltration in groundwater. Phosphates are not toxic to aquatic life, but their presence in water can cause some imbalances. Phosphates concentrations found in tap water show globally no risk to human health[23]. The maximum allowable in drinking waters to 5 mg.l^{-1} of P_2O_5 which corresponds to approximately 1.1mg.l^{-1} of phosphates and 0.4 mg.l^{-1} of P_2O_5 in water for human consumption[24,25]. Figure-12 shows the evolution of the phosphates concentration with sampling sites.

Figure-8: photo-1

Figure-9: photo-2

Figure-10: photo-3

Figure-11: photo-4

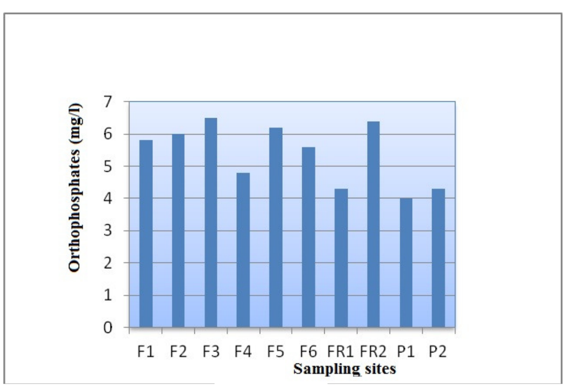


Figure-12
Histogram of evolution of the concentration of phosphates with the sampling location in 2012

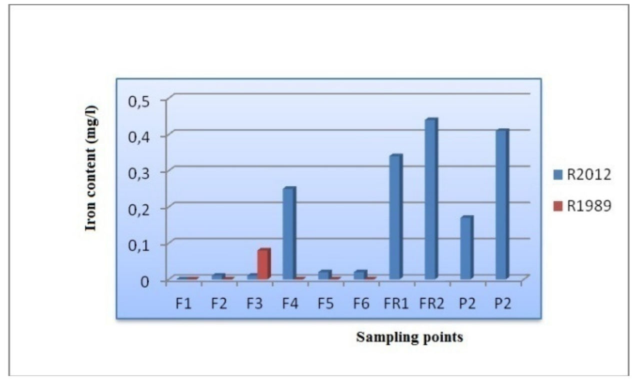


Figure-13
Histogram of the evolution of the iron content as a function of time and sampling points

Figure-14
Photo-5: iron head of drilling attacked by rust

Figure-15
Photo-6: well with coping but not covered

Iron: Iron in rural groundwater supplies is a common problem: their concentrations are often high, whereas iron levels recommended is less than 0.3 mg/l for water[13]. Iron is found naturally in the aquifer but the concentrations in groundwater may increase due to human activity (drilling, ...). When contaminated with iron, groundwater often has a characteristic color. Dissolved iron in groundwater is in the oxidized form of iron (II). This form is soluble and normally is not a problem by itself. The iron (II) is further oxidized to iron (III) by contact with oxygen in air, dissolved oxygen or by the action of bacteria. Iron (III) is then precipitated as hydroxides insoluble in water, causing rust staining and clogging of pumps and pipes. Figure-13 in annex shows the evolution of the iron concentration versus time and sampling points. The analysis shows low iron content in drilling F2, F3, F5, an average level for drilling wells F4 and P1 and a high level above the standard of 0.3 mg/l for drilling FR1, FR2 and well P2[13].

In 1989, there were only traces of iron present in some wells such as F2, F4, F5 and F6. The current presence of iron in the water of theses drillings may be related to the materials used (filter, tubing) which are made of iron and therefore undergo corrosion over time; photo-5 in the figure-14 shows it. This corrosion is much stronger when water is acidic. The presence of iron can also be due to the nature of the rock through which water infiltrates. The high content of iron in FR1 and FR2 which are recent drillings and installed in the center of the village of Sapone may be explained by the very high frequency of the use thereof. The presence of iron in the water of wells P1 and P2 can be also explained by the presence of metallic objects dropped into the wells that have copings but are not covered; photo-6 in the figure-15 shows that.

Toxic substance (arsenic): Arsenic is naturally present in the soil and is therefore in the corresponding aquifers. This is one of the toxic substances that are commonly found in water. Certain industrial activities also use arsenic, traces of which are found in rivers several years after the end of the operation. The concern about the carcinogenic effects of arsenic has led to the lowering of the quality limit to 0.01 mg/l for drinking water. Our analyses have shown that there is no arsenic in the water. This means that there is no arsenic in the soils where the waters were collected and this is an indication that there were no activities around these sites related to its production.

Conclusion

Drillings are the primary source of drinking water supply in Burkina Faso, but no studies on the water quality is often conducted subsequent to their implementation, while most of the wells are older than twenty (20) years. The aim of our study was to determine the impact of drilling equipment on the physicochemical quality of water from the wells in the long-term and to check whether there is any pollution related to agricultural activities or not. To do this, we conducted our study on six (6) holes drilled since 1989 in a village near Ouagadougou, capital of Burkina Faso. Water samples from these wells were collected and physicochemical parameters were analyzed. We then compared our results with analyzes of these water holes done during their implantation in 1989. We also analyzed the waters of other drillings recently established (2002) in the same area in order to compare the results.

It appears from this study that: i. The water quality of all drilled holes is owned to consumption; these waters are very soft in nature which means that the concentrations of magnesium and calcium are not high; ii. over time, their materials made of iron (filters, pipes) undergo corrosion and this causes water contamination; similarly, the frequency of use of the drillings can cause short-term corrosion of their materials; iii. the amount of substances such as nitrates and orthophosphates found in these waters is closely linked to agricultural activities and others such as washing around the boreholes and wells studied. However their concentrations do not exceed the standards. There is absence of nitrites and arsenic in these waters.

Recommends: The implantation of boreholes is closely related to their characteristics such as their depth and diameter, the type of soil to cross before reaching the aquifer, the constituents of the aquifer, and the characteristics of the water table (pressure, flow rate, physicochemical quality of the water ...). Drillings are very important for the supply of drinking water for surrounding population as well as for animals. They must be protected. We therefore recommend what follows to the authorities in charge of these water sites: i. drilling must be protected by a fence equipped with a door that is kept closed and only opened when needed. There should be an anti-quagmire slab, a gutter that insure the drainage of runoff water and a cesspool (or sump) for collecting water from the gutter; ii. the immediate vicinity of the borehole must be cleaned: there must be no domestic or agricultural activities; iii. maintenance of the structure must be done regularly by repairing and changing the pumps as well as blowing (or developing) them periodically.

We make the following recommendations to the populations: the wells must have: i. covers that limit pollution by dust, insects or animals; ii. curbstones, about 0.70 m in height, which prevent access to animals; iii. anti-quagmire slab to hold the water containers and prevent infiltration of runoff; iv. a gutter around the well and a cesspool (or sump) so that the edges of the wells remain dry because stagnant water are breeding sites of insects; v. a device for hanging the dipper and the rope;

There must be: i. no latrines within fifteen (15) meters of boreholes and wells for bacteria of human excreta can seep into the groundwater and pollute it ; ii. sealing of the well casing at least three meters from the top; iii. regular cleaning of the immediate vicinity of wells and boreholes.

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