WATER SUPPLY CONSTRAINTS IN THE COMMUNE OF KEROU IN NORTHERN BENIN

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ABSTRACT

Water is of vital biological and economic importance. The hydrosphere is the foundation of life and ecological balances. The aim of this research is to analyze the constraints of access to drinking water in the Commune of Kerou.

To achieve this, a methodological approach based on the collection, processing and analysis of results was adopted. Statistical protocols were used to estimate drinking water access parameters.

It appears that modern wells, AEVs and FPMs are the main structures for accessing drinking water resources in the Commune of Kerou with a service rate of 55%. Several constraints limit the populations' sustainable access to water. According to 78% of respondents, the geological facies prevents access to groundwater because it is made up of hard rock. Regarding the distance traveled to get water, almost 70% of households cover between 500 and more than 1,000 m to get drinking water. Climate instability has a huge impact on water resources because droughts combined with other factors, including high water demand, have led to lower river flows. Likewise, a reduction in recharge has been observed, resulting in the early depletion of aquifers.

Keywords: Constraints, access, water, Commune, Kerou.

1. INTRODUCTION

Water is a vital resource for living beings. It is an essential liquid for the proper running of the human body. This precious resource is used in a variety of ways. Surface and groundwater are used for domestic consumption, agricultural and industrial activities and the production of electrical energy (Nya E.L; 2020; P 26).

Accessibility to safe drinking water is an ongoing concern for people in many parts of the world, mainly in rural areas of developing countries. While 85% of the urban population in Africa had access to safe drinking water, 55% of the rural population did not have access at the beginning of the last decade.

Despite government efforts, rural populations still rely on water sources of questionable quality. According to the Integrated Modular Survey on Living Conditions of Households (INSAE, 2010, p 17), more than 22% of Beninese households continue to use non-drinking water source.

According to the report on the implementation of the government's 2020 action programme, the rate of access in rural areas rose from 42% in 2016 to 69% by the end of 2020 (Ononfin, A; et al; 2021, p 32). Despite these achievements, many communities still have difficulties in getting drinking water; a guarantee of social and economic well-being. This is the case in the Commune of Kerou where, despite a service rate of around 68% (General Directorate for the Coordination and Monitoring of Sustainable Development Goals (DGCS-ODD; 2017, p 55), the population

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continues to get water from non-drinking sources. Under these conditions, the question is to know what constraints are the basis of access to drinking water for households in the commune of Kerou.

The commune of Kerou is located in the northeast of Atacora department and extends between Alibori valleys in the east; Atacora chain in the west and the Pendjari river in the northwest. Located between 10°26' and 11°23' of north attitude and 1°26' and 2°16' of east longitude (Figure 1), the commune of Kerou covers a total area of 3,745 km² (INSAE 2002) and has four districts, 28 villages and town districts. It is bordered to the north by the Republic of Burkina Faso, to the northwest by the commune of Tanguiéta, to the south by the commune of Pehunco, to the southeast by the commune of Sinende (department of Borgou), to the west by the commune of Kouandé and to the east by the communes of Banikoara and Gogounou (department of Alibori).

It is affected by the Sudano-Guinean climate (Adam and Boko, 1993). It is characterized by the alternation of a rainy season from mid-April to mid-October with an average rainfall of between 800 and 1100 mm/year, the maximum being between July and September, and a single dry season from mid-October to mid-April.

In terms of hydrography, the Commune of Kerou is drained by two large rivers, the Mekrou and the Pendjari, with their numerous tributaries with a torrential regime. In the east of the commune are the tributaries of Alibori. To this hydrographic network can be added the seasonal watercourses. It should be noted that the arms of these rivers are home to the eight (08) water reservoirs of the commune. It also has many lowlands that are scarcely used for off-season crops.

The vegetation formations are dominated by shrubby savannahs. This savannah is subject to severe deterioration due to intensive clearing for agriculture. Increasingly, fallow mosaics dominated by shea and nere are found in place of natural vegetation. The degradation of the vegetation cover goes hand in hand with a decrease in biodiversity. Some useful plant species are becoming scarcer. Adansonia digitata (baobab), Vitellaria paradoxa (shea), Lophira lanceolata (false shea), Parkia biglobosa (cowpea), Khaya senegalensis (kaileedrat), Tamarindus indica (tamarind), Blijia sapida (cheese tree), are the best known species. However, this vegetation is quite deteriorated by agricultural activities and uncontrolled logging. Several types of soil support this vegetation and crops.

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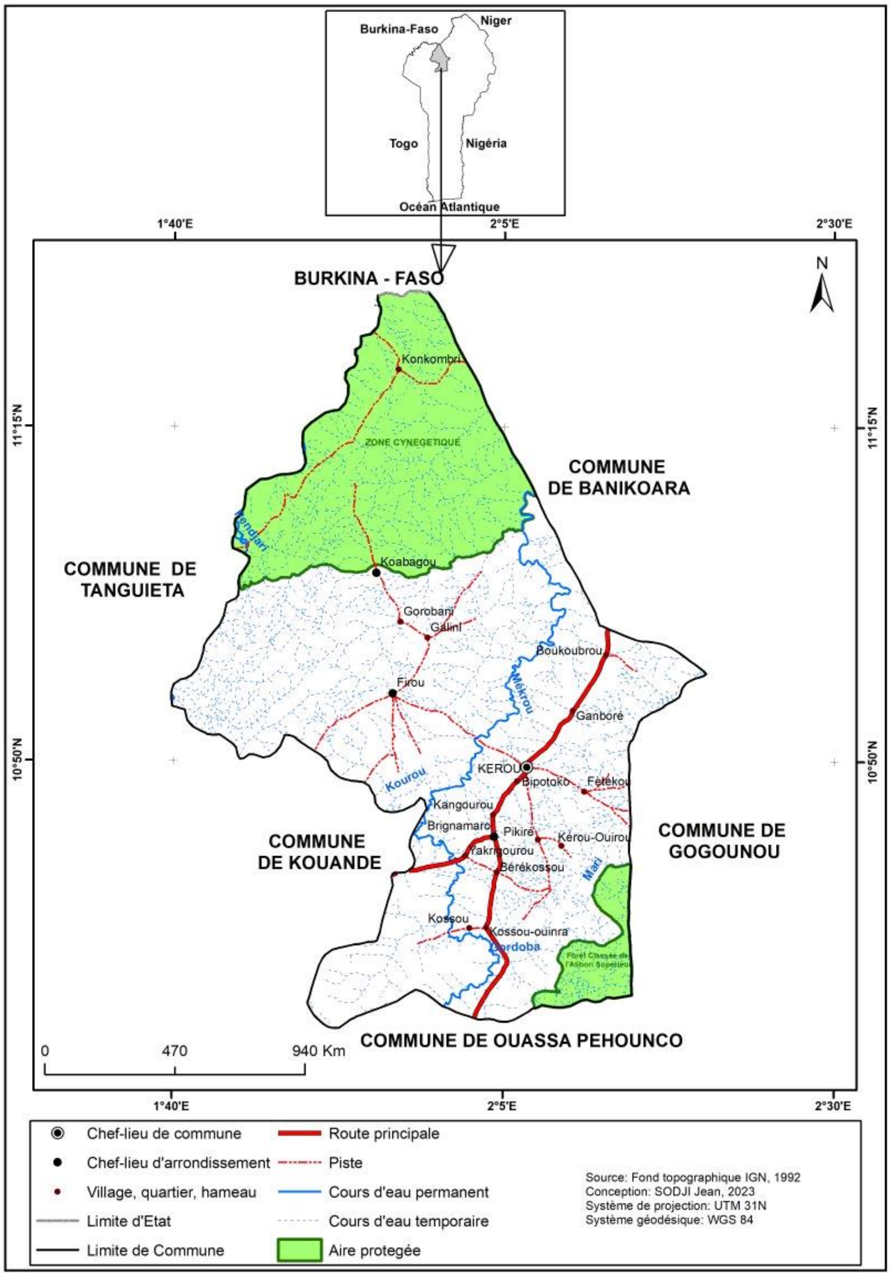

Figure 1 : Geographical and administrative location of the commune of Kerou

2.MATERIALS AND METHODS

2.1 Survey data

The climatological data used in this study are:

- Rainfall data made up of monthly and annual rainfall amounts from Kerou and Natitingou stations over the period 1965 to 2009. These various data were collected at Meteo-Benin, LACEEDE and the Water-Parakou service.

Socio-anthropological data (quantity of water used, availability of a water point, distance) were collected through a semi-structured survey in the districts of the Commune of Kerou. Statistical tools were used to make the analysis.

Owing to this, questionnaires were used to discuss about various problems of access to water with the population. Surveys were conducted among the population and wise people.

2.2- Sampling

Households were selected using purposive sampling. The total number of households selected was determined by the probabilistic formula of SCHWARTZ (1995):

$N = Z\alpha 2.\ P\ Q / d2$

With:

N: the sample size; P: the proportion of households in the Commune of Kerou; $Q = 1 - p$; $Z\alpha = 1.96$, the smallest deviation corresponds to a risk α of 5%; i: the margin of error of the estimate of any parameter to be calculated on the basis of the sample size n, the value of i considered is 5%. For a margin of error of 5%, a proportional sampling of 15% was then applied to determine the number of households to be covered per district (Table I).

Table I: Distribution of households surveyed by district

Districts	**Number of households**	**Sample size**	**Wise people**
Brignamaro	1636	41	5
Firou	1306	34	5
Koabagou	394	12	3
Kerou	3827	57	7
Total	7163	144	20

Source : Field survey, 2017

The results show that 144 households were interviewed out of 7,163 households in the commune of Kerou. In addition, 20 wise persons were interviewed of whom 5 were in Brignamaro, 5 in Firou, 3 in Koabagou and 7 in Kerou district. These wise people are managers of water points, agents of the town hall and managers of health centres in the commune.

2.3 Data processing methods

Several statistical protocols were used for data collection. Thus, the arithmetic mean is used to study rainfall and hydrological regimes. It is the fundamental trend parameter. It is expressed as follows:

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} xi$$

The average $\overline{X}$ enabled us to calculate the arithmetic mean and to develop some dispersion indices.

Scattering parameters

They are calculated from the average.

The calculation of the standard deviation makes it possible to evaluate the dispersion of the values around the "normal" average. It is determined by calculating the square root of the variance:

$$\sigma(x) = \sqrt{V}$$

V: is the variance

The standard deviation is the indicator of variability by excellence.

Based on the calculation of the standard deviation, the study of monthly and interannual reduced rainfall centred anomalies was undertaken by standardizing the data. Discrepancies are calculated through the following formula:

$$x'_i = \frac{x_i - \overline{X}}{\sigma(x)}$$

wih :

x'_i = centred reduced anomaly for the year i

xi = value of the variable,

$\overline{X}$ = average of the series.

$\sigma(x)$ = standard deviation of the series

The Accelerated Participatory Research Method (APRM) is used to collect information on constraints related to water supply for the population. To collect the information, individual or focus group interviews were conducted with farmers and the population.

3.RESULTS

3.1. Water access works in the Commune of Kerou

The populations of the commune of Kerou get drinking water from wells and boreholes so as to meet their water needs. The sources of water supply vary according to the villages and also the period of the year. Generally speaking, drinking water access facilities are grouped into traditional wells and modern facilities. Plank I shows some of the water access structures in the Commune of Kerou.

Photo 1: Modern well at Firou *Photo 2**: FPM at Batenin***

*Photo 3: **Water tower in Firou*** *Photo 4: **Fountain terminal in Sokongouna***

Plank I: Water access works in the Commune of Kerou

***Shooting :** SODJI J ; 2017*

Table II shows a synopsis of the drinking water facilities in the Kerou commune.

Table II: Summary of drinking water access facilities in Kerou

Districts	Populations	AEV	BF	FPM	PM
Brignamaro	21751	0	0	39	2
Firou	15235	1	7	38	1
Kerou	50497	2	11	93	7
Koabagou	4872	0	0	4	1
Total	92355	3	18	174	11

Source : Field survey 2017

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The analysis of Table II reveals that 206 drinking water access structures serve the populations of the commune of Kerou, i.e. 174 human-powered pumps, 11 modern wells and 18 standpipes connected to 3 AEVs. According to the Water Directorate's standard, which stipulates that there should be one water point for every 250 people, the rate of access to drinking water in the commune is 55%. This rate is well below the rate of access to water at the departmental level, which is 76.2% compared to 63% at the national level (MMEE, 2008, p. 15). Though there is a real need for water, its provision in some districts is still low because of the specific characteristics of these districts. It should also be noted that the dispersal of dwellings makes it difficult to install structures that are accessible to the entire population of a village and constitutes a handicap to the rational coverage of water point needs.

3.2 Factors in the provision of drinking water

Various factors have been highlighted in the field and in the literature as influencing user satisfaction with the drinking water service. These include the inadequacy of water sources, the distance of water supplies from villages, the poor quality of water, income, the price and the presence of alternative water sources.

3.2.1 Hydrogeological factors

The lithological nature of the geological formations has a very strong influence on water availability. In the commune of Kerou, the aquifers are of disconnected type. This means that they are linked to the fracture, which itself is locally continuous. The aquifer that can be tapped is located in the fractured part of the sound rock and/or in the alteration layer. This situation makes it very difficult to access the groundwater and the structures dry up quickly in dry seasons

Photo 5: Partial view of the wall of a traditional well in Kerou

Shooting : *SODJI J ; 2017*

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According to N'TCHA and al (2020), three different hydrogeological zones corresponding to the three geomorpho-structural units described above are distinguished (Ahissou and Goudalo, 2004):

- the mainly shale reservoir zone;
- the predominantly quartzite reservoir zone;
- the migmatito-gneissic reservoir zone.

The schistose bedrock zone; located to the northwest, is composed of schists with quartz vein intercalations; these schists belong to the Tagayéï formation. This is an area where water inflow is linked to the presence of quartz veins and/or veinlets and quartzite intercalations. The thickness of the alteration layer is less than 25m. Flows are generally low and recharge is very slow (Geohydraulics, 1985).

The quartzite bedrock zone: located in the north-east, is represented by the sites located on the slopes and uplands of the micaceous quartzite hills; it is the largest zone with folded formations in some places and with several levels of fracturing, and fractures sometimes filled with quartz. Nevertheless, its productivity is better than that of the previous zone (Geohydraulics, 1985).

The migmatito-gneissic bedrock zone: located to the south, is characterized by layers of alterites capable of storing a certain amount of water which can be locally enhanced by the existence of different networks of fractures with sometimes tight meshes, especially if they are not filled by the alteration clays. This is the potentially favourable zone where an average exploitation rate of up to 10m3/h is obtained. The aquifers are contained in two types of reservoir in these zones (Ahissou, Goudalo, quoted by N'tcha T et al, 2020, p 15):

-an upper reservoir made up of alterites and residues from the mechanical disintegration of the parent rock. Boreholes drilled in these aquifer formations show a succession of armour-plated or gravelly alterites, clayey alterites and then arenas. The thickness of these alterites has been estimated at 17m on average by Sogreah-Scet, cited by N'tcha T and al (2020).

-a lower reservoir consisting of cracks and fractures in the bedrock that allow water to seep into the crystalline rocks. This type of reservoir overlies the healthy rock. The deep fractures extend laterally over tens of kilometers and are therefore relatively favourable reservoirs.

3.2.2 Household access to safe water

In West Africa, fetching water is the main problem faced by the population, especially women. Indeed, the time spent by women to supply the household with drinking water is one of the parameters that inhibit the development of their economic activities. The Rural Drinking Water Supply and Sanitation Programme (PAEPA) in Benin defines a maximum distance of 300m between the water point and the place of use for adequate access (FAD, 2012). Very often, the burden of fetching water falls on women and children who often have to cover long distances, leaving less time for other activities such as domestic chores, income-generating activities, etc. In the commune of Kerou, the distance and time taken are a function of the type of resource, the geographical location of the resource and the size of the household. Figure 3 shows the average distances covered by the population to reach a drinking water point.

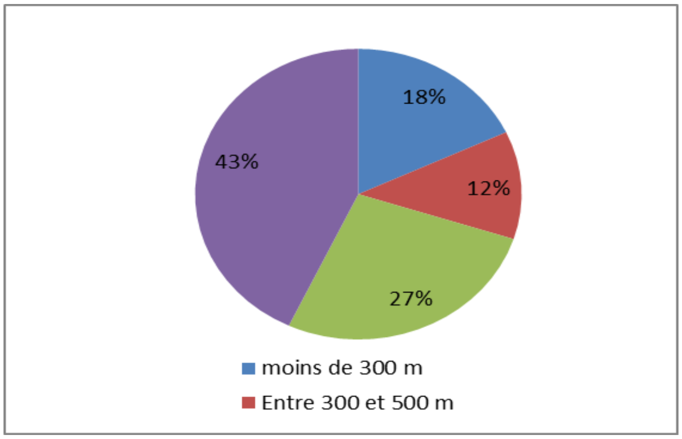

Figure 3: *Average distance covered to get drinking water*

Figure 3 shows that in the Commune of Kerou, 18% of households cover less than 300m each way to fetch drinking water, all seasons combined. All the same, 12% of these households walk between 300 and 500 m daily to obtain the vital liquid. Finally, nearly 70% of households travel between 500 and more than 1,000 meters to fetch drinking water. In some districts, especially in rural areas, the lack of water points and the early drying up of aquifers during the dry season means that people have to walk more than a kilometre to get drinking water. Sometimes, they travel up to 5 km to obtain water from unhealthy ponds for consumption (photo 6). According to the WHO guidelines, more than 70% of the population have difficulties in accessing drinking water in the commune of Kerou.

Photo 6: Woman collecting water from a river
Shooting: *SODJI J ; 2017*

3.2.3 Climatic factors

Like Africa, Benin has been confronted with disturbances in rainfall patterns that are indicative of climate change for several decades. In the Commune of Kerou, the evolution of rainfall (Figure 4) has been characterized by a downward trend since 1970s, with values almost always below average. These different aspects of climatic disturbances have repercussions on all sectors, mainly water resources.

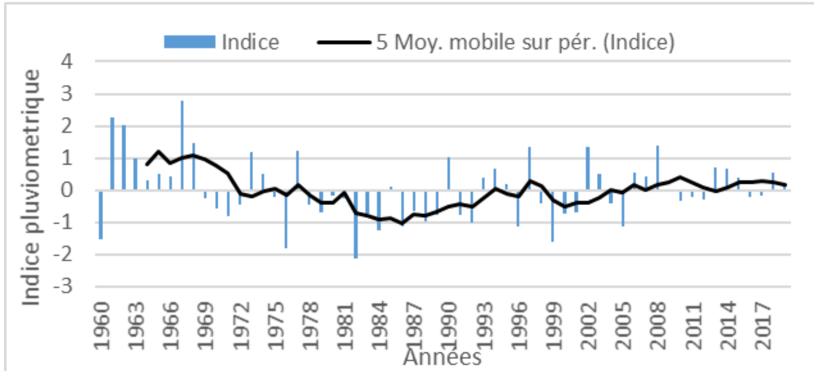

Figure 4: Rainfall index in Kerou from 1960-2020

Three phases have been identified in the evolution of rainfall at Kerou Station. The first is marked by rainfall surpluses, and covers the period 1960-1972; the second sub-series is characterized by rainfall deficits between1973-1990. The third phase is characterized by a very strong instability in the evolution of rainfall and concerns the period 1991-2020.

The impacts on water resources (surface and groundwater) are huge (reduced agricultural production, deterioration of food security, increased incidence of floods and drought, spread of diseases and increased risk of conflicts due to land and water scarcity) and are already evident. Indeed, these phenomena affect the quantity and quality of water. Droughts combined with other factors, such as high water demand, have led to a decrease in river flows. Likewise, a reduction in recharge has been observed, resulting in the early drying up of aquifers.

3.2.4 Transfer prices for water services

According to F. Nowak (1995, p. 27), "The price of water does not exist". Indeed, if we are to compare the tariffs of different water services, there is no pre-established value that enables to easily know if the price of our service is higher than that of the neighbouring service. This depends on the pricing structure and the consumption level. Fauquert (2007, p 37) assumes that there is no 'fair price' attributable to water, but a 'fair process' of defining the price of this resource. Firman, N (2011, p15) argues that pricing water promotes equality, efficiency and sustainability in the water service. However, its implementation is a major challenge. Indeed, the price is the result of a process of identifying the supplier of the service. The local authority and the operator will come to a co-defined price and contract after a series of discussions.

In the commune of Kerou, the selling price varies according to the unit of measurement, the source and the village. However, the price of a 25-litre basin varies between 15 and 125 francs at the FPM level and 25 francs at the BF level. The results of the data processing show that a household of 5 people uses about 3 basins of water per day for domestic needs, i.e. about 45 to 375 F/day to spend on water. This amount seems outrageous given the standard of living of the population (less than a dollar a day). To reduce these costs, people who do not have the means only buy drinking water at drinking water points and fetch the rest from rivers. The lack of financial means therefore forces people to use unsafe water.

The high cost of developing drinking water resources is a major obstacle to improving access to water in poor areas, especially in rural Africa. However, villagers are willing to make a major financial contribution in order to secure a local source of clean water.

3.2.5- Lack of hygiene at drinking water points

Water is drinkable or safe when it is safe to drink. The lack of hygiene at drinking water points contributes to the pollution of water that used to be drinkable at the source. Photos 7 and 8 show the unsanitary condition of water points and some of the acts that contribute to water pollution.

Photo 7: ***Presence of naked children on***

Photo 8: Wearing shoes on the protective slab of a FPM

The analysis of photos 7 and 8 clearly shows the unsanitary state of these water points. People keep their shoes on their feet even when they are on the protective slab of the structure. Likewise, the presence of naked children on the protection slab is noticed. These behaviours are potential sources of water contamination. The hygiene rules in the sanitation manuals prohibit such behaviour. The water collected in these basins can be contaminated from the source of supply. All these practices show that the populations neglect the rules of hygiene around the water points. What is the quality of the water consumed by the population?

6.DISCUSSION

Water is a vital resource not only for survival, but also for environmental sanitation, public health, social peace and economic growth. It is crucial to human beings and nature. Several factors inhibit efforts to access water. By way of comparison, the study carried out in Ouagadougou by Dos Santos S. (2005) revealed that households covered an average of 350 meters to get water directly from the collective water point. The typology of Howard G. and Bartram J. (2003, p.13), shows that good accessibility to water is defined as having a drinking water point within 100 meters. Thus, it results that only about two out of 10 households (15%) have easy access to drinking water. According to (WHO cited B. Hounmenou, 2014, P3), accessibility is a concept that reflects the ease with which users can access a service. When applied to drinking water, it is expressed in terms of the availability of the resource, permanence, the distance between the household and its water point and quality. In the study area, 70% of households cover between 500 and more than 1,000 meters to obtain drinking water. In some districts, especially in rural areas, the shortage of water points and the early drying up of aquifers during the dry season force people to cover more than one kilometer to get drinking water. Through their research on the determinants of the volume of drinking water used in rural areas in Oueme valley in Benin, Cocker, F et al (2020, P7) have shown that the analysis of the relationship between the distance covered and the quantity of drinking water collected show that a distance of more than 300m determines the collection of less than 20L of water. Hounmenou (2014; P5) concludes that when the distance to the supply point increases, users have to expend more energy and time to benefit from the service. This reduces their satisfaction with the service and thus increases the risk that they will switch to traditional (and supposedly closer) water sources.

With regard to financial constraints, the selling price varies according to the unit of measure, the source and the village. However, the price of a 25-litre basin varies between 15 and 125 francs at the FPM level and 25 francs at the BF level. The results of the data processing show that a household of 5 people uses about 3 basins of water per day for domestic needs, i.e. about 45 to 375 francs per day to devote to water. This amount seems staggering given the standard of living of the populations (i.e. less than a dollar/day). For Clement and al (1999, p 128) and Montginoul and Rinaudo (2006, p 43), the main reason for using an alternative source of water is to reduce the cost of water. However, a sharp rise in the price of water or an upward trend in the tariff structure encourages consumers (who therefore see their water expenditure rise sharply) to resort to sources other than the present one, instead of reducing their water consumption (Limam, 2002; p13).

The aquifers are of discontinuous type; that is to say linked to the fracture which itself is locally continuous. The aquifer that can be tapped is in the fractured part of the sound rock and/or in the weathered layer. This situation makes it difficult to access groundwater and the works dry up quickly in the dry season.

The rate of early drilling depletion is higher than the thickness of the weathering layers is low. This means that the thickness of the alteration layers depends on the productivity of the boreholes. This logic of hydrogeology of the basement zones has been verified by others such as Boukari and al in 1984 and N'go and al in 2005 who argue that drilling productivity increases with alteration thickness in crystalline and crystallophyllous rocks where medium and high flow rate (Q> 2m3/h) are generally found in areas with thicknesses between 10 and 40 m in Agboville region in Ivoiry Cost.

7.CONCLUSION

The access to drinking water is an issue for populations in many parts of the world, especially in rural areas of developing countries.

The findings of this research show that the main factor affecting access to water in the Commune of Kerou is the distance (D) covered for the supply. Distance has a significant negative impact on supply time. The important factors are the geological facies made up here of crystalline bedrock in which aquifers are difficult to access, the high cost of water transfer forces the populations to resort to unhealthy sources. Climatic factors and the level of sanitation are also obstacles to the satisfaction of the population with the public water service.

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