**International Journal of Agriculture, Environment and Bioresearch**

Vol. 3, No. 05; 2018

ISSN: 2456-8643

# CLIMATE VARIABILITY AND MANAGEMENT OF WATER POINTS AND AEV IN THE NATITINGOU COMMUNITY: EVALUATION OF ACCESS RATES TO DRINKING WATER AND ANALYSIS OF SUSTAINABILITY (BENIN, WEST AFRICA)

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## ABSTRACT

One of the major challenges facing humanity is the problem of water, especially for the well-being of low-income communities. The objective of this research is to diagnose the results of the implementation of decentralization on the management of water points and AEVs in the Municipality of Natitingou in Benin.

The methodological approach adopted to conduct the study consisted of data collection as a first step. These data consist of socioeconomic data from field surveys, demographic data obtained at INSAE, climate and statistics related to the various water points and AEVs carried out in the municipality. These data were collected thanks to the documentary research and the investigations in real environment. At the end of this study, it appears that a total of 125 hydraulic structures were built in the municipality of Natitingou by the authorities at the central level of the State. These efforts continued with the local authorities following the advent of decentralization in 2003 through the construction of more than 110 hydraulic structures.

**Keywords:** Natitingou, decentralization, management, drinking water

## 1. INTRODUCTION

One of the major challenges facing humanity is the problem of water, especially for the well-being of low-income communities. Access to and good governance of this resource is a determinant of economic, social and local development (CARE International, 2007). In Benin, legislation on decentralization gives local and regional authorities the responsibility for realizing hydraulic infrastructure (Article 83 of Law 97-029). Since 2003, it is at the local level that the implementation and governance of water resources is organized. According to Protos (2015), in order to improve the local governance of this vital resource, Benin carried out in 2005 a re-reading of the National Drinking Water Supply Strategy carried out in 1992. Indeed, several amendments have introduced namely the delegation by the municipality of the management of

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water works to a natural person chosen by the community or a private operator in place of a Water Points Management Committee which has shown its limits. Similarly, the establishment of a communal framework for the maintenance and monitoring of simple structures has been adopted. Moreover, since the 1990s, the international community has recognized the fact that good governance plays an important role in improving the living conditions of peoples (Vissin, 2007). Persistent development challenges, as well as current and projected water crises, reflect governance failures in terms of water management (UNDP, 2002).

The MDGs adopted by the UN General Assembly recommend, among other things, to ensure a sustainable environment by integrating the principles of sustainable development into national policies and by reversing the current trend towards the loss of environmental resources in the face of increasing populations and their multiple needs (UN, 2005).

The Municipality of Natitingou did not remain outside this legal provision. After the installation of the municipal council in 2003, the municipality is committed to meeting the water needs of the population through various actions.

So, does the method of management of the hydraulic structures adopted by the local authority improve the rate of access to drinking water and ensure the sustainability of the achievements?

**1.2. Field of study**

Located in the north-west of Benin in the Atacora department between 1 ° 03'22 " and 10 ° 29'14 " north latitude and between 1 ° 25'29 " and 1 ° 29'22 " east longitude, the Municipality of Natitingou covers an area of 3045 km2 or 12.8% of the total area of the department. It is bounded on the north by the Commune of Toucountouna, on the west by the Commune of Boukoumbé, on the south and on the east by the Commune of Kouandé (figure 1). Equidistant and epicenter of the majority of the Communes of Atacora (Tanguiéta, Copargo, Kouandé and Boukoumbé), the Municipality of Natitingou is 111 Km from Porga, a locality bordering the Republic of Burkina Faso by the Pendjari and 515Km from Ouagadougou, capital of Burkina Faso.

The geographical position of the Municipality of Natitingou makes of it a city of transit towards the countries of the inter-land including Burkina-Faso, Niger and Mali. Thanks to the paving of the National Inter-State Road (RNIE 4), the transit knows a considerable increase. Also the practicability of this road is a real asset for the development of all sectors (primary, secondary and tertiary).

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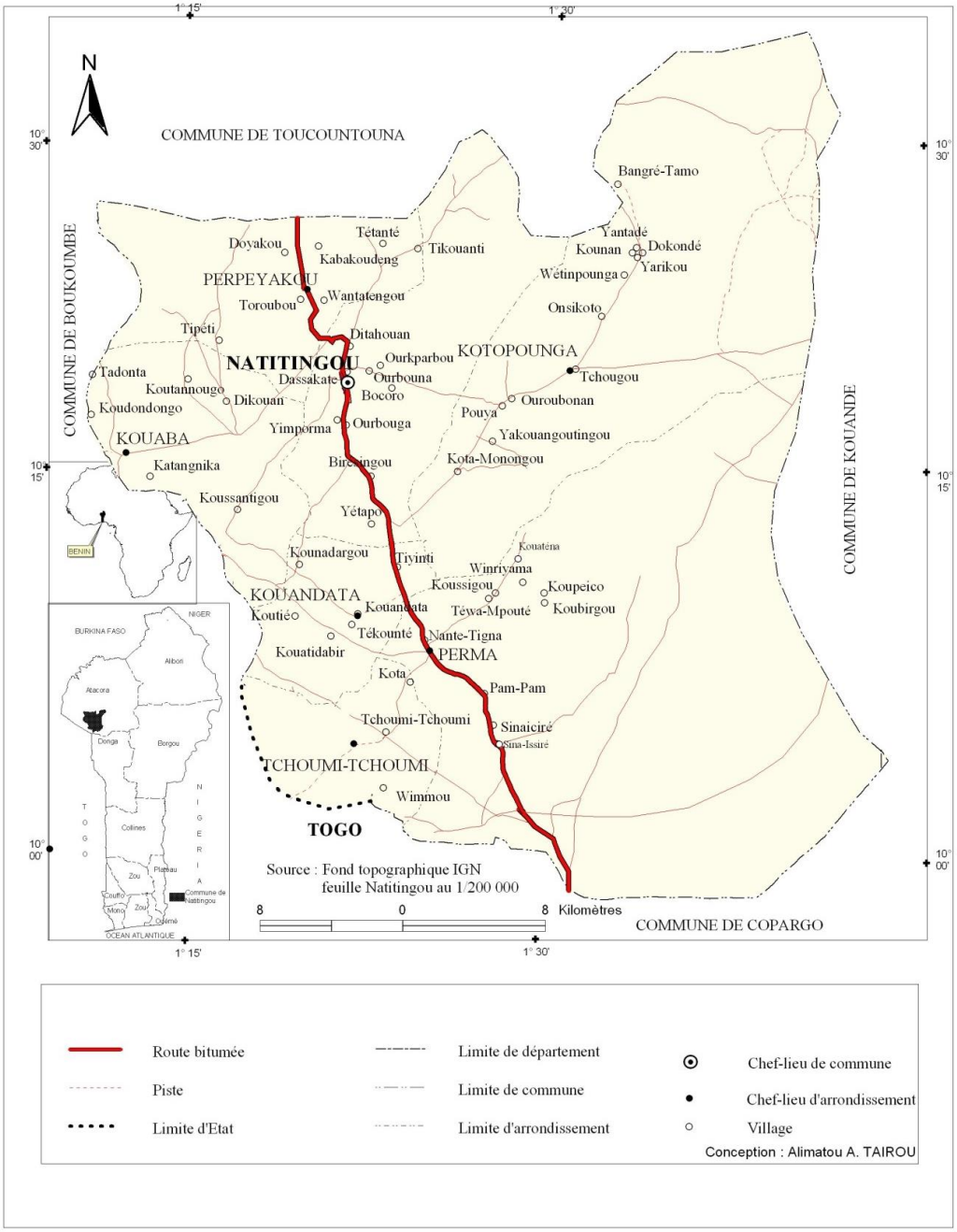


Figure 1: Geographic location of the municipality of Natitingou

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## 2. MATERIAL AND METHODS

### 2.1. Data collected

The data of the monthly and Interannual rainfall series collected at the Agency for the Safety of Air Navigation in Africa and Madagascar (ASECNA) from Natitingou. Also, maximum and (monthly) temperature data. All these data come from the synoptic station of Natitingou for the period 1965-2015.

Demographic data, they concern the population numbers of 1979, 1992, 2002 and 2012 (RGPH 1, 2, 3 and 4). Similarly, population projection data produced by the same structure are used for this study. They make it possible to assess the evolution of the population and to relate this information to that of the water resources of the municipality.

Socio-economic data, they relate to the information that comes from field surveys. To them, are added the photos taken as well as the geographical coordinates of the various water points and AEV of the municipality

### 2.2. Data collection tools

Several tools were used for data collection. These include:

questionnaires addressed to local elected officials, the population and grassroots actors involved in the water sector and which have helped to collect information relating to the assessment of the rate of access of populations to water drinking in the municipality;

an observation grid to assess the surface water resources in the field. It is a technique of visual appreciation that allows, thanks to the presence of certain predefined elements in the middle to make a judgment on certain aspects related to the research works.

a digital camera for taking pictures during fieldwork;

### 2.2. Data collection technique

direct observation in the field to ascertain the state of the surface water resources;

a documentary search was carried out in order to better define the contours of the subject. For this purpose, existing general and specific works related to the subject have been identified and read. This step allowed to take stock of the knowledge and to elucidate the concepts related to the subject.

The survey technique used in this study is the survey. These surveys, which follow the exchange and observation work in the field, made it possible to search for additional information to better understand the management of the water points and EVAs in the Municipality of Natitingou.

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In addition, it should be noted that sampling is done randomly to determine the identified target groups.

In order to collect as much information as possible, several households are interviewed in the various districts of the municipality. These boroughs are composed of both urban and rural districts.

For the collection of socio-economic data, the targeted target is households. The statistical unit concerned here is the Municipality of Natitingou. For this purpose, the sample size was determined according to the method of Schwartz (1995). This method results in the following protocol

Calculation of the sample size: $\boldsymbol{X = (Z_{\alpha})^2 \times p(1-p)/i^2}$ ;

Avec : X = la Taille de l'échantillon ; $\boldsymbol{Z_{\alpha}}$= reduced gap corresponding to a survey rate 95 % ($\boldsymbol{Z_{\alpha}}$=1,96) ; $\boldsymbol{p = n/N}$ ; avec p = proportion of households in selected localities (n) compared to the total number of households in the commune (N).

Ainsi : $\boldsymbol{p = \frac{n}{N} = \frac{9412}{13057} = 0,7208}$, soit 72,08 % ; $\boldsymbol{i =}$ précision désirée égale à 5 % et $\boldsymbol{1 - p = 27,92\ \%}$, Donc, $\boldsymbol{X = 1,96^2 * \frac{0,72(1-0,72)}{0,05^2} \approx 310\ \text{ménages}}$.

The sample size to be surveyed is 310 households. This number was randomly distributed in the districts according to the Schwartz method.

**Table I shows the distribution of households by district in the Municipality of Natitingou.**

**Table I: Sampling**

| | Arrondissements | Ménages | Echantillonnage |
|---|---|---|---|
| 1 | Kotopounga | 1685 | 56 |
| 2 | Koundata | 710 | 23 |
| 3 | Tchoumi-Tchoumi | 731 | 24 |
| 4 | Natitingou I | 1830 | 60 |
| 5 | Natitingou II | 1841 | 61 |

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| | | | |
|---|---|---|---|
| 6 | Natitingou III | 2615 | 85 |
| **Total** | | **9412** | **310** |

Data Source: INSAE, 2012

### 2.2. Data processing method

A manual and detailed analysis of the survey cards is done. The results from this count are part of the database. Statistical data collected at INSAE, the hydraulic service and the Mairie are completed in the database. It is from this basis that the processing and analysis are done.

Thus, using the Excel software, figures and tables relating to the population of the municipality and its distribution, hydraulic infrastructure, management mode of these infrastructures are made. The different maps are made with Arc view, Word is used for text entry.

After drawing up the graphs and tables, they were analyzed and commented on.

#### 2.2.1. Processing of demographic data

2025 as well as the assessment of the population's water requirements taking into account the population demographics of 2012.

On the basis of population growth rate, that of other years was determined. Thus, the following formula made it possible to determine the number of the population in 2015

$Pt = Po (1 + r)^{t}$ with

Po = Population at the start time considered, in 2002 and Po = P2002

r = Rate of population growth

1 = constant

#### 2.2.2. Treatment of climatic parameters

The variability of the rainfall heights has been studied in order to assess the interannual and monthly rainfall regime in the said commune by means of the formula below:

$\overline{X} = \frac{1}{n}\sum X_i$ avec,

$\overline{X}$ : Moyenne,

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Xi: the average rainfall in each month,

n: number of years over the study period.

### 2.3. Method of analysis of the results

The SWOT model (Strengths Weakness Opportunities, Threat-Strengths, Weaknesses, Opportunities and Threats) has been exploited with the aim of identifying the assets that contribute to the implementation of private delegate management and farmers through leasing and delegatees. promoted since 2009 (Figure 3). In addition, the constraints that influence this management were also highlighted. This allowed to maximize the assets and to minimize the obstacles related to these two main strategies on the access to drinking water to allow a durability to the access to the water resource in favor of the populations of the Municipality of Natitingou .

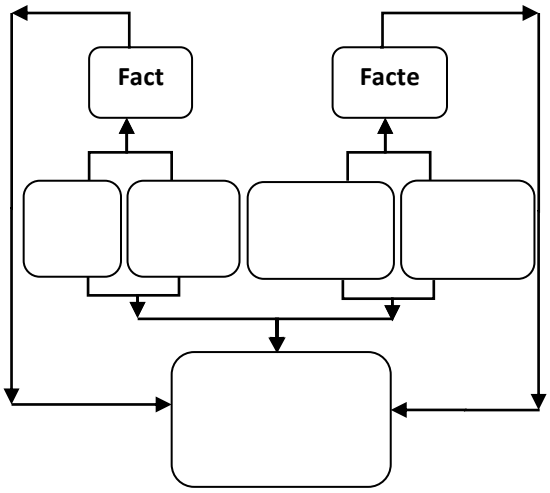


Figure 3: SWOT Analysis Model

## 3. RESULTS AND DISCUSSION

### 3.1. Climate variability at Natitingou

From a climatic point of view, the Municipality of Natitingou benefits from a local climate of the Atacorian type. The temperatures are therefore cooler because of the altitude. At Natitingou, the average temperature is about 27 ° C with variations from 17 ° C to 35 ° C during the harmattan. According to the Basic Report on the development of the Atacora strategic plan for sustainable development, rainfall, linked to both the arrival of the monsoon front and orographic influences,

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places the region among the most watered in Benin. The year is divided into two well-defined seasons:

- A rain season that starts in April and ends in October.

- A dry season that starts in October to end with the harmattan in April.

In fact, the rainfall varies between 1000 mm and 1400 mm with the highest amounts of water recorded during the months of August and September. Figure 2 shows the ombrothermal curve of the municipality of NatitingouSource: Learned, Christensen, Andrews and Guth, 1965

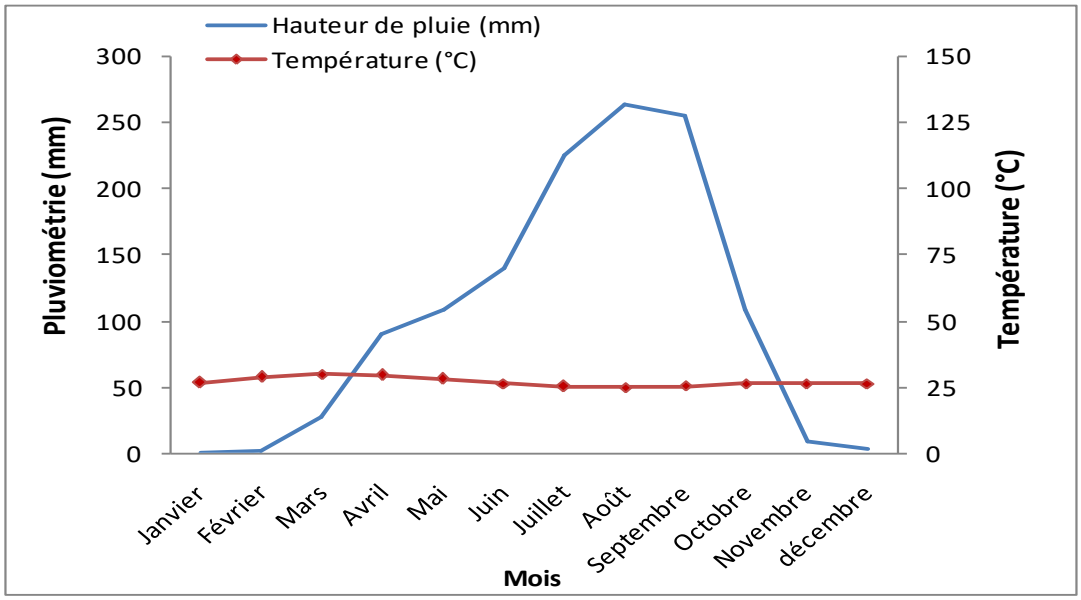


Figure 2: Natitingou's ombrothermal curve over the period 1965-2015

### 3.1.1. Rate of accessibility to drinking water before decentralization

Before the advent of decentralization in 2003, the municipality of Natitingou already had hydraulic structures allowing people to access drinking water. However, these infrastructures are not equitably distributed in all the boroughs (figure

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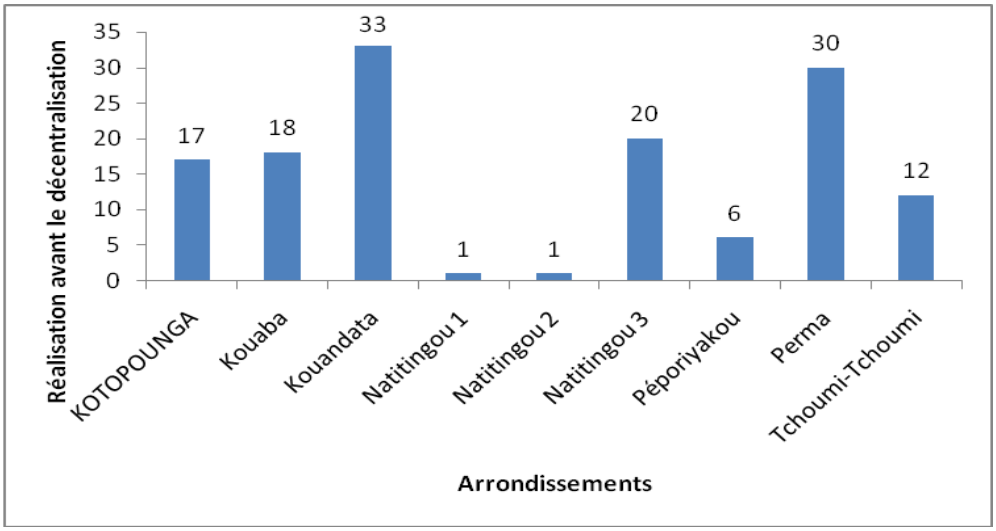


Figure 4: Accessibility to drinking water before decentralization

From the analysis of figure 4, it appears generally that all the districts had hydraulic works before 2003. Thus, in total, 125 hydraulic works were realized in the commune of Natitingou by the central State. For example kouandata has 33 water points, Perma 30, kouaba 18 etc. These efforts continued with local authorities after the advent of decentralization in 2003 through the construction of hydraulic structures.

### 3.1.2 Access to drinking water in the era of decentralization

After the advent of decentralization in 2003, local authorities continued in line with those at the central level. This has increased the number of existing structures per district. Figure 5 shows the number of structures completed per district from 2003.

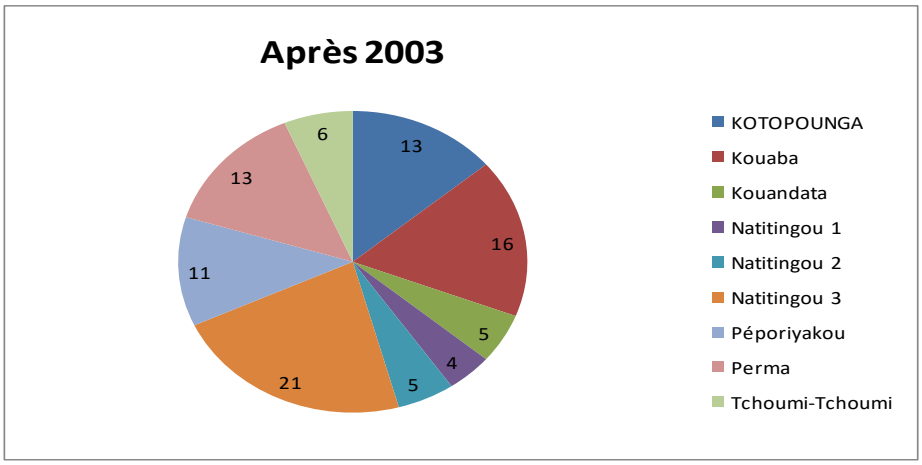

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Figure 5: Accessibility to drinking water in the era of decentralization

From Figure 5, it appears that the efforts of realization of the hydraulic works made it possible to drill 110 since 2003. Thus, in Kotopounga, 13 works were realized, 16 with Kouaba, 5 with Kouandata, 30 with Natitingou 1,2 and 3 In the district of Péporiyakou, 11 works have been completed, 13 at Perma and 6 at Chumi-Tchoumi.

Figure 6 presents the comparative evolution of the works carried out before and after 2003 in the municipality of Natitingou.

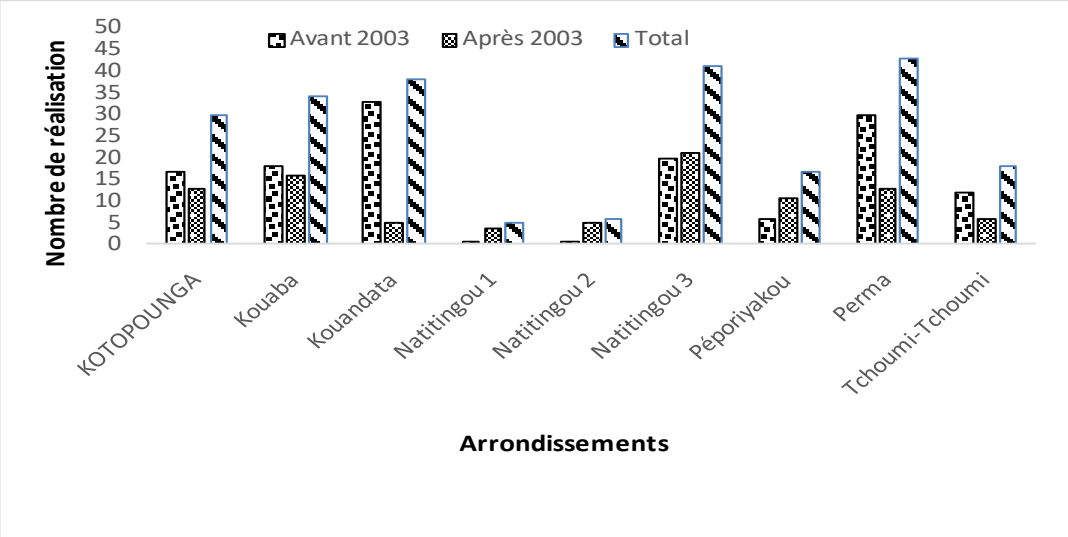


Figure 6: Accessibility to drinking water by borough

### 3.2. Management of drilling and AEV

In the commune of Natitingou, two modes of management are highlighted. This is private and leased management.

#### 3.2.1. Private delegation management

Given the limits of community management (high failure rate, mismanagement of works, etc.), the private delegation mode has been adopted by all Benin municipalities. Thus, this mode of management consists of entrusting the management of human-powered boreholes to a natural person chosen by the community or a private operator. The municipality of Natitingou did not remain on the sidelines of this decision, especially since it started the process and reached a delegation rate of 65% in August 2015. Indeed, although the central state and all the communes agreed to reach a 100% delegation rate in March 2015, there is still in the commune of

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Natitingou wells that are managed in a community way. However, the pumps that are managed by private delegates pay a sum of 5000 CFA francs to the mayor's office every month. Thus, only the pumps which are up to date in the payment of the royalties are repaired by the local authority in case of big breakdown. As for small breakdowns they are the responsibility of the delegate. But, in the municipality of Natitingou the delegate and two alternates are usually chosen within the community to sign with the mayor a management delegation contract including a specification that describes the responsibilities of both parties. It is up to the delegatee to have apprehended the tasks incumbent upon him.

In order to improve the quality of drinking water service, the State of Benin has set up drinking water consumer associations (ACEP) in the various municipalities. CAPE already exists in some communes of Atacora such as Boukoumbé and Cobly, however, Natitingou, municipality that is the subject of this study does not yet have. In the majority of localities the sale of water to users is done monthly at 300 FCFA per household. One of the major problems facing delegatees is the non-payment of fees by some households. More than 70% of the surveyed households recognize that this new management mode of MWF allows continuity in the service of the supply of drinking water.

As part of the maintenance of the equipment there are in the municipality repairmen who complain about the disorganization of their sector by the town hall and the unavailability of the municipal stock of spare parts of current wear of the works.

### 3.2.2. Farm Management

This management mode concerns AEVs. In this management mode, the municipality signs a lease contract directly with a private operator (farmer). The farmer has several roles that are among others:

- operate the works and sell the water to consumers at a rate fixed by the contract;
- ensure the operation, routine maintenance and maintenance of the system;
- pay at the start of the contract a deposit on the "Water" account of the municipality;

According to this mode of management, it is the municipality which is in charge of the renewal of the pumping system and the realization of possible extensions. The farmer is a natural or legal person with a legal existence whose competence allows him to manage the AEV (PADEAR, 2008). The farmer recruits an operator who is in charge of starting the group, making sure that the castle is full and that all the FFs are served and then collecting water from the fountain makers. He is the representative of the farmer on the ground. Also his role is to go through the

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BF and the private connections to raise their consumption in m3, collect the funds of water and then report to the farmer. The fontainer as indicated by his name, takes care of the maintenance and the sale of water from the BF for which he is responsible. Of the six BFs available to the territorial community of Natitingou two do not work (that of Peporiyakou for more than one year for lack of profitability and that of Sinaiciré in the Perma District whose circuit breaker caught fire only days after its implementation. provisional service).

The transfer price practiced varies little according to the localities. As an indication, the water is delivered by the farmer of Kotopounga at 550 F per m3 at the fountains and at 580 F at the private connections.

### 3.3. Rate of access to drinking water for the population of the municipality

#### 3.3.1. Evolution of the population of Natitingou

According to the last general census of population and housing, the commune of Natitingou has 99,656 inhabitants. This population is distributed as follows by rounding (Figure 7).

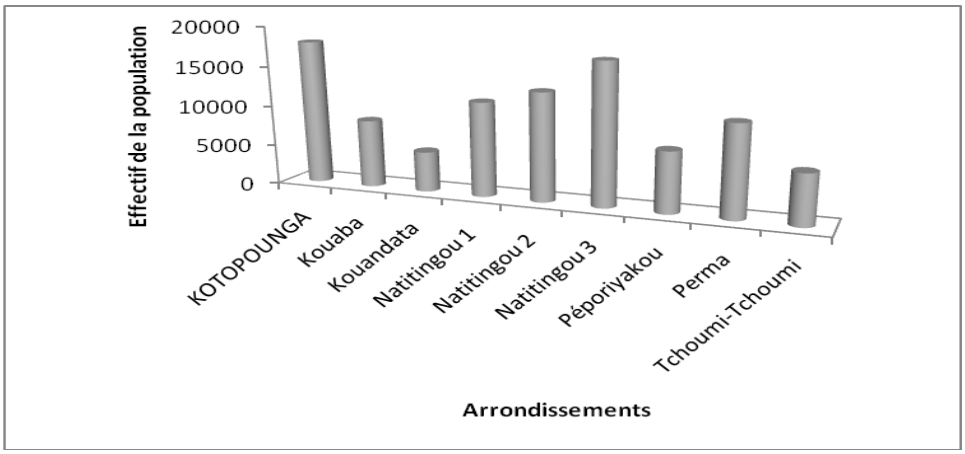


Figure 7: Population of Natitingou Commune

From the analysis of this figure, it appears that the district of Kotopounga has more inhabitants (18 0003) than all the other districts of the municipality. Then come the three urban districts including Natitingou 1, 2 and 3 with respectively 11,782, 13,489 and 17,584 inhabitants. Finally, the district of Perma with 11,419 inhabitants. After these large districts, come those whose populations are relatively less important including Kouaba (5,024), Tchoumi-Tchoumi (6,322), Péporiyakou (7,576).

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### 3.3.2. Rate of access to drinking water by borough

According to the international standard for access to water points, a population of 250 inhabitants is required for a water point. Thus according to this standard, it is important to remember the following (Figure 8).

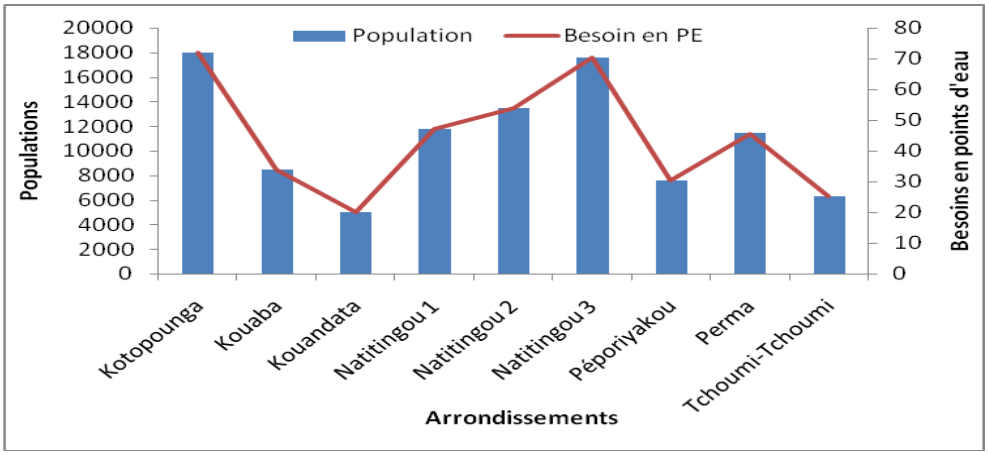


Figure 8: Water requirements of the populations of Natitingou commune

From the analysis of figure 16, it appears that according to the forecasts, it is necessary for a population estimated at 99656 inhabitants, 399 water points distributed as well as follows by rounding. Thus, 72 water points are needed for the district of Kotopounga, 34 for Kouaba, 20 for Kouadata, 171 water points for the three urban districts of Natitingou, 30 for Péporiyakou, 46 for Perma and finally 25 for Tchoumi-Tchoumi.

Table II summarizes the information on the service rate and the equivalent of the water point in the municipality.

Table II: Synthesis of the water points of the municipality of Natitingou

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| Arrondissements | Population | Besoin en PE | Taux de desserte (%) | Total EPE équipés | EPE fonctionnel | Taux de panne (%) |
|---|---|---|---|---|---|---|
| Kotopounga | 18003 | 72 | 109,7 | 91 | 79 | 11,24 |
| Kouaba | 8457 | 34 | 139,9 | 53 | 47 | 11,32 |
| Kouandata | 5024 | 20 | 263,7 | 58 | 53 | 5,36 |
| Natitingou 1 | 11782 | 47 | 14,9 | 8 | 7 | 12,5 |
| Natitingou 2 | 13489 | 54 | 18,5 | 11 | 10 | 0 |
| Natitingou 3 | 17584 | 70 | 41,2 | 32 | 29 | 3,33 |
| Péporiyakou | 7576 | 30 | 118,8 | 39 | 36 | 7,69 |
| Perma | 11419 | 46 | 153,3 | 77 | 70 | 2,78 |
| Tchoumi-Tchoumi | 6322 | 25 | 102,8 | 27 | 26 | 3,7 |

From the observation of Table II, it appears that the service rate of populations in water points is above 100% for all rural residents of the municipality. On the other hand, in the urban districts, the service rate is below expectations. This situation is justified by the fact that the urban districts are fed by the waters of the National Water Company of Benin (SONEB) contrary to the rural districts.

Moreover, this remarkable statistic hides realities observed in the field. Indeed, several water points are abandoned due to repetitive breakdowns observed. Failure rates vary from 0 to 13% depending on the districts.

### 3.4. Strategies for sustainable management of boreholes and AEVs in the commune

For sustainable management of boreholes and AEV in the municipality of Natitingou, strategies have been proposed taking into account the various actors involved in the water sector in the area.

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 Ensure an equitable distribution of hydraulic structures according to the districts, taking into account the norm stipulating 250 inhabitants for a water point;

 carry out periodic water quality checks and the state of drilling due to repeated failures observed in the field;

 support the municipality in achieving its mission as project owner.

 Common

 periodic verification of hydraulic structures to prevent breakdowns;

 periodic verification of the condition of the generators supplying the AEVs.

 Technical and Financial Partners (TFP)

 follow-up post-implementation for the sustainability of learning;

 assist in the construction of hydraulic structures in underserved areas.

 NGOs

 intensify information, education and communication activities on hygiene and sanitation with a view to changing behavior with regard to the maintenance of structures;

 create a consultation framework between water point managers to enable them to exchange experiences;

 Social Intermediation (ImS)

 promote collaboration between the local authorities of the municipality, the decentralized services, the operators and the users;

 make people understand the obligations of the actors and make them adapt to the chosen management method;

 accept and bring in the private sector to face the demands of the municipality in the construction of hydraulic infrastructure.

 Farmer and private delegate

 better organize water managers through training and advice;

 periodic inspections of operators and fountainmen;

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 ensure the periodic maintenance and repair of the works;

 regularly sweep the immediate surroundings of water points and remove all sources of pollution from water points.

 Local Community

 Establishment of drinking water consumer associations (ACEP)

 respect the rules of hygiene and sanitation around hydraulic structures;

 actively participate in the rehabilitation and cleaning of hydraulic structures and surface water sources;

## 4. DISCUSSION OF RESULTS

Before decentralization, the central authority was the one who realized or had water points and AEVs built in the commune of Natitingou. Since 2003, this task has been entrusted to the local authorities. Thus, the management mode by private delegate and the farmer contract are currently in vogue and allow the management of hydraulic infrastructure in the municipality. But the population has trouble conceiving that water is paying. They find it inconceivable to budget for water. This management mode of water points and AEV is practiced in all Benin municipalities. But what is more prominent in the commune of Houeyogbé is management by delegation (Zankpo, 2015) due to the reduced number of AEV and important water points. In all localities, management committees or user associations have been set up to encourage the management, ownership and sustainability of the infrastructure by the beneficiary populations. These management committees have been created around the various works and are composed of the different social strata of the localities, so there is no ACEP.

At the technical level, the spare parts are not accessible to the repairing craftsmen in charge of the maintenance of the hydraulic structures. Indeed, they have to move in the big cities and border countries to look for spare parts. These remote displacements entail additional burdens for the populations. Worse, sometimes the parts not available. This problem is not only found in the commune of Natitingou but also in Kétou (Zinsou, 2015) and Houéyogbé (Zankpo, 2015) where this situation leads the populations to resort to old sources unsuitable for the consumption especially the waters of surface (marigot, ponds, dikes, makeshift, etc. (Adomou, 2008).

## CONCLUSION

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At the end of this study, it emerges with regard to the role of decentralization in the accessibility of drinking water, that before the advent of decentralization in 2003, the municipality of Natitingou already had hydraulic infrastructures allowing populations to access drinking water. Thus, a total of 125 hydraulic structures were built in the commune of Natitingou by the central state authorities and about 110 hydraulic structures built in 2003.

With regard to the management of boreholes and VECs, two main modes are in vogue, namely management by delegation and that entrusted to farmers.

As for the evaluation of the access rate, it appears that according to the forecasts, it is necessary for a total population of the municipality of Natitingou estimated at 99656 inhabitants, 399 water points are necessary. Thus, 72 water points are needed for the district of Kotopounga, 34 for Kouaba, 20 for Kouadata, 171 water points for the three urban districts of Natitingou, 30 for Péporiyakou, 46 for Perma and finally 25 for Tchoumi-Tchoumi.

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