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HYDRAULIC INFRASTRUCTURES MANAGEMENTIN KETOU MUNICIPALITY IN REPUBLIC OF BENIN (WEST AFRICA)

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Abstract: Motivation/Background*: The insufficient management of the hydraulic infrastructures of Kétou commune limits access to drinking water for households in this commune. This research aims to analyze the management methods of hydraulic structures in Kétou commune.* ***Method****: For this propose, documentation, observations, and field surveys in 150 households selected according to the low or medium level of access to water infrastructures were carried out. Likewise, resources such as local elected officials and those in charge of water management of those infrastructures. The data collected was compiled in Word and Excel 2010 on Windows, descriptive statistics were used for the processing of these data and QGIS 2.14.6 was used for the creation of buffer zones which spatially prioritize the density, the average and weakness of the service points in water points as well as human concentrations.* ***Results****: As results, the drinking water supply rate for the Kétou commune is 42.75¨%. This commune has 182 hydraulic structures (FPM, PM, PEA, AEV) unevenly distributed, of which 106 structures are functional, ie a rate of 58¨% and 76 are broken down, ie 42¨%. This situation leads households in unserved localities travel long distances to obtain drinking water. It urges that communal, local and government actors in collaboration with the population of Kétou define strategies for easy access to drinking water for households in the commune.*

Keywords: B*enin, Kétou, unequal distribution of hydraulic structures, difficult access to drinking water*

INTRODUCTION

Water is a very precious natural resource and essential for the survival of human beings. Water is a finite and vulnerable resource essential for life, development and the environment. Water is a precious and necessary good for all ecosystems (M. Adoubiaran, 2008). It is very present on our earth and poorly distributed between countries, regions and people. Some suffer from water stress: a critical situation characterized by water unavailability. It is currently a scarce resource whose spatial and temporal distribution is unequal (B. A. Zannou, 2011). Fresh water represents only 2.5% of the total water that covers the planet (DGE, 2008). According to the United Nations (UN) estimates in 2005, more than a billion people are deprived of the right of access to drinking water. Africa is the continent most affected by the problems of access to drinking water where half of the population is affected by water-related pathogens (PHAC, 2012).
In West Africa, Benin is not on the sidelines of this situation of access to water. Benin has relatively large water resources. The average annual rainfall is between 700 mm and 1400 mm (L. Odoulami and M. Boko, 2009). Surface water resources are estimated at 14 billion cubic meters of water and the annual groundwater recharge capacity is estimated at 1.87 billion cubic meters (National WaterPartnership of Benin, 2007). But these resources are unequally distributed over the entire national territory and great difficulties are still linked to the supply of drinking water, especially in rural areas.

They undergo degradation and their quality becomes more and more critical. Thus, Benin has integrated in its Agenda 21 and in its Growth and Poverty Reduction Strategy Paper (DCRP), the protection of its water resources and adopted within this same framework, the Management Program. Integrated Water Resources (IWRM) through the Kouhounou declaration. But, it is clear that, until now, there are still problems of scarcity and inequality in the distribution of this resource.

In the commune of Kétou the problem of water supply is acute. People who do not have easy access to drinking water resort to dubious sources which are, among others, rivers, backwaters and sometimes even runoff, which has enormous consequences for their health. Geospatial technologies such as Geographic Information System (GIS) can be of significant contribution to drinking water supply problems. They are an alternative for studyingthe problems of drinking water supply. They offer the possibility of combining multi-source, multi-scale data and of regularly updating data essential for continuous monitoring of the production and supply of drinking water. This is what justifies the choice of this subject, which relates to the management of hydraulic infrastructures by geographic information systems in the commune of Kétou in Benin.

By assuming that GIS is an essential tool for establishing the diagnosis of water supply in order to make decisions for better coverage, the objective of this research is to understand by means of the Information System Geographic (GIS) problems related to the supply of drinking water in the commune of Kétou. GIS is simultaneously an analysis, management and simulation tool (E. Raynard, 2000). It allows to describe the structure of the studied reality and to model its functioning. It is also a set of spatially referenced principles, methods, instruments and data, used to capture, manage, analyze,model, simulate and map phenomena and processes distributed in geographic space. The data is analyzed in order to produce the information necessary to help decision-makers (N. Mbaye, 2011). As part of this research, GIS is a tool that allows you to enter, store, update and analyze georeferenced data to extract information useful for decision-making.The commune of Kétou is located at the northern end of the Plateau department, between latitudes 7 ° 10 'and 7 ° 41' 17 "North on the one hand and between longitudes 2 ° 24'24" and 2 ° 47 ' 40 "East on the other hand. It covers an area of 1775 km^2, or 1.55% of the national territory and 54.38% of the Plateau department. It is limited to the north by the Municipality of Savè, to the south by the Commune of Pobè, to the west by thecommunes of Ouinhi and Zangnanado and to the east by the Federal Republic of Nigeria.It is accessible by a permanent carriage road generally in good condition and is located 108 km from Porto-Novo, the capital of Benin. The Municipality is divided into six (06) districts which are: Adakplamè, Idigny, Kétou, Kpankou, Odomèta and Okpomèta. These districts are subdivided into 28 villages and 10 city districts. Commune is Kétou, located 138 km from Cotonou, the economic capital of Benin (figure 1).

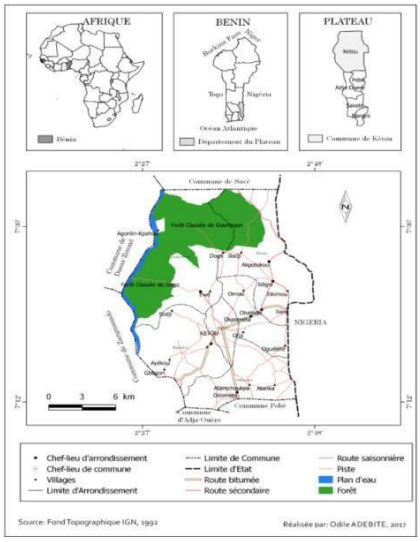

Figure 1. Geographical location of the municipality of Kétou
Source: Topographic Fund, IGN, 1992

MATERIALS AND METHODS

The methodological approach used to carry out this study revolved around documentary research, data collection and data processing. The documentary research helped to better define the main research questions. It consisted of visiting documentation centers and libraries, specialized institutions, the Internet, and other organizations capable of providing information relating to the water sector.
The reasoned choice technique was used to identify the households surveyed. The criterion of choice is based on the villages most affected by the problem of drinking water supply. The statistical unit is the household and only the head of the household is taken into account. This person can be the head ofthe household or his wife. But if both are present, the wife is privileged because it is the wife whotakes care of the water management better. To determine the sample, fourteen (14) villages are targeted. These are the villages most affected by the problem of drinking water supply. Thus, out of 28,059 households (INSAE, 2013) in the commune of Kétou, one hundred and fifty (150) households with an average size of 04 to 10 members (per household) were surveyed. The distribution is made according to the demographic weight of each district. This sample was supplemented by a list of 21 resource persons investigated. In total, 171 people were interviewed during the fieldwork. All of the data and information collected has been processed.
The information collected from the questionnaires developed is processed manually. The questions are first differentiated into two sub-groups: questions whose answers can be the subject of statistical analysis and those whose answers are to be summarized.
The statistics of the different variables obtained from the counting are put in tables or in figures. The mapping of the water points available in the municipality was made taking into account the database of the coverage of water points in the municipality of Kétou. These data are supplemented by those collected in the field. The formula used by PCEAU (2013) was used to calculate the drinking water supply rate.

$$TD = \left[\left(NbrEPE * 250 \right) + \left(NbrabS * 12 \right) \right] * 100 / EffPopuT$$

where

$$TD = PopuD / EffPopuT$$

With, TD = Taux de desserte; NbrEPE=Number of water point equivalent;
NbrabS= number of subscribers of theSoneb; EffPopuT= Total number of the population;
PopuD= Served Population.

The service rate is an indicator of the satisfaction of the populations' drinking water needs. Thus, the calculation of the service rate takes into account public water works such as FPM, BF, PM, PEA and active connections of SONEB.
The georeferenced statistical data has undergone various cartographic processing (the creation of a hydraulic infrastructure database which enabled us to produce the maps). Geographic coordinates are projected for each type of infrastructure.
QGIS 2.14.6 software is used for this processing. Their distribution is assessed by district and according to the demographic weight of each locality.
An analysis is based on the national standard in force for the distribution of hydraulic infrastructures and which is 250 inhabitants for 1 water point with a coverage of 1000 m of radius (DGH, 2005) was made.
Buffer zones are created in order to determine the service area of the water points. This technique makes it possible to visualize spaces where the coverage of hydraulic infrastructures is very dense, therefore very good physical accessibility.
The Strengths, Weaknesses, Opportunities and Threats (SWOT) model made it possible to analyze the management mode of the municipality's water infrastructure, the opportunities and threats are the external factors linked to the management of the infrastructure and which have an effect positive or negative on the water supply. Then, strengths and weaknesses are internal factors that contribute to or prevent the good management of drinking water supply and sanitation systems in Kétou Commune.

RESULTS AND DISCUSSION

Hydraulic works in the municipality of Kétou

The populations of the commune of Kétou are supplied by various sources of drinking water supply, including the water supply network of the National Water Company of Benin (SONEB) and the village water supply.

SONEB, which is in principle the leading supplier of drinking water throughout the national territory of Benin, covers only one district out of all six districts in the municipality. This is the Kétou district. However, network coverage within this arrondissement is still partial.

The communities of the districts of Idigny, Kpankou, Okpomèta, Odomèta and Adakplamè which do not yet have access to the SONEB water supply, benefit, thanks to the support of the various partners, from village water supply services in through the Adductions d'EauVillageoise (AEV), the BornesFontaines (BF), the Manual Pumps (PM), the Boreholes equipped with Human Motricity Pumps (FPM), the Autonomous Water Stations (PEA) and modern wells .

These various infrastructures bring the drinking water supply rate in the municipality to 42.75%. This rate hides, however, the difficulties of access for populations, especially rural ones, to drinking water. Several situations are at the origin of the populations' poor access to drinking water. These are: the low coverage of drinking water facilities, the non-functioning of some existing facilities and the high cost of water. Figure 2 shows the distribution of hydraulic infrastructures in the municipality of Kétou.

Figure 2: Spatial distribution of hydraulic infrastructures in the municipality of Kétou

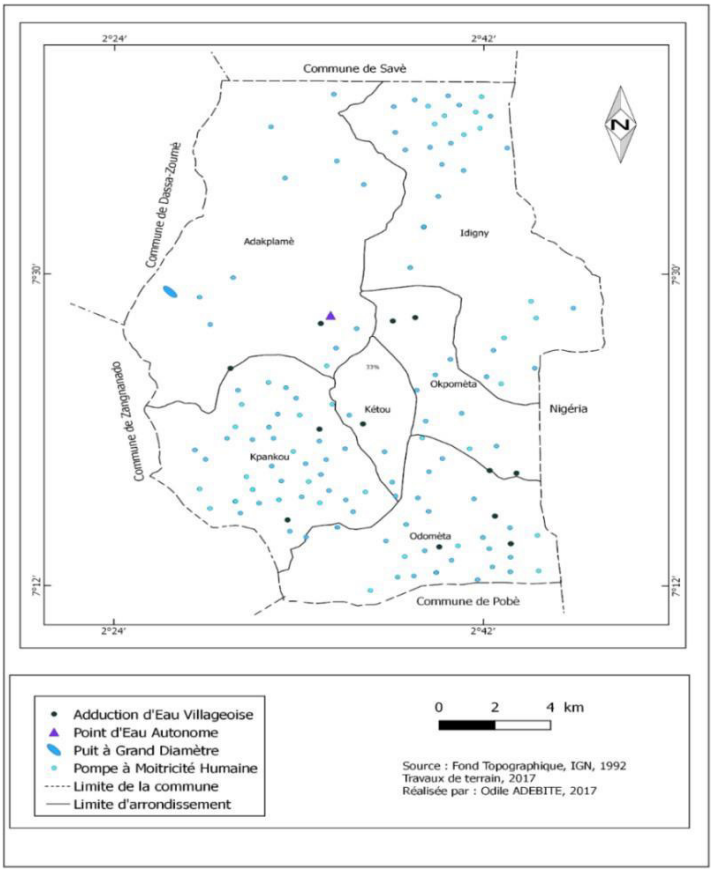

Figure 2 The infrastructure is concentrated in the south and northeast of the municipality.
Source: Topographic Fund, IGN, 1992

The North West and the Center are almost devoid of infrastructure. TDCs are the most important structures; then come the AEV, the PEA, and the PGD. This unbalanced distribution is explained by

the presence, in the northwest of the municipality, of tributaries of the Ouémériver and of the iron ion. The North-West and Center parts are almost devoid of it because of soil constraints. The districts concerned are Adakplamè and Kétou. This situation can be explained in part by the geographical position of these districts. Several infrastructures are sometimes installed in the same place because of the demographic weight of the surrounding localities. Thus, each infrastructure can serve a specific area and can support a limited demographic load for its sustainability. The various proximity analyzes based on buffers made it possible to determine areas of high concentration. The result of this process isshown in Figure 3.

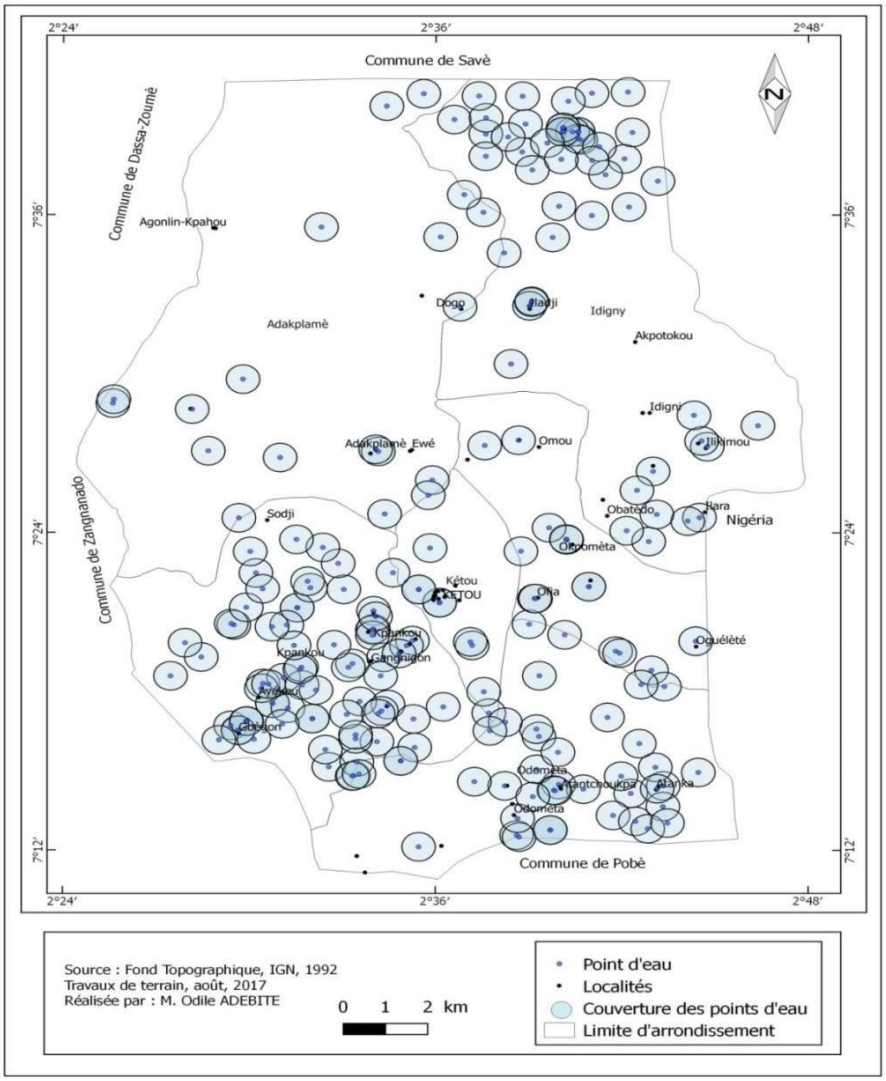

Figure 3. Service area for hydraulic structures
Source: Topographic Fund, IGN, 1992

The analysis of this figure shows that some localities are better served and others are less so because within a radius of 1km the hydraulic structures only cover 48 localities, i.e. a population of 44,958 out of the 157,352 inhabitants in this area. common.
The boreholes do not cover all the localities of the municipality and are therefore insufficient in number. It is therefore urgent to set up hydraulic relay infrastructures in areas not covered in order to alleviate the suffering of the populations who reside there. This means that populations beyond one or two kilometers will no longer have to travel a great distance before obtaining supplies.

Management methods for hydraulic structures
Management of modern structures

Modern structures such as large-diameter wells, PEAs, FPMs and AEVs are generally managed by the following few structures and individuals: the Association of Drinking Water Consumers (ACEP), the Permanent Commission, the Commission de Energy and Water, farmers and delegates. These structures and individuals are not remunerated for the service they provide, only they can obtain supplies from these different water points for free. Likewise, they are not invested with a mandate because in the event of mismanagement, they are systematically replaced by others.
It should be remembered that two modes of management of structures are practiced in the municipality: delegation for simple structures and leasing for complex structures.

Management by delegation
It concerns simple works. These are modern large diameter wells and boreholes equipped with hand pumps.
Modern large diameter wells
They are managed by the committee elected by the villagers. the committee receives training with technical support from the town hall, water service agents, in the management of hydraulic works. Unfortunately, there are no repair agents in the town. You therefore have to travel to Porto-Novo or Cotonou to find it. As a result, repairs take a long time and sometimes even these works are abandoned.
Boreholes equipped with human-powered pumps
They are also the responsibility of the committee which sells the water and maintains the borehole. The management of the borehole poses serious problems due to the frequent breakdowns caused by the high number of people using the pump, the insufficient competence of the maintenance teams, the careless handling by the users, the poor design of the thing. public. These failures sufficiently tire the populations who, in the worst case, end up abandoning the water point. Management is carried out by the delegates proposed by the village chiefs or district chiefs. Management fees are set work by work and on a case-by-case basis depending on the supply and the geographical position of the work. Finally, contracts are signed between the municipality and the repair agent for the maintenance of the structures.

Management by affermage
This new situation has been underway throughout the country since 2008, especially at this time when the town hall is the contracting authority. It specifically concerns AEVs and consists in contractually entrusting their management to a private person (company, natural person). Today AEVs are managed by farmers under management contract. The cost of water per m3 is 600 FCFA in the commune, or 25 FCFA per 35-liter basin.

Mechanical maintenance or maintenance
Routine maintenance is an easy task for the village pump repairer. It consists of ensuring the correct functioning of the pump on a daily basis. Thus, the village pump repairer is responsible for lubricating and replacing worn parts if possible. But we notice that in all the commune of Kétou there are no repair agents. In the event of a breakdown, these structures and individuals are obliged to appeal to the municipal authorities who are obliged to go to Porto-Novo or Cotonou, to seek a repairer.

Sanitary maintenance
Sanitary maintenance concerns the cleaning of the surroundings of the boreholes. The stagnant waters become the breeding ground for mosquitoes and wandering animals.

Financial management
Financial management concerns the maintenance of water points in the event of a breakdown. Thus, it becomes necessary to sell the water. In the localities where water is sold, there is a fund where the

funds are kept. But there is often no transparency in the management of this fund. In some localities, financial participation is requested from the populations for a possible technical intervention.

Geographic accessibility of populations

The populations of Kétou commune face various problems in obtaining water supplies. These are the remoteness of waterworks and the high cost of water. The penalties that people endure to have access to drinking water facilities depend on the position of their home in relation to the drinking water point.In the district of Kétou, 11.81% are close to the works and 88.19% are far, in Kpankou, 24.32% are close to the works and 75.68% are far, in Idigny, 10.52% are close to works and 89.48% are far, in Adakplamé, 19.29% are close to works and 80.71% are far, in Odométa, 15.78% are close to works and 84.22% are far and Okpométa, 15% are close to the structures and 85% are far (Figure 4).

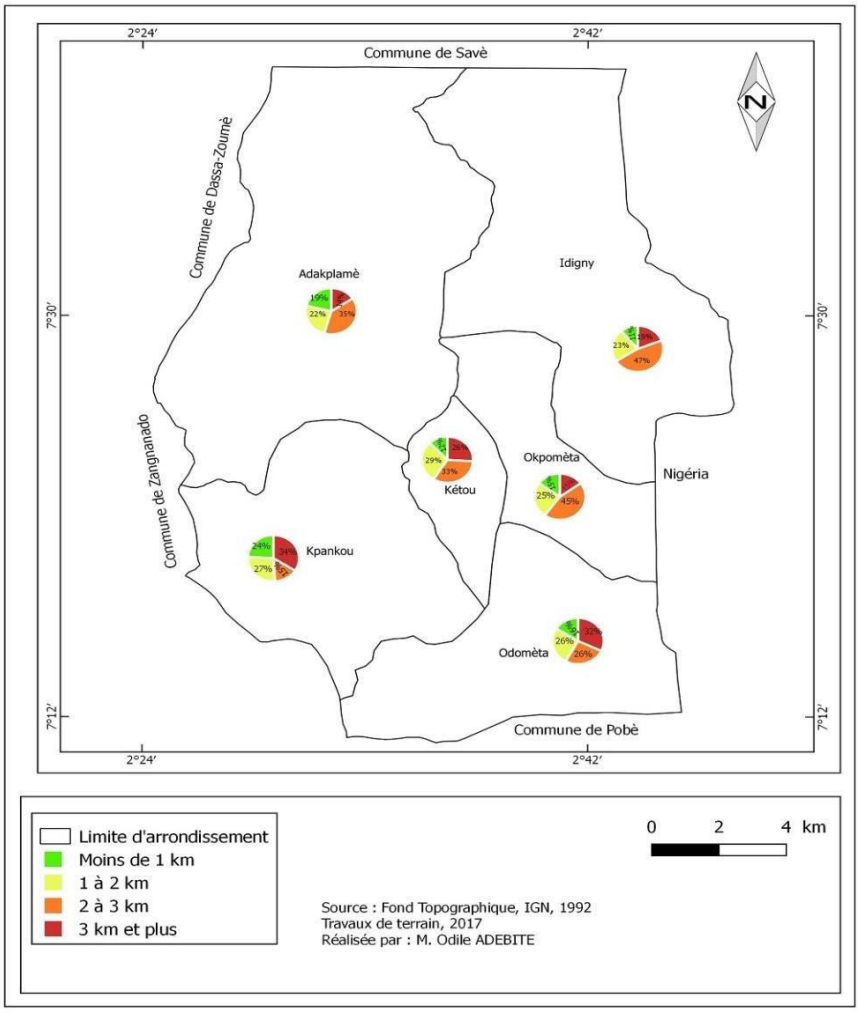

Figure 4. Distance traveled to obtain drinking water
Source: Topographic Fund, IGN, 1992

Figure 4 shows the distance traveled by the population of Kétou to obtain drinking water. It emerges from this figure that the majority of the populations of the commune of Kétou travel very long distances (2 to 3 km) before obtaining drinking water.

DISCUSSION

Access to drinking water and poor coverage of hydraulic infrastructure in the municipality of Kétou

The inventory of hydraulic infrastructure in the municipality of Kétou identified four (4) types of structures. These structures are large-diameter wells, autonomous water points, village water supplies and human-powered pumps, which are in the majority. Indeed, most of these infrastructures are located in the South and North-East of the municipality with a virtual absence in the North-West. These results obtained are similar to those obtained by (E. Evens and P. Lindskog, 2000), who also noted the unequal distribution of hydraulic infrastructures in the Republic of Haiti.

In the commune of Kétou, the hydraulic infrastructures are not equitably distributed. Prior work should be done in order to involve the population in the installation of the structures. These observations are also made in the work of I. Douelle (2008) who showed the importance of taking into account the opinions of the populations in the identification of the place of installation and the possibleform of said structures. This would certainly avoid problems of supply at the source and the egalitarian use of standpipes. This is the case of AEVs whose service areas do not cover all the localities of the municipality. In addition, each infrastructure will have to support an average of 865 inhabitants. This overload often creates queues for supplies and wastes people's time. This sometimes results in situations of water scarcity and the orientation of populations to unimproved sources to save time, allof which seriously compromises their health. This is where GIS is so helpful. These facts reinforce the findings of I. Assouma (2011), who showed in his study that GIS is of paramount importance in understanding the problems of access to water. The establishment of a database allows authorities at various levels to have an idea of the distribution of these infrastructures in order to make useful decisions for the happiness of the populations.

GIS and hydraulic infrastructures

GIS therefore offers the possibility of having historical and up-to-date data on the quality of the resource, its availability, its management and allows them to be optimized by focusing on cartography.The issue of access to water resources is addressed for all through the look at infrastructure to ensure the quality of their distribution. The results obtained within the framework of this study concerning theutility and the role played by GIS in the hydraulic field is similar to those of (A. El Garouani and A. Merzouk, 2006). These authors, have aimed in their work a fundamental objective which is based on the improvement of national knowledge on water resources and their protection.

In this current context, GIS has played a major and quite important role. It provided an idea of the typology of these infrastructures and their distribution over the entire municipal territory. A similar study was carried out by S. C. Hounguevou et al (2013), in the locality of Zè in Benin. Indeed, througha GIS approach for a spatial analysis of hydraulic infrastructures, these authors used the proximity analysis based on the buffer zones in order to assess the spatial distribution and to determine theservice area of the waterways. water points. In conclusion, they showed an unequal distribution of infrastructures on the territory of the municipality. The same is true of H. Smida et al. (2006) whohave shown in their studies that the importance of GIS lies in its ability to predict the deficit of hydraulic infrastructures and to ensure distribution for the happiness of the beneficiary population. Forthese authors, the contribution of GIS lies in its large capacities for data storage, processing, analysis and visualization. The aim is to develop a geographic database and determine the most favorable areas for recharging.

CONCLUSION

At the end of this study, we can retain that the hydraulic infrastructures of the municipality of Kétou are poorly distributed. This leads to an insufficiency of drinking water points in the area, which pushesthe populations of this town to obtain supplies from undeveloped doubtful sources such as: courtyards and water bodies. In addition, the lack of a mechanism for good management, poor maintenance and overexploitation observed on the said structures are all factors limiting the population's access to drinking water. The right of access to water is a fundamental right, a right to life and to development. In addition, the benefits arising from the use of GIS are enormous, especially in terms of infrastructure distribution. It saves time, facilitates access to water resources and information. Given these enormous opportunities offered by GIS, the next study will focus on Geographic Information System (GIS) and drinking water supply in the Plateau department in Benin.

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