Problematic Of Contrast Strategies And Seasonal Indigenous Water Supply In A Plinth Area: Case Of Dassa-Zoumé Commune (Republic Of Benin, West Africa)

René Ayéman ZODEKON, Brice Saturnin DANSOU, Léocadie ODOULAMI

Laboratoire Pierre PAGNEY, Climat, Eau, Ecosystème et Développement (Laceede)/ DGAT/ FASHS/Université d'Abomey-Calavi (UAC), 03BP1122 Cotonou, République du Bénin (Afrique de l'Ouest),
radeckrenezodekon@yahoo.fr

Laboratoire Pierre PAGNEY, Climat, Eau, Ecosystème et Développement (Laceede)/ DGAT/ FASHS/Université d'Abomey-Calavi (UAC), 03BP1122 Cotonou, République du Bénin (Afrique de l'Ouest),
bdansou86@gmail.com

Laboratoire Pierre PAGNEY, Climat, Eau, Ecosystème et Développement (Laceede)/ DGAT/ FASHS/Université d'Abomey-Calavi (UAC), 03BP1122 Cotonou, République du Bénin (Afrique de l'Ouest),
leocadieo@yahoo.com

Abstract: The water supply of the population is strongly influenced by the phenomenon of seasonal contrast in the commune of Dassa-Zoume. This study analyzes the endogenous water supply strategies of the population against those contrasts in the commune. The data pluviométriques to collect to the ASCENA of 1954 to 2015, then demographic gotten to the INSAE are used in the setting of this research. They have been completed by the socio - anthropological information gotten by the documentary research and the investigations of land tracks by questionnaire in 200 households chosen The Factorial analysis of the Correspondences (AFC) achieved in the software Minitab and the FFOM model) permitted to analyze the gotten results. It results from the statistical processing and analysis of data collected an increase of average temperatures and declining of rainfall from 353.9 mm in 1995 to 1514.18 mm in 2010, a reduction of rainy season, a prolongation of the dry season. In response to these climate changes, 52 % of households use well water, 22 % water drilling, 9 % water alveolar pots and 17 % use surface water. Other strategies are needed to address this challenge: the optimal water management available, the application of IWRM, water purification and wastewater reuse, use of impluviums.

Keywords: Benin, Commune Of Dassa-ZoumÉ, Plinth Area, Seasonal Contrast, Water Supply Strategies

1. Introduction

A rapidly changing climate is observed in recent decades generally in the world. It is expressed mainly by thermal and rainfall variabilities that affect the environment [1] and [2]. The manifestation of this phenomenon is reflected in Africa and particularly in West Africa by the rise in temperature and rainfall recessions. Indeed, rainfall deficits observed in the 1970s in this region have continued to occur even if it changes observed. Thus, the reduction in rainfall would vary from 20 % to 30 % in West Africa [3]. This would have negative impacts especially on water resources in the region. In Benin, the climate context is marked by a reduction of 15-30 % of rainfall between 1990 and 2025, if the increase in temperature increased to 0.6 ° C in particular under the latitudes between 5 ° and 10 ° north [4]. Thus, the precipitated amount of water would decrease by 20 % and the water needs of the population would be dissatisfied advantage. The town of Dassa-Zoume is not on the sidelines of this situation. In this county, climate variability is marked by a decrease in rainfall amounts of 3 % to 24 % during the last three decades compared to rain values observed between 1941 and 1970 [5]. These deficits negatively affect water resources, the consequences are felt in the supply of water to the population of the municipality. Indeed, the Dassa-Zoume commune is situated between 7 ° 29' et 7°57' de latitude north and 2 ° 9' et 2 ° 13 'east longitude (Figure 1).

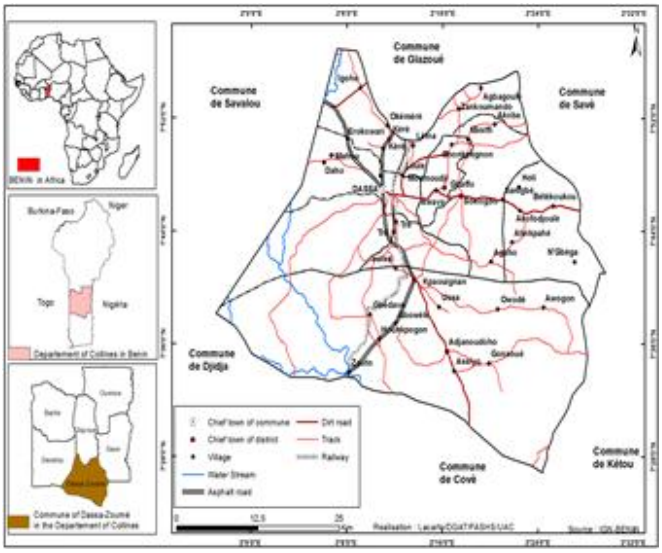

***Figure 1**. Geographical situation of the commune of Dassa Zoume*

It covers an area of 1711 km2 and has 112,118 inhabitants in 2013 (INSAE, 2013). The average annual rainfall amounts in said common balance around 1100 mm; temperatures vary between 20 ° C and 37 ° C and can sometimes rise to 38 ° C ([6]; [5]). The relief on which this commune is established a plateau with hills whose geological characteristics are gneiss and granite to almost zero porosity and permeability [7]. The main objective of this work is to study the different water supply strategies developed by populations in said common

2. Data and Research Methods

Rainfall data and minimum and maximum monthly and annual temperatures taken respectively from the Dassa-Zoumé / ASECNA rainfall station in Cotonou and the Save / ASECNA synoptic station over the period (1954 to 2014) divided into two sub-areas. periods (1954-1984, 1984-2014). These two data were chosen because they represent the most important parameters in the intertropical zone in the context of climate variability analysis at the commune level ([8], [9] [1]); Statistics of hydraulic structures (modern wells, AEV, drilling) of the town taken from the database of the hydraulic service Hills; Statistics subscribers to the system of the drinking water network SONEB and network length of the period 2003-2010 were extracted from the SONEB database. These data were used to determine the spatial distribution of existing hydraulic structures and evolution of subscribers to this network. Demographic data of 2013 of the municipality was collected INSAE. They were used to make the population projection for the year 2015 is the year of the assessment of the MDGs. Field observations have served to identify the different water supply strategies in the municipality; tools such as tape measure was used for the measurement of diameters, lengths and widths of alveolar pots and a graduated stick was also used as a gauge for measuring the depth of the alveolar pots; Questionnaire surveys were also conducted in a sample of 200 households in a reasoned way selected from households in the town and people resources (traditional leaders, agents of the municipality and NGOs) were consulted. Heads of selected households have at least 50 years and have a minimum experience of 30 years on the evolution of rainfall and water resources in their area. As for those resources, they have been identified based on their responsibility for the water supply of the town and water resource management or their knowledge of the relationship between climates - water resources. For the sampling of households investigation, the [10] was used: X = Zα2 XPQ / i2; with: X = the sample size; Z α = 1.96 is the z-score corresponding to an α risk of 5%; p = n / N; p = proportion of households in selected villages; n is the proportion of households in 28 villages served to surveys the number of households selected within ten (10) districts of the municipality; N is the total of households in the commune of Dassa-Zoume and n / N is the ratio of n and N. A total of 200 households were surveyed in 28 villages. Then socio-anthropological surveys were carried out in the town with various techniques. In addition to the focus groups conducted for the analysis of various difficulties and strategies developed in access to water in the town, state observations of hydraulic works and water points and measures on some issues have made. On the temperature and collected radar data, the arithmetic average was carried out with the formula X = 1 / nΣ (xi) X = arithmetic mean; N = the total number of terms; Xi = modality studied character. The climate balance of the period was also calculated with rainfall data from the following formula: P = Bc-ETP with Bc: climate balance; P: rain and ETP: potential evapotranspiration. He identified the effects of the seasonal contrast by following the following considerations:

- P-ETP <0, the balance is in deficit;
- FTE P-> 0, the balance is in surplus;
- P- FTE = 0 the balance sheet is balanced.

Then, analyze the strategies adopted by these households. The IT tools used in the realization of this study are:

- Excel software was used to capture some monthly and annual data and their transformation into charts and graphs;
- The ArcView software was used for the mapping of information collected
- Word software was used for the drafting of this study.

3. Results and Discussion

3.1 Biophysical Factors of the Hard Access to Water in the Commune of Dassa-Zoume

3.1.1. Evolution of the Temperature in the Commune from 1954-2015

Evolution of inter-month temperatures at Dassa-Zoume between 1954-1984 and 1984-2014. Figure 2 shows the intermensual variability of the minimum and maximum temperatures over the two sub-study periods.

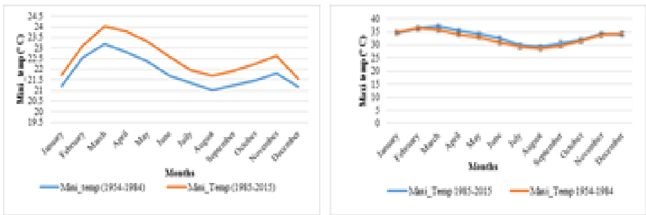

Figure 2. *Average and minimum temperatures during the 2 periods*

Figure 2 shows the intermensual variation of minimum and maximum temperatures over the period (1954-1984) and (1985-2015). The analysis of the latter shows that the minimum temperatures increased for all months of the year. This increase is marked by increases of +0.5; +0.57; +0.81; +0.96; +0.94; +0.87; +0.59; + 0.66; +0.67; +0.77; +0.85 and +0.35 respectively for the months of January, February, March, April, May, June, July, August, September, October, November and December. As for the maximum temperatures, they increased for the months of March, April, May, June, July, August, September, October and November during the year. This increase is marked by respective increases of +0.13; +1.6; +1.29; +1.64; +0.72; +0.71; +0.97; +0.33 and +0.33 for these months. The months of March, April, May, June, July, August, September, October and November devoted have therefore become hotter in contrast to the months of December, January and February which have become less hot. his variation in temperature with an upward trend impacts the availability of water resources in the commune of Dassa-Zoumé.

3.1.2. Evolution of Monthly Rainfall in the Municipality of 1954-2015

Figure 3 shows the evolution of the rainfall patterns of the commune of Dassa-Zoumé on the series (1954-1984) and (1985-2015).

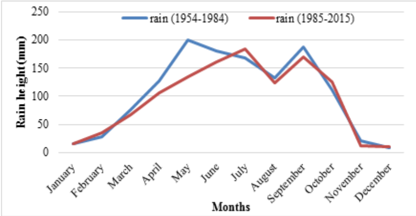

Figure 3. *Variation in the rainfall pattern of Dassa-Zoume 1954-1984 and 1985-2015*

A comparative analysis of the rainfall patterns in Figure 3 shows that the 1985-2015 period seems to be the most critical with a sharp decrease in precipitation for all the months of the rainy season except those in July and October in Dassa-Zoume. This reduction in rainfall heights is the source of modification of the spatio-temporal distribution profile of the rainfall regime, which previously was bimodal, but tends towards a unimodal regime that gradually settles in Dassa-Zoumé. The availability of water resources over the period 1985-2015 is in deficit compared to the wet period 1954-1984. This gradual change in rainfall patterns can be explained by the "less rainy conditions of the monsoon flow" during its migrations. These results seem to be consistent with those of [11], which shows a decrease of around 20 % for the period 1970-1990 for Benin, and [12] which also, in the commune of Dassa-Zoumé, showed that the monthly rainfall heights have been on a downward trend.

3.1.3. Evolution of Interannual Rainfall Heights in the Commune from 1954 To 2015

The annual rainfall heights experienced irregular variation over the period 1954-2015. They peaked in 1963 at 1752.2 mm and dropped to 151.3 mm in 2007 (Figure 4)

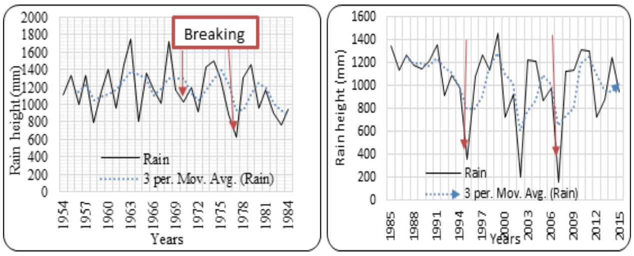

Figure 4*. Interannual variation in rainfall heights for the periods 1954-1984 (a) and 1985-2015 (b)*

The analysis in Figure 4 shows that rainfall amounts varied from year to year. Indeed, over the period 1954-1984, the maximum height of rain is recorded in 1963 with 1752.2 mm of water and the minimum one is recorded in 1977 with 623.6 mm of water. Rainfall disruption occurred in the decade of the 1970s. This result is consistent with the results obtained by [13], [14] and [15], [1], [16], [17] and [18]. Moreover, over the period 1985-2015 there was also an irregular variation marked by a break between the years 1963 and 2007. In view of the international variation in rainfall heights, the availability of water resources is over the period 1954-1984 and it is in deficit for the period 1985-2015.

3.2 Vulnerability of Water Resources by Climate Variability In Dassa-Zoume

The water resources of the commune of Dassa-Zoumé are of three types namely rainwater, surface water and groundwater. However, these water resources are influenced by climate variability. Indeed, rainfall amounts vary considerably, surface water (hydrography systems) are affected by the decline in their rates; the waterlogged soil retention capacity of rivers and river valleys has declined. These wet areas and conducive of crop for dry season which once constituted sources of income for the agricultural community are weakened by the weather of the drought. The same report was done on aquifers that most of which owe their existence to cracking and weathering of rocks due to the crystal structure, is very feebly conducive to the infiltration of rainwater. These aquifers are only pockets of water trapped using large diameter wells (100 m sometimes) and boreholes. Drilling is unproductive 2-5 m3 / h and dry up in a few years. That ground water dries up in the dry season following the decline of groundwater level [19]; [20]. This finding was confirmed by [21]; [22] and [23] in their studies that emphasize that groundwater under more pressure in difficult climatic conditions and they present major mobilization constraints than other sources in the basins of the north Benin. It is in these conditions that is observed the change in quantity and quality of water resources And also an increase in water deficit of those water resources in the commune of Dassa-Zoume. So, besides the climatic conditions, those precarious water resources are under the demographic pressures in the commune. Indeed, domestic water needs have increased with a population that passed from 93967 in 2002 to 112122 in 2013 [24]; [25]and would reach 145 125 habitants in 2015. To satisfy those water needs, several strategies have been developed.

3.3 Water Supply Strategies in the Commune of Dassa-Zoume

These strategies are traditional and modern order. The traditional water supply strategies vary according to the sources of water used. About the rainwater, the households collect it in bowl, jerry cans and cisterns connected to the roof by a pipeline system (photo 1 and 2).

Photo 1*. A jar used to collect rain water in Bétou*

Photo 2*. water take in a tank in Kpékouté*

Figure 1: *Testing data- load current (amperes)*

Photos 1 and 2 show a jar and a cistern used to conserve rainwater in the commune of Dassa-Zoumé during wet seasons. They show technical collection and rainwater conservation developed by households to have water at home and to use it in time. These practices are adopted in approximately 85 % of survey households. It should be noted that 99 % of household survey to retain rainwater in containers and 45 % have tank at home. This low percentage of households that have the cistern is relative to the cost raised of construction of a cistern. But most households have low incomes and can easily build this storage device in the home. Regarding groundwater, they are not easily accessed by households. However, flood areas are inspected and dug to collect water. But the water thus collected is often treated before its home consumption (photo 3 and 4).

Photo 3. *A hole dug in the ground to access water at Odo-Otchere (Borough of Kere).*

Photo 4. *A traditional well done to reach ground water Ayédèro*

3.4 Tables

Place table titles above the tables. Photos 3 and 4 present a shallow hole made on the ground and a traditional well. These techniques show the modes of accession to underground water resources. These techniques allow access to water. This groundwater is used in gardening activities and households after treatment with potassium sulfate. These practices are adopted by about 5% of survey households. Besides groundwater, households also use surface water. Since the Dassa-Zoumé commune is surrounded northeast by the hills, the population also uses cellular pots during times of rainfall deficits. These alveolus pots are natural holes on the hills. They are created as a result of climate weather (photo 5 et 6)

Photo 5. *Water intake beverage in a alveolus pot in Arigbokoto*

Photo 6. *Appearance of a alveolus pot in Awaya*

Photo 5 shows the removal of water from an alveolus pot in Arigbokoto (district of Dassa I). The waters drawn from these alveolus pots are for domestic purposes. Alveolus pots serve as a source of water supply. The storage time varies pots, but can cover two months till one year. They have different shapes. Their dimensions vary from one pot to another. Indeed, the diameter of the alveolar pots conical varies at least 2 m to 22.4 m, and the depths of these pots range from 1 m to 5 m. As regards their volume of water, it ranges from 1.046 m3 to 656.46 m3. As the cylindrical-shaped cells, the diameter ranges from 4 m to 1l, 5 m and their capacity varies 33.5 m3 to 796 m3. Those water resources reduce the difficulties of the population during the rainfall deficits (photo 6). The photo 6 has a alveolus pot in the commune of Dassa-Zoume. It shows another natural source used by the population. But this source is not sustainable. When water ends up in these alveolar pots, the village chief of instruction, traditional chiefs organizes ceremonies and instructed to clean those points. Just after this cleaning water is renewed following a rain that falls on the hills. Despite these measures taken by the population, their water needs are not met because of the rainfall variability in the commune. To face this situation, other strategies are developed.

3.5 Adaptation Strategies to Rainfall Variability in Dassa-Zoume Commune

The water resource variability causes behavior change in the supply and use of water. The new water-saving habits affect the diversification of supply points, planning of uses, the quality protection and improvement of water resources management. According to the source sampling, the use of water is rationed. According to 75 % of respondents, surface water used for washing, showering and washing dishes, whiles the water pump and drilling is for drinking and cooking. The synthesis of new strategies is presented in Figure 5.

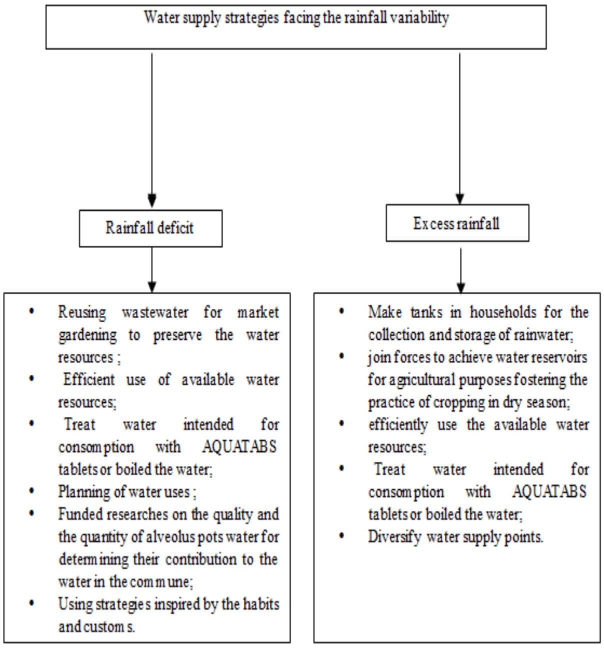

Figure 5. *water supply Model proposed to populations facing climate variability*

This model shows water supply strategies proposed for the moments of deficits and for excess rainfall times. These strategies are interdependent. They could solve the problems of access to water for the population. But the effectiveness of these strategies requires efficient management of available water resources on the part of the people of the commune of Dassa-Zoume.

4. Conclusion

The study on water supply strategies in the context of the seasonal contrast has shown that rainfall amounts have a downward trend with an irregular distribution. These situations have led to new strategies for water supply. But these strategies are not very effective for sustainable water resources. With a view to overcome these access to water problems, it is urgent to conduct a long project on the environment alveolar pots to assess the quantity and quality of available water resources. This amount will assess the contribution of cellular pots in the water supply of the town in particular and in general areas of pedestals.

References

[1] Ogouwalé E. (2006): Climate Change in Southern and Central Benin: Indicators, Scenarios and Prospects for Food Security. PhD thesis at UAC / FLASH, 277 p.

[2] IPCC (2007): Impacts, Adaptation and Vulnerability, contribution of working group to the fourth Assessment report of the IPCC. Cambridge University, pp 391-431 p.

[3] Kamagaté B. (2006): Hydrological functioning and origins of flows in a basin of tropical basement in Benin: watershed of Donga (Upper Valley of Ouémé). PhD - Thesis, University of Montpellier II, 320 p.

[4] Ogouwalé E. (2001): Vulnerability / Adaptation of agriculture to climate change in the Department of the Hills. Master's degree in Geography, 103 p. + annex.

[5] Agbétou Esse G. (2012): Vulnerability and adaptation of the paysannat to climatic constraints in the commune of Dassa-Zoumè. Master's thesis UAC / FLASH / DGAT, 85 p.

[6] Ahoutounmè G. (2011): Mobilization of surface water for adaptation to climate change in the commune of Dassa-Zoumé. Master's thesis UAC / FLASH / DGAT, 78 p.

[7] Adam S. and Boko M. (1993): Benin. Flamboyant Ed, new Ed. 95 p.

[8] Boko M. (1988): Climate and Rural Communities of Benin: Climatic Rhythms and Rhythms of Development. State doctoral thesis in Humanities and Humanities. CRC, URA 909, University of Burgundy, Dijon, volume 2, 601 p.

[9] Afouda F. (1990): Water and culture in central and southern Benin: Study of the variability of water balances in relation to the middle of the African savannah. Doctoral thesis new regime, Paris IV-Sorbonne, 428 p.

[10] Schwartz D. (1995): Statistical Methods for Physicians and Biologists. 4th edition, Medicinal Edition, Flammarion, Paris, 314.

[11] Barbe L. Alé G. Millet B. Texier H. and Borel Y. (1995): Monograph of the surface water resources of the Republic of Benin. Paris, ORSTOM, 540 p.

[12] Zodékon A.R. (2014): Water supply strategies in the face of climate variability in Dassa-Zoumè. Master's thesis UAC / FLASH / DGAT, 76 p.

[13] HOUNDENOU C. (1992): Rainfall variability and socio-ecological consequences in the plateaux of Lower Benin (West Africa). Memory of DEA, University of Burgundy, Dijon, 90 p. + annexes.

[14] VISSIN E. W. (2001): Contribution to the study of the variability of precipitations and flows in the Niger River basin. Memory of DEA, University of Burgundy. Dijon, France, 52 p.

[15] VISSIN E. W. (2007): Impact of climatic variability and dynamics of surface states on the flows of the Benin basin of the Niger River. PhD thesis, University of Burgundy. Dijon, France, 285 p.

[16] Odoulami L. (2009): The issue of drinking water and human health in the city of Cotonou (Republic of Benin) PhD thesis at UAC / FLASH, 230 p.

[17] Totin V.S.H. (2005): Hydroclimatic Trends and Water Resource Management Scenarios in Southern Benin. DEA dissertation, LECREDE / EDP / FLASH / UAC, 85 p.

[18] Totin V. S. H. (2010): Sensitivity of groundwater of the coastal sedimentary basin of Benin to the evolution of the climate and the modes of exploitation: Strategies of sustainable management. Unique Doctoral Thesis at UAC. 272 p.

[19] Boukari M. (1982): Contribution to the hydrological study of the basement regions of intertropical Africa: Hydrology of the Dassa-Zoumè region. PhD Thesis in Hydrogeology, Option Applied Geology. University of Dakar, 173 p.

[20] Iloukossi F. (2008): the problems related to the water shortage of the municipality of Dassa-Zoumé. Master's thesis UAC / FLASH / DGAT, 128 p.

[21] N'Tcha M'po Y. (2010): Impacts of climate variability on the operation of the yeropao hydroelectric dam and water supply of the populations of the city of Natitingou. Professional license in hydrology. Quantitative hydrology option. FAST / UAC, 69 p.

[22] Ogouwalé R. (2009): Hydro-rainfall resources: status and trend in the Okpara Upper Watershed. Diploma of the Diploma of Advanced Studies (DEA), 75 p.

[23] Boko M. Kosomowski F. Vissin E. (2012): The challenges of climate change in Benin. Program for Political Dialogue in West Africa, 76 p.

[24] INSAE (2004): Cahiers of villages and city districts of the Collines department, Cotonou, 24 p.

[25] INSAE (2013): Results of the fourth general census of population and housing, 112 p.