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ORIGINAL ARTICLE

RAINFALL AND HYDROGEOLOGICAL REGIMES AND SOCIO-ECONOMIC ACTIVITIES IN THE DANGBO COMMUNE IN BENIN (WEST AFRICA)

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Abstract:

The populations of Dangbo commune are submitted to the seasonal effects of strong rains and hydrodynamic rhythms of the Ouémé River. This phenomenon annually exposes the populations of Dangbo commune to the floods. This study identifies and analyzes the physical and social characteristics which are at the base of these rainy impacts in Dangbo commune. The information retrieval, the observations of the most places in the commune affected and the investigations by questionnaire conducts in 382 households are done. The rainfall records (1971-2010) and hydrogeological data collected were treated using the descriptive statistics. They are completed by information on the socio-economic activities of the commune collected in CeCPA. This reveals that Dangbo commune is annually exposed to the floods from mid-July to September-October. This causes losses estimated at 120.000 F CFA per hectare for the vegetal crops and at 80.000 F CFA per hectare for the manioc, the deceleration of the activity of fishing in period of rising, the impracticability of the tracks, etc.

Face this situation, the endogenous strategies such as the rising of the precarious houses on stilts, early harvest in the fields, etc. are adopted but remain insufficient. It would be interesting that the communal authorities in collaboration with the agricultural technicians and the populations develop the agricultural activities of against seasons for the food security in the commune.

KEYWORDS:

Benin, Dangbo commune, hydrodynamic rhythms, flood impacts, deficient strategies

INTRODUCTION

The frequency of flooding and its corollaries are well known in the world today and are an obstacle to food security and to the development of the affected nations. The most vulnerable to this flooding phenomenon are mostly countries of wetlands. Indeed, in tropical and inter-tropical areas, the vulnerability of the populations to flooding is raised, due to a strong correlation between farming systems and climate (Donou, 2009). Located in sub-equatorial zone, Benin, is not spared of these climatic constraints manifested by a strong irregularity in inter annual rainfall and in it distribution (Boko, 1988). It follows a change in rainfall patterns, resulting in a change of seasonal hydrological regimes. This affects agricultural production and human settlements.

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In wetlands in general and particularly in Benin, the phenomenon of flooding became recurrent (Zannou et al, 2012). In the lower valley of Ouémé, flooding is a real challenge people face every year. Located in the southern part of Benin, between 6 ° 6 ° 31' and 6° 40' north latitude and 2°25' and 2 ° 38' east longitude, Dangbo commune is bounded on the north by Adjohoun municipality, to the south by Aguégués municipality, to the east by Akpro-Missérété municipality and west by Sô-Ava municipality in the department of the Atlantic (Figure 1).

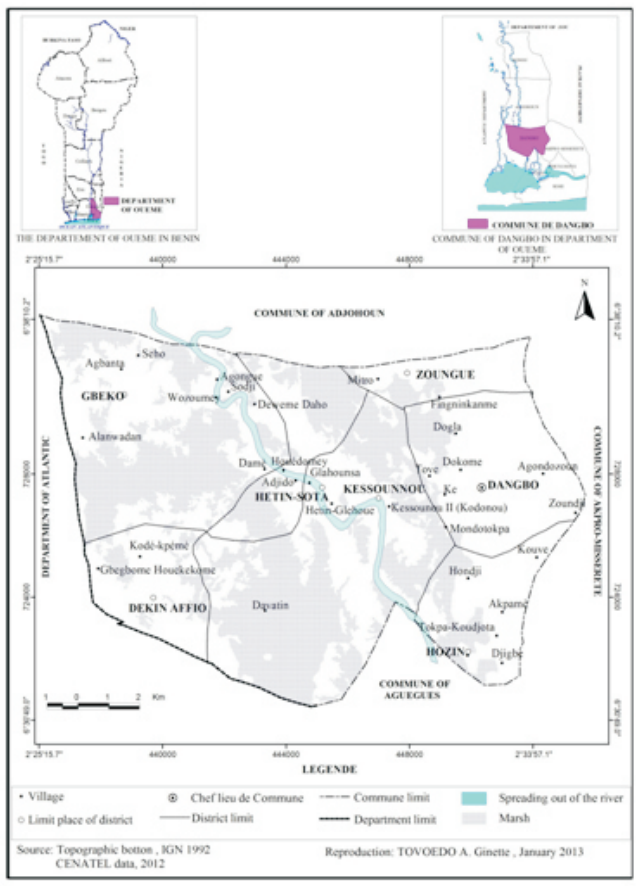

Figure 1: Geographical situation of Dangbo commune

Dangbo commune has 41 administrative villages in seven districts which are: Dangbo, Dèkin, Gbéko, Houédomey, Hozin, Kessounou and Zounguè. With an estimated 95,908 inhabitants in 2013, Dangbo commune covers an area of one hundred forty-nine (149) km² with a population density of 443 inhabitants per km² (Dangbo commune, 2010).

Every year, people are exposed to flooding during the months of August to September. According to HASKONING/IWACO/AID Environment (2000), wetlands provide enormous benefits to populations in areas such as agriculture, fishing ... However, in Dangbo commune, climate and hydrological conditions overwhelm populations by limiting the enjoyment of these benefits.

This research aims to identify and analyze the socio-economic implications of climatic and hydrological regimes in the Dangbo commune. Such research requires data and methodological approaches.

1. Data and methods

Rainfall data processed in the framework of this study are obtained at Bonou station. They are supplemented by those extracted files from National Meteorological Service (SMN) of the Agency for the Safety of Air Navigation in Africa and Madagascar (ASECNA) Cotonou over the period 1971-2010. Hydrogeological data are collected at DG-Eau. Informations on socio-economic activities of the commune are collected over the period 2003 to 2010 at CeCPA (Communal Centre for Agricultural Promotion) of

Dangbo commune. Observations boroughs (Kessounou, Houédomè, Dekin, Gbéko) strongly affected by the floods helped to understand the strategies developed by the people.

These data are supplemented by questionnaire surveys in 382 households in the commune. The size of the sample was determined by the formula and Beaud Marien (2003). The statistical procedure used is: n '= N x 400/400 with N + n' = sample size; 400: consistency; N = size of households. It was calculated with a confidence level of 95% and a margin of error of plus or minus 5%.

The arithmetic mean is calculated over the period 1971-2010. Its formula is: with: X (arithmetic mean), n (the total number of variables), xi (the heights of rain) for the relevant series. This average was used to determine the rainfall regime of Dangbo commune. The calculation of the standard deviation over the period 1971-2010 was used to evaluate the dispersion around the average "normal" Whereas it is deficit (resp. surplus) when the value of the gap is lower (resp. upper) to 20% (resp. 20%). It is determined by calculating the square root of the variance: $\sigma = \sqrt{V}$ where V "is the variance set"; the standard deviation is an indicator of variability by excellence.

This methodology permits to obtain the following results.

2. Results and Discussion

2.1. Inter-monthly evolution of rainfall in Dangbo commune from 1971 to 2010

The commune of Dangbo is under the climatic influence subequatorial with two dry seasons from December to March and August and two rainy seasons from April to July and September to November. Figure 2 shows the rainfall over the period 1971 to 2010 in Dangbo commune.

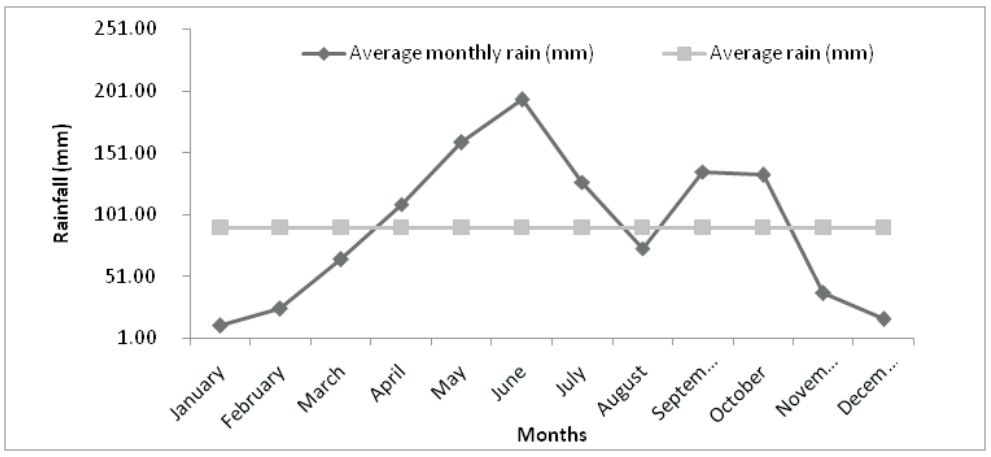

Figure 2: Rainfall regime in Dangbo commune from 1971 to 2010
Source: data, ASECNA, June 2012

Figure 2 shows that the rainfall regime of Dangbo commune is bimodal with a peak in June (194.17 mm) and September (136.65 mm). Forty to sixty percent of the rainfall amounts are recorded in March, April, May, June and July and ten eight to thirty percent of the rainfall amounts are recorded in September and October (Boko, 1988; Zannou et al, op cit.). These rainfall amounts received annually by Dangbo commune is reinforced by the descent of rainwater from the northern part of the valley Ouémé and increases the flow of Ouémé River (Figure 3).

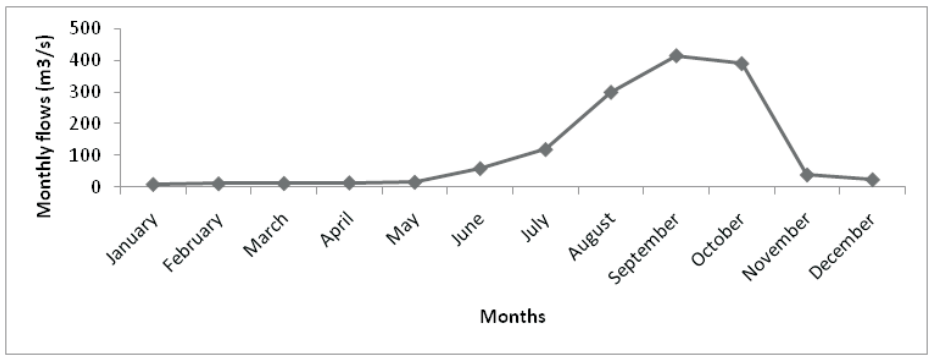

Figure 3: Evolution of monthly flows of Ouémé River from 1971 to 2010
Source: data ASECNA, June 2012

Figure 3 shows the evolution of the Ouémé river flows over the period 1971-2010. They are low in January, February, March, April, May and December, but they have a tendency to increase during the months of June, July, August, September and October with a maximum of 415 m3/s in September. These raised rates are a function of contributions of rainwater that drains Ouémé from north to south. This phenomenon easily led his minor Ouémé river bed to its floodplain in the lower valley. Which increases flooding in the floodplain particularly in the districts of Kessounou, Houédomè, Dèkin, Gbéko. Indeed, the concentration of rainwater in the lower valley is annually causing floods between June and October in the upstream portion of the watershed and the impermeability of the Precambrian basement crossed explains the close relationship between the upper basin flood and that of the lower river at the delta plain. At this level, the waters of the river and its tributaries begin invading the floodplain and surrounding districts from mid-July and peaked in September-October. These floods create much havoc in Dangbo commune. But the scale of flooding varies from one year to another (Figure 4).

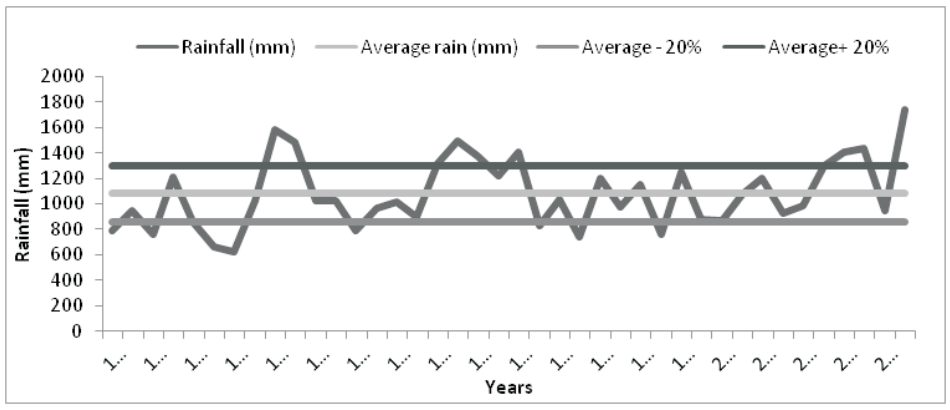

Figure 4: Interannual rainfall evolution in Dangbo commune 1971-2010
Source: data ASECNA, June 2012

Figure 4 shows the heights of rain fell in Dangbo commune from 1971 to 2010. The commune has registered 25% surplus years are marked by significant damage; 52% of average years where the event of flooding is almost uniformly over the period with some variation in the magnitude of socio-economic damage in Dangbo commune and 23% deficit years.

The years 1979, 1980, 1987, 1988, 1988, 1989, 1991, 2006, 2007, 2009 and 2010 are surplus. It should be noted that the year 2009 was particularly marked by significant floods (Zannou and al., 2012). Also, it is worth remembering that the lean years are not absent from the event of flooding, but they are more or less attenuated and less damage is significant. But the influence of these rainfall amounts on socio-economic activities in the Dangbo commune depends on the structure of the terrain and soils.

2.2. Hydro pedological characteristics of Dangbo commune

Dangbo commune like all municipalities in the lower valley of the Ouémé lies partly in the the

alluvial plain constituted of the recent detritus formations. The latter constituted of vertisols or hydromorphic gley soils, waterlogged pseudogley and otherwise, lateritic soils of the continental shelf terminal (ABE / PAZH, 2001 Pelissier, 1963).

These soils are the result of the accumulation and processing environment in periodically flooded organic and inorganic materials. They evolve in a physico-chemical ambiance of anoxymorphie promoting phenomena redox (Azontondé 1991; Amoussou, 2010). They are at the bottom of a slope on acid bedrock and undergo intense leaching by rainwater. They are characterized by a lower oxygen rich environment due to a temporary or semi-permanent saturation of the medium by groundwater. Their evolution and characters depend on the sheet of water precipitated the rise of the groundwater and soil deposits of different streams. They are rich in clays (30-60%) and are deep enough (greater than 1 m). Permeability is low and average surface depth. Their water reserve is low and varies from 75 to about 100 mm (Azontondé, op. cit., Amoussou, op. cit.).

The soils of Dangbo commune have a variety of potential but often have low water holding capacity and high erodibility. They are partly responsible for the flooding problem in the commune. However, these soil morphological units are good for various agricultural activities, sources of revenue of the people of the commune.

From the point of lithologic view, soil of the Dangbo commune show from top to bottom, the recent alluvial deposits of Ouémé or detritus deposits of the Quaternary middle and old (Continental and Terminal), clay and marly deposits of the Eo-Paleocene and Cretaceous, Paleocene limestone formations, the sands of the Upper Cretaceous (Maastrichtian) and the crystalline basement. This set is the most extensive aquifer and the deeper tray. Their rates are around 200 m3/s and power ranges from 60 to over 140 m. The Quaternary alluvial deposits have an average thickness of 20-40 m and 80 m in exceptionally large alluvial valleys. The rates vary between 5 and 15 m3/s (Pelissier, op. cit., Azontondé, op. cit., Okioh, 2008).

The low permeability of the soil to rainwater runoff increases, accumulation and flooding in Dangbo commune. This explains the socio economic damage recorded in Dangbo commune in the years 2007, 2009 and 2010.

2.3. Socio-economic impacts of floods in Dangbo commune

2-3-1 Negative Impacts

The arrival of the annual flood waters has consequences on the main socio-economic activities such as agriculture, fisheries and transport. Photo 1 shows a field flooded in Dangbo commune.

Photo 1: Extended of fields of cultures flooded during the high tide. Shooting: Kougblénou, july 2010

The photo 1 shows the flooding extension in Dangbo commune. Such an extension of flooded fields exposes people to food insecurity. In fact, according Clédjo (2011), in agriculture, water flooding through the gallery forests and invade the fields of lower slopes. Destruction of crops and the difficulties of preserving agricultural products create a loss for producers. According to 85% of the population, the most vulnerable to rising waters crop is cassava whose roots still in the ground to rot. They are then forced to

make early harvest, creating their shortfalls. These losses were estimated at 120 000 F CFA per hectare for horticulture and 80 000 F CFA per hectare for cassava.

In the area of □ □fisheries, it is noted a decrease in the fish production due to the slowdown during floods. Indeed, the current velocity during flood forces people to take a break in the practice of fishing. But rising water causes the penetration of fish in the marshes and lakes time; fishing activity thus moves the stream to these lakes and marshes experiencing a proliferation of fishery products in times of flood.

In the field of transport, some access roads are rendered impassable, isolating the farmer and his production in his village. Low attendance markets observed in certain localities that are suddenly isolated by flood waters.

This is confirmed by the report of the workshop on prediction of water resources and agricultural production (Afouda, 1997). The author noted that tropical Africa is particularly subject to food insecurity due to several risks including floods.

Photo 1: Flooded homes in Dangbo commune. Shooting: Tevoédo, August 2012

Photo 2: School Complex of Hêtin-sota flooded. Shooting: Tevoédo, August 2012

Photos 2 and 3 show homes and a school complex flooded in the Dangbo commune. Flooding of homes (photo 2) is an obstacle to the development of socio-economic activities of households who are forced to migrate to the plateau. As the flood of school complex Hêtin-Sota, it causes the change of the school calendar. Such hydrological constraints creates the fragmentation of families and disadvantage some members on the social assistance plan.

These results corroborate those obtained by Odoulami, Vissin and Boko (2010) in a study on adaptation strategies hydrodynamic risks in the context of climate change in Benin: the case of flooding in the city of Cotonou. This study revealed flooding homes and community social infrastructures of the city of Cotonou. Better for Houndénou (1999) and Ogouwalé, Houndagba and Houssou (2009), the lack, excess or poor spatio-temporal distribution of rainfall and generating sources of climate and economic crises, with their socio-economic benefits especially insofar as "climate depends ... the abundance or scarcity of crops." Disruption of socio-economic activities due to flooding in the town of Dangbo confirms these results.
Faced with this situation, adaptation developed by populations: building houses on stilts at the end of the long rainy season (June and July), repair, manufacture or purchase of canoes and more resistant of motorized boats for moving goods and people, building houses, raising the concrete stilts given the magnitude of floods/floods in order to prevent their collapse.

2-3-2 Positive Impacts

Floods have positive impacts on agriculture. Indeed, the withdrawal of water indicates a strong fertilization of the floodplain by providing minerals listed above, and a flourishing agriculture. This is what justifies the practice of recession crops and installed by season against the plain people.

Floods also promote transport by canoe as they impede traffic on the roads. This activity is profitable for permanent and casual paddlers who provide crossing flooded roads. According to 75% of boatmen, given the density of traffic, the passenger gives them a recipe from 1500 to 2000 CFA per day if the traffic is dense. What makes an average of 45 000 F CFA 60 000 F CFA per month.

CONCLUSION

This study socio economic impacts of rainfall and hydrological regimes in the Dangbo commune revealed that the study area annually undergoes influences flood mid-July to September-October. Thus, populations are periodically flood victims with major damage to the social and economic consequences. Given the magnitude of impacts, people have developed coping strategies that are proving very effective. Then it is important to install community stores food products to overcome the food deficit during

floods/floods to raise awareness to gradually build their homes in sustainable materials and build communal centers host of affected populations. In addition, we must raise awareness and dissemination of information on the impacts of hydro-risk to allow awareness of populations. To this end, the implement PPRI (Prevention Plans Flood Risk) is probably the most effective measure to prevent the consequences of flooding.

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