ANALYSE OF SOCIO-ECONOMIC IMPLICATIONS OF FLOODINGS IN THE LOW VALLEY OF OUEME IN DANGBO (REPUBLIC OF BENIN, WEST OF AFRICA)

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Abstract

The low valley of the Ouémé is confronted to the damaging risks of flooding to the socio-economic activities. This work aims to analyse the socio-economic effects of the flooding in the Commune of Dangbo. To reach this objective, the data hydrometric and rainfall of the station of Bonou on the period 1971-2010 as well as those on the adaptive measures have been collected at the time of the documentary research and the works of the land investigations by 4% of the affected households of the Commune.

The gotten results show on the economic plan, the arrival of the high waters and the yearly rises in the water level has a very negative consequences that positive on the main economic activities that are agriculture, the fishin…, Face this situation, the endogenous strategies as the elevation of the precarious dwellings on stilt, the precocious harvest in the fields,… are insufficient. It is recommended to the local actors to develop initiatives of backing of the strategies in work in the Commune.

***Key words**: Benin, Commune of Bonou, low valley, flooding, strategy of adaptation*

Résumé

La basse vallée de l'Ouémé est confrontée à des inondations fréquentes qui ont des impacts notables sur les activités économiques des populations. Cette étude a analysé les implications socio-économiques desdites inondations dans la basse vallée de l'Ouémé à Dangbo. Pour atteindre cet objectif, les hauteurs de pluie et les données hydrométriques de la station de Bonou ont été collectées sur la période 1971-2010. Elles sont complétées par les informations collectées lors de la revue documentaire et les enquêtes de terrain réalisées avec 4% des ménages enquêtés et touchés par les inondations dans la Commune.

Les résultats obtenus montrent que sur le plan économique, la descente des eaux du nord dans le bassin de même que l'augmentation saisonnière du débit du fleuve ont des impacts négatifs et positifs sur les activités économiques, notamment l'agriculture, l'élevage, …Face à cette situation, les stratégies endogènes de précarité des conditions de logement, de récolte précoce dans les champs, sont insuffisantes. Il est recommandé aux acteurs locaux de développer des initiatives de soutien aux stratégies en cours dans la commune.

***Mots clés:** Bénin, commune de Bonou, basse vallée, inondation, stratégie d'adaptation*

Introduction

All over the wolrd in general and in tropical and intertropical areas in particular, the vulnerability to flooding is high, because of a strong correlation between agricultural production systems and climate (B. Donou, 2009, p.35).

Located in sub-equatorial area, Benin, is not spared these climatic constraints manifested by strong interannual irregularity of rainfall both in their magnitude and in their distribution (M. Boko, 1988: p.118). In the southern basin of Ouémé, flooding is a real challenge that people face annually (A.B. Zannou et K.J-B. Vodounou, 2012: p.492). The consequences of this phenomenon are particularly noticed in the Municipality of Dangbo. Located in the southern part of Benin, between 6° 31'et 6° 40 'north latitude and 2° 25' and 2° 38 'east longitude, the common Dangbo is bounded on the north by the Municipality Adjohoun, south by the Municipality Aguégués, east by the Municipality of akpro-missérété and west by the Municipality of Sô-Ava (Atlantic's department). It has 41 administrative villages in seven districts which are: Dangbo, Dekin, Gbéko, Houédomey, Hozin, Kessounou and Zounguè (figure 1).

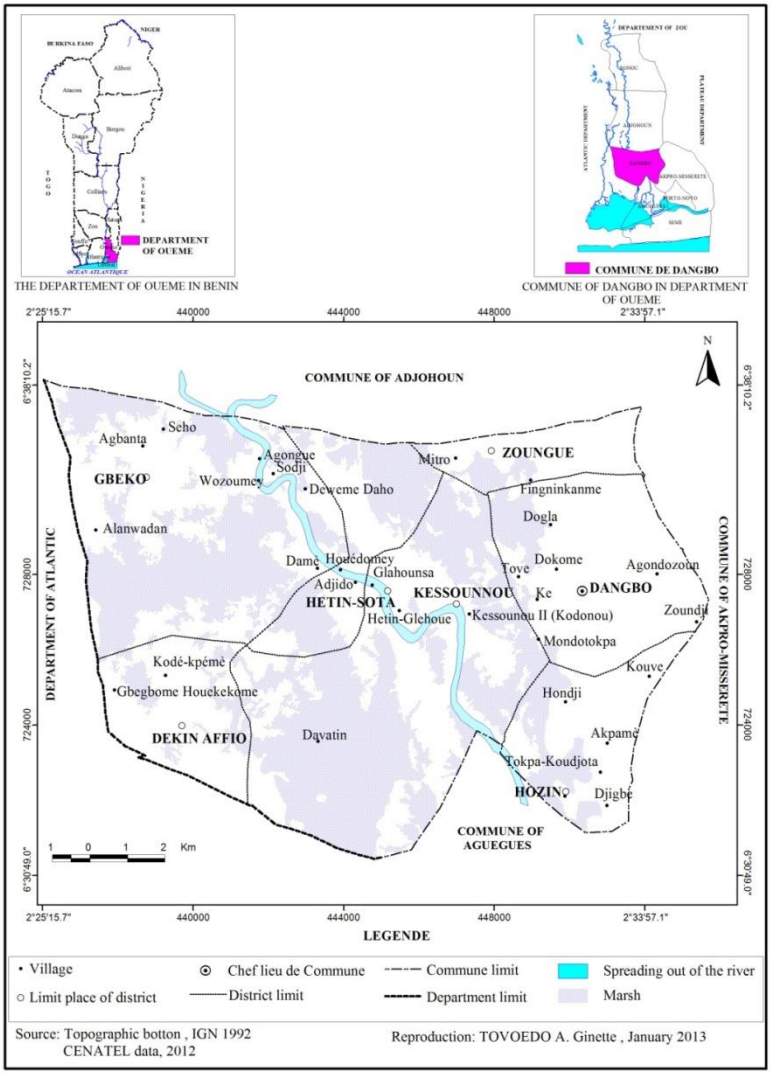


Figure 1: **Location of the Municipality of Dangbo**

Source: Topographic botton, IGN 1992; CENATEL dat, 2012

Every year, people are exposed to the seasonal flow of water during the months of August-September. Now this proccure wetland huge benefits to the people. But the recurrence of floods limitations in the enjoyment of these benefits. It is to analyze the socio-economic implications of such a phenomenon that the research is conducted in the Municipality of Dangbo.

1. Data and Methods

Rainfall data analyzed in this study were collected at the Agency for the Safety of Air Navigation in Africa and Madagascar (ASECNA) Cotonou over the period from 1971 to 2010. The hydrogeological data are collected in the Department of Geography and Planning

(DGAT). Information on socio-economic activities of the Municipality are collected over the period 2003-2010 to CeCPA (Communal Centre for Agricultural Promotion) of Dangbo. These data are complemented by socio-economic surveys in 4% of households. Direct observations of the districts heavily affected by the floods and the adaptation strategies developed by populations were analyzed.

The arithmetic mean is calculated on the 19871-2010 period with the formula: $X = 1/n \sum_{i=1}^{n} (xi)$

, X, having the arithmetic average; n the total variable workforce; xi rain heights of the relevant series. This average was used to determine the rainfall pattern in the borough of Issaba.

The standard deviation is calculated for the period 1971-2010. He assessed the dispersion around the average "normal" Whereas deficit (respectively excess) when the value of the gap is lower (respectively superior) to 20% (respectively 20%). It is determined by calculating the square root of the variance :

$\sigma = \sqrt{V}$ where V "is the variance is defined"; the standard deviation is the variability of the indicator par excellence. Socio-economic impacts are analyzed using the Leopold Matrix (table 1) and the reference of the ABE (1998).

Table 1: Components of the Leopold-type matrix et *al.*1971

Source impact	Environmental component affected by flooding			
	Land		Human settlements	
Inondation	Cropland	Productivity	House	Earnings

Source: Adapted from L.B. Leopold et *al.* 1971: p.45

The analysis and evaluation of the significance of impacts are based on a methodology that integrates the three parameters of the negative impact such as the duration (temporary, permanent or momentary), extended (spot, local or regional) and the degree of disturbance (low, medium, hight or very hight). The intersection of these three parameters, through the framework of the A.B.E (1998: p.37), allowed to deduct the significance of the impact that can be of three types: high, medium or low (table 2).

Table 2: Terms of reference for the assessment of impacts

Duration	Extended	Disturbance degree			
		Low	Medium	High	Very hight
		Importance of impact			
Momentary	Spot	Low	Low	Low	Medium
Momentary	Local	Low	Low	Medium	Medium
Temporary	Spot	Low	Low	Medium	Hight
Temporary	Local	Low	Low	Medium	Hight
Momentary	Regional	Low	Medium	Medium	Hight
Permanent	Spot	Low	Medium	Medium	Hight
Temporary	Regional	Low	Medium	Hight	Hight
Permanent	Local	Low	Medium	Hight	Hight
Permanent	Regional	Medium	Hight	Hight	Hight

Source : A.B.E, 1998

2. Résultats

Several factors determine the flood. These are factors climatisques and soil structure of the medium.

2.1. Hydropluviometric trends in the municipality of Dangbo from 1971 to 2010

The municipality of Dangbo is under the influence of sub-equatorial climate with two dry seasons from December to March and August and two rainy seasons of April-July and September-November. The following graph shows the monthly evolution of the rains on the 1971-2010 period in the town of Dangbo.

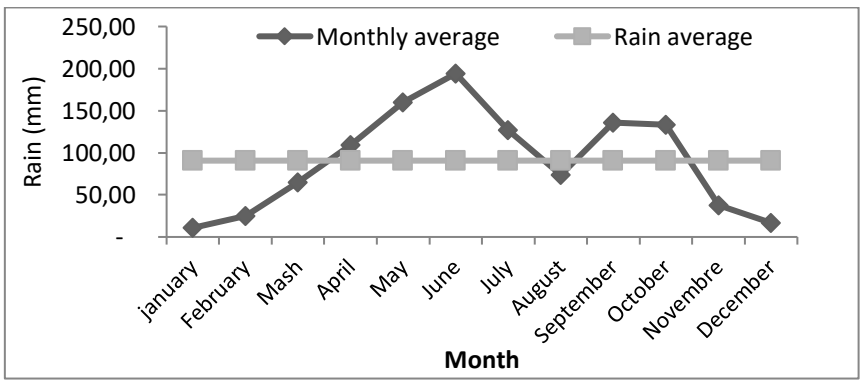


Figure 2: **Monthly evolution of the rainfall in the Commune of**

Source: ASECNA, Cotonou over the period from 1971 to 2010

Figure 2 shows the monthly evolution of 1971 to 2010. The rains it is bimodal rainfall regime has a concentration of 40-60% of the rains on the main rainy season (March, April, May, June, July) and 18-30% in the small rainy season (September, October) (M. Boko, 1988: p. 208; A.B. Zannou et K.J-B Vodounou, 2012: p.423). The rainy season can record on average 120 mm of rain per month. The uneven distribution of monthly rainfall heights can also be observed on an annual basis (figure 3).

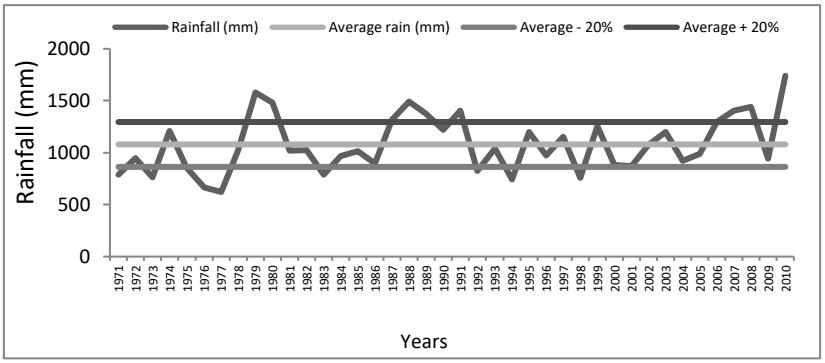


Figure 3 : **Annual evolution of rainfall in the municipality of Dangbo from 1971-2010**

Source: ASECNA, Cotonou over the period 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 (A.B. Zannou et K.J-B Vodounou, 2012: p.501). 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.

This amount of rain water that receives monthly commune Dangbo is reinforced by the rise and overflow of water from the river Ouémé during the rainy seasons. Indeed, these determine the evolution Flows Ouémé River (figure 4).

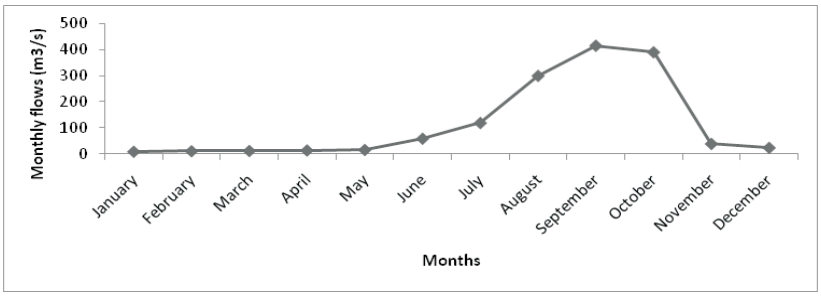


Figure 4 : **Evolution of monthly flows of Ouémé River from 1971 to 2010**

Source**:** ASECNA, over the period from 1971 to 2010

Figure 4 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 m^3/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 Késsounou, 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 influence of these rainfall amounts on socioeconomic activities in the Dangbo commune depends on the structure of the terrain and soils.

2.2. Hydro pedological facets

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 (P. Pelissier, 1963: p.82).

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 (A. Azontondé, 1991: p.36). 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 (Dansou and Odoulami, 2012: p.519).

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 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 m^3/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 m^3/s (P. Pelissier, 1963: p.130; A. Azontondé, 1991: p.43).

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 implications of floods in Dangbo commune

The arrival of the annual flood waters has consequences on the main socio-economic activities such as agriculture, fisheries and transport. The assessment of the impacts of floods in the municipality of Dangbo was performed with the crossing of the Leopold matrix and the framework of the A.B.E (table 3).

Table 3: Evaluation Matrix socio-economic impacts of floods Dangbo

Component affected by flooding	**Impact**	**Nature**	**Duration**	**Extended**	**Disturbuance degree**	**Importance**
Land	Destruction of cultivated land	Negative	Temorary	Local	Very hight	Hight
	Decreased productivity	Negative	Temorary	Local	Very hight	Hight
Human settlements	Destruction of homes	Negative	Temorary	Local	Hight	Medium
	Lower revenues	Negative	Temorary	Local	Very hight	Hight

Source: Results analyses, 2014

Table 3 highlights the magnitude of the impacts of floods in the municipality of Dangbo. These impacts are negative in nature, with varying degrees of disruption from the strong to very strong. Indeed, the degree of disturbance is strong on the home. Crop fields, productivity and incomes are greatly disturbed by cons. The agricultural sector is the most affected by the floods. The confirmation of this is given by 82% of survey households.

Moreover, it emerges that the floods have both negative and positive impacts on key components of the environment.

2.3.1 Negatives impacts

Floods degrade the physical environment and the living environment of the populations settled in the Ouémé River floodplain.

The often unexpected overflow courses or water bodies from their beds because of a lack of hydro-warning system, increasing the water flow field (P Clédjo, 2011: p.58). Indeed, floods combined with runoff cause morphological and biogeographic degradation lowlands. During floods, water destroy habitats for some animals. They then migrate to non-flooded land where populations are installed. According to 89% of those surveyed, wild animals such as *Varanus niloticus, Causus rhombeatus, Dendroaspis viridis*, ... are found in homes in the immediate area and sometimes in the rooms in flood period. Water erosion in turn contributes to the removal of the banks and carries the particles toward the valley and over the depression of water bodies under the threat by filling the solid loads.

The flooding affects also the main activities of the populations. In agriculture, water floods the galleries through forests and invade the fields of lower slopes. The destruction of crops and agricultural products conservation difficulties create a shortfall for producers. According to 83% of the population, the most vulnerable culture to the rising water is cassava, whose roots still underground rot; Hence the need to make early crops, creating their shortages of around 120,000 CFA per hectare for vegetables and 72 000 FCFA per hectare for cassava.

In the transport sector, the floods make impracticable some feeder roads from the town of Bonou, isolating the peasant to his village with his production that can not be marketed. Low attendance of markets is observed in some communities that are isolated from the blow by the flood waters. Photo 1 shows a damaged road due to flooding Kessounou.



Photo 1 : Flooded roads to Kessounou

Shooting: TOVOEDO, 2010

This degradation of tracks led people to use the boats for quickly join two nearby locations. The permanent and casual paddlers ensure the crossing of the valley for a sum of 100 CFA francs per kilometer and seat.

Floods affect more homes with local materials (adobe, board, rack) installed in the floodplains of the river Ouémé in defiance of habitability standards. Thus, homes, schools, and even whole villages are devastated by the waters overflowing (photo 2).



Photo 2. School Complex flooded Hetin-Sota

Shooting: TOVOEDO, 2013

Photos 2 show a school complex flooded in the Dangbo commune. Flooding of homes 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 create the fragmentation of families and disadvantage some members on the social assistance plan.

These results corroborate those obtained by L. Odoulami and *al.* (2010, p.66) 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.

2.3.2 Positive Impacts

By 65% of respondents, 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 77 % of boatmen, given the density of traffic, the passenger gives them a recipe from 1500 to 2800 CFA per day if the traffic is dense. What makes an average of 45 000 F CFA 84 000 F CFA per month.

2.4 Sustainable adaptation strategies

To cope with these heavy flooding consequences (based on periods of appearance pronounced floods and hydrogeological characteristics of the environment), it is important that local authorities, municipal, and actors working with the agricultural community, adopt new strategies for strengthening existing strategies. This is to strengthen education, training and awareness of farmers in the management of agricultural land also taking into account weather forecasts of ASECNA; strengthening farmers in water management techniques to help them improve their irrigation techniques. It is desirable that the micro-arrangements or agricultural areas and excess rainwater drainage techniques are developed and defined.

It is important to install community stores food products to overcome the food deficit during 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.

Conclusion

In recent years, flood risk populations settled in the flood plains of rivers and lakes in the lower valley of Ouémé Dnagbo to have increased. Floods affect the environment and socio-economic framework of these populations. The River flood waters causing major environmental damage and socio-economic in the Municipality of Dangbo. These will damage the degradation of the physical environment to the destruction of homes and fields. They thus mark a slowdown in socioeconomic activities and cause damage to the livelihoods of the populations. Several measures may be considered to reduce the various impacts of floods in the lower valley of Ouémé to Dangbo.

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