International Journal of Agriculture, Environment and Bioresearch

Vol. 2, No. 02; 2017

ISSN: 2456-8643

COPING STRATEGIES OF MAIZE GROWING TO THE RISK OF FLOODING IN THE WATERSHED FROM COUFFO TO LANTA

HOUEDANOU Séraphin (1)

KOUMASSI Dègla Hervé(2)

AKINDELE Akibou Abaniché(3)

(1) Doctorant, Département de Géographie, Faculté des Lettres, Arts et Sciences Humaines, Université Abomey Calavi, Bénin, (00229) 97 70 84 26, houedanouson @gmail.com

(2) Laboratoire Pierre Pagney ''Climat, Eau, Ecosystèmes et Développement'' (LACEEDE/UAC), BP : 922, Abomey-calavi, Bénin ;Tél : (00229)95373824 , kherd5@yahoo.fr

(3) Laboratoire Pierre Pagney ''Climat, Eau, Ecosystèmes et Développement'' (LACEEDE/UAC), BP : 922, Abomey-calavi, Bénin ; Tél : (00229)97139187

ABSTRACT

Floods are nowadays a plague throughout the world. Owing to the baneful aftermath of the floods, people have developed several adaptation strategies. The aim of this research work is to study the adaptation strategies of the corn growing to the risk of flood in the overturning basin from Couffo to Lanta.

To achieve this goal, the daily rainfall data of 1971-2015, the agricultural statistics, the peak flows of 1971-2015 were respectively collected in the ASECNA, in the CERPA and the DGEau. The collected data were handled by the methods of the descriptive statistics such as the average arithmetic, the standard deviation. A frequent analysis was made to consider the values of hydro pluviometric events and their periods of return.

The analysis of the data shows that the recurring floods in the basin are caused by the annual daily maximal rainy heights located between 74 and 189mm. In the same vein, the recurring floods responsible for the fluvial flooding in the basin are caused by the maximal flows of which values are between 63 and 208m3/s. Due to the recurrence of the floods, people developed several strategies in the production of the corn. Among these is the adoption of new varieties of short cycle, the new methods of preservations.

Keywords: Risk, flood, corn growing, Cougar in Lanta

Introduction

There is now a consensus among scientists around the changing climate of the planet. Indicators of such climatic changes are the increase and multiplication of extreme weather events: droughts, floods, etc. (UNDP, 2008). Floods have become a real scourge in recent years in the world. They are becoming more frequent and devastating. West Africa is experiencing intense flooding in recent years (GAYE, 2009). Floods are disastrous for urban communities lacking sustainable solutions to these phenomena (GAYE, 2009).

In Benin, the floods of 2010 and the damage caused are still in everyone's minds. Generally, floods can be a result of floods or simply heavy rain. According to the 2011 Post Disaster Needs Assessment Report, flooding in 2010 caused significant damage. The total damage caused by the floods on the Beninese economy amounts to nearly 78.3 billion FCFA. They concern the total or partial destruction of goods, including buildings and their contents, infrastructure, stocks, etc. The first victims are the poor or impaired.

Faced with the occurrence of flooding phenomena, the populations of the Couffo watershed have implemented several adaptation strategies. This research focuses on adaptation strategies for maize growing in the Couffo watershed. Maize is the most important crop of the major season, covering 80-90% of the area devoted to seasonal crops (STRAVER, 1989). It is grown for self-consumption and sale in the basin and is therefore the main source of income for the latter.

1-Study environment

The Couffo watershed is located between 6 ° 30 'and 7 ° 35' north latitude and 1 ° 38 'and 1 ° 07' east longitude (Figure 1). It is limited to the north by the watersheds of Mono and Zou; To the east by the watersheds of Zou, Hlan and the river of five fingers; To the west and south by the Mono watershed

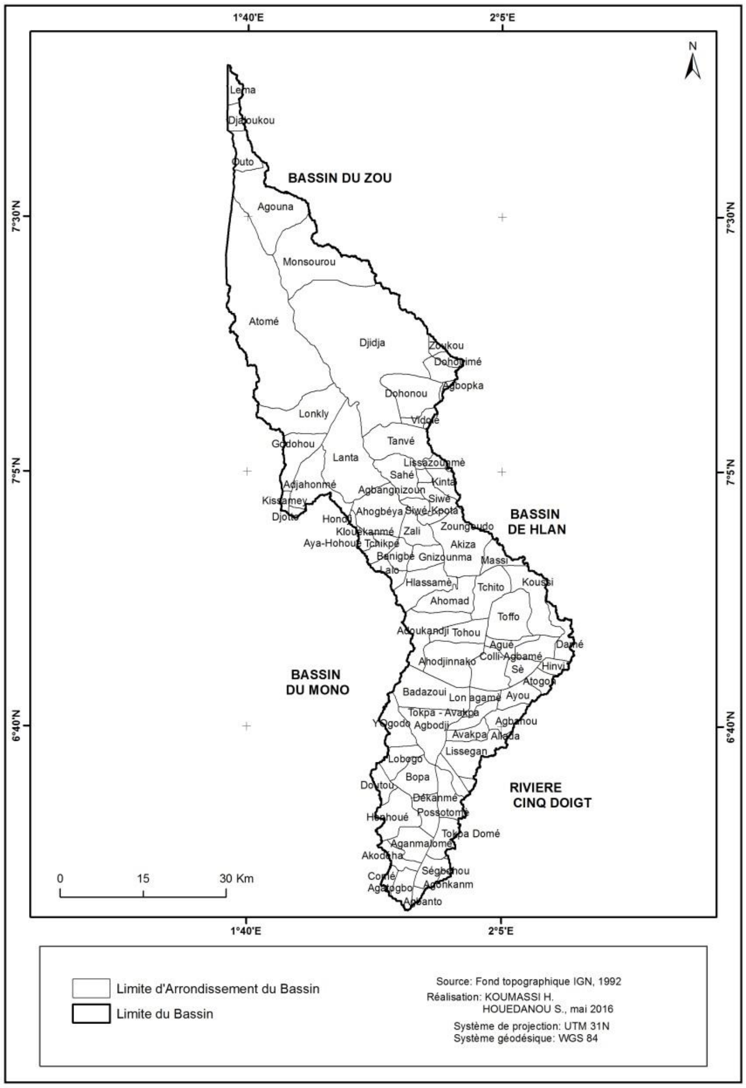


Figure 1: Situation of the Couffo watershed

The Couffo watershed is characterized by a subequatorial climate with two seasons of crops, one of which runs from April to July and a small one from October to November. This climate has created a rather dense hydro graphic network dominated by the 190 km long Couffo river. It originates in Togo at an altitude of 240 meters, near the border, near the village of Tchetti. It first follows a direction NW-SE. After 100 km of course, it hacks the formations of the Continental Terminal and progressively takes an N-S direction. 54 km later, it flows into the 24-km-long Ahémé Lake whose outlet is the lagoon complex of the "Mouth of the King". This river supplies several types of soil:

Vol. 2, No. 02; 2017

ISSN: 2456-8643

- Vertisols are black montmorillonitic soils, very fertile, on the marly or calcareous formations of the Paleocene and Eocene of the median depression of Chihomandégbé. With a depth of 1 m, these soils are mediocre in terms of permeability and quantity of water actually available to plants. They become congested during the rainy season and become more or less asphyxiating to crops. They are formed on the alluviums of the lower valleys and the clay content varies from 60 to 75% while the silt and sand levels are low, between 7 and 16% (DANGBÉGNON, 1987).

- Hydromorphic soils are soils whose evolution and classification are related to the presence and action of water: rainwater, rivers overflow water, very superficial groundwater rising water that create Situations of periodic congestion of variable duration. They are very fertile but seasonally flooded by the floods of the Couffo river.

- poorly evolved soils or raw mineral soils, characterized by a minimum of differentiation of the surface and deep horizons. They are found in the littoral cords. They are very permeable soils with a very low water retention capacity.

- weakly ferralitic soils, they develop on any rock rich enough in iron and constitute a well-drained medium. They are clayey-sandy formations of the Continental terminal with a clear structure in the deep horizons and with a rather porous structure in the upper horizons, in connection with an intense biological activity. They owe their permeability and drainage to the sand but especially to the good distribution of the sand inside the whole.

They are fertile but very sensitive to anthropogenic degradation, fire and erosion. Among the soaked soils, ferralitic soils appear on the physical plane as excellent supports for dense, dense forest formations.

2- Method of study

The data used in this study relate to rainfall data from rainfall stations in the Couffos Basin from 1981 to 2015; The hygrometric data extracted from the DG-Water database for the period 1981-2015, soil, hydrographic, and socio-agricultural data relating to cropping systems and techniques of maize growing in the Couffo watershed. This information was obtained from ASCENA, from farmers and rural development workers respectively.

In the present research, 299 households were surveyed according to the criterion of ownership of a field or a stakeholder in the agricultural sector. In the same way, the field investigations made it possible to understand the perception of the peasants on the question of the floods and the strategies of adaptation of the populations.

Vol. 2, No. 02; 2017

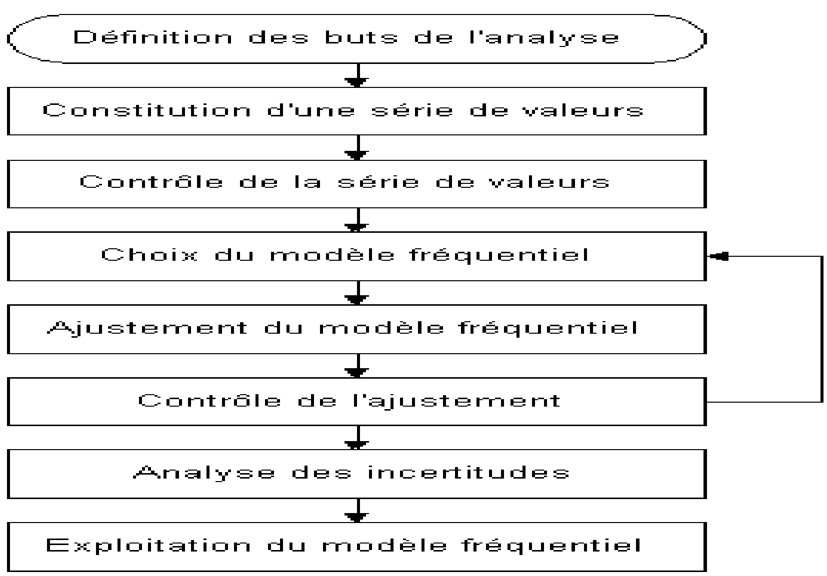
ISSN: 2456-8643

2.1- Method of frequency analysis of the hydro-rainfall series

Frequency analysis is a statistical method of prediction consisting in studying past events, characteristic of a given process (hydrological or other), in order to define the probabilities of future occurrence. The purpose of frequency analysis is to estimate the probability of occurrence of a given phenomenon from hydrological surveys. The data used in this analysis should be assessed taking into account the objectives, duration and completeness of the available records. They must also satisfy certain statistical criteria, in particular as regards their randomness, independence, homogeneity and stationarity.

It is a statistical method of prediction consisting in studying the past events, characteristic of a given process (hydrological or other), in order to define the probabilities of future occurrence. Frequency analysis is used, in particular, to estimate the magnitude of the time event Tx associated with a return period T (quantile of return period T or probability of exceeding p = 1 T).

Frequency analysis of the daily rainfall series allows estimation of the return time by a maximum annual daily value. This prediction relies on the definition and implementation of a frequency model which is an equation describing (modeling) the statistical behavior of a process. These models describe the probability of occurrence of an event of given value. It is of the choice of the frequency model (and more particularly of its type) that the validity of the results of the frequency analysis will depend. Figure 2 summarizes the different steps of the frequency analysis.



Vol. 2, No. 02; 2017

ISSN: 2456-8643

Figure 2: Main steps of frequency analysis

Source: Benyahyet al (2009)

The methods of descriptive statistics allowed to study the hydro rainfall parameters. Among these, there are:

2.2- Arithmetic mean

The calculation of the arithmetic mean allowed to study the rainfall regime and the frequency of the rains at the different stations. It is the fundamental parameter of the central tendency. It is expressed in terms of formula

$$\bar{x} = \frac{1}{n}\sum_{i-1}^{n} xi$$

With:, $\bar{X}$ the average of the series that will be considered,

N, l , The total number of terms,

X_i , The modality of the character studied.

2.3- Reduced centred anomalies

From the calculation of the standard deviation, the study of intramural rainfall and hydrometric anomalies was possible by standardizing the data. The anomaly refers to a situation of deficit and surplus with respect to the average considered as a normal rainfall or hydrological situation. It is an observation measured in a statistical form which can be positive or negative in relation to a given "normal" mean. The anomalies on each station are calculated by the formula:

$$X'_i = \frac{xi - \bar{X}}{\sigma(x)}$$

Where: $=X'_i$ reduced center anomaly for year i,

X_i = The value of the variable,

$\bar{X}$= The mean of the series,

$\sigma(x)$ = The standard deviation of the series.

Vol. 2, No. 02; 2017

ISSN: 2456-8643

The use of standardized values makes it possible to target the surplus years and the deficit years of the series studied. For example, all years with abnormalities above normal indicate wet years, and conversely, all years with anomalies below normal represent dry years.

2.4 - Standard deviation

This is the square root of the variance. It made it possible to make a study on the dispersion of precipitated annual rainfall and hydrological values over the period of registration at the post considered around the mean. Its formula is the following: where V is the variance is defined as:

$\sigma(x)=\sqrt{V}$ Where V is the variance is defined as:

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(xi - \bar{x})^2}$$

The route method is used to identify farm households. The Participatory Research Methodology (PRA) allowed for exploratory visits to selected locations where information was gathered, and to identify resource persons. Tools such as the survey questionnaires and the survey guide Interviews have gathered information from the populations.

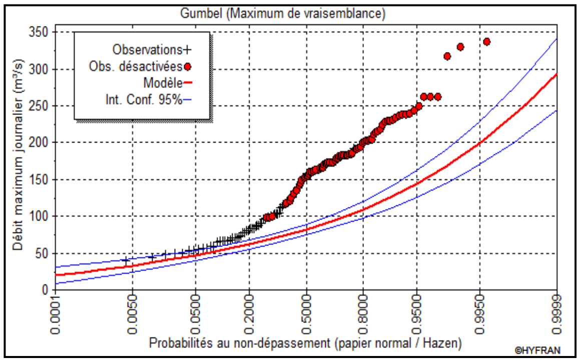
3- Results

3 -1. Characterization of flooding in the Couffo watershed

Flooding in the Couffo catchment area is due to heavy rainfall and flooding of the Mono River. The characterization of flooding involves determining the periods of return of maximum rains and peak flows in the basin.

3.1- Characterization of the flood hazard

Figures 3 and 4 show the adjustment of the maximum rainfall at Dogbo and Lokossa stations.



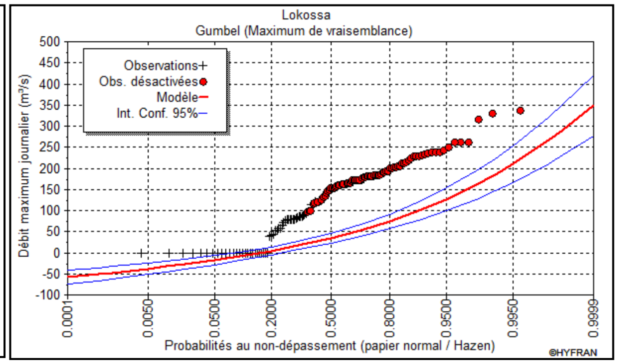


Figure 3 : Adjustment of maximum rainfall by Gumbel's Law to Dogbo

Figure 4: Adjustment of maximum rainfall by the Gumbel Law to Lokossa

From the analysis of FIGS. 3 and 4, it is noted that the variables fit well with Gumbel. This shows the alignment of the observed values on both sides of the model. From the right-hand equation, the rain quantiles were estimated for different return periods. Table I shows the results of estimating the quantiles of rainfall with their return period.

Table I: Maximum rainfall quotient estimated by the gumbel law

Return period (years)	Estimated values		Confidence Interval (95%)	
	Dogbo	Djakotomey		
100.0	183	154	157	209
50.0	166	148	144	189
20.0	144	136	126	162
10.0	127	125	112	141
5.0	109	109	97.4	120
2.0	81.7	75	74.3	89.1

Source: Data Processing

From the analysis in Table I it appears that the recurrent floods in the basin are caused by rainfall heights between 74 and 162 mm (return period ≤ 10 years). Rare floods, that is to say those whose return periods are between 10 and 50 years, are caused by rainfall levels between 126 and 189 mm. Exceptional floods, that is to say those whose return periods are greater than 50 years, are caused by annual maximum daily rainfall with values between 157 and 209 mm.

3.2- Characterization of the river flood hazard

Figure 5 shows the adjustment of peak flows by the normal distribution over the Couffo-Lanta basin.

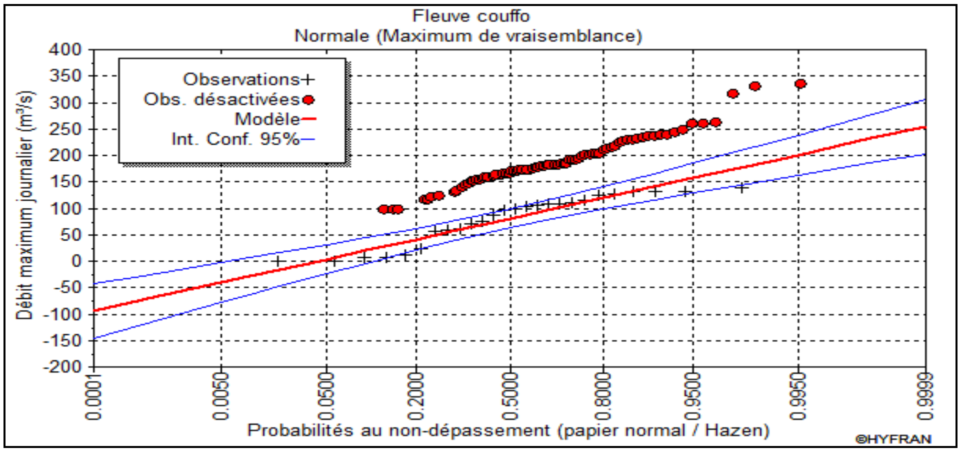


Figure 5: Adjustment of maximum rainfall by the normal distribution

The analysis of FIG. 5 shows that the Normal law is better adapted to peak flows. From the equation line, we estimated the quantiles of rain for different periods of return. Table II shows the results of estimated flow peak quantiles

Table II: Quantile of peak flows estimated by the Normal law

Return period	Estimated values	Confidence Interval (95%)	
100.0	189	154	224
50.0	176	144	208
20.0	157	129	185
10.0	140	116	165
5.0	120	98.7	141
2.0	80.4	62.4	98.3

Source: Data Processing

From the analysis in Table II, it appears that the recurrent floods responsible for river flooding in the basin are caused by maximum flows between 63 and 165m3 / s (return period ≤ 10 years). Rare floods, that is to say those whose return periods are between 20 and 50 years, are caused by the peak flows whose values between 129 and 208m3 / s. Exceptional floods, ie those with a return period of more than 50 years, range from 189 to 224 m3 / s.

Both types of flooding affect living population activities in the Couffo watershed in Lanta. The degree of allocation varies according to modes and means of livelihood.

In the face of repeated flooding in the Couffo catchment area in Lanta, populations have developed the techniques for reducing effects. These techniques concern both production and crop conservation techniques.

3.3- Maize farming techniques

Maize is generally grown on organic, well-drained and deep soils (BOKO, 1988). All cropping operations related to maize cultivation are practically carried out manually with rudimentary tools. Corn seeding is done by hand in pockets, and in line either on plowing flat (15 to 20 cm deep) or on ridges.

In pure cultivation (photo 1), corn is sown with 0.80 m × 0.40 m spacing's and two grains per pole or 0.80 m × 0.20 m and one grain per pole, Of 62500 feet per hectare. This technique is mostly observed (89% of producers) in the Tchi depression, in localities Tohou, TchiAhomagnon, TchiAhomadégbé.

Photo 1: Pure maize crop

Picture shot: Houédanou, 2016

Another variant observed is that maize is grown in association in high season with other annual or perennial crops. Annual crops may be associated with maize during growth and development phases where the maize is in pure association. In most fields maize is associated with oil palm, banana (photo2). Similarly, pure maize culture in the senescence phase is associated with other crops (photo3). This technique, known as relay culture, is also carried out during the development phase or just after harvesting (AGON, 2008). The speculation used by the farmers for the relays is cowpea (Vigna ugniculata), pigeon pea (Cajanuscajan).

Photo 2: Corn and Orange Orchard Association in La

Picture shot: Houédanou, 2016

Photo 3: Relais maïs - cowpea in Banigbé

Picture shot: Houédanou, 2016

The cropping techniques used by the farmers are the result of the use of the possibilities of two rainy seasons offered by nature but also and above all a concern for flood risk management in the Couffo watershed. Thus, in the face of the recurrence of the floods, the populations have developed several coping strategies. These strategies are observed in the choice of maize varieties and in the conservation of crops.

3.4- Variety choice

The adoption of new varieties by the populations is done in order to compensate for the consequences of the floods that occur each year in the basin. Indeed, local 90-day corn was grown. New improved maize varieties have been tested and popularized since 1986 to boost the sector. In the Couffo watershed two varieties were adopted by the populations. These improved maize varieties are TZSR-W and NH 2. According to 68% of populations, these short-cycle varieties have the advantage of being produced two to three times per year. Thus, from the first rains of the end of March, they are sown and harvested 60 days later before the floods of the great rainy season.

Nevertheless, of these two improved varieties, NH 2 resists better and, according to 58% of the farmers, it resembles local varieties (48%). Better the farmers found that the percentage of ears of local varieties moldy in the field at harvest is lower than that of the improved varieties. All the farmers have affirmed that the short cycle varieties are mainly intended for sale because they can not be preserved not long. Because of their precocity, 92% of farmers believe that short-cycle varieties can partly replace local varieties. They are harvested before local varieties and can reduce the lean season.

3.5- Storage of maize

Conservation of maize under traditional conditions has shown that the local variety suffers a loss of 13 to 15% of grains, corresponding to 1.5-2% of the weight. Improved varieties suffer a loss two to three times greater. Local varieties are better preserved than improved varieties. This is due to the fact that they are less susceptible to harvesting. TZSR-W can not be stored at all. These spikes are not well covered and the spathes are also thin.

Faced with these situations, the population, just after harvesting, stores the corn cobs in the granaries (photo 4). Traditional granaries made from straw, bamboo, branches or reeds (unpathed cobs). According to 92% of the population, traditional granaries can conserve the maize of the high season two years and the maize of the small season two and a half years if it is well stored. Corn storage must be avoided at all times during the storage period.

Photo4: Corn attic in Ahomadegbé

Picture shot: Houédanou, 2016

Photo 4 shows the corn cobs stored in the attics. These granaries are made taking into account the characteristics of the soil. To prevent the attic being flooded by water during the floods, the attics are made on stilts. The vegetable species known to resist water are used for the realization of granaries. According to the populations, the variety TZSR-W does not preserve at all. So just after harvest, corn is temporarily stored in attics or at home. Two to three weeks later, the crop is dehulled using the mills (photo 4) or manually. It is after this operation that the maize is sifted, sorted and placed on the market.

Photo4: Corn Ginner in TowétaYovotonou

Picture shot: Houédanou, 2016

Photo4 shows a corn ginnering machine. In the past the husking operation is purely manual. But nowadays, with the increase in yields and the adoption of short-cycle varieties, new hulling strategies such as mills are being used to reduce operating time.

Conclusion

Climate change is now reflected in the occurrence and frequency of events. Among these extreme events, flooding is at the forefront in the Couffo watershed in Lanta. Faced with the damage caused by the floods every year, the populations have put in place several adaptation strategies. In the maize sector, adoption of improved varieties and crop storage techniques are the different strategies put in place by the populations.

Bibliographic reference

1. UNDP (2008). Adapting to the inevitable: national action and international cooperation. In Human Development Report 2007/2008, Chapter 4, 36 pp. [Online] http://hdr.undp.org/en/reports/global/hdr2007-2008/chapters/english/.

2. GAYE A. (2009): Sub-regional consultation for flood preparedness in West Africa (online)

3. STRAVER G., (1989): Agricultural trials: participation and peasant appreciation. MDR / DRA / RAMR, Cotonou

4. DANGBÉGNON C., 1987. Knowledge systems and informal peasant research. A case study: maize cultivation on the Adja plateau (Dadohoué and Dékandji villages). Thesis of agronomic engineer.

5. BOKO M. (1988): Climate and Rural Community in Benin, climatic rhythms and development rhythms. PhD thesis, Dijon, University of Burgundy, 608 p.

6. AGON.S.A, (2008): Contribution to the improvement of the performance of the Directorate of Prevention and Civil Protection in disaster management, UAC - Diploma of Higher Technician in General and Territorial Administration, 90p

7. BENYAHYA L, ANIK D, DANIEL C, DAN B, ANDRE ST-H., (2009): Characterization of the natural flow regime of eastern Canadian watersheds. Research report. 67p

8. SDI (2003): Corn, Technical itinerary. Www.sdi@intnet.bj. Accessed November 15th, 2011

9. Adégbola P. (1994), Experiences and acquired countries in maize cultivation in southern Benin. Production and valorization of maize at the village level in West Africa, Archives of FAO documents.