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Socio-Health Impacts of Floods in the 13th (Agla District) of Cotonou

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Abstract

Agla is prone to flooding during the rainy seasons, due to the inadequacy of the drainage system, a low slope, populations who settle haphazardly in the lowlands, swamps as well as in the natural outlets that they have filled in, the environment is also unsanitary which creates many negative consequences on the living environment of the populations. The objective was to carry out an analytical study of the socio-health aspects of flooding in Agla, an almost annual phenomenon. The methodological approach adopted is based on documentary research, field surveys, and the collection of fundamental data on the impact of flooding in the 13th arrondissement of Cotonou. The survey covered 136 households in the Agla district. For this, flood-prone and non-flood-prone areas were defined with 68 households surveyed within each area. The survey only included households that had lived at least two years in the study area. Households were subjected to a questionnaire survey, followed by direct observation. The present study found a higher frequency of loss of assets (varying from 5.8 to 48.5%), malaria (52.2%), and health expenses (Average 7,500 FCFA /person) among populations flooded areas. the frequencies of diarrhea and dermatoses were similar, contrary to expectations. This seems to indicate a similarity in behaviors not favorable to environmental hygiene within the two zones.

Keywords

Flood, Health, Environment, Cotonou (Agla)

1. Introduction

Floods are major water-related disasters facing many regions around the world.

Over the past decade, several countries have been seriously affected. The costs caused by natural disasters linked to water have doubled over the last ten years (Brüschweiler, 2003: p. 66).

Cotonou, the economic capital of Benin, is territorially divided into 13 districts, with 144 districts which extend over an area of 79 km^2 (Mairie De Cotonou, 2008: p 30). Wedged between Lake Nokoué (250 km^2) and the Atlantic Ocean, its spatial development, which is much more towards the west and towards the east, seems to go hand in hand with its demographic growth estimated at 875,803 inhabitants in 2011 (INStaD, 2002: p. 79) with 8419 inhabitants/km^2. This demographic pressure is explained by the fact that Cotonou brings together the majority of industrial establishments, banks, various companies, major decision-making centers of Benin, ministerial departments, the Dantokpa international market, the Bernadin Gantin international airport, the autonomous port. Every year several districts of the city of Cotonou, such as Agla, Avotrou, Sainte Rita, Fifadji, Vossa, Agbato, Sodjéatimè to name but a few are subject to serious flooding. Floods usually occur twice a year. We therefore distinguish the floods of the long rainy season in June and that of the short season in September. The floods of 1983, 1987, 1988, 1995, 1997, and the most recent that of 2010, were the most significant in the last forty years, given the material damage and loss of life caused (Vissin et al., 2014: p. 66).

One of the consequences of this demographic surge in the city of Cotonou is the anarchic and galloping urbanization, the scarcity of land and the increase in rent prices in the city center, which sends the population towards the outskirts areas where the prices are lower. Certain peripheral areas (Agla, Houénoussou, Avotrou, Yénawa, Sainte Rita, Fifadji, etc.) have the following physical characteristics: low slopes, the outcrop of the water table is largely marshy. But, although unsuitable for human settlement, these very marshy areas accommodate and continue to accommodate a large mass of population. The flooding added to the residual unsanitary conditions aggravates environmental pollution through the spread of urine, feces and household waste (De Souza, 2007: p. 39). Thus during the rainy season, a large part of these municipalities are flooded. These risk areas were occupied in an anarchic manner, in a context of non-existence of appropriate legislation and non-application of the various existing orders and decrees (Lavalin, 2018: p. 89). The objective of this study is to propose mitigation measures linked to socio-health constraints due to flooding in the Agla district.

Presentation of the Study Area

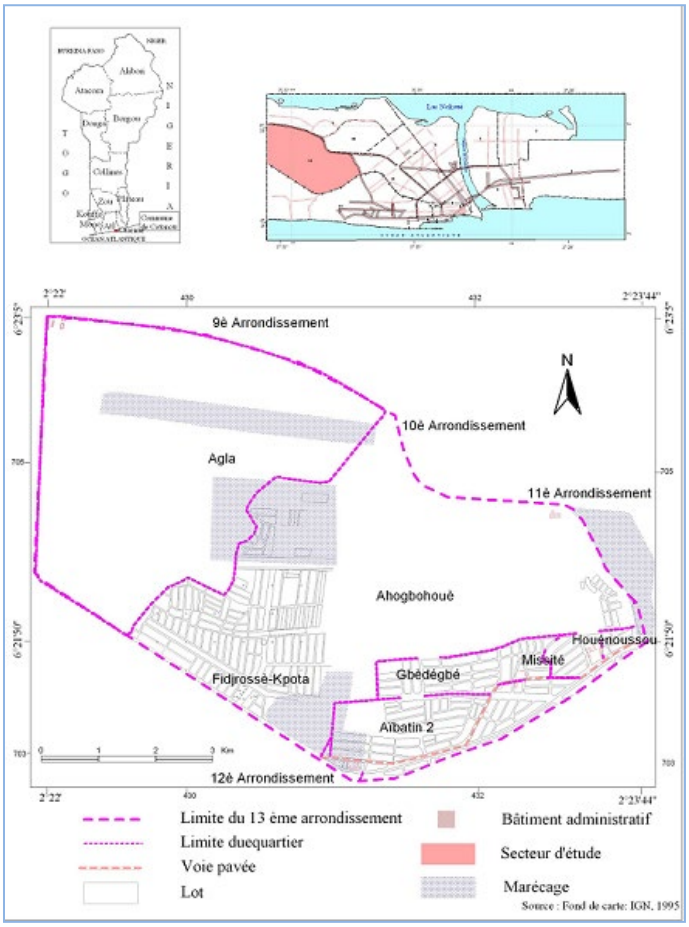
Cotonou, a coastal city in the Littoral department, is between 6˚10' and 6˚40' North latitude and 1˚40' and 2˚45' East longitude. It is limited to the north by the commune of Sô-Ava, to the south by the Atlantic Ocean, to the west by the commune of Abomey Calavi and to the east by the commune of Sèmè Kpoji. With an area of 7900 ha (PDC-Cotonou, 2008).

The Agla district is limited to the north by the RNIE, on the other side of this road are the districts of Lanta, Mènotin, Zogbohouê and Kouhounou. It is limited

to the south by Fidjrossè-Kpota, to the east by Ahogbohouè, Gbèdègbè and Aïbatin 2; to the west by the town of Godomey. Given its large spatial extension and for reasons of administrative efficiency, it has been divided into five (5) zones (A, B, C, D and E).

This district located to the west of Cotonou is one of the largest in the city with an area of approximately 387 ha (Centren Beninois Pour Le Developpement Durable, CBDD, 2000: p. 37) or 4.9% compared to the entire city.

The RNIE which limits the Agla district to the north constitutes a barrier between the marshy areas of Agla and Lake Nokoué. The Agla district is also limited to the south by the railway line. Field observation revealed that a few bridges had been built under these rails to evacuate water from the large swamp south of Agla, but unfortunately, the lack of maintenance of these bridges and their dimensions had become too small to drain all the waters of this area. All these elements combined with others contribute to worsening flooding. Agla being a marshy area and still on a coastal plain is not at all resistant to flooding. This situation causes a huge problem for the populations of the 13th arrondissement. Figure 1 presents the situation of the study area in the 13th district of Cotonou.



Source: Field work, 2011.

Figure 1. Location of the study area in the 13th district of Cotonou.

2. Méthodologie

This part covers the methodological approach adopted as part of the present study carried out in the 13th arrondissement of Cotonou. It was based on the collection, the collection technique and the method of processing the data as well as the method of analyzing the results.

The data used in this study are:

- demographic data for the city of Cotonou, made up of the number of populations living in flood-prone areas of the city, available at INStaD;
- data and information on the soil of Cotonou and its characteristics in terms of water retention and infiltration available in the various libraries;
- climatological data (rainfall amount, average temperatures over the period 1980 to 2010) from the ANM;
- health statistics in public and private health centers in the study area, at the MS and the DHAB;
- socio-spatial data (population perceptions of floods, their causes, their impacts on the socio-economic and health environment and the strategies developed to mitigate these impacts).

All this data was collected through documentary research, investigations and direct observations in a real environment.

The sample used is based on the reasoned choice and the representative nature of the different actors concerned by flooding issues. To this end, the choice of households surveyed meets one of the following criteria:

- be at least twenty-five (25) years old and have lived in the study area for at least two (2) years;
- be an actor in prevention and protection against flooding;
- be a member of the Neighborhood Development Committee or an association;
- health center (public and private).

The defined sample is made up of Agla households divided into two (2) zones (flood zone and non-flood zone) and resource persons from the different structures of the town hall whose activities relate to the fight against floods.

In total, 136 people were surveyed during fieldwork. The study area was divided into two (2) (68 respondents in flood zones and 68 others in non-flood zones). Added to this figure 21 resource people and others.

To determine the minimum sample size to be surveyed, the following formula was usedee:

$$\mathbf{Ni = (N \times Z^2 \times P \times (1 - P)) / (Z^2 \times P \times (1 - P)) + (N \times E^2) = 136\ (Ni = 136)}$$

With: N: number of target population = 8489 households.

Ni: sample size;

Z: the 95% confidence level = 1.96;

P: the estimated standard proportion = 0.1 (10%);

E: maximum error tolerance = 0.05.

Thus twenty-one (21) people were identified including: two (02) community

leaders (Town Hall, DST), one (01) from the Directorate of Prevention and Civil Protection (DPPC), seventeen (17) at the level of public and private health centers and finally one (1) district manager.

The EXCEL software was used to analyze the results collected in the field and made it possible to develop tables and graphs relating to the analysis of social and health data.

After the tables and graphs were drawn up, the graphs were analyzed and commented on. This work was done not only to illustrate the present study, but to make meaningful comparisons on the social and health aspects between flooded areas and those which are not, based on the data collected.

3. Results and Discussions

The results obtained relate to the description, analysis and comparison of the socio-health consequences of flooding in the Agla district. Some results have been grouped in the form of tables and figures.

3.1. Description and Comparison

Table 1 shows the domestic damage caused by flooding in Agla with the percentages of people surveyed by area.

Table 1. Domestic damage caused by flooding.

population enquêtée / Dommages	Ensemble NI = 136			Zones inondables Ni1 =6 8			Zones non inondables Ni2 = 6 8		
	Nbre	%	Coût moyen estimé en FCFA	Nbre	%	Coût moyen estimé en FCFA	Nbre	%	Coût moyen estimé en FCFA
Denrées alimentaires	44	32.3	9350	33	48.5	13500	11	16.1	5200
Animaux (noyade)	30	22	26100	21	30.8	34000	9	13.2	18200
Mobilier	10	7.3	X	6	8.8	X	4	5.8	X
Sur le logement	41	30.1	79450	31	45.5	115600	10	14.7	43300

The costs expressed in Table 1 were estimated by adding the amounts declared by the respondents, the whole divided by the number of households having declared having endured domestic damage during the floods. This was not taken into account for the comparison; everything suggests that they were poorly evaluated by the households surveyed (undervaluation and/or overvaluation, possible damage). It also appears from this table that 48.5% of respondents in flood-prone areas declared having lost food, 16.1% in non-flood-prone areas. Damage to housing is greater in flood-prone areas (45.5%).

Overall, it appears that the damage is higher in flood-prone areas, however, regarding damage to movable property, it is not significant.

Table 2. Description and comparison of household living conditions at the time of the floods.

population enquêtée / gêne dans conditions de vie	Ensemble NI = 136		Zones inondables Ni1 = 6 8		Zones non inondables Ni2 = 6 8	
	Nbre	%	Nbre	%	Nbre	%
l'eau stagne dans la cour des concessions	103	75.7	62	91.1	41	60.3
L'eau empêche l'accès à la chambre à coucher	54	39.6	43	63.2	11	16.1
L'eau stagne et envahie la chambre à coucher	51	37.8	42	62.6	9	13
Déménagement à cause de la stagnation de l'eau ayant rendu inhabitable le domicile	16	11.7	12	17.6	4	5.8
Ménages ayant hébergés des personnes sinistrées	16	11.7	7	10.2	9	13.2
Empêchement dans les occupations quotidiennes	52	40.2	36	52.9	16	23.5
Empêche de se rendre aux occupations	28	20.5	21	30.8	7	10.2

Source: Survey results, June 2011

It appears from the analysis of Table II that the proportion of stagnant water in the courtyards of the concessions of the two zones compared is quite significant, 91.1% in flood zones and 60.3% in non-flood zones. This stagnant water prevents 63.2% of respondents from accessing the bedroom compared to 16.1% in non-flooding areas. Water invades 62.6% of bedrooms in flood-prone areas compared to 13% in non-flood-prone areas, thus pushing 17.6% of households in flood-prone areas to abandon their homes for a while compared to 5.8% in non-flood-prone areas. According to our surveys, only 10.2% of respondents in non-flood areas were prevented from going about their business, the most affected households came from flood areas (30.8%).

This confirms the first hypothesis which states that living conditions are made difficult during floods.

Plate 1 below are some visual supports of the realities on the ground.

Shooting: EWONDO J, June 2011

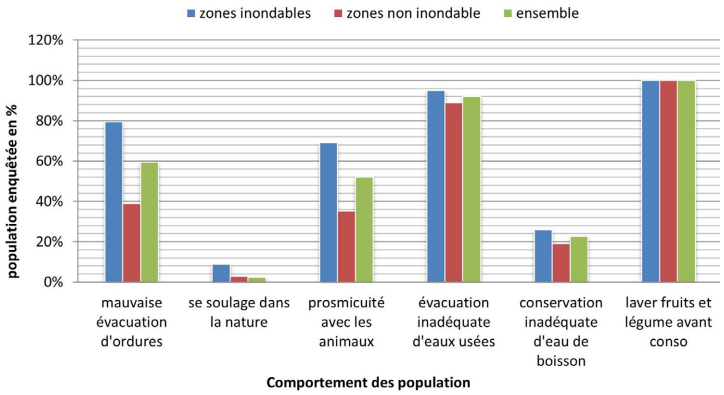
Plate 1. Dwellings abandoned due to floods and anarchic occupation of swamps and their filling.

Some flooded homes in the study area were abandoned by their occupants

because they had become unsuitable for habitation. The high concentration of populations in these environments and the various uncontrolled developments there contribute to promoting flooding in Agla.

Household Practices Regarding Water-Related Diseases

Figure 2 shows household practices during the flood period in the sample surveyed.



Source: Survey results, June 2011

Figure 2. Household practices during the flood period.

Looking at Figure 2, the observation is that 59.5% of respondents dispose of their household waste poorly. 92.6% also dispose of their wastewater poorly by dumping it either in the compound courtyard, in the street or in puddles. We also note promiscuity with wandering animals of the order of 52.1%.

Despite this grim observation, we can still note certain attitudes considered favorable: 100% of respondents wash their fruits and vegetables before eating them raw. However, this positive result does not mean that the water used to wash fruits and vegetables is healthy. Only 2.4% of respondents declared relieving themselves in nature; we believe that some were not sincere given the presence of excreta during direct observations around certain concessions surveyed.

To illustrate this situation, Plate 2 provides an overview of some realities on the ground.

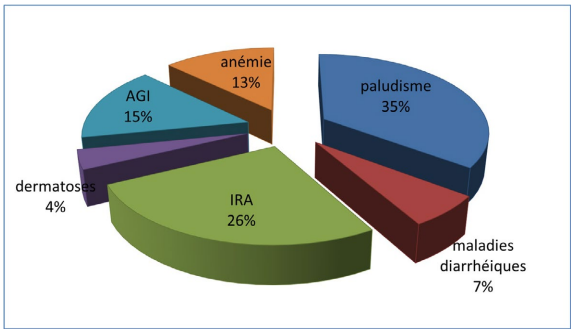
Shooting: EWONDO J, June 2011

Plate 2. Wandering animals in Agla and Woman of Agla preparing to collect water in a flooded well.

During the flood, domestic animals roam, whose droppings contain many pathogens which also pollute the water. 52.1% of households surveyed. Observation has shown that the supply of drinking water becomes more difficult, health problems are accentuated by consumption of polluted water.

3.2. Analysis of Conditions during the Rainy Season

Figure 3 below reveals the percentages of respondents who suffered from each type of illness due to flooding.



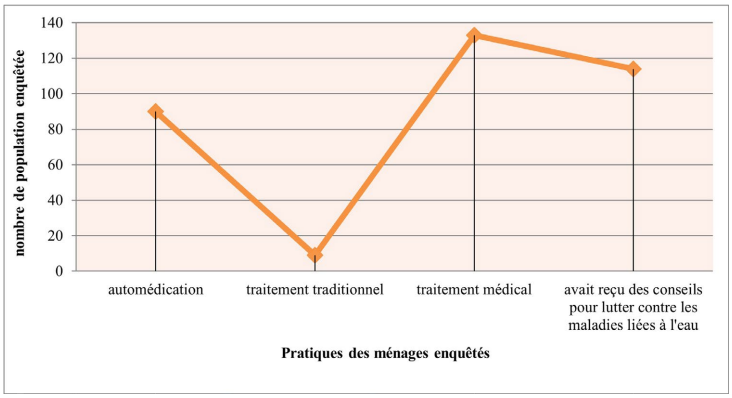
Source: Survey results, June 2011

Figure 3. Frequencies of water-related illnesses.

Figure 3 shows that the most common illnesses among surveyed flood victims are: malaria (52.2%), respiratory infections (38.9%), gastroenteritis 15%, anemia (19 %).

Contrary to what was expected given the unsanitary state, the frequencies of diarrhea and dermatoses are low and are around 9.5% for diarrheal diseases and 5.8% for dermatoses. 97% of households surveyed reported being more vulnerable to diseases during rainy seasons. Health expenses range from 500 to 200,000 FCFA. Average cost 7,500 FCFA

Figure 4 reveals the percentage of respondents' practices regarding water-related diseases.



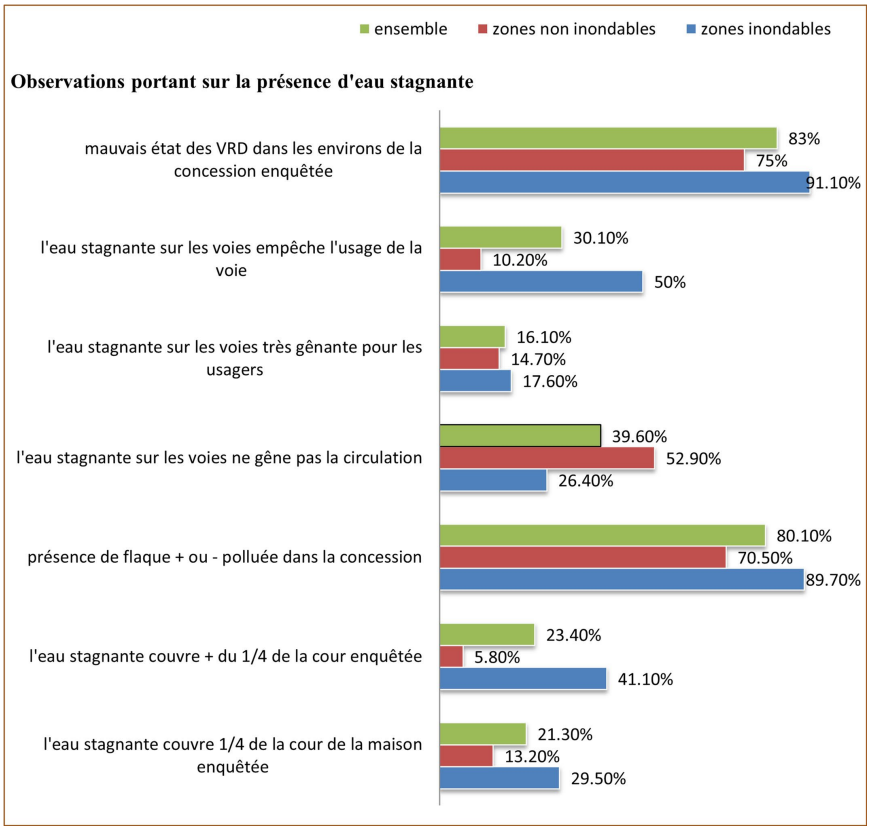
Source: Survey results, June 2011

Figure 4. Household practices regarding water-related diseases.

From this Figure 4, we deduce that the practices of going to traditional healers are almost insignificant, only 9 out of 136 respondents or 6.6% are concerned. It is satisfactory to note that 133 respondents, or 97.7%, are following medical treatment, but many admitted that they only go to a health center when the condition they are suffering from becomes complicated, but before arriving at this stage, 90 respondents out of a sample of 136 households, or 66.1%, practice self-medication. Awareness and information campaigns on water-related diseases, carried out by health workers, television, radio, etc., affected 83.7% of households surveyed, which is an encouraging figure. It should be noted that all levels (from the poor household to the most well-off) were affected by these practices.

Direct Observation of Household Living Conditions during Floods

We find through Figure 5 and Table 3 the direct observation made in the field on the living conditions of the households surveyed during the floods.



Source: Résultats d'enquête, Juin 2011

Figure 5. Portant sur la présence d'eau stagnante et la surface qu'elle couvre.

It appears from Figure 5 that stagnant water covers most of the concession courses in both flood-prone and non-flood-prone areas. The observation showed that 21.3% of the courses surveyed are ¼ covered with stagnant water. 23.4% were covered by more than ¼ of stagnant water. In 80.1% of the concessions surveyed, they are covered with puddles of more or less polluted water. 83% of the VRDs

located around the concessions surveyed were in poor condition. The presence of this stagnant water on the tracks is annoying for 16% of users and prevents 30.1% of respondents from using the track.

The actual presence of the aforementioned impacts confirms the 3rd hypothesis according to which households in flood-prone areas are more affected than those in non-flood-prone areas.

Flood-prone areas are the most affected. Plate 3 below illustrates some of the consequences that result from stagnant water.

Shooting: EWONDO, Juin 2011

Plate 3. Access to a home made difficult due to flooding and poor road conditions making circulation difficult.

Access to certain homes in flood and non-flood areas is difficult. This stagnant water constitutes larval breeding grounds. Observation has shown that the roads are becoming inaccessible, in addition to the deterioration of means of transport (mopeds, motorbikes, cars).

Table 3. Description and comparison of household living conditions. ((**b) relating to the level reached by the water)**

population enquêtée / observations	Ensemble NI = 136		Zones inondables Ni1 = 6 8		Zones non inondables Ni2 = 6 8	
	Nbre	%	Nbre	%	Nbre	%
L'eau stagnante occupe uniquement la cour	42	30.8	34	50	8	11.7
L'eau stagnante envahie les chambres	14	8.8	11	16.1	3	1.5
L'eau stagnante envahie la chambre en la rendant inhabitable	10	13.2	9	13.2	1	0.5

Source: Survey results, June 2011

It appears from the analysis of Table 3 that stagnant water occupies on average 30.8% of the areas surveyed (50% in flood-prone areas and 11.7% in non-flood-prone areas). This stagnant water invades on average 8.8% of rooms with a greater proportion in flood-prone areas (16.1%) and 1.5% in non-flood-prone areas.

13.2% of rooms invaded by water in flood-prone areas are thus made uninhabitable compared to only 0.5% in non-flood-prone areas.

3.3. Solutions for Implementation against Flooding

In view of the increasingly pronounced recurrence and scale of floods, the municipal authorities have set up a specific flood control operation called "Cotonou en Campagne Contre l'Inondation". (3CI).

Operation Cotonou Campaign against Flooding (3CI)

Presentation of the plan

This is an emergency program initiated by the Cotonou town hall since 2003 to relieve flood victims. The objectives of this program are, among others:

- facilitate people's access to public places (schools, public services, socio-community infrastructure, etc.);
- provide assistance to populations in the most catastrophic cases with the participation of the Fire Department in operations as well as all the structures that can contribute;
- have the shortest possible response time for interventions.

The program has three (3) essential phases of intervention, namely:

The preventive phase during which the following operations are carried out:

- cleaning of gutters;
- resurfacing and reprofiling of earthen tracks;
- the opening of the trenches;
- the drying up of socio-community infrastructures;
- repair of paved roads.

The curative phase during which the following operations are carried out:

- maintenance of trenches;
- pumping of rainwater;
- drying of flooded sites.

The phase after the main rainy season during which the following operations take place:

- track maintenance;
- resurfacing degraded roads;

To achieve these objectives mentioned above, an intervention and organizational framework.

was put in place for flood management. For the organization of the intervention, the city of Cotonou was divided into five (05) zones, each having a Command Post (CP) which coordinates the interventions in each zone.

4. Conclusion

At the end of this study, we can conclude that the spatial development of Beninese cities was based on a spontaneous and anarchic occupation of the population, sometimes in marshy areas, in lowlands or natural outlets. This is especially the case in the outlying districts of Cotonou including Agla. This situation coupled

with the very high rainfall concentrated in a limited number of days, the geographical nature of the soil, the flush water table, the very difficult land to drain, the lack of maintenance of the rainwater evacuation gutters, etc.

These main factors mean that floods are almost annual in Cotonou. They take on catastrophic aspects, leading to a deterioration in social living conditions among populations and an increase in water-related illnesses.

If it is not possible to influence the rainfall and the nature of the soil, it is nevertheless necessary to prevent the resurgence of water-related illnesses and to avoid the deterioration of the living conditions of households affected by the flood.

The solutions proposed come at the right time to stop the deterioration of the living environment and the living conditions of the population of Agla because they perfectly integrate respect for the modes of operation of this environment.

In Benin, texts were developed, structures were put in place, training and retraining seminars took place, in the search for solutions to flooding; However, what is needed is a change of attitude. It is also considered useful to create a culture of prevention within society. There are many examples around the world where communities that have considered that prevention pays off have invested in this direction. The essential condition and the great ally needed to guarantee the protection of the environment and provide better living conditions for populations is political courage.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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