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Consequences of disparities in sanitation infrastructures on the environment and the health of populations in the city of Cotonou

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Abstract

This study focused on the problems of disparities in sanitation infrastructure and their consequences on the environment and health in the city of Cotonou. The methodology focuses on documentary research, sociological surveys by questionnaire, direct observation using an observation grid. A total of 10 boroughs and 20 neighborhoods were covered. The Accelerated Participatory Research Method (MARP) was used to reach households in order to have their perceptions on the causes of floods and sanitation problems, their impacts on the environment and health. The model (Strengths, Weaknesses, Opportunities and Threats (SWOT) served as the basis for the analysis and interpretation of the results. The cartographic data was processed using GIS software. The maps were drawn up using the topographic base map from the National Geographic Institute (IGN). The results obtained show that there are significant differences in terms of sanitation in Cotonou. This is partly due to the irregular settlement of populations in unhealthy areas where the land have not been serviced in time. As far as the collectors are concerned, there are arrondissements which are not or poorly provided for, whereas the need is real. This is the case of the 1st, 2nd, 7th, 8th, 12th, arrondissements. This same trend is observed with the paved roads and gutters in these respective arrondissements. It has been observed that the majority of domestic wastewater is discharged on the ground, outside or in the courtyard of the concessions (87% households) and this is explained by the fact that the majority of households do not have pits for the collection of this water. The water from the shower is collected in the pits (77% of households) or is left to infiltrate directly into the ground (40% of households). The existence of sewage streams and uncontrolled deposits of solid waste in the city are certainly one of the causes of ailments such as malaria, diarrhea, and acute respiratory ailments.

Keywords: Sanitation infrastructure; Environment; Hygiene; Health; City of Cotonou

1 Introduction

The question of spatial planning is topical in the world, especially in Benin, where pollution problems are increasing day by day [1]. Since the United Nations Conference on the Environment and Sustainable Development (Rio de Janeiro in June 1992), particular attention has been paid to the environment and to all the factors that could harm it [2]. The

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lack of water, hygiene and sanitation can have an impact on health and on the economy. According to the World Health Organization (WHO), 7% of deaths in the world and 8% of the global burden of disease are due to diseases linked to a lack of sanitation. According to the same sources, it is estimated that about 2.4 million deaths (i.e. 4.2% of all deaths) could be prevented annually by appropriate hygiene practices, reliable sanitation and the availability of drinking water (UNESCO -PS-EAU, 2014). On the economic level, the impacts are as enormous as on the health level. Indeed, according to the same sources, the lack of water, hygiene and sanitation costs approximately US\$340 million to households and US\$7 billion to national health systems. The very advanced state of unsanitary conditions in which Beninese cities are bathed generates serious illnesses which hinder the well-being of the populations [3]. According to [4] (Sotindjo. S. D., 1990), the more or less excessive development and concentration of socio-cultural activities in certain regions of the world generate phenomena of macrocephaly at various levels of the urban structure of each country. This phenomenon favors the influx of populations on one side. This then results in enormous problems of development and especially of sanitation characterized, among other things, by a lack of infrastructure for the supply of drinking water, management of excreta, household waste, evacuation of rainwater and sewage [5]. According to [6] (Vennetier, 1986), insalubrity in large cities results both from the increase in their population and the lack of control of the sanitation network. For [7] (VIGAN, 1986), population growth in Beninese cities is not followed by behaviors that are able to promote the preservation of the living environment.

In Cotonou, the largest urban agglomeration, the situation in terms of hygiene and sanitation is still characterized by non-compliance with sound hygiene practices, difficult access to an adequate sanitation system, flooding in rainy season, an embryonic garbage collection system. Although all sections of the population are affected by the conditions caused by this situation, children, pregnant women and the elderly are particularly the most vulnerable. However, in the declarations of the World Water and Sanitation Decade (1980-1990) of the United Nations Organization and the Global Strategy for Health for All of the WHO (1992-2000), it is all urban social strata are recognized as having access to quality sanitation services. At the African level, the "Abidjan Declaration" of February 16, 1996 reaffirms this need to tackle spatial and social disparities in sanitation services by providing consistent and non-discriminatory responses on the subject of waste management. It follows from this statement that all urban spaces and all city dwellers must be considered in the same way with the same degree of attention in the distribution of services. From the highlighting of sanitary situations in the city to the invention of new management methods, all the questions that challenge the management of sanitation can be asked within the framework of a study centered on Cotonou.

2 Material framework and study methods

2.1 Study framework

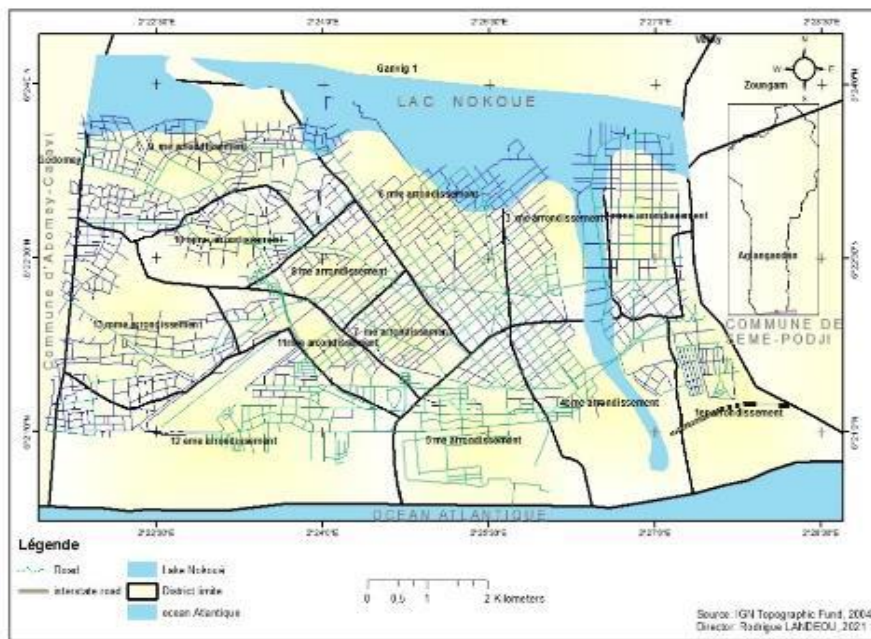


Figure 1 Geographical location of Cotonou

The geographical study of the city of Cotonou reveals that it is located in the south of the Republic of Benin between 6°20' and 6°23' north latitude and 2°22' and 2°30' east longitude. The city of Cotonou is considered the economic capital of the country. It is bounded to the north by Lake Nokoué (Commune of So-Ava), to the west by the Commune of Abomey-Calavi, to the east by the Commune of Sèmè-Kpodji and to the south by the Atlantic Ocean (Figure 1).

Administratively, the city of Cotonou is subdivided into thirteen (13) districts and one hundred and forty-four (144) districts. Commune with special status and essentially urban, Cotonou is the only city in the country erected in a department: that of the Littoral. It is run by a municipal council headed by a mayor. The city of Cotonou is built on the coastal plain, between the Atlantic Ocean to the south and Lake Nokoué to the north and divided into two parts by the Cotonou Channel which connects Lake Nokoué to the Atlantic Ocean. On these two parts, the city extends from east to west over a total area of 79 km². The city of Cotonou does not have any waterways, but Lake Nokoué (85 km²) and some swamps constitute the city's water reservoirs. During the flood due to the descent of the waters from the north and especially the long rainy season, the city is threatened by serious flooding (low level, strongly influenced by variations in the level of the water bodies; maximum flood level: 1.50 meters). The geographical location of the city of Cotonou, which does not have a large space, is a constraint in the management of household waste, where the swamps and the banks of Lake Nokoué constitute the places of waste dumps for the populations and certain pre-collection structures. Household solid waste [8].

2.2 Study materials and methods

2.2.1 Type of study

This is a descriptive and cross-sectional study that took place from March to June 2021. It aims to contribute to a better understanding of the environmental problems related to the lack of sanitation infrastructure in the city of Cotonou and their impacts on the environment and human health.

2.2.2 Study populations

In the context of this study, the targets are made up of all the players in the household waste sector. These are the households, the politico-administrative authorities.

2.2.3 Study data

The types of data used are among others:

- demographic data;
- data and information on soil types and their characteristics in terms of water retention and infiltration available at the Laboratory of Soil, Water and Environmental Sciences (LSSEE);
- climatological data (height of rainfall, average temperatures);
- sanitation issues, which are: rainwater, gray water, sewage and household waste;
- the actors' basis of intervention: regulatory texts and other measures;
- the various actions of the actors in the management of the problems of insalubrity: installations, equipment, methods of management of rainwater, waste water and household waste;
- the factors explaining the problems of insalubrity: the physical, socio-cultural, economic, financial, administrative and political conditions;
- the implications of insalubrity problems: pollution and diseases linked to the environment,
- housing: cleanliness of concessions;
- roads: state of the roads;
- Socio-spatial data (population perceptions of sanitation problems, their causes, their impacts on the socio-economic environment and the strategies developed for their mitigation).

2.2.4 Data collection techniques and tools

The research was carried out along the following three axes: documentary research, interview survey and direct observation.

Literature search

Documentary research was the first step in data collection. It has made it possible to draw up an exhaustive list of the bibliography dealing with questions relating to the problem of sanitation, its impacts and management strategies in particular. In this context, the documents and certain scientific works concerning the subject were consulted on the

shelves of the Department of Geography and Regional Planning (DGAT). They have been supplemented by works from the documentation centers of the Department of Prevention and Civil Protection (DPPC), the Ministry of the Environment and Nature Protection (MEPN), the documentation center of the town hall of Cotonou, the Laboratory of Soil, Water and Environmental Sciences (LSSEE), the Ministry of Health, the Safety Agency for Air Navigation in Africa and Madagascar (ASECNA), Beninese Agency for the Environment (ABE), Regional Planning Delegation (DAT), etc. The data obtained during this documentary research were supplemented by field surveys.

Field surveys

The field surveys were mainly carried out in different neighborhoods of the different districts of Cotonou. Table I presents a summary of the districts of Cotonou where the investigations were carried out.

Table 1 Summary of neighborhoods taken into account by the sample

Arrondissements	Quartiers échantillonnés
1er arrondissement	Dandji, Avotrou
2ème arrondissement	Sènadé 1 et 2
3ème arrondissement	Fifatin et Sègbèya sud
4ème arrondissement	Sodjatimey est, Suru- Léré, Missessin
6ème arrondissement	Ladji, Vossa, Djidjè
7ème arrondissement	Hindé, Aïdjèdo3
8ème arrondissement	Agontinkon, Mèdédjro
9ème arrondissement	Fifadji
12ème arrondissement	Cocotier, Fidjrossè
13ème arrondissement	Agla

A total of 10 districts and 20 neighborhoods were chosen with regard to the parameters relating to the state of sanitation and the vulnerability of the populations living there, after a series of observations made during the pre-survey. In addition, the collection of data necessary for the evaluation of strategies to combat sanitation problems in Cotonou was carried out in the various structures responsible for these issues. This study focuses on three types of neighborhoods. A type of modern and better structured housing district, a type of moderately structured housing district comprising both modern and precarious housing and a type of popular housing district of precarious type. In each type of neighborhood, a certain number of people were chosen at random. Through this division, all social categories are represented. Thus, within the household, we interviewed the head of household or his representative.

Sampling and choice of investigation neighborhoods

The sample used was determined by the quota method, which is based on the reasoned choice and the representative character of the various actors concerned by sanitation issues. For this purpose, the choice of the people surveyed meets one of the following criteria:

- be between 30 and 50 years old and live in one of the selected neighborhoods;
- be a player in prevention and protection against the consequences of environmental degradation and flooding;
- Be a member of the Neighborhood Development Committee or a local elected official.

The defined sample is made up of the populations and elected representatives of the neighborhoods indicated above (Table I) and resource persons from the various structures whose activities relate to sanitation, flood control (technical services of the town hall, health centre, Ministry of the Environment and others Table II presents the characteristics of the sample chosen as well as the sampling rate.

Table 2 Sample characteristics and sampling rate

N°	category	Total Actors of the category	Size of the sample	Rate the sample in %
1	Households	7.717	365	5
2	Development Committees Neighborhood (CDQ)	10	2	20
3	District Heads	10	10	100
4	Head of the Department of Technical Service (DST) Cotonou	1	1	100
5	Road service managers and sanitation of Cotonou	1	1	100
6	Head of district	20	10	50
8	Health actors	-	10	-
Total		-	399	

A total of 399 people were interviewed during the fieldwork. For the households (head of the household or any person representing him), it was mainly those who lived in the neighborhoods concerned who were interviewed.

Actual investigation

The survey was carried out in the period from March 15 to April 15, 2020 and made it possible to deepen the research and provide answers to the various investigations. For this, four types of target populations, namely the authorities; municipal services (primarily responsible for the management of household waste, wastewater and rainwater); service providers in the field of waste and wastewater management (collectors, pre-collectors, emptiers), health center managers and the population (head of household or his representative). Thus two survey methods were used: direct interviews using questionnaires and semi-structured interviews using an interview guide. As for the Accelerated Method of Participatory Research (MARP), it made it possible to take an interest at first sight in the daily realities of the populations before having their perceptions on the causes of the floods, and sanitation problems, their impacts and the strategies and vision in relation to the occurrence and management of the after-effects of these problems.

Field observations

This method was used to collect qualitative data in addition to the interviews. The aim is to collect data on the basis of observations made in the field regarding household waste management methods.

Data processing techniques and analysis of results

Several statistical and cartographic methods were used for data processing. The questionnaire and the survey sheet were processed manually. The same was true for the statistical data collected from specialized institutions. The data analyzed were processed using several methods and software depending on their specificity or nature. Thus the demographic and climatic data were processed using the Excel spreadsheet and made it possible to draw up graphs relating, among other things, to the evolution of rainfall, the analysis of socio-economic data from the evolution of economic activities, etc. The cartographic data was processed using Geographic Information Systems (GIS) methods, in particular Atlas GIS 3.2 and ArcGIS 10.4 used for cartographic analysis. The maps were drawn up from the base funds extracted from the IGN topographic map and with reference to previous scientific work. After the tables and graphs were drawn up, they were analyzed and commented on. The cartographic representation made it possible to make a spatial analysis of the nuisances linked to sanitation problems and floods. Several tools were used for this cartographic representation. In addition, based on factor analysis, the major risk areas of Cotonou neighborhoods were selected using a multivariate analysis technique. This relates the different people surveyed in the context of the investigations, with a few variables that form the basis of the research, namely: the perception of the risk of sanitation and flooding problems, knowledge of the means of protection and the existence of constraining social factors.

The SWOT approach: Strengths, Weaknesses, Opportunities and Threats (Strengths, Weaknesses, Opportunities and Threats) helped in the analysis of the results obtained.

3 Results and discussion

Sanitation issues fall under two levels of responsibility that also apply to two distinct areas. A first level concerns, on a reduced scale, the household, which must take care of the cleanliness of the domestic space located under its responsibility. It appeared through the surveys that 19% of households designate the State as solely responsible for this task. On the other hand, 71% think that the municipality and the State are jointly responsible for public health. Only 10 % of households think that it is also the responsibility of the population.

- In Cotonou, housing is essentially urban and very little differentiated. It is characterized by a dominance of low houses in fenced compounds with one or more courtyards. Served by roads that are generally orthogonal except on the outskirts, the neighborhoods give off a certain impression of typological uniformity. However, the differences to be noted are essentially a function of the quality of services and infrastructures, which also explain the lack of planning, income inequality and the historical development of the city.

As a basic element of housing, there are several types of housing in Cotonou (MEHU, 2002).

- Luxury housing: It extends over 1381 ha and is found in the residences les cocotiers, la Haie-Vive, and the city Vie Nouvelle, the city Houéyiho, the area of the Embassies, etc.). Initially, with a density varying between 50 and 80 inhab/ha, this type of housing gradually became denser.
- Mixed housing or housing-commerce: Developed around the Dantokpa, Missèbo and Ganhi markets, it extends over 126 ha with an average density of 100 inhabitants/ha.
- Old house: It extends over 74 ha with a very high population density exceeding 300 inhabitants/ha. Generally unhealthy with precarious hygienic conditions, it is found in neighborhoods such as Xwladodji, Enagnon, Guinkomè, etc. This type of housing is similar to that developed in the first extensions of Cotonou subdivided before the 1970s and those subdivided between the 1970s and 1990s.
- Peri-urban housing: It is developed in the Agla, Ahogbohoulè and Houénoussou districts where the density varies between 30 and 50 inhabitants/ha.
- Dwelling in marshy areas: Here are found the most disadvantaged sections of the population of the city. These populations live in precarious hygiene and sanitation conditions and under-equipped. There are two sub-types of dwellings, one of which is subdivided (districts along the Cotonou lagoon and Lake Nokoué) and the other not subdivided (Agla and Houénoussou districts, Avotrou, etc.).
- Poor and unsanitary housing: It is found almost everywhere in the districts of the city such as Xwladodji, Enagnon, Donatin (by the sea), Aboki-Codji and Ladj (by the lagoon and Lake Nokoué), Zongo (downtown), Agla, Dandji (on the outskirts).

Several reasons make it possible to understand the extreme diversity of housing types in Cotonou and especially its heterogeneous spatial distribution. For these reasons and according to the field surveys, we can retain:

- non-adhesion or refusal of owners to facilitate the servicing of operated subdivisions;
- legal dualism (coexistence of traditional and modern) and the absence of a real land policy;
- the insufficiency or non-existence of housing financing structures or subdivision works until recently;
- the poor application of the texts relating to the permit to live and to build
- The absence of an effective policy and control in terms of land management.

The populations give the feeling that the public authorities owe them the management of sanitation and therefore, they only note the insufficiency of the service while waiting for a better tomorrow. Most respondents expressed the view that collection services simply need to have more vehicles, collect waste more often, put bins in isolated areas and clean public spaces. As soon as it is the public authorities who are responsible for programming, planning and organizing the management of sanitation in public spaces, some inhabitants tend to resign and lose interest because they no longer feel concerned by this public affair. Moreover, this attitude of the inhabitants shows that the laws do not evolve in relation to the representations.

The habitat is heterogeneous and disparities are present everywhere. The occupation of swamps by unsuitable and badly positioned constructions often blocks the flow of water and aggravates sanitation problems. The distribution of the population as well as its density is very heterogeneous. There is a maximum in the district of Placodji with 340 inhabitants per hectare and minima in the marshes with 30 inhabitants per hectare [9]. The housing situation in Benin

has long been characterized by the absence of a real state policy in this area. Field surveys show that Cotonou is characterized by anarchic construction and overcrowding of houses, coupled with the precariousness of housing units (Plate 1).



Shooting: Avocèfohoun, 2020

Figure 1 Housing situation in several neighborhoods of Cotonou

The survey results show the permanent buildings adjacent to precarious housing, sometimes erected not far from uncontrolled waste dumps. Some populations build their homes in unsanitary places, thus aggravating environmental problems (Plate 2). It is clear that, to respond to the influx of migrants in the city and despite the perfect knowledge of the floods in certain neighborhoods (Vossa, Houéyiho for example), no rigorous development (sanitation network - wastewater, rainwater-) has not been implemented.



Shooting: Avocèfohoun, 2020

Figure 2 Location of dwellings in unfavorable areas

It should be noted that 9 km of paved roads out of 48 km are municipal roads (roads whose maintenance is the responsibility of the town hall). Furthermore, it should be noted that the city of Cotonou is well served in terms of road transport infrastructure, even if their condition remains problematic.

Overall, this coverage extends to the entire territorial space of the city with large disparities towards the eastern and western outskirts.

Even in the districts where the proportion of construction of gutters is higher in the city of Cotonou, these structures are currently experiencing management and maintenance problems. It is also necessary to underline the incivility of certain unscrupulous users who transform them into waste dumps (plate 4).



Shooting: Avocèfouhou, 2020

Figure 3 Condition of certain roads in the rainy season in the city of Cotonou



Shooting: Avocèfouhou, 2020

Figure 4 General condition of gutters and cases of incivility or practices observed on public infrastructure in Cotonou

Another paradox of the urbanization of the city: by surfacing the roads to improve user comfort, man has contributed to reducing the infiltration capacity. A Canadian study estimates soil impermeability at 75% in the central areas of Cotonou and at 55% in the extension areas [10].

The high insalubrity of certain neighborhoods is the reflection of a total lack of control over the extension of the city, so much so that we have moved from a natural problem to a real environmental challenge.

Effective sanitation in Cotonou is currently "a veritable way of the cross". The town hall and the State are nevertheless trying to remedy this, but it must be admitted that this problem does not currently find a solution. Whether it concerns the management of wastewater or waste, certain districts of the city are home to veritable open dumps, without this really worrying the inhabitants of Cotonou. Failure of the authorities, abuse of the inhabitants..., everyone has their share of responsibility in this evil that is the lack of effective and balanced sanitation in Cotonou.

3.1.1 Situation of waste water and sludge

While Benin's entire sanitation network is very failing, Cotonou is currently the best-endowed city in the country. But, in view of the results of surveys, it appears that inequalities and significant differences exist within the agglomeration itself. This is partly due to the irregular settlement of families in unhealthy areas where the land has not been serviced. In makeshift buildings with no sanitary facilities, the water used by households is drawn off and then discharged directly into the open air, thus polluting the ground, groundwater, but also the ambient air (bad smells).

During the field surveys, it was noted that the majority of kitchen waste water is dumped on the ground outside or in the courtyard of the compounds (87% of households) and this is easily explained by the fact that the majority of households do not have pits for collecting this water. Households in fact consider that throwing dirty kitchen water in the yard is not likely to bother anyone insofar as this water infiltrates quickly. In fact the city of Cotonou is on sandy soil. The infiltration is then high and the water thus thrown does not stagnate for long. Not seeing the effects of a certain pollution of their environment, the concessions therefore do not feel the need to evacuate this water in a pit. The water from the shower is collected in the pits (23% of households) or is left to infiltrate directly into the ground (77% of households).

The price of emptying is relatively high according to some users (37% of households) and thus explains the relatively long time they take before emptying. Sometimes the pits are completely full before being emptied.

In the city of Cotonou, most concessions use on-site sanitation systems. This situation explains the emergence of private operators who have mobilized to meet the growing demand for pit emptying.

According to the results of the surveys, the households for the emptying of pit latrines often resorted to emptying trucks.

With regard to this pit emptying activity, after requesting the services of an emptier, customers are sometimes forced to wait several days before being served. The response from the emptiers is not spontaneous and can be explained more likely by the superiority of demand over supply, which is more common during rainy periods.

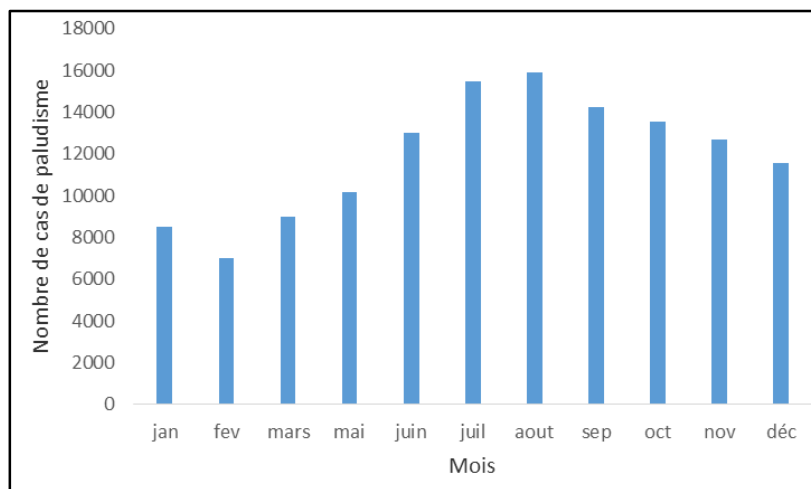
On this subject, we can also speak of an organizational problem within these emptying companies. Indeed, it is clear that the agents of these companies are not in a hurry to provide the service, once the request is made by the customer.

Often the commercial policy of these companies leaves much to be desired. Sometimes, after having paid in advance, the customers feel subject to the will of the companies which then come to empty the pits “when they want”.

With regard to solid waste, the situation is even more crucial.

3.2 Effects of inadequate sanitation on population health

The counting and formatting of the monthly routine data of the causes of consultation collected from the health centers of Cotonou over five consecutive years were carried out and the monthly evolution of the various affections was analyzed from 2005 to 2009. Figure 5 shows the monthly evolution of malaria cases in the city of Cotonou from 2015 to 2020.



Source: SNIGS/DPP, 2021

Figure 5 Monthly evolution of malaria cases in Cotonou from 2015 to 2020

Analysis of Figure 11 shows that the number of malaria cases increases dramatically from June to September with a peak in August. This increase would be linked to the arrival of the great rainy season in the city of Cotonou and aggravate the problems of sanitation deficit.

Surveys show that the epidemiological profile of the city highlights the preponderance of environmental diseases such as malaria, respiratory infections, skin conditions and diarrheal diseases mainly linked to the unsanitary environment. As far as children are concerned, survey results show that diarrhea is one of the main causes of consultation in health posts. Malaria and skin diseases are generally linked to the presence of stagnant water in the environment of residential areas. In addition, diarrhoea, vomiting, other digestive disorders as well as intestinal parasites are often linked to indigestion of infected food or water or to unsanitary conditions.

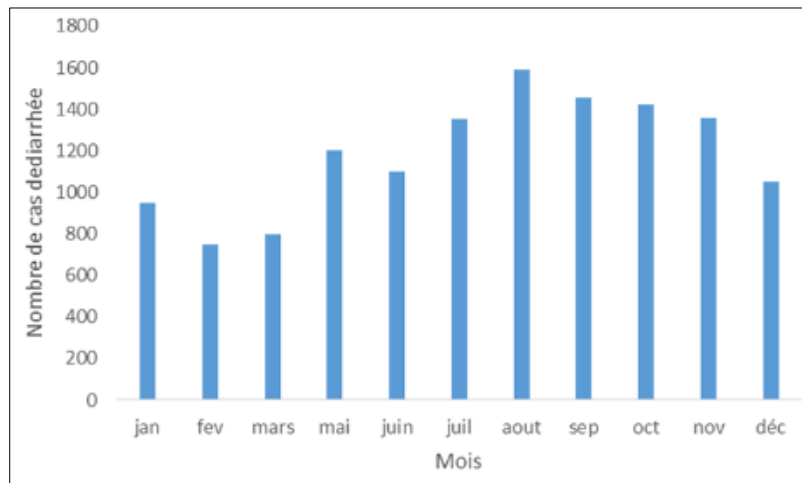
The particular ecological conditions create a favorable incubation center for invasive agent vectors that expose populations to a set of health risks [11]. The circulation of such germs within the population transits through intermediaries, among which the conditions of health play a major role [12]. The faecal-oral cycle, the main route by which diseases such as diarrhea spread, is extremely effective when hygienic conditions are particularly poor [13, 3].

The existence of sewage streams and wild dumps in the city, as well as the development of street food, are certainly one of the causes of these various conditions [14]. A survey carried out in 1998 in the Dakar region on behalf of the Ministry of Public Health found a prevalence of more than 26% of diarrhea among children aged 0 to 5 years.

According to [15] (Landéou R., et al., 2018) malaria is the major cause of death in children aged 0 to 4 years. During floods, these stats are sometimes doubled or tripled. [16] (Landéou R., et al., 2017) also noted that among the diseases recorded in unhealthy areas, malaria alone accounts for 33% of infectious and parasitic diseases in Cotonou.

It can be mentioned that the dry months (especially December, January and February) experience fewer cases of malaria. The few cases observed would be due to the sanitation conditions of the areas where these people live.

Apart from malaria, other diseases are rampant in the city of Cotonou (Figure 6).



Source: SNIGS/DPP, 2021

Figure 6 Monthly evolution of cases of diarrhea in Cotonou from 2015 to 2020

Analysis of Figure 12 shows that the number of diarrhea cases increases dramatically from April to September with a peak in August. This increase would be linked to the arrival of the rainy season in the city of Cotonou. This disease is caused by a microbe (protozoan, virus, and bacterium) which is spread by the faecal-oral route, in particular by infestation of fresh water or food contaminated by the stools or by direct contact with the infected stools [17].

But, the fact that the disease manifests itself during all periods of the year, leads us to affirm that only the presence of floods is not enough to explain the evolution and the development of this disease in the city of Cotonou, it must see also environmental conditions.

4 Conclusion

Among the factors that influence the representations of city dwellers vis-à-vis public health, the legislative, institutional, political and organizational aspects also play an important role. In this context, it is necessary to know who is responsible for public health, who plans and implements a policy in this sector. At the end of this study, it should be

noted that significant problems are noted in the access of the populations to sanitation services. The legislator is lagging behind in relation to the urban conception of the street and the common good and the consequences are disastrous in terms of health with the appearance of certain diseases on a regular and cyclical basis. Develop in such a way as to meet current standards so as not to pollute groundwater. In Cotonou, the management of domestic wastewater and excreta poses enormous problems. Only sixty-two out of a thousand households properly dispose of their waste water. More than 90% of the inhabitants of the city of Cotonou continue to dispose of wastewater and garbage in the street, in the courtyard or in their concession.

Compliance with ethical standards

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Disclosure of conflict of interest

The writing of this manuscript is without conflict of interest. Each of the authors contributed to the success of this manuscript.

Statement of informed consent

All participant who contributed to this study gave their consent and agreed to participate in this research

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