FLOOD DYNAMICS IN THE MBO PLAINS (WEST CAMEROON) AND THE IMPACTS ON HUMAN HEALTH

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Abstract

Flood plains in general and those found in a subsided block are areas where all sort of polluted water collects and where flooding couples with filthiness to give rise to poor health of the population. This is the case of the Mbo plains in the west region of Cameroon. From the recent floods registered in this locality, this article examines potable water supply infrastructure and the period favourable for these infections. Spatial distribution of the infections was made using ArcGis software application. Adopting an analytical method of data collected during the interviews conducted on the medical personnel of the Santchou District Hospital as well as enquiries on the households, results show that water-related diseases in Santchou are a consequence of the frequent floods registered in the plain. On the 1793 cases of water-related diseases registered between 2010 and 2014, 497 cases of malaria (75.85%) and 263 cases of typhoid fever (73.76%) were diagnosed within the period September to march. Potable water supply infrastructure and preventive sanitary measures on the living space of the population constitute key ways to reducing these infections.

Keywords: Flood, Water-Related Illnesses, Water Supply Infrastructure and Mbo Plain.

1. Introduction

Water causes morbidity and mortality worldwide (Clasen *et al*, 2007 and WHO 2010).Malaria is one of the water related diseases endemic in 117 countries with about 3.2 billion people living in risk areas all over the world (WHO/UNICEF 2005 and UNICEF 2008).In the United States of America, water sanitation and hygiene cause about 60% of illnesses (Mead *et al.*1999). Control of water washed diseases depends more on the quantity than on quality of water (UNICEF, 2008).Flooded in the rainy season and swampy in the dry season, the Mbo plain is par excellence an area where there is water all year round. This water, although vital for humans, can also be fatal through water-related diseases and unsanitary conditions (which is the main instigator). In this plain, these diseases are particularly on an upsurge. Cases of malaria, typhoid fever, gastroenteritis, diarrhea, can cause loss of life (Clasen *et al*, 2007), despite the existing means of managing these infections. The plain therefore appears as an area at risk of flooding which is an attraction for human concentrations and raises concerns about their safety. This remark immediately invites us to explore the links between floods and water-related diseases. Moreover, if we think flood is responsible for these infections, we still have to identify the originality of the latter. Our work therefore proposes a reflection on the flood-disease relationship in the plain.

The question that emerges is whether there is a relationship between floods and water-related diseases. The main interest of this study is to analyze the role of flood dynamics on the health of populations while proposing a spatial distribution of water-related diseases. Based on the results and analyses, this study will improve knowledge of the direct or indirect effects of floods on the health of people in the Mbo plain. It is therefore necessary to reason from the registers of the district hospital of Santchou for a period of four years. We postulated that: there is a link between floods due to the physical conditions of the study area and the prevalence of water-related diseases, because some diseases are specific to given geographical areas. It is therefore a research that wishes to increase knowledge on the conditions of development of these infections and their spatial distribution associated with a risk factor in the municipality of Santchou.

2. Materials and Methods

2.1. Spatial framework

The Mbo plain occupies a central and southern position in the Nkam watershed in Melong, thus encompassing the Santchou council within which this study takes place. It extends over approximately 510 km² stretching between latitudes 5°.7' and 5°.23' N and longitudes 9°.4' and 10°.7' E. The Santchou councilis one of the largest in surface area in the Menoua Division with about 20,000 ha (Figure 1). It is sited on a granito-gneissic basement (Geze B., 1943). Pedologically, it is made up essentially of hydromorphic soils. From a climatic point of view, the region receives enough water (about 2000 mm/year) to trigger floods almost every year.

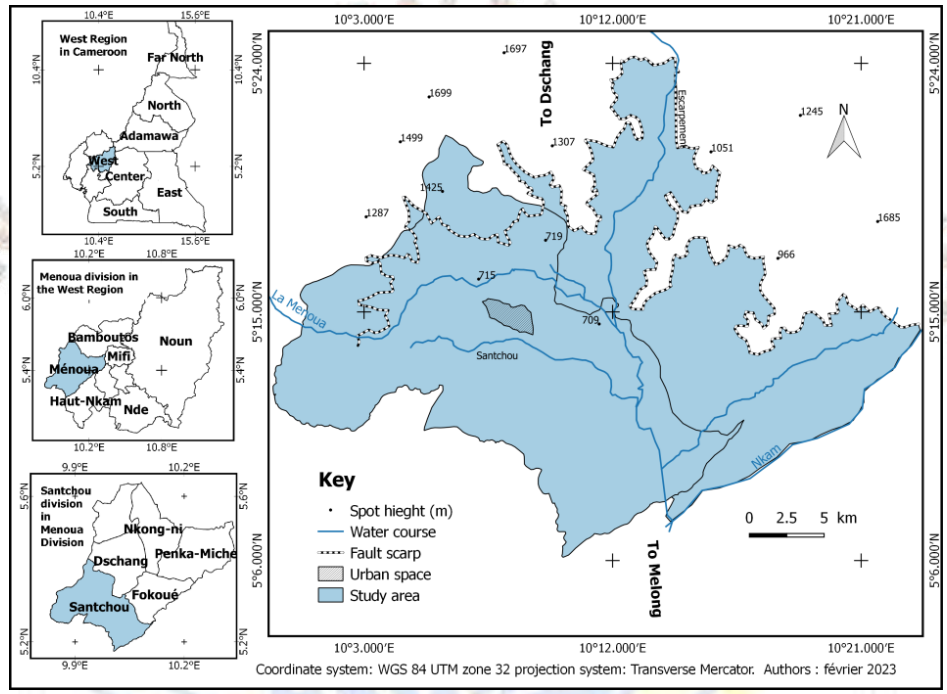

Figure 1: Location of the study area

2.2. Data Collection

To conduct this study, four types of data were collected, namely rainfall, topographic, epidemiological data and households surveydata. Rainfall data consisting of annual rainfall amounts for the 1996 - 2014 time series and monthly rainfall amounts for the 2008-2014 time series, recorded at the Santchou District Delegation for Agriculture and Sustainable Development, allowed the determination of the period par excellence of the floods. With the help of a medical staff of the Santchou District Hospital, the number of patients was determined from the water-related diseases that appeared in the hospital registers. The selection of households was based on a two-level survey. The first level being that of the most inhabited neighborhoods and the second the proximity to the river. A total of 100 households were surveyed. This data collection took place during the months of July, August and September 2015. This period coincides with the major rainy season during which there is arise in water levels in the plain.

2.3. Data processing and analysis

After data collection, we proceeded with manual treatment of the data by assigning codes to the type of answers (1=hospital, 2=indigenous, 3=self-medication) concerning the place of health care of patients, then to their treatment of the coded data using Excel and SPSS 20.0. Given the localities of the municipality and water-related diseases, we had to spatially define the distribution of these water-related infections. Two layers of data were used: that of the density of patients per km² and that of the number of cases of water-related diseases

recorded at the hospital. These data underwent thematic analyzes using the ArcGis software. The histogram of the density values made it possible to constitute three classes: weak (< 2 patients/km²), average (2-5 patients/km²), very strong (> 5 patients/km²). The boundaries of the group were apprehended by vectoriation of the Western Regional Atlas 2 and that of the plain by digital processing of the DEM of the municipality. The precipitation analysis method was based on the determination of the standardized precipitation index of Mckee *et al. 1993*to determine the dry and wet years, the total rainfall and the total number of wet months. These indices were calculated over the period taken into account.

2.4. Diagnosis of water supply sources

The diagnosis of water supply sources focused on the location and condition of the infrastructure. These elements were gotten using the CDP[1], field surveys and observations. Data recorded through questionnaires focused on water supply issues. The water supply sources studied were selected from those mostly demanded by the population. The condition, of the wells and other boreholes made it possible to assess the indirect causes of the floods on the health of the populations.

3. Results and discussion

3.1. An area with excess water

The Mbo plain is an area of excess water. Figure 2 shows the persistence of wet years over the period 1996-2014. Over this period taken into account, twelve years (1997, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2009, 2011, 2012 and 2013) were years of surplus (> 0), of which one year (2013) had too much water than the surplus most often registered within the years considered (> 2). On the other hand, five years (1996, 1998, 2008, 2010 and 2014) were in deficit. There is also an uninterrupted wet period of seven years.

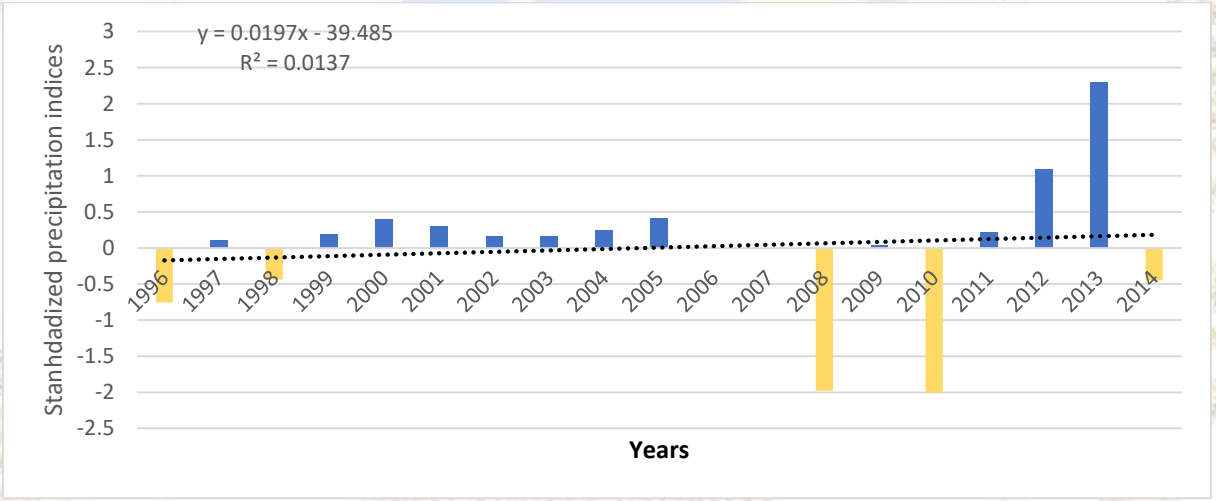

Figure 2: Persistence of wet years in the study area (1996-2014) of the Divisional Delegation for Agriculture and Sustainable Development of Santchou

The analysis of Figure 2 shows that precipitation in the study area evolves positively during the observation period. The trend curve vividly illustrates this increase since the equation has a leading coefficient greater than zero (0.0197), the hypothesis of the trend towards increased rainfall in the study area is confirmed. These rains are concentrated over seven months (from April to October) which represents almost all of the annual. The peak of the rains is most often recorded during the months of August, September and October. Figure 3 presents the monthly precipitation amounts for the observation period.

[1] Council Development Plan of Santchou

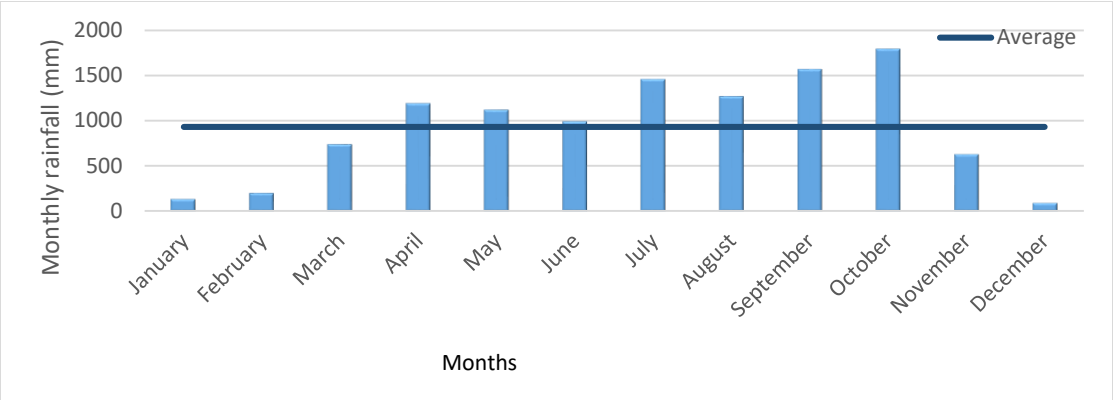

Figure 3: Monthly variability of precipitation during the observation period

For this period of observation, we see that 11150.16 mm of rain fell and that from the month of March, the heights of rainfall gradually evolved to reach the peak in October (1786.6 mm). During these months of abundant rainfall(from July to October), the rivers which are already struggling to circulate normally, overflow their banks and cause floods which, coupled with the living environment of households, has a negative cumulative effect on water supply infrastructure and therefore on the health of population.

3.2. Poor conditions of water supply infrastructure

The difficulty to access drinking water and sanitation is the major pathological risk factor present in the study area. The situation of the municipality of Santchou in terms of water and sanitation is as shown in Table 1.

Table 1: Status of water supply infrastructure in the commune of Santchou

Sources of supply	Location	Condition of infrastructure
Boreholes	Santchou city	Not functional
Wells	Santchou city	Fair condition
Water towers	Fongwang, Ako, Nguiango and Balé	Bad condition
Gravity water supply	Nka	Bad condition (Not functional)
Standpipes/fountains	Fongwang and Tawoum	Non functional
Wells with electric pump	Fongwang	Good condition

This already bleak situation occurs during periods of floods as shown in Figure4.

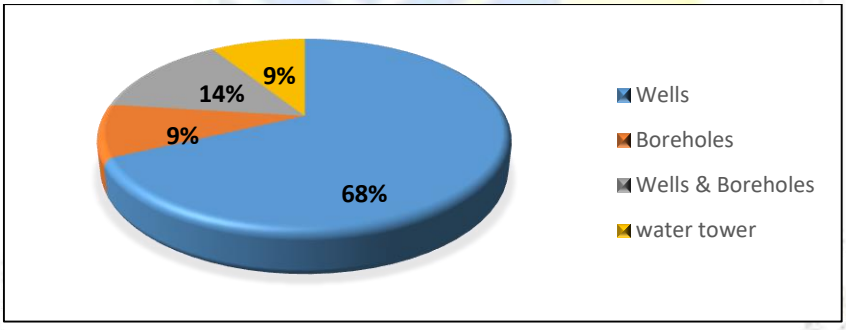

Figure 4: Comparisons of water sources.

The most represented source of drinking water is the well 68%, followed by the couple Wells and boreholes 14%, boreholes 9% (coming from Dschang and Melong) and finally the water supply network with towers 9%. During floods, it is observed that the inaccessibility or immersion of wells causes the mixtures to fall back on the water supply network and in the rivers. Household activities are carried out only with well water.

The environment of these wells is no longer healthy due to the garbage and excreta carried by the flood waters and infiltration from Long-Street and Madagascar neighborhoods. This water, which is generally untreated or badly treated before use, nevertheless carries pathogens responsible for the deterioration of the health of populations. The resurgence of malaria is justified by the favourable conditions for development or proliferation of Anopheles mosquitoes, which requires water stagnation and soil saturation after rains.

3.3. A high proliferation rate of malaria and typhoid in the dry season

An analysis of data from epidemiological disease declaration forms in the Santchou district hospital made it possible to obtain the profile of water-related diseases cases. As a result, we discovered that over four years (2010 to 2014), the hospital recorded 1793 cases of water-related diseases. This epidemiological profile gives malaria and typhoid fever the top diseases recorded in the area. This top diseases period most often corresponds to the October, November and December quarters which coincide with the start of the dry season as shown in Figure 5.

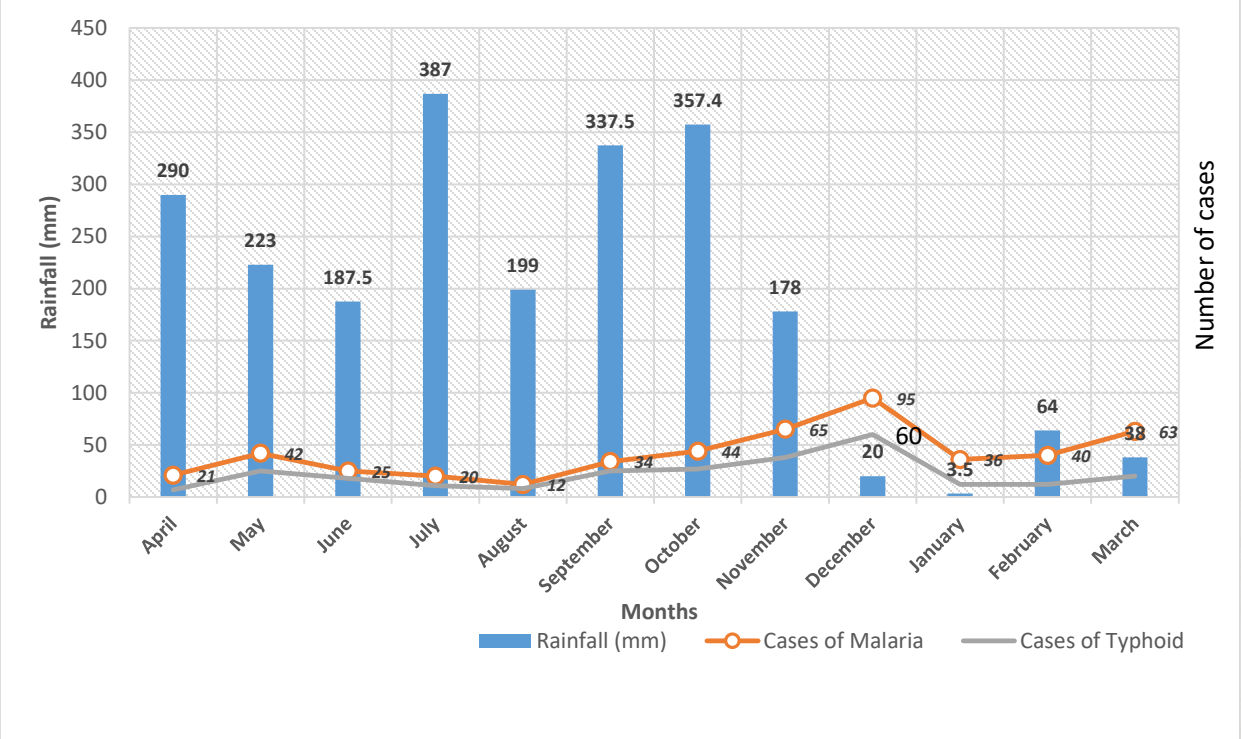

Figure 5: Monthly evolution of malaria and typhoid cases in the Mbo plain in 2012.

According to Figure 5, malaria cases (75.85%) are recorded between the months of September to March, with an average of 54 cases/month and a peak in December with 95 cases. This can be explained, among other things, by the concentration of larvae in the puddles resulting from the retreat of flood waters from the rivers. During the other periods, there is a drop in the number of malaria cases, i.e. 24.15% of cases with an average of 24 cases/month, so the month of August is the least represented with only 12 cases. This situation finds an explanation because, in the rainy season, the flow rates of rivers are high and therefore do not allow the development of Anopheles mosquitos which requires just stagnant water.

However, cases of typhoid fever are frequent (194 cases recorded) between the months of September and March, with a peak in December (60 cases). The seasonal appearance of typhoid fever is justified by the use or consumption of surface contaminated water polluted during flood episodes. The rare cases of these infections which become a subject of a consultation in the rainy season are due to the response capacity of the patient's immunity who can contract the disease in the dry season but receive the first symptoms only in the rainy season. The study area therefore presents a health picture marked by the predominance of malaria and typhoid and the known environmental causes stem from the dynamics of the Nkam and Menoua rivers as they more often overflow their banks.

3.4. Spatial distribution of cases of water-related diseases

In the classification of water-related diseases to which the population of the municipality of Santchou is exposed, malaria and typhoid fever figure prominently. These diseases of environmental origin rarely depend on a single factor. Although all groups in the municipality are concerned, it should be noted that the degree of vulnerability is not the same everywhere. To this effect, a spatialization of these infections was carried out (Figure 6) on the basis of data collected at the Santchou district hospital.

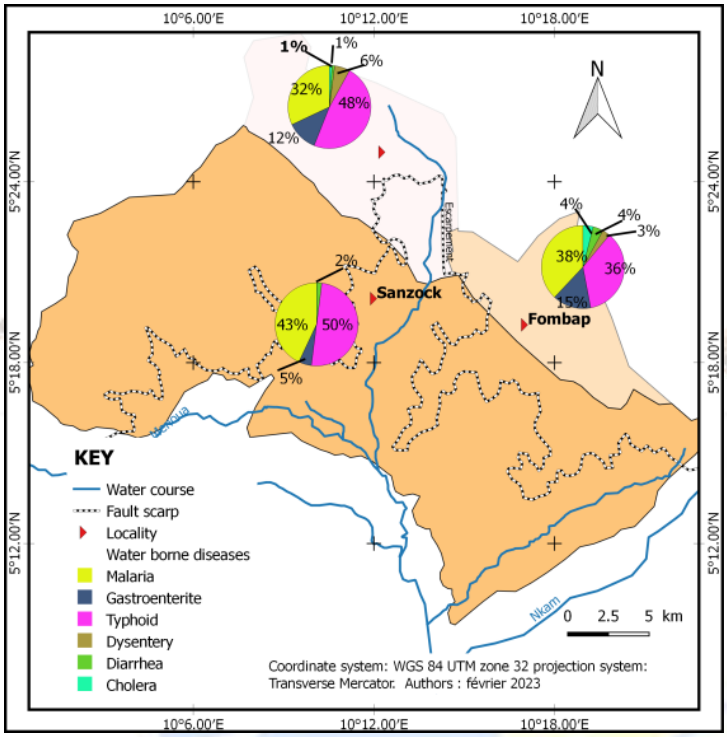

Figure 6: Spatial distribution of cases of water-related diseases in the municipality of Santchou

Figure 6 shows the unequal spatial distribution of waterborne diseases between the different village groupings in the Santchou municipality. We note that the Fondonera and Fombap village groups are less affected with 1% and 10% respectively, while Sansock has the highest percentage of water-related diseases with 89%. The results also show that the plain plays an essential role in the distribution of these infections. It is responsible for the accumulation of wastewater which is due tosite configuration and soil texturepresentin the area. Our findings shows that the Sansock village group occupies about 96% of the plain where most wastewater stagnates reason for the highest level of waterborne disease prevalence (89%).

4. Discussion

4.1. Paradox of water in the municipality of Santchou

Despite the abundance of water in the Mbo plain, access to good quality water remains a major concern for the population. The problem is much more acute in the lower Santchou area. However, the region is naturally well placed to provide water to all its inhabitants without difficulty. This statement is confirmed by Kuété M. (1990) for whom the Mbo plain is a basin for collecting water from the mountainous setting and whose main collector is the Nkam. The problem arises in terms of accessibility and not availability. Indeed, the lower area of Santchou does not benefit from a conventional water supply from the CamWater or Camerounaise des Eaux (CDE). Drinking water supply is a real challenge because only a few wells are supply points for the population, and the other supply points are in poor condition and or not functional even though they exist. Furthermore, we believe with Fêmi C. (2007) that the high prevalence of waterborne diseases in health consultations is suggestive of under-equipment in water supply infrastructure or at least the poor functioning of existing ones.

4.2. Analysis of the water supply problem

The problems of drinking water supply in the Santchou council are not analyzed only in terms of insufficient infrastructure, but above all on the floods which pollute these sources of supply by carrying waste which flows into well, main source of water supply in the locality. This is the same observation that appears in the work of Bouba L. (2012) in the Far North region of Cameroon when he presents floods as a factor aggravating the risk of transmission of cholera, by contamination of sources of drinking water. The health of the population is deteriorating given that they acquire non-potable water due to the constraints related to the environment and the water supply infrastructure.

4.3. An epidemiological profile dominated by malaria and typhoid

The health consequences of floods are very significant. According to the WHO (2002), floods occupy a primordial place among all the natural disasters to be combated. They constitute a destabilizing element of a healthy environment, a source of health problems and especially of the proliferation of many deadly diseases for population. Recurrent infections in our study area come from the modification of environmental parameters. Speaking of conditions conducive to malaria, Delmont J., *et al*. (2012) observe that differences in rainfall, breeding sites, occurrence of unusual climatological events, are the environmental conditions responsible for malaria in sub-Saharan Africa. The results of our research are almost the same as those encountered in the summary report of the day of reflection on the socio-economic and health consequences held in 1998 by the I.A.S.; in which the main health consequences of floods are malaria, typhoid fever, diarrhea, dermatitis and conjunctivitis.

4.4. Dry season: season par excellence for malaria and typhoid

Santchou, not having collective equipment to provide drinking water, this situation exposes its population to health risks by allowing the dissemination of enteric microorganisms favored by humidity and inadequate hygiene. These ecological conditions of the environment, conducive to the survival of pathogenic germs, are present in the study area under the influence of floods which favor the proliferation of these water-related infections. In addition, as Ndongo B., *et al*. (2015) portray, the environmental factors favorable to the latter are formed during the post-flood period. This period (dry season) represents more than 87% of the annual catches of female Anopheles Baldet, T. (1995). This period in Santchou, unlike the rainy season, is characterized by the higher presence of fecal coliforms in the wells as confirmed by Epallé G. and Etame S. (2016).

4.5. The plain: a site at high risk of water-related diseases

Alluvial plains correspond to low land depressions Belosevic *et al*., (2001). Like the other topographic units, the plain at Santchou is a site at risk for population health. These risks are high judging from the 89% rate of water-related diseases. Unlike the highlands (Fondonera and Fombap), the plain in Santchou (most of which is in Sansock) is an environment favorable to the accumulation and stagnation of polluted water. These waters laden with impurities reach the wells, the main source of water supply for the locality. At the slightest flood, the health risk becomes inevitable. Thus, due to its pedological (essentially hydromorphic soils and shallow water table) and topographic (700m to 800m altitude) characteristics, the Mbo plain is a space where runoff loaded with fecal matter such as demonstrated Epallé G. and Etame S. (2016). These diluted feces produce microorganisms responsible for various waterborne diseases.

Conclusion

In this article based on the hypothesis that there is a link between floods and the prevalence of water-related diseases in Santchou, the evaluation of the role of flood dynamics on the health of population and the inventory of a spatial distribution of these diseases associated with a risk factor were among the objectives of this study. This research confirms that flooding is a major public health problem in the municipality of Santchou. Indeed, these floods have the disadvantage of directly or indirectly weakening the health of the population through the use of dirty water in households and the concentration of larvae which occurs in the puddles resulting from the retreat of rivers. This phenomenon, due to the intense rains recorded in the rainy season and whose peak varies between the months of September and October, deteriorates the living environment of the populations by polluting the water supply infrastructures. During the dry season, we witness the emergence of water-related diseases such as malaria, typhoid, gastroenteritis, which develop preferentially in the plain. These different diseases in the plateau zone have a low prevalence or at least an almost zero prevalence. At the end of this study, it appears that floods constitute a threat likely to cause loss of human life through the development of water-related pathologies. They can therefore harm the environment and health and seriously compromise the development of the area. In view of this situation, local elected officials, with the help of donors, should:

- Provide the municipality with a conventional water supply.
- Raise awareness about sanitation in the living environment of households because most of these infections are directly linked to non-compliance with hygiene rules.
- Respond to the demand for care not only by implementing planning policies that have an impact on land use planning, but also by improving the living environment of the population made impure by the floods (cleaning of gutters, collection weekly waste, construction of individual and public latrines).

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