Liaising Water Resources Consumption, Urban Sanitation and Cholera Epidemics in Douala, Cameroon: A Community Vulnerability Assessment

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Abstract

The occurrence of cholera on the Atlantic coast of Cameroon, especially in Douala is not just a public health crisis but a humanitarian disaster as well. From 2010 to 2012, 23,000 people contracted cholera of which 843 died. Based on a field inventory (2010, 2011 and 2012 epidemiological periods), this study posits that, cholera endemic heavily impacts the younger age groups, with the young adult and adult age groups being the most vulnerable. As concerns sex, the males are far more vulnerable than females. Cholera risk factors such as slum settlements, lack of proper social amenities and services, for example, potable water; drainage; waste collection; hygiene and sanitation facilities, are generally spread throughout the Atlantic coast, though characterized by glaring unevenness. Social characteristics not generally considered in public health strategies, including: attitudes towards hygiene and sanitation; limited knowledge of diseases/cholera transmission mechanisms, as well as "magico-religious" beliefs on the origins of cholera, are, however reasons for the high vulnerability to cholera and/or major hindrances to effective mitigation. Though there appears to be a direct relationship between the existence of cholera risk factors and community vulnerability, it might be deduced that social attitudes and beliefs are the bridge linking these two concepts.

Keywords: Water resources consumption, Cholera epidemics, Sanitation, Community vulnerability

1. Introduction

Cholera is a bacterial disease caused by *Vibrio cholerae*, which has been found to be native to coastal ecosystems. Vibrios, including *V. cholerae*, can be found almost in any coastal water body, particularly in the tropics and subtropics [1]. The cholera-causing bacteriais spread by faecal-oral transmission and causes a range of disease from asymptomatic or subclinical infection to severe dehydrating diarrhoea that can cause death within 6-12 hours, a limited period of time in which patients can lose more than 10% of their body weight in fluid losses, and adults can lose 20 litres or more [2]. Cholera is indeed a global health catastrophe, though the brunt of epidemic events and impacts are borne more by poor developing countries. About 3 to 5 million cases are registered each year, mostly in poor parts of Southeast Asia, especially in the Ganges Delta, and were previously believed to occur in epidemic proportions and become endemic in areas of the world where the 20th century innovations of clean water and latrine use were not yet realized [2]. Even in poor countries, the disease has been observed to affect various segments of population differently, imposing a form of epidemiological segregation built along lines of poverty and social wellbeing. Nossiter [3] reported a fierce cholera epidemic spreading through the coastal slums of West Africa, resulting to the dead of hundreds and sickening many more in one of the worst regional outbreaks in years, made worse by an exceptionally heavy rainy season that flooded the sprawling shantytowns in Freetown (Sierra Leone) and Conakry (Guinea). The role of meteorological factors in the spread of the disease is also highlighted here. The same article goes further to point out that in both countries, an estimated two-thirds of the population lack toilets, and a potentially lethal danger in the rainy season because of the contamination of the water supply. In Asia, the case of Bangladesh in particular has received much media attention. Being reputed as the most densely populated countries in the world, the capital city Dhaka is home to at least 15 million residents, most of who live in urban slums. Weil [2] makes allusion to the fact that the great majority of cholera patients comes from the urban slums, particularly Mirpur Slum and the major causes of cholera endemicity have been identified as: manipulation of water pipes through illegal piping which leads to sewage mixing with the water supply, failure by most people to boil or treat their water prior to usage, and the general belief that in Dhaka, diarrhoea is a common and somewhat normalized fact of life. This denotes clearly the distinction between risk and vulnerability factors. In yet another study by Sur et al. [4] in Kolkata, the third largest city in India and one of the world's most densely populated, cholera remains a persistent scourge in the community of slum dwellers. The authors note that the study site, 0.7km^2 in size, was

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already in maps from 1856 as a poor residential area known as Narkeldanga, which encompasses what is known today as bustees, legally recognized and registered slums, characterized by narrow streets with little space between houses, intermittent piped municipal water supply shared by several households, one or two latrines and sewage collected in open gutters which overflow when it rains [4]. An earlier study in cholera-endemic Bangladesh from 1966 to 1980 found out that cholera is age selective, most common between 5 and 9 years of age, followed by children 1–5 years [5]; however, Sur et al. [4] caution that despite this selectivity, no age groups is spared during an outbreak, though the very young suffer most. The precise mechanisms and environmental interactions that give rise to increased numbers of *Vibrio cholera* in an aquatic environment have yet to be fully understood, and this is tied to the fact that it is not yet possible to construct mechanistic models for prediction of their presence and abundance with exquisite accuracy [6]. However, innovative studies in the field demonstrate how closely cholera is tied to environmental and hydrological factors and to weather patterns — all of which may lead to more frequent cholera outbreaks as the world warms [1]. In 2002, Lipp et al. [1] identified temperatures in the range of 25° to 30°C as well as favourable salinity levels of about 15‰ and the bloom of algae (copepods) which have a positive effect on attachment of *V. Cholera* as favourable conditions for cholera emergence. Following in this direction, recent statistical models presented in a study by Louis et al (2003)provide a valuable understanding of the large-scale processes that dominate the ecology of *V.cholerae* by showing that the seasonal pattern of occurrence of *V. cholera* was correlated with higher temperatures, indicating that there is a temperature threshold between 17 and 19°C, and the frequency of occurrence of *V. cholera* is greater at temperatures above 19°C and lower salinity levels between 2 and 14 ppt; the optimal salinity being between 2 and 8 to 10 ppt [7]. Therefore, if *Vibrio cholera* is a free living occupant of aquatic environments, why then are some areas experiencing severe epidemic outbreaks year in year out, whereas others record just a few cases from time to time? With this question in mind, while much research has focused on enhancing understanding of the environmental and ecological mechanisms which favour the thriving of the cholera-causing bacteria, social factors and attitudes in cholera endemic areas, which may contribute to high or low exposure of people to the deadly disease need equal consideration. Therefore, a sociological study of the attitudes and beliefs of people inhabiting an endemic zone can open a window into the vulnerable situation of the populations as well as provide opportunities for preventive measures which save lives prior to the development of long term predictive and eradicative measures.

1.1 Review of the status of Cholera in Douala

Douala is the economic capital of Cameroon. The city also serves as the capital of the Littoral Region. Infectious, emergent and re-emergent diseases have become important components in the medical vocabulary of the Littoral Region of Cameroon since recent episodes. Most of these diseases are linked to water or the poor management of the water environment in Douala, and classified as very high degree of risk. Some of the most common include: food or waterborne diseases (bacterial and protozoan diarrhoea, hepatitis A and E, and typhoid fever); vector-borne diseases (malaria and yellow fever); water contact disease (schistosomiasis; respiratory disease); meningococcal meningitis, etc. The human health situation in this area has therefore exceeded a normal public health challenge and can rightly be classified as a humanitarian crisis, given the frequent of yearly outbreaks and number of casualties. Of all the diseases listed in Table 1, cholera and malaria are the most dramatic and major causes of death, and therefore of greatest concern. But unlike malaria, a more silent health issue, which is known to be caused by the female anopheles mosquito, cholera is multi-causal and thus highly complex, characterized by spectacular outbreaks. Given the figures, cholera has a far greater case fatality rate (CFR).

Table 1: Summary of some major diseases in the Littoral Region (2010 – 2011)

No	Diseases	Number	
		Cases	Deaths
1	Cholera	5669	9
2	Malaria	11498	9
3	Meningitis	1	0
4	Yellow Fever	12	0
5	Measles	8	1
6	Acute Paralysis	2	0
7	Common Cold	476	0
8	Dracunculiasis	1	0
9	Gastrointestinal disorders	113	0
10	Trypanosomiasis	2	0
11	Hepatitis	17	0
12	Acute Diarrhoea	164	0

Source: Banyouko Ndah, S. Derrick Ngoran [5]

Cholera therefore stands out in the region, which is endemic for the deadly viral infection since the arrival of the 7th pandemic of cholera in the Gulf of Guinea [8], with recorded epidemic outbreaks dating from 1971 through to present [9]; [10]. In the early periods of cholera emergence, outbreaks were observed to be occurring approximately after every two or three years during the dry season [11]. Recent national trends point to a higher frequency of occurrence, with ever fluctuating mortality rates among the afflicted populations (Figure1). According to the Regional Delegation of Public Health, a total of 28 major epidemics have been recorded in Douala alone, the most deadly being those of 1971, 1983, 1991, 1996, 1998, 2004, 2005, 2010, 2011, with over a thousand cases each [12]. The major outbreak of January 2004 resulted in approximately 2924 cases and 46 deaths in Cameroon from the 1st of January to the 9th of June 2004. In Douala, more than 500 cases were reported within seven weeks of the onset of the pandemic, leaving at least 13 people dead [13]. By the time the disease subsided, 6000 persons were reported infected and hundreds dead. However, a lot of inconsistency remains in the data from different sources.

During the short rainy season in March and April of the 2010 epidemiological year, cholera peaked with an average of 120 cases per week, followed by a number of peaks and troughs, and by September to mid-October the number of cases increased to more than 400 cases per week in Douala [14]. There was a sudden resurgence of the epidemic in Littoral region, particularly in Douala and the surrounding localities, with over 430 cases a week, in 2011 and by the 44th week of 2011, a total of 3,792 cases and 77 deaths were registered in Douala alone [5]. Official figures however placed the total number of reported cases in Douala at a staggering 5,463 between January and December 2011 with a case fatality rate of 1.92% [14]. By the 11th week of 2012, in the month of March, the Littoral Regional Delegation of Public Health officially reported 33 cases with a case fatality rate of 3.03%.The situation is presented in Figure 1 and Table 2.
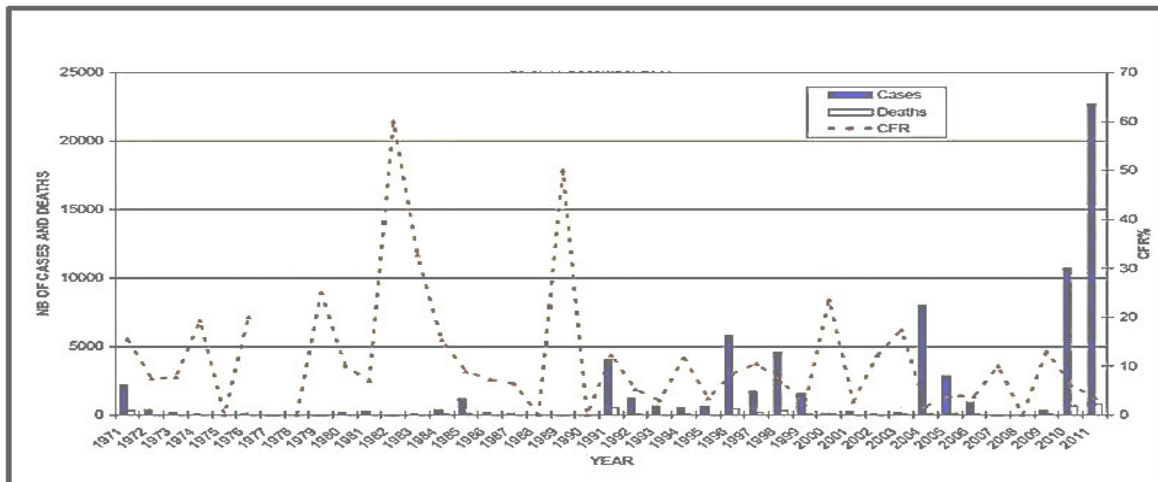

Figure 2: WHO-notified Cholera cases and deaths in Cameroon between 1971 and 2011 [15]

Table 1: No. of cholera cases/resulting deaths in Cameroon, notified to WHO between 1996-2005

Year	Total number of cases including imported case/deaths	Deaths	Case fatality Rates (%)
2005	2847	110	3.86
2004	8005	137	
2003	207	36	
2002	66	8	12.12
2001	259	7	2.7
2000	123	29	
1999	326	35	
1998	4603	316	
1997	1709	180	

Source: Ndah, [23]

It is therefore clear that Cameroon in general and Douala in particular, like other endemic regions of cholera, the disease does not disappear after an epidemic peak but returns in successive waves making it of great relevance the need to identify environmental or climate factors that may promote epidemics, thereby enhancing understanding of the dynamics of the disease. Thus, it becomes imperative to provide answers to the following questions: what causes periodic oscillations in cholera epidemics, and why are some areas more prone to endemism [1]?

Some studies have made significant advances in establishing the underlying causes of cholera

endemicity in Douala. Guévart et al. have provided a comprehensive description of the environmental factors contributing to cholera endemicity in Douala. In their study, the natural location of Douala in the Cameroon estuary, an environment characterized by poor water circulation due to its low-lying nature, as well as high demographic and socio-economic pressures; the sandy clay soils which are poorly consolidated and facilitates the contamination of ground water; shallow dirty polluted foul-smelling groundwater; the presence of vast expanses of marshes, streams or drainage ditches, infested with Algae; with low rainfall, high temperatures and drought during certain periods of the year, [10] have cumulatively subjected Douala into a cholera endemic zone. Tatah et al. ([16], in a localized study in the Bepanda area in Douala, found out that 27.4% of the water samples were contaminated the cholera-causing bacteria, with high isolation rates obtained from streams (52.4%) and wells (29.8%). The number of isolates was also significantly higher ($P < 0.05$) in the rainy season (35.5%), 23 (24%) O1 serogroup isolates were detected in streams and wells, whilst 64 (66.6%) were non-O1/non-O139. They conclude that water sources, poor hygiene and sanitation were a major reservoir and cause of cholera endemicity in the area, as well as climatic influences (temperature and salinity).

Similarly, a prospective study to investigate the extent of pollution and assess the scope of potential bacterial pathogens in the Douala lagoon led to the finding that indiscriminate disposal of untreated wastes which are often heavily laden with sewage and the presence of potential bacterial agents such as *Klebsiella pneumonia, Pseudomonas aeruginosa, Aeromonashydrophila, Bacteroidesfragilis* and *E. coli* in the Douala lagoon pose a serious threat to the health and well-being of users of the Lagoon [17]. This may constitute another potent cause of cholera epidemics in Douala.

Infrastructural lapses such as the absence of a good drainage or sewage disposal system in Douala, as well as the fact that the 8,000 wells in Douala (about 98% of all wells) are not protected and are located near latrines which definitely drain into them, have therefore been noted to constitute major risk factors, according to the head of mission of Medecins Sans Frontiers (MSF) in Cameroon, Max Antoine Grolleron [5]. Shallow drains which pervade the entire city function as pathogen reservoirs and the use of water from these reservoirs for any household activity are the most important risk factors that influence the spatial distribution of cholera in Douala [10].

These points probably explain why most outbreaks begin in Bepanda, an overcrowded residential slum built on a garbage dump in a swampy zone in the city of Douala; a result of uncontrolled urbanization [13], with a population of about 11,000 people, who live without adequate access to clean water or basic sanitation facilities [13]; [14]. The important contribution of climatic variables such as temperature and associated changes in salinity, in the evolution and spread of cholera epidemics in Douala, has also been noted [10]; [16]. The seasonality of cholera outbreaks proves that climatic factors play a big role in the endemicity of cholera in Douala [10]. The majority of previous attempts to establish the causes of cholera epidemics in Douala therefore have the general conclusion that, coupled with its endemism in the area, economic poverty and poor living conditions, as well as the contamination of water systems with faecal matter and cholera-causing bacteria are responsible for frequent outbreaks [8]; [17]; [18]; [19].

With this perception in mind, and with no solution to the poverty issue in the slum-infested city in the foreseeable future, public health authorities have resorted to the only reasonable course of action available to them based on the narrow techno-centric perspective common with medical practice – that is 'wait for the epidemic to strike and intervene with medication and awareness campaigns. In the management of the disease, a mirage of hope often clung upon by Cameroonian public health authorities as a measure of success in the fight against cholera is that the case fatality rate (CFR) of cholera, though still relatively high and constantly fluctuating, has been greatly reduced despite the skyrocketing number of cases in recent years (Fig 1). This has been attributed to the timely medical interventions during outbreaks, as well as free medical attention and treatment provided by health authorities. The primary treatment is re-hydration, and in most patients oral rehydration is sufficient. In situations accompanied by severe vomiting, or dehydration that leads to depressed consciousness, intravenous rehydration is mandatory, while antibiotic treatment decreases the severity of disease and shortens the duration of symptoms [2]. This may however a dangerously inadequate measure as the CFR risk increasing again with evidence of current resistance of the *Vibrio cholerae* to drugs.In a study by Garrigue et al. [11] on the massive and systematic use of chemoprophylaxis which began in April 1983, it is revealed that as early as the 1984-1985 epidemic, 89.3% of the isolated strains were resistant to sulphamides, 87.5% to a sulfamethoxazole-trimethoprim combination and to the 0/129 disk, 55.3% to tetracycline, 91.1% to chloramphenicol, 73.2% to streptomycin and 94.6% to ampicillin. Unfortunately, these drugs have remained the major remedy used by medical authorities to combat outbreaks of cholera.

Social issues however stand prominent amongst the barriers to cholera prevention and control, leading to misinterpretations and misconceptions, principally during outbreaks in cholera-endemic regions. In the attempt to establish the underlying causes of high vulnerability of the populations of Douala to cholera, some studies have deviated from the focus on social infrastructural and environmental risk factors, and have cited social behavioural factors such as individual characteristics, societal norms and sources of health educational

messages [13] as well as the reformation of urban tribes and persistence of traditional attitudes toward waste disposal and water use, which have not only led to high-risk behaviour but also created barriers to sanitation and hygiene [20]. Though these salient points have been stated earlier, they have however not been investigated intensively. This study exploits this gap and adds on another dimension not currently considered by researchers in the field; that is: gender and age–based cholera vulnerability. This is therefore an enquiry into the sociological characteristics of sections of communities of Douala which may provide vital insights into the nature of vulnerability of the populations to cholera, so as to tailor limited response resources efficiently and effectively.

2.1 The Study area

The Douala sedimentary basin is located in the Littoral Region of Cameroon, precisely in Wouri Division and has as major physical feature the Cameroon Estuary. Geographically, Douala is located at latitude 4 1´ North and longitude 9 45´ East and covers a surface area of about 886 km² (Fig 2) [21]. This city of about 3.5 million inhabitants today, displays a nucleated settlement pattern [22] constituting the built-up area as well as the marine and coastal space is administered under the Wouri Division of the Littoral region of Cameroon. The Douala municipal area has grown on a typical marine and coastal space where the old barrier islands were colonized by the Bonanjo, Akwa, Deido, Bepanda-Bassa, Bonamoussadi and the Bonaberi districts, which today support high population densities [23].

Today, six sub-divisions make up Douala's administrative setup, each administered by a mayor, under the authority of a Divisional Officer, while a Governmental Delegate governs the metropolitan area under the Urban Council (Table 3). Presently five of the six sub-divisions, which make up the Wouri Division are considered as strictly within the urban council and thus fall under the influence of the Government Delegate; areas whose jurisdiction is also claimed by the Divisional Officer [5], creating an avenue for conflicts of authority which strongly reflects in the poor management of the city. In addition to administrative gaps, the Douala area has the crucial problem of abundant aquatic environment in the face of scarcity of land, which poses a serious challenge to coastal zone management, leading to environmental degradation as a result of the pursuit of urban spatial growth [23].

Table 3. Sub-divisions which make up Douala in Wouri Division, Littoral Region of Cameroon and the major quarters

Sub division	Major quarters
Douala 1	Bonanjo, Akwa
Douala 2	Youpwe, New Bell
Douala 3	Logbaba
Douala 4	Bonaberi, Bonasama
Douala 5	Bonamousadi, Makepe

Source: Ndah, [23]; data obtained from Douala Urban Council
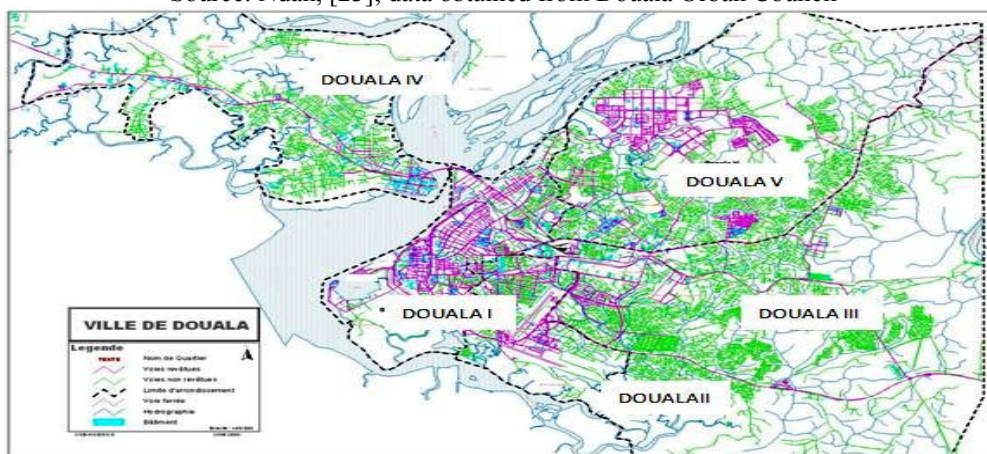
Fig 2: The location of subdivisions in mainland Douala (Ngoran [21]; Ndah [22])
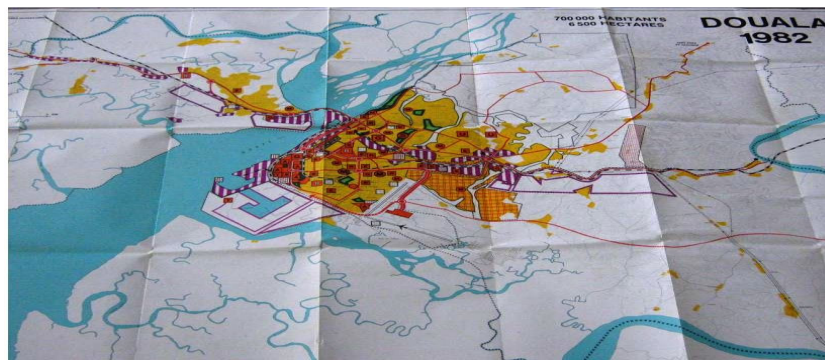
Fig. 3: Map of Douala Town in 1982 (Douala Urban council, 2011)

2.1.1 A brief historical perspective

In pre-colonial times, neighbourhoods of the city of Douala, on the banks of the river Wouri were ethnically based; Joss Plateau (today known as Bonanjo, located in Douala 1 subdivision), Akwa (today, located in Douala 5 subdivisions) and other villages were the basic parts of the city of Douala [25]. At the end of the nineteenth century, the issue of coexistence between Europeans and Africans surfaced, and led the German colonial administration to impose its cruel urban policy based on racial segregation (Von Rhom Master Plan for the city of Douala) [25].

This plan led to the following:

- ➢ Joss plateau (now Bonanjo) was occupied by the German administration, the ideal position to control the port and dominate indigenous areas;
- ➢ Rapid acquisition of sufficient land to build a "tropical city healthy for Europeans";
- ➢ Creation of a safety zone of at least one kilometre wide which separates the colonial settlement from African quarters in valleys and wetlands (Valley Bésséké);
- ➢ Programming new neighbourhoods for indigenous peoples led to the creation of a wide "free zone" in the east of the city to accommodate the influx of migrants, people from other ethnic groups notably the Bamilekes, Ewondos, Yambassa, Banens, who moved in search of blue collar jobs [25]. This area which included New-Bell (today located in Douala 2 subdivision), originally scheduled for resettlement of indigenous Dualas excluded from Joss plateau, later became the true focal point of the city with densities up to 400 inhabitants per km^2 since the 1950s [25].

The city of Douala, as it is today, is divided into quarters, following along colonial lines, with Akwa and Bonanjo being the most important; Akwa being the centre of Douala's nightlife and major commercial institutions, and Bonanjo its port and administrative centre; Bonanjo has remained a carefully planned area with gardens, squares and beautiful rows of trees, decorative street lighting and street furniture, though most structures are currently decaying due to inadequate care [24] Due to the overcrowding of New Bell, the initial settlement allocated to indigenous peoples by the German colonialists, new neighbourhoods grew and attached themselves to old one, for example, New Deido; Bépanda; Nylon or Nkolmintang [24]. In recent years, the city has sprawled uncontrollably, extending beyond the traditional boundaries (airport and Bassa industrial zone), with overflow to the North (Bépanda quarter) and to the South-East (Madagascar quarter); these areas have continued to attract people from the rural communities because the promise of cheap and sometimes free land and affordable accommodation (mostly shacks) [24]. The new quarters developing out of the old indigenous ones, today make up the subdivisions of Douala 2, 3 and 4, characterized by poor planning, broken roads, vast slum areas, chaotic constructions and commercially activities, very limited supply of water, sanitation and waste disposal facilities, etc., and general low-lying and swampy nature prone to seasonal floods.

According to the Littoral Department of Statistics and National Accounting, Wouri Division alone has a population density of 3830 habitants/Km². Moreover, the population of Douala continues to grow at a rate of 3.4% higher than the national average of 2.9. This, however, varies a great deal between the different subdivisions which make up the Division (Table 4). This huge population has led to the "mushrooming" of industries, squatter settlements and slums which lack basic amenities such as clean water for drinking but have several shallow and polluted wells which are also closely located by pit latrines [9]; [18].

Table 4: Population growth rate of Wouri Division and future projections

Division	Sub division	Population		Growth rate	Projection	
		1987	**1998**		**2005**	**2015**
Wouri	Douala 1	154.369	236.330	3.94	309.899	456.420
	Douala 2	152.304	246.800	4.49	335.543	520.385
	Douala 3	323.867	436.869	3.32	583.024	808.222
	Douala4	65.431	189.000	10.12	371.211	973.686
	Douala5	130.000	296.647	7.79	501.472	1.061.624
Total		825971	1432646	29.66	2101149	3900417

Source: Ngoran et al. [20]

3 Data Collection and Analysis

This stage of the study, which seeks to establish the sociological signatures of cholera as well as community vulnerability, investigates samples (households) from five of the six the sub-divisions which make up the Douala municipal area (Douala 1-5) (Fig 3).

Two main methods were utilized to collect data for this study namely questionnaires and interviews. Interviews were conducted with relevant officials at the Littoral Regional Delegation of Public Health, from where vital statistics on the total incidence of cholera in the region as well as data on the disparities in cholera vulnerability between age groups and gender, were obtained.

Questionnaires, the major data collection tool for this study were administered based on stratified random sampling techniques. The quarters and health districts constituted the major sample strata. A systematic sampling technique was utilized to derive the final sample population. The questionnaire which is of the structured open-ended type contains 10 questions, relating to the following broad sections:

1. Family health status relating to cholera
2. Household water supply and treatment
3. Household garbage disposal habits
4. Susceptibility to floods
5. Nature and quality of hygiene and sanitation facilities
6. Household knowledge on cholera contraction and spread
7. Household beliefs on the origin and spread of illnesses (cholera).

The sample of this study constitutes 1657 households drawn from five subdivisions (Douala 1 – 5). The average number of households per subdivision is 331, about 20%. The largest number of sampled households investigated was drawn from Douala 3 and 4, notably in the localities of Mabanda and Grand Hangar in the Bonaberi area (Fig 3). The data has been organized in tables and graphs and percentages have been calculated for the individual study variables.
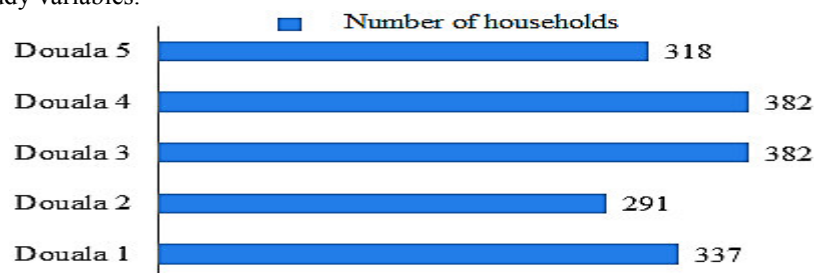
Fig 3: Distribution of sampled households by Subdivision

4. Results

4.1. General distribution of cholera cases in the Littoral Region by gender during 2010, 2011 and 2012 epidemiological years

Cholera in Douala, based on the analysis of the recent outbreaks of 2010, 2011 and 2012, has been observed to heavily impact male than female members of the community. In 2010, out of a total of 392 cases registered, 218 were males while 174 were females. A similar but more dramatic scenario was experienced in 2011, whereby a total of 5653 cases were recorded, with males constituting 3321 case while females made up the rest, 2599 (Table 5; Fig 4). The data for 2012 epidemiological year though incomplete (January – May), shows a similar trend. Going by health districts, the number of male victims surpassed the female in all health districts except two health districts (Logbaba and Nylon), which had slightly higher numbers of female victims in 2010. The underlying reason for this gender disparity is currently not known and can only be speculated. However, based on field interviews and surveys, the most probable explanation for this variation may be that: though the population structure of Douala is slightly dominated by females, all economic activities are dominated by males especially in the informal sector [26]; a sector which employs majority of young men who migrate from villages,

mainly as street vendors and manual labourers. By moving from place to place, they become more exposed to cholera, especially coupled with the absence of public taps forcing them to purchase water of doubtful sources and quality sold on the streets or drink from wells.

Table 5: Distribution of cholera cases by gender in the 6 Health Districts of Douala

Health districts	2010			2011			2012		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Bonassama	22	46	68	301	401	702	0	20	20
Cite des palmier	5	7	12	94	130	224	5	5	10
Deido	28	41	69	770	930	1,700	0	5	5
Logbaba	28	16	44	88	162	250	0	0	0
New-bell	53	77	130	473	624	1,097	1	10	11
Nylon	38	31	69	745	935	1,680	11	11	22
Total	174	218	392	2,471	3182	5653	17	51	68
Percentage	44.39	55.61		43.71	56.29		25.00	75.00	
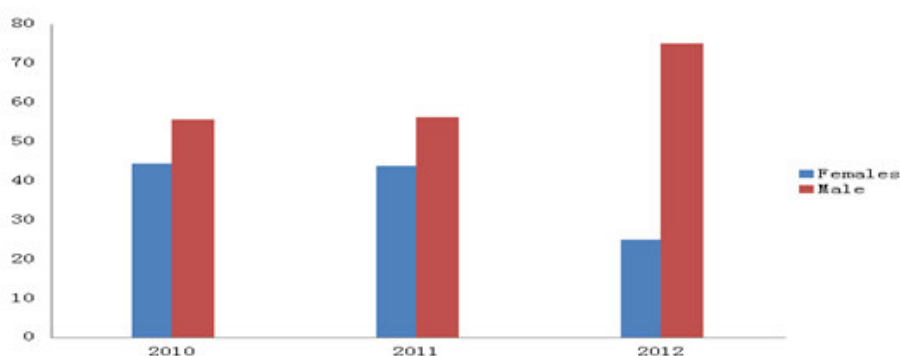
Fig 4: Percentage distribution of cholera cases by gender in Douala

4.2 Distribution of Cholera cases in Littoral Region by Age groups

In the literature, Cholera has been said to befairly age-selective, the brunt of its impacts falling heavily on the youthful age groups (0 - 10 years). However, as can be observed from the data of the 2010, 2011 and 2012 Epidemiological years obtained from the Littoral Regional Delegation of Public Health, the adult age groups, 20-30, 31– 40 are the most vulnerable groups. Similarly, no reasons have been advanced for this disparity, but the high mobility of these age groups compared to the others can be held accountable, as these are the most active age groups (Table 6).

**Table 6: Distribution of Cholera cases by age groups, 2010**

Age groups	No.	%	Cumulative %
>0 – 10	1	3.10	3.10
>10 – 20	1	3.10	6.30
>20 – 30	7	21.90	28.10
>30 – 40	10	31.30	59.40
>40 – 50	5	15.60	75.00
>50 – 60	5	15.60	90.60
>60 – 70	2	6.30	96.90
>70 – 80	1	3.10	100.00
Total	32	100.00	100.00

In 2010, 2011 and 2012, the same age-group has been featuring prominently as the most cholera-susceptible group. The adult and young adult age groups are therefore most affected during recent cholera epidemics. Due to limited and the patchy nature of available data, an in-depth analysis of the incidence of cholera based on age and gender over a longer time frame could not be done.

4.3. Sources and quality of water utilized for drinking and cooking and attitudes towards water treatment

Analysis of questionnaires reveals that 44% of all households utilize water from facilities of 'La Cameroonaise Des Eaux' (*CDE) for cooking and other domestic activities whereas 32.5% of the respondents use water from wells and 32% from springs (Fig 5 and 6).
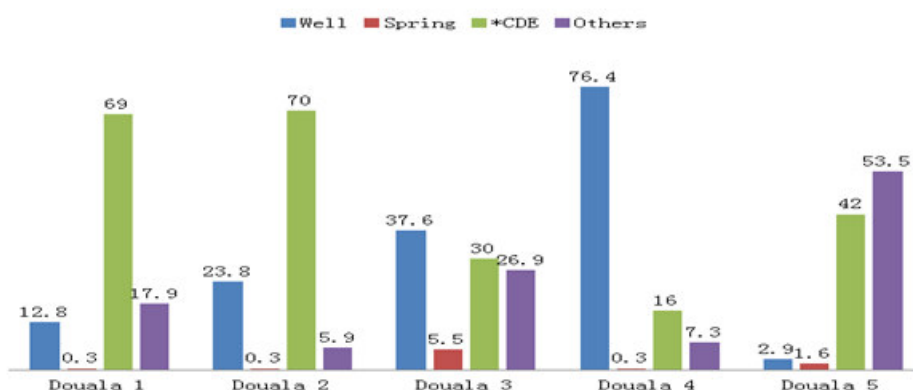
**Fig 5: Sources of water used for cooking**
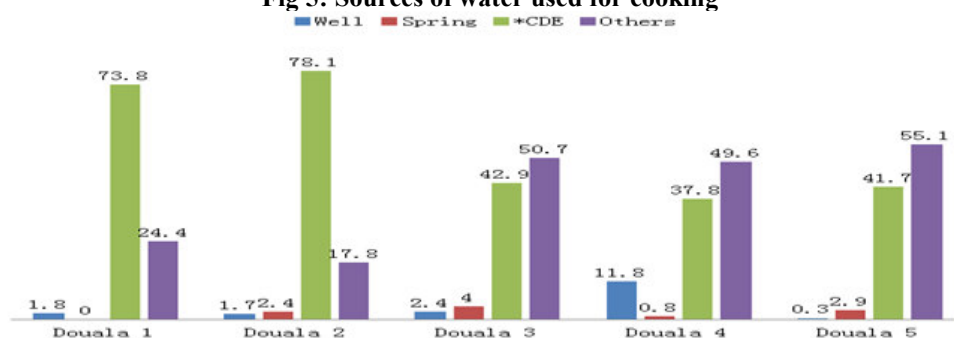
Fig 6: Sources of water used for drinking

*CDE (La Camerounaise Des Eaux) – main company supplying pipe borne water in Cameroon

Concerning drinking water, the households surveyed also stated a variety of sources from which water is obtained. The majority of households consumed pipe borne water supplied by CDE, the major water supply company, which is portable water (53.9%), followed by 3.9% from wells and 1.9% from springs. Other sources of water consumed include underground water and open water bodies, by a total of 661 households out of the total number surveyed. A clear disparity was observed between the surveyed subdivisions. In this case, in Douala 1 and 2 subdivisions, more than 70% of the households are served with pipe borne water supplied by CDE, as opposed to 45% of the households of Douala 3, 4 and 5 (Fig 6).

4.3.1 Household attitudes towards water treatment prior to consumption

In the case of water treatment, in general, only a few households treat their water prior to drinking, irrespective of the origin (35.4%), whereas as large as 64.6% of the respondents do not use any form of water treatment or purification before consumption. There was a significant difference between the subdivisions (0.016). In Douala 2 and 5, more than 70% of the households do not treat their water prior to consumption (Fig 7).
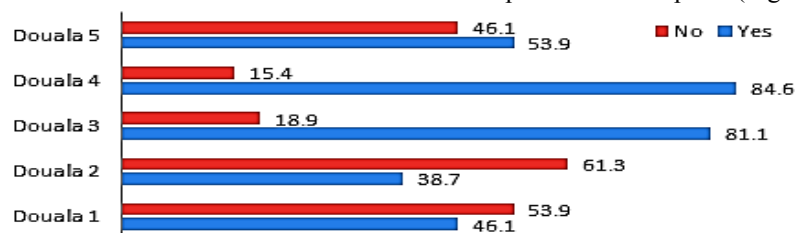
Fig 7: Attitudes towards water treatment prior to consumption based on the question (%): Do you treat your water prior to consumption?

The results of this study therefore reveal that a large proportion of people in Douala consume water directly from shallow wells, springs and other exposed water sources, constituting a major risk factor. Water is particularly a problematic resource in Douala, in terms of its abundance and quality. Based on data obtained from the Littoral Regional Delegation of Habitat and Urban Planning (MINUH), the production and distribution of water is very limited and deficient, and the drinking water network which covers a little less than 40% of the city, remains to be developed and unevenly distributed. A reform of the water sector resulted in the privatization of the National Water Company of Cameroon (SNEC) and split into two companies, namely: CAMWATER and La Camerounaise Des Eaux (CDE), in charge for the marketing and delivery of water to end users. Despite this reform, the water supply network of the city remains old, inadequate and unsuitable, characterized by the regular

interruptions in several neighbourhoods. Only 15% of households are subscribers to the official water network and most of them are from the wealthy classes, while 11% of households use a collective subscription. 1% of households are served with public taps. The vast majority of households (40%) is supplied by a tap water dealer or re-seller. Nearly 9% of households obtain their drinking water supplies from surface water sources (wells, springs, rainwater) [23]. Based on the spatial analysis of the water network and the number of subscribers per sector distribution, large parts of the city are insufficiently covered by the drinking water network [24]

Consumption of water from wells and springs, especially if untreated, is very worrying. Previous studies in the area have shown that pollution evident from high concentrations of organic (up to 94.3 mg NO3/l nitrate) faecal coliform and faecal streptococcus have been detected in the springs and bore wells (values of 2,311 and 1,500 cfu/100 ml, respectively); with pH ranging from 3.4–6.5, which is lower than the guidelines for drinking water [19]. The presence of bacterial agents like vibrio cholerea, sucrose fermenting and non-sucrose fermenting organisms have also been detected in well water utilized by the populations of Douala, posing great health threats in the study area [18]; the most probable cause being the antagonistic location of wells by latrines, with a possible seepage of pollutants from the latrines into the wells as a result of the sedimentary nature of the Douala alluvial basin ([18; [20]; [27]; [28]).

In addition, Douala generally suffers from flooding; due in part to the low-lying nature as well as its geographical locations on marshlands and/or near coastal areas and rivers; but flooding is also exacerbated by blocked waterways and drainage systems due to chaotic land development and constructions (Figure 2), and indiscriminate waste disposal. Flooding in Douala not only directly affect the physical life and property of the inhabitants of the area, but also have an enormous impact on water quality and the spread of cholera. This is because the flood waters wash the contents of the makeshift toilets and permanently putrefying mountains of garbage, into wells and homes, bringing along a wide variety of diseases, notably cholera. Former colonial areas (Douala 1, notably Bonanjo, formerly Jos Plateau, and Douala 5 – notably Akwa, Bonamousadi) are located on relatively higher ground and therefore suffers less intense flooding, coupled with better facilities such as road, storm drains and better planning

## 4.4 Beliefs and perceptions towards cholera epidemics

Though the inadequacy of potable water constitutes an important risk factor for cholera, beliefs and attitudes of the people towards the disease, personal hygiene and sanitation and environmental sanitation, and knowledge of the causes and spread of diseases, remain important determining factors for high or low vulnerability within all the subdivisions of Douala. In total, 75.3% of the households surveyed are of the opinion that there are no mystical reasons attached to the outbreak and spread of cholera epidemics, while a lesser but equally significant percentage of respondents attribute cholera epidemics to bad luck or witchcraft (24.7%). This latter category of people, in addition to being more vulnerable to cholera, also constitute an important risk factor to the entire municipality and even beyond because in such a cholera-endemic region and given the rapid rate of propagation of cholera, these people stand a greater chance of contracting the disease and spreading it around. Going by subdivisions, Douala 2 and 4 had greater proportion of households which did not believe cholera had mystical origins (84.7%), as opposed to Douala 1 and 5, where a large percentage of respondents take an affirmative stance (40.5% and 41.2% respectively). Therefore, while there is a great need for education in all health districts, in order to initiate a change of mindset, this need is even greater in the latter subdivisions. Thus, with limited resources and manpower, available resources for the fight against cholera can be rationed, with Douala 1 and 5 receiving more hours of community health education and more community health workers than Douala 2, 3 and 4 (Fig 8).
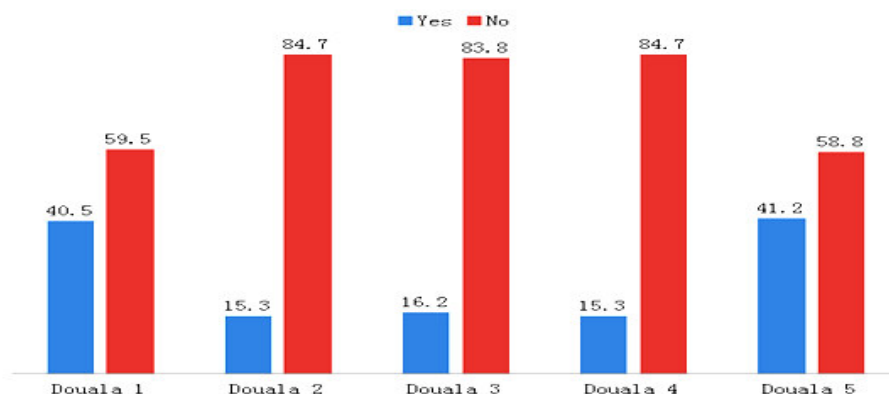
Fig 8: Household beliefs on the mystical origin of cholera based on the question: Do you think the rampant cholera outbreaks in Douala might have magico-religious origins?

4.5 Level of community awareness of the mechanisms of diseases/cholera contraction

When asked whether non-potable water and/or the poor management of the water environment was a major cause of morbidity in the Region, the majority of the respondents thought that non-potable water and poor state of the water environment was the cause of numerous illnesses (96.7), whereas 3.3% had a contrary view (Fig 9).
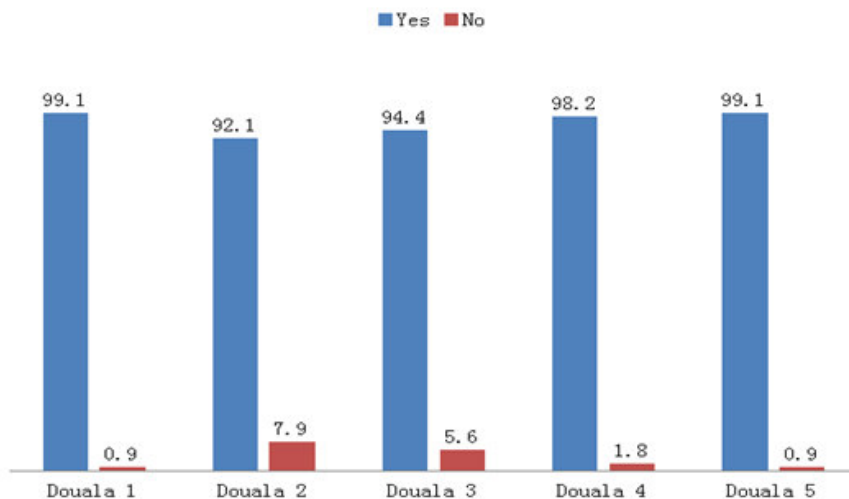

Fig 9: Community awareness of the contraction of diseases via the consumption contaminated water and poor state of the water environment Based on the question: Do you think diseases could be caused by the consumption of non-portable water?

Data on the major diseases currently prevailing in Douala (Fig 10), strongly attest to the fact that water is a critical resource in Douala, not only because of its physical inadequacy, but also notable because major diseases in Douala are related to water and the management of the aquatic environment [23]. Therefore, as mentioned earlier, in a cholera endemic region, 3.3 % of the population spread across all the subdivisions, indulging in risky behaviour such as indiscriminate consumption of water may endanger an entire country.
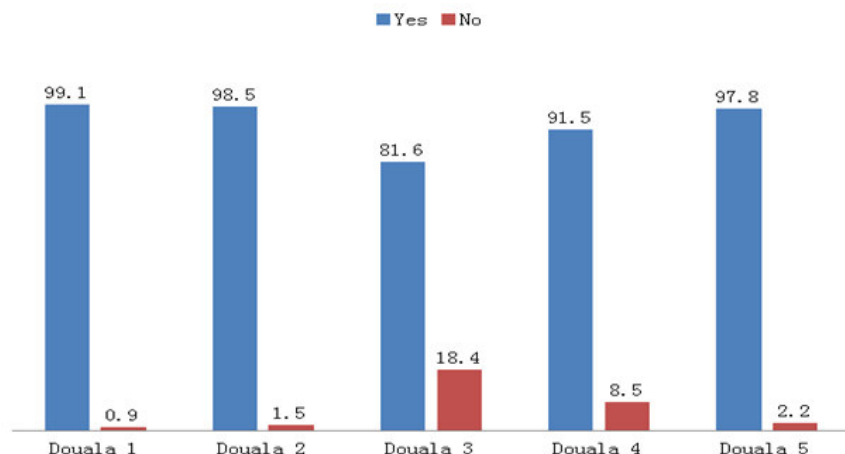

Fig 10: Community awareness of the contraction of cholera via drinking water sources based on the question: Do you think cholera could be caused by the consumption of non-potable water?

Similarly, when asked their opinion on how cholera in particular can be contracted, 93.9% of households mentioned unsafe water. However, in the specific case of cholera, the responses vary significantly between all the subdivisions. In Douala 3 and 4, an important proportion (18.4% and 8.5% respectively) of the households did not think cholera can be caused by non-potable water (Fig 10).
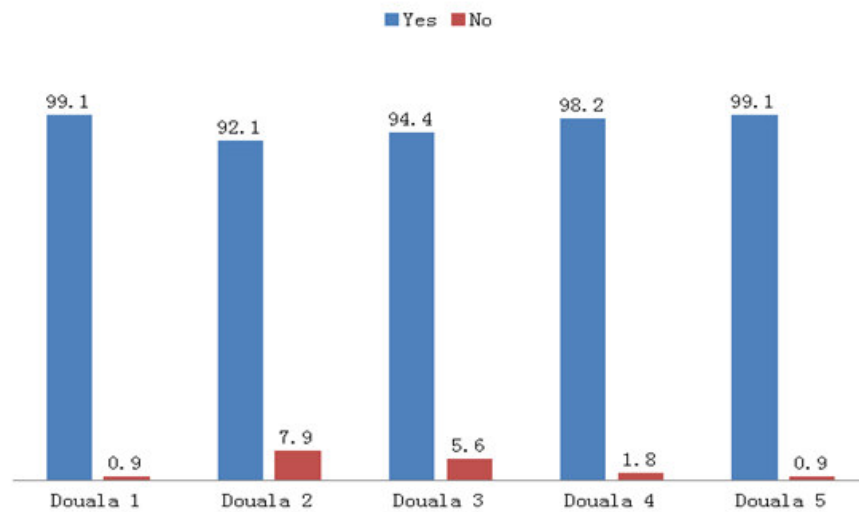
Figure 11: Households' knowledge of the spread of diseases via contaminated foodstuff and beverages based on the question: Do you think diseases could be caused by the consumption of poorly conserved and unclean foods?
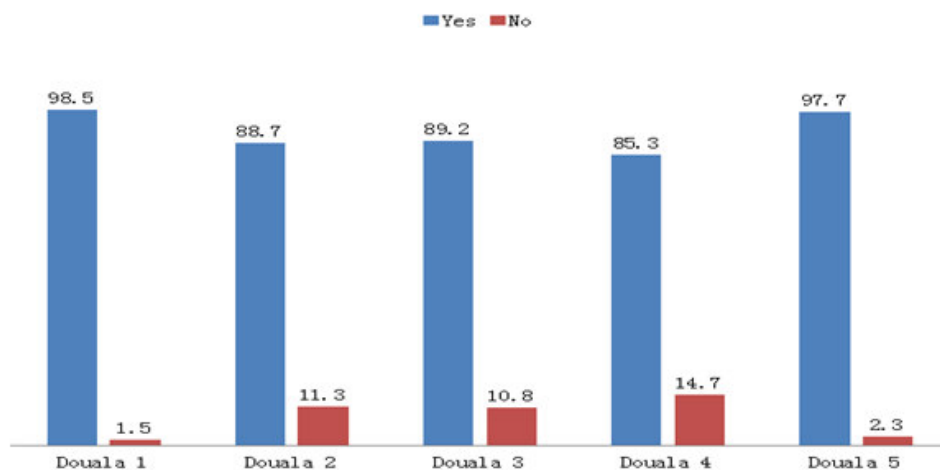
Figure 12: Households' knowledge on the spread of cholera via contaminated foodstuff and beverages based on the question: Do you think cholera could be caused by the consumption of poorly conserved/unclean foods?

Likewise, as expected, a large proportion of respondents (94.6%) think that unprotected, unwashed or contaminated foodstuff can cause diseases, whereas 5.4% believe the contrary. In the case of cholera, the majority of respondents are of the opinion that contaminated and unwashed foods could cause cholera (91.6%), as opposed to 8.4% who do not share the same opinion. These later respondents constitute 126 people, out of the total sample population, which is a significant number in the prevailing conditions of cholera endemicity.

4.6 Households' attitudes towards waste Disposal

Concerning waste disposal, 45% of households disposed of their waste in open pits around their homes. 44.6% of the households disposed their waste rightfully in HYSACAM refuse dumps, while 6% and 3% respectively dispose of their wastes in open spaces and water bodies (swamps, marshlands, streams, etc) (Fig 13). An important difference in attitudes of respondents towards waste disposal can be observed between the subdivisions. In Douala 1 for example, a larger proportion of households surveyed dispose of their waste in HYSACAM refuse disposal facilities (77%) whereas only 10.4 percent of households in Douala 4 dispose of their waste in or are served by HYSACAM facilities.
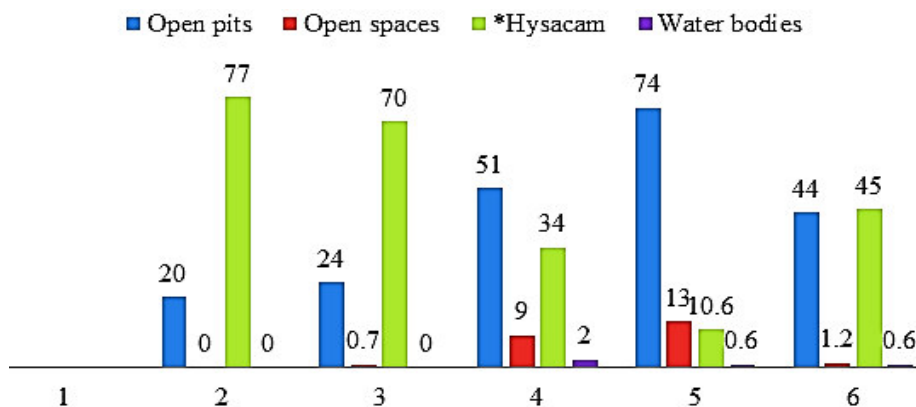
Fig 13: Modes of household waste disposal

Results of a statistical and demographic survey carried out in Douala supports the data presented here, as it reveals that reveals that, at least 45 million kg of waste is produced every month in Douala, and each citizen produces on average 500 grams of organic liquid waste per day. The same survey mentions that garbage collection covers only 40%, meaning 750,000 tonnes of waste are collected per annum, of the 2 million tonnes generated yearly – not including industrial waste. Thus, millions of tonnes have not been collected for years now, requiring that that effort and capacities be doubled to meet the real needs of waste collection in the city of Douala. Therefore, in this area, a greater proportion of households (80.6%) dispose of their waste indiscriminately open pits (74%), open spaces (13%) and water bodies (0.6%).

4.7 Availability and state of sanitary facilities/toilets

The results of this study also show that only 32.7% of toilets in all surveyed households are equipped with hygienic water evacuation systems. Analysis of household responses also points to the fact that, in general, 61.8% of toilets in households surveyed have an open evacuation systems that washes directly into the environment (61.8%).

The results of the questionnaires and field survey reveal that the state of sanitation facilities in the study area is deplorable. Large numbers of toilets notably in Douala 2, 3 and 4 characterized by vast expanses of slums, are known locally as 'toilettes sauvages' or 'makeshift toilets' with no running water system, and no system to empty or clean them, from which emanate a stench which permanently pollutes the local environment, and a harbour for flies and other insect-vectors of diseases. In some cases, based on field surveys, the toilets are constructed with zinc sheets or wood, usually above a water body or swamp, into which excrement is dumped directly, especially in Mabanda area in Bonasama health district (Douala 2) and Youpwe in New Bell health district (Douala 4). Sadly these same water bodies with such sanitary conditions are used for fishing and other domestic purposes.

5. Discussions

It is the view held here that, for 40 years, the inability of Cameroonian public health authorities to provide long term eradicative solutions and the continuous reliance on short term ineffective and inefficient measures in the face of such a major killer point to two main aspects:

1. The complexity of the Vibrio cholerae brought about by its significant social, environmental and climatic associations have led to poor understanding of the disease, and in many ways, masked the underlying causes of the frequent cholera epidemics as well as reasons for its endemicity and vulnerability of the populations.
2. Ineffectiveness of the Public Health Management System in Cameroon and limited consideration of social and behavioural factors which contribute to increasing community vulnerability to Cholera.

Generally, cholera risk factors abound in the entire city of Douala and the Littoral Region. However, a glaring disparity in these risk factors can be observed within Douala, imposing an invisible but real boundary between high risk and low risk areas. The high risk areas which also correspond to high vulnerability areas, have recorded the highest number of cases during all outbreaks, and have been generally identified in Douala 2, 3 and 4 council areas, where as Douala 1 and 5 are relatively safer. The main reason for this difference in cholera risk include: better social amenities and improved hygiene and sanitation facilities, less susceptibility to serious flooding due to locational advantages, better planning and drainage facilities, and better waste disposal, collection and management facilities in Douala 1 and 5, following along colonial footpaths in these areas, as described previously. However, pockets of high vulnerability still exist within these relatively 'well served' and 'safer' subdivisions, due to the rapid increase in population and the development of slum conditions at the

peripheries of clean and well planned quarters such as Bonanjo and Akwa in Douala 1 and 5 subdivisions. However, due to stricter and constant efforts by the municipality, the situation is somehow under control, thus preventing slum conditions from engulfing the whole area. The other subdivisions of Douala 2, 3 and 4, characterized by physical signs of total abandonment and neglect on the part of city administration, has been almost completely transformed into vast expanses of slums.

This study however holds steadfast to the opinion that, cholera, being an ailment generally contracted through the oral route, the mere inexistence of potable water, limited sanitation and lack of conventional waste disposal facilities in Douala, though constitute important risk factors, are not in themselves enough reason for high cholera-vulnerability observed in the city. This is because there are cheap and simple methods of water treatment, food preservation and personal hygiene, which are just not practiced by numerous vulnerable populations for reasons which may be related to their level of health general and education, beliefs, ignorance etc. Thus, an understanding of the vulnerability status of the populations based on information of their knowledge of the causes and pathways of cholera contamination, local beliefs towards diseases, quality of life, attitudes towards personal hygiene and sanitation etc, will serve as an important step towards pinpointing the real causes of cholera vulnerability, and aid in the search for long term eradicative solutions. In this perspective, as appropriately stated by Shah: "with the environment changing, the disease on the move, and poverty still entrenched in many parts of the world, "cholera cannot be defeated by medicine alone," unless with "a new approach" [5], and this includes a change in the perception of the disease and human socio-environmental relationships.

6. Conclusion and Recommendations

Cholera being a highly infectious disease which can kill within an hour is different from other kinds of environmental disasters (physical or man-made) which tend to be more localized; a single case of Cholera in an area can result in city-wide or even nation-wide pandemic within days. Though the populations of Douala 1 and 5 are relatively less exposed to cholera risk factors, indicating at first glance that they are relatively less vulnerable to cholera than those of Douala 2, 3 and 4, cholera cannot be effectively brought under control along lines of high and low vulnerability in the same city. It is therefore highly deceptive to plan mitigation strategies for cholera epidemics based on these lines. This is because it might result in a complete shift of resources to high vulnerability subdivisions, thus overlooking the pockets of high vulnerability existing in relatively less vulnerable areas and the rapid propagative character of the disease. Thus, as a common saying goes; 'a single case of cholera constitutes an epidemic'. Therefore, it seems more logical to attempt an understanding of specific factors that contribute to an increase in vulnerability within the whole area irrespective of internal disparities in risk factors. This can reduce the cost of fighting this humanitarian disaster by redirecting limited resources to directly tackle vulnerability factors, in this case, social and behavioural characteristics of the population.

An understanding of the societal and behavioural implications of cholera by analyzing the relationship between age/gender and cholera vulnerability; the attitudes and perceptions of people towards cholera, as well as their interactions with the environment, has led to the conclusion that though the physical conditions of Douala contribute immensely to the endemicity of cholera, frequent epidemics are accounted for by the poor treatment people inflict upon their environment and living spaces, especially through careless waste disposal, their unhygienic attitudes, deplorable sanitary conditions, poor knowledge of cholera transmission mechanisms, fetish and unorthodox beliefs about cholera, and a general feeling of nonchalance and ignorance on issues of health and healthy living.

As mentioned earlier, the mere fact that people must consume water from wells for example, is a risk factor, but does not directly guarantee that they will contract cholera. Cholera epidemics generally breakout when they fail to apply cheap and affordable methods of water purification such as boiling and sieving, along with proper location and construction of their toilets relative to homes and water wells.

With no intention to ignore the responsibility of the government and various decentralized entities, this study states point blank that Cameroon as a nation and the Douala municipal government have failed woefully in setting the stage for the attainment of Millennium Development Goals (MDGs) especially concerning human health and environmental sustainability. The continuous use of antibiotics which the disease has been proven to become resistant to since the 1980s; the inability to provide basic social facilities such as public toilets and waste disposal/management infrastructure, inadequate provision of potable water, unplanned residential areas; the yearly reactive character of cholera-management efforts in a cholera endemic setting, clearly attest to the fact that the government and the health department are inefficient and ineffective in public health management, and especially in developing and strengthening the invaluable partnership between environment and public health. This failure may be the result of the following factors:

1. The complex nature of cholera due to its environmental, social and even cultural and even spiritual linkages, which requires concerted efforts by all stakeholders: governmental sectors, corporate bodies, academics and all members of the community. This is simply not possible for now, due to the highly

centralized political and administrative system existing in Cameroon. All management decisions (including health) must come from the central government based in the capital city, Yaoundé, with little knowledge of the prevailing situation around the country, as well as limited interactions between different ministerial departments. The strong plea made here is therefore that despite the difficulties involved with changing such a system, political efforts should be made to decentralize the health sector so that regional health departments can make decisions and carry out actions irrespective of the dictates of ministerial bureaucrats in the capital city, far removed from the reality in the regions.

2. The management of a health issue of the magnitude of cholera in Douala requires substantial financial resources. The funds available to the Douala municipality and the Regional Delegation of Public Health may not be much, as claimed by public health authorities, but may be sufficient to bring about a big improvement in the public health situation if put in the proper context. That is, if diverted from the over-reliance on treatment and antibiotics and the creation of ineffective cholera management committees, to more effective preventive strategies through intensive outreach and education programs, in addition to the provision of basic sanitation facilities and policies to improve basic household hygiene through constant home inspections, proper urban planning and management.

In addition, due to limited resources, a sequential cholera management strategy can be adopted for the city of Douala, on vulnerability lines; based on the effective identification of factors contributing to high vulnerability, vulnerable age groups, vulnerable gender, and vulnerable localities within all the subdivisions. Knowing where direct vulnerability lies, as well as the nature and causes of such vulnerability are important for the effective response to cholera hazards in the area. As a preliminary step therefore, this research has identified social and behavioural factors as major causes of high vulnerability, and recommends intensive and continuous city-wide education and awareness programs in order to initiate a change of mindset and attitudes of people living in high risk areas so as to reduce their vulnerability to Cholera. This should be followed by the use coercive measures to reinforce good attitudes in hygiene and sanitation through constant sanitary inspections to homes and neighbourhoods by health authorities and the punishment of defaulters through heavy fines; and even the organization of most sanitary community contest, more like the 'carrot and stick approach'.

It is also strongly recommended that this study be complemented by detailed environmental, climatic and micro-biological surveys in the same area, to establish the environmental and climatic risk factors associated with cholera. Moreover, due to limited data, the analysis of age/gender/cholera relationship is limited only to the most recent outbreaks (2010, 2011 and 2012). A more detailed and continuous study is recommended in this direction as well. With these, it will be easy for the development of an early warning and response system for the fight against cholera; a system which will effectively reduce human vulnerability to cholera, as well as improves response timing and action. This is however to be supported by a strong political will, and adequate financial contributions to further research, which may stand as a major hindrance to the eradication of cholera epidemics in Douala in particular and Cameroon in general. International organizations such as WHO can intervene by imposing guidelines and deadlines on the government, geared towards reducing cholera epidemic outbreaks by a certain time frame.

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