Journal of Environmental Protection, 2025, 16(8), 771-791
https://www.scirp.org/journal/jep
ISSN Online: 2152-2219
ISSN Print: 2152-2197

# Investigating Households' Urban Resiliency and Perceptions of Health Impacts Associated with Solid Waste Management Practices in Douala, Cameroon

**Shella Nchia[1*], Kenichi Matsui[2]**

[1]Doctoral Program in Environmental Studies, University of Tsukuba, Ibaraki, Japan
[2]Faculty of Life and Environmental Sciences, University of Tsukuba, Ibaraki, Japan
Email: *nchiashella@gmail.com

**How to cite this paper:** Nchia, S. and Matsui, K. (2025) Investigating Households' Urban Resiliency and Perceptions of Health Impacts Associated with Solid Waste Management Practices in Douala, Cameroon. *Journal of Environmental Protection*, **16**, 771-791.
https://doi.org/10.4236/jep.2025.168040

**Received:** June 19, 2025
**Accepted:** August 24, 2025
**Published:** August 27, 2025



## Abstract

Past solid waste management studies have overlooked diverse practices within a municipality that affected residents' capacity in dealing with health threats. Given the theory of urban resilience, we still have little understanding of how Africa's urban residents, as agents of urban resilience, perceived and coped with waste management challenges. This study aims to fill these gaps and demonstrate how locally different solid waste management practices within Africa's sprawling urban municipality can be better understood by approaching from urban resilience theory. We conducted field and questionnaire surveys in several neighborhoods of Douala regarding residents' health risk awareness, waste management practices, and disposal techniques. Findings reveal that waste management practices differed largely among selected neighborhoods/communities although a substantial portion of the respondents similarly recognized or experienced negative health effects. Two sprawling residential-manufacturing neighborhoods (Logbaba and Kotto) faced irregular waste collection (34% - 43%), while administrative/commercial neighborhood (Bonanjo) had relatively reliable service, with 79% of respondents reporting either daily (17%) or weekly (62%) waste collection. Our Chi-square analysis showed significant links between socio-demographic factors and waste disposal behaviors. Age was significant in New Bell ($\chi^2$ = 33.75), Bonassama ($\chi^2$ = 35.60), and Kotto ($\chi^2$ = 123.56). Gender showed significance in New Bell ($\chi^2$ = 11.83), Logbaba ($\chi^2$ = 9.98), and Bonassama ($\chi^2$ = 7.79). Education was significant in New Bell ($\chi^2$ = 34.03), Logbaba ($\chi^2$ = 31.60), and Bonassama ($\chi^2$ = 22.60). Household size and income also showed statistically significant correlations in New Bell and Logbaba.

**Keywords**

Community Vulnerability, Environmental Health, Solid Waste Management, Household Waste Disposal, Municipal Waste Services, Douala City, Cameroon

## 1. Introduction

Past studies suggest that poor household waste management practices contribute to environmental pollution and disease transmission [1] [2]. Solid waste attracts rodents, insects, and flies that transmit many of life-threatening communicable diseases [3]. The connection between urban zoonotic diseases, particularly those transmitted by Aedes mosquitoes and solid waste accumulation was found [4]. Improperly managed waste containing such healthcare waste as sharps caused physical injuries, tetanus, HIV, and hepatitis B and C [5] [6]. In addition, hazardous materials (e.g., medications, pesticides, batteries) are mixed with general municipal waste [7].

Past studies paid much attention to these waste management consequences for urban and rural populations in Africa [8]-[10]. A growing number of studies focused on cities in Cameroon as situations there appeared particularly concerning [11]-[13]. Somewhat similar to past studies on other sub-Saharan countries, those about Cameroon's waste management highlighted its inappropriate disposal methods, such as open dumping, burning, and uncontrolled landfills with consequences of gastrointestinal infections, respiratory disorders, vector-borne illnesses, and other chronic maladies [13] [14]. Cameroon generates approximately 16,000 tons of solid waste daily or 5.5 million tons annually [15]. Poor disposal methods like open dumping and burning have caused health issues, including gastrointestinal infections and respiratory problems [16]. Between 2015 and 2021, Cameroon imported 121.5 million tons of plastic, worsening pollution due to ineffective waste management [17]. The system faces challenges such as insufficient funding, weak regulation enforcement, and governance issues, which sustain open dumps and uncontrolled landfills.

Some studies attributed these problems to residents' poor awareness of potential health risks associated with exposure to waste sites [8] [9]. This point sounds convincing to some extent, especially if one emphasizes the powerlessness of poor residents without recognizing their agency and diversity. However, given the theory of urban resilience, which emphasizes a community's ability to absorb, adapt to, and recover from external stresses, we still have little understanding of how Africa's urban residents as agents of urban resilience perceived and coped with waste management challenges [18]. These community-scale urban resilience attributes can be understood in terms of distance, diversity, and self-organization [18]. If so, we may be able to develop good and unique insights into waste management-related urban resilience, which has not yet been explored in the past. For

this to be done, we need much more information about how urban communities with different socio-economic characteristics respond to the health risks of inappropriate waste disposal. However, despite growing awareness of these health risks among residents of Douala, there remains a significant gap between household perceptions and their actual waste management practices. Given this context, this study examines how households in different communities of Douala perceive negative health effects from poor solid waste management sites.

## 2. Materials and Methods

### 2.1. Study Area

This study focuses on Douala. It is Cameroon's largest city and primary economic hub, experiencing rapid growth in informal settlements. As the most populous and industrialized city in the country, Douala generates more solid waste than any other urban areas in Cameroon. However, we have very limited studies about waste collection coverage, dumping practices, and the health impacts. These conditions make it a critical site for examining household-level health risks and adaptive behaviors [19].

This section describes about the study area, Douala, Cameroon with focus on its demographics, environmental challenges, and waste management practices. It highlights why this urban setting is relevant to understanding residents' perceptions and behaviors regarding solid waste management.

To understand community responses and perceptions, we selected Douala city, as shown in **Figure 1**, an economic hub in the Central African Economic and Monetary Community region. It consists of six municipalities: Douala 1e, 2e, 3e, 4e, 5e, and 6e, which are French abbreviations for 1st, 2nd, 3rd, 4$^{th}$, 5$^{th}$, and 6th. Each subdivision, known as an arrondissement, functions as a local administrative area with its own governance and jurisdiction. For our sampling purposes, we selected the following five urban communities in five municipalities: Bananjo in Douala 1e, New Bell in Douala 2e, Logbaba in Douala 3e, Bonassama in Douala 4e, and Kotto in Douala 5e. Bonanjo mainly houses administrative and commercial centers. New Bell represents a densely populated informal settlements and businesses. Logbaba has a mix of residential and industrial areas. Bonassama is a high-density suburban area with active micro-enterprises. Lastly, Kotto is a growing middle-class neighborhood without waste collection services. Each has a somewhat distinct socioeconomic trait that appeared to have affected solid waste management practices and public health. The population is estimated at 4,203,000 people with an average growth rate of 4.8% [20].

Bonanjo represents an overall profile of Douala 1e as home to administrative offices, financial institutions, and corporate headquarters. It is the oldest district among five municipalities we focus in this paper. It was established as Douala's administrative center during the colonial period [21]. According to the UN-Habitat (2024), the volume of solid waste had increased in Douala 1e [22]. In our preliminary field survey in 2024, waste management appeared relatively well-man-

aged here, though occasionally illegal dumping was observed. It has comparatively better-run waste collection services with regular pickups. One of the most recent studies showed the presence of serious solid waste health hazards due to a high-density population here [12].

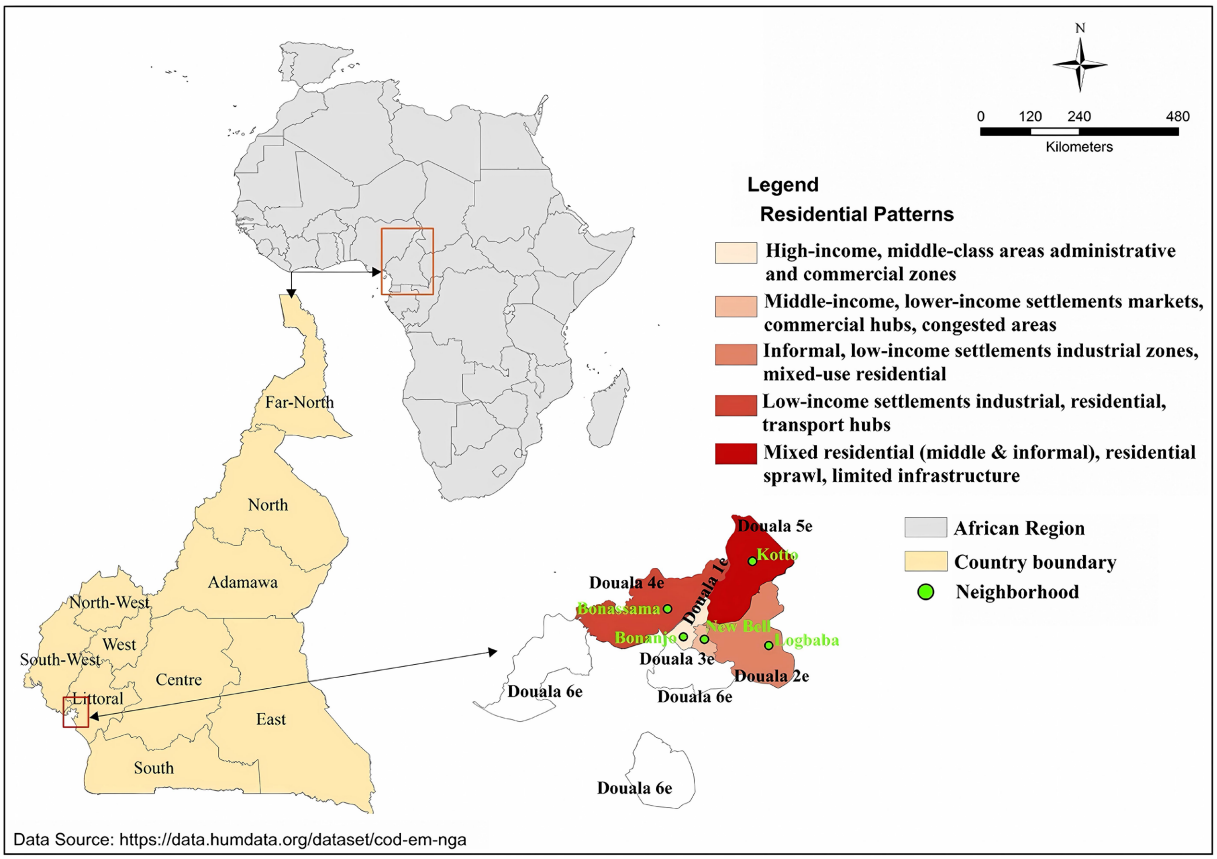


**Figure 1.** Map of Africa showing Cameroon and Douala urban city neighborhoods.

Douala 2e (New Bell) is one of Douala's oldest areas, with a sizable residential population and informal businesses. Marché New Bell, a significant market that boosts the local economy, is located there. The area has many open dumpsites and informal settlements due to inadequate garbage collection services and poor urban planning [23]. The community has engaged in informal garbage management (e.g., sorting, reuse, dump-site cleanups) and locally driven waste treatment strategies [24]. Douala 3e (Logbaba) is a mix of residential and commercial communities. It has an increasing industrial presence with factories and warehouses, but faces widespread uncontrolled dumping and inconsistent waste collection. As a component of the primary data collection procedure, observational field research was carried out in various neighborhoods of Douala. Photographic evidence was utilized to document observable signs of waste management conditions. For example, **Figure 2** depicts an open dumpsite in Logbaba, captured during the field survey conducted in 2024. The photograph demonstrates the pervasive accumulation of uncollected household and commercial waste along public streets, shed-

ding light on the critical issue of improper waste disposal practices in densely populated areas.

**Figure 2.** Open dump site at Logbaba taken during the field survey in 2024.

Douala 4e (Bonassama) is a suburban residential area characterized by numerous micro and small enterprises and local markets, with trade and service activities dominating. It comprises both middle- and low-income neighborhoods, with informal settlements in the latter being densely populated [12] [25]. The area faces poor road infrastructure, which hinders access for waste trucks, especially in informal zones. A lack of designated bins, landfills, and proper drainage systems contributes to waste buildup and blockages [26]. Illegal open burning and dumping are common, as in Douala 3e, though community-led initiatives like private collection services reflect local resilience despite limited resources. Douala 5e (Kotto) is a primarily residential area. It has experienced substantial population growth in recent years with a surge in real estate price due to its attractiveness to middle-class people. Open dumpsites are seen in new residential areas due partly to lack of adequate trash disposal facilities.

Douala's urban resilience and home waste habits have been significantly affected by governance shortcomings despite the availability of legal and policy frameworks [27]. The National Environmental Management Plan (NEMP) meant to address solid waste management with the emphasis on sustainable practices and collaboration. A 2012 decree establishing the Hygiene and Sanitation of Cameroon (HYSACAM) for urban waste collection and sanitation improvement, but it has met limited funding and infrastructure access challenges. The Urban Waste Management Policy (2009) attempted to address urban waste challenges by encouraging public-private partnerships, improving infrastructure, and promoting sustainable practices with limited success. The National Strategy for Sustainable Waste Management promoted environmentally friendly waste management through enhanced practices for waste generation reduction and recycling. These policies

did not pay much attention to informal settlements like New Bell and Bonassama [28]. HYSACAM's formal garbage services primarily assisted higher-income or administrative communities like Bonanjo [29].

## 2.2. Data Collection and Analysis

In this section, we outline our data collection and analyses, such as surveys, and the techniques applied to analyze the data. We conducted a paper-based questionnaire survey by drawing on the knowledge, practice, and attitude (KPA) method from February to March 2024. This method was used in past waste management studies [30] [31]. It allows us to assess urban resilience households. The KPA method is particularly suited for determining resilience-related behaviors, as it captures critical components that influence how individuals and communities respond to environmental stressors. The questionnaire was designed to capture both vulnerabilities and adaptive responses to household perceptions of improper solid waste management practices and their health impact.

The questionnaire was divided into four sections with 22 questions. The first section attempted to understand the socio-demographic information of the respondents by neighborhood, including gender, age, marital status, education, occupation, household size, and monthly income. The second section was to understand the current state of household solid waste management practices. Section three focused on their health perceptions and impacts. The final section explored their opinions on waste collection services in connection to urban resilience.

In selecting communities for sampling, we focused on communities with different socio-economic backgrounds. Bonanjo has a relatively low population compared to other districts in Douala, primarily serving as a business hub. In contrast, New Bell is one of the most densely populated areas. Logbaba has a moderately high population, balancing residential and industrial sectors, while Bonassama has a high population density, dominated by sprawling informal settlements. Kotto, a developing area, has a medium-to-high population density as urban expansion continues.

Considering the household population size of Douala, we conducted a household survey and distributed 400 questionnaires across five communities. The sample size was determined using Yamane's formula with a 5% margin of error, based on an estimated 657,644 households. We received 360 valid responses. The distribution of valid responses was as follows: Bonanjo (n = 78), New Bell (n = 61), Logbaba (n = 83), Bonassama (n = 85), and Kotto (n = 53). Our questionnaire consisted of closed-ended questions featuring both five-point Likert-scale and yes or no questions. The collected data were analyzed by using Microsoft Excel and SPSS. A chi-square correlation test examined the relationships between respondents' socio-demographic characteristics (e.g., age, gender, education, household size, income) as independent variables and their household waste disposal practices as dependent variables. This test allowed us to determine whether these independent factors significantly influenced waste disposal behaviors across different communities in Douala.

In the questionnaire's second section, we examined household solid waste management practices, including waste segregation, type and capacity of waste bins, weekly waste volume, waste collection frequency, and the household member responsible for disposal. These factors helped assess the formality, regularity, and roles in waste handling across five communities. In the third section, residents' awareness of health risks from poor waste management was measured using a five-point Likert-scale. Statements covered risks like vector-borne diseases, respiratory and gastrointestinal issues, injuries, pollution from burning, and soil and water contamination, revealing how residents perceive the health impacts of improper waste disposal.

In this study, categorical variables were numerically coded to facilitate statistical analysis. For instance, gender was coded as 1 for males and 2 for females, while education, income, and household size were categorized into predefined ranges. Household waste disposal practice as key variable was coded as follows: 1 = local authority collection, 2 = private collection, 3 = designated dump site, 4 = customary dump site, 5 = random disposal on the street, and 6 = other methods. These coded categories allowed the chi-square test to assess associations between waste disposal behaviors and demographic characteristics. The chi-square test was particularly useful in identifying associations rather than causal relationships, helping to highlight disparities in waste management behaviors among different demographic groups.

To analyze residents' awareness of health impacts associated with poor solid waste management, descriptive statistics (frequencies, means, and standard deviations) were used to summarize responses to Likert-scale items. The results of the chi-square analysis were presented using descriptive statistics, tables, and graphs to illustrate significant correlations across the five communities studied. This approach provided insights into the varying impacts of socio-economic factors on waste disposal practices, offering a data-driven foundation for discussing urban resilience and its analytical approach revealed variations in how knowledge, practices, and attitudes contribute to resilience at the household and municipal levels.

$$n = N \Big/ \left(1 + Ne^2\right)$$

$$n = 657644 \Big/ \left(1 + 657644\left(0.05\right)^2\right)$$

$$= 399.76$$

$$= 400$$

The sample size for the study was determined using Yamane's formula (Yamane, 1967). Where

$$n = N \Big/ \left(1 + Ne^2\right)$$

$n$ = sample size.

$N$ = estimated number of Households in Douala (657,644).

$e$ = marginal error (0.05 for 5%).

Sample size = 399.76.

## 3. Results and Discussion

### 3.1. Socio-Demographic Characteristics of the Five Municipalities

In this section, we discuss the results and the implication within a larger academic context. As briefly mentioned in the methodology section, it is divided into socio-demographic characteristics, waste management practices, and community perceptions about health impacts from improper solid waste management practices.

The first section of our questionnaire survey aimed at identifying the socio-demographic characteristics of the respondents (Table 1). We discovered a similar age distribution pattern across all five communities, largely aligning with the national average. About 59% of the respondents belonged to age groups of 20 to 49. This figure is slightly higher than the national average of 55% in the 15 - 64 age group reported in 2022 [32]. Notably, the younger age groups (20 - 39 years) were concentrated in specific areas. For example, 73.8% of the respondents in Bonanjo (a commercial and administrative hub) and 68% in Kotto (a new middle-class neighborhood) fell within this age range. Similarly, in New Bell, an older residential area, over 65% of the respondents belonged to the 20 - 39 age group. In contrast, Logbaba and Bonassama showed higher proportions of the 40 - 49 age group (Table 1).

Regarding household size, according to the population and housing census of Cameroon [33], about 67.9% of households had 3 to 6 persons. Similarly, in our sample, about 67% belonged to this range of household size. Each community we examined, however, had somewhat different compositions. Bonanjo and New Bell had more than 40% of the respondents with 3 - 4 persons whereas residential areas like Bonassama and Kotto had 4 - 6 persons. A newly expanding middle-class neighborhood like Kotto tend to have more than 5 persons, including about 18% of households with more than 7 persons.

Females represented 44.9%, 51.8%, 54.7%, 39.8%, and 49.2% of the sampled population in Bonanjo, New Bell, Logbaba, Bonassama and Kotto, respectively. Some past studies in other African communities showed essential roles women played in managing household hygiene and garbage dumps [34] [35]. Given this, women's views on household waste management and public health concerns can be insightful, particularly regarding risks to children, food contamination, and waterborne illnesses.

Education is another significant factor that impacts the way individuals view and practice household waste management [36]. In Cameroon, the rate of tertiary education attainment is low (12% - 15%), but that of our respondents was about 55%, indicating a strong interest in waste management among educated people. About 77% of the respondents in Bonassama, for example, had completed higher tertiary education than those in other studied communities. In New Bell, which tends to have informal business operators, our respondents had the lowest percentage (47.5%) of tertial education among all communities, but those who had completed up to junior high or senior high school education (37.7%) showed interests in participating in this survey.

Table 1. Socio-demographic characteristics of the respondents in Douala's five communities.

| Locations | Bonanjo | Bonassama | Kotto | Logbaba | New Bell | Average |
|---|---|---|---|---|---|---|
| **Age** | % | % | % | % | % | |
| 20 - 29 | 30.77 | 15.29 | 32.08 | 25.30 | 31.15 | 94 (26.11%) |
| 30 - 39 | 42.31 | 34.12 | 35.85 | 39.76 | 34.43 | 135 (37.50%) |
| 40 - 49 | 17.95 | 29.41 | 16.98 | 27.71 | 13.11 | 79 (21.94%) |
| 50 - 59 | 8.97 | 14.12 | 3.77 | 7.23 | 14.75 | 36 (10.00%) |
| 60 - 69 | 0.00 | 4.71 | 11.32 | 0.00 | 6.56 | 14 (3.89%) |
| Above 70 | 0.00 | 2.35 | 0.00 | 0.00 | 0.00 | 2 (0.56%) |
| **Gender:** | | | | | | |
| Male | 55.13 | 48.24 | 45.28 | 60.24 | 50.82 | 189 (52.50%) |
| Female | 44.87 | 51.76 | 54.72 | 39.76 | 49.18 | 171 (47.50%) |
| **Highest education** | | | | | | |
| None | 7.69 | 11.76 | 3.77 | 4.82 | 3.28 | 24 (6.67%) |
| Primary | 5.13 | 11.76 | 3.77 | 10.84 | 11.48 | 32 (8.89%) |
| Junior high | 10.26 | 11.76 | 3.77 | 14.46 | 21.31 | 45 (12.50%) |
| Senior high | 25.64 | 11.76 | 11.32 | 14.46 | 16.39 | 58 (16.11%) |
| Tertiary | 51.28 | 52.94 | 77.36 | 55.42 | 47.54 | 201 (55.83%) |
| **Household size** | | | | | | |
| 1 person | 10.26 | 10.59 | 1.89 | 6.02 | 4.92 | 26 (7.22%) |
| 2 persons | 15.38 | 5.88 | 15.09 | 19.28 | 18.03 | 52 (14.44%) |
| 3 persons | 19.23 | 10.59 | 7.55 | 13.25 | 29.51 | 57 (15.83%) |
| 4 persons | 21.79 | 29.41 | 18.87 | 16.87 | 18.03 | 77 (21.39%) |
| 5 persons | 8.97 | 10.59 | 20.75 | 25.30 | 11.48 | 55 (15.28%) |
| 6 persons | 14.10 | 20.00 | 16.98 | 4.82 | 18.03 | 52 (14.44%) |
| 7 persons | 7.69 | 2.35 | 7.55 | 2.41 | 0.00 | 14 (3.89%) |
| Above 7 persons | 2.56 | 10.59 | 11.32 | 12.05 | 0.00 | 27 (7.50%) |
| **Job-status** | | | | | | |
| Student | 15.38 | 12.94 | 9.43 | 12.05 | 22.95 | 52 (14.44%) |
| Unemployed | 20.51 | 25.88 | 24.53 | 33.73 | 24.59 | 94 (26.11%) |
| Employed | 64.10 | 61.18 | 66.04 | 54.22 | 52.46 | 214 (59.44%) |
| **Occupation** | | | | | | |
| Private | 87.18 | 91.76 | 77.36 | 89.16 | 86.89 | 314 (87.22%) |
| Public | 12.82 | 8.24 | 22.64 | 10.84 | 13.11 | 46 (12.78%) |
| **Household income** | | | | | | |
| Less than 20,000 | 21.79 | 23.53 | 15.09 | 18.07 | 26.23 | 76 (21.11%) |
| 21,000 - 50,000 | 26.92 | 21.18 | 7.55 | 15.66 | 24.59 | 71 (19.72%) |
| 51,000 - 100,000 | 20.51 | 23.53 | 30.19 | 34.94 | 24.59 | 96 (26.67%) |
| 100,001 - 250,000 | 21.79 | 20.00 | 26.42 | 25.30 | 16.39 | 79 (21.94%) |
| Above 250,000 | 8.97 | 11.76 | 20.75 | 6.02 | 8.20 | 38 (10.56%) |

Source: Author's construct from fieldwork, 2024.

Employment rates were higher than the national medium (59.4%) in Kotto (66%), Bonanjo (64%), and Bonassama (61%) (Table 1). A relatively lower employment in New Bell compared to others can be explained by a higher presence of students (23%). However, an average rate of unemployment in the study area is about 26%, which is higher than the national rate of 3.65% [37].

Low income is viewed as a significant factor that could affect people's perceptions about and attitudes toward solid waste management systems [38]. Cameroon's GDP had 4% increase from 2022 to 2023 [39], but income levels in Douala revealed significant disparities, reflecting unevenly distributed growth. Considering our samples, in Douala, about 21% of our respondents earned less than 20,000 XAF (US$33) per month, but about 48% earned between 51,000XAF and 250,000 XAF per month. In New Bell, the low-income proportion was relatively higher than that in other communities, having 32% earning less than 50,000 XAF or US$85 per month. In Logbaba and Bonassama, the middle-income group (51,000 - 100,000 XAF/month or US$85 - 170) consisted of 35% and 30%, respectively. Another 25% of our Logbaba respondents earned between 100,001 - 250,000 XAF/month or US$170 - 425. Kotto was presented by higher income groups with more than 77% earning 51,000 XAF/month or more.

### 3.2. Solid Waste Management Practices

In the next section, our questions aimed to gain insight into solid waste management practices by communities. Past studies on waste management in African cities tend to emphasize poor waste separation practices [40], without examining diverse practices due partly to the socio-demographic characteristics of neighborhoods. To see if there are any significant differences in community waste management practices, our respondents were asked if they segregate waste at home (Figure 3). Our analysis reveals notable regional differences. In Bonanjo, a business/administrative hub of the city, 46% practiced waste separation at home. In Logbaba, where factories and residences are mixed, 39% did so. The rest of the

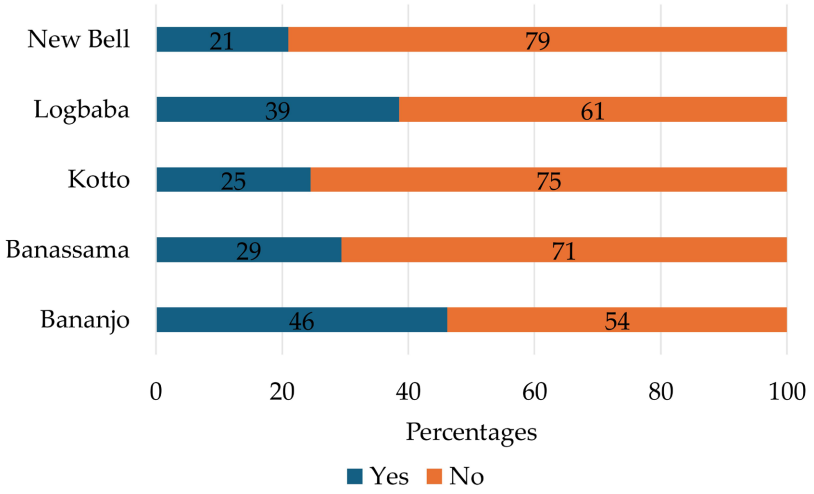


Figure 3. Households waste separation by neighborhoods of Douala.

communities had 20% - 30%. These different waste segregation practices show that households modified waste management practices according to local socio-economic and infrastructural conditions.

Then we asked the respondents how and by whom their household waste was collected. For them to answer, based on our preliminary fieldwork and policy document research, we gave them a list of six options: (1) local authority collection, (2) private collection, (3) designated dump site, (4) customary dump site, (5) at random on the street, and (6) others (Figure 4). Overall, all respondents observed that local authorities had played minor roles in collecting waste. About 30% of them had their waste collected at nearby customary collection sites. Only Bananjo and Logbaba had relatively high results (27% - 31%) in local authority collection. These two had smaller private sector collection contributions (6% - 12%) compared to other municipalities (16% - 20%). In Kotto, only 11% relied on the local authority collection, whereas the rest relied largely on placing their waste on dump sites. In addition, controversial practices of street-side dumping at random and other illegal forms of dumping existed in all municipalities. The reliance on customary disposal locations and informal dumping led to the emergence of self-organization among residents. When formal collection services are not available, residents responded with alternative methods to manage waste.

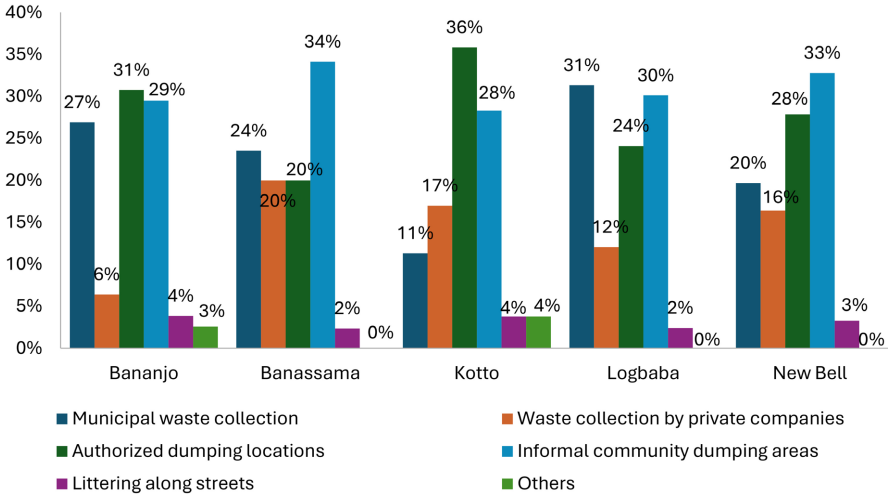


Figure 4. Waste collection methods by municipalities.

Past studies emphasized that insufficient local authority waste management practices led to poor urban resilience consequences. In Nigeria, Olukanni *et al.* (2020) found that inadequate waste collection services in Ogun State made residents adopt alternative ways of disposing waste, such as irregular dumping/burning on roadsides, which affected residents' safety and hygienic conditions [41].

To better understand how often waste collection was available within a week, we asked the respondents to choose one of the given choices: (1) daily, (2) once a week, (3) twice a week, (4) three times a week, and (5) irregular (Figure 5). The results were then analyzed by community. We found that more than half of the

respondents in Bananjo (62%), Banassama (53%), and New Bell (57%) had a weekly collection service. On top of this, 17% in Bananjo had daily collection service. Kotto had the lowest weekly collection service among all. As we mentioned above, Kotto has recently experienced new middle-class residential developments, but waste management services have not caught up with the speed of developments. The disparities in frequency of waste collection services among communities reflect the importance of distance, meaning that a proximity to collection points and service accessibility influenced residents' ability to maintain proper waste disposal.

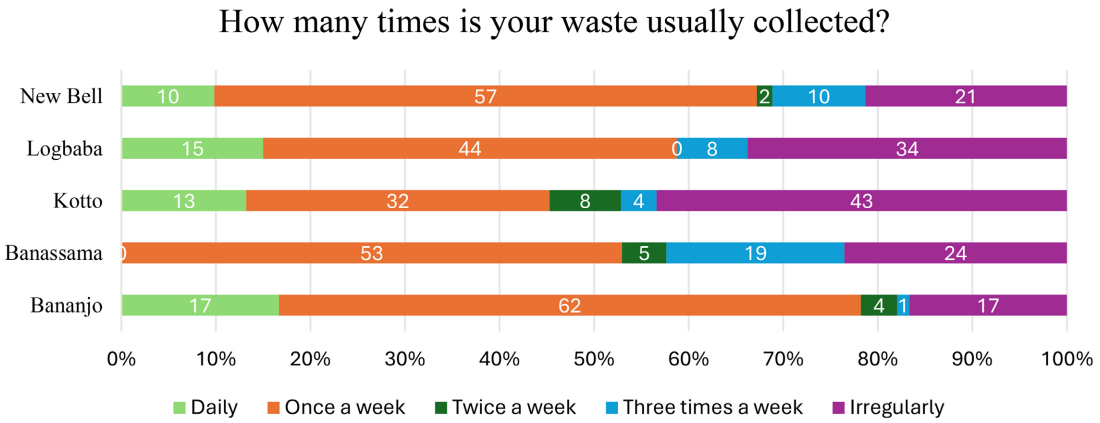


**Figure 5.** Household waste collection frequency by municipality.

Regarding household waste management, our field observation noted various household waste management practices. Typical waste included plastics (bags, containers, bottles), textiles, metals, organic trash (food scraps, yard garbage), and limited hazardous waste (spent batteries, expired prescriptions). Many locals engaged in household composting for organic waste for gardening, especially in Kotto and Bonassama. Due to a lack of accessible and reasonably priced formal disposal options, low-income households in New Bell and Bonassama frequently burned waste, particularly plastics and textiles. Glass bottles and plastic containers were recycled or used for home storage. Informal reuse and recycling were widespread.

We also observed local waste collecting programs in informal neighborhoods of Logbaba and New Bell, where locals are employed for solid waste collection and disposal in designated or traditional dumpsites. Middle-class houses in Kotto were increasingly using private garbage services, either on their own or through local groups [42]. Here, community members developed dumpsites.

### 3.3. Understanding Health Impacts through Community Perception

Urban resilience theory suggests that communities that understand and recognize environmental risks better develop adaptive strategies, such as waste segregation, sanitation practices, and advocacy for improved waste management infrastructure [43]. To understand the health impacts of improper waste management, we posed

several key questions in the third section of our survey, as shown in Figure 6. These included inquiries about personal experiences with waste-related injuries, the perceived effects of soil and water contamination on food safety, and the prevalence of health issues linked to waste management practices.

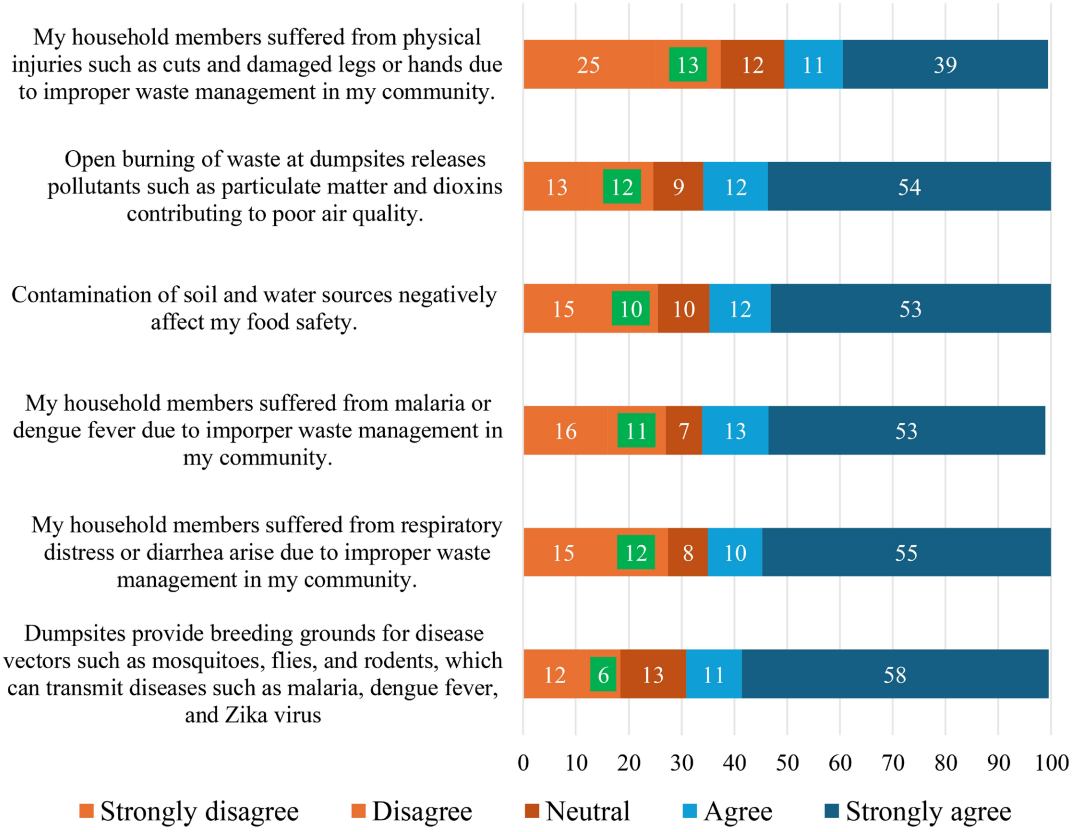


Figure 6. Household perceptions about health and social impacts from past solid waste management in Douala.

We asked a Likert-scale question with six statements for the respondents to choose the level of their agreement. These statements are: (1) the respondents had experienced any cuts or injuries related to improper waste management; (2) open burning of waste at dumpsites releases pollutants; (3) soil and water contamination negatively affected respondents' food safety; (4) household members suffered from malaria or dengue fever due to improper waste management; (5) household members suffered from respiratory distress or diarrhea due to improper waste management; (6) dumpsites breed such disease vectors as mosquitoes, flies, and rodents.

In response to the health impact related statements (1st, 4th, 5th statements), 50%, 65%, and 55% strongly agreed or agreed with experiencing injuries, infectious diseases, respiratory distress and diarrhea, respectively. Another 53% linked soil and water contamination to food safety risks. The last statement about dumpsites as breeding grounds for disease vectors was strongly agreed or agreed by 69% of the respondents. These results indicate social disparities about health and environmental risks of poor solid waste management. The recognition of these risks ap-

pears to be more pronounced in communities with higher exposure to waste sites, such as Bonassama, where informal settlements are prevalent.

We conducted a chi-square analysis to identify significant correlations between household waste disposal practices and respondents' socio-demographic characteristics (Table 2). The chi-square analysis revealed that age showed a strong correlation in New Bell ($\chi^2 = 33.754$, $p < 0.01$) and Bonassama ($\chi^2 = 35.600$, $p < 0.01$). Similarly, gender exhibited a significant relationship in New Bell ($\chi^2 = 11.834$, $p < 0.01$), Logbaba ($\chi^2 = 9.981$, $p < 0.05$), and Bonassama ($\chi^2 = 7.793$, $p < 0.05$), suggesting that men and women may have distinct roles or behaviors related to household waste management. In New Bell ($\chi^2 = 34.033$, $p < 0.01$) and Logbaba ($\chi^2 = 31.596$, $p < 0.01$), education significantly influenced waste practices, reflecting the importance of educational attainment in promoting proper disposal methods. Household size was highly significant across all communities, especially Logbaba ($\chi^2 = 44.678$, $p < 0.01$) and New Bell ($\chi^2 = 38.236$, $p < 0.01$), where larger households may produce more waste, placing strain on disposal systems. Income showed mixed results with significant correlations in New Bell ($\chi^2 = 35.164$, $p < 0.01$), Logbaba ($\chi^2 = 21.648$, $p < 0.05$), and Bonassama ($\chi^2 = 25.318$, $p < 0.05$). The significant correlations between socio-demographic factors (e.g., age, gender, education, household size) and waste disposal behaviors in particular communities suggest a diversity attribute in urban resilience theory. This means that a fluid nature of socio-demographic characteristics resulted into the formulation of urban communities with regionally different socio-demographic characteristics that in turn influenced residents' collective waste disposal behaviors in a relatively short period of time. These collective behaviors might have worked as a deterrent for individuals to dispose of waste more safely and properly.

**Table 2.** Chi-square analysis of the correlation between respondents' socio-demographic and household disposal practice.

| | Bonanjo (n = 78) | | New Bell (n = 61) | | Logbaba (n = 83) | | Bonassama (n = 85) | | Kotto (n = 53) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable | $\chi^2$ | d.f | $\chi^2$ | d.f | $\chi^2$ | d.f | $\chi^2$ | d.f | $\chi^2$ | d.f |
| Age | 26.551*** | 9 | 33.754*** | 12 | 13.088 | 9 | 35.600*** | 10 | 123.560** | 12 |
| Gender | 2.540 | 3 | 11.834*** | 3 | 9.981** | 3 | 7.793** | 2 | 0.824 | 3 |
| Education | 13.893 | 12 | 34.033*** | 12 | 31.596*** | 12 | 22.598*** | 8 | 17.183 | 12 |
| Household size | 44.678*** | 21 | 38.236*** | 15 | 36.974** | 21 | 27.138** | 14 | 32.849** | 21 |
| Average monthly income | 14.142 | 12 | 35.164*** | 12 | 21.648** | 12 | 13.293 | 8 | 25.318** | 12 |

*10%, **5%, and ***1%, significance levels.

Table 3 reveals significant disparities in waste management practices among the five communities, primarily influenced by socio-demographic factors, infrastructure availability, and institutional support. In Bonanjo, where the population tends to have higher-income and better education, there are structured waste collection services and a heightened awareness of waste management issues. This might have led to more effective waste separation and proper disposal practices.

In contrast, New Bell and Bonassama, characterized by lower-income populations and informal settlements, experienced irregular waste collection with heavy reliance on open dumping and burning. Logbaba presented a blend of industrial and residential activities, resulting in varied waste disposal behaviors. Some residents utilize private waste collection services, while others resort to informal disposal methods. Meanwhile, Kotto, a rapidly expanding residential area, faces challenges due to insufficient waste infrastructure, causing many households to engage in illegal dumping despite an increasing awareness of the importance of proper waste management.

Behind all these factors, it is also worth noting that social norms and social behavioral patterns might have played an important role in motivating the respondents to inappropriately dispose their household waste. In one past study on Douala City, waste management was perceived as a communal rather than individual responsibility [13]. Behavioral inertia, shaped by habit and a lack of immediate health consequences, further contributed to persistent informal practices despite residents' stated concerns about health risks [44]. Among the uninformed respondents, there might have been a disconnect between health risks and the adoption of safer waste disposal practices.

Table 3. Key socio-demographic characteristics, waste collection/disposal practices, and awareness levels in the five communities in Douala.

| Community | Socio-Demographic Characteristics | Waste Collection & Disposal Practices | Waste-Health Awareness |
|---|---|---|---|
| **Bonanjo** | High-income, educated residents, administrative and commercial hub | Regular waste collection by private and municipal services, high waste separation | High awareness, proper disposal methods |
| **New Bell** | High population density, low-income households, informal settlements | Irregular collection, reliance on open dumping and burning | Moderate awareness, but limited proper practices |
| **Logbaba** | Mixed residential and industrial zone, middle-income households | Combination of private collection, informal dumping, and industrial waste accumulation | Moderate awareness, some waste separation practices exist |
| **Bonassama** | High-density suburban area, mix of low- and middle-income residents | Inconsistent collection, high reliance on customary dumping sites and burning | Awareness exists but weak infrastructure + services |
| **Kotto** | Rapidly growing middle-class neighborhood, new residential area | Formal waste collection exists but is inadequate, leading to illegal dumping | Growing awareness, but poor infrastructure |

## 4. Limitations

This research has a number of limitations. First, as communities we examined are fluid in nature, our examination may not be fully representing all communities in Douala today. Second, the data we collected through the questionnaire survey is endowed with some uncertainties regarding residents' daily waste management behaviors. The questionnaire survey, which is based on self-reports, could reflect social desirability or recall biases, particularly concerning sensitive issues like illegal waste disposal. Third, despite efforts to encourage broad household involvement, some non-random non-response may have impacted the representativeness of the sample. Finally, the research was conducted solely in Douala, which is the

largest city in Cameroon; consequently, the results may not entirely capture waste management behaviors or challenges in smaller urban areas with differing socio-economic and infrastructural conditions.

## 5. Conclusions

This paper attempted to better understand urban resiliency from perceptions of solid waste management practices in Douala, Cameroon. It demonstrated varied community practices within one African city, defying a simple characterization of "improper" waste management practices in African cities. We attempted to understand why these diverse practices are happening and how these fragmented practices have contributed to poor waste management capacity in Douala at large. We then attempted to understand how our respondents perceived consequences of poor solid waste management practices, including health impacts.

Communities like Bonanjo and Kotto had more younger generations (67% - 73% in 20 - 39 age groups) with higher education (51% - 77% with tertiary). Kotto respondents had more than 20% with monthly income above 250,000 XAF, the highest among those in other communities. We found a relatively high level of waste-related health risk awareness among these households, which are more likely to engage in waste separation and responsible disposal practices. On the contrary, communities like New Bell with a high population density and low income (75% below 100,000 XAF) did not have regular waste collection services; therefore, resorting to disposal in unauthorized dumping sites or open burning. Logbaba, a mixed residential and industrial community, showed varied waste management practices. More than 55% had completed tertiary education, and 6% earned above 250,000 XAF. Another issue we found was the poor waste management planning for emerging communities, such as Kotto. Overall, irregular/unreliable collection services led to the accumulation of household waste at open dump sites.

This said, residents' awareness of negative consequences from poor waste management practices appears to be improving. We found that younger and more educated residents in areas like Bonanjo were more likely to engage in proper disposal practices. Furthermore, Douala communities with dominant female populations were found to adhere to proper disposal practices. Interestingly, the higher education has helped better understand the negative impacts of improper waste disposal. The average household income of 51,000 - 100,000 FCFA was found to be adequate to handle waste more properly.

Additionally, this study observed varying levels of self-organization, where informal community practices such as customary dumping sites partially addressed gaps in formal services. However, the prevalence of illegal disposal methods highlights the limitations of self-organization without adequate institutional support. These findings stress the importance of integrating diverse socio-economic contexts into policy and intervention strategies.

From a health perspective, the overall absence of standardized and robust waste collection systems and weak enforcement mechanisms left these communities ex-

posed to these risks, undermining urban resilience. Unlike previous studies that focused on waste management in isolation, this study connects waste management practices and health outcomes to the broader concept of urban resilience. By doing so, it helped us better understand the interplay between waste management systems, community adaptive capacity, and public health risks. The findings underscore that achieving urban sustainability and resilience, as envisioned in SDG 11 (Sustainable Development Goal 11: Sustainable Cities and Communities) and SDG 3 (Good Health and Well-being), remains unattainable without addressing socio-economic inequities in waste management infrastructure. WHO's guidelines on environmental health further emphasize the urgency of reducing waste-related health risks to promote sustainable urban development.

Finally, we elaborate on the importance of recognizing agency of Africa's urban residents in connection to urban resilience theory. Our findings are consistent with key ideas in urban resilience theory, in which residents are not simply victims nor culprits of improper solid waste disposal practices. We observed a variety of waste management practices, such as backyard composting, informal transportation arrangements, private collection services, and local dump site management. These are adaptive responses to environmental and infrastructural stress residents attempted to overcome in rapidly expanding urban communities. Those communities that had developed alternative waste management to insufficient municipal support showed emerging self-organization and localized resilience. All these, we argue, are essential to consider urban environmental sustainability in African cities in the future.

## Authors' Contributions

For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, Shella Nchia" and Kinichi Matsui; methodology, Shella Nchia. and Kenichi Matsui; formal analysis, Shella Nchia. and Kenichi Matsui; investigation, Shella Nchia.; data curation, Shella Nchia. and Kenichi Matsui; writing—original draft preparation, Shella Nchia.; writing—review and editing, Kenichi Matsui; supervision, Kenichi Matsui All authors have read and agreed to the published version of the manuscript.

## Funding

This research received no funding from any organization, institution, or NGO.

## Data Availability Statement

Data supporting the original results presented here are available on request.

## Acknowledgements

We acknowledge the support from the people of the Douala Municipality during survey. We also acknowledge the Cameroon's Douala Municipality with necessary

documents and information.

## Conflicts of Interest

The authors declare no conflict of interest.

## Ethics Statement

This study followed the ethical guidelines established by the University of Tsukuba's Faculty of Life and Environmental Sciences for non-invasive, non-interventional research. Formal ethics committee review was not required as no personal or sensitive information was collected. Informed consent was obtained from all participants, who were informed about the study's purpose and their voluntary participation. The researcher completed the university's research ethics training and complied with all relevant standards.

## References

[1] Akmal, T. and Jamil, F. (2021) Testing the Role of Waste Management and Environmental Quality on Health Indicators Using Structural Equation Modeling in Pakistan. *International Journal of Environmental Research and Public Health*, **18**, Article No. 4193. https://doi.org/10.3390/ijerph18084193

[2] Mahajan, R. (2023) Environment and Health Impact of Solid Waste Management in Developing Countries: A Review. *Current World Environment*, **18**, 18-29. https://doi.org/10.12944/cwe.18.1.3

[3] Etea, T., Girma, E. and Mamo, K. (2021) Risk Perceptions and Experiences of Residents Living Nearby Municipal Solid Waste Open Dumpsite in Ginchi Town, Ethiopia: A Qualitative Study. *Risk Management and Healthcare Policy*, **14**, 2035-2044. https://doi.org/10.2147/rmhp.s309295

[4] Krystosik, A., Njoroge, G., Odhiambo, L., Forsyth, J.E., Mutuku, F. and LaBeaud, A.D. (2020) Solid Wastes Provide Breeding Sites, Burrows, and Food for Biological Disease Vectors, and Urban Zoonotic Reservoirs: A Call to Action for Solutions-Based Research. *Frontiers in Public Health*, **7**, Article No. 405. https://doi.org/10.3389/fpubh.2019.00405

[5] Jerumeh, T.R., Igbinadolor, J.I. and Akinbinu, T.O. (2020) Public Health Implications of Solid Waste Management in Akure, Nigeria. *GeoJournal*, **87**, 1121-1131. https://doi.org/10.1007/s10708-020-10300-6

[6] Mamady, K. (2016) Factors Influencing Attitude, Safety Behavior, and Knowledge Regarding Household Waste Management in Guinea: A Cross-Sectional Study. *Journal of Environmental and Public Health*, **2016**, Article ID: 9305768. https://doi.org/10.1155/2016/9305768

[7] Sridevi, V., Modi, M., Lakshmi, M.V.V.C. and Kesavarao, L. (2012) A Review on Integrated Solid Waste Management. *International Journal of Engineering Science and Advanced Technology*, **2**, 1491-1499.

[8] Misganaw, A. (2022) Potential Impact of Municipal Solid Waste: Case Study of Bahir Dar City, Ethiopia. *The Journal of Solid Waste Technology and Management*, **48**, 450-458. https://doi.org/10.5276/jswtm/2022.450

[9] Sima, M.F. and Debelo, M.A. (2023) Assessment of Solid Waste Management Practices and Role of Community Participation in Mettu Town, Ethiopia. *The Journal of*

*Solid Waste Technology and Management*, **49**, 132-140.
https://doi.org/10.5276/jswtm/iswmaw/492/2023.132

[10] Haywood, L.K., Kapwata, T., Oelofse, S., Breetzke, G. and Wright, C.Y. (2021) Waste Disposal Practices in Low-Income Settlements of South Africa. *International Journal of Environmental Research and Public Health*, **18**, Article No. 8176.
https://doi.org/10.3390/ijerph18158176

[11] Ndam, S., Touikoue, A.F., Chenal, J., Baraka Munyaka, J., Kemajou, A. and Kouomoun, A. (2023) Urban Governance of Household Waste and Sustainable Development in Sub-Saharan Africa: A Study from Yaoundé (Cameroon). *Waste*, **1**, 612-630.
https://doi.org/10.3390/waste1030036

[12] Ngo Ngwe, N.F., Tavea, F.M., Essomè-Koum, G.L., Djimbie, D.J., Kottè-Mapoko, E.F., Boubakary, B., *et al*. (2024) From Sanitation to Clean Energy—Biogas Potential of Three Organic Wastes Collected in and around Douala City (Cameroon). *Journal of Ecological Engineering*, **25**, 84-98. https://doi.org/10.12911/22998993/189298

[13] Mbue, I.N., Bitondo, D. and Azibo, B.R. (2015) Municipal Solid Waste Generation, Composition, and Management in the Douala Municipality, Cameroon. *Journal of Environment and Waste Management*, **2**, 91-101.

[14] Mabogunje, A.L. (1995) The Environmental Challenges in Sub-Saharan Africa. *Environment: Science and Policy for Sustainable Development*, **37**, 4-10.
https://doi.org/10.1080/00139157.1995.9929233

[15] Paddy, E.Y., Namondo, B.V., Fopah-Lele, A., Foba-Tendo, J., Ibrahim, F.S. and Tanyi, E. (2024) Assessment of the Energy Potential of Municipal Solid Waste: A Case Study of Mussaka Dumpsite, Buea Cameroon. *Bioresource Technology Reports*, **25**, Article ID: 101784. https://doi.org/10.1016/j.biteb.2024.101784

[16] Veronica, E.M., Oru, T.O. and Martin, N.N. (2019) Household Perception and Willingness to Pay for Improved Waste Management Service in Mamfe, Cameroon. *African Journal of Environmental Science and Technology*, **13**, 354-364.
https://doi.org/10.5897/ajest2019.2681

[17] IPEN (2023) Country Situation Report on Plastic in Cameroon: Executive Summary.
https://ipen.org/sites/default/files/documents/csr_on_plastic_in_cameroon_-_executive_summar.pdf

[18] Marcus, L. and Colding, J. (2014) Toward an Integrated Theory of Spatial Morphology and Resilient Urban Systems. *Ecology and Society*, **19**, Article No. 55.
https://doi.org/10.5751/es-06939-190455

[19] Ndjama, J., Kamgang, K.B.V., Sigha, N.L., Ekodeck, G. and Tita, M.A. (2008) Water Supply, Sanitation and Health Risks in Douala, Cameroon. *African Journal of Environmental Science and Technology*, **2**, 422-429.

[20] Macrotrends (2024) Douala, Cameroon Metro Area Population 1950-2024.
https://www.macrotrends.net/globalmetrics/cities/20362/douala/population

[21] World Population Review (2024) Douala, Cameroon Population.
https://worldpopulationreview.com/cities/cameroon/douala

[22] UN-Habitat (2024) Urban Planning & Infrastructure in Migration Contexts: Douala Cameroon-Douala 3, Volume 2 Vision, Area Planning & Action Plan Report.
https://unhabitat.org/sites/default/files/2025/01/250126_upimc_cameroon_vision_and_area_planning_final_for_publishing.pdf

[23] Peter, N., Marie, E.L.G. and Nga, N. (2023) Identifying Sustainable Biomedical Solid Waste Management Practices in the Context of Limited Resources in Selected Healthcare Facilities in Douala Cameroon. *Microbiology Research Journal International*, **33**, 80-

95. https://doi.org/10.9734/mrji/2023/v33i11-121419

[24] Harrison, S., Johnstone-Robertson, M., Pott, R., Verster, B., Rumjeet, S. and Nkadimeng, L. (2016) Towards Wastewater Biorefineries: Integrated Bioreactor and Process Design for Combined Water Treatment and Resource Productivity. Water Research Commission Report 2580.

[25] Caroll, M.F. and Foncha, J.N. (2023) Recovering Clean Energy from Household Waste: The Case of Douala IV Municipality, Littoral Region, Cameroon. *WIT Transactions on Ecology and the Environment*, **261**, 151-161. https://doi.org/10.2495/esus230131

[26] Manga, V.E., Forton, O.T. and Read, A.D. (2008) Waste Management in Cameroon: A New Policy Perspective? *Resources, Conservation and Recycling*, **52**, 592-600. https://doi.org/10.1016/j.resconrec.2007.07.003

[27] UN-Habitat (2024) Douala 3, Cameroon: Vision, Area Planning and Action Plan Report. https://unhabitat.org/douala-3-cameroon-vision-area-planning-and-action-plan-report

[28] McKay, T.J., Mbanda, J.T. and Lawton, M. (2015) Exploring the Challenges Facing the Solid Waste Sector in Douala, Cameroon. *Environmental Economics*, **6**, 93-102.

[29] HYSACAM (2017) Questions fréquemment posées. HYSACAM Propreté. https://www.hysacam-proprete.com/en/node/14

[30] Conti, A., Viottini, E., Comoretto, R.I., Piovan, C., Martin, B., Albanesi, B., *et al.* (2024) The Effectiveness of Educational Interventions in Improving Waste Management Knowledge, Attitudes, and Practices among Healthcare Workers: A Systematic Review and Meta-Analysis. *Sustainability*, **16**, Article No. 3513. https://doi.org/10.3390/su16093513

[31] Shaker, E.M., Younis, T.I., Al-Hussein, R.Y.H. and Saadi, A.M. (2024) Knowledge, Attitude, and Practices of Community Regarding Solid Waste Management (SWM). *Journal of Bioscience and Applied Research*, **10**, 318-327.

[32] Statista (2023) Cameroon Age Structure from 2012 to 2022. https://www.statista.com/statistics/446554/age-structure-in-cameroon/

[33] Cameroon Data Portal (2015) Population and Housing Census. https://cameroon.opendataforafrica.org/PHCC2015/population-and-housing-census?region=1001720-douala&lang=en

[34] Dogoli, M.A., Nunbogu, A.M. and Elliott, S.J. (2023) Attention to the Needs of Women and Girls in WASH: An Analysis of WASH Policies in Selected Sub-Saharan African Countries. *Global Public Health*, **18**, Article ID: 2256831. https://doi.org/10.1080/17441692.2023.2256831

[35] Okesanya, O.J., Eshun, G., Ukoaka, B.M., Manirambona, E., Olabode, O.N., Adesola, R.O., *et al.* (2024) Water, Sanitation, and Hygiene (WASH) Practices in Africa: Exploring the Effects on Public Health and Sustainable Development Plans. *Tropical Medicine and Health*, **52**, Article No. 68. https://doi.org/10.1186/s41182-024-00614-3

[36] Fadhullah, W., Imran, N.I.N., Ismail, S.N.S., Jaafar, M.H. and Abdullah, H. (2022) Household Solid Waste Management Practices and Perceptions among Residents in the East Coast of Malaysia. *BMC Public Health*, **22**, Article No. 1. https://doi.org/10.1186/s12889-021-12274-7

[37] MacroTrends (2024) Cameroon Unemployment Rate 1960-2024. https://www.macrotrends.net/global-metrics/countries/CMR/cameroon/unemploy-

ment-rate

[38] Longe, E.O., Longe, O.O. and Ukpebor, E.F. (2009) People's Perception on Household Solid Waste Management in Ojo Local Government Area in Nigeria. *Iranian Journal of Environmental Health Science & Engineering*, **6**, 201-208.

[39] World Bank Group (2023) GDP Growth (Annual %)—Cameroon. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=CM

[40] Sow, I. (2019) Wastes Management in African Cities. In: Mboup, G. and Oyelaran-Oyeyinka, B., Eds., *Smart Economy in Smart African Cities*, Springer, 201-218. https://doi.org/10.1007/978-981-13-3471-9_6

[41] Olukanni, D.O., Pius-Imue, F.B. and Joseph, S.O. (2020) Public Perception of Solid Waste Management Practices in Nigeria: Ogun State Experience. *Recycling*, **5**, Article No. 8. https://doi.org/10.3390/recycling5020008

[42] Mbeng, L. (2013) Informal Waste Recovery and Recycling: Alleviating Poverty, Environmental Pollution and Unemployment in Douala, Cameroon. *Journal of Scientific Research and Reports*, **2**, 474-490. https://doi.org/10.9734/jsrr/2013/4436

[43] Kong, L., Mu, X., Hu, G. and Zhang, Z. (2022) The Application of Resilience Theory in Urban Development: A Literature Review. *Environmental Science and Pollution Research*, **29**, 49651-49671. https://doi.org/10.1007/s11356-022-20891-x

[44] Samel, K. and Joseph, S.P. (2023) An Application of Nudge Theory in Changing Waste Segregation Behavior in Urban Households. *International Journal of Novel Research and Development*, **8**, d813-d822. https://www.ijnrd.org/papers/IJNRD2311390.pdf

## List of Abbreviations

SDG: Sustainable Development Goal.

SWM: Solid Waste Management.

WHO: World Health Organization.

UN-Habitat: United Nations Human Settlements Programme.

FCFA: Central African CFA franc.