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Short communication

Socioeconomic analysis of household waste production in Ouesso, Republic of Congo

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Abstract
Managing household waste is a major challenge in sub-Saharan African cities, where rapid urbanization, population growth, and changing consumption patterns are straining existing systems. In Ouesso (northern Congo), the lack of modern collection and treatment infrastructure worsens waste accumulation and its environmental and health impacts. However, limited research has examined how household socioeconomic characteristics influence waste quantity and composition. This study investigates the influence of household size and standard of living on waste production and composition. Its objectives are to quantify waste generation per borough, analyse compositional differences based on household occupation, and assess links between socioeconomic factors and daily waste production. A sample of 100 households from two districts in Ouesso was monitored over one month. Waste was regularly collected, sorted, and weighed using the MODECOM method, while surveys provided data on household size, income, and occupation. Results show that daily household waste production, ranging from 0.45 to 0.60 kg, does not significantly vary by district or household size. Average waste density is 416.76 ± 96.85 kg/m³ in Mbindjo and 370.07 ± 92.8 kg/m³ in Nzalangoye. Waste composition is dominated by biodegradable materials, followed by plastics and paper/cardboard, indicating relatively homogeneous consumption patterns. However, socioeconomic differences are evident: formal sector and middle-class households generate more total waste, while lower-income or informal households produce less overall but relatively more per capita. These findings highlight the need for differentiated waste management strategies integrating organic recovery, plastic reduction, and targeted awareness to support urban sustainability and resilience.

Keywords*: waste management, household, socioeconomic factors, Ouesso, Congo*

INTRODUCTION

Household waste management remains a major global challenge, particularly in Africa, where rapid urbanization and demographic growth are occurring alongside changing consumption patterns. In comparison with other continents, African countries generate lower per capita waste quantities; however, these quantities are increasing rapidly and are projected to grow significantly in the coming decades. At the same time, Africa lags behind other regions in terms of waste collection, treatment and recycling systems, as many countries still lack effective integration into international waste

management policies and circular economy frameworks. These disparities highlight the growing gap between global sustainability objectives and local implementation capacities.

In sub-Saharan Africa, these dynamics lead to increasing and heterogeneous solid waste generation [1]. Recent estimates suggest that the volume of waste produced in the region could double by 2050 if current trends persist, thereby exacerbating the pressure on already inadequate collection and treatment systems [2]. In this context, understanding the factors influencing waste quantity and composition remains essential for aligning local practices with international sustainability goals [3].

In the Republic of Congo, medium-sized cities such as Ouesso, the capital of the Sangha department, experience significant changes in consumption habits driven by population growth and regional economic activity. This is accompanied by an increase in household waste volume and diversification in its composition, with a significant proportion of organic matter alongside a growing presence of plastics, paper and other non-biodegradable materials [4]. However, these cities rarely have modern waste collection, sorting and treatment infrastructure, which leads to waste accumulation in the environment and generates health risks [5].

Several studies conducted in Central and West Africa show that socioeconomic factors such as income, level of education and household size have a significant influence on the amount and type of waste produced [6]. For example, high-income households tend to generate a higher proportion of dry waste, such as packaging and plastics, whereas lower-income households mainly produce organic waste [4]. Similarly, household size directly affects the total mass of waste generated and influences its composition [5]. However, few studies document these relationships in Ouesso, despite the city being representative of Congolese urban realities and offering a relevant setting for developing appropriate waste management strategies.

Despite the growing recognition of the role of socioeconomic factors in waste management, specific data on Ouesso remain scarce. The available information is often limited to overall production statistics that do not take into account variations between neighbourhoods, household types or seasons. Without detailed data, local authorities are unable to plan waste collection effectively, promote source segregation, or implement recovery solutions adapted to waste characteristics.

The city of Ouesso faces several structural constraints, including limited logistical and financial resources for municipal services, a lack of treatment facilities and low public awareness of environmental issues. Under these conditions, waste management relies mainly on irregular collection and informal dumping or incineration practices that contribute to environmental degradation and increase health risks. This raises a key question: to what extent do household size and standard of living influence the quantity and composition of household waste produced in Ouesso? Providing an empirical answer to this question would enable better targeting of interventions, optimization of collection systems, and the development of awareness-raising actions tailored to different household profiles.

The overall objective of this study is to analyse the influence of household size and standard of living on the characterization and quantification of household waste produced in Ouesso, Republic of Congo. More specifically, the study aims to: (i) determine the amount of waste produced per household by district; (ii) identify variations in waste composition according to the occupation of the head of household; and (iii) assess the relationship between socio-economic characteristics and daily waste production.

MATERIALS AND METHODS

Studied area

The city of Ouesso, the capital of the Sangha department, was located in the north-west of the Republic of Congo, between 1°37'03" north latitude and 16°03'04" east longitude (Figure 1). It had an estimated resident population of 75,095 [7] and was divided into two districts (Nzalangoye and Mbindjo), thirteen neighbourhoods, thirty-seven zones and eighty-eight blocks. The region had an equatorial climate, characterized by abundant and regular rainfall throughout the year [8]. Annual rainfall ranged between 1,500 and 1,700 mm, with an average monthly temperature ranging from 23.7 to 25.4 °C. The area was dominated by dense humid equatorial forest [9].

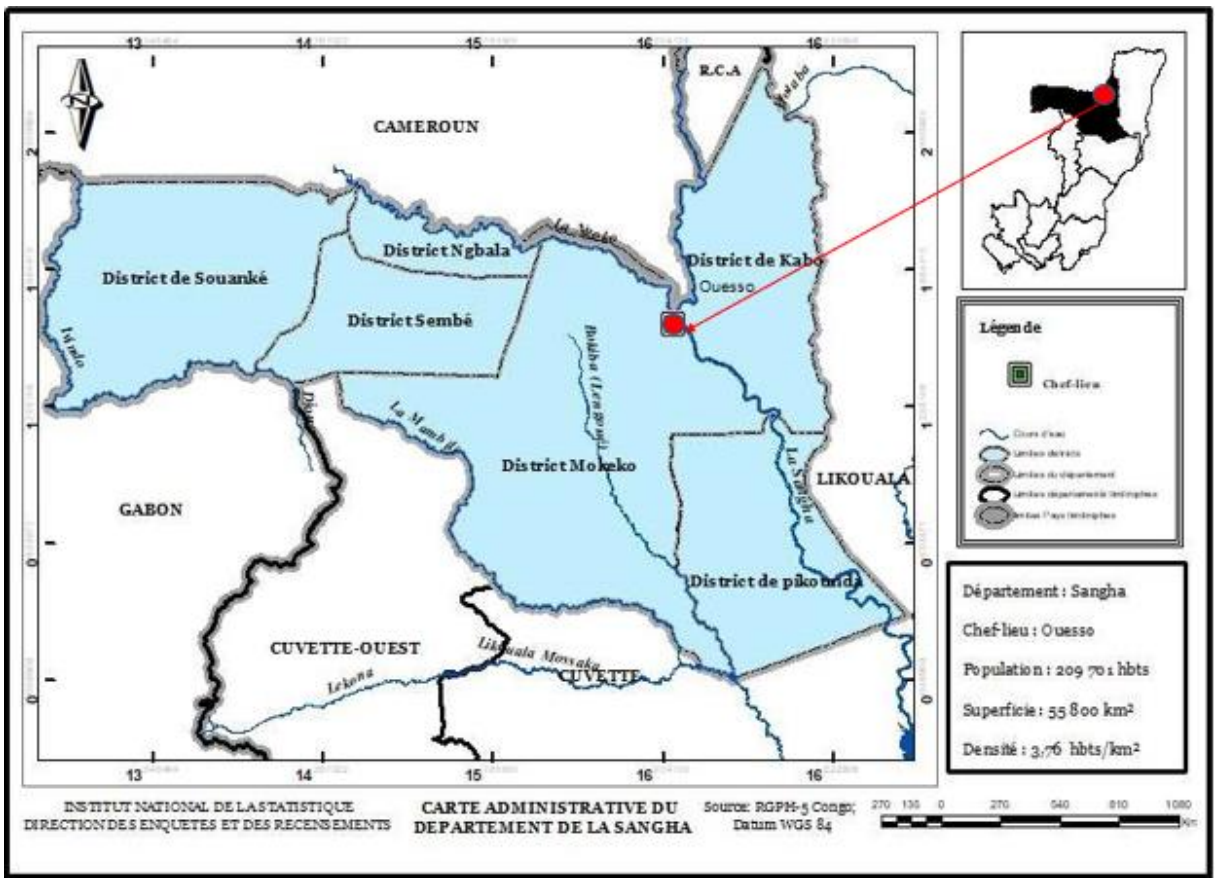

Fig. 1. Location of the town of Ouesso on the administrative map of the Department of SANGHA (Source: National Institute of Statistics, 2024)

Average amount of waste per household

The study was conducted among households in two districts of the city of Ouesso. A preliminary geographical and socioeconomic survey was carried out in collaboration with an operator active in these areas to identify eligible households. The inclusion criteria were: (i) agreement to use the bags provided by the research team for waste disposal; (ii) having a single waste collector; and (iii) compliance with the defined collection schedule.

A total of 100 households were selected and were evenly distributed between the two districts. The sample size was determined using online Sample Size Calculator software (Table 1). Additional surveys were conducted to collect information on household composition, the occupation of the head of household and the exact location of the plots. Geographic coordinates were recorded using a GPS device.

Table 1. Information on sample size

Parameters	Values
Population size (number)	75095
Confidence level (%)	95
Margin of error (%)	5
Sample size (people, no.*)	383
Average household size (people, no.)	5.3
Sample size (household, no.)	72
Survey sample used (household, no.)	100

Each household received a 100-litre rubbish bag, which was collected and reused after each collection. Pickups were carried out every three days from 4 July to 3 August 2024, resulting in a total of nine pickups per household and 900 pickups overall. In collaboration with the pre-collection operators (OPC), waste was transported to the sorting and weighing site using the OPC's logistical resources to ensure proper monitoring and centralization of samples.

At the sorting centre, the waste was dried in the open air for 14 days and then was weighed, taking into account its place of production.
The average daily waste production per capita was calculated using equation 1 [9] :

$$Q(kg/capita/day) = Qi/P \quad (1)$$

where Q is average amount of waste produced per capita per day; Qi is the amount of waste produced per household per day; P is the number of people in each household.
The density of the waste produced was then calculated as the ratio of the waste mass to the container volume according to equation 2 [9] :

$$d = m /V \quad (2)$$

where m is mass of waste (kg); V is volume of container (m^3); d is density of waste produced (kg/m^3).

Composition of solid household waste and its relationship to socio-economics
The waste was sorted into categories using the MODECOM method [10], and was then weighed separately. At the same time, a questionnaire was administered to collect information on household size, income and the occupation of the head of household. Comparing these characteristics with the proportion of each type of waste revealed trends in waste production.
This inexpensive, reproducible cross-referenced approach provided a clear analysis of the influence of socio-economic factors on waste composition [9]. To analyse the relationships between socioeconomic factors and waste quantity, statistical analysis methods were employed, including simple linear regressions.

Statistical analysis of the data
A statistical analysis of the data was performed using R software (version 4.1.3). A two-factor analysis of variance (ANOVA) was applied to test for differences in waste production and density according to district and household category. Variation in waste composition between districts was assessed using the non-parametric Wilcoxon test. Differences were considered significant at $p < 0.05$. Additionally, linear regression analyses were performed to examine the relationships between quantitative variables, particularly between daily waste production and household size. Household waste production was modelled according to household size, the sector of activity of the head of household, and socioeconomic class. The adequacy of the model was assessed using the coefficient of determination (R^2), which indicated the proportion of variance in daily production explained by the independent variables, as well as the statistical significance of the parameters (*p*-value).

RESULTS AND DISCUSSION
Daily quantity and density of solid household waste
At the local level in Ouesso, analysis of variance revealed no statistically significant differences in the daily amount of waste produced, either between districts (Mbindjo and Nzalangoye) or between household size categories (Figure 2a). This indicated that waste production remained relatively consistent across the city, with values ranging from 0.45 to 0.60 kg per day. This suggested that, within Ouesso, geographical location and household size did not directly influence household waste generation [11], possibly due to similar lifestyles and consumption habits among residents across the city [12].
However, at the local scale, other factors such as income level, access to markets and packaged goods, household waste management practices, and environmental awareness likely played a more significant role in explaining variations in waste production [11]. These findings suggested that, in the context of Ouesso, the analysis of waste generation should go beyond basic socio-demographic variables and incorporate economic and behavioural dimensions in order to better capture local realities. Such an approach was essential for designing effective local waste management strategies, promoting waste reduction at source, and supporting recovery initiatives—particularly composting of organic waste—in line with the "4 per 1000" initiative and the SDGs, especially those related to urban sustainability and soil fertility restoration.

At the local level, the density of solid household waste varied significantly according to household size. Statistically significant differences ($p < 0.05$) were observed between the two districts based on household size categories, whereas no significant variation was recorded within each district (Figure 2a). These differences could be explained by local socioeconomic conditions combined with household size, particularly due to the higher production of organic waste in larger households [9, 13]. Conversely, the absence of variation within districts suggested a relative homogeneity in waste management practices among households within the same localities [13].
Finally, higher waste density was observed in Mbindjo (417 ± 96.9 kg/m³) compared to Nzalangoye (370 ± 92.8 kg/m³), confirming structural differences between the two districts. These differences at the local level were mainly related to variations in the proportion of organic waste and differences in storage conditions within households [14].

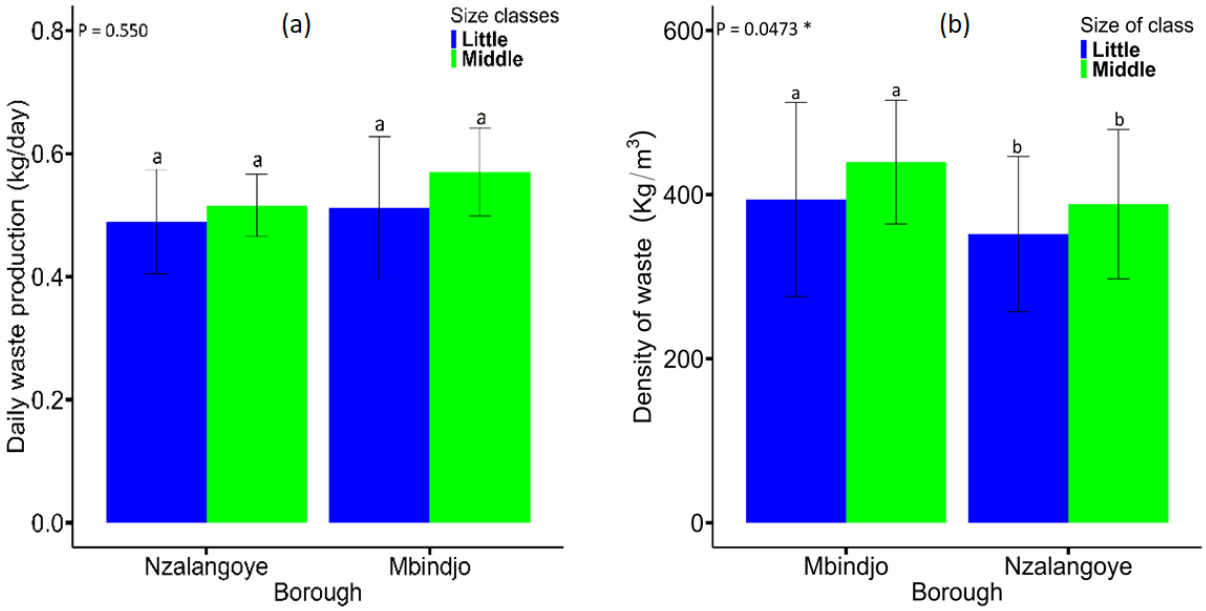

Fig. 2. Daily production (a) and density (b) of solid household waste. The error bars represent the standard deviation of the sample (n = 9). The letters on the graph indicate no significant differences according to Tukey's test at $p > 0.05$.

Composition of solid household waste
In Ouesso, the analysis of variance showed that household waste composition was dominated by organic matter (Figure 3). This dominance at the local level could be attributed to the high availability and consumption of fresh produce, particularly fruits and vegetables within households [9, 15]. As a result, waste distribution across Ouesso appeared relatively homogeneous, regardless of district or household size, indicating that waste generation patterns were similar within the city.
This local homogeneity suggested that waste management strategies in Ouesso could be implemented in a relatively uniform manner across districts, without requiring strong spatial differentiation [16]. It also reflected the similarity of food consumption practices among households in the city, which contributed to limited variation in waste composition at the local scale [16].
However, the significant presence of plastics and paper/cardboard in household waste in Ouesso highlighted the need to develop locally adapted sorting and recycling systems. Such systems would help reduce environmental pressure and address the growing risks associated with plastic pollution in the city [4].
At the operational level, promoting the recycling of organic waste in Ouesso could contribute to improving local soil fertility, in line with the "4 per 1000" initiative, which aims to enhance soil carbon storage as a strategy for climate change mitigation [5]. Furthermore, these findings emphasized the importance of strengthening household awareness at the local level regarding waste

reduction at source and responsible consumption, in line with SDG 11 (sustainable cities) and SDG 12 (responsible consumption and production).
Nevertheless, this study remained limited by the lack of differentiation between subcategories of plastic and organic waste, which may have affected the relevance of the proposed recovery strategies within the local context of Ouesso.

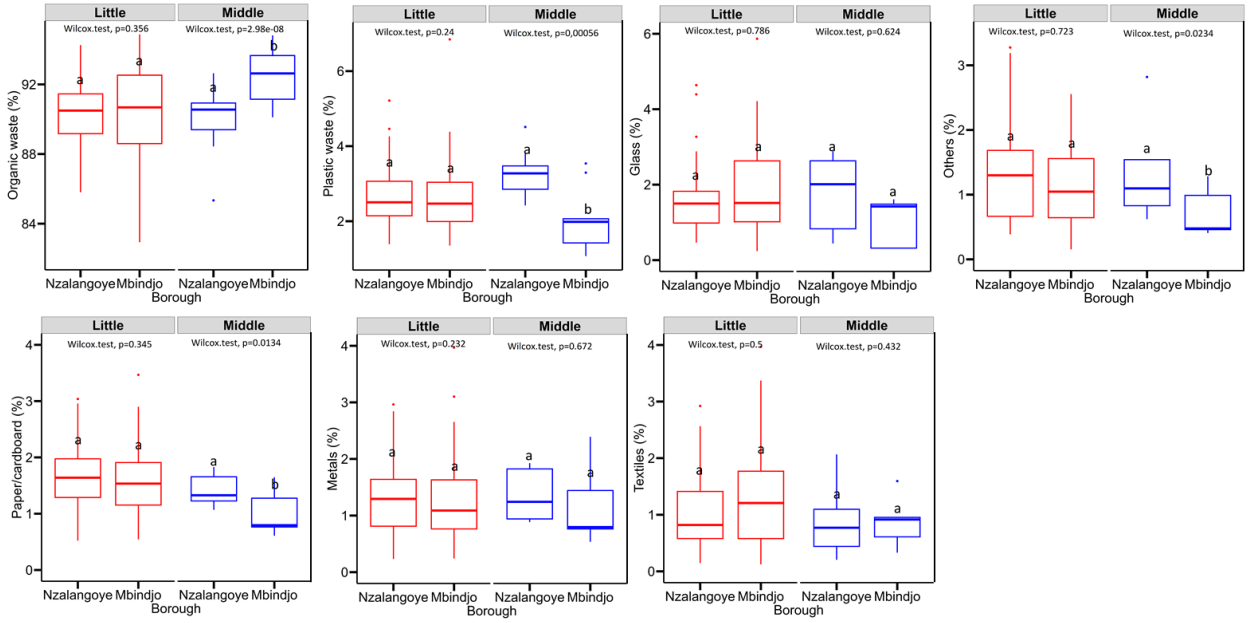

Fig. 3. Composition of solid household waste produced in Ouesso. The letters on the graph indicate significant differences according to the Wilcoxon test at $p < 0.05$.

Relationship between daily production and socioeconomic factors
In the city of Ouesso, the analysis revealed a positive correlation ($R^2 = 0.7037$; $p < 0.001$) between household waste production and household size, according to the sector of activity and the socioeconomic class of the head of household. This correlation suggested that, at the local level, an increase in household size was generally associated with higher waste generation. However, this relationship varied across households depending on the sector of activity and socioeconomic status [4].
At the local scale, households whose heads worked in formal sectors, such as the civil service, the private sector or commerce, generated larger quantities of waste (Figure 4a). This reflected greater access to consumer goods and a stronger dependence on packaged products within Ouesso. In contrast, households engaged in agriculture and the informal sector generated less waste, due to consumption practices centred on local products and the reuse or domestic recycling of residues [17, 18].
Furthermore, within Ouesso, lower-income households produced relatively more waste per capita (Figure 4b), while middle-class households generated higher total waste volumes. This trend reflected the local socioeconomic structure, where middle-class households, with greater purchasing power, had access to a more diversified diet and a wider range of consumer goods. This dual dynamic resulted in higher overall waste generation in these households, illustrating the impact of dietary and consumption patterns at the local level [19].
However, lower-income households exhibited higher individual waste production rates, highlighting reduced resource pooling and a stronger reliance on everyday consumer products within the local context of Ouesso [20].

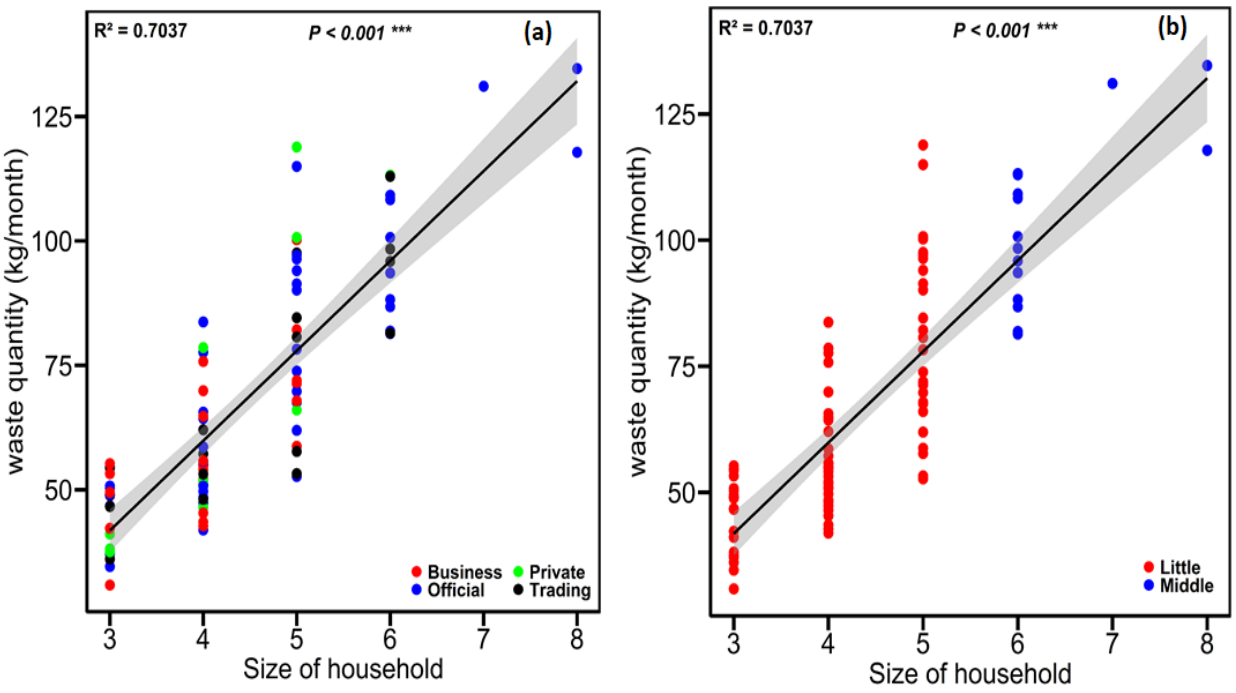

Fig. 4. Relationship between waste production and the head of household's sector of activity (a) and household size (b)

CONCLUSIONS

The study aimed to analyse the influence of household size and standard of living on the characterization and quantification of household waste produced in Ouesso, Republic of Congo. The study conducted in Ouesso revealed several significant findings regarding the production and composition of solid household waste.

Firstly, the daily amount of waste produced per household (ranging from 0.45 to 0.60 kg/day) did not vary significantly between districts or household sizes. The average density of solid household waste produced was found to be 417 ± 96.9 kg/m³ in Mbindjo, compared to 370 ± 92.8 kg/m³ in Nzalangoye. This suggested that these two factors were not major determinants of waste production in this urban context. Other variables, such as income level, the occupation of the household head, and consumption habits, appeared to be more influential.

Secondly, analysis of waste composition showed homogeneity between districts and household classes, reflecting uniformity in consumption behaviours. The predominance of organic materials, followed by plastics and paper/cardboard, reflected the importance of fresh food products in household diets and the increasing use of plastic packaging in expanding cities.

These results suggested the potential for local bio-waste recovery, primarily through composting, and for reducing reliance on landfills. This was in line with the goals of sustainability and circular resource management.

Finally, the observed relationship between waste production and certain socio-economic factors revealed differentiated dynamics. Households whose heads worked in the formal sector generated more waste on average, reflecting better access to consumer goods and an increased reliance on packaged products. Middle-class households also stood out for their higher overall production, reflecting intermediate consumption power and diverse eating habits. In contrast, lower-income households had relatively higher individual production, reflecting the lesser effect of resource pooling and greater reliance on everyday consumer products.

Overall, these results highlighted that a uniform approach to household waste management in Ouesso was not feasible. To design appropriate strategies, it was necessary to consider the socioeconomic and sectoral dimensions of households, promoting composting for organic waste, reducing and replacing single-use plastics, and raising awareness in a differentiated manner according to social

categories. This would not only reduce the environmental impact of waste, but also strengthen urban sustainability and local resilience in the face of the challenges posed by demographic expansion.

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