

# Food wastage in some public markets in Kinshasa City (Democratic Republic of the Congo) and consequences for the urban environment and public health

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## ABSTRACT

### Introduction

Food wastage is a significant global issue with adverse economic, social, environmental, and public health implications.

### Purpose

This study aims to investigate the extent and impact of food wastage in various public markets within Kinshasa City. It seeks to understand the underlying causes and patterns of food wastage, the demographic characteristics of those involved, and the disposal methods employed. Additionally, the study explores the consequences of food wastage on the urban environment and public health. By providing a comprehensive analysis, this research intends to offer insights and recommendations for developing effective strategies to mitigate food wastage and its adverse effects on the city and its inhabitants.

### Methods

The study utilized a combination of surveys, direct observations, and interviews to gather data on food wastage in Kinshasa. A sample of 100 individuals (representing 28.57% of the total market population) was randomly surveyed, and direct observations were made to assess the quantities of food wasted and the disposal methods used. Interviews were conducted to gather additional insights into practices and attitudes toward food wastage. The participants were characterized by low or medium education levels and were predominantly women and young single mothers.

### Results

The study revealed that women constitute the majority of respondents in Kinshasa. Regarding food waste, the survey indicated that 40% of vegetables are wasted, followed by 30% of fruits, 20% of spices, and 10% of cereals. As for waste disposal, the survey revealed that none of the waste is directed to landfill sites as in other markets. Instead, 60% is thrown into the street, 30% into rivers, and a small percentage is either incinerated or used for composting.

### Conclusion

Poor management of food waste increases health risks by attracting pests and causing environmental contamination, which can degrade water and soil quality. Addressing this issue requires implementing awareness campaigns to educate vendors and consumers about the impacts of food waste. Improving food handling practices, enhancing waste management infrastructure, supporting surplus food redistribution, and developing effective policies to reduce food waste are crucial actions to protect public health and promote a healthier urban environment in Kinshasa. These strategies are essential for ensuring food security and sustainability in the city, emphasizing the importance of sustainable consumption patterns and local product valorization through processing, preservation, and composting initiatives within a circular economy framework.

## INTRODUCTION

Food loss refers to food intended for human consumption that experiences a reduction in quantity or quality due to malfunctions in the food production and supply system. This loss is primarily attributed to deficiencies in the food supply chain, such as food rotting in fields or warehouses due to inadequate management, technology, or refrigeration, or food not reaching markets due to poor infrastructure. On the other hand, food waste refers to food meant for human consumption that is intentionally discarded, including both edible and inedible parts. This often occurs in the latter stages of the food supply chain, from retail outlets to the point of consumption.

Kinshasa is a megacity with an urban population representing 34% of the total population, facing several issues related to chaotic urbanization, including significant challenges in modern infrastructure for the agricultural sector. The city is marked by a deficit in basic socio-economic infrastructure (access roads, markets, transport, etc.), leading to low value addition due to the absence or low level of processing of certain products, exposing them to waste during harvest and sales periods. In Kinshasa, cereal warehouses do not meet hygiene standards and are expensive for traders. There are no adequate means of preserving fruits and vegetables after harvest, leading to episodes of waste in the market. Traders bringing food from the provinces sell in open air without proper preservation, and perishable goods are abandoned if unsold, turning into food waste. Food production does not reach 20 million tons compared to a demand of 25 million tons. There is no policy for managing food waste in the urban market of Kinshasa. No data is available on this subject in the DRC. Addressing this issue is crucial as the country faces food insecurity and Kinshasa grapples with rural exodus increasing the demand for food. This situation prevents the DRC from achieving food sovereignty. The problem worsens yearly as food production grows at a low rate of 2% while the annual population growth rate is 3.3%. If the current trend continues, agro-food imports will rise to 1.5 billion dollars by 2025. The coverage rate of food demand by local production would continue to erode, dropping from 75% to 60% (ESA 2009).

Losses and waste are major problems that must be addressed to avoid exacerbating food, environmental, and socio-economic crises in the DRC. Indeed, in Africa and the Democratic Republic of the Congo (DRC), a significant portion of food losses occurs after harvest due to poor storage and transport practices (WFP 2022). Insufficient transport infrastructure and the lack of preservation technology such as silos and cold storage aggravate this problem (FAO 2022). Moreover, poorly maintained roads and the lack of adequate transportation lead to significant losses when moving goods from rural areas to urban markets. Currently, in the DRC, limited access to modern agricultural technologies and crop management techniques reduces the efficiency of food production and contributes to losses. Poverty and food insecurity also significantly influence food waste, according to the United States Environmental Protection Agency (EPA 2013). Low-income households often purchase quantities of food that exceed their storage capacity, leading to losses (BAQ 2012). According to the FAO, one-third of the food produced worldwide is not consumed, amounting to 1.3 billion tons lost each year while 870 million people suffer from hunger. Food waste is typically the result of conscious decisions, poor stock management, and neglect, encompassing spoiled food, food past its expiration date, or food not consumed after preparation. The causes of this waste vary between the Global North and South.

Food waste and crop losses are global issues not just affecting the Congo (FAO 2011). In high-income countries, more waste is observed at the consumption stage, whereas in low-income countries, there is more loss at the beginning and middle stages of the food chain. The wastage in industrialized countries is significantly greater, estimated at 95-115 kg per capita in Europe and North America compared to 6-11 kg per capita in sub-Saharan Africa, South Asia, and Southeast Asia. Studies indicate that food waste in Western countries is around 280-300 kg per capita per year, with each European or North American wasting between 250 and 300 kilos of food annually, including about 200 kilos lost during production, storage, and distribution, and about 100 kilos wasted by consumers. In contrast, populations in Africa and South Asia, many of whom face food shortages, waste very little food (6-11 kilos per year) but experience high losses

during harvesting and storage (100-150 kilos per year) (Poissant 2016).

Schmidt (2016) reviewed literature indicating that households and markets in Western countries (Germany, the UK, Italy, France, Austria, Switzerland, and the USA) are major contributors to food waste. It is challenging to separate consumer behavior and food waste from the broader food system as consumers interact with various elements of this system, participating in what Gille (2012) calls the "waste regime." As summarized by Cloteau & Mourad (2016), while some work has been done on food losses, the environmental consequences of food waste in Kinshasa have not been extensively studied. Food wastage in some public markets in Kinshasa, the capital of the Democratic Republic of the Congo (DRC), has significant implications for public health and the urban environment. The decomposition of food waste in these markets promotes the proliferation of pathogens and pests such as rodents and insects, increasing the risk of diseases like cholera and typhoid. Additionally, the accumulation of this waste releases foul odors and harmful gases like methane, affecting air quality and contributing to air pollution. Inadequate disposal of food waste can also contaminate local water sources, leading to waterborne diseases.

Environmentally, Kinshasa's waste management infrastructure is often overwhelmed by the volume of food waste, exacerbating public sanitation issues and causing soil and water pollution. The anaerobic decomposition of organic waste produces methane, a potent greenhouse gas. To address these issues, it is essential to implement effective waste management systems, educate the public on the importance of reducing food waste, and promote composting and food recovery initiatives. Developing and enforcing policies to ensure proper waste disposal and encourage sustainable practices in public markets are also necessary to protect public health and preserve the urban environment. To our knowledge, this study is the first to address this issue in a market located in a working-class neighborhood in Kinshasa City.

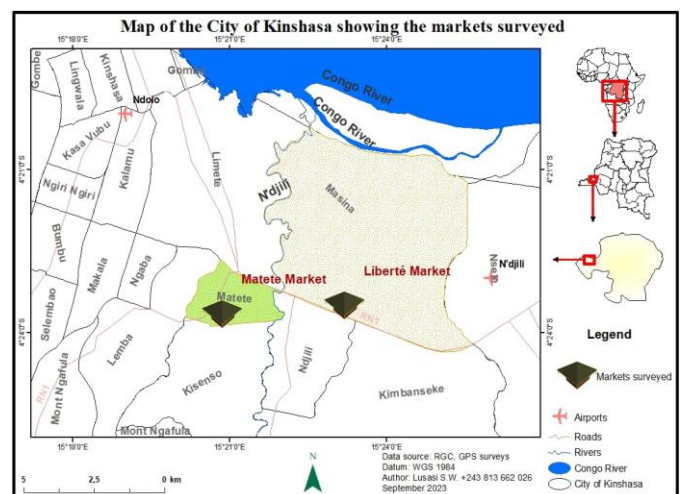
## METHODS

### Study Area

Kinshasa is the capital of the Democratic Republic of Congo (DRC). Located in the western part of the country, it extends between 15°13'15" and 15°26'25" East longitude and between 4° and 5° South latitude, covering an area of 9,965 km<sup>2</sup>. The city comprises 24 communes, including 22 quasi-urbanized communes covering 590 km<sup>2</sup> (6% of the total area), and 2 urban-rural communes covering 9,375 km<sup>2</sup> (94%) (Nzuzi, 2008; Holenu, 2016).

Data collection for this study took place in the Liberté market (Figure 1) in the city of Kinshasa. The Liberté market, one of the most prominent and busiest markets in Kinshasa, was specifically chosen for this study due to its significant role in the local economy and its representation of the city's dynamic trade activities. Located in the heart of Kinshasa, the market is a focal point for the exchange of goods ranging from fresh produce to electronics, clothing, and traditional medicines. It attracts a large number of vendors and customers daily, making it a microcosm of Kinshasa's socio-economic landscape. The market's importance is further underscored by its accessibility and its role in supporting the livelihoods of many residents. It serves as a critical space for small-scale entrepreneurs and informal traders, contributing to the local economy and providing employment opportunities.

**Figure 1:**  
Map of the city of Kinshasa showing study sites



### Materials

The materials used in this study consisted of various animal and vegetable foods undergoing degradation, forming food waste. At the Liberté market, the observed foods included fresh and dried fish, beef, chicken, goat meat, bushmeat (such as antelope and porcupine), fresh vegetables (cassava leaves, amaranth, okra, tomatoes, onions, and peppers), and fruits (mangoes, bananas, pineapples, papayas, and avocados).

### Methods

This study was based on both bibliographic documents (articles, books, theses related to the theme) and fieldwork that included surveys, direct observations, and interviews. It aimed to understand food waste and the sociodemographic profile of market vendors directly involved in the food waste process, as well as its impacts on the environment and human health.

The survey was conducted using a questionnaire with 10 closed and open-ended questions addressing sociodemographic characteristics and waste disposal methods. Our study was conducted at the Liberté market located in the eastern part of the city, aiming to highlight the existence of food waste and its dangers to the environment and public health. The market has about 350 stall occupants, and a total of 100 people, representing approximately 28.57% of the total population, participated in the study. The participants were characterized by low or medium education levels and were predominantly women and young single mothers.

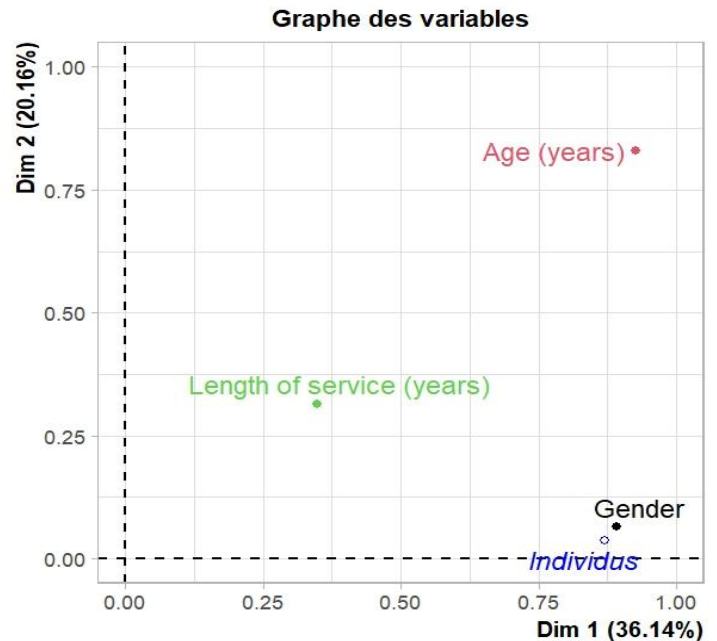
The responses collected from the surveys, direct observations, and interviews were processed manually. Percentage calculations were obtained using Excel 2019 to show the quantities of food wasted. Fisher's exact test was performed using SPSS software to evaluate the degree of dependence between age groups and food waste disposal locations. The Multiple Correspondence Analysis (MCA) was conducted using R 4.0 software to verify the association between seniority, gender, and age group to establish the sociodemographic profile.

## RESULTS AND DISCUSSION

### Socio-demographic Profile of Respondents

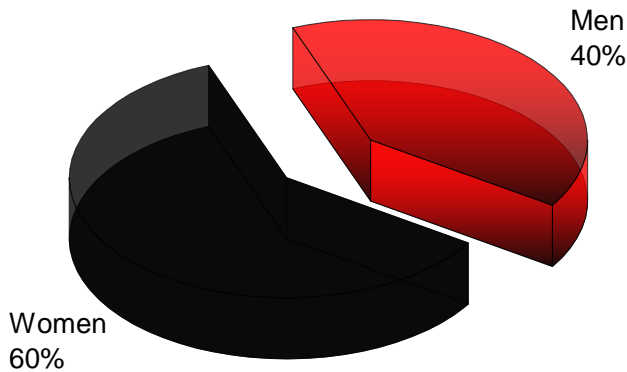
The results of the distribution of respondents according to socio-demographic profiles are presented in **Figure 2** below.

Figure 2:  
Socio-demographic profile of respondents



The Multiple Correspondence Analysis (MCA) test was used to verify the association between seniority, gender, and age group. **Figure 2** shows that there is an association between seniority (in years) and the individual's gender, particularly for females. This finding is consistent with [Kankwanda et al. \(2014\)](#), who reported that half of the informal jobs in urban areas in the Democratic Republic of the Congo are held by women. Women are predominantly found among self-employed workers (55.4%) and often have more precarious jobs compared to men.

**Figure 3:**  
Percentage of Food Waste by Gender

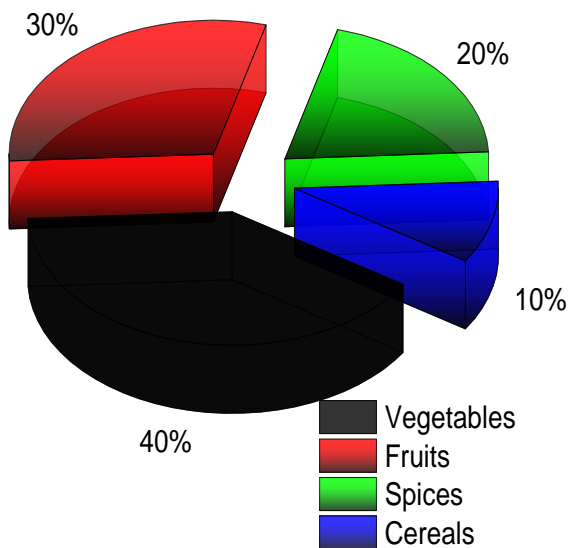


It emerges from Figure 3 that 40% of men are responsible for food waste compared to 60% of women. This aligns with data from the European Union, which states that households are the source of 42% of food waste in Europe. In a recent report, it was noted that it is very difficult to quantify food waste, as some countries do not have "reliable" data. The informal sector in the DRC is dominated by women, who are primarily responsible for food waste due to ignorance, lack of preservation methods, and absence of knowledge in product processing (Le Figaro, 2016).

*Food Wastage*

Figure 4 below provides information on the quantities of food that were wasted and ultimately discarded.

**Figure 4:**  
Variation in Quantities of Food Wasted

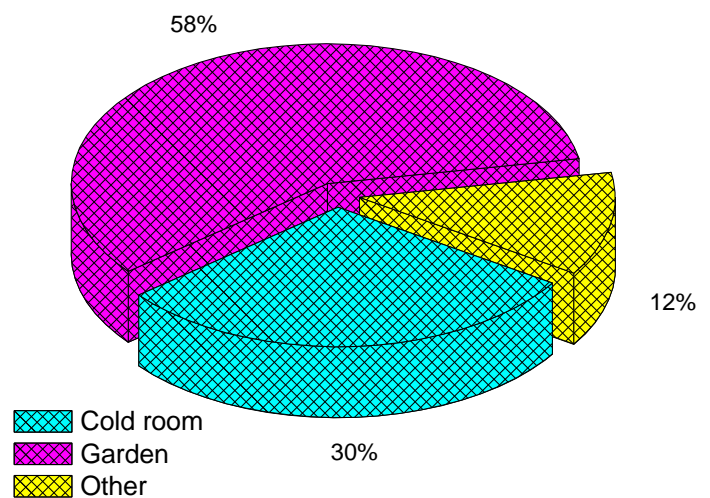


Regarding the quantity of food wasted, Figure 4 above indicates that during the survey, it was reported that 40% of vegetables are wasted, followed by 30% of fruits, 20% of spices, 10% of cereals, and 8% of staples. This result corroborates the findings of the FAO (2019), which reported that the causes of food waste are numerous and influenced by many factors. Firstly, they differ at each stage of the food chain and vary from one actor to another (Gagnon (n.d.)). Secondly, some categories of products, such as fruits and vegetables, are more affected than others. The laws and legal frameworks of each country can also influence food waste, as well as the management and technologies of supply chains (FAO, 2019). This observation aligns with the FAO's findings (Marcilhac, 2013), which attribute these losses mainly to financial, technical, and managerial constraints affecting harvesting, storage, cooling facilities (in regions with difficult climatic conditions), the overall quality of infrastructure, packaging, marketing systems, and climatic conditions that favor food spoilage.

*Source of Goods*

Among the 100 surveyed individuals, 58 identified their garden as the source of their goods, 30 identified the cold store, and 12 identified other sources (Figure 5).

**Figure 5:**  
Source of Food Sold



At Liberté Market, foods like vegetables and certain spices come from market gardens and agricultural farms in the urban-rural commune of Maluku. Local cereals are stored in warehouses that are sometimes in poor condition,

which can lead to merchandise wastage during periods of abundance.

*Variation in Waste Orientation*

The results on waste disposal points for different types of food products are shown in **Table 1**.

**Table 1:**  
Different Food Waste Disposal Points

Age (years)	Erosion heads	Rivers	Gardens	Streets	Others/dump
18 - 25	20	9	2	2	0
26 - 32	13	10	10	1	0
33 - 39	7	9	16	1	0

**Table 1** reports the results of different food waste disposal points. The Fisher's exact test used to evaluate the dependence between age group and disposal location showed that the null hypothesis (H0) is rejectable due to a p-value of 0.007, which is less than the significance level of 0.05. This indicates dependence between age group and the disposal location of food waste. From the table, it is noted that 0% of food waste is directed towards erosion sites, as there are no erosion sites around this market or in the commune where it is located. However, it is important to note that erosion sites have become places for illegal dumping to stop their progression, thus becoming open-air chemical, biological, and microbial digesters, exposing the population to various diseases such as malaria and typhoid fever. A study reported several obvious nuisances such as odors, smoke, proliferation of insects, and attraction of mice and dogs. Various diseases have been identified due to this illegal dumping site, with 67% of the population suffering from malaria, 17% from amoebic dysentery, 10% from typhoid fever, and 7% from diarrhea. This situation is mainly due to the lack of controlled waste disposal.

4% of the waste is directed towards rivers, as there are no laws prohibiting the discharge of food waste or other waste into the rivers that flow through the capital, resulting in their pollution. 30% is directed towards gardens for composting; a segment of the population, particularly women vendors, uses food waste to fertilize the soil. 60% is discarded in the streets, which is a common practice in Kinshasa. This leads to large piles of garbage near markets, where the decomposition of various organic materials creates strong odors. Only 6% is eliminated at other sites. It is important to note that food waste mixed

with other waste leads to the proliferation of rodents and insects. Before fermentation, waste constitutes the primary food for rats, which are direct or indirect agents of serious diseases (plague, fever, etc.). They attract flies and other insects, which are passive vectors of germs and viruses. Moreover, the waste emits toxic gases (methane, hydrogen sulfide, etc.), foul odors, and germs that proliferate in the dust from garbage. Water resources are polluted when waste contaminates groundwater and surface waters if deposited on unsuitable land. Pathogenic germs and heavy metals can reach the groundwater through leachate infiltration or surface waters through the runoff of contaminated rainwater. Marine and surface waters can be contaminated by direct dumping (Holenu, 2016).

**Table 2:**  
Food Waste Disposal Locations and Associated Health Risks

Disposal Location	Percentage	Health Risks and Environmental Impact
Erosion Sites	0%	No erosion sites nearby, but illegal dumping causes health risks
Rivers	4%	Pollution of rivers due to lack of prohibitive laws
Gardens	30%	Used for composting, especially by women vendors
Streets	60%	Common practice leading to large garbage piles and decomposition odors
Other Sites	6%	Various disposal sites, contributing to the spread of diseases and pests

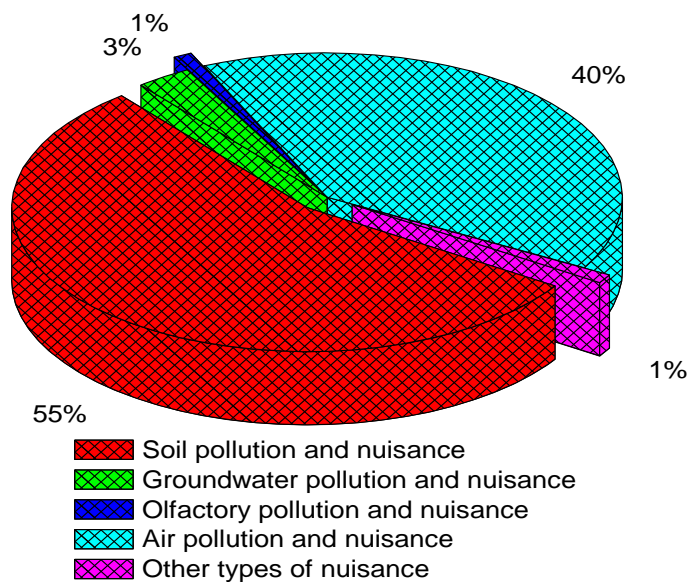
The findings of this study carry significant implications for both public health and the environment, particularly concerning the disposal methods observed at Liberté Market. The improper handling and disposal of food waste can contribute to various public health challenges and environmental impacts. Firstly, inadequate storage conditions observed in warehouses at the market may lead to food spoilage and contamination, potentially causing foodborne illnesses such as bacterial infections (e.g., *Salmonella*, *E. coli*) and fungal toxins. The presence of these pathogens due to poor storage practices can pose serious health risks to consumers who purchase and consume affected foods. Secondly, the disposal of food waste, if not managed properly, can exacerbate environmental pollution. Organic waste decomposition produces methane, a potent greenhouse gas that contributes to climate change when released into the atmosphere. Additionally, improper disposal methods such as dumping waste in open areas or water bodies can contaminate soil and water sources, affecting local ecosystems and potentially leading to waterborne diseases.

Furthermore, the presence of food waste attracts pests such as rodents, flies, and insects, which can act as vectors for disease transmission in the surrounding community. These pests not only pose health risks through direct contact but also contribute to the spread of pathogens from contaminated waste to food and water sources.

*Source of Goods*

Among the 100 surveyed individuals, 58 identified their garden as the source of their goods, 30 identified the cold store, and 12 identified other sources (Figure 6).

Figure 6: Consequences of Food Waste Disposal



The literature indicates that the population is transparent about their waste disposal practices. For example, a study on waste disposal methods among residents of “Avenue de l'Université,” involving 227 households, revealed that 46% use pushcart collection, 28% dispose of waste in illegal dumps, 34% directly discard waste, 19% practice composting, 26% bury waste on their properties, 20% prefer incineration, 30% throw waste into rivers, and 24% discard waste in the streets. The survey also showed that 40% of the households are aware of issues related to poor waste management, such as street filth, while 50% mentioned river pollution, and 21% mentioned air pollution. Additionally, 44% are aware that waste contributes to the proliferation of mosquitoes and insects, 23% noted foul odors, and 27% knew that waste clogs

gutters. Moreover, 22% reported the presence of rats in the waste.

The production of household waste per capita per day varies significantly from one commune to another, and even within the same commune, depending on the population size and type of housing (high-end, mid-range, low-end). Waste production rates also vary over time and space. In Kinshasa, municipal waste mainly consists of household garbage containing putrescible food waste (more than 50%), paper and cardboard (20%), various types of plastics, glass, and textiles (Yombo et al., 2022). This unsanitary condition has significant public health consequences. The population of Kinshasa often suffers from typhoid fever. According to a report by the WHO (2018), typhoid fever represents a major public health issue in many low- and middle-income countries. It is estimated that the global burden of typhoid fever ranges from 11 to 21 million cases annually, with approximately 128,000 to 161,000 deaths. The majority of these cases occur in South Asia, Southeast Asia, and sub-Saharan Africa.

Figure 7: Food Waste



Managing food waste is a major challenge with significant implications for public health, the environment, and the circular economy. Food waste is a global issue, with significant economic, social, and environmental consequences. According to the FAO, approximately one-third of the food produced globally is lost or wasted each year, amounting to around 1.3 billion tonnes of food. This huge amount of food waste has detrimental effects on public health, the environment, and the economy.

From a public health perspective, food waste can have negative health effects. Wasted food can be contaminated

with pathogenic bacteria, toxins, or chemicals, leading to foodborne illnesses in people who consume them (FAO, 2019). Furthermore, the decomposition of food waste produces greenhouse gases, contributing to climate change, which also has impacts on public health, such as increased respiratory and cardiovascular diseases. In Africa, and particularly in the DRC, different studies have reported high rates of typhoid fever in urban areas due to the absence of adequate sanitation systems (WHO, 2019). This demonstrates that improper disposal of food waste in streets or rivers exposes the population to typhoid fever, a significant public health issue in the DRC and globally.

From an environmental perspective, food waste management is also crucial. Landfilling food waste contributes to air, soil, and water pollution, as well as greenhouse gas emissions. Composting food waste is a more environmentally sustainable solution, as it reduces the amount of waste sent to landfills while producing a nutrient-rich organic amendment for soils. The circular economy also offers opportunities to reduce food waste and promote sustainability. By integrating composting into agricultural practices, food waste can be transformed into natural fertilizers, reducing the reliance on chemical fertilizers. Additionally, composting can create green jobs and contribute to local economic growth (Parfitt et al., 2010).

To effectively implement these solutions, it is essential to adopt an integrated approach that involves public awareness, the establishment of adequate composting infrastructure, and the promotion of sustainable food practices. Governments, businesses, and individuals all have a role to play in reducing food waste and promoting the circular economy (United Nations Environment Programme, 2021). This unsanitary condition has consequences on public health, with the population of Kinshasa often suffering from typhoid fever. According to a report by the WHO (2018), typhoid fever is a significant public health issue in many low- and middle-income countries. Estimates suggest that the global burden of typhoid fever ranges between 11 and 21 million cases annually, resulting in approximately 128,000 to 161,000 deaths. The majority of these cases occur in South Asia, Southeast Asia, and sub-Saharan Africa.

The literature review conducted in the first part of this study has highlighted a lack of available data on effective initiatives and programs to combat food waste in Kinshasa's urban markets. The findings identified several potential strategies to reduce waste, including enhancing selective sorting within markets and revealed developing alternative marketing models such as short food supply chains. However, the study also identified significant gaps hindering the implementation of waste reduction and valorization processes among traders. Furthermore, these results should be interpreted cautiously due to sample size and geographical limitations. Overall, adopting the FAO's 3Rs system—prevention to reduce food surplus and waste, reuse within the food chain, and recycle waste—is essential. There is a need to raise awareness among market vendors about food preservation practices, encourage wholesalers to adjust pricing structures to facilitate perishable food flow, and redirect unsold items deemed unfit for consumption to sanitation authorities rather than illegal dumping sites. Municipal market administrators should collaborate with NGOs to establish donation programs for unsold goods, integrate education and awareness modules into vendors' training, and promote social responsibility among traders. These efforts aim to transform markets into hubs for environmentally and public health-conscious food redistribution.

#### *Limitations of the Study*

The sample size of 100 participants, though small for broad generalization, was selected based on available scope and resources, considering the intensive labor and time required for detailed assessments of food degradation and waste formation. Participants were chosen to represent diverse vendors and customers at Liberté Market, ensuring varied food types and storage practices. However, limitations include potential biases in data collection, such as selection and observer biases, which may have influenced study outcomes and the representativeness of observed food waste practices. Despite these constraints, the study provides valuable insights into urban food waste dynamics and emphasizes the need for larger, more diverse samples to enhance findings' robustness and applicability across markets in Kinshasa and beyond.

## CONCLUSION AND RECOMMENDATIONS

The study highlights significant challenges posed by food wastage in Kinshasa, underscoring the urgency for proactive interventions. It is imperative to implement targeted strategies to mitigate economic losses and address environmental and public health risks associated with food waste. One critical implication is the potential for food wastage to facilitate disease spread, emphasizing the need for integrated sanitation programs and public awareness campaigns under the oversight of the Congolese Ministry of Environment and Nature Conservation. Effective waste management systems should include specific measures such as improved infrastructure for waste collection and disposal, alongside the promotion of composting as a sustainable solution for organic waste.

Improper food waste disposal, such as dumping in streets or waterways, creates breeding grounds for disease vectors like flies and mosquitoes, contributing to diseases such as cholera, typhoid fever, and dengue fever. Additionally, food wastage exacerbates environmental degradation through greenhouse gas emissions from organic waste decomposition, impacting public health with respiratory and heat-related illnesses.

To address these challenges comprehensively, proactive measures must encompass public education on responsible food consumption and waste management practices. Strengthening food handling standards, enhancing waste management infrastructure, promoting surplus food redistribution, and developing effective policies tailored to local contexts are essential. These initiatives not only safeguard public health but also enhance urban environmental sustainability and support food security efforts in Kinshasa.

Adopting a holistic approach that integrates economic, social, environmental, and public health considerations will be key to effectively reducing food wastage and its detrimental impacts in the city.

**Ethical Approval:** Not applicable

**Conflicts of Interest:** None declared.

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