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Assessing the Impacts of Plastic Waste Pollution in Exacerbating Urban Flooding in Douala.

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Abstract

Plastic pollution is simply the accumulation of plastic waste in the earth's environment and this accumulation is mainly caused by anthropogenic activities. Plastic waste affects millions of people across the world as it alters habitants and natural processes, causes floods and greatly affects climate change. This thesis explores the impact of plastic waste pollution on exacerbating urban flooding in Douala, Cameroon, with a focus on three distinct study areas: Makepe, Bonapriso, and Bonaberi. The growing issue of plastic waste accumulation in urban environments has led to blocked drainage systems, contributing significantly to the frequency and intensity of flooding. The research aimed to assess the correlation between plastic waste and urban flooding in these areas, providing insights into local perceptions and the role of waste management practices.I made 100 questionnaires that were distributed across these study areas Makepe, Bonaberi and Bonapriso in the ratio 4:3:3 respectively, capturing responses from residents and local stakeholders. I utilized both qualitative and quantitative research methods consisting of field surveys, interviews as seen in appendix 2 helped me come up with this questionnaire and statistical analysis, to evaluate the presence of plastic waste in drainage systems and relate to their perception about plastic waste and its impact on flooding. The results indicated an association between the accumulation of plastic waste and blocked drainage systems though other parameters were likes to flood in Douala such as, deforestation, poor drainage system and a high Topographic Wetness index as large catchment areas for watersheds which in turn exacerbated flooding incidents. Moreso, the study found varying levels of awareness and responses to the issue of plastic waste across the study areas.
This thesis concludes by recommending strategies for improving waste management system, promoting community awareness, and implementing sustainable practices to mitigate the impacts of plastic pollution on urban flooding in Douala I also pointed out some limitations and proposed possible ways to mitigate them.

Language: English
Key Words: Pollution, Plastic, Waste, Floods, TWI, DEM, Douala, HYSACAM, Scalgo,

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1 Introduction

1.1 Background

Plastic has long been the dominant packaging material worldwide, but this extensive production has led to a significant environmental issue: plastic pollution. This crisis is escalating rapidly, posing serious threats to our survival by contributing to climate change, global warming as these plastics originates from fossil fuels and when it pollutes the environment, it causes floods that wash away natural ecosystems like trees(deforestation), farmlands and wetlands that serve as natural carbon sinks hence reducing the absorption of GHG like Carbon dioxide. Over 8,300 million metric tons of virgin plastics have been produced, with only about 9% recycled, 12% incinerated, and a staggering 79% accumulating in landfills or the natural environment. If current trends persist, it is estimated that around 12,000 million metric tons of plastic waste could end up in landfills or natural settings by 2050. (Roland et al., 2017).

Douala, the economic capital and largest city in Cameroon, has experienced rapid urbanization in recent years, driven in part by the ongoing Anglophone crisis. This conflict has forced many people to flee the war-torn regions of the Southwest and Northwest, resulting in an increase in waste production, particularly plastic waste. The widespread use of single-use plastics for packaging, bags, and containers has overwhelmed Douala's waste management system Hugue Nkoutchou(2019). According to the UNDP Human Development Report 2019, Cameroon has an annual population growth rate of 2.2%, with 30.4% of the population living on less than $2 a day. Given this growth, the primary challenge facing the Douala City Council is the collection, treatment, and disposal of plastic waste. Poor waste disposal practices, a lack of adequate recycling facilities, and limited public awareness have further exacerbated the problem, leading to widespread plastic pollution in waterways, streets, and public spaces, which contributes to flooding.

Douala, located along the Wouri River, is divided into six municipalities and lies within the Littoral Region of Cameroon. It is bordered to the northwest by the Southwest Region, to the northeast by the Centre Region, where the capital city Yaoundé is situated, and to the south by the South Region, as shown in (Figure 1) below. Douala hosts a major port and serves as a key hub for trade and commerce in Central Africa. With a population of over 3 million people, the city's drainage systems and waterways are often blocked by plastic waste during the rainy season, resulting in severe flooding. This makes Douala a critical case study for understanding the role of plastic pollution in exacerbating flooding in urban areas.

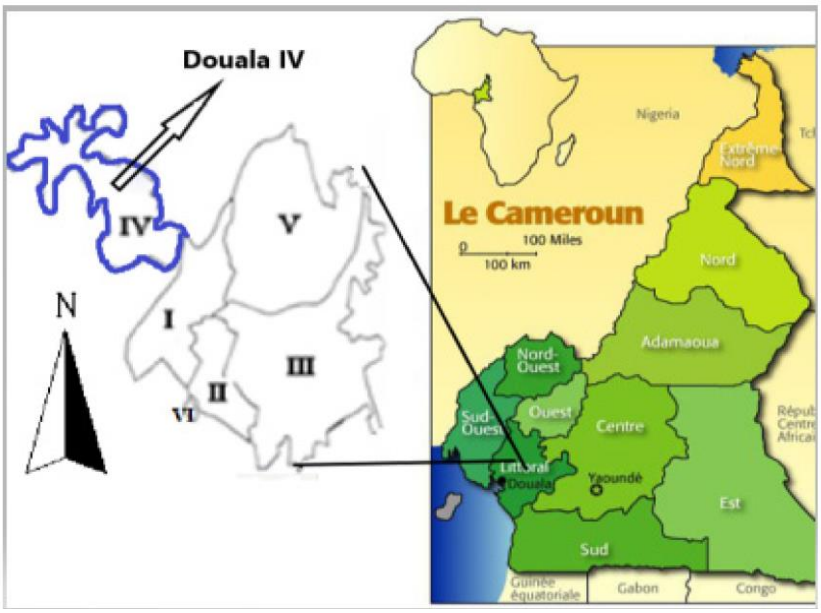

Figure 1 Map of Africa and Cameroon showing the city of Douala and its municipalities
Source: Emmanuel Tonye, 2019

Despite global urbanisation that has led to spike in waste generation, limited research still exists on direct link between plastic waste and flooding in Douala leaving gaps in effectiveness on policy making and community driven solutions as this research seeks to fill the gap in current literature and contribute valuable insights of this relationship.

1.2 Research Question

1. How do demographic factors influence individuals' perceptions of plastic waste pollution and its impact on flooding in Douala?

2. What are the primary sources of plastic waste pollution in Douala, according to residents, and how do these sources correlate with flooding issues?

3. To what extent are residents aware of plastic waste accumulation in drainage systems, and how does this relate to perceived flooding issues?

4. What are the socio-economic impacts of flooding on residents, specifically in terms of transportation, property damage, health risks, and business disruptions?

5. Which flood mitigation strategies do residents believe will be most effective in addressing both plastic waste pollution and urban flooding?

1.3 Research Objective

The saying goes, "The road to hell is paved with good intentions," and plastic serves as a prime example of this paradox. Today, plastic pollution poses a global threat, endangering both environmental and public health in all corners of the world. This issue has motivated me to develop the following objectives:

- ❖ Explore residents' perception on Plastic waste origin
- ❖ Assess peoples' opinion on impacts of plastic waste pollution in Douala
- ❖ Examine people's opinion about waste management
- ❖ Investigate role of Plastic waste in causing floods

These findings seek to understand where residents believe plastic waste originates, whether it comes from households, industries, or other sources, knowing residents' concerns whether related to health, environmental degradation, or economic impacts can inform targeted interventions, such as community education, policy development, or waste reduction campaigns, Examining public opinions about waste management is crucial for addressing practical challenges in plastic waste disposal an can uncover issues like dissatisfaction with existing waste management services, lack of infrastructure and help me understand where improvement is needed and finally addressing this challenge could involve practical solutions such as improving waste disposal infrastructure, implementing stricter regulations on plastic waste, and educating residents on the importance of proper waste disposal. Identifying this link will help prioritize cleaning up drainage systems and preventing blockages caused by plastic waste.

1.4 Significance of the Study

While plastics are essential in many ways, their poor management has rendered them a significant threat to both the environment and human health. Douala being a fast-developing urban center faces huge challenges related to waste and plastics pollution and the efforts put in place to tackle this such as recycling, education and waste reduction ties with the SDG goal 11 which aims at making cities safe, resilient, and sustainable. Hence, the influence of demographic factors on individuals' perceptions of plastic waste pollution and its role in exacerbating flooding is essential. This research will contribute to understanding the broader public awareness of environmental issues. Additionally, it will shed light on the primary sources of plastic waste pollution, which may be crucial in identifying the key areas requiring urgent intervention to reduce urban flooding.

Furthermore, this report will be valuable to a variety of stakeholders, including HYSACAM, the company that provided me with extensive knowledge of waste management in Cameroon; the Ministry of Public Health of the Republic of Cameroon; the Cameroonian government; NGOs; students from both Cameroonian and Finnish universities, particularly Novia UAS; the residents of the HYSACAM neighbourhood; and the general public who may have access to this report.

The findings of this research will help many understand that mitigating plastic waste is not a solo endeavour. If we all collectively implement the recommendations proposed at the end of this report, every stakeholder can take pride in making this world a better place for future generations. Like any research project, I faced numerous challenges, including data collection, resource mobilization, and my absence from the field, which complicated collaboration on certain tasks. Finally, investigating residents' perspectives on the most effective flood mitigation strategies will provide a locally informed basis for improving flood management policies, encouraging sustainable waste management practices, and enhancing community resilience to flooding.

2 Literature Review

Global plastic production is closely linked to fossil fuel extraction and climate change (Center for International Environmental Law, 2019). Since the 2000s, plastic production has more than doubled, increasing from approximately 200 million tonnes (Mt) to over 400 Mt by 2019. This surge in production has led to a corresponding rise in plastic waste, contributing to the proliferation of microplastics and associated chemicals (Geyer, 2020).

In response to these challenges, the United Nations established 17 Sustainable Development Goals (SDGs) as part of the 2030 Agenda for Sustainable Development (Fox & Stoett, 2016). These goals aim to unify global efforts toward a sustainable future by addressing interconnected economic, social, and environmental issues.

Research has revealed the pervasive nature of plastic pollution. It has been detected in various environments, including the deep sea (Peng et al., 2018), rainwater (Brahney et al., 2020), the summit of Mount Everest (Napper et al., 2020), and even in human placenta (Ragusa et al., 2021) and blood (Leslie et al., 2022). Moreover, microplastics have infiltrated the water we drink (Marsden et al., 2019). This widespread contamination underscores the significant barriers plastic pollution poses to sustainable development on a global scale (UNEP, 2016).

Several studies, particularly in developing countries, have identified that plastic waste, such as bags, bottles, and packaging, can clog drainage systems, significantly contributing to urban flooding (Amin Hosseinian-Far et al, 2017). Waste management practices and urban flooding in Cameroon are two critical urban environmental challenges as municipal solid waste in Cameroon primarily composed of kitchen waste, yard waste, paper and

cardboard, textiles, leather, rubber, plastic, glass, wood, metal and other materials this waste frequently leads to blockages in drainage systems adverse effects on the environment such as urban flooding. Low priority is often accorded to the management of solid waste in developing countries like Cameroon because of inadequate financial resources, low levels of enforcement of regulations and poor governance (Mabel N. et al 2023)

The European Union has responded to these challenges by implementing a set of Waste Framework Directives aimed at improving waste management practices. These directives establish a waste hierarchy to prioritize waste prevention and promote recycling and recovery efforts. This waste hierarchy place waste prevention as main management practice followed by reuse and further Recycling, Recovery and the last alternative for waste is disporsal as shown in (Figure 2).

Figure 2: EU's waste Hierarchy

Source : EU Waste strategies, (2020)

In their efforts to combat plastic pollution, the European Union aims to reduce littering and unnecessary consumption, enhance the recycling of plastic waste, and promote the use of recycled plastics instead of fossil-based materials. They also prioritize the analysis and assessment of hazardous substances found in plastic waste. According to Syke (2023), these initiatives significantly contribute to waste separation, thereby minimizing pollution by preventing the mixing of plastics with other waste types, as outlined in Section 5 of the Waste Framework Directive (646/2011). Moreso, the EU has implemented energy and climate policies to increase the production of bio-based fuels and expand plastic recycling facilities.

Douala, the economic hub of Cameroon, is abundant in natural resources that are frequently exported to Europe, China, and the USA. Protecting these resources is crucial, particularly in the context of mitigating climate change and addressing plastic pollution in

the city and its water bodies. As previously mentioned, plastic pollution is a significant global challenge, with extensive research documenting its harmful impact on ecosystems, wildlife, and human health. Plastics are slow to decompose, and when disposed of improperly, they accumulate in drainages, rivers, oceans, and landfills, exacerbating environmental degradation (Earn et al., 2021).

In Douala, plastic accumulation is directly related to flooding as these plastics end up blocking drainage systems hence obstructing water from free flow therefore de-routing the water from its path and causing floods in certain areas. Hence affecting freshwater bodies around, damaging property, causing deaths and huge affecting the ecosystem. To quantify environmental impacts of plastic, Life Cycle Assessment (LCA) is a frequently used tool, especially for businesses and product designers. With an LCA, the environmental impacts of the product throughout all life stages of a product or technology are assessed (A.E. Schwarz et al, 2019)

Studies on waste management in developing countries indicate that inadequate infrastructure, rapid population growth, and economic constraints are significant barriers to effective waste management (Earn et al., 2021). In urban areas like Douala, plastic waste contributes to clogged drainage systems, resulting in flooding during the rainy season and the contamination of water bodies, such as the Wouri River. Understanding the interactions between urban flooding and plastic pollution is the primary objective of my research.

Previous research in Cameroon has highlighted that poor waste management, inadequate enforcement of environmental policies, and low public awareness regarding recycling significantly contribute to the plastic waste problem in Douala (Salifou et al. 2023). The increasing frequency and severity of heavy rainfall, aggravated by improperly disposed plastics, play a major role in flooding throughout the city .

Despite the increasing impacts of plastic pollution (Earn et al., 2021), there is urgent need to mitigate these effects (Uhrin et al., 2022), policymakers in the municipality must implement effective and sustainable policies. It essential that these efforts include collaboration with the private sector (Dijkstra et al., 2020).

2.1 History of Plastics

Plastics are ubiquitous in modern life, and their origins are quite fascinating. According to a TED-Ed video on the brief history of plastics (2020), the journey began in 1863 when American inventor John Wesley Hyatt created celluloid from cellulose. This marked the first significant step in plastic development.

Subsequently, the combination of phenol and formaldehyde led to the invention of Bakelite, the first synthetic plastic, in the early 20th century. In the 1920s, polystyrene was developed, followed by the creation of polyvinyl and acrylic plastics. The introduction of

polyethylene in 1933 further revolutionized the industry as seen in (Figure 3). This period also saw the emergence of injection moulding technology, which enabled large-scale plastic production by allowing manufacturers to create various shapes economically and efficiently. But it is essential noting that all these plastics end up somewhere and hence prompted me to investigate on their effects on floods in Douala.

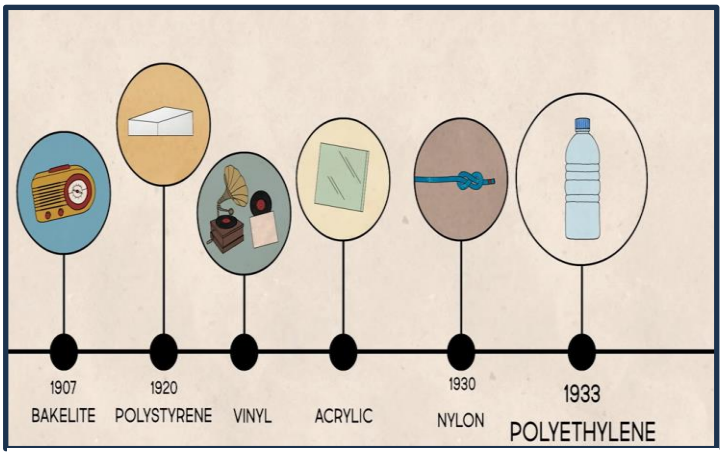

Figure 3: Brief History of plastic

Source: Screenshot TED Ed, (2020) YouTube video

Plastics are synthetic materials composed of long-chain polymers derived from petrochemical sources. Their durability, versatility, and lightweight nature have driven a significant increase in demand, resulting in widespread use and production (Pandey et al, 2023). In 2021, global plastic production reached over 391 million tonnes (Plastic Europe, 2022). Alarmingly, only 9% of produced plastics are recycled, while 19% are incinerated for fuel and other products. Approximately 50% end up in landfills, and the remaining 22% escapes waste management systems and disperses into the environment (OECD, 2023). Low-density polymers, which can float on water. Despite global urbanisation with waste generation, there's still much to be done to link plastic waste to urban flooding leaving gaps for effective policy making and community driven solutions.

2.2 Types of Plastics

Plastics are ubiquitous in our daily lives, found in everything from mobile phones and TVs to groceries, vehicles, and aircraft. They come in various sizes, categorized as macroplastics (>20 mm), mesoplastics (5-20 mm), microplastics (0.1 µm - 5 mm), and nanoplastics (0.001 µm - 0.1 µm) (Novia Faroe Island, 2024). Some of the most common types of plastic as seen in Tabel 1: Types of plasticsTabel 1) include high-density polyethylene (HDPE), low-density polyethylene (LDPE), polyvinyl chloride (PVC), polystyrene (PS), polypropylene (PP), and polyethylene terephthalate (PET). Together, these materials account for approximately

90% of total plastic production worldwide (Andrady & Neal, 2009). Refer to Table 1 for a detailed breakdown of these plastics.

Tabel 1: Types of plastics
Source B. P. Rahul (2016)

Acronym	Full name	Common examples
PETE/PET	Polyethylene terephthalate	Soda bottles, Films,
HDPE	High density polyethylene	Milk jugs, Packaging, Shampoo bottles, Yogurt containers, Detergent bottles, Shopping Bags
PVC	Polyvinyl chloride	Clear food packaging, Candy wrappers, Some bottles, Water pipes, Curtains, Credit card, Packaging films, Water films
LDPE	Low density polyethylene	Plastic bags, Wire cloth, Squeezable bottles, Shopping bags
PP	Polypropylene	Caps, straws, Some bottles, Plastic bag and toy, Drinking straws
PS	Polystyrene	Takeout food containers, Disposable cups & plates, Fast food boxes, CD cases,
PC	Polycarbonate	Water jugs, DVDs, Sunglasses,
PA	Polyamide/Nylon	Toothbrushes

These plastic polymers are used in different fields of work and divided into various segments as Packaging adds up to more than 40% of EU's plastic production followed by the building and construction sector which has 19.8%, and the automotive segment which has slightly above 10% as seen in (Figure 4) below.

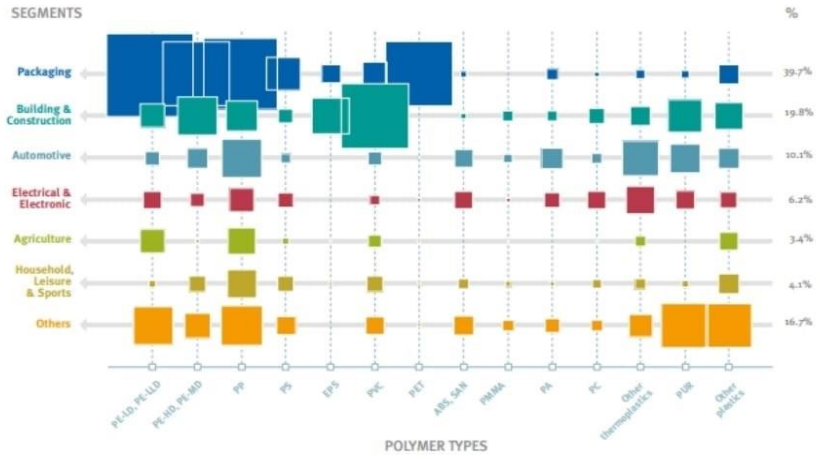

Figure 4: Global polymers demand by different market segments
Source: Plastic Europe, (2018)

2.3 Sources of Plastic Waste

Drainage systems have become critical pathways for the transfer of mismanaged waste, carrying it from land to streams, rivers, and ultimately the ocean. Plastic waste does not occur naturally in the environment and is not a byproduct of any living organism. This indicates that plastic pollution primarily arises from anthropogenic activities as earlier mentioned. Consequently, addressing plastic pollution has become a key focus of international initiatives (GESAMP, 2015; G20, 2019; UNEP, 2021; COP, 2023). It is projected that plastic pollution in ecosystems will triple by 2050. While plastics can gradually break down into smaller fragments due to UV radiation and physical abrasion, they still require hundreds of years to fully disintegrate. Studies indicate that plastic waste is the predominant type of waste found in oceans (Stefatos et al., 1999).

Plastics are ubiquitous, found in nearly every aspect of modern life. As a result, they pose significant risks to wildlife; organisms can ingest plastic particles or become entangled in them. Thus, plastic waste permeates the entire ecosystem (Sutherland et al., 2010). According to Europe plastic, Asia produces morethan 50% of global plastic and of which 3/5 comes from China alone while Europe and NAFTA distribute 18.5% and 17.7% respectively as seen in (Figure 5) below.

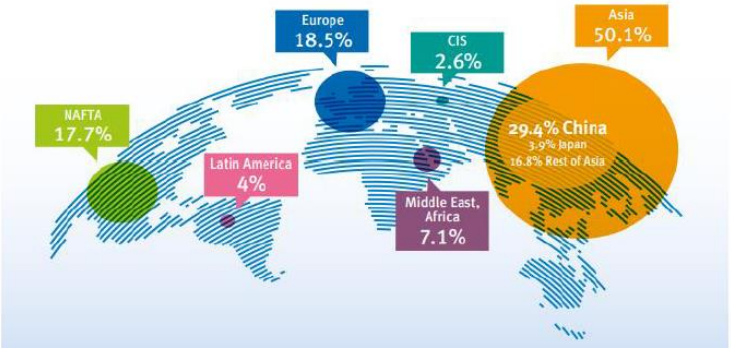

Figure 5 Distribution of Global plastic production. Source Europe Plastic (2017)

In (Figure 6)below we notice that the problem with Asia is not just it's more than 50% global plastic distribution but its mismanagement too as the red portion indicates the amount of mismanaged plastic. We can clearly see that Africa especially Nigeria, Egypt and Algeria have huge management issues too related to plastic.

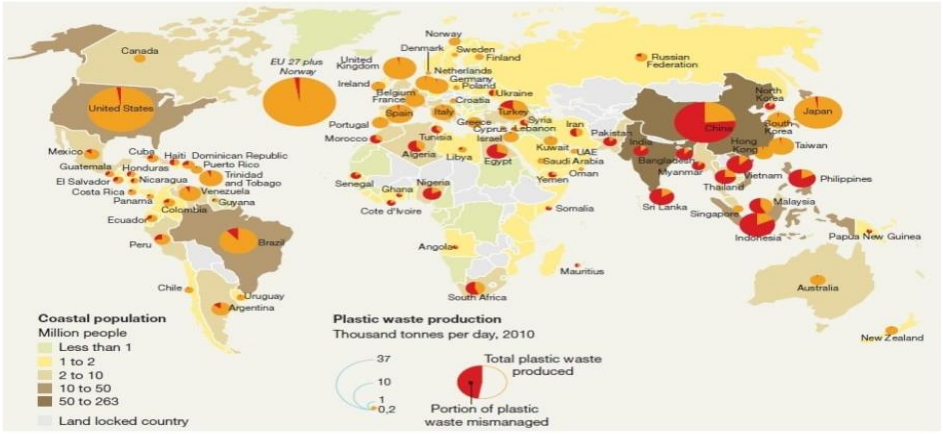

Figure 6 Mismanaged Global Coastal plastic
Source : Joan et al (2016) from Jambeck et al (2015)

2.3.1 Consumer Goods

Rapid technological advancements have led to a dramatic increase in consumer waste, with millions of items discarded daily. Most of this waste is categorized as packaging materials, commonly used for bottling water and wrapping groceries. The excessive use of these plastics contributes significantly to the growing waste problem. Additionally, electronic waste (e-waste) from devices like phones and TVs often contains toxic substances such as mercury, further complicating the waste management (Yu Gong et al, 2020)

2.3.2 Medical Waste

Medical waste is generated from hospitals, clinics, and laboratories, encompassing items such as syringes, gloves, and pharmaceuticals. These materials are essential for healthcare professionals to provide care and improve health outcomes. However, their disposal poses a significant environmental challenge.The prevalence of PVC is particularly problematic, given that it is often disposed of through incineration, a process that generates harmful chlorine gases. (A. C. Fletcher et al, 2021)

2.3.3 Single-Use Plastics

Single-use plastics are among the most pervasive and problematic forms of waste. Although they are widely utilized in our daily lives, such as in plastic bottles, bags, food wrappers, and straws, they take hundreds of years to decompose while serving a very short lifespan. This contradiction highlights the urgent need for alternatives and better waste management solutions as only small amounts are being recycled (Yuan Chen et al, 2021)

2.3.4 Fishing Industry

Ghost fishing is a significant contributor to plastic pollution in marine environments. This occurs when discarded fishing gear such as nets, lines, and traps also known as ghost gear, remains in the water and continues to trap marine species. Animals such as turtles and seabirds, may mistake disintegrated plastic debris for food. According to Gall and Thompson (2015), plastics account for 92% of encounters between marine species and debris, with over 30,000 recorded cases of entanglement 55% of all interactions compared to 34% involving ingestion. The high rates of entanglement can be attributed to the prevalence of such gear in marine habitats. Seabirds, although not typically found in their natural feeding grounds, can become ensnared in nets while diving for food (Li et al., 2016).

2.3.5 Tourism and Festivals

Plastic pollution tends to escalate during the summer months when tourism and festivals peak. Tourist destinations such as cities, resorts, and beaches, become hotspots for waste accumulation. Large quantities of disposable items, such as promotional materials, plastic cups, and bottles, contribute to this problem. Major events, such as music festivals and sporting activities, often struggle to manage the waste generated, leading to significant environmental impacts.

As per Figure 7 below by Joan et al; (2016), we see how macroplastics washed into large water bodies disitegrate over long period of time to form smaller meso, micro and nano plastics that affects marine ecosystem as sea birds engulf these plastics mistaking them for food(fish), so do dolphins e consume them alongside fish and zooplanktons so do do sea turtle and other marine mammals mistake them as food.

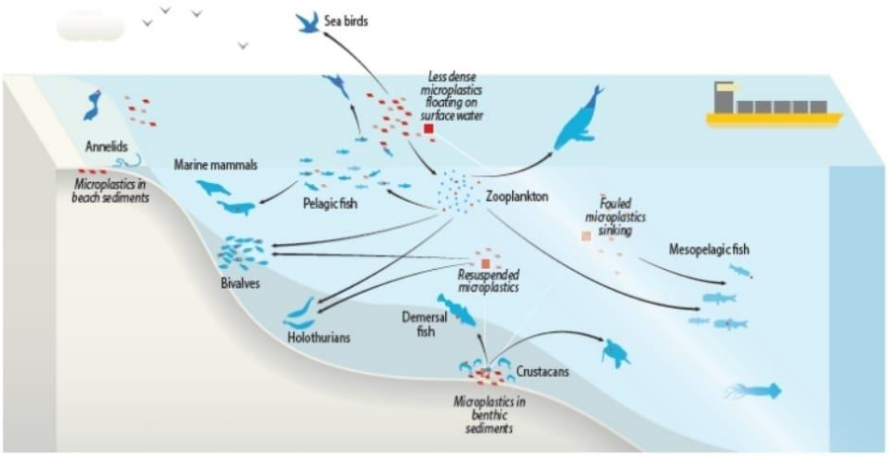

Figure 7:Plastic distribution and ingestion by sea mammals

Source: Joan et al (2016)

Douala on its part has mainly plastic bottles and plastic bags that litter the city and they may originate from the multiple sources listed above reasons I believe plastic waste may be reasons for most of the floods in Douala as they are not well managed. This prompted

me to try to get more insight with respects to their effects on floods all around the city of Douala.

2.4 Impacts of Plastics

2.4.1 Floods

Inadequate waste management policies and the accumulation of plastic waste significantly contribute to the occurrence of floods. When plastic waste is transported via water currents through drainage systems, it increases water levels and flow velocity leading to floods as seen in (Figure 8) where flood occurred in Bonaberi this October as a result of plastic preventing free flow of water. This waste can flow directly into aquatic environments or be conveyed through urban drainage and sewer systems (Borrelle et al., 2020). Douala, as a commercial hub with a dense population faces substantial challenges in waste management. During floods in Bonaberi as seen in (Figure 8), additional plastics are washed into rivers, while rising water levels results in the entrapment of plastics in vegetation and on streets (Van Emmerik et al., 2022). Thus, floods serve as both transport mechanisms and accumulation sites for plastic waste. This issue has had huge consequences, contributing to more than 100 deaths between 2000 and 2010 (MINATD, 2011)

Figure 8: Flood in Bonaberi

2.4.2 Toxication

Microplastics pose significant risks to the marine food chain, with two primary types: primary microplastics, such as microbeads found in cosmetics, and secondary microplastics, which are fragments of larger plastics that have degraded over time due to sun exposure. These microplastics accumulate along coastlines and can transfer toxic

chemicals within the ecosystem (Albert Menendez et al., 2020). Additionally, plastic pollution can contribute to waterborne diseases, particularly in the context of flooding.

2.4.3 Ingestion

Aquatic organisms and seabirds often mistakenly ingest microplastics, believing them to be food. This consumption can lead to serious health issues, including damage to digestive organs, choking, and disruption of reproductive and growth hormones. Such effects decrease the survival chances of fish and other marine life, posing immediate and long-term threats to marine ecosystems and potentially affecting human health as well Paul Agbekpornu et al., (2023).

2.4.4 Entanglement

Plastic pollution has profoundly impacted lakes, rivers, seas, and oceans, primarily through lost or discarded fishing gear and packaging materials left by fishermen. Despite global efforts to address this issue, entanglement remains a significant problem (Hartley et al., 2018). This issue affects various marine species across multiple trophic levels, including seals, fish, birds, sea lions, and turtles, leading to the mortality of 243 marine species (Gall and Thompson, 2015). The plastics most commonly responsible for entanglements include monofilament lines, ropes, and other fishing gear, which often enter the water near coastal cities through commercial fishing activities and shipping corridors (Laist, 1997).

3 METHODOLOGY

3.1 Research Method

This study employed a mixed research method, incorporating both qualitative and quantitative approaches to provide a comprehensive exploration of how plastic pollution contributes to flooding in Douala. This multifaceted approach allows for a holistic examination of the issue. The questionnaire in appendix 1 were distributed to 100 respondents.

3.1.1 Qualitative Research Method

The qualitative research component focused on exploring real-world problems, such as the plastic waste management crisis and public awareness of how plastic pollution exacerbates flooding. This research design facilitated investigations into plastic accumulation and its role in blocking drainage systems, allowing us to address the "how" and "why" through residents' experiences, perceptions, and behaviours (Tenny et al., 2022). I conducted interviews to gauge future perceptions of flooding if plastic waste continues to accumulate, as well as to explore youth involvement in tackling plastic pollution. Unfortunately, I encountered challenges in obtaining desired track records and responses during these interviews

3.1.2 Quantitative Research Method

Following the qualitative interviews, I gained insights into how residents perceive the contribution of plastic pollution to flooding in their neighbourhoods. For the quantitative aspect, I applied a descriptive research method to gather raw data from the study area. This method was crucial for understanding the state of plastic waste management and its impact on flooding. Descriptive research uses surveys or questionnaires to collect information about people, groups, and organizations (Östlund et al., 2011). I designed a questionnaire (Appendix 1) in English, French, and Pidgin to gather information from respondents in three target areas.

3.2 Data Collection Methods

3.2.1 Qualitative Data Collection

We did on-site interviews as my friends who acted as my eyes and ears on ground. The goal was to assess public awareness regarding plastic pollution in relation to flooding, investigate the role of HYSACAM (the primary waste management company), and understand other factors contributing to plastic pollution, including government involvement in addressing the issue. I considered tribal diversity in conducting this

interview and I made the purpose of this research clear to all participants, it was voluntary, and anonymity and confidentiality of the discussion was made explicit.

This was the most complex part of this research as not being on site wasn't an advantage for me, I organised a series of questions as seen in (appendix 2) to help me understand how to go about achieving my objectives by knowing more about the peoples' opinion on this whole research. Interviewees where clearly informed that it is voluntary and the discretion is core to this interview and they were well informed about the purpose of this research, I also made sure cultural norms were respected like Muslim women who answered with their faces covered. I tried doing video and audio interviews from here but due to poor internet network, noisy background, and most participants were not willing to be recorded. I then strategized to the use of jotters (manual notebooks) where just the essential points were jotted and all this information gotten from this interview guided me in making my survey. Most of the interviewees were still not willing to participate so we just got 1 video interview, 2 audio notes and 7 jotted out of over 50 attempts. Most of them know plastic pollution is the littering of environment with plastic bottles and they said most floods occurred during the heavy rains that fall at night, but a good number 4 assimilated floods to bad governance but most believed the youths of today will have a great role to play in reducing this problem.

3.2.2 Quantitative Data Collection

I administered a series of paper questionnaires in English, French, and Pidgin as seen in (appendix 1) to a diverse range of stakeholders, including market vendors, council workers, and residents. Participants were purposefully selected to represent various actors in plastic waste management within the study area. Due to concerns about internet instability, I opted for a more reliable approach i.e. Paper questionnaire as seen in (appendix 1).

To analyse flood trends in relation to significant changes in climatic variables and fluctuations in rainfall and temperature (Derbetini A. et al, 2021). I focused on three neighbourhoods: Marché Makepe Missoke, Bonaberi Rail, and Bonapriso due to their reputation on floods frequency. The surveys were conducted at a ratio of 4:3:3, distributing 40 questionnaires in Marché Makepe Missoke, and 30 each in Bonaberi Rail and Bonapriso. The collected data included demographics, types of waste, the most prevalent plastic waste, disposal methods, and perceived environmental benefits. Surveys were conducted within October 2024. The questionnaires facilitated an assessment of respondents' views on the relationship between increased plastic waste and flooding in their vicinity.

I used Scalgo (a large terrain analyses software) to simulate watershed to see where water moves and how it is sent to the oceans and seas by simulating on the movement of water by activating the resolution so as to delineate the watershed to see the direction of flow the higher accumulation values indicate regions where water will collect more so Scalgo did the simulation as I selected my study area and from there it was easy to visualize how water travels.

4 RESULTS

This mixed approach provided me with a comprehensive understanding of how plastic waste exacerbates flooding in Douala as the Qualitative data offered me with a better understanding of the peoples' opinion on my research and aided me in writing the survey that permitted me in getting the raw data I collected. I got the following results upon analyses:

I aim to understand the factors that influence perceptions on plastic waste, origin of these waste, the level of awareness, impacts at mitigation measures for plastic waste pollution. I selected people from different sectors such as students, market vendors, customers, waste cleaners and quarter leaders and from this interview, I will say they all had a basic understanding of plastic pollution as they were all in line with proliferation of plastic made material in the environment but with respect to changes in flood patterns, I had diverse responses as just 2 from jotter, the video and 1 audio interview were those who taught plastics contributes to their local community as the others attributed this floods to poor drainage system, bad governance and poor waste management. It is worth noting that they all said floods were frequent around them and were not satisfied somehow with the work done by the waste management Company as 4 complained of they not frequently getting rid of the bins on time hence causing overflow and leading to the proliferation of waste around their neighbourhoods some till the point where some are spread in the drainages.

As for the survey, data gotten is presented below:

Makepe Misoke goe a 100% participation rate as all 40 respondents participated while Bonaberi had a turnout of 96.7% as 1 questionnaire got missing during the collection and finally 26 out of the 30 given to respondents were analysed making it 86.7% response rate and this summed up to have 95% global participation rate. as shown in (Table 2).

Table 2: Questionnaire distribution and participation rate

Area	Total Questionnaires	Respondents	Response Rate (%)
Makepe Missoke	40	40	100
Bonaberi Rail	30	29	96.7
Bonapriso	30	26	86.7
Total	100	95	95

I also found that 40% of individuals under 18 identified households as the main source of plastic waste. Similarly, 40% of respondents aged 18-28 also pointed to household waste. In contrast, 36.8% of those aged 29-39 attributed most plastic waste to markets, while 28.6% of respondents in their 40s and 50s viewed industries as the primary contributors.

Interestingly, 33.3% of participants aged 50 and above struggled to identify the primary source, citing both markets and industries.

Demographic Results from the Survey were as follows:

Table 3: Gender

Male	Female	other
43	51	1

Female made 51% of the recipients (Table 3) as the survey was mostly carried out around markets

Table 4: AGE

UNDER 18	18-28	29-39	40-50	ABOVE 50
4	22	43	21	5

43% of the respondent's range between 29-39 as this was the majority of those willing to partake in the survey (table 4) and made up of workforce age in Douala.

Table 5: EDUCATION

None	Primary	Secondary	University
7	18	45	25

More than 50% had completed primary as in (Table 5) but did not have any university degree

Table 6: OCCUPATION

Student	Civil Servant	Business	Other
11	8	69	7

About 75% of these respondents were Business owners (Table 6). This was purposely done to see the significance of their business in plastic pollution

I had these other results with respect to knowledge and experience on plastic pollution.

Majority of respondents rate the situation as Poor (34%) or Average (29%), suggesting that a significant portion of the population believe waste is poorly managed.

Figure 9a: Waste Management in the area

Respondents under 18 and those within 18-28 are more likely to recognize households as a major source of plastic waste than older individuals, indicating a potential age-related difference in awareness as seen in (Figure 9)

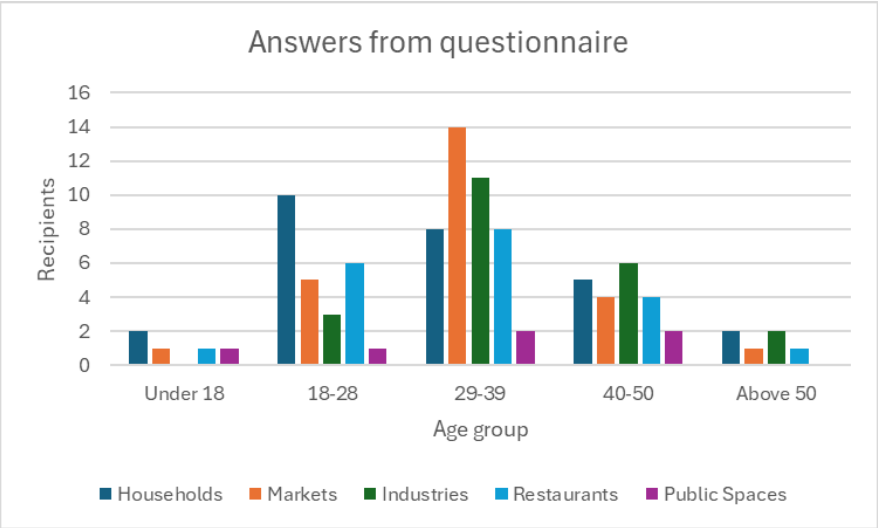

Figure 9: Major sources of plastic pollution identified by each age group.

Based on the recipients believe on plastic waste being a major contributor to flooding the are in (Table 8), 43 were for while the remaining 52 were against and not sure and this more than 50% not abiding to my theory made room for plastic not being the main cause of flooding.

Table 8: The degree of waste Accumulation in Causing Floods

Yes	No	Not Sure
43	38	14

Impacts of floods on daily activities as per (Table 9) is illustrated below for the general study area shows an understanding devastating effect on businesses as shops are closed. There is also destruction of property that followed next, and we had some concerning health issues destruction of transportation and communication networks.

Table 9: Impacts of flooding

Transportation	Property	Health	Business	Other
10	33	13	36	3

My research was centred around 3 regions in Douala and thanks to Google Earth, the display of coordinates of my displayed locations where questionnaires were distributed are seen in an aerial view of Douala. I later made use of Arc GIS pro to symbolise the different sex of recipients who answered my questionnaire wherein females where symbolised in red circles and males in black hexagons as seen in (Fig. 10a, 10b and 10c

Figure 10: Aerial view of case study (Makepe, Bonaberi and Bonapriso) via GOOGLE EARTH

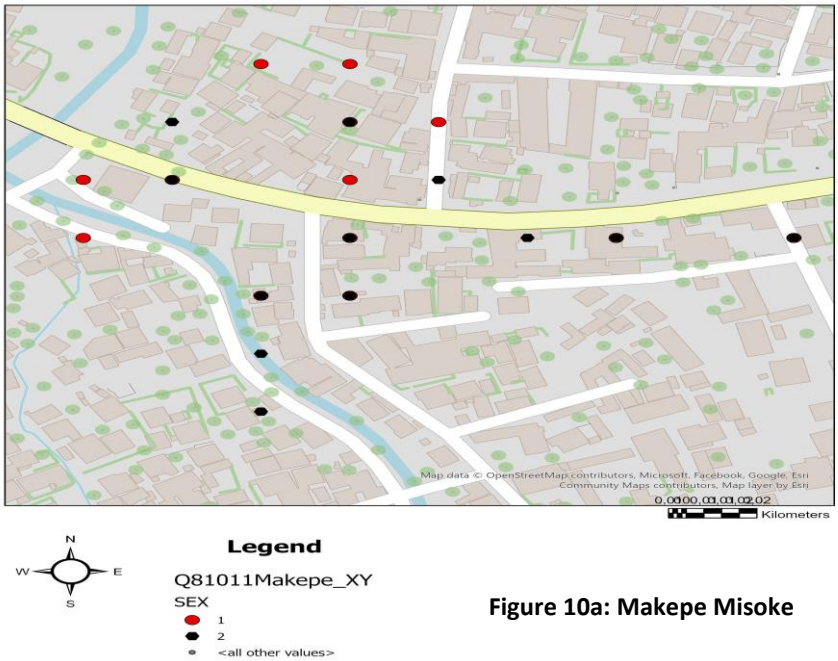

Figure 10a: Makepe Misoke

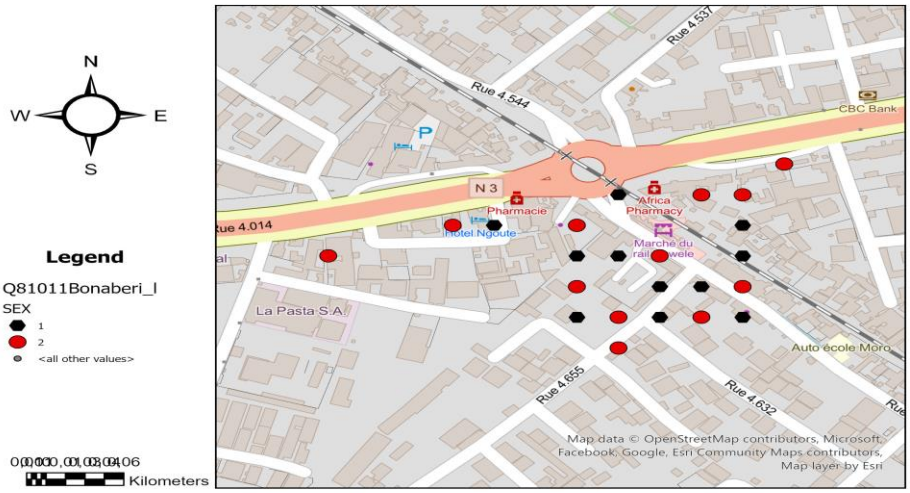

Figure 10b: Bonaberi

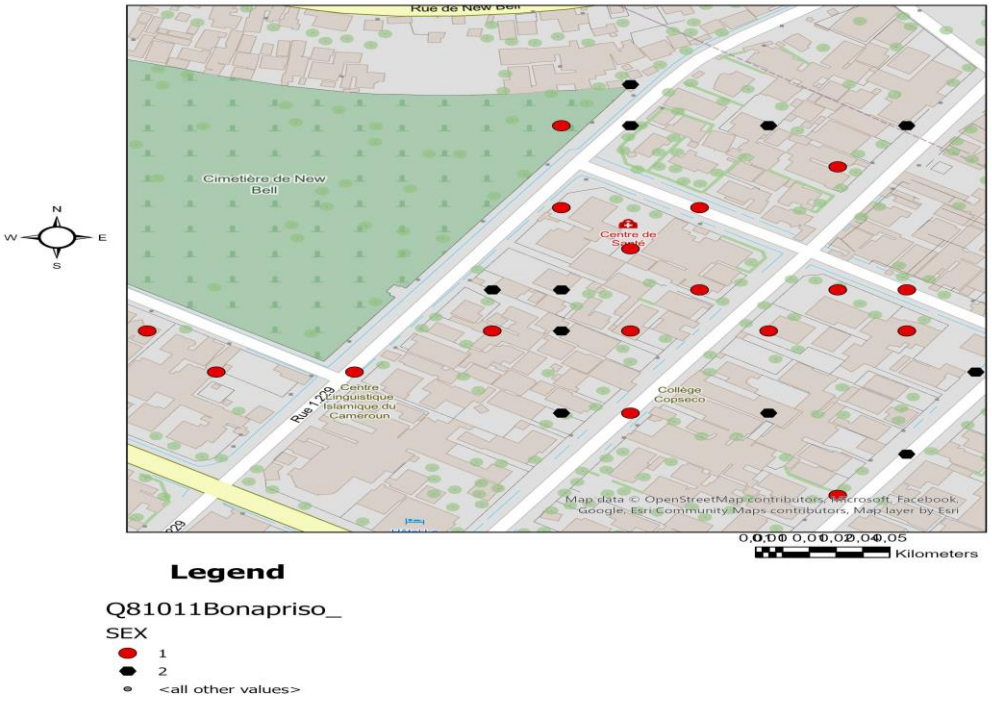

Figure 10c: Bonapriso

In addition to this, I conducted a perception analysis regarding the relationship between plastic pollution and the frequency of floods, referring to questions 10 and 11 in the questionnaire (Appendix 1). A good number of participants 43 respondents were certain most of the floods in their neighbourhood was caused by plastic blocking water paths while 14 recipients were not sure as to plastic being the main cause and 38 recipients did not agree that floods were caused by plastic pollution. So, I can't conclude on plastics being the main cause of flooding from this perceptions.

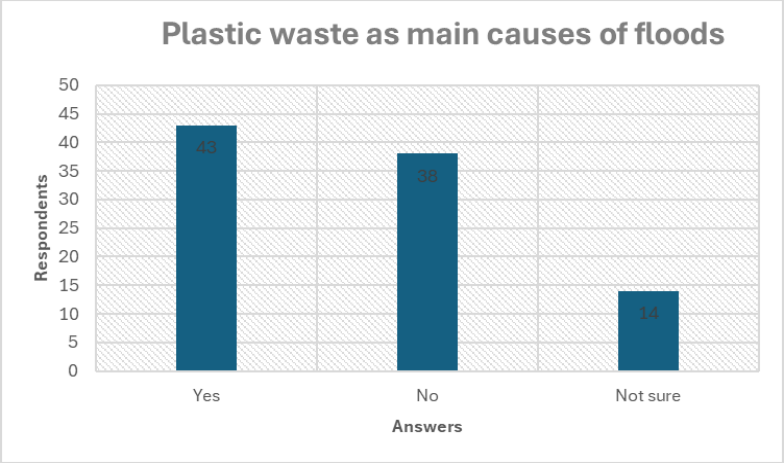

Figure 11: Main causes of floods in case study

I also noticed as seen in (Figure 12) 87 participants confirming that floods frequently occur in these areas and 7 people said it occurs occasionally while 1 person in Bonapriso said it occurred rarely

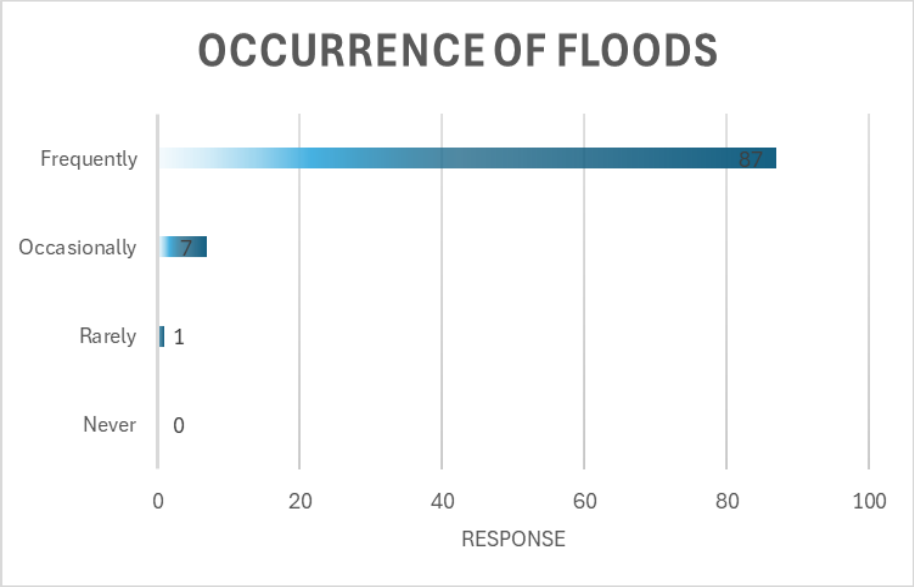

Figure 11: Flood occurrence in Study area

I used a large-scale terrain analysis and flood modeling software called Scalgo to represent catchment areas in my study area, as illustrated in (Figure 13, 14 and 15) below, specifically in the case of Makepe. In these figures, the green polygons represent zones where water drains into the main watershed. These areas are situated above flood levels, so water from these regions flows down into the red polygons which directs the water to sea and ocean, which represent the catchment areas. As water accumulates, plastic waste swept along with the water downstream causes blockages in the drainage systems that receive water from the green zones.

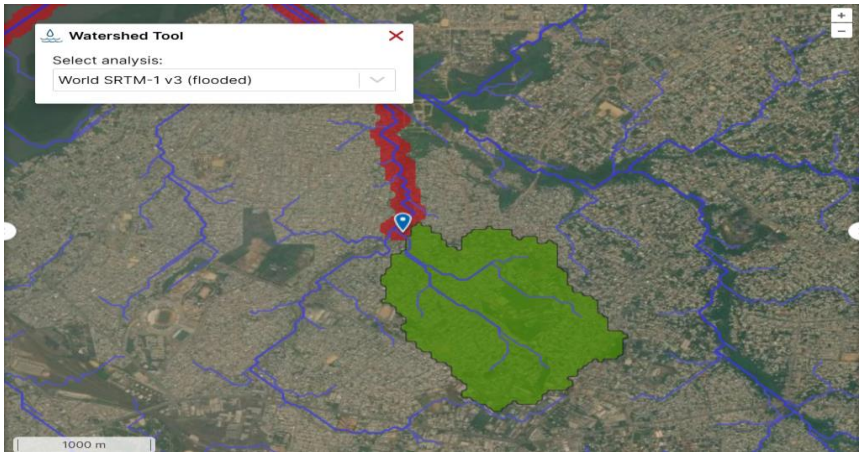

Figure 12: Watershed for Makepe
Source: Scalgo Live (2024)

Figure 14: Watershed and Catchment Bonapriso
Source: Scalgo Live (2024)

Figure 15: Watershed and Catchment Bonaberi
Source: Scalgo Live (2024)

During the study, we observed significant amounts of plastic waste across all study areas, with noticeable accumulation in drainage systems. Much of this waste was mixed, indicating a lack of effective waste separation practices. Additionally, the waste management company (HYSACAM) often left waste uncollected for several days, further exacerbating the situation. It was evident that there were no designated separation chambers for waste, leading residents to dispose of their trash in hazardous ways. This inadequate waste management infrastructure contributes to the ongoing plastic pollution and flooding challenges in the region.

Upon trying to understand these accumulations, I investigated the methods of waste disposal by participants, and I noticed that their waste disposal methods are seen as shown in the (figure 15a) below

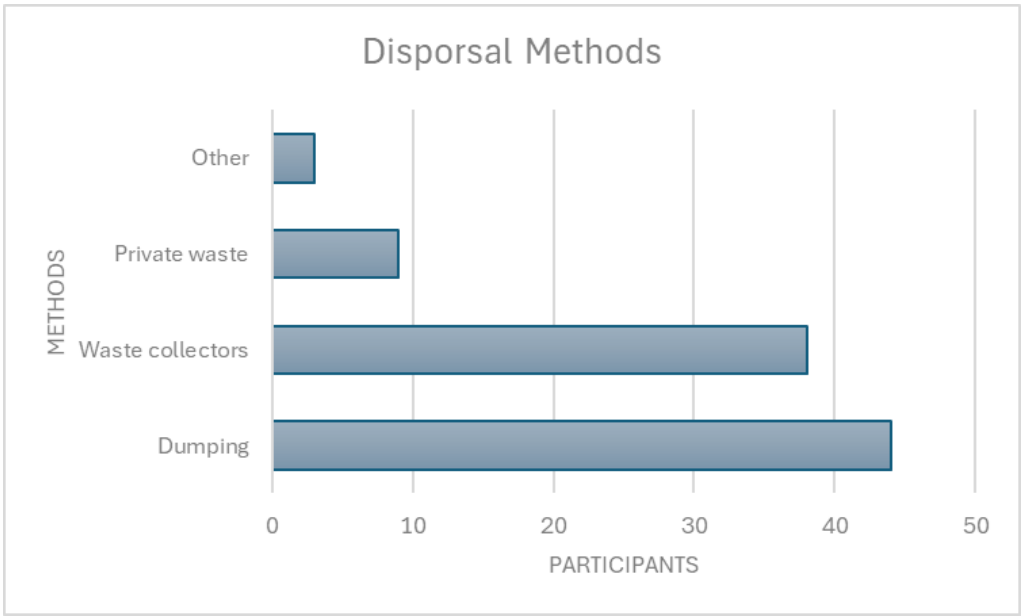

Figure 15a: Waste Disposal methods

From our questionnaire, 44 recipients admitted dumping sites was the main dumping methods while 38 admitted that HYSACAM's collection bins were their main disposal method and just 9 people talked of private dumping as these private waste collectors take them and sort to so, the can get recycling raw materials especially plastic bottles and 3 people talked of how they use the biodegradables as manure for their farms on their yards and gardens and they also said they incinerate the non-bio products (plastic bags, plastic bottles, textiles, electronics).

During the interview session, many recipients confirmed using opendumping as best means of dumping as they accused the waste collectors for not emptying the large waste cans making them full and disgusting (Figure 16) and (Figure 17) below show open dumping site in two of my study areas.

Figure (16): Dumping sites in Bonaberi

Figure17: Dumping sites in Makepe Misoke

These images illustrate our study areas, captured in October 2024. These pictures reveal an abundance of mixed waste, predominantly composed of various types of plastics. Often, this waste is washed from dumping sites into drainage systems, where it accumulates and causes blockages. This prevents the free flow of water during rainy seasons, exacerbating flooding in areas as water leaves from large areas to be channelled to the ocean via Scalgo.

From these observations, we can clearly identify the challenges faced by the waste management company HYSACAM, as well as the community's attitudes toward waste management. We strongly believe that these factors contribute significantly to flooding in the region. To address these issues, corrective actions must be implemented, and my report outlines several recommendations for mitigation.

Given the urbanization trends and the significant challenges of plastic waste pollution in Douala, my study suggests that younger respondents tend to associate household waste with plastic pollution more than older respondents. Older individuals, in contrast, perceive industrial and market sources as more prominent contributors. Additionally, Douala's flat topography, low elevation, and contribute to the accumulation of water after rainfall. This hinders the flow of plastics washed into water channels (such as drainages), causing blockages and leading to overflow, which in turn results in property damage.

Beyond the destruction of property, flooding also poses a significant risk to food crops, which are often destroyed during such events. This reduction in crop availability leads to higher food prices and lower living standards, as hunger spikes due to limited food in local markets. The flooding also has a devastating effect on public health, as it facilitates the spread of waterborne diseases such as cholera, typhoid, and diarrhoea, which are prevalent in Douala (Mabel N. et al., 2022).

The lack of waste separation practices, inadequate waste collection by HYSACAM, and improper disposal methods by residents are key factors exacerbating the plastic pollution problem. These issues need to be addressed in the context of Cameroon's local realities.

During this research, I faced several challenges. One of the main obstacles was administering the questionnaires, as many participants were unwilling to engage without an incentive. To overcome this, we developed a strategy of offering small incentives to market vendors, asking them to spare 10 minutes for our surveys and interviews. Additionally, the unavailability of detailed data on flooding events, plastic waste accumulation, or infrastructure posed a challenge. We were unable to access certain data that we had collected during an internship at HYSACAM, as we were not permitted to use it for this research.

While my study suggests a relationship between plastic pollution and flooding, I cannot definitively claim that plastic waste is the main cause of flooding in Douala as the interaction between plastic waste and flooding is likely complex and influenced by multiple factors, including rainfall intensity, seasonal variations, the quality of urban infrastructure (such as the drainage system), and population growth. Cameroon's climate has been changing and this has caused extreme generally associated with strong rainfall causing floods to many cities and Douala in particular. (Derbetini A. Vondou et al, 2021)

5 DISCUSION

Plastic waste pollution is being treated as an alarming issue not just in Douala or Cameroon in particular but all over the world as every country has its own effects of this non-biodegradable plastic affecting the ecosystem. My study is aimed at assessing the impacts of plastic waste pollution in exacerbating urban flooding in Douala, Cameroon, with a particular focus on identifying the source of plastic waste and understand the role of waste management in Douala with respect to my research topic. Through a combination of a comprehensive questionnaire survey, in-depth interview and data analysis, I was able to uncover several key insights into the relationship between plastic waste and flooding and propose sustainable waste management practices that could mitigate these challenges.

From my research, I noticed plastic waste plays a vital role in exacerbating flooding in Makepe, Bonaberi and Bonapriso primarily by obstructing drainage systems and blocking water flow leading to increase water stagnation during rainfall events, contributing to huge property lost, serious health risks and disrupting daily activities. My surveys and interviews targeted at Waste management workers, market people, residents, urban planners and youths gave us more knowledge with a good majority of respondents sighting insufficient waste collection services, lack of public awareness, and inadequate policies as primary contributors to the problem and coupled to rapid urbanisation due to the ongoing Anglophone crises and climate change has amplified Douala's vulnerability to flooding. I also tried using Digital Elevation Models (DEM) to create a 3D representation of the terrain, which could help in mapping and urban planning in Douala as the study area exhibits a high Topographic Wetness Index (Beven and Kirkby, 1979), which contributes to water accumulation following heavy rainfall but due to my amateurism on this software, I had to let go. Scalgo helped me see the watersheds and catchment areas to assess the downstream and upstream.

Above all, addressing the double challenge of plastic waste pollution and urban flooding in Douala, there is urgent need for multifaceted approach that involves collaboration between local government authorities (Ministry of environment, Protection of Nature for Sustainable Development MINEPDED), communities, and private sector, and all stakeholders. I therefore outlined a set of recommendations that will help Douala move towards a more sustainable and flood resilient city. My research highlights the need for

continued monitoring and adaptive management strategies to ensure that Douala's urban infrastructure is better equipped to cope with the growing challenges of plastic waste pollution and urban flooding in the face of climate change reasons I will encourage upcoming students, researchers and experts' home and abroad to investigate more on this problem and develop better sustainable practices for this beautiful city.

6 CONCLUSION

This research reveals how demographic factors such as age, sex and occupation influence perceptions of plastic waste pollution and its impacts on flooding While many residents in Douala are aware of the direct link between plastic waste and flooding, their understanding of the sources and solutions remains varied. Plastic waste, primarily from households, markets, streets and industries, and inadequate waste management systems, is found to clog the city's drainage channels, hindering water flow and increasing the likelihood of flooding during heavy rains but this is not fully endorsed as a good number of the residents believed other factors such as poor drainage system, poor urban planning and even deforestation contributed to floods. Moreso, the socio-economic impact of flooding in Douala is substantial as residents report disruptions in transportation, property damage, health risks, and business interruptions as some of the most pressing concerns. However, there is also a call for stronger enforcement of waste disposal laws such as Re-use, Recycling or reducing and some mitigation measures for effective waste management strategies like improved waste collection, recycling initiatives, and public education campaigns. In conclusion, there is an urgent need for a more integrated waste management system, greater community engagement, and policy enforcement. Future research could focus on evaluating the effectiveness of specific flood mitigation strategies and exploring the potential for sustainable urban development practices to reduce both waste generation, do better city planning and maintain drainage system so as to reduce flooding risks flooding risks in Douala.

7 LIMITATIONS

This piece of work wasn't as smooth as it feels from as I had some difficulties which consisted of:

1. Collecting participants information wasn't an easy task as most were not concerned about our project, we had to promise to buy goods sold by the market people to get them interested in participating.

2. We had many people whose data was taken from some position so, making the points on map look limited compared to participation as same coordinates took 3 questionnaires at times

3. I also lost 5 questionnaires during analysis this affected the participation rate.

4. My absence on field made it difficult to have the real feel of operations.

5. Data restriction clause I signed prevented me from using the available data in my possession during my internship. So my had to work without.

6. I had other issues too with Scalgo as i didn't get high resolution flood modelling making it difficult to exactly know how the water is going.

7. Plastic pollution may not be the sole contributor of flooding as during our interview sessions, most participants attributed other factors related to flooding such as poor drainage systems, Deforestation and excessive rainfall.

8 RECOMMENDATION

In my humble opinion, I have a series of suggestions to this research which I hope, and wish can be considered wherever need arises. I think the first step to combatting this problem is by unity, every stakeholder from Government to private sector, vendors, students every person needs to work hand in gloves as a synergy to understand the core issue and how it will affect each and every one of them in the future which I named Sustainability Communicative Approach and through this approach, promoting waste segregation at the household level and increasing public awareness about the environmental impacts of plastic waste will be facilitated and will help reduce the volume of waste entering drainage systems.

1.1 Mitigation of plastic pollution

Plastic pollution truly calls for concern and needs to be addressed and this escalation needs to be tackled now and the youths have got a great role to play in making Douala, Cameroon and the world better for future generations. Some measures in reducing plastic include;

1.1.1 Legislature

The Cameroonian government and city councils need to adopt strong policies to reduce the huge production of non biodegradablenon-biodegradable plastics; (Zalasiewicz et al., (2016). The London Convention (1975) or London Protocol (2006) aim to effectively control all sources of marine pollution including implementation of practical steps to minimize dumping of waste at sea Joan et al; (2016) made a study to an proposed sewage and dredged materials might be added to blacklist as they are likely to contain some amounts of microplastics.

1.1.2 Public Awareness

The population of Douala generally has a role to play as public awareness is societies' level of understanding of the existence of the problem, its causes and consequences public awareness campaigns are can becan be made to advertise the plastic waste pollution through various media channels, education, events and activities. Moreso, educate Douala people on consumption and disposal of single-use plastics. Plastic Pollution Coalition;Coalition: (2019) and pay keen attention on making the people know about the

devastating effects of straw and encourage them to drink strawless drinks or avoid using straws.

1.1.3 Re-use of plastics

The re-using of plastic bags, bottles and even plastic pallets will hugely reduce plastic waste production and propagation as well as we know plastics have a very long life span and aside these reasons, it turns ourout to be cost efficient as well as consumers will save alot in not paying extra money for plastic bags.

1.1.4 Recycling

Plastic recycling has become a vital part in the fight against plastic littering as it ensures a good number of plastics in nature can be recycled forrecycled for production of same or other products for instance primary recycling of plastic bottles in a closed loop to produce plastic bins or crates. Recycling greatly combats plastic pollution as most plastics turn out to e raw material for production of other plastic components.

1.1.5 Community cleanup

Water bodies like rivers, seas and oceans are are main routes for transporting plastics from one place to another and thus beach cleanup campaigns are essential for plastic waste reductionreduction, and it is important to have regular clean-up events to remove plastic waste from public areas, rivers, and beaches, fostering community involvement.

1.1.6 Research and Innovation

Research has helped made eco friendlyeco-friendly packages like biodegradable bags more appealing and beneficial in the fight against plastic waste pollution, thanks to research and innovation, many countries include price for plastic bottles at groceries where the can get back their money after using the bottles. Seabin project Leonardi, (2018) also helped in cleaning oceans via its catching capacity of 20Kg of debris. Ocean cleanups to help mitigate marine plastic pollution.

Moreso, enhancing waste collection efficiency through the expansion of coverage to every part of Douala and having fixed frequency of services, particularly in informal settlements, is essential. Organising sectoral clean up campaigns on weekends in case the HYSACAM

workers do not respect the routine cleaning. MINPEDED must implement stricter regulations on plastic production and disposal such as high taxes and encourage the promotion of biodegradable alternatives through incentives. Finally, cleaning drainage systems before the start of the rainy season or building better water pathways taking into consideration the Topographic Wetness Index of every corner of the city will help mitigate floods and make Douala and Cameroon a sustainable city.

I developed these other proposals to overcome the limitations listed above:

- Work more with local community leaders who already have established trust in the community to help encourage participation.
- Using a higher-accuracy GPS device or apps that can give precise coordinates will help get a millimetre difference in coordinates.
- Using GIS 123 Survey in making digital surveys would avoid me from losing any questionnaires and have real time back up and cloud-based storage.
- Using remote video tools such as making regular video calls and having a good internet connection to indirectly participate in activities.
- I would have considered other available flood modelling software or data platforms that can offer better resolution, such as GIS-based tools or open-source platforms like QGIS, which can work with high-resolution satellite data.
- I had to conduct a more thorough analysis that incorporates all contributing factors such as poor drainage, deforestation, rainfall, using statistical models to assess the relative impact of each factor on flooding in every area.

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10 APPENDICES

Appendix 1

Questionnaire to inhabitants of study area (Makepe, Bonaberi and Bonapriso) to understand the impacts of plastic waste pollution in aggravating urban flooding in Douala.

English Version

Dear Respondent,

You are invited to participate in a research study as part of my Bachelor thesis aimed at understanding the impact of plastic waste pollution on urban flooding in Douala. Your answers will help me better understand how plastic waste influences drainage systems and contributes to flooding. This questionnaire will take approximately 10-15 minutes to complete, and your responses will remain confidential.

Thank you for your valuable time and contribution.

Section A: Demographic Information

1. **Gender:**
   - Male
   - Female
   - Other (please specify): _____
2. **Age:**
   - Under 18
   - 18-28
   - 29-39
   - 40-50
   - Above 50
3. **Level of Education:**
   - No formal education
   - Primary
   - Secondary
   - University
4. **Occupation:**
   - Student
   - Civil Servant
   - Business Owner
   - Other (please specify): _____

Section B: Knowledge and Awareness of Plastic Waste Pollution

6. **What do you believe are the major sources of plastic waste in Douala? (Select all that apply)**
   - Households
   - Markets
   - Industries
   - Restaurants/Food Vendors
   - Public spaces (e.g., streets, parks)
   - Other (please specify): _____
7. **How would you rate the management of plastic waste in Douala?**
   - Very poor
   - Poor
   - Average
   - Good
   - Excellent
8. **Have you noticed plastic waste accumulating in drainage systems around your area?**
   - Yes
   - No
   - Not sure

Section C: Experience with Flooding and Drainage Issues

10. **How often does your neighbourhood experience flooding during the rainy season?**
    - Never
    - Rarely
    - Occasionally
    - Frequently
11. **Do you believe plastic waste is a major contributor to flooding in your area?**
    - Yes
    - No
    - Not sure
12. **How would you describe the severity of the flooding in your area over the past 5 years?**
    - Less severe
    - Unchanged
    - More severe
13. **How does flooding impact daily life in your neighbourhood? (Select all that apply)**
    - Disruption of transportation
    - Damage to property
    - Health risks (e.g., waterborne diseases)
    - Loss of business or income
    - Other (please specify): _____

Section D: Perceptions on Waste Management and Flood Mitigation

15. **How effective do you think the government's waste management efforts are in preventing urban flooding?**
    - Ineffective
    - Neutral
    - Effective
16. **What waste disposal methods are most commonly used in your area? (Select all that apply)**
    - Dumping in open areas
    - Municipal waste collection services
    - Private waste collection
    - Other (please specify): _____
17. **What actions do you think can help reduce plastic waste pollution in Douala? (Select all that apply)**
    - Public awareness campaigns
    - Stricter regulations on plastic use
    - Improvement of waste management services
    - Recycling initiatives
    - Community clean-up efforts
    - Other (please specify): _____
18. **What measures do you think can be taken to reduce flooding in Douala? (Select all that apply)**
    - Improved drainage systems
    - Better waste management practices
    - Better urban planning
    - Regular cleaning of gutters and drains
    - Other (please specify): _____

Section E: Personal Opinions and Recommendations

19. **Do you think plastic waste pollution will worsen the flooding situation in Douala in the future?**
    - Yes
    - No
    - Not sure
20. **What personal actions, if any, do you take to reduce plastic waste in your area?**
    - Reuse plastic items
    - Participate in clean-up campaigns
    - Properly dispose of plastic waste
    - Advocate for recycling
    - Other (please specify): _____
    - None
21. **What recommendations would you give to the local authorities to address the issues of plastic waste and flooding?**

_____
_____
_____
_____
_____

Thank You for Your Participation!

Questionnaire Pidgin

Dear Respondent,

You dey invited to take part for one research study wey dey try understand how plastic dorty dey affect town flooding for Douala. Your answers go helep me know how plastic dorty dey influence drainage systems and dey contribute to flooding. Dis questionnaire go take around 10 to 15 minutes, and your answers go remain secret.

Thank you for your small time and contribution.

Section A: Demographic Information

Sex:

- Male
- Female
- Other (please specify): _____

Age:

- Under 18
- 18-28
- 29-39
- 40-50
- Over 50

Level of Education:

- I no go school
- Primary
- Secondary
- University

Occupation:

- Student
- Civil servant
- Business man
- Other (abeg specify): _____

Section B: Awareness of Plastic Waste Pollution

Wetin you feel say be the main place wey plastic dorty di comot for Douala?

- Households
- Markets
- Industries
- Restaurants/Food vendors
- Public spaces (e.g., streets, parks)
- Other (please specify): _____

How you go rate plastic dorty management for Douala?

- Very poor
- Poor
- Average
- Good
- Excellent

You don notice plastic waste dey gather for drainage systems for your area?

- Yes
- No
- No sure

Section C: Experience with Flooding and Drainage Issues

How often your area dey experience flooding for rainy season?

- Never
- Rarely
- one one time
- Frequently

You think say plastic waste na major cause of flooding for ya area?

- Yes
- No
- No sure

How you go describe the seriousness of flooding for ya area in the last 5 years?

- Less serious
- No change
- More serious

How flooding dey affect daily life for your neighborhood? (Check all wey apply)

- worry transport transport
- spoil cargo
- brind sick dem (e.g., cholera, dysentry)
- Loss of business or money
- Other (abeg specify): _____

Section D: Views on Waste Management and Flood Mitigation

How you see gomna yi management fo dorty fo prevent floods?

- Ineffective
- Neutral
- Effective

Wetin be ya style for waste disposal for your area? (Check all wey ei apply)

- Dumping for open spaces
- Municipal waste collection services
- Private waste collection
- Other (please specify): _____

Wetin you think wey ei fit help reduce plastic waste dorty for Douala? (Check all wey apply)

- Awareness campaigns
- Stricter regulations on plastic use
- Improve waste management services
- Recycling initiatives
- Community cleanup efforts
- Other (please specify): _____

Wetin you feel say fit help reduce flooding for Douala? (Check all wey apply)

- Improve drainage systems
- Better waste management practices
- Better urban planning
- Regular cleaning of gutters and drains
- Other (please specify): _____

Section E: Personal Opinions and Recommendations

You think say plastic pollution go make flooding worse for Douala fo future?

- Yes
- No
- Not sure

Which kind thin you di do fo reduce plastic dorty for your area?

- Reusing plastic items
- Join clean up meeting them
- Properly trowey plastic dorty
- put power fo recycling
- Other (please specify): _____
- None

Wetin you fit recommend for local authorities to arrange plastic dorty and flooding palava?

VERSION FRANÇAISE

Cher répondant,

Vous êtes invité à participer à une étude de recherche dans le cadre d'une thèse de licence visant à comprendre l'impact de la pollution par les déchets plastiques sur les inondations urbaines à Douala. Vos réponses m'aideront à mieux comprendre comment les déchets plastiques influencent les systèmes de drainage et contribuent aux inondations. Ce questionnaire prendra environ 10 à 15 minutes à compléter, et vos réponses resteront confidentielles.
Merci pour votre temps précieux et votre contribution.

COCHER LA CASE CORRESPONDANT A VOTRE REPONSE

Section A : Informations Démographiques

1. Sexe :
   - ☐ Masculin
   - ☐ Féminin
   - ☐ Autre (veuillez spécifier) : _____
2. Âge :
   - ☐ Moins de 18 ans
   - ☐ 18-28 ans
   - ☐ 29-39 ans
   - ☐ 40-50 ans
   - ☐ Plus de 50 ans
3. Niveau d'étude :
   - ☐ Pas d'éducation formelle
   - ☐ Primaire
   - ☐ Secondaire
   - ☐ Université
4. Profession :
   - ☐ Étudiant(e)
   - ☐ Fonctionnaire
   - ☐ Propriétaire d'entreprise
   - ☐ Autre (veuillez spécifier) : _____

Section B : Connaissances et Sensibilisation à la Pollution par les Déchets Plastiques

6. Quelles sont, selon vous, les principales sources de déchets plastiques à Douala ? (Cochez tout ce qui s'applique)
   - ☐ Ménages
   - ☐ Marchés
   - ☐ Industries
   - ☐ Restaurants/Vendeurs de nourriture
   - ☐ Espaces publics (ex : rues, parcs)
   - ☐ Autre (veuillez spécifier) : _____
7. Comment évalueriez-vous la gestion des déchets plastiques à Douala ?
   - ☐ Très mauvaise
   - ☐ Mauvaise
   - ☐ Moyenne
   - ☐ Bonne
   - ☐ Excellente
8. Avez-vous remarqué des déchets plastiques s'accumulant dans les systèmes de drainage de votre région ?
   - ☐ Oui
   - ☐ Non

- ☐ Pas sûr(e)

Section C : Expérience avec les Inondations et les Problèmes de Drainage

10. **À quelle fréquence votre quartier est-il touché par des inondations pendant la saison des pluies ?**
    - ☐ Jamais
    - ☐ Rarement
    - ☐ Occasionnellement
    - ☐ Fréquemment
11. **Pensez-vous que les déchets plastiques sont un contributeur majeur aux inondations dans votre région ?**
    - ☐ Oui
    - ☐ Non
    - ☐ Pas sûr(e)
12. **Comment décririez-vous la gravité des inondations dans votre région au cours des 5 dernières années ?**
    - ☐ Moins grave
    - ☐ Inchangée
    - ☐ Plus grave
13. **Comment les inondations impactent-elles la vie quotidienne dans votre quartier ? (Cochez tout ce qui s'applique)**
    - ☐ Perturbation des transports
    - ☐ Dommages matériels
    - ☐ Risques pour la santé (ex : maladies d'origine hydrique)
    - ☐ Perte d'activité ou de revenu
    - ☐ Autre (veuillez spécifier) : _____

Section D : Perceptions sur la Gestion des Déchets et l'Atténuation des Inondations

15. À quel point pensez-vous que les efforts du gouvernement en matière de gestion des déchets sont efficaces pour prévenir les inondations urbaines ?
    - ☐ Inefficaces
    - ☐ Neutres
    - ☐ Efficaces
16. **Quelles méthodes d'élimination des déchets sont les plus couramment utilisées dans votre région ? (Cochez tout ce qui s'applique)**
    - ☐ Déversement dans des zones ouvertes
    - ☐ Services de collecte des déchets municipaux
    - ☐ Collecte privée des déchets
    - ☐ Autre (veuillez spécifier) : _____
17. **Quelles actions pensez-vous peuvent aider à réduire la pollution par les déchets plastiques à Douala ? (Cochez tout ce qui s'applique)**
    - ☐ Campagnes de sensibilisation
    - ☐ Règlementations plus strictes sur l'utilisation du plastique
    - ☐ Amélioration des services de gestion des déchets
    - ☐ Initiatives de recyclage
    - ☐ Efforts de nettoyage communautaires
    - ☐ Autre (veuillez spécifier) : _____
18. **Quelles mesures pensez-vous peuvent être prises pour réduire les inondations à Douala ? (Cochez tout ce qui s'applique)**
    - ☐ Amélioration des systèmes de drainage
    - ☐ Meilleures pratiques de gestion des déchets
    - ☐ Meilleure planification urbaine
    - ☐ Nettoyage régulier des caniveaux et des drains
    - ☐ Autre (veuillez spécifier) : _____

Section E : Opinions Personnelles et Recommandations

19. Pensez-vous que la pollution par les déchets plastiques aggravera la situation des inondations à Douala dans le futur ?
    - ☐ Oui
    - ☐ Non
    - ☐ Pas sûr(e)
20. Quelles actions personnelles, le cas échéant, entreprenez-vous pour réduire les déchets plastiques dans votre région ?
    - ☐ Réutiliser des objets en plastique
    - ☐ Participer à des campagnes de nettoyage
    - ☐ Éliminer correctement les déchets plastiques
    - ☐ Plaider pour le recyclage
    - ☐ Autre(veuillezspécifier) _____
    - ☐ Aucune
21. Quelles recommandations donneriez-vous aux autorités locales pour traiter les problèmes de déchets plastiques et d'inondations ?

    _____
    _____
    _____

Merci de votre participation !

Appendix 2

We did interviews to gather first hand data of the inhabitants' experiences and understanding their perspectives and personal anecdotes that can enhance the report's credibility. I listed a series of interviews which are:

- What is your understanding of plastic pollution?
- Have you noticed any changes in flooding patterns in your locality and to what extend does plastic contribute to it?
- Can you describe any flooding in your vicinity and how frequent does it occur?
- What do you think about the current waste management in your neighbourhood and how do they contribute to flooding?
- How significant does plastic waste block drainage system and how can you reduce this?
- How do you foresee the future of flooding in Douala if plastic waste continues to rise and what role can the younger generation play to tackle this issue?