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Status of plastic packaging use and its environmental impact in the city of Basoko (Tshopo Province, DRC)

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Abstract
This study consists of an assessment of the problem of poor management of plastic packaging and its environmental risks in the city of Basoko. Three techniques were used to carry out this work: direct observation, documentary analysis, and surveys. The analysis reveals that despite the Congolese legislation, the production and use of plastic packaging among the local and urban population is still ongoing practice. In the city of Basoko, a rural entity, the use of plastic packaging, population also relies on cardboard and plant leaves from forest as packaging. The only difference is that the ardboard and leaves are biodegradable. According to the categorisation, our sample includes a total of 550.81kg of packaging distributed as following: 36.8% is green waste (leaves), 66.4% refers to the sample of 360 interviewed using flexible plastic packaging (bags). 50% of people who incinerate the packaging after its use. Regarding the risks of this packaging for the environment, the surveys show that 66.7% of the population has no access to information. Furthermore, there is a lack of involvement of public structures responsable for environmental safety and the awareness of the population. Yet, the effects of plastic packaging are visible and can have negative impact on the environment.

Keywords: ***Use of plastic packaging, environmental impact, City of Basoko, DRC***

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I. Introduction

The use of plastic packaging has become an integral part of people consumption patterns. Such a comfort is not without consequences for the environment. According to studies conducted by CEPRIPADE (2012), plastic waste represents 10% of the total tonnage of waste in African cities. It is mainly polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS) and polyethylene terephthalate (PET). These plastic wastes create real environmental problems.

According to Ilombe et *al* (2022), plastic packaging contains toxic pollutants that damage the environment and cause soil, water, and air pollution. Plastic can take hundreds or even thousands of years to decompose, so the damage to the environment is long lasting. Several authors (Thompson et al., 2009; Pilz et al., 2010; Ilombe et al. 2022) suggest that the consequences of plastic waste are diverse and include impacts on the immune and respiratory systems, endocrine disruption, decreased fertility, increased risk of cancers... These effects exist at every stage of the plastic life cycle and therefore multiply the health consequences.

In the cities of the Republic, as far as the Democratic Republic of the Congo (DRC) is concerned, it is enough to simply make a small tour in our cities such as Kinshasa, Kisangani to realize the mountains of garbage which are raised in the vicinity of the markets, in the streets with the sight and the knowledge of the public authority responsable of the public salubrity as in other countries. The Decree N° 17/018 30 of December 1017 of the DRC prohibits the production, the importation, the marketing, and the use of plastic bags, sachets, films and other plastic packaging for the sale of food, water, and any drink are prohibited in the DRC.

According to the Social Justice Issue Report (NU, 2021), governments are encouraged to adopt and strengthen the implementation of the ban on single-use plastics and facilitate plastic reduction, recycling and reuse. Unfortunately, for the DRC, this DECREE N°.17/018 30 of December 1017 has remained a dead letter. Studies conducted by the UN (2015) in DRC concluded that on a daily basis 48,154 kilos of plastic waste (plastic bottles, bottle caps, food packaging, plastic bags, lids, straws, etc.) are produced, and that 85% of this

waste is poorly managed. Plastic packaging alone represents 9.89%. Many of the daily users do not even think about where this waste could end up. This ignorance affects even some of the biggest producers. With the reality of the country, this volume is constantly increasing to the point of raising the debate on the management and effective treatment of plastic waste in the DRC.

The city of Basoko does not escape this sad reality. Wastes from different vendors, consumers are thrown here and there releasing nauseating smells that compromise public health. The poor management of waste can therefore lead to a health and environmental disaster because landfilling leads to the degradation of landscapes (soil occupation, visual and olfactory pollution...; (UNEP, 2005). The decomposition of waste releases methane - a powerful greenhouse gas - and toxic elements (such as heavy metals) that contaminate the soil and groundwater. Meanwhile, plastic packaging and other trash continue to thrive and finish abandoned in the wild (Gyres Institute, 2013).

Plastic pollution disproportionately affects marginalized communities and those living near plastic waste production and processing sites, generating an environmental injustice, (see recent report by the United Nations Environment Programme (PNUE, 2019): *Plastic pollution, an environmental injustice for vulnerable communities (NU, 2022).*

As a result of mismanagement, packaging (especially in bags) is abandoned in nature causing the unhealthier environment. Therefore, the research questions of this study are the following:

- What are the different types of packaging used by the inhabitants of the city of Basoko and which is the most used?
- Are there among these plastic packaging, those that are biodegradable and non-biodegradable?
- What are the environmental impacts observed in the field?

In general, in the city of Basoko, the use of plastic packaging (bags) is beginning to take place in the habits of the population, neglecting the traditional packaging (sheets, bags made of raffia). with all the environmental consequences. almost completely ignored by the community of the city of Basoko. Due to a poor management, the packaging (especially in bags) are abandoned in the nature causing the insalubrity of the environment. To this end, the main objective of this paper is to evaluate the use of plastic packaging and to illustrate its environmental impact in the city of Basoko. The specific objectives are among others: (1) to identify the plastic packaging used in this city, (2) to quantify the most used and (3) to show the management mode and its impact on the environment.

The poor management of waste contributes to climate change and air pollution. It also directly affects many ecosystems and species. Both aspects are therefore subject to special regulations for their management and recovery under Congolese law.

II. Material And Method.

Study environment

The city of Basoko is located on the right bank of the Aruwimi River near its confluence with the Congo River; it is served by the RP 405 road 266 km northwest of the provincial capital Kisangani. It is located between a latitude of 1.23333, a longitude: 23.58331° 13′ 60″ North, 23° 34′ 60″ East and an altitude of 381 m. Its surface area 2,267,700 H or 22,677.00 km² (Figure 1).

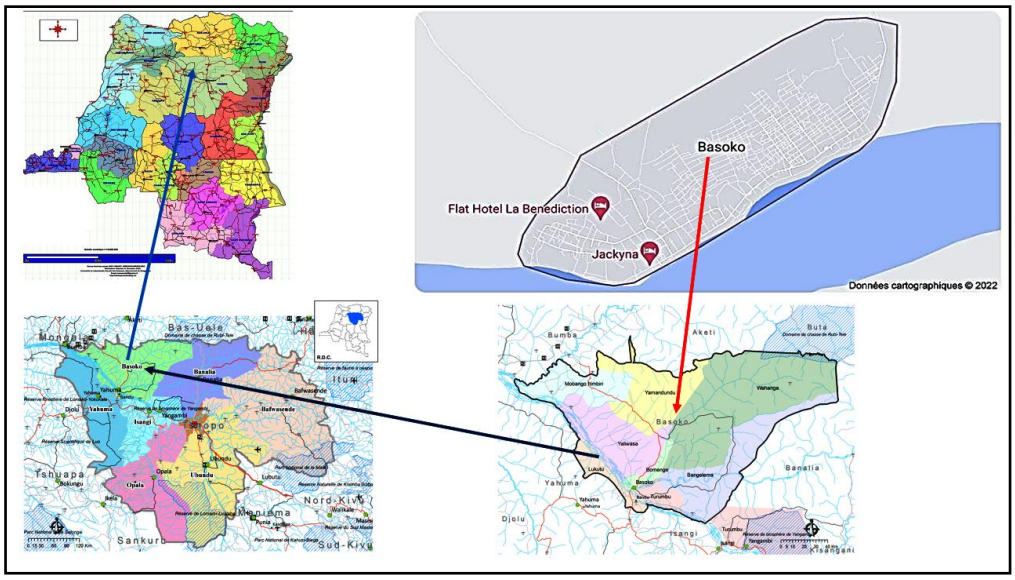

Figure 1: Map of the city of Basoko in the upper right corner.

The climate is Aw type according to the classification of Koppën belonging to the equatorial climate with the alternation of two seasons, the rainy season and the dry season. The average temperatures during the year vary between 24° and 30°; its soil is relatively clayey-sandy and suitable for tropical crops.
The total population of Basoko is estimated at 46,600 inhabitants, of which 24,233 are men and 22,367 are women; the majority of this population is composed of young people. Its density is 3,328.5 inhabitants/km2. (Urban Office, 2020).

III. Methodology

Data collection

To carry out this study, we used the descriptive method supported by three techniques (direct observation, documentary and surveys "semi-structured interview and focus group"). For the last technique, the circle layout was adopted to avoid hindering the freedom of expression between the researcher (facilitator) and the participants (Gavard-Perret et al., 2011; Moreau et al., 2004).
In the field, we used: an empty bag to collect and transport the waste; bags for the collection of each type of waste collected; a scale for weighing the waste to draw a sample of the garbage and determine the composition of the waste deposit.

Data analysis and processing

To collect data, we drew a sample of 30 garbage cans at least twice a week for 6 months (Figure 2 and 3). Then we sorted the waste in such a way as to collect a different type of waste in each bag and weigh each bag containing a different type of waste by taking the weight of each type of waste collected. Finally, these data were recorded in a notebook. During the surveys in the city of Basoko, we interviewed 390 people, i.e., 90 people per commune.

Figure 2. *Sale of plastic packaging (A&B) and food packaged for sale (C) in the vicinity of Basoko Central Market (Photos, Afundi Ndetshala Didi, May 2022)*

The total sample of the study includes 550.81 Kg of waste drawn from public and household garbage cans in the city of Basoko and 90 households (responsible for purchases for their households). For this paper, variables that were used for the analyses are: the type of waste, the proportion of plastic packaging in the total mass of waste, the mode of management of packaging after use; the behavior of the population in relation to waste and the harm of packaging on the environment (Figure 3).

We analyzed the qualitative data from the questionnaires and semi-structured interviews with the SPSS version 16.0 program. This program was used to code all the data collected in the field. It proved to be very useful during the analysis of the data, in this case the production of averages, frequency tables and contingency tables. The processing of the data first focused on the search for percentages and arithmetic averages of the variables analyzed. To better analyze our data, we used descriptive statistics.

Figure 3. *Collection of different plastic packaging in bags, cardboard ... discarded in the main street of Basoko (Photo: Gendodone Bakalanga, May, 2022).*

IV. Results

Socio-demographic analyses

Socio-demographic data are fundamental. They define largely the social position of any person for this study. They include : Age range, Sex, Family status, Profession, Level of study. The histogram (figure 2) shows the results of the socio-demographic variables. From this table, the following results can be seen according to the socio-demographic variables: the age group between 31 and 51 years is the most representative, (58.9%), followed by the age group between 18 and 30 years, which is represented by 23.1%. - Regarding the sex we have considered useful to represent the principles of son-in-law, that is 50% female and 50% male. According to the family status, 35,6 % of our respondents are married. They are followed by single people represented by 35%. According to the profession of our target population, the most important are state officials who are supposed to protect the environment and enforce the law, are best represented with 37.5%, followed by teachers who are the trainers of the population (31.7%). In addition, according to the same table, 58.9% of the respondents in the city have secondary level of education.

The equation of the regression quality index (R^2) or linear coefficient of determination of the explained variance is significant (> 0.05). This shows the inequality of the interviews despite the observed balance.

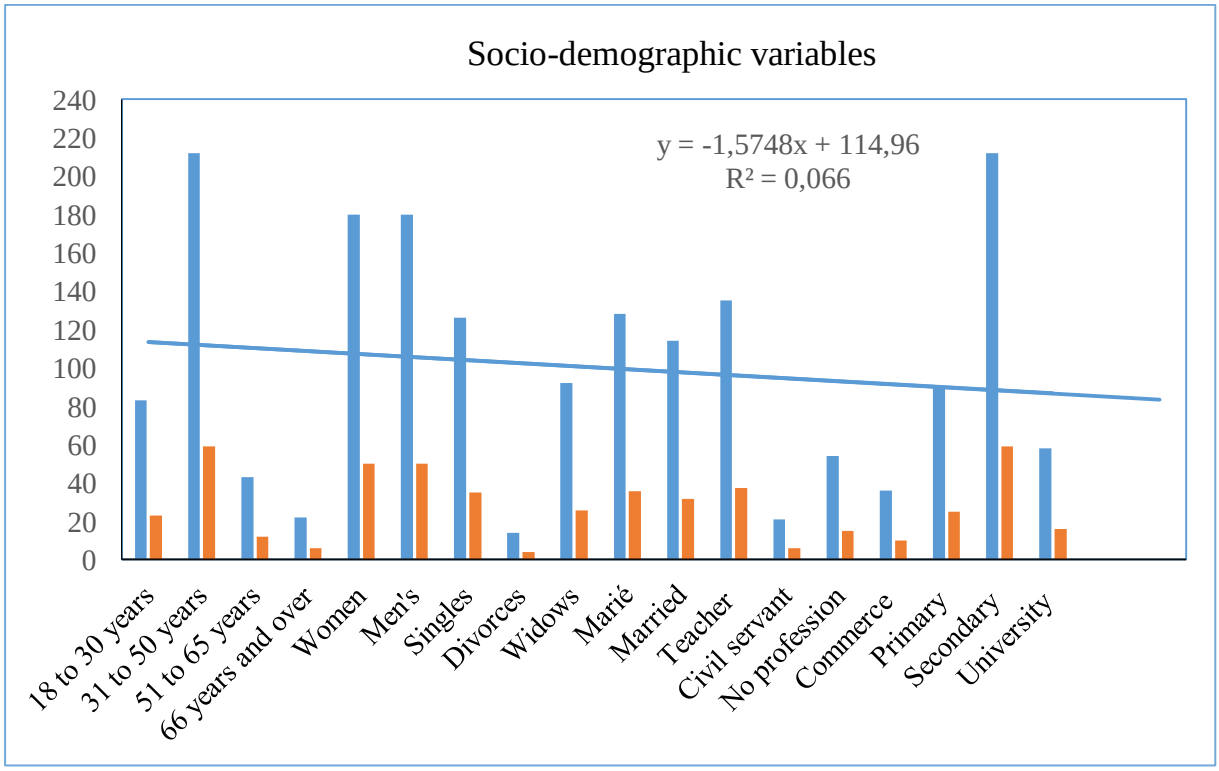

Figure 4. Histogram of surveys by socio-demographic variables

Characterization of packaging in the city of Basoko.

The waste of the dustbins of the city of Basoko include a total of 550,81 Kg of waste representing 100% of our sample. Green waste (leaves) are best represented with 202.700 Kg (36.80%) (Table 1). They are followed by soft plastic waste which is composed of 165.79 Kg (30.13%). The high rate of leaf waste in the garbage of the City of Basoko is explained by the fact that the staple food of its inhabitants is cassava (*Manihot esculenta*).

The majority of the population does not have enough money to buy long lasting multipurpose rice bags at home. Rice becomes expensive and is only affordable for households with a high living standard. Poor people therefore daily rely of cassava leaves. The garbage and waste category can be considered as indicators to determine the food consumption and (living standard) by households in the city.

Tableau 1 : Caractérisation des emballages de la Ville de Basoko.

Type	Weight in kg	Percentage
Cardboard waste	109,29	19,82
Hard plastic waste	63,63	11,55
Soft plastic waste	165,79	30,13
Sheet metal waste	9,40	1,70
Green waste (leaves)	202,70	36,80
Total	**550,81**	**100**

Source : Our field surveys

Types of packaging used

The data related to the use of packaging by the population of Basoko town is recorded in Table 2 below. Out of a total of 360 people interviewed on the use of packaging for the transport of goods purchased at the market, 250 people (69.4%) use flexible plastic packaging (bags). They are followed by another 85 people (23.6%) who use hard plastic packaging. We also found that the abundant use of soft plastic packaging (bags) compared to other packaging is explained by the fact that this packaging is less bulky, more practical, easily transportable despite the risk of tearing because it cannot support a large weight.

Table 2: Category of packaging types.

Type of packaging	**Fréquence**	taux
Hard plastics	85	23,6
Soft plastics (bags)	250	69,4

Green packaging (sheets)	20	5,56
No packaging	5	1,39
TOTAL	**360**	100

Source: Our field surveys

How plastic packaging is managed after use.

The management of waste and waste limitation aims to reduce its effects on human and environmental health and the living environment. For some decades now, emphasis has been placed on reducing the effect of waste on nature and the environment and on its recovery in a circular economy perspective. Data related to the waste management method can be found in Table 3. It informs us that out of 360 people questioned on the management mode of plastic packaging, 180 other people interviewed (i.e. 50%) incinerate this packaging after use and 120 other people (i.e. 33%) tell us that they throw the packaging (especially bags) in the street. Unfortunately, there is no mechanism to recycle this packaging.

Table 3: Management of plastic packaging after use.

Management method	Frequency	Percentage
Incineration	180	50
Storage in landfills	60	16,67
Discharge into Streets	120	33,33
TOTAL	**360**	100

Source: Our field surveys

Other purposes of use of waste by the population

The information concerning the management of packaging by the population of our study area is recorded in table 4. In total 228 people (63.3%) burn the waste after filling the garbage cans, while another 60 people (16.7%) use the waste as green manure for their gardens.

Table 4: Use of waste by the population of the city of Basoko for other purposes.

Type of use	Frequency	Percentage
Green fertilizer for gardens	60	16,7
Filling of swamps	48	13,3
Dikes against rainwater	12	3,33
Filling of holes in the streets	12	3,33
Incineration	228	63,3
TOTAL	**360**	100

Source: Our field surveys

Awareness on the environmental hazard of garbage

The data on the population's knowledge of the environmental risks of garbage is shown in Table 5. This table shows that 240 people (66.7%) have no knowledge of the environmental risks of waste and 120 other respondents (33.3%) recognize that waste is a danger for the environment. Analysis of this table and the results of Table 6 shows that a good number of respondents are unaware of the environmental hazards posed by waste.

Table 5: Population's knowledge of the environmental danger of garbage.

Answers	**Fréquence**	**Pourcentage**
Knowledge	120	33,3
No knowledge	240	66,7
TOTAL	**360**	**100**

Source: our field surveys

Harms of Garbage by Population

The information on the harms of garbage is recorded in Table 6. Table 6 shows that 120 people (33.3%) said that garbage destroys the beauty of the environment, 96 people (26.6%) said that garbage is a reservoir for harmful insects such as flies, mosquitoes, cockroaches, etc. The remaining 96 people (26.6%) said that garbage causes odor. The other 96 people (26.6%) said that the garbage gave off foul odors. While 48 people (13.4%) said that the waste of all kinds, clogged the sewers and other drainage channels. Indeed, the garbage abandoned all around the city (in full view of the local public authorities), markets, in front of the plots, affects the morphological aspect of the environment.

Table 6: People's Views on the Harms of Garbage (Mismanaged)

Misdeeds	**Fréquence**	**Pourcentage**
Destruction of the beauty of the city	120	33,4
Reservoirs of harmful insects	96	26,6
Release of bad smells	96	26,6
Clogging of sewers	48	13,4
TOTAL	**360**	**100**

Source : nos enquêtes sur terrain

V. Discussion

Use of plastic packaging

The current situation of plastic waste management in the DRC is increasingly worrying and little progress has been made in this area. Plastics have now invaded the daily life of the Congolese. Almost 30% of household waste in the DRC is made up of plastic packaging. According to the Technical Directorate of the National Agency for Meteorology and Remote Sensing by Satellite (METELSAT), despite natural disasters due to heavy rainfall in the DRC, plastic waste has invaded, for ages, the soil and streams, including the Congo River, for ages.

These buried plastic bags block the pipes and make the soil impermeable by preventing the infiltration of rainwater. As a result, water flows on the surface, causing the overflow of gutters already obstructed by plastics. This causes flooding and soil degradation leading to human death and multiform damage in many urban areas.

It is important to highlight that Decree No. 17/018 of 30 December 2017 on the prohibition of production, import, marketing, and use of bags, sacks, films, and other plastic packaging, in its Article 1 paragraph 1 states: "the production, import, marketing and use of bags, sacks, films and other plastic packaging for the sale of food, water, and any other beverage are prohibited in the DRC", Official Journal of the DRC of March 1, 2018, No. 5, col 82).

With regard to the provision in the Decree mentioned above, the constituent established this legal order with the unique goal of protecting the environment against any non-degradable material. For a good implementation, the decentralized entities must adopt this law on the protection of the environment within the framework of the protection of their entities such as it was initiated in its time in the city of Kinshasa by the circular No. SC/ 002/ GVK/ GMM/2021 of January 2021 in the only desire to preserve the Kinshasa environment.

Policymakers have to address the key issues of environmental protection and the impact of pollution on people's quality of life and the planet's sustainability. They must empower people to become active agents of sustainable and equitable development and bring communities at the centre of solutions for environmental problems. To this end, environmental education of the population and capacity building of institutions will help protect the environment in the DRC.

Furthermore, the results of our study are in line with those of KAPAMONA (2013) who stated that poor waste management in Kisangani resulted in several health and environmental problems. AFRIKA (2013), in his study entitled "*Problematic of sanitation in schools in the commune of Mangobo in Kisangani"* concluded that waste management in the mentioned schools was not improved by the fact that the number of garbage cans put at the disposal of the users was essentially low to the extent that the pupils threw away the waste they produced.

NIKIEMA(2012), in his master's thesis entitled "*Plastic waste in Ouagadougou: characterisation and analysis of the population's perception*", using the method of characterization of plastic waste, concluded that the waste deposit in the city of Ouaga was largely made up of flexible plastic packaging and hard plastics, which is in line with the results of our study with regard to the type of waste used. This plastic waste is then thrown into bins, gutters and streams. This has negative consequences for both the ecology and human health

Threats of plastic packaging to the environment and human health

In the city of Basoko, packaging waste is dispersed in the environment without respecting hygiene rules and waste management legislation. As a result, this waste can spread into the environment through leachate percolation, runoff of leachate into nearby watercourses, or through outgassing of volatile compounds trapped in the waste matrix that escape into the open air, or through flying debris and dust.

The results in Table 4 show that 50% of the population incinerates this packaging after use and 33% throw the packaging on the street. Unfortunately, there is no mechanism for recycling this packaging. These environmental poisons can last up to 100 years or more and burning them generates harmful gases. They contribute to pollution by incineration, which generates many chemical pollutants such as dioxins and concentrated heavy metals like mercury, lead, and cadmium or arsenic. "This is a big problem for the city.

Unfortunately for the inhabitants of Basoko town, incineration is the most common way of managing waste disposal, they simply ignore other ways of handling it. "This is a big problem at the city level.

Unfortunately for the people of Basoko, the incineration is the most common way of disposing of waste, they simply ignore other ways of managing it. This also shows the resignation of the public authority which has no policy for good waste management despite the risk it represents. According to Bergeret (2002), waste incineration (especially plastic packaging) is very harmful to human health and also to the environment. According to Barles (2005) and Rocher (2006), the sound use of waste management includes the collection, trading and brokering, transport, treatment (treatment of waste), recycling, or elimination of waste, usually those resulting from human activities

According to our results, plastic packaging waste not only threatens the physical environment, but can also lead to a range of public health problems. 33% of the respondents suggest that the garbage destroys the beauty of the environment and for 27% of the respondents, the garbage constitutes a reservoir for harmful insects such as flies, mosquitoes, cockroaches, etc.

These results are related to those of KULONDWA (2008) who evaluated the problem of plastic solid waste management in the commune of Bagira; those of DJE A, (2012) in his doctoral thesis on *Governance and management of urban household waste in Abidjan: case of the communes of Abobo, Cocody and Yopougon*, and BILUBI, U (2014) on his work entitled "*public insalubrity and environmental health in the sanitary district of Bukavu.* Both studies show that the waste made of plastic packaging, exacerbated by diseases, is an integral part of the global pollution crisis. Waste management problems, alongside biodiversity loss and climate change, represent a triple planetary emergency that must be addressed through massive changes in the way humanity uses natural resources.

According to the report of The United Nations Environment Programme (UNEP, 2019), the consequences of plastic waste on vulnerable populations goes far beyond inefficient and sometimes non-existent waste management systems. The World Health Organization (WHO 2010) emphasizes in its report that the effects of non-biodegradable packaging are diverse for human health, in particular on the immune system and the respiratory system, endocrine disruption, decreased fertility, increased risk of cancer ... These effects exist at each stage of the life cycle of these plastic packaging and thus multiply the consequences on health (Asimbo et al., 2021).

A question of social justice for human and his environment

In the DRC, despite the ban, nothing is done on the ground, while the law recommends that governments expand their monitoring of plastic waste, study its health effects, and invest in its management. Governments are also encouraged to adopt and strengthen the implementation of the ban on single-use plastics and facilitate the reduction, recycling and reuse of plastic.

In addition, they should organize awareness campaigns among the affected communities and help them to take action by ensuring access to an effective judicial system that respects the principles of environmental justice, such as free prior and informed consent (FPIC), and the right of access to information." Plastic packaging pollution is a social justice issue," suggests the Azul Founder's report, and because, "current efforts to manage and reduce plastic pollution are insufficient to address the full range of problems it causes. "(see https://www.rewmi.com/la-pollution-plastique-une-injustice-environnementale-pour-les-communautes-vulnerables/). This confirms our results regarding the population's knowledge of the environmental danger of garbage. The majority of respondents (66.6%) is unaware of the dangers that garbage represents for the environment due to the lack of awareness of the population.

According to the founder of Azul, "the disparate impact on communities affected by plastic at every stage from production to waste, should make environmental justice a matter of course in the field of conservation." (see https://news.un.org/fr/story/2021/03/1092962)

In addition, the report responds to UN Environment Assembly resolution 2/11, calling on UNEP to further study the environmental, health and social impacts of plastics. It demonstrates how plastic waste undermines the achievement of the Sustainable Development Goals (SDGs), including SDG1 on poverty eradication, SDG2 on zero hunger, SDG14 on the protection of marine ecosystems, and SDG16 on access to justice for all and effective, accountable and inclusive institutions at all levels.

The urgency and seriousness of the situation require that sanitation becomes a major national concern. It requires changes in behavior and the adoption of urgent measures. The country's institutions must reflect the will to eradicate, if not significantly, reduce the harm of this pollution to ensure a healthy environment and good health to the people, in accordance with Article 53 of the Constitution.

VI. Conclusion

The present study is an assessment of the use and environmental impact of plastic packaging in the city of Basoko. The surveys conducted reveal that the use and management of plastic packaging poses many problems in the city despite a decree of the Prime Minister abolishing the production of these tools. In addition, the study has also allowed to list the daily problems that hinder the sector.

In particular, the results obtained show that the waste in the city of Basoko is made up of sheet waste and flexible plastic waste (bags). Most used packaging for the transport of food after purchase at the market is the flexible plastic packaging. The poor management of the packaging visibly reveals environmental impact and destroys the most visible morphological aspect of the environment (beauty) with the release of stinky smells. These smells also pollute the physical environment as result of the waste incineration.

Despite the law infringement, the authority of the city of Basoko should implement a good policy for waste management in general, and punish those who keep the garbage in front of the houses and public places; organize collective works of the sanitation of the environment (this regularly). Therefore, we advocate for awareness campaigns on the insalubrity to sensitize the population about the consequences of the waste in the environment.

While municipal authorities and non-governmental organisations represent an important link to waste management through their pre-collection activities, they are notable for their lack of environmental and public health awareness. In other words, the involvement of all citizens is necessary. Therefore, we suggest to the municipal and city authorities to strengthen the effort of informing and raising awareness among households on the need to limit their consumption of plastic bags as much as possible.

A great deal of work will need to be done with all the actors, particularly the population, in order to improve their civic awareness of this problem.

This is why, in our next steps, we will develop certain aspects that are not fully developed or not addressed in this document, in particular

- an in-depth analysis of the different forms of spatial differentiation in the city to better understand the real causes.
- a more in-depth approach to waste recovery methods in order to optimize their use.

As the expression suggests: "the best waste is the waste that is not produced".

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