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HOUSEHOLD WASTE MANAGEMENT AND ENVIRONMENTAL PROBLEMS OF THE CITY OF PORTO-NOVO

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Abstract

In Benin, municipal solid waste poses a threat not only to the environment, but most importantly to public health and safety (EBA, 2002). The general objective of this research is to inventory the infectious foci and pre-collection structures of DSM in the city of Porto-Novo

In order to achieve the results, several software and data collection tools were used. These are questionnaires, the development of landfill census records and observation grids, Garmin 60 GPS for surveying the geographical coordinates of the dumps and seats of DSM pre-collection structures, cameras digital for taking photos of dumpsites and observations made on the ground of certain phenomena, Arc GIS 10.3: is used for the realization of the thematic maps and the spatial analyzes. The target population is composed of heads of households in the 31 districts selected for the study. The application of Schwartz's formula (1995) made it possible to choose 383 people as the size of the sampling. At the end of the processing of the different data, the following results were obtained. Thus, the inventory of dumps reveals 581 dumps of DSM distributed throughout the territory of the municipality of Porto-Novo. Analysis of landfills and their areas of influence show that 92% of the surface area of the study area is threatened by a hazard, of which 34% is considered to be at high risk.

Keywords: Management, household solid waste, environmental problems

Introduction

The question of health and the environment mobilizes more and more all the actors who act in the city. This mobilization goes from the largest international financial institutions to the smallest neighborhood associations, from NGOs to municipal, communal and local authorities. The Partnership for Municipal Development (PDM) and the Water Solidarity Program (PDM / PS-Water, 2003) have emphasized that environmental damage has disastrous short and long-term impacts on the health status and population health, soils, animal and plant resources. This situation is more critical in cities where high population densities result in concentrations of waste that further complicate the problem. While in developed countries the disposal of waste is relatively well controlled, this is not the case for developing countries (Attahiet al., 2003, Aloueimine, 2006). In these, liquid and solid waste management practices contradict, even more than in the industrialized countries, the principles of ecological prudence and sustainable development. At the urban level, the accumulation of household garbage in neighborhoods poses a greater threat to health than the waste accumulating in a landfill (Ouédraogo, 2002).

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Uncontrolled landfills become infectious foci, mainly for poor urban populations (Muhigwa et al., 2000, Knezovic 2004, Sharholy et al., 2007). Potential risk factors for a landfill are proliferation of insects, rodents, childhood accidents, human and animal excreta, specific toxins (Listorti and Doumani, 2001).

In developing countries, mainly in Sub-Saharan Africa, sanitation is the "poor relation" of investments (Kientga, 1998). This is the area of least interest to policy makers (Hauptet et al., 1996, Onibokun, 2002). In large cities, most households do not have access to a collective sanitation system. It is almost 0% in Cotonou (Benin) and less than 20% in Dakar (Senegal), Dar es Salam (Tanzania) and Kampala in Uganda (Valfrey, 2003).

In Benin, it has been noted that municipal solid waste poses a threat not only to the environment, but more importantly to public health and safety (EBA, 2002).

Waste management reforms in these cities, which are primarily technical, also have a strong political dimension since they question the capacity of municipalities to control their territory and respond to the demands of international and governmental actors (Gbinlo, 2011). In this context, information spatialization tools are of great value to communities in their ongoing quest to find innovative, cost-effective solutions to different urban problems.

Just like the capitals of other countries in the sub-region, Porto-Novo is part of a growing urbanization movement resulting in the growing production of household waste, the corollary of which is the distribution of diseases.

Research environment

The city of Porto-Novo is one of nine (09) communes that counts the department of Ouémé. Located 30 km from Cotonou, it is located between 6 ° 27'10 " and 6 ° 31'53 " north latitude and 2 ° 34'15 " and 2 ° 37'29 " east longitude (Figure1). In the North, the communes of Akpro-Missérété, Avrankou and Adjarra, in the south the commune of Sèmé-Kpodji, in the East the commune of Adjarra and in the West the municipality of Aguégués constitute the limits of the city of Porto-Novo. It covers an area of 52 square kilometers or 0.05% of the national territory.

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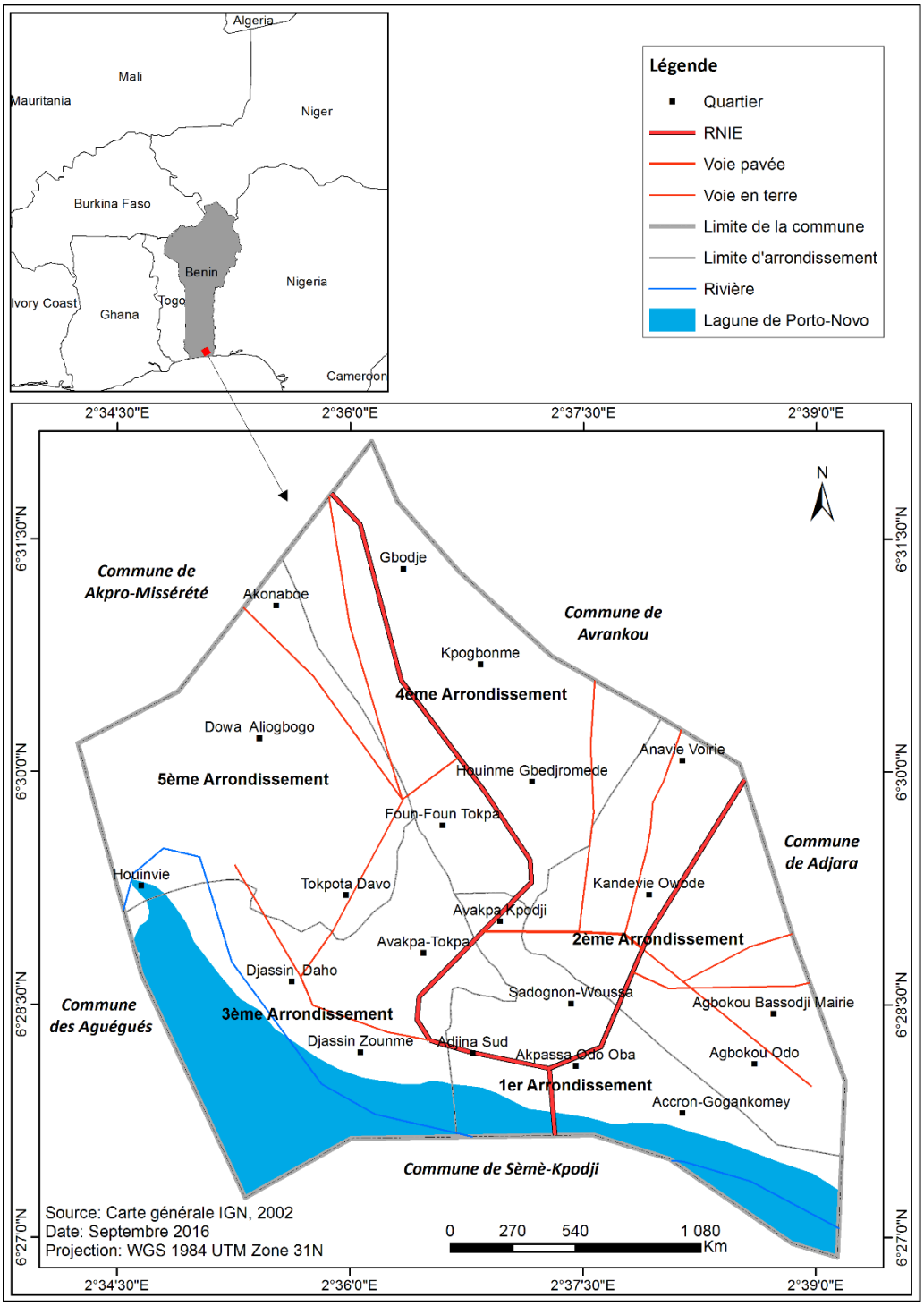

Figure 1: Location of the city of Porto-Novo

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Research methodology

Equipment used

In order to achieve better results, several data collection tools and software were used, namely: questionnaires for household surveys, landfill census cards and observation grids. The Garmin 60 GPS for the survey of the geographical coordinates of the dumps and seats of the pre-collection structures of the DSM; a digital camera for shooting dumps and field observations of certain phenomena; and ArcGIS 10.3: is used for thematic maps and spatial analysis. The spreadsheet of Microsoft Excel 2013 allowed the organization, the structuring in table and the computations of statistics and the realization of certain figures. The target population is composed of heads of households in the 31 villages selected for the study.

Sample size

The determination of the sample size is obtained following the Schwartz protocol (1995): x = (〖Z_α〗 ^ 2 × p × q) /i ^ 2 x = sample size; p = n / N with p = proportion of households in the thirty-one (31) villages selected (n) in relation to the number of households in the eighty-three (83) villages (N) of the municipality of Porto-Novo .

Thus, p = 24095 / 46,000 = 0.524; q = (1-p) = (1-0.524) = 0.476; α = 5% from where Z_α = 1.96; i = 1.5% (desired accuracy)

n = (〖1.96〗 ^ 2 × 0.524 × 0.476) / ((0.05) ^ 2) = 383.27it is 383 as the people surveyed

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Photo 1 : Poubelles à Dowa

Photo 2 : Poubelle à Adjina nord

Photo 3 : Poubelle respectant les normes à Les Palmiers

Plate 1: Types of garbage cans in different concessions

Shooting: Soglo, August 2016

Photo 1 shows some specimens of garbage cans used in spontaneous habitats. There are old buckets, old aluminum basins, old plastic basins, plastic bags, etc. None of these containers is regulatory. Photo 2 shows a homemade trash can made from recovered materials in fish shops and thrift stores. These filled bins become heavy and difficult to transport by the pre-collectors. They are often found in neighborhoods with evolving habitats. In photo3, we observe a trash can respecting the standards. But this type of container is found in almost all residential neighborhoods and rarely in neighborhoods with changing housing.

Differentiation of the quality of garbage has already been shown in the social classes. While some well-to-do households use buckets with lids and well-kept food, the poor households focus on the items of recovery (old kitchen utensils, bags, etc.) that are confused with their contents (waste). Figure 2 shows that the oldest lowers are the most used (30.95%), followed by the older (24.73%) and Dangote (17.95%). The buckets with lids remain a prestige of the wealthy households and in a way of saving household income.

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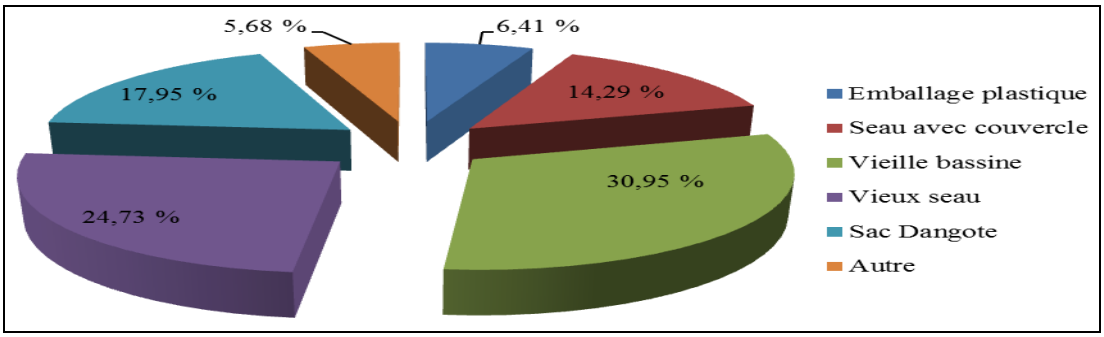

Figure 2: Representativeness of the nature of the bins in Porto-Novo

Source: Household Survey, July-August 2016

The capacity of the garbage cans, whatever their size, varies between 10 and 100 liters. The trash garlic is 90% plastic. Aluminum is aluminum or local (rattan, bamboo).

The absence of rubbish in Porto Novo means that there is still an unrivaled initial inventory. Nevertheless, some households have a strong interest in extracting reusable or marketable objects. Garbage cans are kept out of living rooms and their location varies according to their nature, the organization of the property, the location of the house in relation to the communication routes and the type of habitat (Table I).

Tableau I : Relation emplacement de la poubelle et nature de la poubelle

Effectif		Nature de la poubelle						
		Emballage plastique	Seau avec couvercle	Vieille bassine	Vieux seaux	Sac Dangote	Autre	Total
Emplacement de la poubelle	Dans la cours	6	35	84	71	56	0	252 **(46,15 %)**
	Derrière la maison	17	24	68	48	28	0	185 **(33,88 %)**
	Véranda	12	12	17	11	3	0	55 **(10,07 %)**
	Autre	0	7	0	5	11	31	54 **(9,89 %)**
	Total	35	78	169	135	98	31	546 **(100 %)**

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Source: Household Survey, July-August 2016

From the interpretation of Table II, it appears that 46.15% of garbage cans are placed in the yard, 33.88% behind the house. The installation of garbage cans in the courtyard, which generally opens onto the street, makes it easier for pre-collectors to work. The garbage cans kept in the garbage cans (10.07%) are still in good condition (buckets with lid, bags, etc.) and sometimes cost too much. This is the reason why multiple layers of garbage cans are used by people (passengers, garbage collectors, etc.). .) that do not accept that a new or clean container is used as a bin. Containers that are poorly preserved by the owners are used for other purposes that the robbers deem useful.

Exposure to risks and risks related to waste

Inequalities in access to the public waste service, as a result of an inefficient strategy in the Porto-Novo area, have led most of the inhabitants of the country to implement alternative techniques for the treatment of their household waste. This is particularly the case with incineration of open garages and savage deposits which, however, have become nuisance and risk factors. quite serious for the people. The malaise observed in the Beninese cities and specifically in Porto-Novo is inexorably reviving the debate on the right of every citizen to access a healthy environment (the security of their living environment and their well-being).

Creating Wild Deposits

An observation of the behaviors of the households in Porto-Novo makes emerge two cases of figure. On the one hand, the inhabitants who do not like to do anything (lack of will, refusal of effort, superstition, etc.) to comply with the general rules of hygiene and sanitation. The latter, although served and equipped with the necessary material, persistently dump their garbage in nature. On the other hand, some households, with garbage storage equipment, are deprived of any collection service. Therefore, the release into the nature of the waste produced becomes an alternative solution to the treatment of their waste in the hope of cleaning up their living environment. The incivism of some and the illusion of others combine to expose them as well as their close or distant entourage to the nuisances and risks. Figure 3 shows the locations of waste deposits differently used by the populations.

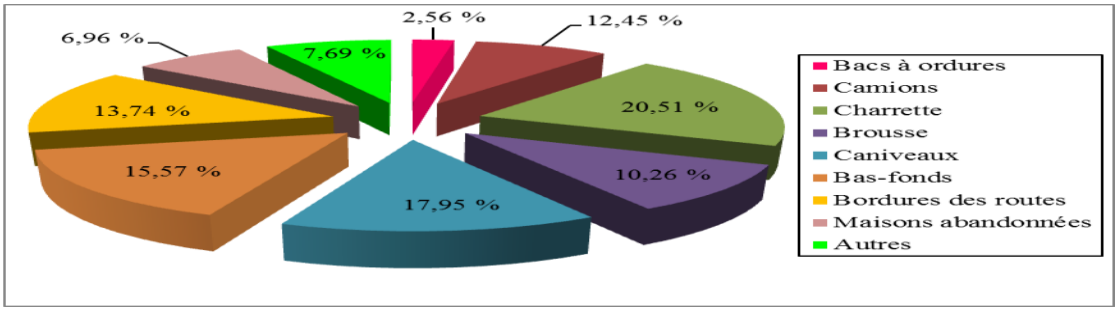

Figure 3: Household waste places in Porto-Novo

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Source: Household Survey, July-August 2016

It is noted that only 31.32% of waste is collected in the carts, bins and trucks of the collection structures (20.51% in the carts, 8.24% in the trucks and 2.56% in the bins) . The rest is disproportionately rejected in the different components of the urban environment. There are 60.99% in the industrial area as well as in the wild (bush 10.26%, road margins 17.95%, gutters 10.26%, lowlands 15.57% and houses abandoned6.96%).

Other disposal methods (7.69%) are generally the result of biodegradable materials in gardens used during planting as an organic amendment to enhance soil fertilization and backfill. Part of the putrescible waste is also piled up, recovered after decomposition and used in nurseries by horticulturists.

The rejection of waste in the nature by the inhabitants has been assimilated in several neighborhoods to a claim to a social status, that of belonging to the city of Porto-Novo: "we are also inhabitants of Porto-Novo and have the same rights… ".

This event, far from being a contempt for nuisances and risks, is only the defense of a social cause namely, assert its rights of access to the service of collection and treatment of waste that the neighborhood where it is held.

The risks and risks incurred by the population are not overlooked by the municipal authorities: "Many people are complaining because of the garbage that is detrimental to their well-being. But we do not have the human, material and technical means to eradicate all the wild deposits or to put the garbage bins in all the districts, it is the duty of the community to take care of it or to provide us the means to extend the public waste service in all the commune ".

Thepropospresents, summed upby the technical services of the Porto-Novo City Council, make it impossible to find

This is a key factor in the exponential creation of spontaneous deposits, especially along the lines of communication. In order to reduce ridership, the municipal services are currently called upon to collect structures which, unfortunately, eliminate only a fraction of the costs. This situation is reinforced in some districts by the introduction of associations, but their intervention is limited in time to the financial and financial resources made available to them by the municipality. The intermittent commitment of the populations to the destruction of the deposits is certainly a good action but still remains insufficient. As long as the tanks are not installed or the intermediate points of collection of waste are not created, the spontaneous deposits reappear at least two weeks. The exposure of the Porto-Venezuelans to the risks and risks has mainly increased by the proliferation of immovable and irremovable depots in the light of municipal authorities. the distribution of wild deposits in terms of volumes throughout the territory of the municipality of Porto-Novo (Figure 4).

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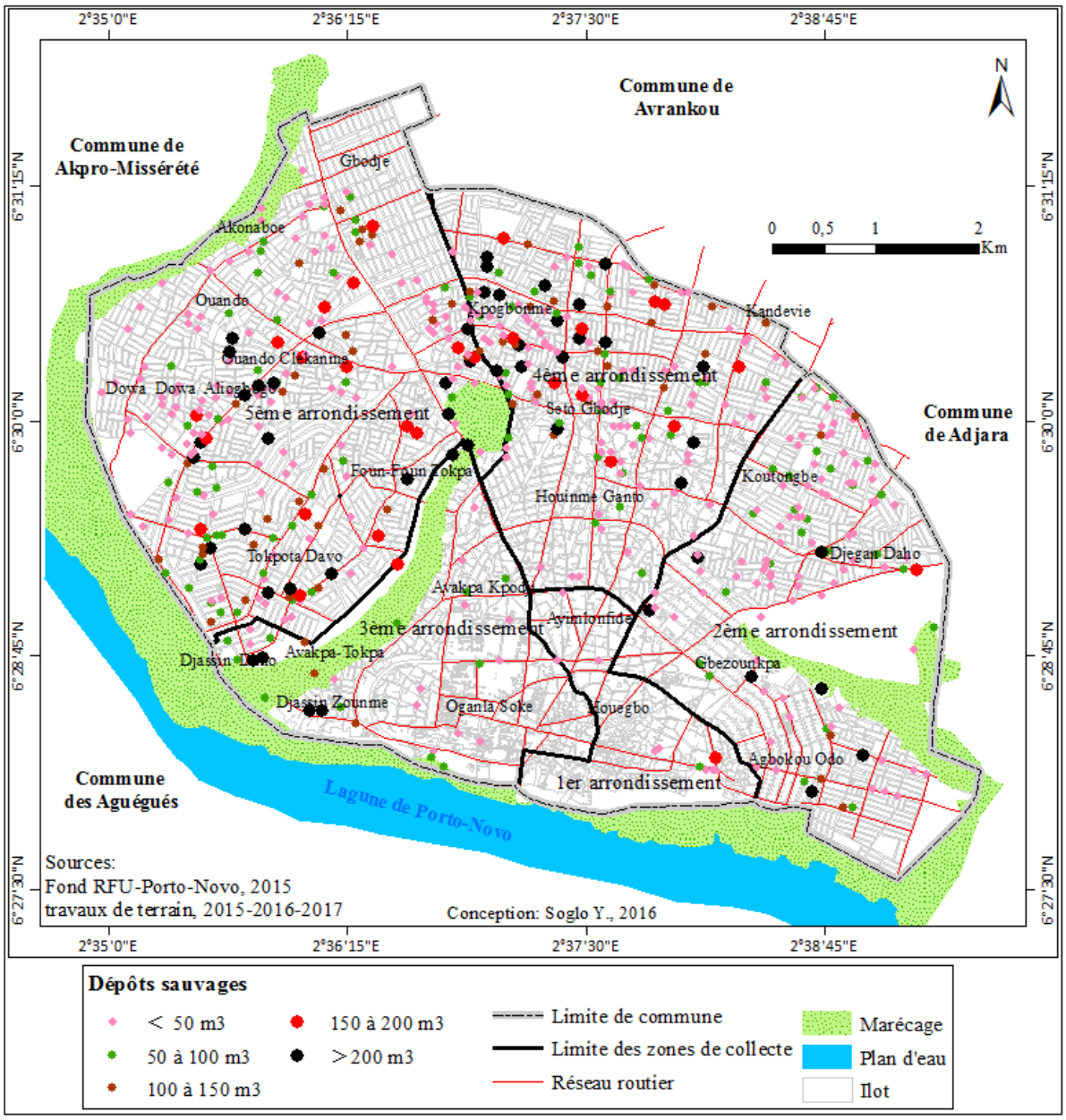

Figure 4: Location of wild deposits in the municipality of Porto-Novo

We note that, formerly reserved for underserved or unserved neighborhoods, the plague "wild deposits" has relocated in prestige and reference environments (wealthy neighborhoods, downtown, markets, etc.). The problem is already trivialized to the point of believing that the Portonovans have agreed to see and live without hindrance to daily filth (Table III).

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Table III: Volume of wild deposits recorded in the municipality of Porto-Novo

Arrondissement	Nombre de dépôts sauvages						Volume total (m^3)
	< 50 m3	50 à 100 m3	100 à 150 m3	150 à 200 m3	> 200 m3	Total	
1er arrondissement	8	1	0	1	0	10	473,68
2ème arrondissement	82	25	5	1	7	120	6840
3ème arrondissement	14	11	4	1	6	36	3221,05
4ème arrondissement	91	32	21	10	18	172	13805,05
5ème arrondissement	120	38	27	16	20	221	18117,47
Total	**315**	**107**	**57**	**29**	**51**	**559**	**42457,3**

Source: Field Investigations, 2016-2017

The phenomenon of wild deposit is very present in the 5th district of Porto-Novo. The zone of the 5th district contains 221 wild deposits (for a total volume of 18,117.47 m3 of waste). The affluent neighborhoods are not spared.

The most unhealthy neighborhoods are, Akonaboè, Dowa, Louho, Ouando and Tokpota. In these districts, over a distance of 200 to 300 meters, one could count about 10 wild deposits without having traveled all the places, their volumes vary from 15 m3 to 850 m3 lying in full nature. In informal settlements with a precarious waste collection situation, the creation and development of mounds of rubbish has for decades been anchored in the way of life of the population. The cloud of wild deposits observed along the road network is located in the popular neighborhoods. The less affected areas located at the entrance of the city (to the south) along the road network, are the urban areas still sparsely populated. Table IV after analysis, shows a volume of 42457.30 m3 of waste piled up at the time of our passage in the municipality of Porto-Novo. These statistics and the spatialization of deposits in Figure 5 are only a glimpse of the phenomenon of perennial wild deposits in the city of Porto-Novo.

Visual and olfactory pollution of waste

A high or low elevation of the capital represents a rolling city. But when you walk through it, you are quickly struck by a visual annoyance that deviates from its trajectory. The urban landscape is more than 60% damaged by the mounds of filth that rise in the scrub, erode a part of the chaussees, bury themselves in the levels,

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Sediment entaufonddesbas land. The aesthetics of the city is long-lasting, causing instantaneous embarrassment for the tourist guide, inconvenience or discomfort for the visitor and curiosity for the researcher who would be tempted to find the cause (plate **). The putrefaction of garbage in the open air under the effect of heat and humidity adds to the malaise with odor nuisance (foul odors). These mounds of garbage are also large reserves of animals (rats, flies, cockroaches, etc.) whose invasions in the habitations are current. These animals are vectors of several diseases and consequently very harmful for the populations. At the disposal of Djassin, the situation is more drastic because the people accumulate environmental inequalities.

The district is neither a space of waste production nor a space of reception of the amenities but quite simply a place of accumulation of the waste produced in the area.

Porto Novo (plate 2).

Photo 4 : Wild deposit in Koutongbé

Photo5 : Overflow bin at Dowa

Photo 6 : Wild deposit on the way from Avakpa district to Zounvi district

Photo 7 : Mound of waste along the railway line in Kokoyè

Planche 2 : Spontaneous deposits in the landscape and along the lines of communication
Shooting: Soglo, August 2016 The wild deposit (photo 4) is located along the bottom of

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Koutongbé over a length of 120 m. Its area is estimated at 725 m2 for a total volume of 3875.25 m3 of waste. It is bordered on both sides by the lowland and houses constantly subjected to cremation. Existing for several decades, this deposit is already part of the decor and life of the inhabitants.

In the photo5, in the background, there is a modest construction in front of which is deposited a 60 cubic meter tank, insufficient to contain the volume of waste produced in this local area. The waste can go up more often on the horse and, when they are removed, the dirt in the form of 24 hours. The solutions would bring to the accommodation of the inhabitants a bin of greater capacity.

Photo 6 shows that the population has built a monkey bridge that runs along the landfill for 15 m. This wild deposit was created in a wasteland and in a flood zone. Its volume is reduced periodically by incineration and torrents which carry a large part of it in the Zounvi lowland. The landfill was removed in 2006 on the left bank by the construction of a house. The last houses in the background are located 10 m from the landfill. The houses on the right bank, behind the woman on the bridge, are next to the landfill.

The garbage dump (photo 4) is located at the southern exit of the Porto-Novo railway station. In the background, there are houses. A gauche, the pedestrians escapes extreme waste with a risk of accident. On the right, 50 m away, is the bus station called "Pobè la gare".

In Zouvi, the security perimeter has been well defined. The first buildings are at least 1 km from the landfill. This cordon of safety does not prevent the exposure of residents to pestilential odors and the invasion of flies, roaches and mice in houses. According to the head of the landfill contacted in October 2016, "every three months, a campaign of disinformation and disinsection is organized in the areas bordering the site". These remarks have been verified with residents who attest to seeing the rat control campaigns from time to time. Notwithstanding, the sensible measures to reassure and protect the inhabitants take into account only part of the discomfort. The problem that annoys and depresses the residents more than the inhalation incessantfétides odors. The qualifier of a noise olfactory screaming to Zouvi (air pollution) may seem exaggerated and sometimes improbable for those who visit the dump, the neighborhood, the makeshift camp. skimmers. Because in the absence of the wind, we can observe a lull of the spread of odors for half a day or more. The reality is that the inhabitants of Zuni conjugate daily with the discharge and its odors infected without a solution to the extent of the nuisance is applied.

Incineration of open waste

The incineration of garbage is the main mode of waste treatment in neighborhoods that are not or not well served by the collection service. Figure 5 illustrates that 48% of the inhabitants recognize that they have sometimes had to do this once and for all.

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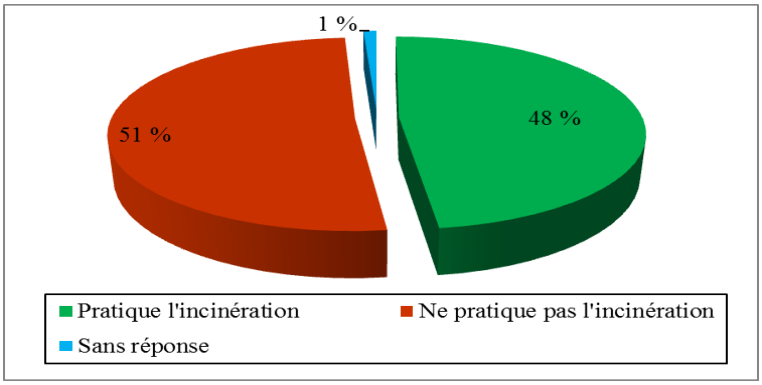

Figure 5: Participation of residents in open waste incineration

Source: Household Survey, July-August 2016

The awareness and education campaigns carried out by the associations have made people aware of the nuisances and risks generated by the incineration of garbage. All the inhabitants interviewed recognize that "Burning garbage is bad ... it's forbidden by municipal officials ... there are health risks ...". Despite these discourses, the incineration of garbage and the proliferation of wild deposits remains a common and inflexible practice among Porto-Noviens (Plate 3).

Photo 8 : Incineration of a wild deposit in Agbokou

Photo 9 : Eroded wall and swish by waste incineration fumes in Sèdjèko

Plate 3: Open burning of waste in Porto-Novo

Shooting: Soglo, August 2016

The regrouping point of Agbokou, transformed into a wild deposit (photo8), receives waste from several neighborhoods. In the background is a 60 m3 garbage bin filled. Here, it does not happen two days without the wild deposit is ignited. The fumes are continuously present in the air. Therefore, all those who live nearby inhale them on a daily basis.

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The wild deposit (photo 9) is located in Sèdjèko and runs about fifty meters between houses. We observe an eroded wall, discolored by smoke and partly engulfed by waste.

The open burning of waste is justified by the need for neglected inhabitants to get rid of and to reduce by their own methods mounds of waste that deform and disfigure their living environment. We observed that in neighborhoods such as Founfoun tokpa, Avakpa tokpa and Ouando market, households live almost in wild deposits. The frequency of ignition of the waste is sometimes weekly, which means that the landfills constantly keep smoke, inhaled on a daily basis by the children who play there, the traders who have activities in the neighborhood and the inhabitants. The walls of houses are eroded under the pressure of waste and blackened by smoke. The exposure of populations to the dangerous gases contained in the waste gases seems no longer to be a concern of the City Council. No plausible explanation has been given to justify this new tendency to incinerate heterogeneous waste in the open.

The adoption of incineration as an easy way to reduce or eliminate waste is a misunderstanding for Portonovans in terms of the risks and nuisances it may cause in the medium or long term. As Vermande P. put it by Debyser (2004), "I am convinced that when we burn garbage containing plastics, people who have lung weaknesses die of hydrochloric acid or will have their life shortened."

Waste and watercourses

There are no major rivers in the city of Porto-Novo. But the springs, the rivers and the lagoon, even if they experience a water deficit in the dry season, never dry up. The course of the rivers takes the following preferential directions: south - west and south - east. All these rivers are marshy, some are interspersed with lagoons and ponds. Their valleys are deep. The difference in level between streams and trays is clearly visible. The network of the city of Porto-Novo is a real receptacle for household waste because no form of surface water resources has so far escaped the dumping of household waste (photo 10).

Photo 10: Spillage of waste in the gutter receptacle of the waters of the Donoukin swamp

Shooting: Soglo, August 2016

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In photo 10, there is the gutter in the foreground with a mound of rubbish along it. In the background is a marshy vegetation. Most garbage comes from households located upstream because, at about fifty meters, there is a garbage bin and the area is served by mobile collection.

Households living near swamps generally do not have garbage cans. All sweeps and residues recovered in a plastic packaging, shovel, cardboard, etc. are directly thrown into a shallow. Wild deposits are created around swamps. Other sources of waste in the river system are torrents that drain wild deposits created in natural and artificial drains, on natural slopes and slopes. At the Donoukin dump, waste can remain piled on the ground for weeks. without being buried and decompose under the effect of heat and moisture creating leachate flows on the ground.

Partial distribution of the public waste service in the city of Porto-Novo has contributed to the exponential creation of wild deposits in all habitats. The elements of the environment where wild deposits are located are streams, gutters, roadsides, scrub and empty land. The transfer of waste collected from Porto-Novo to the built dumps was the solution adopted by the Porto-Novopour City Council to remove the Portonovans from their waste. The foul odors from the landfill are spread all day long in neighborhoods. Thus, the residents suffer the nuisance of waste produced elsewhere. In Porto-Novo, the same nuisances and risks appear and mix with other evils such as floods, air pollution by open burning and various pathologies.

Conclusion

The idea of this research is based on the observation that the city of Porto-Novo is facing a problem of management of its household waste. For example, waste is disposed of in landfills that do not meet environmental standards or in officially licensed but uncontrolled landfills. This type of waste disposal has disastrous short and long-term impacts on the health status of the population and the environment. Therefore, the need arose: to find a system that would optimize the waste management system for better planning actions. The present research attempted to answer this need. The general objective was to propose a GIS-based model to optimize waste management in the city of Porto-Novo, in order to better protect the health of the populations.

The work done is not based on a simple diagnosis of the public waste service. On the one hand, it was necessary to study the sources of inequalities of access to the public waste collection and disposal service, as well as the risks and nuisances incurred by vulnerable populations in Porto-Novo and the on the other hand, to use the GIS application as a tool to participate in a better knowledge of current practices and improved waste management. These two approaches make it possible to have a complementary vision of the waste issue, which is both a source of difficulties but also a source of dynamism for African cities, especially Benin.

The sustainable management of household solid waste in Porto-Novo remains an ongoing challenge facing municipalities. The problem no longer arises in terms of disposal of waste by a conventional method of landfilling. The solution would be to design and implement new strategies not only to keep waste away from living spaces, but also to structure and promote waste recovery / recycling channels.

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Bibliography

1. ABE, 2002: Directory of Environmental Indicators for Sustainable Development and Statistical Compendium of Benin, Ministry of Environment, Housing and Urban Planning (MEHU), p. 304.

2. Aloueimine S. O., 2006: Characterization methodology for household waste in Nouakchott (MAURITANIA): Contribution to waste management and decision-making tools, PhD Thesis University of Limoges, 195p.

3. Attahi K .: 2003: Governance and Waste Management in Africa, IDRC. 26 p.

4. Gbinlo R. 2010: Organization and financing of household waste management in the cities of sub-Saharan Africa: Case of the city of Cotonou in Benin. PhD Thesis, Orléans Economics Laboratory, 315 p.

5. Haupt F.0., 1996: Management of industrial and hazardous waste in urban areas in West Africa, Abidjan, GREA.AO, 19 p.

6. Kientga M.S., 1998: Test of development of a SIRS for the management of the drinking water supply system of the city of Ouagadougou, diploma work, EPFL, Lausanne, 89 p.

7. Kientga S., 2008: Contribution of GIS to the analysis of waste-health links in urban areas in developing countries: Case of two sectors of the city of Ouagadougou, Burkina Faso. Doctoral Thesis, Faculty Natural Environment, Architectural and Constructed, Swiss Federal Institute of Technology Lausanne, Switzerland, 241p.

8. Knezovic A., 2004: Perceived health risks in urban areas by the population of the district of NongrMaasom in Ouagadougou, Burkina Faso., Master thesis in Environmental Sciences, ETH Zurich, Knezovic, 2004;

9. Listorti J.A. and Doumani F.M., 2001: Environmental Health: Bridging the Gaps, World Bank. , Newyork, 32 p.

10. Muhigwa J.-B., 2000: "Research Note on the Control of Anopheles and Malaria in Bukavu and Lwiro", Health and Traditional Medicine, vol. 14, p. 61-66.

11. Onibokun A. G., 2002: Urban Waste Management: Solutions for Africa. Paris, Karthala, 260 p.

12. Ouédraogo S., 2002, The management of household waste in Ouagadougou, Master's thesis, University of Ouagadougou, Ouagadougou, 75 p.

13. PDM / PS-Water, 2003: "Sustainable Urban Sanitation: Lessons from a Program of Research Actions", World Water Forum, 3rd World Water Forum, Kyoto, Japan, UNEP. 125 p.

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ISSN: 2456-3676

14. Sharholy M., 2007: "Municipal Solid Waste and Management in Allaha-Bad, India", Waste Management Vol. 27 p. 490-496.

15. Valfrey B., 2003: "Independent Sanitation: A Viable Answer", The 3rd World Water Forum, Kyoto UNEP, 45 p.