



## SOLID WASTE MANAGEMENT STRATEGIES AT THE PORT OF COTONOU (BENIN, WEST AFRICA)

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### ABSTRACT

This research studies the strategies of solid waste management in the autonomous port of Cotonou. The socio-anthropological investigations, based on the techniques of individual maintenance and direct observation, made it possible to identify the solid waste management strategies at the autonomous port of Cotonou. The participatory approach allowed all the target actors of the study to express their views on waste management strategies in the port of Cotonou. The results of the analysis show that solid waste management strategies include pre-collection, collection, periodic removal of waste and treatment of damaged products by the internal institutions of the autonomous port of Cotonou. The management of the excreta is carried out by the autonomous sanitation system of the port. The different strategies for solid waste management in the Port of Cotonou have many shortcomings and are inadequate and are therefore not very effective and not convincing. The environmental department of the autonomous port of Cotonou has difficulty coordinating all the activities of collection, removal and treatment of port waste. Moreover, no follow-up measures are observed in their treatment, this neglect causes a deep degradation of the port environment.

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### INTRODUCTION

Developing countries in search of economic growth are increasing their industrial production effort, and this is not without negative consequences for the environment. Thus, large cities such as Bangkok, Manila or Jakarta, for example, produce up to 3000 m<sup>3</sup> of wastewater per day (Strauss and Montenegro, 2002). This reverse of industrialization unfortunately spares no country. As a result, the city of Cotonou is part of this trend. Cotonou, as a center of intense production and consumption activities, it generates large quantities of waste of every kind (Gbedo, 2002, Ezoun and Fassinou, 2010, Sare et al. 2017).

But those waste have not been the object of an effective management policy with the notorious inability to cope with environmental attacks. At the beginning of the 20<sup>th</sup> century, Cotonou was less important than Porto-Novo, Abomey and Ouidah considering the space and demography aspect (N'Bessa, 1997). But in a few decades, this city has seen its population grow exponentially and becoming the largest city in the country despite the major constraints linked to its site. Thus, for an area of 79 km<sup>2</sup>, Cotonou has a population of 655,000 inhabitants (INSAE, 2004). Its population is 9.82% of the national population with a density of 8.419 inhabitants per km<sup>2</sup>. Estimates predict Cotonou population to more than 1000000 inhabitants by 2025.

This situation is due to the construction of several socio-economical infrastructures such as the Dantokpa market, Bernardin GANTIN international airport, and particularly the autonomous port of Cotonou (the backbone of the national economy). The port transformed Cotonou into a very dynamic economic center that imposes itself on the other cities of the country, creating a very strong demographic attraction. Though these infrastructures participate effectively in the development of the country, they deserve special attention from all the actors involved in their operations. Despite these efforts by the port authority and the handling operators (SOBEMAP, COMAN SA and SMTC SA), three major challenges remain i) increasing and strengthening the reception and processing capacity of ships and the storage of goods, in particular containers and improving the quality of service provided to users ii) improve port performance and productivity and iii) strengthen environmental management in the maritime and port sectors (CAP, 2011, Capo-Chichi, 2007, Dalode and Toessi, 2011). This issue of environmental management in general and solid waste management in particular is a major concern of the port authorities. Thus, the aim of this study was to go insight the solid waste management strategies at the autonomous port of Cotonou.

**MATERIALS AND METHODS**

**Study area**

The present study was carried in the port of Cotonou, located in the Gulf of Guinea between latitude 06°21'22"N and longitude 02 ° 26 '30' E (Figure 1).

The port is one of the greatest economic platform of Benin, covering an area of 240 hectares (120 hectares of land and 120 hectares of sea). The autonomous port of Cotonou offers a great advantage of plan of water to the ships for the commercial operations and the refueling of the water in the best conditions. It is divided into several zones which makes it easy to carry out tasks according to the nature of the products. Thus, products of the same nature are treated in the same zone.

**Data collection**

The target group chosen concerns officials of the Directorate-General for the port, SOBEMAP, private structures operating in the port area, dockworkers, transporters and traders. These categories of users are not only the most involved in the production and management of waste, but they are also able to provide useful information. The digital camera, a questionnaire and an observation grid helped to achieve the objective of this study.

**Data analysis**

The collected data processing resulted in the development of the statistical tables used in this study. The illustrative photos were also selected, while the other figures and calculations were made using the Excel software.

The analysis of the results consisted of describing, commenting and interpreting the various figures and statistical series in order to highlight solid waste management strategies in the port of Cotonou.

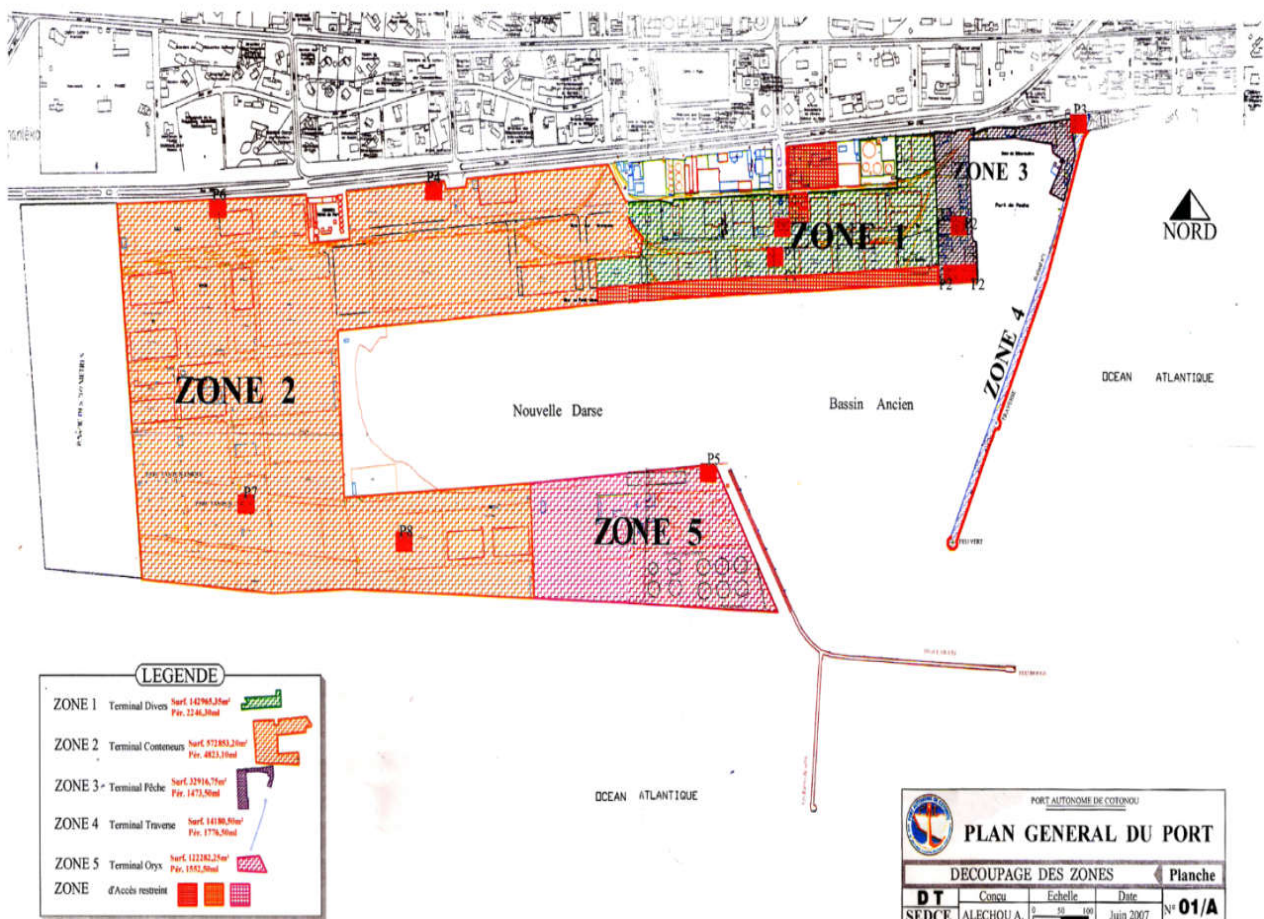


Figure1. Study area

## RESULTS AND DISCUSSION

### Solid Waste Management Strategies at the Port of Cotonou Waste management mode

The method of managing garbage produced by the various port actors is for the most part limited to their periodic removal from the port by the pre-collection structures. These structures deal with the cleaning and removal of waste (figure 1).

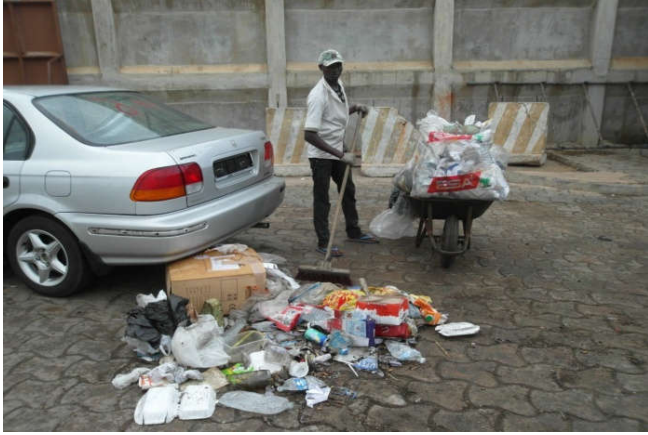


Figure 1. Picture showing a garbage collection process

Officially the port authorities have entrusted the cleaning and removal activities to private companies. These include companies which have signed contracts with port management (SALEF, KOLEF, KOLE BTP, BEMS, and PROBUCE) and those which have contracts with SOBEMAP (SADO, and ABF). Each cleaning or waste removal company has its own well-defined area. In addition, most of large companies (SOBEMAP, SAGA, SDV, SMTC, FSG, CAJAF-COMON and AWA FISH) located in the port area request the periodic removal of their waste either by internal structures or by collection and pre-collection of their convenience. Table 1 presents the different modes of solid waste management adopted by each company surveyed.

For 82% of these companies, measures to limit the impact of waste generated on the environment relate only to regular cleaning of the port environment and the periodic removal/disposal of grouped waste. In addition, other preventive measures are being taken by the port authorities to avoid uncontrolled deposition of waste in the port area.

### Assessment of the amount of solid waste produced in the enclosure port

The analysis of the situation of insalubrity found in the port enclosure made it possible, before any management, to assess the quantity of solid waste produced daily in the port area. The method used to estimate the quantity of solid waste produced at the port per day was effective because of the number of containers for grouping this waste. For this purpose, it should be pointed out that the tray model used varies from a company to another. Waste collection companies with a contract with the port authority use the identical 3.42 m<sup>3</sup> tanks. All the companies without contracts with operators do not use 3.42 m<sup>3</sup> tanks.

According to the autonomous port of Cotonou (2010), the average daily quantity of solid waste removed by the collection structures having a contract with the port authority and the main authorized operators is estimated at 22.3 m<sup>3</sup> (8.4 tons). So, about 201.6 tons/month and 2822.4 tons/ year of solid waste may be produced at the port of Cotonou. Companies in contract with the port authority collect about 76% of the waste, compared with 24% for providers of licensed operators operating in the port. Previous studies on solid waste conducted by LINER-environment (2008) on the port indicate a collection rate of 80%. So the solid waste daily production amount can be estimated to 29 m<sup>3</sup> (~10.5 tons) in the port area.

### Management of damaged products

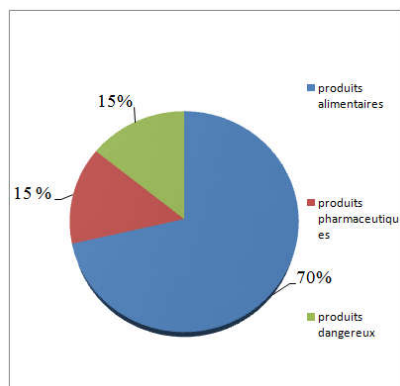
Figure 2 shows that food products perish faster (70%) and constitute solid waste storage that requires management thinking.

Table 1. Different modes of solid waste management in the port of Cotonou

Zones	Companies	Waste management patterns	Waste collection structure	periodicity
Zone1	ONASA/GMB (wheat storage)	Evacuation of the harbor by the pre-collection services	Internal cleaning agents	Twice a week
	DIFEZI (rice store)		NEB, pre-collection NGO	Thrice a week
	SONAPRA (Cotton bale store)	Waste Disposal Company	Maintenance Agents	Twice a week
	NITRA (Niger Transit)		None	-
	TRANSCO	Deposit in the containers of the port enclosure	None	-
	AGETRAC	Evacuation by collection services	STAF	Twice a week
Zone 2	COMAN/ MAERSCK	Evacuation of the port enclosure by the pre-collection services of the waste	CPAA	Twice a week
	SDV/SMTC/SAGA	Evacuation of waste and treatment of the soil by the pre-collection services	TRAPUSUR	Twice a week
	SNTE	Evacuation of the port enclosure by the pre waste collection services	Maintenance team and pre-collection NGOs	Twice a week
ATRAL	Internal maintenance agents		Twice a week	
CAJAF COMON		Evacuation by waste collection agencies	Several times a day	
Zone3	Artisanal and industrial fishing port	Cleaning of terraces with products as fish are evacuated	Internal maintenance agents	Twice a week
	AWA FISH	Evacuation by NGOs		NGOsES-HEALTH
Zone4	ORYX Benin	Waste cleaning and recycling	Internal maintenance service	Once per quarter

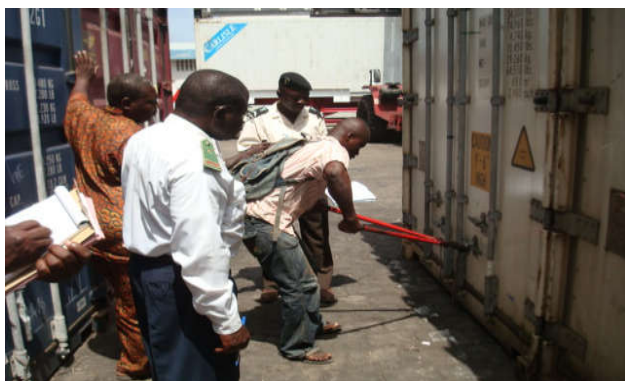


Hazardous and pharmaceutical products represented 30% of the solid waste products. Our observation can be explained by the fact that the Hazardous and pharmaceutical do not perish but may be outdated. The interception of the damaged products carried out during dumping operations by the structures in charge of inspection, namely: Customs, health services (depending on the nature of the products), Directorate of Food and Nutrition, Directorate for the Promotion of Quality and Packaging, Directorate of Agriculture, Directorate of Livestock.



**Figure 2. Proportions of spoiled foods that were not sold**

The figure 3 shows a dumping operation (operation involving the opening of the containers) in the presence of a customs officer, a health police officer, Directorate of Food and Nutrition and the Directorate for the Promotion of Quality and Packaging agents. Thus, the presence of the Directorate of Food and Nutrition and the Directorate for the Promotion of Quality and Packaging is justified by the nature of the products present in the container. Once the container has been opened, and the food products declared healthy (fit for consumption), the owner of the products will fulfill the formalities for its exit and the marketing of the latter. But, if the products are declared "damaged", they will be seized by the customs. All the services present will issue a certificate of insalubrity to the owner of the food in the container, who will have to take steps to destroy them.



**Figure 3: Deposition operation in the presence of the services of the Customs, Health Police, and other services**

Various techniques are used by the competent services to verify the damage of the products. The visual observation (appearance, odor...) is first made and if necessary, the toxicological analyzes. When toxicity levels are high, the toxicologist suggests the appropriate method of destruction. So, once deemed damaged, the customs seized the goods and with the other inspection structures draws up a certificate of insalubrity to the owner of the goods.

There are several reasons for the abandonment of goods by importers (problems between importers and exporters, death of the owner of the goods, etc.). It should be noted that the initiation of the product destruction process allows the importer to take possession of his funds from suppliers, if they are insured. The documents issued are sent, in the case of dangerous products, to the Environment Agency for a certificate of environmental compliance, which allows the destruction of the product on the national territory. It should be noted that in the case of dangerous goods, Environmental Impact Assessments are carried out and their destruction requires a duly signed authorization from the Minister in charge of the Environment. Figure 4 shows the conditions under which the destruction of damaged products is often carried out. In this picture, we observe the presence of the populations bordering on the site of destruction which at the slightest drop of vigilance of the forces of the order present on the place, seize the damaged products either to consume them, or to resell them.



**Figure 4: Destruction Operation in the Presence of populations**  
Several methods of destruction are used

**Incineration:** It is a technique for the destruction of waste by the action of fire; it is also a thermal treatment of refuse in an appropriate oven in the presence of excess air and whose heat collected is partly transformed into energy (Adissin, 2008). The incineration method is shown in the picture 5. As the picture shows, this destruction necessitated the digging of a large pit, the size of which corresponds to the quantity of the damaged products to be destroyed. For example, for the chicken legs, it must be removed from their packages, be placed in the pit where thousands of liters of gasoline will be spilled, followed by firing.



**Figure 5. Picture showing the Incineration of a waste product coming from the port**

The use of this method would be justified by the efficiency and the rapidity of destruction known to the fire. The application of this method is certainly effective, but with consequences on the environment. Pollution of air, soil and, if possible, water (depending on the depth of the water table), are the impacts that this destruction can have on the environment. Burial: This method can be used for the destruction of damaged products consisting in putting the damaged products in a large pit, to spray them with denaturing products and to cover them sand. In case of dangerous products, during the destruction process, the bottom of the pit is covered with a layer of reinforced concrete, and the walls cemented. So for each layer of hazardous products buried, a layer of concrete is deposited until the total burial of the hazardous products (Figure 6). The figure 6 illustrates one of the destruction methods used in the management of damaged products. The method used here is that of burial but with the particularity that it was realized in the form of tomb. This particularity in this case of burial is due to the nature of the product to be buried which is in this case, batteries. The choice of this method of destruction is due to the chemical composition of the batteries, in particular mercury, the effects of which are dangerous for man and the environment, if it were buried simply.



**Figure 6. Tomb carried out for the destruction of the batteries (dangerous products)**

### Management of excreta

In the port area, excreta are evacuated by an autonomous sanitation system. This system consists mainly of latrines carried out by the port authority or by private operators operating on the port platform. It is characterized by flush latrines each connected to an individual septic tank. Most private operators have built flush toilets on their own funds to serve their staff. Thus, 67 latrine cabins (figure 7), 53 showers and 13 urinals were counted in the port area. The number of users is about 700 people. However, most of the private structures do not allow users who are not part of their staff to access their facilities. Among the private structures that allow access to their places of comfort to all users are the company ORYX which deals with the storage, transport and distribution of hydrocarbons. This company drains more than 300 people daily and has at its disposal nine showers exclusively reserved for users. Apart of the above mentioned company, we can mention FSG, which handles communication on fish products, which reserve two modules of eight showers and four latrine cabins. The figure 7 shows a toilet infrastructure within the autonomous port of Cotonou built by port authorities.



**Figure 7. Picture showing a toilet cabins in the Port of Cotonou area**

For this kind of toilets, a total of seventy-four flush toilets were identified, of which sixty-five (65) were functional, serving approximately 2,600 people, which is really insufficient. The latrines carried out by the port authority are housed in old buildings that have been built for several years and also lack maintenance.

### Constraints related to the different modes of solid waste management at the port of Cotonou

The various methods of collecting and disposing of solid waste from the Port have many shortcomings and inadequacies and are therefore not very effective and not convincing. This state of affairs is linked to the various reasons that our investigations have identified. We can mention:

- the absence of suitable materials for management;
- the lack of capacity building for General D Environment staff,
- inadequate paved and remediated road networks;
- coexistence of sensitivity, socio-cultural behavior and different levels of instruction in the same space.
- the absence of solid waste disposal plans for good management planning;
- lack of control over the waste treatment system;
- the lack of sustainable funding for the management of waste from the port;
- insufficient garbage;
- inadequate garbage bins;
- poor distribution of garbage bins;
- insufficient monitoring of the services provided by the companies managing the
- Solid wastes;
- insufficient latrines and toilets;
- insufficient monitoring of the benefits of latrines managers.

### Conclusion

The port of Cotonou produces an enormous amount of waste every day through the activities linked to its exploitation. The management of solid waste in the port of Cotonou is a major concern of the authorities. Indeed, each port operator company and the port authority organize the evacuation of waste. The main reason for this failure is the non-coordination of these port waste disposal activities by the direction of environment. Similarly, no follow-up measures are observed in the treatment of solid waste from the port.

The consequence of neglect of environmental issues could be observed in economic damage (degradation of marine and coastal fisheries, loss of socio-economic infrastructure, etc.) and health (food poisoning, poor quality of life in the environment Port, acute respiratory infections, etc.).

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