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Survey and Quantification of Household Waste in Tsévié City, Togo

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The management of solid household wastes in Tsévié is the environmental concerns that the municipality faces on a daily basis. The aim of this study is to assess the amount of waste produced daily per resident in Tsévié and then to determine the socio-economic dynamics involved in the production of waste. A quantification campaign coupled with the socio-economic assessment are carried out. The households selected are chosen at random from different parts of the city and their number is defined on the basis of the size of the population so as to cover at least one hundredth of this population. The results obtained indicate that the ratios vary by neighborhood and by the lifestyle of population. These ratios range from 0.476 kg/hab/d to 0.587 kg/hab/d with an average of 0.54 0.10 kg/hab/d. The production of household wastes in the city of Tsévié is estimated at 13440 tonnes per year. For the other sectors, especially the central market and commercial structures, production is estimated at 744 tonnes and 149 tonnes of waste respectively per year. With an estimated annual waste production in the city of Tsévié of approximately 14,333 tonnes, urgent steps must be taken toward the efficient management of this waste.

Keywords: Scrap, Waste, Quantification, Household, Management.

INTRODUCTION

With ever greater and more diversified consumption throughout the world, the production of wastes continues to increase in quantity and quality, thus generating enormous risks on the environment and consequently, on the health of populations [1]. Like the secondary cities of developing countries [2], the city of Tsévié in Togo faces technical, organizational and financial difficulties in waste management. In some cities of developing countries, non-environmentally friendly practices such as uncontrolled dumping of the wastes, dumping waste in the streets and in empty spaces are noticed [3,4]. No reliable data on the quantification and characterization of waste existed in the town of Tsévié, yet these data should serve as a prerequisite for any effective and sustainable waste management strategy [1]. Due to a lack of support, pre-collection structures are struggling to emerge in the city despite the high demand from households for the collection of household waste. This phenomenon is observed in other African cities such as Yaoundé in Cameroon [5] and in Dar Es Salam in Tanzania [6]. Tsévié currently covers 25 km^2, with an estimated population of 54,474 inhabitants according to the 4th general census of population and Habitat carried out in year 2010. Knowledge of the amount of waste generated in an environment is essential for planning a management system to best predict the size of the collection and processing facilities and the waste disposal center [7-10].

The aim of this research work is to assess the amount of waste generated by a resident per day in Tsévié city, Togo. For a better appreciation of the production ratio, an evaluation of socio-economic factors is made through a field survey.

EXPERIMENTAL

Study site: Tsévié is located between latitude 6°26′ North and longitude 1°13′ East. It is a city in Togo, the capital of the maritime region and the prefecture of Zio. It is located about 35 km to the north of the capital Lomé and at the crossroads of several roads, including National Main Road.

Field investigation: Information on the different stakeholders involved in the waste management chain is obtained through an on-the-ground diagnosis by touring public and private services. The sociological survey was conducted among households and commercial structures. The data were collected through the administration of a questionnaire. For the house-

hold questionnaire, information on the identity of the respondent, the living area, lifestyle, waste management and the sanitation of the place were also collected. Some commercial structures known as 'equipment' which may produce waste have also been investigated. These are some hotels, schools and drinking/resturants establishments.

Determination of households sample size: The stratified random sampling method was used for the selection of households. The number of households to be surveyed by area was chosen to have the minimum representative sample for sorting waste, including 500 kg as recommended by the European Environmental Agency [11].

Data processing: Data processing began with entering answers to questions and setting up a database of all the data collected. A computer spreadsheet was used to transcribe the data. The Software used is the Statistical Package for Social Sciences (SPSS) version 21.

Waste quantification (production ratio): After a three-day garbage production in the households, the garbage bags are collected, enclosed and labelled with a card indicating the code of the household and the district of origin. They are then transported to the experimental site where they are weighed per household and per area. Pre-collection was conducted twice a week over 4 weeks. The weighing was done subsequently, provided that the production of each household has been clearly identified using an electric scale with digital display of 150 kg of range and precision 0.1 kg. The per capita daily production mass (ratio) of an area (r_Q) and that extrapolated for any city (r (Tsévié)) respectively were determined as follows:

$$r_Q = \frac{M_Q}{3N_Q} \quad (1)$$

$$r_{Tsevie} = \frac{\Sigma(E_Q \times r_Q)}{\Sigma E_Q} \quad (2)$$

M_Q = mass of waste collected (produced in 3 days) in area Q; N_Q = number of producers of waste collected in area Q; E_Q = population of the area Q.

RESULTS AND DISCUSSION

Socio-demographic survey: The surveys carried out have shown that the heads of households are in the majority of cases male with a rate of 65.41%. This may be explained by the fact that in African societies in general and in Tsévié in particular, houses or households are dependent on men, so they are automatically heads of households or houses. Women who are heads of household account for 34.59% and are either widowed or divorced or single. Since, it is women who are actually involved in waste management in the households, the lack of involvement of men as heads of households has a negative influence on the effective management of waste. The heads of households of the surveyed populations are generally married (75%) with a strong dominance of monogamy (67% monogamous *versus* 8% polygamous).

The majority of heads of households are adults in all study areas with 51.82% having an age group between 36 and 55 years. The younger generation with an age group of 15-35 years is a minority (12.41%).

In terms of education, the level of education of the heads of households surveyed varies between primary education (35.45%), secondary education (28.91%) and university education (15.17%). Nevertheless, there is a significant proportion of illiterates (20.47%). The school plays an important role in sanitation practices. Indeed, it is at school that one learns the basics of the cleanliness of the environment, of the prote-ction of the environment. When the illiterates and primary-level groups were also included, it is realized that this fringe represents the majority. This fringe, which does not have adequate information on the effective management of wastes, could have a negative impact on waste management. This state of affairs would justify the organizational difficulties and shortcomings in the management of waste in households. This affects the quality of waste management throughout the city. Awareness of good waste management practices should be encouraged in order to improve this management in Tsévié city, Togo.

The survey made it possible to classify the types of habitat in Tsévié city of Togo. The low standing occupies the highest proportion with 54% followed by the average standing with a rate of 40% and low standing comes in last position with 6%. The standard of living affects the amount of waste in a given environment. Indeed, residents of high standard produce more garbage [12].

Several factors can influence the standing of a household dwelling. However, the results of this study show (Table-1) that in the case of Tsévié city, the correlation is (R = 0.049). According to the results of the analysis (Table-1), the principal activity of the head of household in the city of Tsévié, does not affect his dwelling occupancy status (R = -0.094).

Household income: On average, 48.4% of households have a monthly income below 50,000 CFA franc per month, out of which 23.84% have an income below 35,000 CFA franc which represents the minimum inter-guaranteed wage (SMIG) in Togo. As households do not have enough resources, they find it difficult to finance the management of their waste and especially their removal. Most often, the waste is either thrown onto empty spaces or onto the streets, or burned in the open air with all the consequences this has on human health and the environment. Among these consequences, we can cite air and soil pollution, the clogging of rainwater drainage channels, the proliferation of rodents and waterborne diseases.

Quantification of household wastes in Tsévié city

Cases of households: The results of a month's collection of household waste in the city of Tsévié are shown in Table-2. These results generally represent the quantities of raw waste assessed in each neighborhood studied.

Generally, the highest average value (0.587 kg/hab/d) is obtained in zone 4 and the lowest (0.476 kg/hab/d) in zone 3. This is an average of 0.54 0.10 kg/hab/d in Tsévié city, a high value in terms of the standard of living of the population. This average value is simply the average of the four zones. Changes in production in areas and neighborhoods could be linked to the living standards of the inhabitants. The inhabitants of high

TABLE-1
HOUSEHOLD MAIN ACTIVITY DATA RELATED TO THE STANDARD OF ACCOMMODATION

		Housing standard			Total
		High	Average	Low	
Main activity of the head of household	Public employee	0.68	7.53	2.74	10.96
	Formal private employee	0.34	5.82	4.11	10.27
	Trader	0.68	8.56	9.93	19.18
	Farmer/breeder	0.00	4.79	12.67	17.47
	Craftsman	0.68	4.11	14.04	18.84
	Student	0.00	0.34	1.03	1.37
	Unemployed	0.34	2.74	2.05	5.14
	Retired	0.68	8.22	0.68	9.59
	Housewife	0.00	0.68	3.77	4.45
	Inactive	0.00	1.03	1.71	2.74
Total		10	3.42	43.84	52.74
Correlation of Pearson R = 0.049; Positive correlation if R = 1, negative if R = -1 and nil if R = 0					

TABLE-2
MONTHLY WASTES COLLECTION DATA OF TSÉVIÉ CITY

Zones	District	Ratio (Kg/hab/d)			
		Min	Max	Average	Standard deviation
1	DJIDOME	0.103	1.446	0.528	0.190
	WAGBA	0.095	2.714	0.571	0.450
	KPATEFI	0.163	1.057	0.555	0.214
	DEVE	0.238	2.286	0.602	0.332
	CENTRALE	0.300	0.743	0.533	0.137
	Global Zone 1	0.095	2.714	0.558	0.369
2	MIVAKPO	0.171	0.821	0.514	0.144
	BOLOUMODJI NORD	0.135	3.500	0.642	0.519
	KPALI	0.086	0.786	0.512	0.204
	MANOGUIAKPO	0.242	0.786	0.602	0.140
	N'DANYI NORD	0.286	1.500	0.539	0.227
	AKAKPOKONDJI	0.113	1.143	0.534	0.191
	TEKANYI	0.171	0.771	0.541	0.152
	ADIAKPO	0.143	0.800	0.510	0.166
	GBENODOU	0.286	0.786	0.570	0.158
	Global Zone 2	0.086	3.500	0.552	0.264
3	DAVIEMODJI-ATITO	0.143	0.786	0.502	0.165
	BLEVE	0.190	0.762	0.474	0.163
	N'DANYI SUD	0.214	0.762	0.491	0.159
	BOLOUMODJI SUD	0.129	0.714	0.436	0.163
	Global Zone 3	0.129	0.786	0.476	0.163
4	DEME	0.245	0.778	0.597	0.149
	ASSIAMA	0.156	1.214	0.544	0.212
	N'TIFAFA	0.286	0.776	0.607	0.121
	WEME SUD	0.429	0.810	0.602	0.104
	Global Zone 4	0.156	1.214	0.587	0.171
	Tsévié town	0.086	3.500	0.543	0.103

standing produce more garbage [12]. This increase in waste produced according to standing, in both Northern and Southern countries, is explained by eating habits and reflects a similar relationship between the standard of social living and the amount of wastes produced [12].

Table-3 shows that Tsévié's daily per capita ratio of 0.54 kg/hab/d falls within the range of ratios for cities in developing countries (0.21-0.89 kg/hab/d) [13]. However, the value of Tsévié is among the average productions. It is higher than that of Kara which is 0.41 kg/hab/d [14] and lower than that of Bujumbura which is on average 0.6 kg/hab/d [15]. Tsévié production ratio is average and characterizes the standard of living of the population that reuses garbage, especially in livestock as in Nouakchott [16]. However, since characterization studies are conducted neither in the same way nor during the same period, it is not advisable to compare the results obtained between them. Simialry, Hernandez-Berriel *et al*. [17] indicated that the ratio changes over time, citing the example of Mexico where the daily ratio went from 0.86 kg hab^{-1} d^{-1} in 2000 to 0.96 kg/hab/d in year 2005. Similarly, it is expected that waste generation rates might double over the next two decades in developing countries [18].

Commercial sources: These include drinking establishments, shops, artisan workshops and health centers. Table-4

TABLE-3
WASTE GENERATION DATA OF SOME DIFFERENT CITIES AROUND THE WORLD

City	Country	Ratio (kg hab^{-1} d^{-1})	Ref.
Kara	Togo	0.41	[14]
Lomé	Togo	0.80	[19]
Nouakchott	Mauritania	0.21	[16]
Chittagong	Bangladesh	0.25	[20]
Bujumbura	Burundi	0.31	[21]
Annaba	Algeria	0.49	[22]
Kinshasa	DRC	0.50	[23]
Mexicali	Mexico	0.59	[24]
Yaoundé	Cameroon	0.60	[25]
Mostaganem	Algeria	0.62	[26]
Abomey-Calavi	Benin	0.89	[27]
Tsévié	Togo	0.54	Present work

TABLE-4
WASTE GENERATION DATA FROM COMMERCIAL SOURCES OF TSÉVIÉ CITY

		Ratio (kg hab^{-1} d^{-1})			
		Min	Max	Average	Standard deviation
Bar	District 1	0.44	0.68	0.56	0.169
		0.49	0.98	0.74	0.346
	District 3	0.43	1,17	0.8	0.52
Shop	District 1	0.52	0.55	0.54	0.021
	District 3	0.61	0.81	0.71	0.14
	District 4	0.63	0.71	0.67	0.056
Mechanic shop	District 1	0.61	1,07	0.84	0.32
Sewing workshop	District 3	0.27	1,12	0.70	0.60
	District 4	0.64	0.74	0.69	0.070
Hospital	District 2	0.71	0.85	0.78	0.098
Tsévié city		0.56	0.87	0.72	0.23

shows the production ratio of the structures identified within this study. The highest average value (0.84 kg/hab/d) in zone 2 is obtained in the mechanical workshop followed by the bar (0.80 kg/hab/d) in the Kpatefi district. The average value of the ratio in commercial sources is only an indicative value. Each amount of waste produced in commercial sources daily is assessed by its ratio because of their heterogeneity.

The density of waste in Tsévié is 0.43 T/m^3. It is noted that an average of 42.15 m^3 or about 2.6 tonnes of waste per day and 18 tonnes of waste are generated each week at the central market of Tsévié city. Table-5 shows the quantities of waste produced on the basis of daily, weekly and monthly throughout the Tsévié city. About 62 tonnes per month and 744 tonnes per year of waste are available in the large market. In households, about 1120 tonnes and 13440 tonnes of wastes generated per month and per year, respectively. At the level of commercial sources, approximately 12.4 and 149 tonnes of wastes generated per month and per year, respectively. At the city level, the daily generation is 42.6 tonnes of waste, representing an annual production of 14,333 tonnes of waste.

TABLE-5
AMOUNT OF WASTE PRODUCED IN THE CITY OF TSÉVIÉ

Amount of waste (T)	Day	Week	Month	Year
Machineries	0.44	3.10	12,40	149.00
Markets	2.16	15,40	62,00	744.00
Households	40.00	280.00	1120.00	13440.00
Total	42.60	298.50	1194.40	14333.00

Conclusion

In this work, the current situation of the household wastes management of Tsévié city (Togo) was surveyed. It is found that people's knowledge of domestic waste management was negligible. A quantification campaign was carried out in Tsévié city. Generation of wastes varies by neighbourhood and area and ranges from 0.476 kg/hab/d to 0.587 kg/hab/d with a city-wide average of 0.54 0.10 kg/hab/d. This average production ratio compared to the population of the whole city, is estimated at 13,440 tonnes per year. The Tsévié central market produces about 744 tonnes per year and commercial sources produce 149 tonnes of waste per year. At the city level, annual generation is 14333 tonnes. These data could serve as support for a technical and financial approach for the efficient and sustainable waste management of Tsévié city of Togo.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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