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The Economic Costs of Illness from the Disposal of the Yaoundé Household Waste at the Nkolfoulou Dumping Site in Cameroon

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ABSTRACT This paper assesses the economic costs of illness from the disposal of the Yaoundé household waste at the Nkolfoulou dumping site by using the cost of illness approach. The results show that, in comparison to the Yaoundé-city population, people living near the dumping site of household waste are two times more exposed to various diseases due to environmental pollution. The medical cost expenses and the loss of earnings resulting from illness are also two times higher for the dumping site population. The difference of the pooled financial, time and intangible costs from diseases between the Yaoundé-city and dumping site populations which is 607,310 FCFA[1] per year per person (about 926 Euros/year/person) could represent the cost of pollution from disposing household waste at the Nkolfoulou dumping site. However, that amount could be avoided or reduced by simply processing the organic household waste into compost (so that only the remaining non-compostable inorganic residues can be landfilled) or by finding another waste dumping site location in less popular villages farther away from Yaoundé-city.

1. INTRODUCTION

Like in the main African capital cities, the big towns of Cameroon (Yaoundé, Douala, Bafoussam, Garoua) have not escaped from a rapid urbanisation with all environmental problems that it engenders. For instance, each inhabitant produces on average 0.65 kg of household waste per day in Cameroonian cities (Ndoumbé et al., 1995; Waas et al., 1996). In Yaoundé, the capital city of Cameroon with a population of 1.2 million inhabitants, about 1023 tonnes of solid household waste are produced daily (Ngnikam, 2000; World Bank, 2004).

The increasing migration of the Cameroon's population to the capital-city, Yaoundé (in the search for jobs and well-being), has provoked an overpopulation in well-known suburbs of the city thereby enhancing urban settlement and waste management problems. As a matter of fact, with an annual growth rate of more than 6.8%, the Yaoundé-city population has been multiplied by 5 between 1968 and 1988: it has increased from 152 thousand inhabitants in 1968 to more than 800 thousand inhabitants in 1988 reaching thereby 1.2 million inhabitants in 2004 (Ministry of Plan, 1999). Until the early 1990s, the spontaneous quarters which represent 45% of the city's land area have never benefited from household waste collection because of inaccessibility by heavy vehicles. Hence, out of the daily production of 1023 tonnes of household waste from Yaoundé-city, only 70% (about 700 tonnes) could be collected every day by the municipality at that period (Ndoumbé, 1994; Ngnikam, 2000; Ngnikam et al., 1995). The remaining 30% represented household waste that could not be collected mainly from neighbour-hoods without or with poor road infrastructures and thus difficult for the municipality vehicles to drive inside.

The inefficient collection system observed until the early 1990s led to the heaping up of various household waste provoking a dirty, unaesthetic environment, water pollution, bad odours causing air pollution and multiplication of flies that are diseases' carriers (malaria, typhoid, diarrhoea, cholera, dysentery) for the Yaoundé population. An attempt of solving the problem by the government or Yaoundé municipality was materialized by the development of road infrastructures to collect household waste and remarkably by the creation since 1990 of a dumping site of household waste around the Yaoundé urban area (namely the Nkolfoulou dumping site located in Nkolfoulou I village at 16 km from Yaoundé-city center). With a total land area of about 45 ha, the Nkolfoulou dumping site which has already been functional for 17 years (from 1990 to 2007), continually receives without

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any treatment the totality of the daily collected household waste from Yaoundé-city (about 1023 tonnes every day).

Actually, all this collected quantity of 1023 tonnes of the Yaoundé household waste is daily transported to the Nkolfoulou dumping site where it is discharged, deposited, injected, dumped, spilled, leaked or placed into the land in a deplorable manner so that such household waste or any constituent thereof may enter the environment or be emitted into the air or discharged into surrounding rivers, polluting groundwater (Bakri, 1995; Buekens, 1997). Unfortunately, this "disposal" method of waste evacuation has rather enhanced environmental problems or provoked severe diseases to people living near the Nkolfoulou dumping site of household waste (Jaza, 2005).

In the villages Nkolfoulou I, II and Nsan located near that dumping site, there is no adduction of the SNEC[2] potable water, so one can imagine the disastrous state of health of the 953 inhabitants living in those villages since their sources of drinking water are traditional wells, forages and existing surrounding rivers (Kuete et al., 2003). One may count about 163 days per year of rainfall in that area. Thus, the frequent torrential rains drain part of the discharged wastes to pollute the surrounding watersheds. Hence, all the sources of drinking water (wells, forages, rivers) are frequently contaminated by lixiviates water originating from the dumping site thus favouring many diseases proliferation. Such situation leads to water pollution causing frequent epidemic diseases (typhoid, diarrhoea, cholera, malaria, dysentery). Regretfully, none well equipment standard hospital is located in villages near the Nkolfoulou dumping site of household waste. Therefore, in order to better cure their diseases, people living in those villages always have to travel to the "Yaoundé General or Central hospitals" (which are the highest modernised or the best equipped hospitals of Cameroon).

Furthermore, at the Nkolfoulou dumping site, there is no constant removal of leachate and effective cleaning up and landfilling to avoid any pollution. Sometimes, in that dumping site, wastes are incinerated in an open area with no care of different toxic gases produced (SO_x, NO_x). Thus, populations from those villages surrounding the dumping site always complain on such pollution disturbances or higher diseases frequency (from household waste disposal) and are always making advertisements on the negative environmental pollution effects people may suffer by visiting their villages/environment. However, a few household waste management experts, consultants and researchers in Cameroon doubt whether the localization of the dumping site at its present location (Nkolfoulou I village) really has or not an impact on the state of health and standard of living of the population residing in its surroundings. Thus, this paper will try to answer that question through an assessment of the economic costs of illness from the disposal of the Yaoundé household waste at the Nkolfoulou dumping site.

2. MATERIALS AND METHODS

2.1. The Study Area and Data Collection

The field survey was carried out in Cameroon during the period from October to December 2003. It was undertaken precisely in the Yaoundé-city and the three villages Nkolfoulou I, Nkolfoulou II and Nsan surrounding the dumping site of household waste. Yaoundé was chosen because it is the capital city of Cameroon and generates the highest quantity of household waste (1023 tonnes per day) among the Cameroonian cities, the existence of a dumping site for discharging the household waste from the city and the availability of secondary data for that city.

Administratively, the dumping site is located in Nkolfoulou I village at 16 km (road length distance) from the Yaoundé-city center. The other surrounding villages Nkolfoulou II and Nsan near the dumping site are located at respectively 17 km and 18 km (road length distance) from the Yaoundé-city center. Demographically, Yaoundé counts about 1.2 million inhabitants whereas the villages Nkolfoulou I, II and Nsan have a total population of 428, 158 and 367 inhabitants respectively (Kuete et al., 2003).

A stratified random sampling was used to select a total of 194 people comprised of 86 persons living in the Yaoundé-city and 108 persons (36 from each selected village) residing around the dumping site of household waste. The selected persons were mainly the heads of households (adult persons between 25 to 65 years of age) who have resided during the previous 10 years in the locality.

Using a prepared questionnaire and interview schedule, cross-sectional primary data of the year 2003 were collected from the selected groups. The data collected were estimation made from own assessment of each person and concerned mainly the types and frequencies of common diseases, the income or salary of the heads of households, the value of one manday of labour, the taxi cost for travelling to the hospital, the waiting and travel time to the hospital (per day and illness type). Secondary data were collected from records and documents of the Yaoundé municipality and the Yaoundé General or Central hospitals. They include namely: the average cure expenses per disease, the mean length of each illness, the price of hospital room and the daily food price at the hospital.

2.2. Analytical Approach

To assess the economic costs of illness of the disposal of the Yaoundé household waste at the Nkolfoulou dumping site, the "cost of illness approach" developed by Turner et al. (1993) is preferred in this paper.

2.2.1. Justification and Assumptions for the Use of the Cost of Illness Approach

According to Turner et al. (1993), the cost of illness approach is more suitable for projects designed to improve public water supplies or waste disposal systems which will ultimately improve human health thus an implication on the net social welfare (Turner et al., 1993). Hence, the cost of illness approach is applicable if: a direct cause-and-effect relationship can be established and the etiology of the disease is clearly identifiable, the illness is not life-threatening and has no chronic effects, an accurate estimate of the economic value of earnings and medical care is available.

In general, it is easier to value environmental effects using the cost of illness approach when the illness is relatively short, discrete, and does not have negative long-term impacts (Harrington et al., 1989; Turner et al., 1993). Effectively, in the research related to this paper, the pollution of population from household waste disposal gives rise to short and discrete epidemic diseases (like malaria, typhoid, dysentery, cholera and diarrhoea) that do not have negative long-term impacts. Thus, the cost of illness approach is more appropriate and was chosen for this paper in order to assess the economic costs of illness from the disposal of the Yaoundé household waste at the Nkolfoulou dumping site.

2.2.2. Specification of the Cost of Illness Approach: Mathematical Formulation

The cost of illness approach is based on an underlying damage function. The damage function usually relates the level of pollution (exposure by household waste disposal) to the degree of health effect. With this approach, costs are interpreted as an estimate of the presumed benefits of actions which would prevent the damage from occurring. According to Turner et al. (1993), the costs to be counted include three main groups:

(i) Medical costs such as for doctors, hospital visits or stays, and medication;
(ii) Time costs/any loss of earnings resulting from illness;
(iii) Any other intangible costs/related out-of-pocket expenses (such as the loss of productivity at work, leisure time, pain, risks of death or being handicapped).

The basic mathematical formulation from Turner et al. (1993) using this approach could be as follows (equation 1):

$$C = I + L + \lambda \qquad (1)$$

Where: C=Total cost of illness: the total expenses and loss (in FCFA/year/person); I=Financial costs/Medical costs for doctors, hospital visits or stay and medication (in FCFA/year/person); L=Time costs/Loss of earnings resulting from illness (in FCFA/year/person); λ=Intangible costs/related out-of-pocket expenses such as the loss of productivity at work, leisure time, pain, risks of death or being handicapped (in FCFA/year/person).

Equation (1) is a more general equation which follows the conventional way of measuring the costs of illness (C) directly as the sum of financial resources used to treat the illness (I) and the time costs/opportunity costs of labour lost associated ill health (L) (Asfaw et al., 2004; Harrington et al., 1989; Turner et al., 1993). Following a more detailed reasoning from Asfaw et al. (2004), the financial resources used to treat the illness (I) include: Medicine and consultation costs (M), Transport cost to go to the hospital (T), Accommodation cost during the hospital stay of the illness (A); Food and the like costs

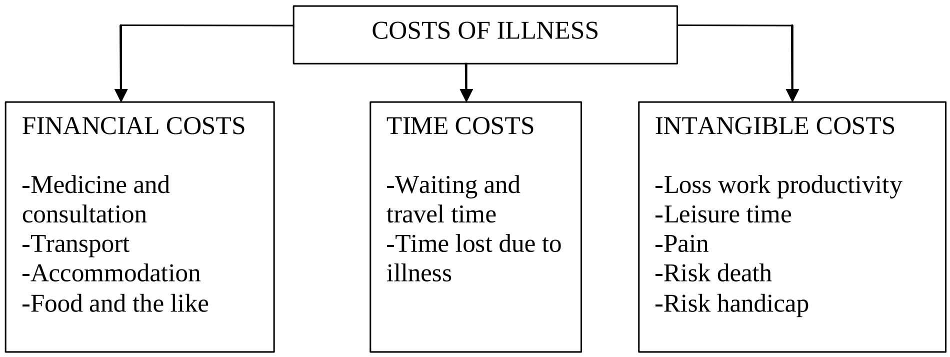

Fig. 1. Diagrammatic classification of costs of illness types
Source: Modified from Asfaw et al. (2004)

during the hospital stay of the illness (F). In the same line, the time costs or opportunity costs of labour (L) during the illness period are further subdivided as: Waiting and travel time cost for joining the hospital (W), Cost of time lost due to illness or loss of Earnings resulting from illness (E). The diagrammatic classification of all those types of costs of illness is presented in Figure 1.

Generally, by summing up all the costs of illness types from Figure 1, the total cost of illness of equation (1) is further specified in equation (2) as follows:

$$C=M+T+A+F+W+E+\lambda \quad (2)$$

Where:

C= Total cost of illness: the total expenses and loss (in FCFA/year/person);

M=Medicine and consultation costs: the medical costs for doctors, hospital visits or stay and medication (in FCFA/year/person);

T=Transport cost to go to the hospital (in FCFA/year/person);

A=Accommodation cost during the hospital stay of the illness (in FCFA/year/person);

F=Food and the like costs during the hospital stay of the illness (in FCFA/year/person);

W=Waiting and travel time costs for joining the hospital (in FCFA/year/person);

E=Cost of time lost due to illness: the loss of Earnings resulting from illness (in FCFA/year/person);

λ=Intangible costs/related out-of-pocket expenses such as the loss of productivity at work, leisure time, pain, risks of death or being handicapped (in FCFA/year/person).

In equation (2), the time costs (L) and transport cost to go to hospital (T) are calculated for both the sick person and his caretaker. Assuming that the minimum wage rate of unskilled labour is used to estimate time costs (through a human capital approach), this equation seems to be more complete (Asfaw et al., 2004) and thus, has been chosen and used for calculations in this paper.

Using the above equations and reasoning, the collected data were processed and analyzed with a computer. EXCEL for Windows was used for the graphical presentation of results whereas the descriptive analysis (mean, standard deviation) and statistical tests (t-test, χ^2-test) were done using the SPSS software program (version 11.5).

3. RESULTS

This paper is based on a "*With and Without*" situation. Thus, its results compare the situation of the Yaoundé-city population ("*Without*" waste disposal site nearby their environment) and the situation of the dumping site population ("*With*" waste disposal site nearby their environment). The difference between the two situations is therefore attributed to the pollution from household waste disposal.

3.1. Diseases Frequency in the Yaoundé-City and Dumping Site Villages

Figure 2 compares the annual diseases frequency between the people living in the Yaoundé-city and those residing near the dumping site of household waste. That Figure has been drawn on the basis of annual diseases frequency figures as shown in Table 1. Diseases considered in this case are only those related to

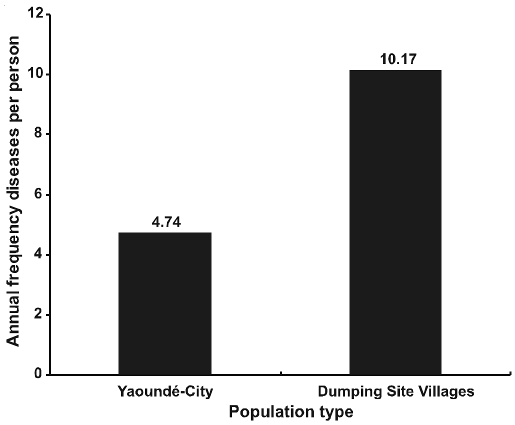

Fig. 2. Comparison of annual diseases frequency between the populations of Yaoundé-city and nearby dumping site of household waste

any pollution from household waste disposal such as malaria, typhoid, dysentery, cholera, diarrhoea, bronchitis and other respiratory or digestive diseases.

Table 1: Annual diseases frequency for the Yaoundé-city, dumping site villages and total populations (in number/person)

Population type	*Yaoundé-city (N=86)*	*Dumping Site villages (N=108)*	*Total population (N=194)*
Minimum	0	2	0
Maximum	9	19	19
Mean	4.74	10.17	7.22
Standard Deviation	2.30	4.18	4.25
Mean Difference People Yaoundé-city and Dumping Site= 10.17-4.74 = 5.43**** t-value=-6.954 (p=0.000)			

****: Significant at ≤ 0.001

It can be remarked that the diseases frequency is more than two times higher in dumping site neighbourhoods compared to the Yaoundé-city. That means, people living near the dumping site of household waste are two times more exposed to environmental pollution from household waste compared to the Yaoundé-city population. More precisely, the annual diseases frequency per person living nearby dumping site ranges from 2 to 19 with an annual average of 10.17 while it ranges from 0 to 9 with an annual average of 4.74 per person living in the Yaoundé-city (see Table 1).

The minimum figures of Table 1 suggest that, it may be possible for a person living in Yaoundé-city to be healthy (without being sick) for a whole year whereas this is impossible for people living around the dumping site since they are more likely to get sick at least two times a year. Likewise, the maximum number of annual diseases is 19 for people living nearby dumping site villages and only 9 for people living in Yaoundé-city (see Table 1).

The diseases frequency of the total population (mix group of Yaoundé *plus* dumping site people) has been computed as a reference value for such a comparison. It is thus remarked that the annual diseases frequency averages 7.22 for the whole population with a minimum of 0 and a maximum of 19 (Table 1). These figures are above those recorded in the Yaoundé-city population and below the ones recorded for the dumping site population. Thus, household waste disposal in dumping site really hampers the surrounding population of the Nkolfoulou I, II and Nsan villages which record more diseases than the Yaoundé population.

To test whether the differences are significant (Table 1), a t-test is used to test the null hypothesis of equality of the mean diseases frequency between the people living in Yaoundé-city with the mean diseases frequency of the population residing nearby dumping site. The computed mean difference (5.43) is statistically "very highly significant" ($p \leq 0.001$). So, the null hypothesis is rejected and the alternative hypothesis of inequality of means diseases frequency (between Yaoundé and dumping site populations) is accepted. Hence, from this t-test, it is statistically proved that people living nearby dumping site villages are much more exposed to various diseases due to environmental pollution.

That t-test is further supplemented by doing another test: the χ^2-test of independence of diseases frequency per location. The computed Pearson χ^2 is also "very highly significant" ($p \leq 0.001$), so the null hypothesis of independence of diseases frequency per location could not be accepted. The frequency of diseases is therefore statistically not the same in the two locations (Yaoundé and dumping site villages).

3.2. Economic Costs of Illness Caused by Environmental Pollution

As already mentioned, none well equipment standard hospital exists in villages located near the dumping site of household waste. Hence, the computation of the economic costs of illness in this section relies on the fact that, people living in those villages (Nkolfoulou I, II and Nsan) always get cure at the Yaoundé General or Central hospitals which are the highest modernised or well equipped hospitals of Cameroon.

3.2.1. Financial Costs of Illness

3.2.1.1. Medicine and Consultation Costs

Table 2 shows figures on medicine and consultation costs (M) for the selected groups comprising the populations of the Yaoundé-city and dumping site villages. From the Table, it can be remarked that the medicine and consultation costs (M) per year per person are more than two times higher for the dumping site people as compared to the Yaoundé-city population. In total, a person living at the vicinity of dumping site loses 142,380 FCFA annually, while the one living in Yaoundé-city loses 66,360 FCFA annually (Table 2). Hence, people living near the dumping site of household waste bear more financial expenses for medicine and consultation costs.

Table 2: Computation of medicine and consultation costs (M) (in FCFA/year/person)

Population location	*Yaoundé-city(N=86)*	*Dumping site villages (N=108)*		
		Nkolf oulou I (N=36)	*Nkolf oulou II (N=36)*	*Nsan (N=36)*
Annual diseases frequency[a] (number/person)	4.74	10.17	10.17	10.17
Average cure cost per disease[b] (FCFA/person)	14,000	14,000	14,000	14,000
Total cost of medicine and consultation[c] (FCFA/year/ person)	66,360	142,380	142,380	142,380

Notes: In this Table, at each location:
[a]The annual diseases frequency is our own field survey findings.
[b]The average cure cost per disease is obtained from the Yaoundé central hospital records.
[c]The total medicine and consultation cost is equal to: the annual diseases frequency multiplied by the average cure cost per disease.

3.2.1.2. Transport Cost for Hospital

Table 3 shows the computation of transport cost for joining the hospital for the populations of the Yaoundé-city and dumping site villages. From the Table, it can be remarked that the transport cost for hospital (T) per year per person is about three to four times higher for the dumping site people as compared to the Yaoundé-city population. More precisely, as compared to the transport amount of 26,544 FCFA/year for the Yaoundé-city's dweller, a person living in Nkolfoulou I or II spends 92,547 FCFA annually for the transport to the Yaoundé central hospital, while the one living in Nsan spends about 106,785 FCFA annually for the same purpose (Table 3). Hence, in general, people living near the dumping site of household waste bear more financial expenses for transport costs. But those living in Nsan record the highest transport costs among the dumping site villages. This could be explained by the fact that, Nsan village is the farthest located village from Yaoundé-city. It is not situated in the main straight road line (which

Table 3: Computation of transport cost (T) for hospital (in FCFA/year/person)

Population location	*Yaoundé-city(N=86)*	*Dumping site villages (N=108)*		
		Nkolf oulou I (N=36)	*Nkolf oulou II (N=36)*	*Nsan (N=36)*
Annual diseases frequency[a] (number/person)	4.74	10.17	10.17	10.17
Mean length of each illness[d] (days)	7	7	7	7
Total of illness days[e] (days/year /person)	33.18	71.19	71.19	71.19
Round trip taxi cost to hospital[f] (FCFA/person)	800	1,300	1,300	1,500
Total cost of transport[g](FCFA /year/person)	26,544	92,547	92,547	106,785

Notes: In this Table, at each location:
[a]The annual diseases frequency is our own field survey findings.
[d]The mean length of each illness is taken from hospital records.
[e]The total of illness days is equal to: the annual diseases frequency multiplied by the mean length of each illness.
[f]The round trip taxi cost to hospital is the current tariff applicable by the Ministry of Transport.
[g]The total transport cost is equal to: the total of illness days multiplied by the round trip taxi cost till hospital.

passes at the center of the villages Nkolfoulou I and II) coming from Yaoundé but rather in a difficult accessible area by vehicles/cars.

3.2.1.3. Accommodation Cost During Hospital Stay

The accommodation cost (A) per year per person is more than two times higher for the dumping site people as compared to the Yaoundé-city population (Table 4). In total, a person living at the vicinity of dumping site spends 355,950 FCFA annually for accommodation during hospital stay, while the one residing in Yaoundé-city loses 165,900 FCFA annually for the same purpose. Hence, people living near the dumping site of household waste bear more financial expenses for accommodation during hospital stay (see Table 4).

Table 4: Computation of accommodation cost (A) during hospital stay (in FCFA/year/person)

Population location (N=108)	*Yaoundé-city*	*Dumping site villages (N=86)*		
		Nkolfoulou I (N=36)	*Nkolfoulou II (N=36)*	*Nsan (N=36)*
Annual diseases frequency[a] (number/person)	4.74	10.17	10.17	10.17
Mean length of each illness[d] (days)	7	7	7	7
Total of illness days[e] (days/year/person)	33.18	71.19	71.19	71.19
Price of hospital room[h] (FCFA/day/person)	5,000	5,000	5,000	5,000
Total cost of accommodation[i] (FCFA/year/person)	165,900	355,950	355,950	355,950

Notes: In this Table, at each location:
[a]The annual diseases frequency is our own field survey findings.
[d]The mean length of each illness is taken from hospital records.
[e]The total of illness days is equal to: the annual diseases frequency multiplied by the mean length of each illness.
[h]Both people from Yaoundé-city and dumping site villages receive their medical treatment at Yaoundé. So, the price of hospital room is the current tariff applicable at the Yaoundé central hospital.
[i]The total accommodation cost is equal to: the total of illness days multiplied by the price of hospital room.

3.2.1.4. Food and Likes' Costs During Hospital Stay

The food and likes' costs (F) per year per person are also more than two times higher for the dumping site people as compared to the Yaoundé-city population (Table 5). In total, a person living at the vicinity of dumping site spend 106,785 FCFA annually for accommodation during hospital stay, while the one residing in Yaoundé-city loses 49,770 FCFA annually for the same purpose (see Table 5). Hence, people living near the dumping site of household waste bear more financial expenses for the food and likes' costs during hospital stay.

Table 5: Computation of food and likes' costs (F) during hospital stay (in FCFA/year/person)

Population location	*Yaoundé-city (N=86)*	*Dumping site villages (N=108)*		
		Nkolfoulou I (N=36)	*Nkolfoulou II (N=36)*	*Nsan (N=36)*
Annual diseases frequency[a] (number/person)	4.74	10.17	10.17	10.17
Mean length of each illness[d] (days)	7	7	7	7
Total of illness days[e] (days/year/person)	33.18	71.19	71.19	71.19
Daily food price[j] (FCFA/person)	1,500	1,500	1,500	1,500
Total cost of food and likes[k] (FCFA/year/person)	49,770	106,785	106,785	106,785

Notes: In this Table, at each location:
[a]The annual diseases frequency is our own field survey findings.
[d]The mean length of each illness is taken from hospital records.
[e]The total of illness days is equal to: the annual diseases frequency multiplied by the mean length of each illness.
[j]The daily food price is the current tariff applicable in Yaoundé and its surrounding villages.
[k]The total food and likes' cost is equal to: the total of illness days multiplied by the daily food price.

3.2.2. Time Costs of Illness

3.2.2.1. Waiting and Travel Time Cost for Hospital

From Table 6 results, one can remark an increasing trend of the waiting and travel time cost (for hospital) as we move far away from

Table 6: Computation of waiting and travel time cost (W) for joining the hospital (in FCFA/year/person)

Population location	*Yaoundé-city (N=86)*	*Dumping site villages (N=108)*		
		Nkolfoulou I (N=36)	*Nkolfoulou II (N=36)*	*Nsan (N=36)*
Annual diseases frequency[a] (number/person)	4.74	10.17	10.17	10.17
Mean length of each illness[d] (days)	7	7	7	7
Average waiting and travel time per day per person[l] (hours)	1.5	3	3,25	3,5
Waiting and travel time per disease per person[m] (hours)	10.5	21	22.75	24.5
Annual waiting and travel time per person[n] (hours)	49.77	213.57	231.37	249.17
Value of 8 hours of labour[o] (FCFA/manday)	2,000	1,500	1,500	1,500
Value of one hour labour[p] (FCFA/hour)	250	187.5	187.5	187.5
Total cost of waiting and travel time[q] (FCFA/year/person)	12,443	40,044	43,382	46,719

Notes: In this Table, at each location:
[a]The annual diseases frequency is our own field survey findings.
[d]The mean length of each illness is taken from hospital records.
[l]The average waiting and travel time per day per person is our own field survey findings.
[m]The waiting and travel time per disease per person (hours) is equal to: the mean length of each illness (days) multiplied by the average waiting and travel time per day per person (hours).
[n]The annual waiting and travel time per person (hours) is equal to: the waiting and travel time per disease per person (hours) multiplied by the annual diseases frequency.
[o]In Cameroon, 8 working hours of a healthy adult is equivalent to one standard man-day (one man day worth 2,000 FCFA in Yaoundé-city and 1,500 FCFA in dumping site villages).
[p]The value of one hour of labour is equal to: the value of one manday divided by eight.
[q]The total cost of waiting and travel time is equal to: the annual waiting and travel time per person (hours) multiplied to the value of one hour of labour.

Yaoundé-city. The highest waiting and travel time cost is spent by people living in Nsan located at 18 km from Yaoundé-city (46,719 FCFA/year/person) followed in a descending order by the inhabitants of the Nkolfoulou I (43,382 FCFA/year/person) distant at 17 km from Yaoundé-city, then by people residing in Nkolfoulou II (40,044 FCFA/year/person) located at 16 km from Yaoundé-city. The waiting and travel time cost is the lowest for the Yaoundé urban population (12,443 FCFA/year/person) which spends less than one third of the amount paid by each dumping site inhabitant (Table 6). Thus, the citizens of Yaoundé benefit much more on the localization of the most prestigious hospitals inside their city and thus they are likely to spend less money for waiting and travelling to hospital.

3.2.2.2. Cost of Time Lost Due to Illness

Table 7 shows the computation of cost of

Table 7: Computation of the cost of time lost due to illness (E): loss of Earnings resulting from illness (in FCFA/year/person)

Population location	*Yaoundé-city(N=86)*	*Dumping site villages (N=108)*		
		Nkolfoulou I (N=36)	*Nkolfoulou II (N=36)*	*Nsan (N=36)*
Annual diseases frequency[a] (number/person)	4.74	10.17	10.17	10.17
Mean length of each illness[d] (days)	7	7	7	7
Mean value of labour[o] (FCFA/manday)	2,000	1,500	1,500	1,500
Average loss per disease[r] (FCFA/person)	14,000	10,500	10,500	10,500
Total cost of time lost[s](FCFA/year/person)	66,360	106,785	106,785	106,785

Notes: In this Table, at each location:
[a]The annual diseases frequency is our own field survey findings.
[d]The mean length of each illness is taken from hospital records.
[o]In Cameroon, 8 working hours of a healthy adult is equivalent to one standard man-day (one man day worth on average 2,000 FCFA in Yaoundé-city and 1,500 FCFA in dumping site villages).
[r]The average loss per disease is equal to: the mean value of labour multiplied by the mean length of each illness.
[s]The total cost of time lost is equal to: annual disease frequency multiplied by the average loss per disease.

time lost due to illness (E): the loss of Earnings resulting from illness (in FCFA/year/person). Although the value of labour in Yaoundé-city (2,000 FCFA/manday) is higher than in the dumping site villages (1,500 FCFA/manday), the overall total cost of time lost for the dumping site inhabitants (106,785 FCFA/year/person) is higher as compared to the Yaoundé-city residents (66,360 FCFA/year/person) [see Table 7]. This is due to the annual diseases frequency which is higher for dumping site people (see section 3.1 and Table 1). Consequently, it can be concluded that, people living near the dumping site of household lose more earnings resulting from illness as compared to the Yaoundé-city's dwellers.

3.2.3. Intangible Costs of Illness

In this paper, the intangible costs (λ) which are related to subjective assessment by interviewed people (thus difficult to evaluate) are not taken into account in the calculations. They include namely: the loss of productivity at work, the loss of leisure time, the pain/disutility during illness, the risks of death or of being handicapped from illness. Thus, the costs components related to those factors are considered as zero in the paper.

3.2.4. Pooled Financial, Time and Intangible Costs of Illness

Table 8 shows the pooled financial, time and intangible costs of illness per year per person living in the Yaoundé-city and dumping site villages. From the Table, it can be remarked that the pooled financial, time and intangible costs per year per person are more than two times higher for the dumping site people as compared to the Yaoundé-city population. On average, a person living at the vicinity of dumping site loses 1,100,034 FCFA annually, while the one living in Yaoundé-city loses 492,724 FCFA annually (see Table 8). Hence, the difference in pooled

Table 8: Pooled financial, time and intangible costs of illness (in FCFA/year/person)

	Population location	*Yaoundé-city (N=86)*	*Dumping site villages (N=108)*		
			Nkolfoulou I (N=36)	*Nkolfoulou II (N=36)*	*Nsan (N=36)*
Financial costs	Medicine and consultation costs (M)	66,360	142,380	142,380	142,380
	Transport cost for hospital[t] (T)	2*26,544 = 53,088	2*92,547 =185,094	2*92,547 =185,094	2*106,785 =213,570
	Accommodation cost during the hospital stay (A)	165,900	355,950	355,950	355,950
	Food and the like costs during the hospital stay (F)	49,770	106,785	106,785	106,785
Time costs[t]	Waiting and travel time cost for hospital (W)	2*12,443 =24,886	2*40,044 =80,088	2*43,382 =86,764	2*46,719 =93,438
	Time lost Earnings from illness (E)	2*66,360 =132,720	2*106,785 =213,570	2*106,785 =213,570	2*106,785 =213,570
Intangiblecosts	λ=Other costs (loss of productivity, leisure time, pain, risks of death or handicapped)	-	-	-	-
	Total costof illness[u] (C)	492,724	1,083,867	1,090,543	1,125,693
			Average from three villages[v]:1,100,034		
	Cost of pollution from disposing household waste at Nkolfoulou[w]	1,100,034 - 492,724 = 607,310			

Notes: In this Table,
At each location, the time costs (the waiting and travel time cost, the time lost earnings from illness computed in Table 6) and the transport cost for hospital (Table 3) are multiplied by two thus computed for two persons comprised of both the sick person and his caretaker.
[u]The total cost of illness is the pooled financial, time and intangible costs from illnesses (the sum of financial costs *plus* the time costs *plus* the intangible costs).
[v]The average from three villages is equal to: the summation of total cost of illness from the three villages (Nkolfoulou I, II and Nsan) divided by three (1,083,867+ 1,090,543+1,125,693=1,100,034 FCFA).
[w]The difference of the pooled financial, time and intangible costs from illnesses between the dumping site population (1,100,034 FCFA) and the Yaoundé-city population (492,724 FCFA) is: 1,100,034 FCFA *minus* 492,724 FCFA= 607,310 FCFA per year per person (about 926 Euros/year/person). This latter figure could represent the cost of pollution from disposing household waste at the Nkolfoulou dumping site.

financial, time and intangible costs between the two groups is 607,310 FCFA (about 926 Euros). That difference could represent the cost of pollution from disposing household waste at the Nkolfoulou dumping site (Table 8).

To test whether this difference is significant, a t-test is used to test the null hypothesis of equality of the pooled financial, time and intangible costs between the Yaoundé-city and the dumping site populations. The difference is statistically "very highly significant" ($p \leq 0.001$). So, the null hypothesis of equality of pooled financial, time and intangible costs is rejected and the alternative hypothesis of inequality of pooled financial, time and intangible costs (between the Yaoundé and the dumping site populations) is accepted. Hence, from this t-test, it is statistically proved that people living near the dumping site bear more financial expenses and loss compared to the Yaoundé-city population.

4. DISCUSSION

4.1. The Higher Diseases Frequency Near the Dumping Site Villages is Mainly Attributed to Existing Unsanitary Conditions

The higher diseases frequency observed in dumping site villages (with 10.17 diseases/year/person) could be explained by the fact that, contrary to the Yaoundé-city (with 4.74 diseases/year/person), there is no adduction of the SNEC[2] drinking potable water available for the populations in the dumping site neighbourhoods (Table 1 and Fig. 2). So, their sources of drinking water (traditional wells, forages, surrounding rivers) are frequently contaminated by lixiviates water originating from the dumping site thus favouring many diseases proliferation. Statistics from the Yaoundé Central hospital confirm this result and show that in 2003, about 75% of patients (mostly children) living in Nkolfoulou I, II and Nsan villages (nearby dumping site) suffered from malaria, typhoid, diarrhoea, cholera and dysentery due to pollution from household waste disposal (Jaza, 2005; Kuete et al., 2003).

Hence, in order to reduce or avoid those higher diseases frequency, the government should in priority create the adduction of potable water in villages surrounding the dumping site villages. But while waiting for the government to act, people in those villages are advised to respect elementary hygienic rules such as boiling the water before drinking or using it, to always and properly wash their hands before eating. Thus, educating those people for following proper sanitary conditions would help them to lower the frequency of some regular types of diseases (diarrhoea, cholera, dysentery, typhoid).

Deplorable unsanitary conditions are also at the origin of higher diseases frequency observed in other African cities. For instance, the prevalence of parasites, tetanus, malaria, hookworm, cholera and diarrhoea in most African cities is attributed to the unhygienic conditions in these cities (Stephens and Harpham, 1992). Songsore and Mcgranahan (1993) reveal that malaria, diarrhoea, intestinal worms and upper respiratory tract infections were among the most common health problems reported at out-patient facilities in the Greater Accra Region of Ghana. In the city of Accra, the major health problem is disease attributed to poor environmental sanitation, which is exacerbated by ignorance and poverty (Ababio, 1992). In Tanzania, Yhdego and Majura (1988) have reported that poor sanitation and improper waste disposal practices result in the spread of infectious diseases, which are the most frequent causes of morbidity and mortality.

Household waste dumped into storm drainage channels, creeks, lagoons and other water impoundment points create serious environmental problems which can escalate into disastrous situations. The devastation of lives and property which occurred due to the 1982 floods in Ibadan, Lagos, Port Harcourt and Aba in Nigeria and Accra, Ghana in 1995 were attributed partly to an accumulation of refuse which blocked these cities' drainage channels (Kinako, 1979; Filani and Abumere, 1992).

Consequently, the deplorable or inadequate household waste disposal and management practices, which culminates in a number of health and environmental problems, has prompted the need to find effective and pragmatic solutions to waste management problems in African cities. Composting organic household waste for farming in villages surrounding cities could be one of the most appropriate solutions.

4.2. Composting Household Waste Could Solve Both Disposal and Crop Fertilization Problems

The computed difference in pooled financial, time and intangible costs between the two groups

(Yaoundé and dumping site populations) which is 607,310 FCFA (about 926 Euros) could represent the cost of pollution from disposing household waste at the Nkolfoulou dumping site (Table 8). However, composting household waste means that there will be less quantity of waste to be disposed or landfilled in the dumping site: only 38% of residues to be landfilled will remain after composting (Jaza, 2005; Ngnikam, 2000). Thus, it could be possible to reduce or avoid such expenses and loss by composting household waste. According to Jaza (2005), composting is the most convenient waste recycling method useful for the community because it guarantees both fertilization alternatives (sustainable improvement of soil properties), poses less environmental problems and can be done at reasonable cost. More importantly, by using composting as waste evacuation method, it can help to close the rural-urban nutrient cycle (see Fig. 3) whereas other waste evacuation methods lead to a break down of such rural-urban nutrient cycle hindering therefore the sustainability of agricultural production (Jaza, 2005).

Thus, the recycling method of household waste may be significant for crop production in the rural areas surrounding Yaoundé (including the dumping site villages which are Nkolfoulou I, II and Nsan). Normally, crops produced in rural areas need soil nutrients which are usually brought through mineral fertilizers (Fig. 3). Since the production in most cases is consumed in cities, there is a movement of soil nutrients from rural to urban areas through the crops. Consumers of those crops in cities generate household waste, meaning that the initial mineral fertilizer nutrients would now be available in the household waste which is disposed in controlled or uncontrolled dumping site (Drechsel and Kunze, 2001).

Therefore, urban centres are vast nutrient reservoirs available in household waste. Unlike refuse in rural areas, urban household refuse is usually lost, contributes to urban pollution, or is used as landfill, meaning there is little or no return of biomass or nutrients to the production areas (rural areas). The results are problems at both ends of the food chain: soil nutrient mining or soil acidification in rural and peri-urban production areas and pollution problems where nutrients and other inputs accumulate. In the urban areas, the resulting problems are those of waste management, health and environment (Fig. 3).

However, such problems could be alleviated by simply turning household waste into compost and making it available to farmers in rural areas for fertilization/soil nutrition purposes (Jaza, 2007). In that way, there may be a biomass transfer (nutrients re-transfer) through compost from the urban to the rural areas. In such a context, agriculture, especially in the rural-urban interface (the peri-urban area), could benefit from nutrient recycling. Consequently, waste composting for urban and peri-urban agriculture may help closing the rural-urban nutrient cycle (Fig. 3).

In the same view, a lot of experts, consultants and researchers of solid waste management are increasingly recognizing the great potential of waste recycling into compost as the best solution to help reduce household waste collection and disposal problems in African cities (Chimbowu and Gumbo, 1993; Egziabher, 1994). This shift in household waste management away from an emphasis on disposal towards one of waste prevention and reuse is grounded in what can be called "resource recognition" (Furedy, 1992). In this context, solid household waste is not perceived as something which is repulsive, useless, and dangerous, but rather as an under-used resource. It is a valuable material which can be recycled and used in food cultivation, thereby reducing the volume of disposed waste and the total cost of pollution.

4.3. An equitable Share of Pollution Cost Should be Envisaged

As indicated by field survey results, the difference of the pooled financial, time and intangible costs from illnesses between the Yaoundé-city and dumping site populations which is 607,310 FCFA per year per person (about 926 Euros/year/person), could represent the cost of pollution from disposing household waste at the Nkolfoulou dumping site (Table 8). That amount could be used in order to influence the government tax policy on household waste producers. Currently, people living near the dumping site bear alone the financial expenses and loss resulting from pollution due to the usual disposal of household waste in their environment. Normally, it would be fair and equitable for the whole society if that cost engendered by waste disposal was incorporated or added to tax rate on household waste fixed by the government and applicable to everyone. In

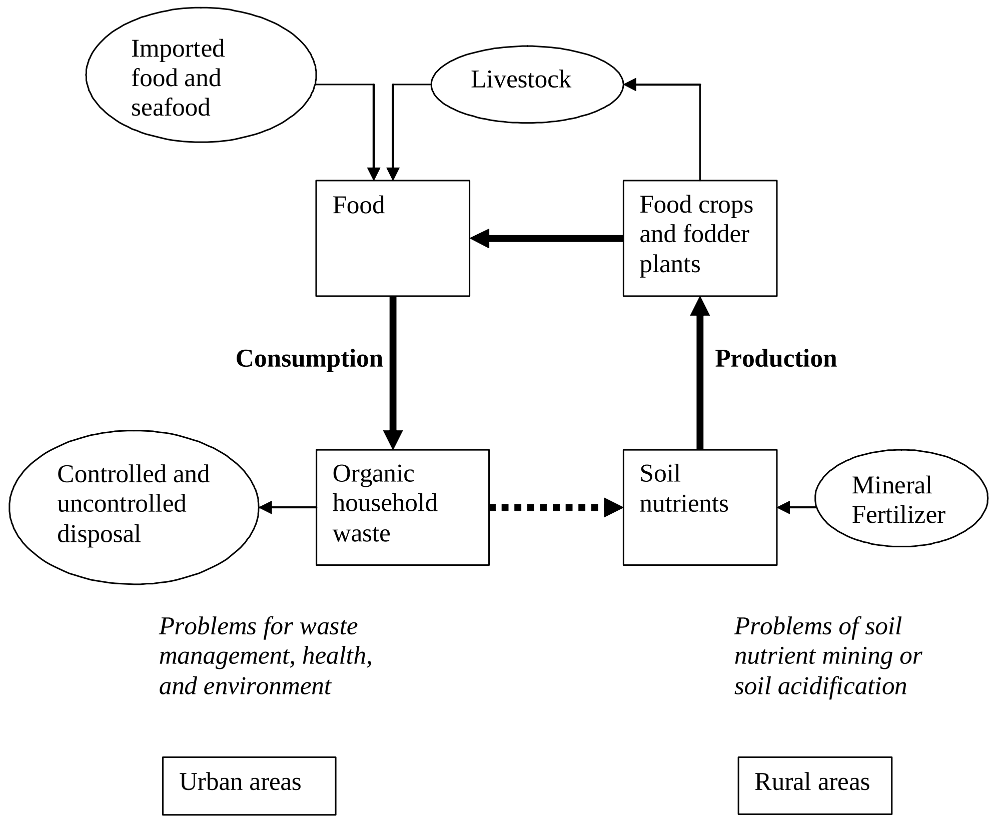

Fig. 3. The waste recycling framework scheme
Source: Modified from Drechsel and Kunze (2001)

this view, the money received from such taxes could be used to subsidize the composting cost and the transport of compost to agricultural farms. However, in the official law of 1996 relating the environmental management policy in Cameroon, none general provision has been laid down into that direction.

Results obtained from the field (Jaza, 2005) by surveying the urban population suggest that, about 70% of the Yaoundé population is willing to pay tax for household waste collection, approximately 79% of this population wants that tax money collected by the government to be used for financing the composting and they suggest that the amount of such tax affordable by everyone should average 703 FCFA per month (Jaza, 2005). The same survey indicates that, people living in Yaoundé-city are willing to contribute for composting within a range of 50 to 2000 FCFA and on average 592 FCFA per month. The main reasons motivating them to pay such an amount were: the reduction of environmental pollution in their neighbourhood and the use of resulting compost for fertilizing their gardens (Jaza, 2005). This indicates that, such a policy of collecting tax from household waste producers in order to subsidize the composting could be successful. Hence, there is a need for the government to implement such a policy in order to reduce pollution charges and loss supported alone by the people living near the Nkolfoulou dumping site.

4.4. The Creation of Another Farther Away Dumping Site Could Help to Reduce Environmental Problems

It is statistically proved that, as compared to the Yaoundé-city population (with 4.74 diseases/ year/person), people living near the dumping site villages (with 10.17 diseases/year/person) are two times much more exposed to various diseases due to environmental pollution (see Table 1 and Fig. 2). Thus, moving the dumping site location farther away from their villages or finding another more appropriate dumping site location in less popular villages farther away from Yaoundé-city seems to be environmentally more beneficial for them (because it would help to avoid or reduce diseases frequency).

But because of the high urbanization rate in Cameroon, the country authorities are requested to take convenient measures on time. Since the Yaoundé residential area is growing very rapidly, its urban locality is expected very soon to reach the dumping site villages (which are located at less than 16 km from the Yaoundé-city center). If such situation happens (if the Yaoundé residential area reaches the dumping site neighbourhoods), then the pollution from household waste would also affect the Yaoundé-city's dwellers. Consequently, there is an urgent need to move the dumping site and place it in other locations farther away from Nkolfoulou. This solution is more gainful since it would also promote the image of the city or country for tourists.

5. CONCLUSION

The disposal of the Yaoundé household waste at the Nkolfoulou dumping site (located at 16 km from Yaoundé-city) has a negative impact on the state of health and standard of living of the people living in its surroundings. As compared to the Yaoundé-city population (with 4.74 diseases/year/person), people living near the dumping site of household waste (with 10.17 diseases/year/person) are two times more exposed to various diseases due to household waste disposal. The difference of the pooled financial, time and intangible costs from diseases between the two groups which is about 607,310 FCFA per year per person (926 Euros/year/person) could represent the cost of pollution from disposing household waste at Nkolfoulou. To avoid of reduce such expenses or losses from pollution, it would be better: (i) to educate the Nkolfoulou inhabitants for respecting elementary hygienic rules such as boiling the water before drinking or using it, to always and properly wash their hands before eating; (ii) to compost the organic household waste directly in Yaoundé-city and only the non-compostable inorganic residues (which create less pollution problems) should be discharged into the Nkolfoulou dumping site; (iii) to implement a policy which would equitably share the pollution cost between the Yaoundé-city and dumping site populations; (iv) to find another and more appropriate dumping site location in less popular villages farther away from Yaoundé-city. This latter solution would help to better clean the city and decrease the pollution in the areas surrounding Yaoundé while promoting the image of the city or country for tourists.

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NOTES

1 FCFA (Franc de la Communauté Financière Africaine) is the currency used in Cameroon. Its conversion rate is: 1 Euro = 655.957 FCFA.

2 SNEC (Société Nationale des Eaux du Cameroun) is the sole official parastatal company in charge of providing potable water to Cameroonians.

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