Solid waste management in Kigali City, Rwanda

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Abstract

Solid waste management is becoming an important issue in Kigali City. Batch of wastes can be seen in various spaces such as roads, riversides and many other open spaces, and this constitutes a crucial problem to human beings in particular and environment in general, the accumulation of these wastes will attract rats, insects, flies and many other pathogens which in turn cause problems, such as water contamination, infectious diseases like diarrheal and so on. Rwanda, being a densely populated country, is undergoing rapid urbanization and a huge number of people are leaving rural areas to Kigali City, this leads to an increasing of challenges associated with providing an effective basic infrastructure including solid waste management system. As cities grow, wastes generated increase in volume as well as in variety. Rwandan urban population growth rate was 5% per year in the period 1978-1991 and currently stands at 9% per year and continues to increase. Regarding these changing issues this paper analyzed the current solid waste management system in Kigali City and proposed some approaches which can be used to solve the problems associated with it, where recycling and composting were found to be more suitable.

Keywords: solid waste management, Kigali City, recycling, composting

Introduction

Worldwide especially in developing countries like Rwanda solid waste management is becoming a big problem for major cities as a result of the rapid increase in solid waste generation caused by rapid population growth, urbanization, rapid industrialization and economic development, while the sustainable management system of solid waste is imperative in order to minimize environmental and public health risks **(**ISWA, 2002; Ball, 2006). The balance between the specific components of this system are already well understood and established in most developed countries, Read (1999) for a UK perspective, but this is not often the case for developing countries

such as Rwanda. According to estimates from the World Resources Institute and USAID, many local authorities in developing countries spend over 30% of their budgets on refuse collection and disposal but can only collect at most 50–70% Municipal Solid Waste (MSW) and most do not meet environmentally safe (MSW) disposal levels because of lacking sanitary landfills Matrix Development Consultants (1993). Many evidences showed that a key driver towards increased efficiency in solid waste management is the involvement of all stakeholders including, the waste generators, waste processors, formal and informal sectors, financial institutions and private initiatives such as non-governmental and community based organizations (Baud et al., 2001; Palczynski, 2002; Read, 2003; Ahmed and Ali, 2004; Henry et al., 2006; Kassim and Ali, 2006; Wilson et al., 2006). For this reason as in Rwanda there are a lot of jobless people, this paper encourages the recycling of wastes by private sector in order to supplement the Government to create more job opportunities.

Other several solid waste management techniques have been described by various authors, we can say for example (Poon, 1997; Kungskulniti, 1991; Tchobanoglous, 1993; Iskandar, 2003; Niemeijer, 2002; Mason *et al.*, 2003; Klang *et al.*, 2003; Button, 2002; White et al.,1995; McDougall et al., 2001). Although studies above can provide useful support in determining the best practicable management option, they are often country specific. For this reason this paper analyzed the current solid waste management system in Kigali City and suggests the suitable waste management alternatives for Kigali City.

Materials and Methodology

Methodology

The basic methodology used in this paper concerns the field study and observation conducted in Kigali city from March 2011 to March 2012. The objective was to have a view of what is done on the field regarding solid waste management from collection to dumping or recycling. For that case, observation was made throughout the city, by visiting Nyanza landfill, cooperatives in charge of wastes recycling and local people with different levels of living in randomly chosen sectors of every District. Some markets and industries were also visited. In order to determine the composition of the solid waste, approximately 1000 kg of solid waste samples were collected from the transitional collection sites in all districts of Kigali City and follow up of the (Company for the conservation of environment) COCEN's activities, was carried out from collection to the production of briquettes. In addition to the field study there were other several techniques which have been used such as interviews and desk survey. Interviews were conducted with the representatives of the Public sector, private sector, informal sector, households and associations dealing with solid waste management in the Kigali City. Desk surveys were made to get information from available literature and to know works previously done in the field of solid waste management in Rwanda.

Study area description

According to Kigali City website, Kigali City, the capital of Rwanda, started in 1907 as a small colonial outpost with little link to the outside world. The City of Kigali is divided into three (3) Districts comprising 35 Sectors, 161 Cells and Cells are subdivided into 1061 villages. It is presently inhabited by approximately 1 million inhabitants on the area of 730 km^2. Its population is relatively young with 60%, and women are slightly more the 50% and shelters approximately more than 44% of the Rwandan urban populations, for more details see Fig.1.

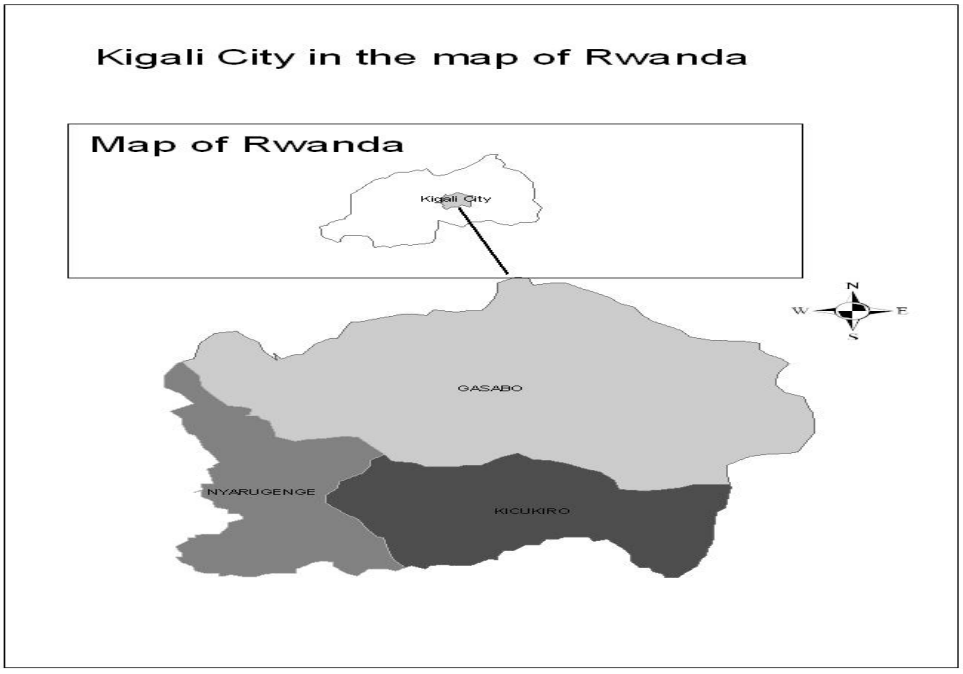

Fig1. Kigali City in the map of Rwanda

Results and discussion

A. Solid wastes characteristics, origin and their amount

The main sources of solid waste in Kigali are domestic, commercial activities, industries, streets, farms and markets. As presented in the table 1. Solid wastes in Kigali City are mainly made by food remnants more than 60% in all districts and in all categories of income except for high income people. In Gasobo district food remnants comprises 67.5% of all wastes; in Nyarugenge they occupy 66.4% while in Kicukiro district they represent 66.7%. Low income people generate more food remnant wastes than others with the percentage of 66.9, middle income people produce 63.1% whilst high income produce 58.9%. The second component of wastes in Kigali City is occupied by paper with 16.4% in Nyarugenge district, 15.4 % in Kicukiro District, 16.6% in Gasabo district, 19.4% for high income people, 16.6% for middle income and 13.5 for low income people.

The third place is occupied by grass, the fourth by wood; the fifth is textile followed by plastic and glass. At the last we have leather preceded by cans. In Kigali city, the average waste generation is between 1800 and 2000 t per day which means 1.8 - 2kg of waste per capita per day.

Table1. Wastes composition in Kigali City by District and income level groups

District	Nyarugenge	Kicukiro	Gasabo	High income	Middle income	low income
waste type	% composition			% composition,		
Food remnant	66.4	66.7	67.5	58.9	63.1	66.9
Paper	16.4	15.4	16.6	19.4	16.6	13.5
Grass	6.7	6.8	7.3	5.9	7.9	8
Plastic	1.6	1.9	1	3.2	3	2.4
Metal	0.9	1.9	0.5	1.2	0.8	0.2
Textile	1.8	1.8	2.4	2.5	2.6	2.9
Glass	1.6	1.7	0.8	1.9	1.2	0.8
Wood	3.2	2.5	3	3.4	3.8	4.6
Leather	0.5	0.4	0.2	0.9	0.6	0.6
Cans	0.9	0.9	0.7	2.7	0.4	0.1

B. Waste collection, storage and transport

Collection, storage and transport of wastes in Kigali City are privatized and every sector has its private company in charge of these activities. Those firms collect house-to-house, typically between one and three times a week, depending on the capacity of the household because they have to pay them according to the amount of wastes they have collected but in some areas the collection is done once per month. After collection in most cases wastes are transported at Nyanza landfill and few to recycling company. Most part of Kigali City is characterized by high population density and unplanned poor residential structures which are hardly accessible especially the suburban areas, which are mainly occupied by poor and jobless people, this leads to the informal management of wastes in those areas because companies in charge of waste collection are not interested by them. They tend to concentrate their services mainly in the central business districts and on the more affluent communities, which have better access and who can pay wastes services easily. In those slums people are fighting for survival and don't care about environmental protection and rapid population concentration has overstretched the capacity of local authorities to adequately provide adequate basic infrastructures. As it is shown by Table.2,

population of Rwanda and that of Kigali City in particular is increasing at high rate. This high increasing of population is due to the movement of people from rural areas to Kigali City looking for employment and rapid population growth of the whole country in general. This leads to the high concentration of the urban population in the Capital which is estimated at 44% of the Rwandan urban population with an average annual rate of 9%. This demographic imbalance between Kigali City and other urban centers is accompanied by an imbalance in the economic activities and services sector which are mainly concentrated in Kigali (more than 70% of industrial activity; about 50% of the wholesale businesses and 70% of the banking services, etc), MINECOFIN (2007). As population and economic activities increase more wastes will be generated which calls for a planned sustainable management for them, but this is not feasible due to that unpredictable high concentration of population in Kigali City and lack of sustainable master plan.

Table2. Evolution of Rwandan and Kigali City's population from 1970 to 2011

Years	1970	1978	1991	2002	2011
Population in Kigali City	57400	115990	235664	603049	1000000
Population in Rwanda	3756432	4832527	7157551	8128553	11000000

C. Techniques used for treatment and disposal of solid wastes in Kigali City

Landfill

In Kigali City, it is the most used technique to manage solid wastes where about 80% of wastes are transported to Nyanza landfill located in Kicukiro District. Fig2. and Fig.3 show wastes disposed in that landfill.

Nyanza landfill is a typical of unsanitary landfill which is located on the top of small hill not far from dwelling houses. During the raining season water from wastes can reach the houses near that landfill, see fig.2 when it is raining it is immediately full and water throws downwards area which is the habitation area and leachate from the site can easily find the way into the nearby water bodies and contaminate them.

Fig.2. Plastic wastes on the top of pong containing wastewater at Nyanza landfill

Fig 3. Scavenger separating solid wastes at Nyanza Landfill

The methods used to treat waste at that landfill are not appropriate, after disposing wastes, they are not covered by soils and the bad odor from those wastes attracts flies which can cause diseases to people who live near or work in the landfill, also light materials, such as paper and plastic bags, are carried by winds, causing aesthetically unpleasant conditions. Even if they try to separate wastes by taking out plastic wastes to be sold to recyclers, scavengers have no facilities or equipment for sorting valuable materials from the solid waste. Unfortunately, they suffer from health problems and injuries due to dust and the presence of broken glass and sharps, from Fig.3, you can see that women is separating wastes and doesn't wear neither the hand guard nor the protective shoes, and is exposed at high risk as said **Cointreau, (2000),** the occupational health risks to waste pickers in developing countries are high because of manual handling and lack of protective clothing/equipment, resulting in direct contact with waste. The separation done is also not sufficient, arriving to the

site you still find the mixture of biodegradable and non-biodegradable wastes while those in charge of landfill claim that they have finished that action of separation. This activity is very difficult given that at the waste generation level they don't separate wastes.

In addition to that poor disposal of solid wastes in Nyanza dumpsite, currently that landfill is almost full. When authorities of Kigali City asked that question, they said that they are preparing another new area to relocate that dumpsite but until March 2012 it was still being used. Note that this landfill has been operating for more than 30 years. When children scavenging at the dump sites were asked how they manage the squander they scavenged, most of all them responded that they first wash them in the streams or rivers or at home then after they sell them to recyclers. This practice can become a major source of pollution as those materials were mixed with chemicals and other pollutants.

Recycling

Though the most part of wastes in Kigali City is biodegradable, the only recycling of biodegradable wastes in the whole City is carried out by one company COCEN which manages the community's household garbage by converting it into fuel biomass briquettes for household use and compost organic fertilizer useful in crop production. COCEN can make 4-12 tones of briquettes per day depending on the season and customers. There were other few associations of that kind but they are no longer operating due to the lack of finance and customers. Fig4. shows briquettes read to be packed and sold at COCEN site. There is another cooperative, COOPED located at Nyamirambo sector, Nyarugenge District which recycles a small percentage of plastic wastes. Those associations are recycling only about 10% of the total waste of Kigali while more than 80% of wastes are spoilable.

In addition to that formal waste recycling, there is also informal recycling carried out by poor and marginalized social groups. This is widespread throughout urban areas of the developing world and it is reported that up to 2% of the population in Asian and Latin American cities depend on waste picking to earn their livelihood Medina (2000). Informal recycling occurs in developing countries because of low levels of economic development. In Kigali informal waste recycling concerns mainly metal wastes which are being collected and sold in neighbor countries such as Uganda and Kenya where they are recycled.

Fig. 4. Briquettes ready to be packed and sold at COCEN

Source reduction by considering Packaging

One of the best ways to reduce municipal solid waste is to limit packaging.

Also the simplest way to reduce waste is to prevent it from ever becoming waste in the first place. The government of Rwanda banned plastic bags which were used mainly for package. Currently package is done using spoilable materials made in papers but waste papers are increasing too quickly and there is no industry to recycle them.

Incineration and burning

In Kigali incinerators are used only to treat medical wastes, but a huge quantity of waste is still being treated using illegal burning especially for agriculture waste and papers. About 2% of waste is handled by this technique.

Composting

Kigali City has a big part which is rural where the main activity is agriculture and the government of Rwanda is encouraging the population to use composting of their wastes to get fertilizers, but in Kigali City only 7% of waste is managed using composting. This is done at the level of household especially in the rural part of the City where people have enough land, every family collect its waste into a hole and let them to be decomposed by bacteria, but also COCEN composts a certain amount of waste it collects. This technique is easier, chipper and economically profitable.

Illegal disposal

Illegal disposal is also common in Kigali City. Piles of solid wastes are often found along roads, underneath bridges, in culverts and drainage channels and in other open spaces. One source is the informal collection workers for those who don't want

or who are not able to pay the contribution asked by waste collectors companies.

D. Different stakeholders involved in waste management in Kigali City

In Kigali City every Sector is in charge of its waste and sectors sign contract with private associations which are in charge of cleanness and handling the problem of solid waste even though the Sector continues to supervise the activities. Districts and Kigali City are also required to make a follow up and supervisions of those activities but their involvement is not sufficient as said the president of COCEN, authorities are major source of the failure of recycling waste associations because they don't help them to sensitize population to pay contributions and to use briquettes from wastes especially government institutions. Landfills are in charge of Kigali City and it is the one who pays salaries for workers in those dumpsites. Householders are also involved in management of their wastes by paying a certain amount of money to those associations even though some people don't pay that money and discharge their wastes into rivers, lakes and streams illegally. In most developing countries people at household level are not given the chance to contribute in design and planning the solid waste management activities, which results in residents being unsure of their roles and it is believed that lack of awareness is the major contributory factor in the failure of most solid waste management schemes Addo-Yobo and Ali (2003), This is true for Kigali City, one of the causes of the failure of waste management associations is the lack of information for local people as they are not involved in establishing the contribution and choosing association to manage their wastes and the choice of dumpsite. It is essential to consult residents on the most appropriate method of collection in their area, on the affordability of possible charges, and on their conceivable role in monitoring the service.

E. Environmental impacts of Solid Waste disposal

In Kigali City, it was found that little or no consideration of environmental impacts was paid attention in the selection of dumpsite and inspection and monitoring of the waste management was not consistent since there are no wells to control groundwater contamination at the landfill and all activities concerning solid wastes management are carried out by private companies which are working for getting benefit with little involvement of the government. No sanitary practices such as application of daily soil cover or fencing were practiced at the dumpsite which attracts rats, flies and other diseases promoter animals. Small children are often in the landfill picking plastic and metal elements for their survival without any protection this is the same for workers in charge of waste separation they are not occupied with any protective equipment and this increases their risks to diseases as they can be harmed by metals, glasses or fire which takes place in landfill at least once per year as said the manager of Nyanza landfill. The disposal of solid waste in the rivers, road reserves, roadsides and especially in the

streams when it is raining is frequent not only in the areas of poor people but also even in the middle income quarters and Central Business District. The increasing growth of water hyacinth in wetlands located in the City such Nyabugogo and Nyabarongo sides is partly attributable to illegal disposal of solid and liquid wastes in the rivers but there is a requirement for proof studies.

F. Measures and recommendations to improve solid waste management in Kigali City

To improve solid waste management system in Kigali City, they should be a new solid waste management policy where the government through local authorities should emphasis on the inspection and monitoring of the whole waste management system, including periodic surveillance of approved waste disposal sites and their surroundings. They should also establish monitoring stations for the control of the disposal of leachate from dumpsites into surface water and groundwater systems. Batteries and other hazardous wastes should be stored in different containers separately from non-hazardous wastes at any area. The government should prepare and periodically up-date the master plan of waste collection and disposal in the city, it should also encourage reuse and recycling through the supporting the associations dealing with wastes recycling as they are not only protecting environment but also create employment. The government should boost the sensitization of using briquettes from wastes as the country is facing the challenge of deforestation starting by its institutions such schools, military camps and so on. To minimize the cost of recycling and to make it feasible, it is important to plan a better handling system where solid waste should be stored in two or three different containers at waste generation and provide a sorting area in order to avoid any mixing of waste with different kinds and to reduce contamination. Only wastes that are not suitable for recycling or composting should be transported at the sanitary landfill. For that case the establishment of the sanitary landfill is obligatory in Kigali City.

In addition to the measures cited above, it is recommended to every citizen to reduce the amount he buys in the first place and purchase only the amount he needs in order to reduce the waste he generates; to select products that are durable which can be used over and over again; to use refillable and reusable containers. Rural exodus needs to be reduced by economic diversification and decentralization of economic activities in secondary cities in order to boost rural incomes, which would be an incentive to remain in the rural areas rather than end up in slums in the urban areas and it is necessary to promote a policy which facilitates the investment in the secondary urban centers supported by suitable incentives. Finally an investigation into the extent of pollution of groundwater urgently needs to be carried out within the vicinities of Nyanza dumpsite.

Conclusion

Kigali City's solid wastes are highly increasing in the quantity and quality as the

number of population and economic activities are increasing while the land for disposal is becoming scarce. Composting, source reduction and recycling of wastes are the most viable alternatives for managing them; however, no single method will control the waste problem as effectively as a comprehensive program that relies on a number of solutions for different situations and the direct involvement of citizens is essential. Formal public and private partnership is also mandatory and will increase the scope of activities of the private sector. This arrangement may improve efficiency of the entire waste sector, and create new opportunities for employment especially in recycling spoilable waste as they occupy more than 80% of wastes in Kigali. Land filling and incineration can be used only for the waste that cannot be used as a resource. The waste management problem is complex because it involves a multitude of scientific, technical, economic and social factors, due to this complexity, it will require the cooperation of government, industries, hospitals, hotels, markets' people, companies for wastes management and households owners working as partners rather than adversaries to find a long-term solution.

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