



Sustainable solid waste management for Kisumu

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THE INCREASING ACHIEVEMENTS of civilization cannot be separated from an increase in the residues of society that do not receive any or only insufficient treatment. Solid residues generated by society have always been a source of severe environmental as well as public health problems. The need to minimize these problems has seen the formulation of regulations to restrict their disposal, hence a significant rise in the associated costs. The provision of waste services is, therefore, a costly and vexing problem for local authorities, especially in the developing countries {Contreau-levire, 2000}, with weak financial power, lacking environmental hygiene conscience, and insufficient knowledge on environmentally friendly and functional solid waste management technologies.

Further more, the fast growing urban population in these countries, estimated to reach 80% of their total national population by 2030, aggravates the waste problem further {GFA/Umwelt, 1999}. This will continue stretching the local authorities' service capacity hence selective delivery. The peri-urban areas therefore, will still be the most neglected. Without these essential services, the urban poor who are the majority in these areas seek alternatives, which in most cases predispose them to health problems.

The quantity of solid waste generated is to a large extent a function of the consumer behavior of the society hence the living standards of the individual. The quantity rises with the rise in the living standards while the specific weight decreases {GFA/Umwelt, 1998}. This implies that the urban poor produce the higher specific weight organic wastes; which provide optimum nutrients and carrier medium for numerous pathogens and disease carrying vectors- under the prevailing climatic conditions. Given the poor waste service delivery in Kenya, these wastes find their way into lakes, rivers and wells, which are the water sources for the peri-urban poor. As a result, waste related diseases

are on the rise. With the rise in poverty, some succumb to these diseases. Apart from these, the eutrophication levels are also on the rise leading to marine ecosystem disturbance hence impoverished lifestyles especially for the poor fisher families.

There is therefore a need for a solid waste management technique that not only solves the waste problem but also improves the environment and living standards of the rural and urban poor. Anaerobic digestion, which incorporates the environmental, economic and agricultural objectives, seems the best for Kisumu.

Kisumu municipality

Situated on the Kenyan shores of Lake Victoria, Kisumu municipality covers an area of 297km². It receives 1,500mm-rainfall p.a. mostly between March and May, and around December. The mean annual minimum temperature is 17°C while the maximum stands at 30°C. The humidity is 60 to 70% at 0600Hrs and 36 to 55% at 1200Hrs.

The population of the municipality has risen from 113,000 in 1969 to around 500,000 today, at the current growth rate of 4.74%. The peri-urban areas have the highest population density while the rural areas the lowest. Over 60% of the people live in poverty {KTEDP, 1999}.

Service delivery

About 60% of the residents have no access to piped water hence seek alternative supply for their daily needs. The sewerage system serves less than 10% of the population, while the only available refuse vehicle collects less than 20% of the 365,000 tons of solid wastes generated per year {KTEDP, 1999}, for example only 58,000 tons have been collected in the last three years.

The peri-urban areas, being on the periphery, have been left with no water supply hence rely on vendors, rivers, the

Table 1. Survey results

Sampled water		parameters					
		pH	NH ₃	-PO ₄	Dissolved O ₂	alkalinity	Life forms present
A	Well	5.8	0.05	-	3.7 {47%}	60	trace bacteria
B	Vended	7	-	-	7.8 {100%}	40	-
C	R. Kisat	6.9	1.2	1.94	2.45 {35%}	120	Blood worm, cut fish
D	R. Auji	7	-	0.57	5.2 {67%}	40	Amphibians

lake and shallow wells. They use pit latrines, which are few and constructed with no consideration of other factors. In some cases fecal disposal is in polythene bags {"flying toilets"}. Garbage is disposed of in drains, on road reserves and a few paces from houses and eating points making these areas filthy. These provide favorable breeding ground for many disease carrying vectors and pathogens. A survey by simple tests on well water, vended water and two rivers by the environment department in October 2001 yielded the results in Table 1.

River Kisat {C} and Auji {D} drain into Lake Victoria. The presence of NH_3 in A and C and PO_4 in both rivers suggests pollution from proximal wastes and latrines/sewage. The decomposition of the organic waste could be the cause of the low oxygen concentration in the two samples; hence the presence of blood worm and cut fish in river Kisat {sample C}, since the two thrive under very low oxygen concentrations. The bacteria in sample A suggest pathogenic activity in the ground water sources. Preliminary research findings by a team from Roben's center {UK} and Vired international on shallow well water in two peri-urban estates of Kisumu show seepage from proximal surface waste as the leading source of thermotolerant coliforms {TTC} and bacteriophage contaminating the well water. The two microorganisms are used as disease pathogen indicators.

The emptying of wastes into Lake Victoria by River Kisat, Auji, and in run off, could have significantly contributed to the hyacinth weed invasion; hence changing of the marine ecosystem. The weed has raised the fishing costs making some fisher families poor and caused water stagnation along shores creating breeding grounds for disease carrying vectors like mosquitoes.

The town's solid waste collected is dumped untreated in open ground. The uncontrolled biodegradation/combustion of the waste release toxic/pollutant gasses; some of which aid in the photo-catalytic chain decomposition of chlorofluorocarbon molecules in the atmosphere, causing Ozone depletion, and increased green house effect. This contributes to global warming hence more related health problems. The above in conjunction with poor nutrition/

hunger {as a result of poverty}, is manifested in the district morbidity data shown below. Death figures not shown.

As can be seen from the table above, most the cases of reported diseases are in one way or the other related to poor waste management/hygiene.

Solution to the problem

Given the municipality's background, there is a need for a solid waste management strategy that sustainably improves the livelihood of the urban poor, creates jobs in the peri-urban and rural areas while at the same time takes care of the environment factors.

Kisumu's household and market wastes are the most problematic. The wastes are mixed hence need sorting before they can be re-used/re-cycled. Metals, plastic, glass and paper can be sold as raw materials to industries. A self-help group in Kisumu is now making mattresses from recycled polyethene. Organic waste however, constituting over 80% of the wastes by weight, though has many recycling options, is yet to be fully utilized. Developed countries are adopting anaerobic digestion for waste treatment. This is because it integrates the energy, environmental and agricultural objectives. It also has the advantages of its simplicity, low operating and maintenance cost and cheap production of multiple products {HABITAT, 1990}, ideal qualities for poor communities.

Over 240,000 people die of hunger and related diseases, while a further 800 million go to bed hungry everyday {WFP, 1999}. Most of these cases are in the developing countries housing the poor subsistent population. The high population growth rate has put pressure on agricultural land hence low yields as a result of over cultivation, while the farmers/peasants are not able to purchase agricultural inputs to enable them improve their food crops production. Anaerobic digestion of organic wastes offers a better alternative to waste management as well as a source of quality manure for food production for the peri-urban poor. By incorporating high nitrogen content plants e.g. *L. leucocephala* or *T. diversifolia* in the feed stock the slurry manure produced can further be enriched. The nutrients in

Table 2. District disease morbidity data (top ten disease cases)

Rank	Diseases	Reported cases	
		Year 2000	Year 2001
1.	Malaria	71,006	82,268
2.	Upper Respiratory Tract Infection	33,217	38,109
3.	Skin infections	12,712	15,666
4.	Diarrhea	15,266	13,813
5.	Intestinal worms	4,500	5,644
6.	Eye infections	6,830	4,266
7.	Tuberculosis	1,346	142
8.	Bilharzia	-	117
9.	Cholera	274	104
10.	Measles	102	280

Source: - Kisumu district health information system 2001

the manure are easily and readily absorbed while the soil physical properties are improved for sustainable peri-urban high value crop production {GFA, Umwelt, 1999}. The effective microorganisms in the slurry could be useful to the crops. The use of Effective Microorganisms {EM} in agricultural production is being experimented by the Kenya Agricultural Research Institute {KARI}.

Despite the low levels of energy consumption in rural communities and the urban poor, the conventional methods of promoting rural electrification has not alleviated the energy problems of the rural and peri-urban settlements. Anaerobic digestion has been hailed as one of the most promising technology for energy supply in the rural economies of the developing countries {UNITAR, 19981}. It produces a safe, clean and low calorie {18,000-kJ/ m³} methane gas fuel for cooking, lighting and running stationary machines in the rural and peri-urban areas, hence cost saving on fuel {HABITAT, 1990}. The switch from wood fuel helps reduce the pressure on the remaining vegetation; thereby ensure bio-diversity and environmental conservation. Community digester projects are known to have succeeded in India and China. Ugunja Community Resource Center in Siaya {Kenya} is now promoting biogas production in rural areas.

Biogas conditions also rids the waste of most of the harmful pathogens {HABITAT, 1990}. Experiments done by the Provincial water office and the District public health office in Embu Municipality and Kigari Teachers college shows that the inoculation of the wastes with Effective Microorganisms {EM} reduces the odor, flies and disease carrying pathogens {Rimberia *et al*, 2001}.

Bio-energy production activities are labor intensive and thus, apart from providing decentralized energy sources for rural houses and industry, can generate gainful employment opportunities thus help in slowing down rural-urban

migration {HABITAT, 1990}. This will in the long run ease the congestion in the urban area hence better service delivery by the local authority and improved sustainable livelihoods for both the rural and urban poor.

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