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Challenges of Solid Waste Management in Kisumu, Kenya

Lesley Kudakwashe Sibanda[1] · **Nelson Obange**[2] · **Frankline Otiende Awuor**[3]

Abstract Solid waste management is a major environmental and public health concern in many urban areas of developing countries. Kisumu like many urban areas of developing countries is grappling with increasing waste generation, an overflowing dumpsite and pollution from uncontrolled discarding of waste. Sustainable solid waste management has remained elusive in the City due to lack of adequate funding and skilled personnel besides poor public attitude towards waste management. Efforts abound to improve the situation but significant progress is hindered by the difficulties in relocating Kachok dumpsite. Recommendations are made for a sustainable solid waste management system supported by a suitably relocated Kachok dumpsite.

Keywords Solid waste management · Kachok dumpsite · Kisumu City · Kenya

Introduction

Solid waste management (SWM) refers to the activities designed to effectively collect, transport, treat and dispose of waste due to public health concerns, aesthetics, natural resource conservation and other environmental considerations (Munala and Moirongo 2011). The principle aim of SWM is to preserve natural resources, protect the environment and safeguard the health of the population (Munala and Moirongo 2011). Unfortunately, many cities especially in developing countries are grappling with high volumes of solid waste and face vast inadequacies with their management (Gutberlet

✉ Lesley Kudakwashe Sibanda
lesley.sibanda@uct.ac.za

[1] African Centre for Cities, University of Cape Town, Cape Town, South Africa

[2] Department of Economics, Maseno University, Kisumu, Kenya

[3] School of Spatial Planning and Natural Resources Management, JOOUST, Bondo, Kenya

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et al. 2017). Increasing rates of waste generation due to rapid urbanisation, population growth, changing lifestyles and consumption patterns continue to contribute to the challenges facing solid waste management (Sharholy et al. 2008). As a result, SWM is considered a big environmental and public health concern in many developing countries. In these countries, SWM is usually characterised by low spatial coverage of waste collection, inefficient collection methods, lack of appropriate solid waste management technologies and infrastructure, inadequate financial and technical resources, improper disposal, pollution from uncontrolled dumping and limited data on waste generation. Other characteristics include lack of public awareness and participation in waste management (Baabereyir 2009; Njoroge et al. 2014; Tan 2012). The inefficiency of SWM systems means that some areas have infrequent and/or no waste collection services. Consequently, open dumping and burning of waste are prevalent. According to Tan (2012), the collection rates in developing countries range between 30 and 50%, and collected waste is disposed of through uncontrolled landfilling. Kisumu, like many secondary cities in Africa, faces major inadequacies with respect to solid waste management. The aim of this article therefore is to provide a comprehensive review of the solid waste management practices in Kisumu City, analyse the environmental and social impacts of these practices and to identify SWM challenges in Kisumu with a view to making recommendations for improved SWM in the City.

Research Methodology

Study Area

Kisumu is situated on the shores of Lake Victoria and as the third largest city in Kenya, covers a total of 417 km^2. Of this, 297 km^2 is dry land and the remaining 120 km^2 is under water (Onyango et al. 2013). The City has a large population of more than 500,000 people (County Government of Kisumu 2013; Gutberlet et al. 2017), of which 60% of the population lives in informal settlements on the urban fringes of the City (Onyango et al. 2013). These areas are densely populated with limited access to basic services such as electricity, sanitation, piped water and solid waste management services (Frediani et al. 2013; Onyango et al. 2013). The waste generation rate in Kisumu is estimated to be between 200 and 450 tons of waste daily (Agong and Otom 2015; Gutberlet et al. 2017; Magezi 2015; NEMA 2015). Of this, only 20% is collected and transported to an overflowing open dumpsite at Kachok, a dumpsite which is next to the City's stadium and Nakumatt, one of the City's leading supermarkets. The remaining 80% accumulates in skips, on vacant land and along passageways as evidenced by the numerous garbage heaps scattered around the City (Munala and Moirongo 2011). Some of it remains unmanaged. According to Munala and Moirongo (2011), the quantities of solid waste generation in Kisumu are likely to increase further due to improved income levels, increasing population, changing lifestyles and consumption patterns. In addition to this, Kisumu City's population is projected to grow by 2.8% annually resulting in added strain on the infrastructure and basic service delivery (Munala and Moirongo 2011). This will further exacerbate the current solid waste management challenges increasing the risk of further environmental pollution and exposing the residents to

associated health hazards. It is therefore imperative that the challenge of solid waste management is adequately addressed (Fig. 1).

Data Collection and Analysiss

Data for this study was collected from in-depth reviews of published literature and reports on waste management in Kisumu City, informal interviews with waste experts in the City and lastly, by observations during fieldwork conducted in Nyalenda, the Kisumu Central Business District (CBD), Dunga Beach and the informal Kibuye open-air market and formal Jubilee market. Data was analysed through content and critical analysis of articles, documents, in-depth interviews and things observed.

Results

This section presents the findings of this study in two broad subsections. The first one reviews the current state of solid waste management in Kisumu City. It details an analysis of stakeholders and the roles they play in the City's solid waste management system. This subsection also chronicles the waste management practices in the City. The second subsection discusses the environmental and social impacts of those practices.

The Current State of Solid Waste Management in Kisumu City

Solid Waste Management Stakeholders in Kisumu City

Prior to the establishment of Kenyan Environmental Management and Coordination Act (EMCA) of 1999, solid waste management was the sole responsibility of local authorities. The Act was enacted to provide the appropriate legal and institutional framework for the protection, management and conservation of the environment (Republic of Kenya 1999). The EMCA also emphasises citizens' right to a clean and

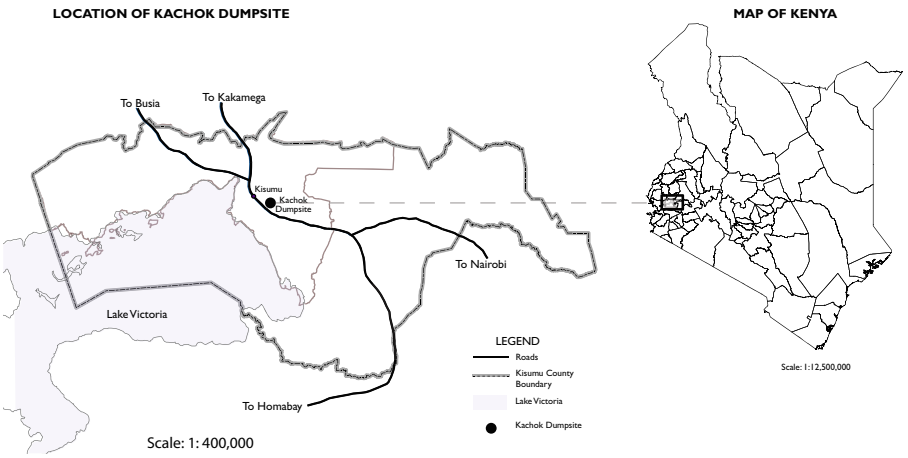

Fig. 1 Location of Kachok dumpsite in Kisumu County, Kenya (map prepared by Peter Maluki)

healthy environment and the duty to safeguard and enhance the environment through disposing of waste in designated areas (Republic of Kenya 1999). The waste management regulations within the Act apply to all waste categories and specify the requirements for handling, storing, transporting, treatment and disposal of waste (Agong et al. 2008; Republic of Kenya 1999). In 2008, the EMCA was complemented by environmental bylaws which specified the appropriate waste practices and outlined the penalties for failing to adhere to the stipulated standards (Frediani et al. 2013). Moreover, these bylaws allowed local authorities to contract private waste collectors licenced by the National Environment Management Agency (NEMA). As a result, the provision of waste management services in Kisumu is a collaborative effort between the City Council of Kisumu, registered private collectors and informal entrepreneurs (Kain et al. 2016).

Kisumu City's Department of Environment is mandated with the provision of solid waste management services. However, the department lacks adequate technical capacity and financial resources required to effectively collect and manage all the waste generated within the City (Frediani et al. 2013). In line with the bylaws and in order to expand waste management services, the City's Department of Environment has contracted SWM services to private collectors and has initiated private-public partnerships. As a result, they have been issued with permits allowing them to provide door-to-door collection of wastes from their clients. Their clients are mostly from middle-income residential areas like Migosi, Lolwe, Kenya-Re and Milimani areas besides numerous institutions, industries and restaurants (Nyaluogo 2016).

Collaborations between the City's Department of Environment, civil society partners and non-governmental organisations also provide additional services. One such collaboration was the initiation of the Kisumu Integrated Solid Waste Management Plan (KISWAMP). The KISWAMP combined centralised modes of service provision with grassroots initiatives and was aimed at expanding the coverage of waste management services to informal settlements where open pits were widely used to manage solid waste (Frediani et al. 2013). This was the plan that enabled the City of Kisumu to contract small- and medium-sized enterprises (SMEs) and other private collectors with waste management. Consequently, low-income residential areas that previously were not covered by the City could receive waste management services (Frediani et al. 2013). The growing interest of a number of non-governmental organisations (NGOs), community-based organisations (CBOs), community-managed organisations (CMOs) and neighbourhood associations has seen the spatial coverage of SWM widen over the years in the City's informal settlements. These organisations typically organise community clean-ups within low-income residential areas and are often the only waste management initiatives in such settlements (Frediani et al. 2013; Gutberlet et al. 2017). The national government, through National Youth Service (NYS) initiatives, has in the recent past cleaned-up low-income residential areas in the City. Besides providing employment to youths in such areas, NYS initiatives made marked improvement in solid waste management within slums. In addition to clean-ups, some CBOs and NGOs recycle waste into sellable products. Such products include but are not limited to handbags from polyethylene and VCR tapes, necklaces from paper, earrings from beer caps and mats from plastic (Gutberlet et al. 2017). This helps tackle the problem of waste while also providing an income for those involved. Besides formal institutions, there are individuals, locally known as 'waste scavengers', who selectively harvest

'wealth' from waste for a living (Gutberlet et al. 2017). Typically, they walk through neighbourhoods searching for valuable materials from waste piles along alleyways, roadsides and within residential areas. Others frequent Kachok dumpsite and sort through the refuse for precious items (Gutberlet et al. 2017).

Kisumu City's Solid Waste Sources and Composition

Waste is generated from different sectors in Kisumu, namely residential areas, markets (formal and informal), commercial enterprises, institutions, manufacturing industries and healthcare facilities. Different researchers have quantified daily waste generation in Kisumu, which is estimated to be between 200 and 450 tons of waste generated daily (Agong and Otom 2015; Gutberlet et al. 2017; Magezi 2015; NEMA 2015). Out of this, organic material ranges from 62.5 to 67% by weight (Gutberlet et al. 2017).

The composition of waste in a city depends on the existing sectors, public consumption patterns, lifestyles, income and cultural traditions. A recent study revealed that waste in East African urban centres is generally comprised of decomposable organic materials (65–70%), paper (5–9%), plastic (6–12%), glass (0.7–4%), metal (0.3–3%) and other waste (0.4–1%) (Okot-Okumu 2012). The same study observed that quantities of electronic waste are on the increase due to increased use of electronic and electrical goods. The findings of Agong and Otom (2015) about Kisumu City's waste composition are close to that of Okot-Okumu (2012). According to Agong and Otom (2015), Kisumu's waste consists of organic material (63%), paper (12.2%), plastic (10.2%), glass (3.2%), scrap metal (1.3%) and other (9.5%). The characteristics of these waste streams and their disposal methods are detailed in Table 1.Construction waste is rarely deposited at Kachock dumpsite or at small informal dumpsites within residential areas. This is because such waste is often used for carpeting home compounds and access roads to private property. Since the soil around Kisumu is clay and loam, residential compounds and earth roads, public and private, often become muddy during rainy seasons. Carpeting them with construction waste proves to be a cheap solution to most people.

Waste Collection and Transportation in Kisumu City

The waste collection rate in Kisumu City is estimated to range between 20 and 35%. In the CBD and Dunga Beach, a three-bin system is in place as the first point of waste collection and separation. These bins are labelled and colour coded to facilitate separation of waste at source. Organic waste is disposed of in the green bin, while plastics and other litter are blue and brown, respectively. In other locations, yellow bins are used to separate glasses and bottles, with white bins for paper (see Fig. 2). However, it was observed, and other studies confirm it (Aurah 2013; Awuor 2016), that the culture of waste separation is not engrained in the public. An inspection of these bins revealed that wastes were mixed in most of them. Furthermore, when waste collectors, private and public, come to collect these wastes, they are all hurdled into one container, thus mixing even those that were well segregated. Even though waste segregation at source should be encouraged, a comprehensive understanding of Kisumu's waste management system reveals that not much is gained from this process since the waste is mixed up at Kachok dumpsite. Maximum benefit is only gained when waste

Table 1 Solid waste streams in Kisumu (adapted from Nyaluogo (2016) and Okot-Okumu (2012))

Waste stream	Waste characteristics and composition	Current disposal method
Residential waste	The waste mostly consists of food wastes and packaging such as paper, glass, metals and plastics. Textiles were also observed but in lesser quantities than organic and packaging waste	Depending on the neighbourhood, waste collection services are provided by the City's Department of Environment and/or private collectors. For informal settlements, services are provided by CBOs and NGOs and individual entrepreneurs. Pits are often used
Market waste	The waste mostly consists of organic waste (i.e. vegetable leaves, stalks, bad and rotten fruit and vegetables) and packaging materials (plastic, paper, sacks and wooden pellets)	Waste collection services are provided by the City's Department of Environment. Some markets are serviced by private collectors sourced by their market associations. A significant proportion of organic waste is sold as animal feed to pig breeders or as input for compost making
Waste from commercial enterprises (shops, companies, restaurants)	The waste consists of organic (food) waste, paper, plastic, e-waste and in certain instances hazardous waste	Waste collection is mostly undertaken by the City's Department of Environment and private collectors
Waste from institutions (schools, colleges, universities)	The waste constitutes organic (food) waste and packaging materials (i.e. cardboard, paper, plastics)	Waste collection is mainly facilitated by private collectors
Industrial waste	The waste generated is dependent on the specific industry and ranges from decomposable food wastes to bottles, plastic containers, cardboard, wooden pellets, ash, construction and demolition waste	Waste collection is mostly undertaken by private collectors. Some industries have recovery and recycling strategies for scrap metal, glass and paper
Waste from healthcare institutions (hospitals, clinics and laboratories)	The waste is mostly biomedical, hazardous and radioactive. Small quantities of paper, plastics and glass are also generated	Mostly undertaken by private collectors and the City's Department of Environment. Some healthcare facilities manage their own hazardous wastes. Common disposal methods include incineration and landfill

scavengers pick their recyclables from the separation bins. However, when the City will get an appropriate waste disposal site, to which efforts are now geared, then it will be positioned to maximally benefit from waste segregation at source.

Waste collection services by the City are mostly concentrated within the CBD and the main market areas around Kisumu City (Kain et al. 2016). The City uses truck/lorries and tractors to collect and transport the waste to Kachok dumping site. A compactor at the dumpsite is used to compress waste in order to reduce their volumes (Liyala 2011). However, these vehicles are not sufficient and have been cited as a hindering factor to effective solid waste management by the City's Department of Environment. This is largely due to the fact that the vehicles are old and the City lacks

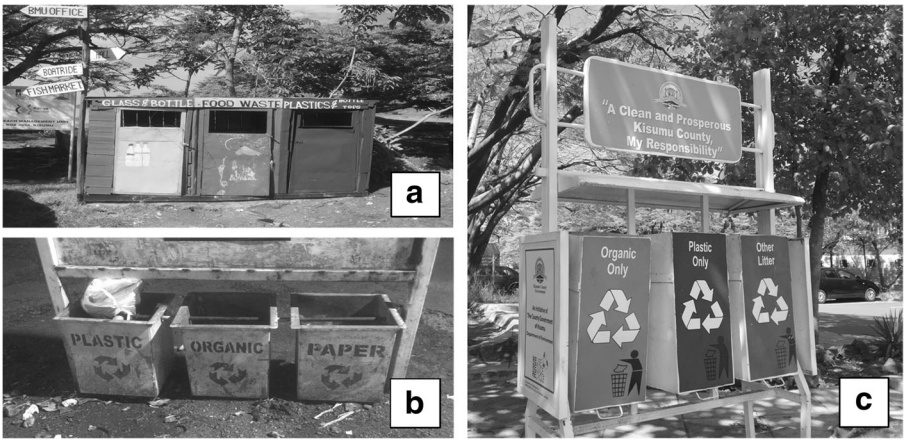

Fig. 2 The three-bin system in Kisumu CBD and Dunga Beach (image taken by Lesley Sibanda**). a** Waste collection and segregation bins at Dunga Beach. **b**, **c** Different labelling of segregation bins by the Kisumu City Department of Environment

adequate financial resources to purchase new equipment and maintain the existing ones in excellent working order (Liyala 2011; Magezi 2015).

Waste collectors from the private sector offer door-to-door waste collection services to major residential estates, schools, universities, hospitals and business complexes that are able and willing to pay them for their services (Njoroge et al. 2014). For homesteads, the monthly collection fees range from 100 to 500 Kenyan shillings (KSh) per month depending on whether the residence is in a low-, middle- or high-income area. For institutions, service charges can be as high as KSh 7000 per month depending on waste volumes. Wastes from households that are not able and/or not willing to pay for these services are disposed of in open spaces, along roadsides and drainage trenches. Some low-income residential areas and informal settlements such as Nyalenda and Obunga slums receive little or no waste collection services from the City or private collectors due to poor accessibility. Consequently, their waste gets illegally dumped by the roadside, along passageways and empty plots of land. Plastics, organic waste, diapers and other non-biodegradable waste can be spotted strewn on vacant land creating an eyesore and posing serious health risks to resident populations. At great risk are children who sometimes play around them and livestock such as cattle and shoats which scavenge for food in the garbage piles (Frediani et al. 2013). Moreover, these heaps of waste smell bad and are a breeding ground for flies, rats and mosquitoes (Obera and Oyier 2002).

In the recent past, KISWAMP project had an initiative that saw the City with strategic central waste transfer points or communal points (Munala and Moirongo 2011). Skips were located at these points for waste collection and later transferred to Kachok dumpsite. However, the use of skips was not very successful. According to Kain et al. (2016), this was largely due to the fact that the City did not have the specialised equipment to evacuate the skips once they were full. Some of the skips have rusted and/or have been set on fire to dispose of the waste that had not been collected. In many of the allocated spaces, the skips have been removed but these areas are still being used as communal disposal areas.

The frequency of waste collection differs depending on the sector. For instance, waste is collected daily from the CBD and commercial areas like hotels, restaurants, markets (Jubilee and Kibuye) and Bus Park. In residential areas, waste collection is mostly done on a weekly basis, with the City collecting less than 2% and private collectors collecting approximately 25% (Kain et al. 2016). High population density areas like Kondele and Nyalenda Ring Road may occasionally get their waste collected more than once a week depending on waste volumes generated (Agong and Otom 2015).

Waste Sorting, Recycling, Treatment and Disposal in Kisumu City

Sorting of wastes in Kisumu happens at a very minimal scale at source and at disposal. As already noted, this is because the system in place is not suited to support waste segregation throughout the waste lifecycle. At Kachok dumpsite, waste pickers sort through the disposed waste for reusable and recyclable materials. However, this is partial sorting and the rest of waste remains mixed up.

Limited reuse and recycling occur in Kisumu. Waste containers made from plastics, glass and metallic cans are generally reused for different domestic and commercial purposes such as storing paraffin and water and packaging cooking oil and honey. However, the generation rate is so high that most of these wastes still end up at Kachok dumpsite. Organic waste from vegetable stalks, banana and potato peelings and leftover food is often fed to chickens, dogs and pigs and sometimes collected by individuals for compost making. Small-scale informal recyclers operate within residential areas and scavenge for recyclable materials from wastes along roadsides, in communal skips, dumpsites and drainage channels. The recovered materials are sold to waste dealers who act as intermediaries between the informal pickers and recycling companies. The intermediaries clean the wastes, and if plastics, shred them and transport the recyclates to recycling companies. Locally in Kisumu, some of the wastes are recycled into crafts, hats, bags, necklaces, earrings, baskets, rugs and mats by artisans and various waste-reusing organisations (Gutberlet et al. 2017; Okot-Okumu 2012). Since the generation of reusable and recyclable wastes is considerable in Kisumu, there is need for a solid waste management system that can support their reuse and recycling (Munala and Moirongo 2011). Such a system should have recycling targets that can periodically be reviewed to assess progress.

Solid waste that would need treatment before disposal in Kisumu most probably would come from industries and medical institutions. However, it is not certain whether wastes of that nature from such institutions, if any, get treated before disposal at Kachok dumpsite. What could be established is that solid waste for recycling is usually treated with disinfectants before it is recycled into products. Since some biomedical wastes such as used syringes and needles were observed at Kachok dumpsite, it remains to be established whether these wastes get treated before disposal at the site. Since these wastes were in small quantities, the authors of this work suspect that they may have been disposed of from self-medicating people or private clinics that do not have capacity to manage their own biomedical wastes.

Landfilling, open burning and illegal dumping are the most common waste disposal methods in Kisumu City (see Fig. 3). All collected wastes by the City and private waste entrepreneurs are dumped at Kachok dumpsite. However, some individuals disposed of

Fig. 3 Uncollected waste in Nyalenda and organic waste disposal in a compost pit (image taken by Lesley Sibanda)

their solid waste in ungazetted spaces, along roadsides, in drainage channels and open spaces, mostly at night when they are not seen. Kachok dumpsite is situated approximately 2 km from Kisumu CBD, in close proximity to Nyalenda residential estate, Moi Stadium and Mega City shopping mall (Nyaluogo 2016). It has a manned gate at which those disposing their wastes at the site are supposed to pay KSh 100 (Liyala 2011). The fee is meant to help raise revenue for managing the site. However, the situation at the site indicates that it is inadequate for the intended purposes or the collection, and expenditure mechanisms are not as efficient. The dumpsite is fenced with iron sheets but they occasionally fall out of place leaving the site exposed and accessible to scavenging animals and informal waste pickers (NEMA 2015). In this state, its boundaries remain unsecured resulting in litter spilling onto nearby stadium grounds, public footpaths, roads and private properties. The 3-acre dumpsite caters for waste from all waste-generating sectors including residential, commercial, industrial and healthcare facilities.

A physical inspection of the dumpsite by Nyaluogo (2016) revealed that the dumpsite is operating over its capacity, emits foul odours and is unsightly. The dumpsite poses significant environmental, health and safety risk from the leachates and toxic wastes. With no leachate collection systems, the leachates generated on the dumpsite pollute both the soil and ground water. Other problems associated with the open dumping of solid waste include odours, vermin, blockage of sewers and drainage systems downstream, and result in the spread of infectious diseases (Okot-Okumu 2012). Periodically, the waste is burnt to reduce its volume resulting in air pollution (Munala and Moirongo 2011).

Disposal by composting is practiced at the household level and is done mainly to provide manure for household gardens. While there is currently no large-scale commercial composting, some market associations have started initiatives for composting organic waste. An example of this is at the Kibuye market where a cooperative of marketers collects organic waste and generate compost. The compost is ground into

fine particles and sold to farmers as manure. Since compostable waste forms a greater percentage (63%) of wastes at Kachok dumpsite, its widespread and large-scale practice has the promise of solving the waste predicament in Kisumu City.

Biogas production has had limited success. This is largely due to a lack of technical expertise on the daily operations of biogas digesters and insufficient financial investment. There is therefore a need for capacity building in this area.

Open burning of the waste piles is one of the most common waste disposal methods in Kisumu. Even though it is effective in reducing waste volumes, its major challenge is that it leads to air pollution (Frediani et al. 2013). Organic wastes are often deposited in open pits and later burnt. Those that are too moist to burn are usually left to gradually decay. If the ground where the pit is dug is often wet, the organic matter can turn into an unsightly mess and a breeding ground for disease vectors (Fig. 3). It was observed that some organic wastes, especially leftover food from hotels, are disposed of by sale to pig farmers as pig feed.

A graphic presentation of Kisumu's current solid waste management system as discussed in the forgoing subsections is shown in Fig. 4. The activities of both formal and informal players within the system have been included to show the various stages and illustrate how the waste management system works.

Environmental and Social Impacts of SWM in Kisumu

Waste management has significant consequences for the environment as well as human health. The different waste management methodologies result in different kinds of human health and environmental hazards. The open dumping of waste is a major source of land contamination, water and air pollution, environmental degradation and health hazards (Omoleke 2004).

The principal impacts from the open dumping of waste include the contamination of groundwater, surface water and soil due to leachates from solid waste dumps (Firdaus and Ahmad 2010). In addition, the waste entering the dumpsite is mixed, and thus it is highly probable that it contains toxic chemicals and hazardous materials. This increases the chances of pollution but also puts the health of the scavengers, waste pickers and

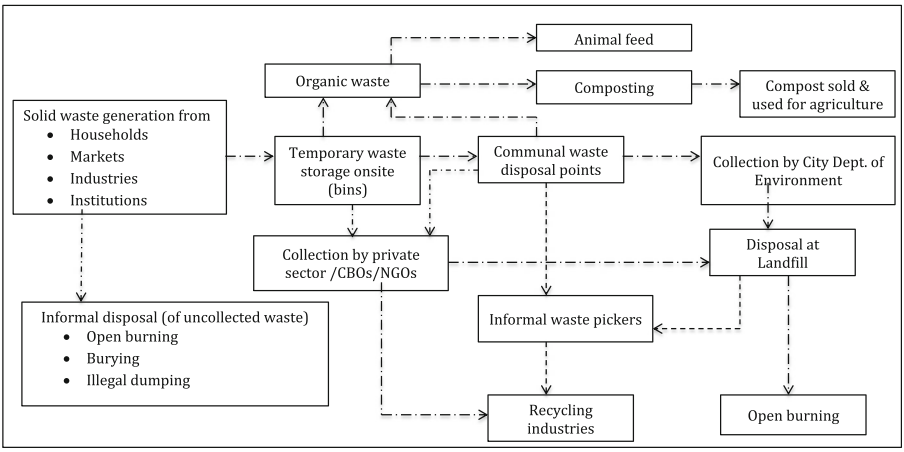

Fig. 4 Overview of waste management in Kisumu

dumpsite workers at risk as they do not have the appropriate protective gear to be handling waste. In addition, these individuals are also prone to cuts and infections as a result of stepping on glass, tin and/or syringes while scavenging for valuable materials (Gutberlet et al. 2017).

The open burning of waste is another challenge as it results in the release of toxic pollutants and emissions such as sulphur dioxide (SO_2), nitrogen oxides (NO_x), dioxins and furans. These gases can cause respiratory diseases when inhaled, and others like dioxins and furans are carcinogenic and known to aggravate bronchial and asthmatic disorders (Omoleke 2004). This also results in air pollution which can adversely impact on human health especially for communities living near landfill sites. Greenhouse gas (GHG) emissions are one of the most significant environmental impacts associated with the conventional landfill and combustion of solid waste (Firdaus and Ahmad 2010). These GHG namely methane and carbon dioxide are also released during the break-down of biodegradable materials. These gases in particular are of concern because of their high global warming potential.

Other risks associated with open dumping include bad odour, aesthetic nuisance, fire outbreaks and the proliferation of insects, mosquitoes, flies, cockroaches, rats and rodents. Such dumping sites often become breeding grounds for vectors of ailments like cholera, dysentery, diarrhoea and yellow fever (Firdaus and Ahmad 2010; Omoleke 2004).

Challenges of Current Solid Waste Management System in Kisumu City

Research indicates that local authorities in developing countries face numerous challenges with respect to service delivery. These include inadequate policy and legislation, lack of public commitment and awareness, lack of technical capacity and poor financing (McAllister 2015; Okot-Okumu 2012). In this section, challenges that have constrained the efficient provision of solid waste services and led to the abysmal solid waste conditions in Kisumu are discussed.

Institutional Challenges

The provision of solid waste services is an expensive undertaking, and resources are required to purchase the appropriate equipment and infrastructure, fund the maintenance and daily operation of vehicles and equipment and train or upskill personnel. The scarcity of resources (financial, technical and logistical) is a major hindrance to effective solid waste management practices in Kisumu (Frediani et al. 2013).

Studies by Liyala (2011) and Kain et al. (2016) cite financial constraints as a hindering factor to solid waste management in Kisumu. The study's findings suggest that the City's Department of Environment has limited revenue sources and low annual budgets. This is further worsened by the fact that a significant proportion of the urban poor is unable to pay for waste collection services. The limited available funds means that the City is not able to purchase new vehicles, and the existing fleet is poorly serviced (Liyala 2011).

Besides inadequate finances, Kain et al. (2016) add that poor political and institutional support, low awareness and poor community attitudes are challenges to SWM in Kisumu City. This already bad state is worsened by a lack of a systematic approach to

waste management, weak technical capacity and poor implementation of waste policies and bylaws (Gutberlet et al. 2017; Kain et al. 2016). In spite of the availability of suitable land within Kisumu County, the lack of a success story in solid waste management in the country has made local communities frustrate efforts by the County to relocate Kachok dumpsite to suitable disposal areas outside the City boundaries.

Poor Accessibility to Temporary Waste Collection Areas

A major challenge and hindrance to effective solid waste management in Kisumu is the inaccessibility of sites by waste service providers. Some of the informal settlements are located in densely populated areas with close-knit houses and poor road infrastructure. In these areas, most of the licenced waste operators and SMEs make use of handcarts for collection as vehicles cannot access the areas.

Poor Public Attitude Regarding Waste Management

Public awareness and the attitude of people towards waste can significantly influence solid waste management systems. According to Zurbrugg (2003), stages of solid waste management from 'household waste storage, to waste segregation, recycling, collection frequency, the amount of littering, the willingness to pay for waste management services, the opposition to the siting of waste treatment and disposal facilities, all depend on public awareness and participation' (Zurbrugg 2003:4). It is therefore a critical issue that can impact positively or negatively on solid waste management systems. The amount of litter and indiscriminate dumping in Kisumu suggest that there is a poor waste handling attitude in most areas. This coupled with inadequate infrastructure for disposal and infrequent or no waste collection services results in open dumping of waste. There is therefore a need to improve public awareness and increase the participation of communities in waste management issues. This will help promote environmental citizenship and sensitise communities to work together towards efficient waste management.

Poor Enforcement

The poor enforcement of waste policies and laws is another problem that significantly contributes to the inefficient management of solid waste in Kisumu. In Kenya, there is sufficient and robust legislation, existing bylaws, policies and programmes regarding waste management. However, these have not delivered the needed impact as the City's Department of Environment lacks adequate capacity in terms of personnel, logistics and legal understanding to be able to implement and enforce waste management laws. In addition to poor implementation, Baabereyir (2009) cites that the City's inability to implement existing bylaws on waste disposal results in a 'throw-it-where-you-like' attitude and general disregard of waste disposal regulations. Consequently, many individuals, households, traders and businesses resort to indiscriminate waste dumping in open spaces, streams, drains and drainage channels (Baabereyir 2009). This creates unsanitary living conditions, blocks existing drainage channels and creates breeding ground for mosquitos and rodents.

Conclusion and Recommendations

Conclusions

This paper has assessed the current solid waste management practices in Kisumu and identified major challenges and constraints which need to be addressed for effective solid waste management. It gives insights to decision-makers about Kisumu's waste generation, separation, collection and transportation, treatment and disposal systems which serve as a base line for understanding the status quo and developing SWM improvement policies.

From the study, it is clear that solid waste management is a multidimensional issue, and improving the solid waste situation in Kisumu requires the active participation of all relevant stakeholders including the City Board Management, civil society, NGOs, CBOs, waste private collectors and entrepreneurs. Increased funding to build capacity and expertise, public awareness and community sensitization and investment in appropriate infrastructure and technologies will aid in improving the waste management system in Kisumu.

Recommendations

Kisumu like many urban African cities is grappling with increasing waste generation, overflowing dumping sites and inappropriate disposal methodologies. Current solid waste management services are inadequate, and the conventional waste management methods which have been predominantly implemented have failed. Kisumu has implemented an integrated approach to solid waste management which involves reduction, recycling, reusing, composting and landfilling. Initiatives that include anaerobic biogas production, composting and recycling have all been implemented but are all occurring at a very small scale without widespread adoption. Despite this, solid waste management remains a major environmental concern with the uncollected waste posing serious health hazards to local communities.

To improve and ensure efficient solid waste management practices, different interventions should be adopted and these are discussed below:

- Reliable data on waste generation rates, types of waste, sources of waste, characteristics and composition as well as the waste disposal practices must be recorded and updated frequently as reliable data is important in ensuring effective waste management practices. The lack of reliable data constrains the effective planning of waste management operations.
- Community waste bins must be provided in residential and informal settlements with designated collection zones and waste collectors. The bins should be within acceptable distances for people to be able to deposit their wastes. Additionally, the bins must be of reasonable size and emptied regularly to ensure waste does not accumulate and overflow. This will reduce the amount of waste dumped along roadsides or on vacant land thereby improving the aesthetics of surroundings.
- Investments into the appropriate disposal bins, transportation vehicles, safety clothing and other relevant equipment should be prioritised. Vehicles used for

transporting waste need to be sufficient for the waste quantities generated, appropriate and specifically designed for carrying wastes and should be serviced regularly to minimise breakdowns.

- Waste recovery technologies such as composting, recycling and biogas generation should be adopted at a larger scale. Investments should be directed to these methodologies as they divert a significant amount of organic and biodegradable waste from landfills in an economic and environmentally friendly manner. In addition, the viability of partnering with private firms in energy recovery from waste should be explored. Such waste-to-energy options include (but are not limited to) incineration, gasification and fuel generation. These should be considered when there are sufficient financial resources to maintain them.
- Activities that focus on recycling and reusing waste should be encouraged and incentives provided to encourage entrepreneurship in recycling and reuse of wastes. Such activities should be promoted to stakeholders as they reduce the costs of waste disposal and minimise environmental impacts associated with wastes.
- Regular awareness and educational campaigns should be launched in order to educate the public on proper solid waste for environmental, human, livestock and wildlife health. These campaigns should be done in collaboration with public sector stakeholders involved in solid waste management. Furthermore, they should build on existing community initiatives aimed at raising public awareness and participation in waste management. Campaigns can be through community meetings, clean-up activities, and radio and TV programmes. For long-term positive impacts on the attitude of the society, solid waste management should be mainstreamed into the formal education system as basic knowledge for all since all are waste generators.
- A monitoring system should be implemented to ensure that solid waste management regulations are adhered to and targets set to improve collection rates by all key players. Through monitoring the performance of SWM services, the County will be able to identify areas that need improvement and therefore be able to deliver better services.
- Existing bylaws on waste management should be strictly enforced by concerned entities. Implementable but stringent policies and penalties should be developed for adherence by all and as a deterrence of would-be offenders.
- The involvement of private waste collectors, CBOs and NGOs in SWM should be encouraged for it will tend to ensure economic sustainability of SWM.

However, all of the above recommendations can only be implemented if adequate financial resources and skilled labour are available to support them. This requires the local government allocating more funding to ensure (i) that the basics of SWM (City cleansing and safe disposal) are put in place, and (ii) that collection services are provided to all residents of the City and (iii) that the polluter-pays principle is implemented, where all generators of waste pay for the services received, even if residents can only pay some small amount for the service as a start. Without political support and financial commitment from the County government, any donor funding to support SWM will fail in the medium-term, due to a lack in operational budgets necessary to sustain the SWM system in place.

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References

Agong, S., & Otom, A. (2015). *Kisumu Urban Sustainable Development Goals (USDGs) targets and indicators: the case of Kisumu*. Available: http://staging.mistraurbanfutures.org/sites/default/files/usdg-report-kisumu_0.pdf.

Agong, S., Odino, P., & Wanga, J. (2008). *A baseline survey on governance, policies and knowledge of urban sustainability in the Kisumu Local Interaction Platform*. Available: http://mistratest.ita.chalmers.se/sites/default/files/a_baseline_survey_on_governance_policies_and_knowledge_of_urban_sustainability_in_the_kisumu_local_interaction_platform_gaps.

Aurah, C. M. (2013). Assessment of extent to which plastic bag waste management methods used in Nairobi city promote sustainability. *American Journal of Environmental Protection, 1*(4), 96–101.

Awuor, F. O. (2016). Provider value perception in co-creation, ecotourism offering development and classification at Dunga Beach in Kisumu County, Kenya. Unpublished PhD thesis (Vol. PhD): Jaramogi Oginga Odinga University of Science and Technology, Bondo, Kenya.

Baabereyir, A. (2009). *Urban environmental problems in Ghana: a case study of social and environmental injustice in solid waste management in Accra and Sekondi-Takoradi* (Doctor of Philosophy Doctoral dissertation). Nottingham: University of Nottingham.

County Government of Kisumu (2013). Kisumu county integrated development plan, 2013-2017. Retrieved from https://kisumu.go.ke/download/3.

Firdaus, G., & Ahmad, A. (2010). Management of urban solid waste pollution in developing countries. *International Journal of Environmental Resources, 4*(4), 795–806.

Frediani, A. A., Walker, J., & Butcher, S. (2013). Participatory informal settlement upgrading and well-being in Kisumu, Kenya. *MSc Social Development Practice Student Report*. Development Planning Unit, The Bartlett, University College London.

Gutberlet, J., Kain, J.-H., Nyakinya, B., Oloko, M., Zapata, P., & Campos, M. J. Z. (2017). Bridging weak links of solid waste management in informal settlements. *Journal of Environment & Development Policy Review, 26*(1), 106–131.

Kain, J.-H., Nyakinya, B., Odhiambo, N., Oloko, M., Omolo, J., Otieno, S., et al. (2016). Translating policies into informal settlements' critical services: reframing, anchoring and muddling through. *Public Administration and Development, 36*(5), 330–346. https://doi.org/10.1002/pad.1782.

Liyala, C. M. (2011). *Modernising solid waste management at municipal level: institutional arrangements in urban centres of East Africa* (Doctoral dissertation). Wageningen: Wageningen University.

Magezi, T. J. (2015). *An investigation of the imbalance of a fast-growing consumer culture and insufficient waste management infrastructure across a number of sub-Saharan African cities* (Master of Science in Chemical Engineering Master's thesis). Cape Town: University of Cape Town.

McAllister, J. (2015). *Factors influencing solid-waste management in the developing world* (Master of Science in Geography Master of Science in Geography). Utah: Utah State University.

Munala, G., & Moirongo, B. O. (2011). The need for an integrated solid waste management in Kisumu, Kenya. *Journal of Agriculture Science and Technology, 13*(1), 65–78.

NEMA. (2015). *The National Solid Waste Management Strategy*. Nairobi: National Environment Management Authority (NEMA).

Njoroge, B. N. K., Kimani, M., & Ndunge, D. (2014). Review of municipal solid waste management: a case study of Nairobi, Kenya. *Research Inventy: International Journal Of Engineering And Science, 4*(2), 16–20.

Nyaluogo, K. O. (2016). *A study of solid waste management: a case study of Kisumu City* (Bachelor of Science in Civil Engineering). Nairobi: University of Nairobi.

Obera, B., & Oyier, M.(2002). *Sustainable solid waste management for Kisumu*. Paper presented at the 28th WEDC Conference—Sustainable environmental sanitation and water services, Kolkata (Calcutta), India.

Okot-Okumu, J. (2012). Solid waste management in African cities—East Africa. In L. F. Marmolejo Rebellon (Ed.), *Waste management—an integrated vision*. Retrieved from http://www.intechopen.com/books/waste-management-an-integrated-vision/solid-waste-management-in-african-cities-east-africa.

Omoleke, I. I. (2004). Management of environmental pollution in Ibadan, an African city: the challenges of health hazard facing government and the people. Journal of Human Ecology, 15(4), 265–275.

Onyango, G. M., Wagah, G. G., Omondi, L. A., & Obera, B. O. (2013). *Market places: experiences from Kisumu City*. Kisumu: Maseno University Press.

Republic of Kenya (1999). *Environmental Management and Co-ordination Act, 1999 No 8 of 1999 EMCA*. Kenya Kenya Gazette Supplement No 74 (Acts No 5).

Sharholy, M., Ahmad, K., Mahmood, G., & Trivedi, R. C. (2008). Municipal solid waste management in Indian cities—a review. *Waste Management, 28*, 459–467.

Tan, Y. J. (2012). *The management of residential solid waste in Mombasa, Kenya*. Retrieved from http://digitalcollections.sit.edu/isp_collection/1388/.

Zurbrugg, C. (2003). Solid waste management in developing countries. SWM introductory text on www.sanicon.net5. Retrieved from http://wwweawag.emp-eaw.ch/fileadmin/Domain1/Abteilungen/sandec/publikationen/SWM/General_Overview/Zurbruegg_2002_SWM_DC.pdf.