Rehabilitation of the Waste Dumpsite in Guatemala City

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EXECUTIVE SUMMARY

Metropolitan Area of Guatemala City, the capital of Guatemala, is home to over 2.5 million people. Similarly to some other capitals in the region, the local authorities in Guatemala City face marked challenges in their efforts to provide adequate solid waste management (SWM) services. This research provides an analysis of the current situation of waste management in Guatemala City and subsequently focuses on disposal component. The research is structured according to the framework of Integrated Sustainable Waste Management (Van de Klundert and Anschütz, 2001), with the addition of the analysis of development drivers (Wilson, 2007), as used by Scheinberg *et al.* (2010). Methods used in this research include review of local documents; interviews with key stakeholders in the city (governmental agencies, non-governmental organisations, formal service providers, and informal waste pickers), and a questionnaire survey on a representative sample of citizens.
Coverage by waste collection services in Guatemala City is inadequate: street sweeping is done only on main roads and waste is collected from only 70-80% of the urban population. There is a high prevalence of illegal dumping. Waste collection services are provided by private associations of micro-entrepreneurs who possess one or more trucks. Material recovery by informal activities is widespread. Questionnaire reveals that almost 60% of the citizens sell or give away their waste products and materials to informal itinerant buyers/collectors for reuse or recycling. Truck crews engage in *cacha* – sorting out of recyclable materials from collected waste. There are between 600 and 2000 waste pickers (*guajeros*) at the city's waste disposal site Zone 3. The disposal site, situated in a natural ravine surrounded by steep slopes, in the middle of a residential area in the city, has no engineered controls installed for environmental protection. Numerous problems with the site are identified in this research, both in field visits and as perceived by the key stakeholders and the citizens. Recently, as the site has reached its capacity after 60 years of operation, the city authorities have initiated activities for closure and rehabilitation. This is a good opportunity for authorities to revise the entire SWM system, build upon the strengths and address the weaknesses. This paper proposes some essential measures to be taken and factors to be considered in the process.

INTRODUCTION

Background

The Republic of Guatemala is located in Central America, and has a population of 14.7 million people (INE, 2012a). Due to its location and topography, the country has with a wide variety of climates, from warm humid coastal regions to cold weather in the mountains. The country is just at the beginning of urban transition – it has a moderate urbanisation rate and, apart from Belize, it is the only country in the region that has not yet surpassed the 50% threshold of urban population (UNDESA, 2012).
Since 1996, when Guatemala reached peace after 35 years of an internal armed conflict, it has been facing great challenges in its efforts to develop. With a Human Development Index of 0.574, Gross National Income (GNI) per capita of 4,164 USD (UNDP, 2012), and 54% of the population living under the national poverty line (INE, 2012b), the socio-economic situation is difficult.

The capital Metropolitan Area, Department of Guatemala, includes (by far) the largest cities in the country, Guatemala City, Villa Nueva and Mixco, and some smaller municipalities. It is situated in the central mountainous region. According to a 2011 estimate (INE, 2012a), over 2.5 million people live in the Metropolitan Area. The Guatemalan municipality area covers 184 km² and is located in a valley whose central area consists of a plateau surrounded by ravines. It is estimated that the ravines occupy 36% of the area of Guatemala City. The current situation regarding waste management in Guatemala City is characterised by inadequate services and adverse impacts on public health and the environment. Solid waste – if collected – is dumped in ravines that drain into rivers; sewage is discharged into rivers without treatment, while significant proportions of the country's population depend on the surface waters as a source of drinking water. The dumpsite Zone 3 has been receiving solid waste and part of the sewage from Guatemala City for decades. The City residents experience a lot of adverse effects from the dumpsite.

Research Objective

The objective of this research is to establish and evaluate the current situation of the SWM system in Guatemala City, with particular focus on the main dumpsite (Zone 3), propose measures necessary for an appropriate closure of the dumpsite and rehabilitation of the area, and identify implications of the dumpsite closure for the SWM system as a whole.

METHODOLOGY

Theoretical Framework

This research is structured according to the concept of Integrated sustainable (solid) waste management – ISWM (Van de Klundert and Anschütz, 2001) that distinguishes three dimensions in analysis of solid waste management and recycling systems, asking three questions:

- WHAT technological components and interactions comprise the SWM system in the city,
- WHO are the stakeholders (actors) involved in the SWM system and how do they interact,
- HOW is the system organised and run – how is the situation regarding various sustainability aspects, such as social, financial, economic, environmental and technical aspects, and institutional strength and arrangements.

In this research, a fourth dimension is added to this structure – driving forces for the development of the SWM system in the city (Wilson, 2007), whereby answering the question: WHY has the system developed to the current state. As the driving forces (drivers) that govern cities' policies and practices in solid waste handling are indicative of their stage of modernisation, we sought to identify the drivers that determine the current situation in Guatemala City.

This theoretical framework is structured into three parts: Development drivers, SWM system (waste generation, collection, resource recovery, disposal) and Governance (inclusivity, financial sustainability, institutional framework), after the one used in the UN Habitat global report "Solid Waste Management in the World's Cities" (Scheinberg, Wilson and Rodic, 2010).

Data Collection and Analysis

Data are gathered from literature review followed by a six week fieldwork in Guatemala City. Local literature pertains to the entire Department of Guatemala, not only Guatemala City. In the fieldwork three data collection methods are used: 16 *interviews* are held with key stakeholders in national and municipal institutions, private sector and informal sector. *Questionnaires* are used to gather information and opinions of local citizens about their concerns and their involvement in municipal solid waste management and other urban services, as well as their perceptions of the impact of the dumpsite on their neighbourhood. Taking an error margin of 5%, a confidence level of 95%, and a response distribution of 50%, the sample size is set at 384. *Observation* is used as a method during three field visits: one across the city to observe cleanliness, illegal dumpsites and collection services; one to the area surrounding the dumpsite, and finally one to the dumpsite Zone 3 facilitated by the dumpsite administration and guided by engineering experts.

SOLID WASTE MANAGEMENT SYSTEM IN GUATEMALA CITY

Why – Development drivers

The main drivers for the development of the municipal solid waste management (SWM) in Guatemala City include protection of public health and resource value. Protection of public health is still a major concern. The street sweeping is done on main roads only and waste collection services are provided to 70-80% of the urban population in the Metropolitan Area. There is a high prevalence of illegal dumping. Recently, micro-entrepreneurs organised in three main associations have become involved in providing waste collection service, partly due to the potential extra income from informal recovery of materials with market value. In general, material recovery by the informal sector is widespread. Environmental concerns are being voiced but appropriate action is still largely lacking due to other, more urgent, problems. As the country has numerous natural hazards such as active volcanoes, hurricanes and other tropical storms, floods, and occasional violent earthquakes, with financial and human resources limited, the priority for authorities is on emergencies related to natural disasters that the country faces every year, rather than on solid waste management.

What – Components of the system

Waste generation

Municipal solid waste consists of household waste, commercial waste, industrial waste, and hospital waste. The composition of municipal solid waste was determined in two studies, one in Guatemala Metropolitan Area by JICA in 1995 (cited in various documents, also by IARNA *et al*., 2006) and one in Dpt. Guatemala by ECONSULT (cited by CGP+L *et al*., 2004), producing fairly consistent results. In the Metropolitan Area approximately 60-65% of waste is organic, around 12% is paper and cardboard, some 10% plastics, 3.5% textiles and 2% metals. Based on 2002 data, the average amount of waste generated is 0.5 kg/person/day or 400,000 tonnes/year (IARNA *et al*., 2006).

Waste collection

The services of street sweeping (the main roads only), cleansing of 23 formal and 15 informal markets, as well as clearing of illegal dumpsites throughout the Metropolitan Area is done by Límpia Verde municipal department. Límpia Verde also provides some of the waste collection services, collecting approx. 20% of waste. Most of the waste collection services (collecting approx. 80% of waste) are provided by private companies – associations of micro-entrepreneurs who own one or more trucks. Owner often drives the truck and family members assist. Three main private associations are Atradesgua, Arsgua and Urbagua. The associations began some 12 years ago, and have since grown considerably. For instance Atradesgua started as a family business providing waste collection by mules; nowadays it has 343 registered trucks. An association coordinates truck routes and ensures a fair distribution of the areas among the trucks, which often involves resolution of conflicts. The Central Municipality authorities check the trucks once a year.

Waste is mostly collected door-to-door in plastic bags, while 21% of the respondents to the questionnaire bring their waste to a collection point – a communal container. Distances to the collection points may be as long as 1100 m (i.e., up to 13 blocks, each block measuring approximately 85 x 85 meters). Selling or giving away valuable materials to itinerant buyers/collectors prior to collection is widespread, as discussed in section Resource recovery below.

In the urban area of Dpt. Guatemala some 325,000 tonnes of waste are collected annually, with coverage rate of 81% of urban population (IARNA *et al*., 2006). According to the results of the questionnaire in this research, coverage rate is 69%. In Zones 3 and 7 near the dumpsite, coverage rate of 57% is found, where citizens either bring their waste directly to the dumpsite or engage informal collectors for such a service. (It should be noted that only 29% of the rural population in Dpt. Guatemala receives waste collection service (IARNA *et al*., 2006).)

Some 10% of the respondents stated that they get rid of their waste by burning, burying or just throwing it away in the street, which would result in some 40,000 tonnes/year. However, the

number of citizens resorting to such illegal practices is likely to be twice as high, as the amount of 74,500 tonnes/year is reported by IARNA *et al*. (2006). At the moment, the locations of the illegal dumpsites are being mapped by the authorities. Several factors, combined, are seen as the reasons for the illegal dumping practices – throwing their waste away in plastic bags in parks, on the sidewalks, and into rivers and ravines. As many citizens are migrants from rural areas, they lack education, are not accustomed to paying for services, and are consequently not willing to pay. Also, due to poverty, many citizens cannot afford the services and thus opt for illegal dumping. Finally, as Límpia Verde provides street sweeping services and clears illegal dumpsites, citizens often take advantage of their efforts and throw away their waste in public spaces. However, this problem is visible everywhere in the metropolitan area – not only in low-income or illegal settlements. For example, inhabitants living near municipal markets throw their waste at collection points designated for market waste only, in order to avoid paying the fee. Finally, there are no penalties for offenders.
Commercial and industrial waste is collected by private companies. Special healthcare waste has been managed (collected and incinerated) by licensed companies since 2003, among which ECOTERMO covers 60% of the hospitals. The incineration ash is handled by another private company. Some hospital waste is disposed directly to dumpsite Zone 3 as well.

Disposal

The dumpsite located in Zone 3 known as El Trebol receives most of the municipal waste from Guatemala City, which is about half the waste received at the site; the other half comes from other municipalities. The site receives household, commercial, industrial and some hospital waste. The dumpsite Zone 3 is managed by the Central Municipality.
The dumpsite Zone 3 started receiving waste in the 1940s; in 1953 some form of management and waste control was implemented; in 1979 it came formally under control of municipal authorities. The dumpsite location responded to the need for an easy, nearby and inexpensive solution for waste disposal when the city started to grow. When it started, the dumpsite was at the outskirts of the city; now, due to the city growth, it is in the middle of a residential area of Zones 3 and 7, covering an area of 19.3 hectares. While such a location keeps the waste transportation costs low, the presence of a dumpsite in the city causes an array of adverse effects on the city and its inhabitants. Based on the questionnaire, 52% of the respondents experiences problems related to bad odour, 39% to smoke, 37% to dust, 31% to dirty streets and insects, 27% to effects on their health, 20% to insecurity issues and 15% to rodents and other discomfort coming from the dumpsite. The auxiliary municipalities regularly receive numerous complaints about these issues from all over the city, particularly in the rainy season and under certain wind directions. There have been recent developments to upgrade and close the site, discussed in chapters below.
Some 450-500 trucks come daily, approximately 385 of which belong to the micro-entrepreneurs of the private sector associations. The large number of trucks creates logistic problems – they wait in long queues to unload. Waste is spread out in layers, which are later covered with soil or gravel and compacted. The machinery available cannot cope with the waste amounts – it takes approximately three days to cover waste received in one day.
As in other developing countries, pickers of valuable materials are active at the dumpsite. Their activities are discussed in section Resource recovery below.

Resource recovery

Currently, municipal authorities are not involved in reuse or recycling. (Central Municipality is developing a comprehensive recycling plan though, to be launched in 2012.) On the other hand, there is a lively material recovery and trade by informal sector, involving an array of stakeholders. Some 90,000 people are engaged in informal trade in Dpt. Guatemala (MINTRAB, 2007).
Reuse of products is mainly practiced with electrical appliances, furniture and textiles. Appliances are repaired and sold in small second-hand shops; old clothes is given away or sold at very low prices to people in greatest need. In addition, zinc sheets and timber pieces are considered as being among the most valuable materials – they are widely reused to build informal housing, which could

be observed during the visit to the area surrounding the dumpsite. In addition to reuse of the above mentioned products and materials, various other materials are in high demand for recycling. The responses of the questionnaire reveal that almost 60% of the citizens sell or give away their waste products and materials to informal itinerant buyers/collectors for reuse or recycling purposes.
Furthermore, there is a widespread activity of *cacha* – sorting out recyclable materials from the waste collected by both private and municipal collection truck crews during collection. They subsequently sell the materials at the end of their route, to the businesses located by the dumpsite Zone 3 entrance or to other companies. The materials most collected include plastics, plastic bottles, aluminium and other metals. The earnings are significant: about 80-100 GTQ (10-12 USD) per day and sometimes even 200-300 GTQ (25-40 USD). The association is opposed to these practices.
What valuable materials are left, they are picked from the waste at the dumpsite. Between 600 and 2000 pickers (locally known as *guajeros*) work at dumpsite Zone 3 – some of them permanently, for a specific buyer outside the dumpsite, others do it as a part time job during the weekends or while waiting for other job opportunities.
Nearby the dumpsite Zone 3 a commercial area has developed where formal and informal buyers trade valuable materials coming from truck collection crews, pickers, informal buyers and a few citizens who bring their own waste to the dumpsite. There are a number of informal agreements, involving payment, between the dumpsite guards and the pickers, as well as between truck crews and pickers to get the right of access to their loads first. Materials such as paper, cardboard, glass, PET and other plastics, ferrous and non-ferrous scrap metals, and wet cell batteries, have a well-established trade structure and market prices.
The authorities are interested in getting to know the stakeholders involved in material recovery in order to establish co-operation; a country-wide inventory study was initiated and financially supported by MARN, MAGA and Rafael Landivar University in 2011 to identify and map recycling technologies used by both numerous small recyclers and large recycling companies.
As far as valorisation of organic waste is concerned, currently only 14,672 tonnes of organic waste from Villa Nueva is composted at Alameda Norte (AMSA, 2009). Several projects, such as the one by CENMA (*Central de Mayoreo*), are being initiated to convert organic waste from the markets into compost and thereby reduce the amounts of waste destined for disposal and raise public awareness about material value.

Governance

Inclusivity

Inclusivity of service providers represents the degree to which both formal and informal sector, private service providers and waste recyclers (pickers), are allowed equitable access to the system. Private companies aspiring to work for the City have to go through a bidding process; Central Municipality is in charge of the relevant procedures. Itinerant buyers/collectors are accepted by the public as part of day-to-day life. As a gesture of inclusivity, the Central Municipality in Guatemala City enacted regulation related to workers and communities around the dumpsite Zone 3 (*Redignificación de trabajadores y comunidades alrededor del vertedero*) in 2004, based on which dumpsite waste pickers get ID cards issued by the Municipality. Waste pickers are not organised in any way and there are no communication channels with the dumpsite administration. There is a small pharmacy though and healthcare attention for pickers in the administration building, initiated by the dumpsite Head.
Inclusivity (equity) of the system users in receiving a fair and adequate service is reflected in the coverage. Collection services reach 69% (or 81%, depending on the source of information) of the urban population in Dpt. Guatemala. Rural area in Dpt. Guatemala has only 29% coverage.
Public participation is possible through neighbourhood committees (*Comite Unico de Barrio*, CUB), where citizens can discuss problems facing the neighbourhood and communicate them to the respective Auxiliary Municipality, which then searches for solutions with a support from the Central Municipality. In that way citizens – as waste service users – can put forward for discussion issues related to solid waste as well. However 74% of the questionnaire respondents state that they

are not aware of a committee or any other platform that addresses solid waste related issues in their area; only 12% actively participate. In Zones 3 and 7 there are around 50 committees each; some are more active than others. Solid waste topics discussed include illegal dumping on the streets and vacant lots, street sweeping services, and dumpsite closure. In settlements close to the dumpsite in Zone 7, the issues mostly raised include health, disease prevention and crime.
In addition to the discussions in committees, Central Municipality gets feedback from the service users through a web page provided for this purpose. CONADES-MARN has a customer service that receives various complaints about pollution. Those related to waste include, i.a., pollution of rivers, waste burning, illegal dumping, smoke and soot, and odour coming from the dumpsite.
Citizens are not involved in strategic planning and site selection for new facilities. For example, local residents were not even informed about the investigations into a site at Las Guacamayas ravine, situated in the rural area within Dpt. Guatemala. On the other hand, a campaign launched by the Capital Municipality and the National Civil Police in order to raise public awareness on waste management in 2002, resulted in a remarkably positive response from the citizens, including those in marginal areas and settlements: the need for street cleansing (removal of illegal dumps) dropped from 150 to 50 trucks.

Financial Sustainability

Municipalities are required by law to invest a percentage of the national revenue budget in projects with community benefit. Due to other needs in the country and political preferences, there has been little investment in solid waste management. Following a national initiative to form funds for SWM, the Municipality of Guatemala City established a fund of 50,000USD. It also imposed a "*Boleto de Ornato*" tax, payable per year by any resident between 18 and 65 years of age. However, this tax is very low; moreover, the residents do not pay, and there is no enforcement (OPS, 2003).
Waste collection services by Límpia Verde and operations and management of dumpsite Zone 3 are financed by the Central Municipality of Guatemala City. The dumpsite operation costs are estimated at 22 million GTQ (2.9 million USD) a year, entirely covered from the Municipality budget. (Association of waste collectors Atradesgua pays just 300GTQ (approx. 40USD) a year for the right to unload at the dumpsite Zone 3.)
Private waste collectors (micro-entrepreneurs usually possessing just one truck, organised in three associations) are paid directly by the service users, once a month. The fee depends on the house location and the distance to the dumpsite. The largest portion of the respondents (41%) has a fee between 30 and 40GTQ (3.9 - 5.2USD), which is 5% of the monthly income for families below official poverty line, thus, in face of other basic needs, likely to be unaffordable (Wilson, Rodic *et al*., 2012). In addition to a clear problem of affordability, lack of willingness to pay for municipal services in general is a problem as well, as many citizens lack insight into relationship between space cleanliness, pollution and health, as discussed above in section Waste collection, in relation to illegal dumping. Unsurprisingly, only 59% of the respondents stated that they pay the fee, 20% said they do not pay, and 21% did not wish to respond to this question.
The fees for collection of commercial and industrial waste are much higher, ranging from 500 to10,000GTQ (65-1,300USD) per month. Private providers of waste collection services state that waste collection is a good business and they see opportunities for expansion in the future.
Recycling is financed solely from material sale revenues, according to the market prices. Materials in demand include paper, plastics, cans and other metals, appliances, timber and textiles. Only a small portion of organic waste is composted and traded by a local institution at Alameda Norte.

Institutional Framework

Guatemala has developed its institutional basis rather recently: the Ministry of Environment and Natural Resources (*Ministerio de Ambiente y Recursos Naturales, MARN*) was created in 2000. As part of MARN, National Council for Solid Waste (*Consejo Nacional de Desechos Sólidos, CONADES*) serves as an advisory body to the Minister. It also oversees municipal SWM projects, verifies compliance with the requirements, and provides SWM training to municipal technical staff.

CONADES-MARN has prepared SWM guidelines, and has been proposing laws and regulations and initiating various education programmes concerning SWM. The hospital waste management regulations (Decree 509-2001) were enacted in 2001. Some legal documents are currently waiting for approval by the Congress. The Ministry of Public Health and Welfare (*Ministerio de Salud Pública y Asistencia Social, MSPAS*) monitors and inspects municipal works regarding their impact on public health, including illegal dumping and pollution of rivers and drinking water wells by leachate. Since 2004 the Ministry of Education has worked on various sustainability themes including forest conservation, climate change, and SWM.
Many research studies of SWM system have been carried out in the last 30 years with the support of national and international institutions including NGOs, the National Environmental Research and Training Center of Mexico (CENICA), the Pan-American Health Organization (OPS) and JICA Japan, but unfortunately they have not resulted in positive change in practice. Currently, these agencies are financing research, consultancies, workshops, and training abroad for municipal staff.
According to the interviewees, there is a lack of communication and co-operation between Central Municipality of Guatemala City and the Ministries.

CURRENT STATE OF DUMPSITE ZONE 3 IN GUATEMALA CITY

Dumpsite Zone 3 has been in operation for over 60 years. The shape of the terrain consists of strong slopes creating a deep ravine. The area is a private property. The owner gave the ravine in quality of usufruct (legal right to use another's property) to the municipality, for a certain period. In agreement with the land owner, waste would be deposited in layers, covered by soil or gravel, and compacted, thus filling the ravine and gradually raising the ground level, and eventually converting the ravine into a flat area. In this way, over 27,000 m^2 have been created, where the municipality developed houses for the pickers, free of charge, as well as public sport and recreation terrains. Based on a site topographical survey conducted in 2003, the remaining use period was estimated at 6 to 8 years. This has prompted the city authorities to start planning closure activities and exploring options for waste disposal in the future. They have engaged a consortium formed by the Spanish company IDOM with Guatemalan companies to conduct a number of feasibility studies regarding dumpsite closure, waste valorisation, and site selection for the new disposal facility. At present, the results cannot be disclosed to the public, due to a pending tender that will be launched by the Central Municipality with the support of the Inter-American Development Bank (*Banco Interamericano de Desarrollo*, BID). Currently, citizens' participation is not an integral part of the planning process.

Until recently, the dumpsite had no measures of environmental protection in place. Inadequately organised operations often resulted in injuries and fatalities of waste pickers due to fires and waste slide accidents. Recently applied technical measures include: installation of 42 torches to flare the gas so as to prevent explosions and alleviate problems with nauseating odour and proliferation of flies; digging of rain water drains at the edges of each platform and along the dumpsite borders; and building a perimeter wall (still not completed). Also, hydrated lime is regularly injected to neutralize leachate pH. As for operations, control at the entrance gate is applied to restrict public access – there is only one entrance gate controlled by three or more armed guards, in an attempt by the Central Municipality to improve safety of operations. Accordingly, each waste picker is issued an ID. The entrance is a busy place, with trucks and other vehicles, and people walking in and out.
In the dumping area there is a main road connecting the ten (working or compacted) platforms. The main road is well compacted, and has rainwater drains. Higher platforms are already compacted but the ground shows erosion and felt soft during the field visit, with water streams running over them. Waste is currently unloaded at the middle and lower platforms. The walls of the ravine are covered with vegetation, except at one part that lost its vegetation cover due to a landslide caused by the tropical storm E-12 in October 2011. One of the ravine walls is excavated for cover material.

The lower platform is a very busy area, with trucks unloading waste, pickers gathering materials and two machines compacting the waste, all working at the same time, practically in the same place. During the field visit there were some 200 pickers working, four trucks unloading waste and more than 20 trucks waiting to unload, with guards trying to guide and coordinate movement of vehicles. In order to make waiting easier, there are informal vendors selling food and drinks.
The leachate from the dumpsite, the sewage from the adjacent settlements, as well as secondary sewage of the city accumulate in a sort of lagoon at the bottom of the ravine, from where they naturally drain into the Zalia River, which joins the Chinautla River. Along the Chinautla River many villages complain about unpleasant odours, flies pests and other insects; the situation gets worse during flooding. Recently several studies have been carried out to measure the environmental pollution. Unfortunately, the results of these studies are not publicly accessible. The neighbourhood around the dumpsite is one of the most densely populated areas in the city, together with Zones 5, 6 and 8, where low and medium-income families live, some of which under very difficult conditions.

PROPOSAL FOR CLOSURE OF DUMPSITE ZONE 3 IN GUATEMALA CITY

The issues discussed here are based on the analysis of the current SWM system in the city and the dumpsite itself. The Proposal consists of five main parts, as presented below.

Dumpsite closure and aftercare. General technical principles of dumpsite closure are well established in engineering literature (e.g., Daniel, 1993; McBean *et al*. 1994; Rushbrook and Pugh, 1999) and are thus not elaborated here. Nevertheless, low cost solutions suitable for the local conditions should be sought, such as leachate treatment by natural systems. Similarly, if feasibility studies show that potential yield of landfill gas does not justify an active extraction and utilisation system, a low cost passive venting system should be installed. As the dumpsite has a peculiar form due to the geomorphology of the site, the issue of geotechnical stability in relation to waste decomposition and differential settling requires special attention. Steep slopes will also dictate solutions for drainage of rainwater. In addition, as the site currently receives both leachate *and* sewage, an integrated solution should encompass both discharges. Finally, locally appropriate vegetation should be selected by an interdisciplinary team of professionals including engineers, planners, landscape architects, soil scientists, botanists and horticulturists. Installation and maintenance of the planting may provide suitable future job opportunities for waste pickers.

Facilities. We propose that the site retains its function within the SWM system, but, instead of disposal, focusing on waste transfer, material recovery and trade, and composting, while providing alternative jobs for the former dumpsite waste pickers. While keeping the existing storage and trade area for recyclables, the site should also comprise a low-tech transfer station with waste sorting, a composting plant, and an office for supervision of the dumpsite monitoring and maintenance. The waste remaining after sorting will be moved to the new disposal site the same day. In order to maintain cleanliness of the neighbourhood, waste containers will be provided for the residents.
The new land uses at the site include recreational area, parks, and flower gardens, as well as a commercial centre, consisting of a market (e.g., such as the Central market in Zone 1), information and education area, NGO offices, and a parking lot. This part of the proposal is based on the questionnaire results: 45 % of the respondent state that they would like to see the neighbourhood greener with parks and trees, and 42 % cite sport areas for affordable free-time outdoor activities.

New waste disposal site. In order to make sure that the closure of the dumpsite will indeed contribute to the environmental protection, a new site has to be secured for the future waste. Two fundamental decisions must be taken prior to the site selection: the size of the new landfill, and types of waste to be accepted there. In order to correctly estimate the amounts of incoming waste, the entire system should be analysed, as discussed in section Integrated SWM solution below. Namely, the contribution of the informal sector is often underestimated because authorities are not

familiar with their activities (Wilson, Rodic *et al*., 2012). As for the types of waste, developing and licensing the new landfill for municipal (non-hazardous) waste only would probably not be an appropriate decision, as the owners of hazardous waste would be left without options. Experience teaches that, in order to achieve an effective waste management system, it is essential that legislation *and* facilities be developed in parallel (Probst and Beierle, 1999).
Criteria for identification of suitable sites are well-established in literature and will thus not be discussed here. Site selection process is bound to be influenced by the NIMBY "Not In My Back Yard" attitude from the public. The Central Municipality authorities are not communicating to or with the public, which has a potential to cause various problems: confusion, conflicts, opposition, delays and increase in costs (Rushbrook and Pugh, 1999). A suitable forum should be established to facilitate communication and consultation among stakeholder representatives, including different municipal departments, affected communities, nongovernmental organizations and financial bodies. Social scientists or anthropologists can contribute to a constructive community involvement in the site selection procedure. Some are already involved in NGOs working with informal sector in SWM, thus could be particularly beneficial due to their familiarity with the SWM issues.

Integrated SWM solution. Based on the ISWM approach, when one component of the waste management system is upgraded, a revision of the entire system is necessary to ensure a successful outcome. Such a change also constitutes an opportunity to evaluate the entire existing SWM system, identify and build upon its strengths, and address the weaknesses. Strengths of the current system include existence of a lively informal recycling sector and the familiarity and acceptance of their activities by the citizens. Also, private providers of waste collection services see business opportunities to expand their services to more users, thus to increase coverage from the current 69% (or 81%, depending on the source of information) to close to 100%.
The fact that 60% of household waste is organic, constitutes an opportunity for some form of valorisation and significant decrease of the amounts of waste destined for disposal. Therefore a composting plant is proposed at the closed dumpsite where organic waste from markets and households can be processed into compost, to be applied in the new public parks in the area.

New activities. A combination of the existing lively trade in recyclables, waste sorting at the new transfer station, and composting, with various small manufacture and repair businesses, will form the basis of the economic activities at the site. Information and education area will have several functions. Citizens and neighbourhood committees can meet there and discuss issues related to the neighbourhood. Training programmes will be initiated for waste pickers so as to enable them to take jobs within the new facilities, including any small businesses that focus on making products – such as colourful jewellery, as is currently the case – out of waste materials. The existing educational programmes supported by the NGOs will be continued for waste pickers' children. Public education programmes – through activities appropriate to Guatemalan culture – are essential in addressing some of the weaknesses of the SWM system. The education should aim at promoting neighbourhood cleanliness, raising public awareness about environmental and health issues and the value of waste, and further encouraging waste segregation at source. A positive experience from the campaign launched by the Capital Municipality and the National Civil Police in 2002 that resulted in markedly lower illegal dumping should be used as a case of positive deviance and built upon.

CONCLUSIONS AND RECOMMENDATIONS

The situation of SWM in Guatemala City is difficult, due to historical developments and natural conditions of the country that dictate other priorities. Still, the system comprises some important strengths, such as an apparently thriving informal material recovery, their acceptance by the citizens, market demand for materials, interest from the private providers of waste collection services, as well as some positive experiences with public campaigns resulting in dramatic decrease in illegal dumping. The weaknesses include general lack of financial resources, and a lack of

communication and consultation among the stakeholders, including that between authorities and the public in the planning process. Due to the site geomorphology, the solution for the dumpsite closure requires specific engineering knowledge. The solution also necessitates alternative sources of income for the hundreds of waste pickers and their families. The good work of the informal sector in material recovery should be facilitated to continue and improve, as it not only diverts waste from disposal, but also contributes to the economy, alleviates poverty, reduces import of materials, and contributes to conservation of resources. Public participation and consultation in the planning process as well as a more open and engaging co-operation between authorities and citizens should be developed for the benefit of both the SWM and a cleaner living environment in Guatemala City.

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