THE MOUNTING PROBLEMS WITH MANAGING WASTES IN RAPIDLY DEVELOPING ISLANDS: THE MAURITIUS CASE

R. MOHEE*, A. KARAGIANNIDIS**, N. THEMELIS° AND ST. KONTOGIANNI**

** University of Mauritius, Réduit, Republic of Mauritius.*
*** Laboratory of Heat Transfer and Environmental Engineering, Department of Mechanical Engineering, Box 483, Aristotle University, 54124 Thessaloniki, Greece*
° Earth Engineering Center, Columbia University, US

SUMMARY: The island of Mauritius is located west of Madagascar in the Indian Ocean and has a population of 1.27 million. Because of rapid economic development, the island is facing a major problem with managing its solid wastes in the near future. The principal landfill has reached full capacity and there is no suitable site for a new landfill. The island has a history in composting and there is a composting plant under construction with a capacity to 100,000 t. However, this leaves an estimated 200,000 tons of post-recycling municipal solid wastes with no place to go by the year 2015. A formal plan for building a grate combustion (mass burn) waste-to-energy plant of 300,000 ton capacity and generate electricity has been submitted to the government. However, this plan has met considerable resistance by environmental groups on the island. This paper examines the mounting problems with managing solid wastes in island settings and examines the options for implementing a sustainable waste management plan for the island of Mauritius that includes recycling, composting, and combustion with energy recovery for the residual municipal solid wastes.

1. INTRODUCTION

In Developing Countries (DC) practices of SWM still do not seem to fully (or often even remotely) protect human health and therefore intermediate customised steps are needed first. In urban areas, especially in the rapid urbanizing cities of the developing world, SWM problems and issues are almost reaching crisis levels, as acknowledged by most governments; however, rapid population growth overwhelms the capacity of most authorities to provide even basic services.

In the urban centres throughout the Africa, less than half of the solid waste produced is collected, and 95% of that amount is neither contained nor collected. It is either indiscriminately thrown away at various dumping sites on the periphery of urban centres, or at a number of so-

Proceedings Venice 2010, Third International Symposium on Energy from Biomass and Waste
Venice, Italy; 8-11 November 2010

called temporary sites - typically empty lots scattered throughout the city. The composition of waste has changed from basically biodegradable to non-degradable materials or substances. This exacerbates further, the existing problems of waste disposal. Within the local governments of most African countries, expenditure for municipal waste management service usually amounts from 20% to 50% of total municipal expenditure (Karagiannidis, 2008).

During the recent years, Mauritius has experienced a rapid economic development. This has been achieved through industralisastion and urbanisation coupled to a general improvement in the standard of living. Production and consumption pattern have changed. In a similar way the volume and nature of waste generated by the various sectors of the economy has changed considerably. Mauritius recognised that the solid waste management practices of 80's and 90's were no longer compatible with the changing quality and quantity of waste produced. In 80's till the early 90's around 24 official dumpsites were operational. There was no controlled landfill site, no waste separation and waste management was the subject of increasing attention (Gopee, 2009).

For small island states such as Mauritius, the management of solid wastes is a critical issue for various reasons such as high population density, competition between land uses, limited domestic markets and high tourist numbers. Limited land areas make the option of landfill disposal unsustainable in the long term. Incineration, while reducing the volume of wastes is prohibitive in terms of cost and still requires disposal of ash containing potential hazardous substances in high concentrations. Over the past, inappropriately sited and poorly managed garbage dumps have significantly contributed to marine pollution and coastal degradation. (Mohee, 2002).

A draft of the policy paper was prepared in 2003, which came up with a strategic plan for 2005. The policy paper is in the process of revision and will come up with new strategies for 2010 – 2015 (CODWAP, 2010). In 2008, the Ministry of Environment and NDU in collaboration with UNEP devised an Action Plan on Integrated Solid Waste Management and Recycling for a period of 2008 to 2013 under the umbrella of National Programme on Sustainable Consumption and Production (SCP) for Mauritius (2008-2013). The overall goals of the Action Plan up to year 2013 are specified as follows:

- Establish an Integrated Waste Management System in all Municipalities and District Councils in the next 2-3 years.
- Increase the recycling of industrial and commercial waste with a focus on cardboards, plastics and paper by at least 25% over the next 5 years compared to 2007.
- Increase the amount of waste going for composting from the hotel and domestic sector by at least 25% and 10% respectively over the next 5 years compared to 2007.
- Devise an action plan for implementing the Extended Producer Responsibility concept in Mauritius by 2010.

Waste generation forecast made in 2004, projected an annual growth of 1% to reach about 398,000 tonnes in 2009 and about 510,000 tonnes in year 2034. However, the country's waste generation has already exceeded the 2009 projections. The cost of municipal waste management in 2005 was MUR 500 millions, that is, about MUR 1548 per household (Scoping Report – Development of a National Programme on SPC, 2007). Figure 1 shows the trend and the proportional relationship between the amount of solid waste disposed in the landfill in tonnes and the GDP per capita of Mauritius from year 1999 to year 2007.

The composition of waste of Mauritius in 1999 is classified as Total Municipal Waste 70%, Industrial Non-Hazardous Waste 15%, Construction & Demolition Waste 11%, Hazardous Waste 5%, Health Care Waste 0.2%, and Sludge 0.08%. The composition (on a weight basis) in 2002 was as follows: Food Waste 25%, Yard Waste 43%, Plastics 13%, Paper 12%, Textiles 3%, and Metals 1%. The moisture content of the waste was around 48% and the calorific value of the mixed wastes was around 18,800 kJ/kg on a dry- weight basis (Mohee, 2010).

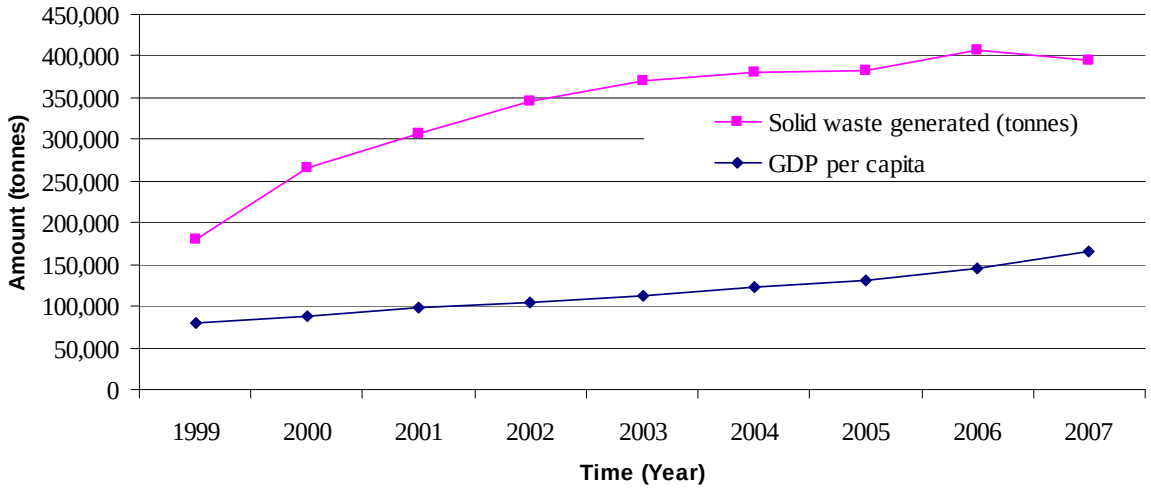

Figure 1: Solid Waste Disposed in Landfill and GDP per capita.

2. WASTE MANAGEMENT SECTOR

The Waste Management System in Mauritius (Figure 2) consists of Collection by the 9 Local Authorities, Compaction in 5 Transfer Stations and Landfilling at Mare Chicose, which is the sole landfill of the island (see Figure 3).

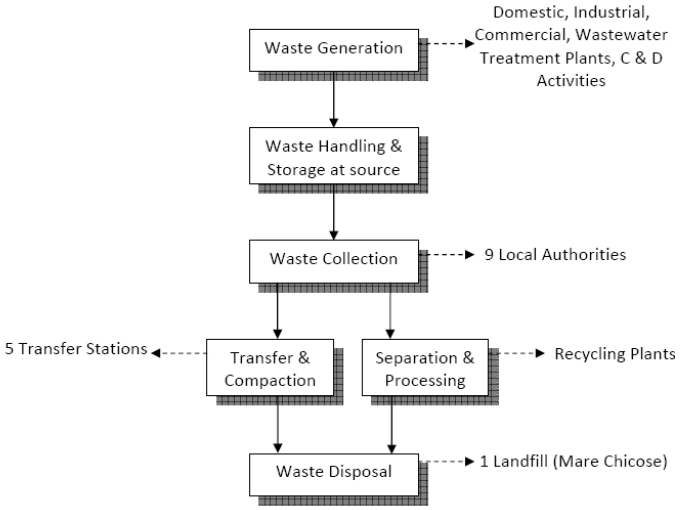

Figure 2: Solid Waste Management System in Mauritius (Mohee, 2010).

2.1 Waste collection

The collection is carried out by different types of rearloaded trucks such as open truck and compactor truck. In 2002, there was manpower of 2,243 people and 133 vehicle fleets involved in the collection of waste throughout the whole island but it was estimated that around 12% of the generated municipal solid waste is not collected. The municipalities charge a general rate based on the value of the property and the cost of collection of waste is around Rs 900/ton. There are still open burning practices in backyards today.

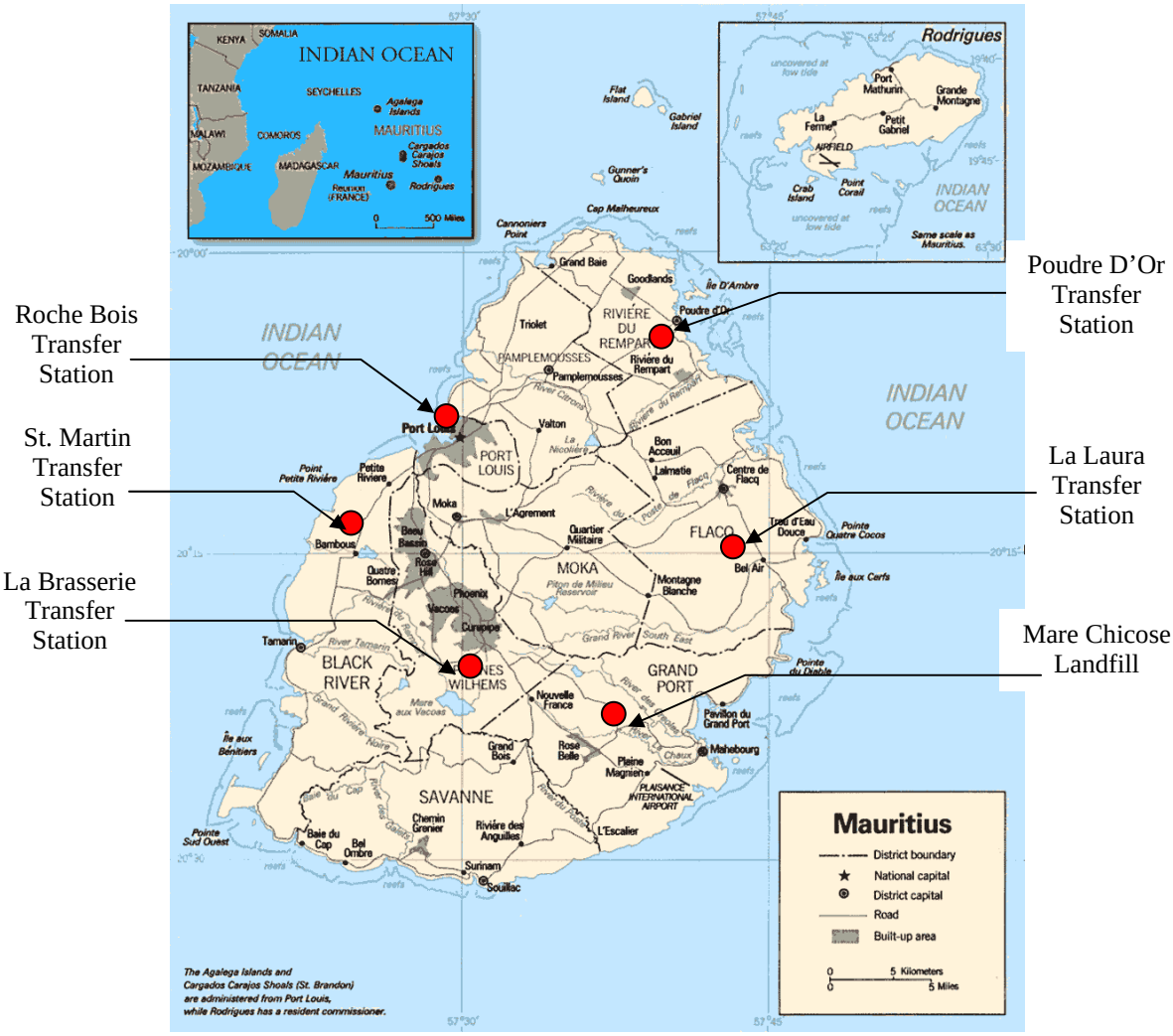

Figure 3: Map of Mauritius with the location of transfer stations.

At present, there are 5 transfer stations around the island for compacting solid wastes before final disposal at the landfill. These are located at La Brasserie, Roche Bois, St. Martin, Poudre D'Or and La Laura. The transfer stations are equipped with weighbridge for recording incoming and outcoming wastes. The wastes at the transfer stations are either compacted into two sizes of closed containers and one closed semi-trailer with typical waste loads of 12-13, 17-18 and 19-24 tonnes respectively or loaded without compaction into large open semi-trailers with typically 15-20 tonnes of wastes. Part of the solid wastes collected in the southern region of the island are directly disposed in the landfill.

2.2 Landfilling

The last dump site in Mauritius was closed in 2001 and now has only one landfill which is located at Mare Chicose. The landfill had an initial surface area of 20 hectares and its planned lifespan was 19 years at a waste generation rate of 300 tonnes per day. The landfill has a surface area of 32 hectares, comprising of 6 cells, with an average monthly input of 36,000 tonnes. The accumulated amount of waste in the landfill as at January 2009 was 3,530,065.5 tonnes. Solid wastes disposed via the 5 transfer stations, represent 80-85% of total waste collected, while the remaining 15-20% waste are collected from the southern region of the island and disposed directly to the landfill (Mohee, 2010). Over the whole life span of the landfill, the cost is $26/ton.

Figure 4 shows the amount of solid wastes disposed from the time the landfill started operation up to the year 2007. It can be observed that the amount of wastes generated per year in Mauritius increased each year and in 2006, there was a peak of 417,729 tonnes due to the outbreak of Chikungunya virus which is spread by the bite of infected mosquitoes.

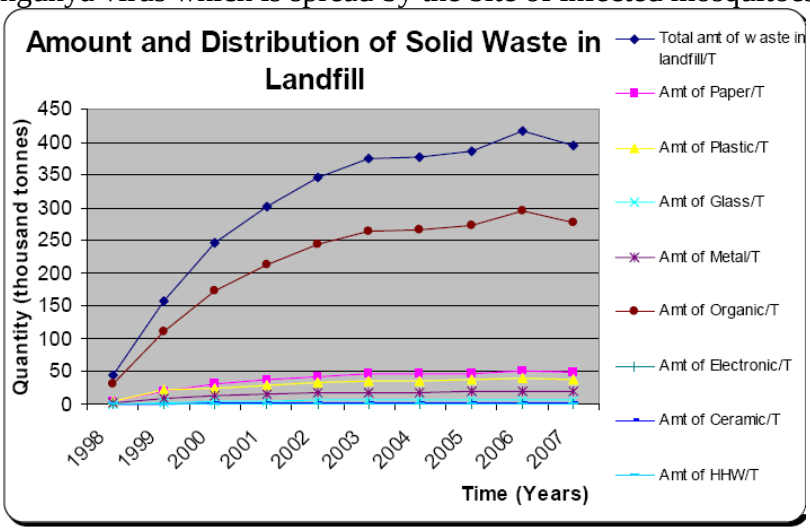

Figure 4: Trend in composition of solid wastes in Mare Chicose landfill from end 1997 to 2007.

The landfill produces about 500 m3 leachate per day on average, which is carted away by trucks and is treated at the St. Martin Treatment Plant. Biogas is being currently collected and flared, whereas, the leachate generated is being carted away to the Roche Bois treatment plant, whereby primary treatment is applied to the leachate, diluted and then discharged at a distance of 1.5 km in the sea. To be noted that the wastewater management falls under the responsibility of the Ministry of public utilities. There is no immediate plan for construction of a leachate treatment plant at the landfill site. There is a future plan to convert the biogas at the landfill to electricity but the sale of electricity to the CEB is under negotiation.

2.3 Recycling Plants

The level of recycling of solid waste in Mauritius seems to be very limited, despite the growth of solid waste generation. Only about 9% of paper, 3% of plastics and 31% of textiles are recycled. Some reused kitchen oils is being recycled for use but to a much lesser extent, and this is yet to be commercialised.

Those involved in the recycling of PET bottles have to organise their own collection system at their own cost. The prive they pay for the used bottles are quite low but these companies face some competiotion with other similar companies. The final products are exported for further use. In case of the recycling of paper and textile waste, much help is obtained from companies involved in production. However the transportation costs is still high compared to the volume of waste that is being recycled. Currently most of the waste produced goes to the landfill and there is not much segregation of waste at domestic level (Gopee, 2009).

From the reviews of recycling plants, there are economic, technical, social, legislative, and informative barriers to the development of recycling activities. Some recycling plants are not fully integrated due to high investment costs, this explain why they export for further processing.

A number of recycling facilities seems to be in short supply of workforce while others complain of unavailability of wastes due to the inefficiency of the collection system itself and high collection costs. Many plants report that lack of incentives from the government together

with insufficient information and participation of the public holds back the growth of recycling. Some recycling plants report that there is low demand of recycled goods while others fear the risks of not meeting the demand of recycled products due to unavailability of raw materials (Mohee, 2010).

2.4 Composting

As presented in Figure 5, the waste stream of Mauritius consists of about 70% organics, followed by about 12% paper. Hence, there is a large scope of composting.

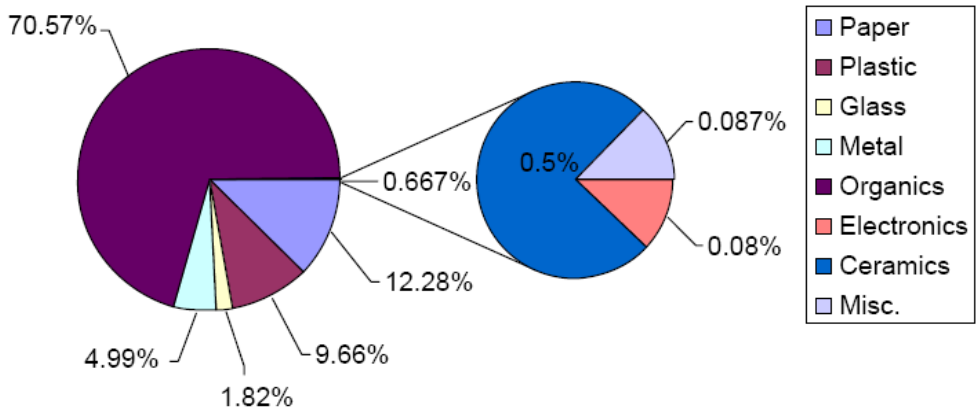

Figure 5: Composition (% wt) of solid wastes in Mare Chicose landfill site from end 1997 to 2007.

Since the majority (more than 60%) of the waste disposed in the island are of organic in nature, setting up of a national composting plant has been proposed by the Solid Waste Recycling Co. Ltd. The facility is intended to process 300 tonnes of unsegregated solid waste per day, that is, 100,000 tonnes per year. This amount represents one-quarter of the total amount of waste being disposed at the landfill site. The composting plant with the partnership of an Indian company, Excel Industries, will be sited at La Chaumière which is on the western part of the island and is about 16 kilometres from the capital and about 36 kilometres from the Mare Chicose landfill.

"Centralized composting for green wastes" option has a big potential in Mauritius as: (1) green wastes represent a high proportion in the waste stream (45%) and (2) in some urban areas in Mauritius, green wastes are collected separately from the mixed waste stream. The green wastes could be composted in a central facility (for example at the transfer stations).

3. FUTURE POTENTIALS: WASTE-TO- ENERGY

The incineration option should be studied further as the heating value of mixed municipal solid waste is quite low. However, it should be noted that bagasse has a similar heating value and is regularly burnt in sugar factories in Mauritius to produce electricity. Also, if the wet organics part of the waste stream is removed and composted, the remaining part of the wastes will have a higher calorific value and this will render incineration more suitable.

A Waste-to-Energy (WTE) Plant has been proposed with a capacity of 300,000 tonnes of solid wastes per year over 25 years of its operational life. The proposed project site is at La Chaumière, near the composting plant. The investment costs will be approximately MUR 6

billion.

In addition to domestic and commercial wastes from all parts of the island, the WTE Facility is designed to process tyre chips, wood waste, off-specification pharmaceuticals and classified documents except asbestos, inert construction waste or hazardous waste. Further, the Plant is intended to produce a 20 MW (net) of electricity which will be sold to Central Electricity Board, the national grid. The bulk volume of wastes will be reduced by about 90%. The ash (bottom and fly) produced from the combustion process is intended to be stored in a Residue Storage Facility which will be adjacent to the WTE facility. Moreover, the slag or furnace bottom ash produced from combustion of MSW had been proposed to be re-used in the construction industry as sub-base material, structural fill and aggregate in asphalt (subject to environmental approvals). Other benefits of the WTE facility are that it will be a source of tax revenue and a private sector investment that will preserve Government financial capital for other essential services and also, there will be a net reduction in greenhouse gas emissions associated with climate change.

DC like Mauritius should aquire a explicit picture of necessary balances and compromises between (a) economic growth and environmental protection, (b) the well targeted environmental policies, models and motives with the healthy imposition mechanisms, and (c) the active public participation with environmental awareness (Karagiannidis, 2008).

3. WASTE AUDIT

In the frame of CODWAP project an analytical waste audit was performed in Mauritius through several site visiting in waste management locations of the country (see Figure 6-a and 6-b).

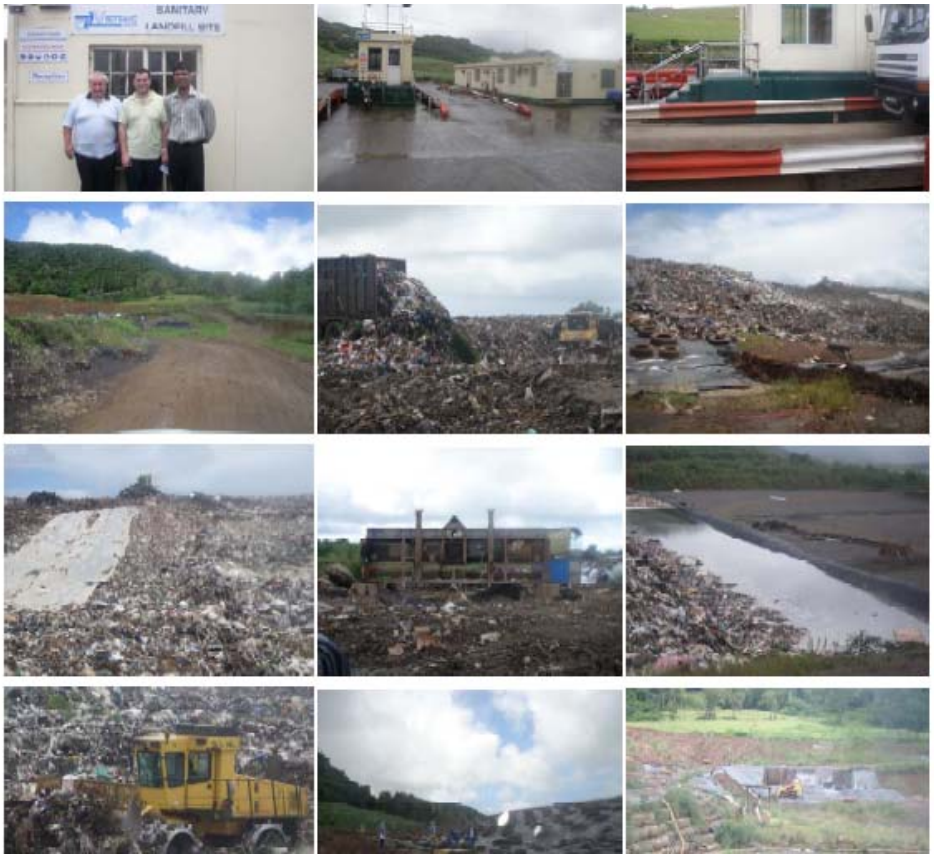

Figure 6-a: Site visiting in waste management locations of Mauritius.

Through discussion with local authorities and waste manasement stakeholders it became apparent that landfilled quantities are increasing, whereas expansion and re-siting prospects are poor if any. This is a significant challenge in the SWM system of Mauritius within the next few years. There are certain difficulties in SW which arise because the country has some specificities as a Small Island Developing State (SIDS).

Currently there is no waste separation and no separate bins for collection of MSW exist because (i) there is no market for separated waste, and (ii) there is no justification for the high capital investment.

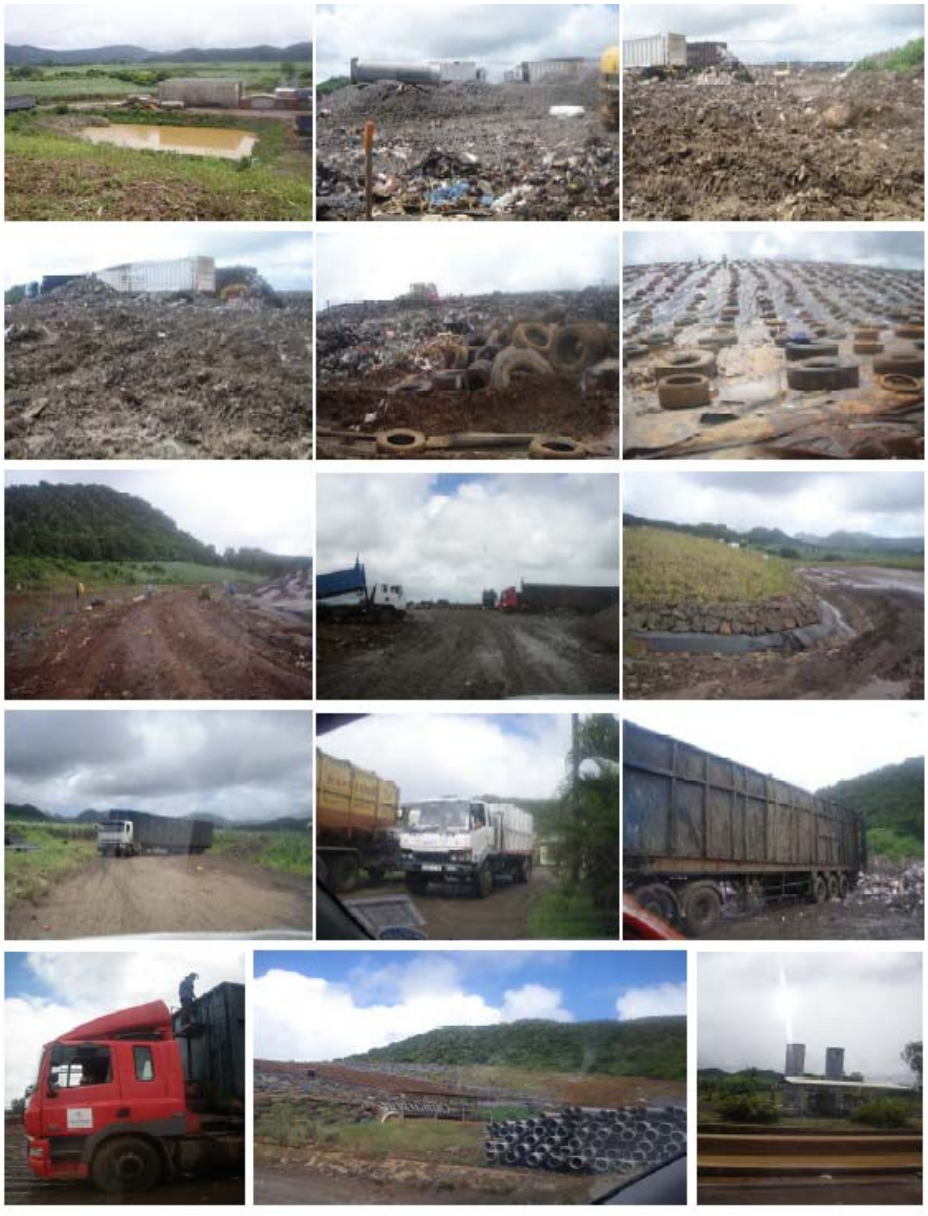

Figure 6-b: Site visiting in waste management locations of Mauritius.

However the government has embarked on sustainable consumption and production initiatives, e.g. collaboration with supermarkets to segregate their waste at source. Scavenging by people and staff of the transfer station has been noticed at the Roche Bois transfer station. To

discourage that authorities aim to adequately train the facility staff.

Recovered waste is exported; PET bottles are recovered, pelletised and sent to South Africa (bottle-to-bottle concept) and since there is no paper mill, paper is sent to China and India for recycling. Scrap metal is led to a local smelter in order to form metal rods (CODWAP, 2010).

There is a composting project by a private company, which plans to compost 100,000 tons of unsegregated municipal solid waste. There is no gate fee foreseen and the economics of the facility relies solely on the sale of the compost product. The plant will be located at La Chaumiere. The composting plant fits in the policy of the government to minimise waste. A compost quality standard is being prepared by the Mauritius Standards Bureau (MSB).

Regarding the types of hazardous wastes in the country include industrial wastes, medical wastes, and used oil; used oil which is recovered, undergo physical treatment processes, and are finally mixed with heavy fuel oil and sold to companies as fuel.

There are 5 hospitals in Mauritius, all of which have their own (often old) operating incinerator for infectious – hazardous hospital wastes. Since there is no centralized incinerator for medical wastes, hospitals incinerate medical waste on their own in situ.

The energy policy for renewables has not evolved yet into a regulation regarding e.g. feed-in tariffs. Nevertheless, 35% of the Mauritius electricity mix is produced from biomass (baggassecombustion in the 12 sugar factories with electricity generation and selling to the national grid) (CODWAP, 2010). The main specific priority for Mauritius is to maximize waste minisation. The improvements required to improve the SWM are: enhance partnership with all stakeholders; better infrastructure for collection, transfer & disposal; optimization of transfer operations; more education and awareness; training in terms of technical expertise at the ministry and local authorities.

5. CONCLUSIONS

The waste management system of Mauritius is not a fully integrated one. Waste generation rate is increasing year after year while the sole landfill of the country will be filled in a very near future. Since Mauritius is a small island and lack of space is a problem, better waste management system is, therefore, a requirement.

Several studies have been made in the past in relation to solid waste management. Most of them concluded that there is a wide scope of composting due to the high organic content (more than 60%) and an appropriate moisture content of around 50%. Several composting studies and successful composting activities have been recorded in Mauritius. These endeavours to support sustainable agriculture practices and manage the organic portion of solid waste have shown that composting in Mauritius economically viable and thus, need to be encouraged at all community level.

The disturbing conditions of solid waste management, two future plans at the national level are in the implementation phase, a composting plant and a waste-to-energy plant, which both will process the annual generation of 400,000 tonnes of waste producing compost and electrical energy respectively.

ACKNOWLEDGEMENTS (please list without numbers)

The authors wish to acknowledge the ACP-EU Cooperation Programme in Higher Education (EDULINK) - A programme of the ACP Group of States, with the financial assistance of the European Union for partly funding this research in the frame of an international project acronymed CODWAP (contract No. 9-ACP-RPR-118#23).

REFERENCES (please list without numbers)

Gopee P., Nowbuth M.D. and Baguant-Moonshiram Y. (2009). Evaluating the potential for recycling of solid waste in Mauritius. 1st International Exergy, Life Cycle Assessment and Sustainability Workshop and Symposium (ELCAS) proceedings, 4-6 June, Nisyros- Greece, pp. 472-479

Karagiannidis A. und Kontogianni S. (2007), Abfallwirtschaft in Entwicklungsländern und Klimawandel (Waste management and climate protection in developing countries), Tagungsband zum Workshop Abfallwirtschaft und Klimaschutz, Emissionshandel-Emissionsminderung-Klimaschutzprojekte (Waste management and climate protection) (B. Bilitewski et al., eds), Dresden, Germany, 26 September, 170-182.

Karagiannidis A., Diaz L. and Kontogianni S. (2008), Solid waste management in developing countries: A review of current issues and a view on future perspectives, Proceedings of the Waste-The Social Context, Edmonton, Alberta, Canada, 11-15 May, CD-ROM edition.

Mohee R. (2002). Assessing the recovery potential of solid waste in Mauritius. Resources, Conservation and Recycling, vol. 36, pp. 33–43

Mohee R., Rughoonundun H. and Peryagh C., (2010). Report for the waste management in Mauritius, CODWAP project Activity 4 Deliverable.

CODWAP (2010). Meetings' and missions' minutes, www.codwap.hs-bremen.de