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Municipal Solid Waste Management – The Sri Lankan Case

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Introduction

Disposal of solid waste is a priority environmental issue in Sri Lanka and at present it has become a national concern. Although haphazard solid waste disposal has been identified to be one of the major causes for environmental degradation in The National Action Plan of Sri Lanka, the most common method of municipal solid waste (MSW) disposal still remains to be open dumping. The issue of MSW is most acute in the Colombo municipal area and in the suburbs of Colombo. Except for the municipality of Colombo, MSW disposal in Sri Lanka is primarily a function of the public sector and in most of the urbanized municipalities MSW management is one of the largest employers of labor. The majority of the MSW management cost is allocated for waste collection and transportation rather than for waste disposal and treatment.

According to the provisions of the Local Government Act, the Local Authorities (LAs) in Sri Lanka are responsible for collecting and disposal of waste generated by the people within their territories. The necessary provisions are given under the sections 129, 130 and 131 of the Municipal Council Ordinance; the sections 118, 119 and 120 of the Urban Council Ordinance; and sections 93 and 94 of the Pradeshiya Sabha Act. The required basis for integrated solid waste management is provided by the present policies, strategies and the legal provisions. The National Environmental Act (NEA) of 1980 which was subsequently amended in 1988 provides the necessary legislative framework for environmental protection in the country. The National Strategy for Solid Waste Management (NSSWM) put forth by the Ministry of Forestry and Environment in 2002 endorsing the need for integrated solid waste management provides the overall guidance for the management of the country's solid waste. The irony of the situation is that though MSW management in Sri Lanka is rather chaotic the required framework for developing an appropriate waste management system has been in place for quite a while in the country.

Socio Economic Factors Governing Solid Waste Generation

Municipal solid waste (MSW) management planning requires knowledge of the quantity of waste generated and its composition. Various past studies have shown that the amount of waste generated by a country is proportional to its population and the mean living standards of the people (Wertz, 1976; Grossmann et al., 1974). Medina (1997) related waste generation rates to income levels of people. In addition socio economic factors such as persons per dwelling, cultural patterns, education, and personal attitudes also play a role (Al-Momani, 1994; Grossmann et al., 1974). Hockett et al (1995) conducted a study to identify and measure the variables which influence per capita MSW generation in the south-eastern U.S.A. They found that the per capita retail sales and tipping fees are the significant determinants of waste generation and that income, urbanization, manufacturing and construction do not significantly impact waste generation rates. Review of the past studies show that that relationships obtained between solid waste generation and socio economic parameters vary by country. This may be due to variations in consumer behavior and lifestyles. Although comprehensive studies that include direct waste analysis and consideration of socio-economic parameters have been conducted in developed countries, such studies are few in developing countries. A study was conducted in Moratuwa, Sri Lanka to determine the waste generation rates and waste composition and to identify the parameters that affect characteristics of household solid waste (Bandara et al 2007). The survey was conducted using 322 households which is about 1% of the number of households in the municipality. Households were selected based on stratified

random sampling approach where the households were stratified into wards and selected according to the number of households in each ward and then they were stratified according to the property tax values which are an indication of the living standards of the people. Through category and regression analyses, the quantities of waste and waste composition were related to several socio-economic factors.

The analyses showed that per household generation of organic waste increases with increase in property assessment tax value or income level. This is explained by the relatively high food consumption trends of higher income groups. A clear increase in the generation of paper per household with the increase in property assessment tax value or income level is also shown. However, a clear relationship between property assessment tax values and glass, plastic and metal waste was not obtained. The study also shows that as the number of people in a household increases, there is a reduction in the per capita waste generation rate. Thus in determining the waste generation of a municipality the per household waste generation is as important measure as the per capita waste generation rate. The number of employed people in a household was also shown to be a contributing factor to waste generation. The average amounts of waste generated per households of different income levels can be used to predict the total amount of waste generated within a municipality. In Sri Lanka, since municipalities in the country maintain a data base of property assessment tax values, the study findings can be extrapolated to other municipalities to estimate household waste generation and composition (Bandara *et al.* 2007).

Municipal Solid Waste Generation and Composition in Sri Lanka

The per capita solid waste generation rate varies among different categories of people. According to AIT (2004) the per capita per day waste generation on the average was 0.85 kg in Colombo Municipal Council (CMC), 0.75 kg in other Municipal Councils (MC), 0.60 in Urban Councils (UC) and 0.4 kg in Pradeshiya Shabhas (PS). The primary sources of MSW in the country are households, markets and commercial establishments while industries and hospitals constitute the secondary sources (AIT: 2004). MSW of Sri Lanka typically consists of a very high percentage of perishable organic material which is about 65 – 66% by weight with moderate amounts of plastics and paper and low contents of metal and glass. The moisture content in the MSW is also very high in the range of 70 – 80% on a wet weight basis. The average calorific value is low of around 600 – 1000 kcal/ kg.

A few studies had been done in the country to find the composition of the MSW stream in Sri Lanka. Table 1 gives the composition of MSW in some selected cities in Sri Lanka. Here, the organic waste is categorized as long term biodegradable (taking 2-3 months for degradation) and short term biodegradable (degrades within 2 months).

Table 1: MSW composition in some selected cities of Sri Lanka

MSW compositions of selected cities in Sri Lanka (2002)							
Cities	**Biodegradable (Short Term)**	**Biodegradable (Long Term)**	**Plastics**	**Metal**	**Wood**	**Glass**	**Paper**
Batticalo	46.79	10.61	8.26	2.90	17.12	2.20	16.45
Colombo	68.15	11.63	6.69	1.85	5.02	1.64	5.99
Galle	41.76	20.25	8.23	4.79	11.18	4.33	9.41
Jaffna	54.85	8.62	7.21	8.49	5.58	2.21	12.80
Kandy	54.83	17.95	4.02	4.46	6.36	5.35	11.08
Matara	56.81	18.60	6.90	3.07	5.78	2.07	8.50
Nuwara Eliya	60.53	9.73	8.46	2.12	8.92	2.90	8.72
Polonnaruwa	35.52	25.10	8.47	3.57	7.63	3.68	16.04
Trincomalee	27.98	20.06	4.33	12.51	22.04	1.85	18.04

(Source: AIT, 2004)

In the detailed case study conducted on the municipality of Moratuwa the average residential per-capita waste generation, average household waste generation and average composition of waste were determined by analysing in the Moratuwa Municipality according to the results is 0.42 kgs and the average household generation is 1.85 kgs per household per day. The results are presented in Table 2.

Table 2: Waste Generation from Households in the Moratuwa Municipality

Waste Type	**Household Waste Composition %**	**Mean Generation kg per day**	
		Per capita	**Per household**
Organic	90	3.744E-01	1.6704
Paper	05	1.891E-02	8.52E-02
Plastic	03	1.407E-02	5.85E-02
Glass	02	6.689E-03	3.08E-02
Metal	01	2.967E-03	1.42E-02
Total		**4.217E-01**	**1.85**

(Source: Bandara *et al*., 2007)

It should however be noted that the above results are based on solid waste generated at household level whereas the composition of MSW collected by the municipality is different. According to the data published for composition of the collected municipal solid waste in the Moratuwa municipality which is given in Table 3, the percentage of organic matter in the waste stream is less than what is generated at household level.

Table 3: Composition of collected MSW for municipality of Moratuwa

Waste Type	**Waste Composition %**
Plastic	10
Biodegradable (Short Term)	70
Bio Degradable (long Term)	8
Metal	0
Wooden waste	0
Glass waste	0
Paper Waste	12

(Source: Ministry of Forestry & Environment, 1999)

From the comparison between the above 2 tables it appears that while glass and metal generated at household level do not enter into the municipal waste stream the other recyclable material, paper and plastic do. The well established recycling industry of glass by the Ceylon Glass Company located close to Moratuwa and collection of metal by small time collectors may be the reason behind this. The organic content though lower is not significantly less showing that most of the organic materials which can be easily composted enter into the municipal waste stream.

A detailed study conducted 135 households in the Nuweraeliya Divisional Secretary Division reports of the household waste generation as 0.51 kg per capita per day (Amarananda, 2006). The composition of waste generated in the Nuwaraeliya MC area is given in Table 4.

Table 4: Waste Generation from Households in the Nuwaraeliya Municipal Council

Waste Type	**Waste Composition (%)**

Organic	77.3
Paper	11.1
Plastic	5.7
Glass	2.7
Metal	-
Textile	1.2
Rubber	0.1
Others	2.5

(Source: Amarananda, 2006)

Table 5 gives the composition of the collected municipal solid waste in the Nuwaraeliya Municipal Council

Table 5: Composition of Waste in Nuwaraeliya Municipality

Waste Type	**Waste Composition %**
Plastic	8.0
Biodegradable (Short Term)	70.0
Biodegradable (long Term)	2.0
Metal	1.0
Wooden waste	3.0
Glass waste	1.0
Paper Waste	12.0
Building waste	0.5
Other	2.5

(Source: Ministry of Forestry & Environment, 2005)

Here the organic content in the collected stream is only slightly less than the generated percentage. The percentages of glass, wood and metal in the collected waste stream is high when compared to the Moratuwa municipality.

Review of all the above studies show that household solid waste generation varies from one local authority in the country to the other. As discussed in the previous section numerous socio economic factors may contribute to this variation. In addition the composition of solid waste which is collected by local authorities also varies. This can be attributed to the services (collection, recycling facilities etc) available in an area, level of participation of residents in optional waste management methods and the climatic factors.

Current Waste Collection and Disposal Practices

The Local Authorities (LAs) are responsible for the collection and proper disposal of waste generated by the people within its territory. Except for the Municipality of Colombo which has a separate Solid Waste Management Unit, the public health department of the Local Authority is responsible for solid waste management in addition to their other responsibilities including health and sanitation. Hence solid waste management is not given much priority within the Local Authority and the budget allocation is rather limited.

Sri Lanka has 309 local authorities of which 15 are Municipal Councils (MC), 37 are Urban Councils (UC) and 257 are Pradeshiya sabas (PS). The daily collection of MSW in the country is about 2683 tons of waste. However the generated amount far outweighs this with almost negligible collection in rural areas of the country. The best estimate of total MSW generation in Sri Lanka was around 6400 tons/day

in 2005 (AIT, 2004). The collection of MSW in the country is very poor except in three main Municipal Councils; Colombo, Dehiwala-Mount Lavinia and Kotte which has about 30-40% collection value. The collection value for other parts of the country is generally 10-15% (AIT: 2004). The collection to generation ratio varies significantly amongst local authorities with CMC having a ratio of 93% and as little as 5% in smaller urban areas (ADB, 1999). When analyzing the data published by the Ministry of Forestry & Environment it was found that about 87 % LAs collects less than 10 T/d by each. Only five municipalities collect more than 100 T/d by each.

According to a household survey conducted for the municipality of Moratuwa, municipal waste collection is available to only 56% of the households. About 20% of the households dump their waste on the roadside and 8% dump the waste into pits in their own back yards. Insignificant number of households uses alternative waste management techniques, while 7% compost their waste and practice recycling. The survey revealed that a high percentage of households from high- and upper-middle- income groups enjoy municipal waste collection services and a lower percentage from the low income groups does so. It was also revealed that a higher percentage of low-income and lower-middle income group households dispose of their waste along roads. When asked about the level of service provided by the municipality, only 0.3% has said it is very good, 3.7% has said it is good, 65% has said it is satisfactory and 30% have said it is poor (Bandara & Hettiarachchi, 2008).

In the past, the main cost involved with solid waste management was for the collection and transport of waste since the common practice of open dumping did not cost anything. It was not a concern because of the free availability of degraded land. However, land scarcity is now a major problem faced by local authorities and therefore finding land for MSW disposal is becoming increasingly difficult. The final disposal of the all waste in open dumps in the country is more than 95 %. Open dumps are generally low lying degraded land which are state owned and are used only for flood retention. In some parts of the country even privately owned lands are used for open dumping in instances where landowners allow dumping on a payment to get their low lying lands filled up. Majority of these dumps are left open where as a few apply a thin soil cover on top due to public opposition. This is the only protective measure taken. These dumps are used to dispose every kind of waste such as industrial waste, municipal solid waste, hospital and clinical waste, slaughterhouse waste altogether without any segregation. Some of the privately owned dump sites had been sold for construction purposes later on. In the central part of the island, most of the time, waste is disposed along road embankments thus contaminating water streams at the bottom of the slope.

The country does not have a state of the art fully controlled sanitary landfill yet in operation. The best landfill in operation is the engineered landfill at Moon plains, Nuwaraeliya, which offers, isolation from the community, prevention of storm water entering the site, daily compaction and covering of solid waste, leachate collection and treatment and gas venting. This is operating successfully at present mainly due to the commitment of the municipal staff. A controlled landfill is operating at Mawanalle which offers limited containment.

Impacts of Present Practices

Unacceptable disposal of solid waste is one of the biggest environmental issues faced by the country at present. The current waste disposal practices in and around the suburbs of Colombo have threatened many ecologically valuable habitats such as the conservation areas of Attidiya and Muthurajawela wetlands which had been used as MSW dumping grounds. The flood retention capacity in many suburban areas of Colombo has been drastically reduced due to use of wetlands and low lying areas for waste disposal. These temporary floods lead to many other problems such as Diarrhea, spread of vector borne diseases such as dengue and filaria, damage to properties, drainage lines and roads etc. Loss of property values in

areas close to disposal sites is another critical social issue which instigates opposition against even proper sanitary landfills.

Other than these visible impacts more complex ones occur due to open dumping. The main ones are the emissions of landfill gases and leachate due to a complex sequence of biological and chemical reactions that occur within the solid waste matrix in a landfill. The contribution to the greenhouse gas budget of Sri Lanka associated with the methane released into the atmosphere from MSW open dumps is significant (Ramya Kumari & Bandara, 2004). In addition to greenhouse gases, the other gases released in the process of degradation of waste material, such as hydrogen sulfide and volatile organic compounds, may create human health and odor problems. Pollutants found in leachate released into the sub-surface include organic contaminants which are soluble refuse components of decomposition products of biodegradable fractions of MSW and a variety of heavy metals (Brown & Donnelly, 1998). Haphazard disposal of solid waste is reported as a primary cause for degradation of the quality of water resources in Sri Lanka (Bandara, 2003). Severity of the problem is much higher in the western province in Sri Lanka and the supply of potable water from ground water in the Greater Colombo Area is constrained due to this.

A study which investigated the quality of water of 45 wells located within 1 km to landfills in the Colombo Metropolitan Area showed that heavy metal concentration in water of some wells located very close to landfills exceeded the standards set by the CEA for inland water quality. The highest values obtained for Pb, Cu and Cr are 0.1 mg/l, 0.02 mg/l and 0.09 mg/l, respectively. The highest values obtained for Phosphate and Nitrate are 0.9 mg/l and 9 mg/l, respectively, while the highest values obtained for BOD and COD are 9.6 mg/l and 100 mg/l respectively indicating that there is considerable contamination of well water from leachate (Samanaraja & Bandara, 2005).

Analysis of quality of water of wells within a distance of 500 m to a landfill in Moratuwa showed that the water is unacceptably acidic and that in all of the samples the COD level far exceeded tolerance limit. Of even more significance is the unacceptable level of cadmium (Cd) present in almost all of the samples. The Cd levels ranged from 25 to 38 µg/L in the five samples which far exceed the tolerance limit of 5 µg/L given by the Sri Lanka Standards Institute for potable water (Bandara & Hettiarachchi, 2008). A recent study involving analysis of water quality 2-3 km away from the landfill site did not find any Cd in the water samples (Ratnayake, 2008). Therefore, the presence of Cd observed in the current study could be associated with the landfill under investigation.

Open burning of waste which is another common practice at present causes another set of environmental impacts by emitting environmentally harmful gasses and soot to the environment.

According to a World Bank study, the current urban MSW generation in Sri Lanka is 0.8 kg/capita/day (World Bank, 1999). The same study estimates that by the year 2025 the urban municipal solid waste generation rate will increase to 1.0 kg/capita/day. Furthermore, the need for land in urban areas for other development purposes is rapidly increasing. Therefore, it is inevitable that the issue of disposal of solid waste will get more aggrevated in the future unless action is taken to adhere to an appropriate waste management strategy.

Integrated Solid Waste Management

Integrated solid waste management has been strongly promoted by the Ministry of Environment, Central Environmental Authority (CEA) and various governmental and non-governmental organizations in the country. Integrated solid waste management includes waste reduction, resource recovery, reuse and recycle, biological treatment, incineration and landfilling.

Resource recovery has been practiced informally for quite some time in Sri Lanka for paper, glass and metal. Small time vendors and scavengers collect these items and sell them for recycling. Paper is recycled at both large and small scale. Paper mills use used paper for the production process and hand-made paper has become a trendy home based industry. Glass recycling is the most successful recycling process in the country since there is an assured market for collected waste glass. Ceylon Glass Company uses about 40 % of recycled glass (cullet) in the glass manufacturing process. In both the cases though possibilities exist lack of support of the community in collection and bringing to centers is the main constraint. In areas where small time door to door recyclable material collectors operate well (in suburban areas of Colombo) the recycling of glass, metal and paper are somewhat successful.

Recently with the solid waste crisis been highlighted even plastic and polythene are collected for recycling and cottage level recycling centers are in operation for these items. These businesses though happening at small scale are slowly increasing. With the initiative of the Ministry of Environment some local authorities such as Negambo have formalized these activities. However, the scale is not adequate to make a significant impact. The main issue is insufficient quantities collected in most areas to make recycling of plastic and polythene financially viable and a lucrative industry in the country.

Even if 100% recycling is achieved in the country given the composition of the MSW in Sri Lanka treatment of organic material in the waste stream is essential in order to reduce the volume of waste to be disposed. Biological treatment is not a new concept in the country. Both anaerobic digestion and composting are proven technologies and have been practiced in the country for a while.

Two types of digesters are used for anaerobic digestion, continuous and batch type reactors. All the necessary resources, material and expertise knowledge are available in the country. A number of agencies in the country are now able to construct and train people on the use of both these types. Sevanatha, Energy Forum and Practical Action are some agencies who have implemented continuous type digesters in areas including Dickwella, Negambo, Karapitiya hospital, Passyala and Wattala. NERD has got an award and has the patent ship for its batch type digester which is in operation in several areas of the country including Kiruloponne, Ja-ela, Anurahapura, Kollonnawa and Vajira orphanage, Kotte. Some of these projects have succeeded while some have failed attributed to poor maintenance and monitoring. Failure has been mainly due to non-separation of waste before feeding to the digester and uncontrolled feeding without shredding. The continuous type digesters at Dickwella and Krapitiya hospital and the batch type digester at the Vajira orphanage are operating successfully. Irrespective of the suitability of our waste for anaerobic digestion (due to the high organic and moisture content) and the advantage of getting biogas as a fuel and sludge as a fertilizer in the process, anaerobic digestion is not established well in the country. Another reason for this may be the reluctance in our society to use black liquor in the digestion process which would certainly enhance the efficiency of the system.

The other biological treatment system, composting or aerobic degradation of solid waste is more popular in the country due to its simplicity in operation. Unlike in anaerobic digestion composting offers many levels of participation. Passive windrow composting which requires low active involvement other than occasional turning of piles can be used anywhere if space is available. Generally this is used for farms or municipalities. Compost plants operated by the Weligama UC, Hambantota UC and Bulathsinghala PS are examples of successful passive windrow compost plants. However, many other centralized composting plants in large LA areas such as Horana have failed mainly due to public protests against the mal-odor and contamination of water bodies (AIT, 2004). Problems in these plants have mainly arisen due to unmanageable quantities of unsorted waste that has to be pre processed prior to composting.

Actively aerated piles where mechanical aeration is supplied to the plants are not yet in operation in the country. The University of Peradeniya has developed an inclined step grade composting system of 6 – 8 tons of waste per day and The University of Moratuwa is operating an in-vessel compost plant designed

by the Chemical Engineering Department of the University itself. This is functioning well and is treating most of the organic waste of the University. Sedawatte composting plant was designed to treat the organic waste generated from the municipality of Colombo but the quantity of waste that enters to the system is difficult to be handled.

At household level also composting is achievable even in areas with very little space. Numerous types of household composters have been introduced to the country. Ministry of Environment (through the "Pilisaru" project), CEA, Sevanatha, Arthacharya and Practical Action are some of the pioneering agencies who have tried to promote household composting programs in the country. Taking the initiative of the Ministry of Environment, a number of Local Authorities, such as Gampaha, Galle and Kotte MCs have distributed compost bins to residents. The success of these is not established yet. However, a survey done in the Galle Municipal area shows that amongst the households distributed with compost bins on the average about 86% actively participated with the composting program (Anthony & Bandara, 2008). The survey also showed that personal and household characteristics play a major role on involvement in the composting program. Ownership of the household, Land area, Monthly in-come, Educational level of the people is the main criteria that affect participation and success. Participation was higher of residents owning the property and with larger land area. The participation of residents of very high income group was shown to be less than low and middle income groups. While educational level had no relationship to the participation it had an effect on the success of the composting activity (Anthony & Bandara, 2008).

The failure of large scale composting is not due to operational failures alone. The lack of an assured market for the product is also discouraging the production of compost at large scale. The skepticism about the quality of compost available in the market is one reason for the low marketability of the product. Although the Sri Lanka Standards Institute (SLSI) has issued quality standards for compost the adherence to the standards is required only if the SLS certificate is requested for a product. Otherwise a product can be put out to the market since there is no other regulation in the country to ensure the quality of compost. Analysis of 13 samples of compost available in the market and made of mixed MSW showed that the heavy metal concentration in all the samples is less than the upper limit given by the SLSI. However, the concentration is higher than of 7 compost samples produced from pure organic material. The nutrient levels in all the samples were below the required nutrient levels (Bandara et al, 2004). From the results it can be concluded that although heavy metal content is below the accepted limits the possibility of heavy metals being present in compost cannot be completely ruled out and that compost from a known origin is better than what is derived from mixed municipal solid waste. The only way to overcome the problem of contamination is to separate biological material at the source of generation itself. Even if sorting is done at the plant site, it is not possible to separate out all of the non-biodegradable and toxic material. Presence of glass in the waste stream is one of the biggest problems in these plants (Kandavinna, 2004).

Recovery of useful products from waste is greatly enhanced if the waste materials can be separated at source into different categories and collected separately. The waste separation at source is still not operating at large scale in Sri Lanka though there have been several pilot projects launched with mixed results. A three month study was conducted to estimate the willingness to participate in an integrated solid waste management program at Nuwaraeliya DS division. The participants were requested to sort waste separately for collection by the municipality. Different colored bags were provided for the purpose. A questionnaire survey conducted at the beginning and end of the of the study period has revealed that while the willingness to sort out the solid waste at the beginning of the study was 98%, only 87% actively participated in the sorting exercise throughout the three month period and that these people had expressed their willingness to continuously sort out and engage in an integrated waste management program in the future. Asked whether they are willing to carry out household level composting 53.3% have indicated willingness to compost if a compost bin is provided while only 19.17% have indicated willingness to compost if a bin is not provided (Amarananda & Bandara, 2006). Cross tabulations also revealed that the socio economic status has a direct bearing on the participation level of people (Amarananda, 2006).

Hence though composting appears to be most logical and simple way of managing solid waste in the country its success depends on several external factors.

Incineration as a solid waste management option is not an appropriate option for the country due to the very high moisture content and low calorific value of the waste. State of the Art incinerators need to be imported and it is highly capital intensive. At present incineration is used only for clinical waste in the country and are available in several government and private hospitals.

Whichever solid waste option we propose and select, landfilling is essential. Recycling and Biological treatment is possible only for certain types of waste material which is source separated which depends heavily on community commitment which is not forthcoming as yet. Even if incineration is chosen against all odds, the product ash, has to be disposed. Hence, it is rather optimistic to suggest that landfills can be dispensed of. However, the necessity of the state of the art sanitary landfills is debatable. For a sanitary landfill to be financially viable at least 300 tons of solid waste should be disposed there per day (Pilapitiya, 2003). This amount is generated only in the Colombo Metropolitan Area which generates 1200 tons per day (tpd) of which 700 tpd is by the Colombo Municipality alone. About 75% of the Local authorities in the country generate less than 5 tpd of solid waste. These LAS either have to form a cluster and operate a centralized landfill if the transport cost is permitting or else small semi-controlled landfills can be operated for these. This latter option is feasible for many local authorities if organic waste is separated and treated biologically which would reduce the pollutant load (particularly the BOD) of leachate and methane thus requiring less stringent control measures.

Discussion

Municipal solid waste issue in Sri Lanka has reached a level of catastrophe in the country today primarily due to lack of public participation. The entire burden of solid waste handling has been left to Local Authorities most of which are incapable of handling the total amount of waste generated in its area due to financial and resource constraints. Often only the affluent members are served and others are left to take care of their waste. In congested suburban areas like Moratuwa the option taken by those are to dump solid waste by roadsides or abandoned lands. Due to severe scarcity of land majority of the LAs also diligently dispose the collected waste in to wetlands or reservation areas. Hence, irrespective of the culprit solid waste handling is really mismanaged in the country.

Number of initiatives has been taken by the authorities and several governmental and non- governmental organizations to implement integrated waste management practices some of which have been successful such as the recycling centers at Negambo municipality, composting project at Weligama UC and a few bio gas plants operating in the country. The success of these can be mainly attributed to the commitment of the authorities concerned who have got public to participate in these endeavors. A few household level composting projects such as the Galle municipality project are also relatively successfully operating. However, surveys have shown that unless the bins and bags are provided people are not willing to participate in these activities. The success of an integrated solid management program lies entirely on the attitudes and willingness of the community. Unless community members are willing to sort out waste material not a single management technique can be applied. It is unfortunate since given the type of waste we generate in the country a major portion can be easily treated at the household or municipal level if the people are willing.

It should also be noted that controlled landfilling is indispensable for solid waste management since there is always a residual left which needs to be disposed. However, if the amount of organics and recyclables are taken care of, the precautionary measures to be taken in land filling may not be that stringent. In any event sanitary landfilling is economically viable for only the CMR. Hence the best management option for the country is to implement suitable integrated waste management systems in combination with a

controlled or engineered landfill. However, unless community commitment is obtained at least by providing incentives it is doubtful whether efficient solid waste management can be achieved in the country in the near future. Till such time the best option would be to convert the open dumps in the country to at least controlled landfills in order to minimize the serious socio-economic and environmental impacts associated with them. In addition local authorities in Sri Lanka can operate small scale communal composting plants within their administrative areas to ease the situation to a certain extent.

References

Amarananda, A.G. (2006), F*actors Governing and Integrated Solid Waste Management Program,* Thesis submitted as partial fulfilment for M.Sc degree in Forestry and Environmental Management, University of Sri Jayewardenepura.

Amarananda A.G. & Bandara, N.J.G.J. (2006), *Factors governing an integrated solid waste management program: A case study at Nuwara-Eliya District Secretariat Division,* International Forestry and Environment Symposium 2006, University of Sri Jayewardenepura.

Anthony, C.S.C. & Bandara, N.J.G.J. (2008), *A study of the effectiveness of household composting through an evaluation of ongoing composting programs,* Research Comm., SLASS, Anl. Sess.2008, Colombo.

Asian Institute of Technology (2004), *Municipal Solid Waste Management in Asia*, A publication of SIDA funded Sustainable Solid Waste Landfill Project.

Bandara, N.J.G.J., Hettiarachchi, P., Wirasinghe, S.C. and Pilapitiya, S.(2007), *Relation of waste generation and composition to socio-economic factors: a case study*, Environmental Monitory Assessment 135:31-39.

Bandara, N.J.G.J., Kandawinna, K.M.W.G. & Mohotti, K.M.(2004), *Comparison of compost derived from different sources for agricultural purposes*, Research Comm., SLASS, Anl. Sess.2004, Colombo.

Bandara, N.J.G.J. and Hettiarachchi, P. (2003), *Environmental impacts associated with current waste disposal practices in a municipality in Sri Lanka – A case study*, Proceedings of the Workshop on Sustainable Landfill Management. pp 19-27. 3-5.

Bandara, N.J.G.J. and Hettiarachchi, P. (2008), *Environmental Impacts with Waste Disposal Practices in a Suburban Municipality in Sri Lanka*, Accepted for publication In IJEWM (international Journal of Environment and Waste Management", Special Issue: Case studies on landfill diversion of household waste.

Kandawinna, K.M.W.G. (2004), *Comparison of compost derived from different sources for agricultural purposes*, Research dissertation submitted as partial fulfillment for B.Sc Special degree in Forestry and Environmental Science, University of Sri Jayewardenepura.

Ministry of Forest Resources & Environment (1999), *Data Base on solid waste disposed by Local Authorities in Sri Lanka*, Ministry of Forest Resources & Environment, Sri Lanka.

Ministry of Forest Resources & Environment (2000), *National Strategy for Solid Waste Management*, Ministry of Forest Resources & Environment, Sri Lanka.

Ramya Kumari S.M.S. and Bandara N.J.G.J.(2004), *Release of Methane and Carbon Dioxide gases from Municipal Solid Waste land fills in the Colombo Metropolitan region*, Ninth Annual Forestry and Environment Symposium, University of Sri Jayewardenepura.

Samanraja, N.S.P. & Bandara, N.J.G.J.(2005), *Ground water quality affected by municipal solid waste landfills in the Colombo metropolitan region*, Water Resources Research in Sri Lanka, Symposium Proceedings of "The Water Professions' Day" Organized by Board of study in Agriculture Engineering, Post Graduate Institute of Agriculture and Geo-Informatics Society of Sri Lanka, October 01, 2005. pp 179-187.

World Bank (1999), *What a waste: Solid waste management in Asia*, Urban Development Sector Unit, East Asia and Pacific Unit, World Bank, Washington, D.C.