

SAFE AND SUSTAINABLE MANAGEMENT OF MUNICIPAL SOLID WASTE IN KHULNA CITY OF BANGLADESH

M. ALAMGIR^{*}, W. BIDLINGMAIER^{**}, U. GLAWE[°], J. MARTENS^{°°}, L.A. SHARIF[#], C. VISVANATHAN^{###} AND W. STEPNIIEWSKI⁺

**Khulna University of Engineering and Technology, Bangladesh, Department of Civil Engineering, KUET, Khulna 920300, Bangladesh*

***Bauhaus Universität Weimar, Coudraystr. 7, D-99423 Weimar, Germany*

°Asian Institute of Technology, Bangkok, Thailand, 58 Moo 9, Paholyothin HWY Km. 42, Khlong Luang, Pathumthani 12120, Thailand

°°Bauhaus International Research & Education Centre (BIREC), Coudraystr. 7, D – 99423 Weimar, Germany

#Khulna City Corporation, Bangladesh, Nagar Bhavan, KCC, Khulna 920000, Bangladesh

###Asian Institute of Technology, Bangkok, Thailand, 58 Moo 9, Paholyothin HWY Km. 42, Khlong Luang, Pathumthani 12120, Thailand

+Lublin University of Technology, Poland, Nadbystrzycka 40B, 20-618 Lublin, Poland

SUMMARY: This paper presents the outline of a demonstration project that aims to develop a safe and sustainable system for the management of Municipal Solid Waste (MSW) in Bangladesh through the practical application of ‘WasteSafe Approach’. Khulna, the third largest city of Bangladesh and situated at the Southwest region of the country, is considered as the case study area. Target groups of this project are local governments, national governmental ministries, professional engineers, academicians, researchers, civic societies, Non Governmental Organisations (NGOs), Community Based Organizations (CBOs), the private sectors and overall the city dwellers who will benefit directly from an improved safe and sustainable MSW management. The main activities are a specific need analysis based on local conditions, the practical application of WasteSafe proposal and its reality check, the development of acceptable composting technology and appropriate landfill construction method through demo projects, studies on the usability of local construction materials and wetlands for engineered landfills, the development of a waste management master plan, the development of technical guidelines for all tiers of waste management, an assessment system and training, seminar and workshops for different target groups regarding to implement an appropriate waste management system as well as technical assistance and backstopping, dissemination and publications.

1. INTRODUCTION

In the rapidly growing cities of developing countries, urban solid waste management is currently been regarded as one of the most immediate and serious issues for city authorities. Due to inadequate and often inefficient solid waste management and visible environmental degradation, solid waste – generated at an increasing rate – has also become an important environmental issue for the residents of the major cities of Least Developed Asian Countries (LDACs) like Bangladesh. In Bangladesh, the urban population have been increasing at a very steep rate, about 6% and is concentrated mostly in six major cities, where nearly 13% of total population and 55 to 60% of total urban population are living. Management of this steeply increasing vast quantities of solid wastes is a very complex process indeed. Due to severe financial constraints, absence of appropriate technology, lack of people's awareness, motivation and participation, ineffective legislation and law enforcement to protect the environment and to handle the waste, the whole system is becoming a threat to city dwellers, planners and other stakeholders. To ensure a clean, hygiene and environmental-friendly city, the city authority is looking for a safe and sustainable solution for the appropriate management of solid wastes.

WasteSafe, a recently completed European Commission funded research project, having six major cities of Bangladesh and the capital of Nepal as the case study sites, realizes that to have a clean, hygiene and environmental-friendly cities in the LDACs an appropriate MSW management technique based on prevailing socio-economic settings, technological capabilities and present needs of a particular urban area to be considered through participation in a constructive dialogue amongst the concerned stakeholders. This study also critically identified (WasteSafe 2005) the present status and constraints of MSW management of the study areas and proposed an approach to solve this problem putting priorities on some specific areas. It advocates the need of demonstration projects for the reality check of the employed approach for required refinement.

To this endeavor, a three years research project, named as WasteSafe II, funded by the EU-Asia Pro Eco II Programme has been undertaken aiming to develop a safe and sustainable management of MSW in Bangladesh through the practical application and reality check of WasteSafe approach. In this project Khulna, the third largest city of Bangladesh is considered as the main case study area. The key activities are: development of waste management master plan, establishment of sustainable technology for sanitary landfill and composting through experimental plants, practical application of WasteSafe approach in a particular area and formulation of technical guidelines for all tiers of MSW management in Bangladesh.

2. MUNICIPAL SOLID WASTE IN BANGLADESH

Municipal solid waste (MSW) is the heterogeneous composition of wastes that are organic and inorganic, rapidly and slowly biodegradable, fresh and putrescible, hazardous and non-hazardous, generated in various sources in urban areas due to human activities (Tchobanoglous et al., 2002). Its composition, characteristics and generation largely depend on geographical location, socio-economic settings, living standards, food habits and people's awareness. The properties of MSW and its management practice in Bangladesh are described as follows.

2.1 Characteristics of municipal solid waste

Bangladesh, like most of the developing countries, is facing a serious environmental problem due to huge amount of MSW generation and its mismanagement. The study reveals that generation rate is very close in each major city. Overall, the per capita generation varies from house to house depending on the economic status, food habit, age and gender of household

members and seasons. Table 2.1 and 2.2 show the generation of MSW in six major cities of Bangladesh as recorded in the year of 2005 (Alamgir et al. 2005a). The Tables reveal that MSW is generated at a rate of 0.325 to 0.485 kg/cap/day obtained from different sources as 75 to 85% residential, 11-22% commercial, 1 to 1.5% institutional, 0.5 to 1.25% municipal services and 0.4 to 2.5% others. The compositions are 68 to 81% food & vegetables, 7 to 11% paper & paper products, 3 to 5% polythene & plastics and 9 to 16% others.

Table 2.1. Different sources in total generation of MSW in the six major cities of Bangladesh

Sources	MSW generated daily from different sources (%)					
	Dhaka	Chittagong	Khulna	Rajshahi	Barisal	Sylhet
Residential	75.86	83.83	85.87	77.18	79.55	78.04
Commercial	22.07	13.92	11.60	18.59	15.52	18.48
Institutional	1.17	1.14	1.02	1.22	1.46	1.29
Municipal Services	0.53	0.51	0.55	1.24	1.15	0.80
Others	0.37	0.60	0.96	1.77	2.32	1.40

Table 2.2. Generation of MSW in six major cities of Bangladesh

MSW Generation	Dhaka	Chittagong	Khulna	Rajshahi	Barisal	Sylhet
Population (Millions)	11	3.65	1.5	0.45	0.40	0.50
MSW generation (tons/day)	5340	1315	520	170	130	215
MSW generation rate (kg/capita/day)	0.485	0.360	0.346	0.378	0.325	0.430

There is an insignificant variation of composition in MSW at six major cities of Bangladesh. The rapidly biodegradable portion is normally very high compared to other portions, essentially due to the use of fresh vegetables and in absence of food processing industries as revealed in Table 2.3 (Alamgir et al. 2005).

Table 2.3 Physical composition of MSW in six major cities of Bangladesh (in wet weight %)

MSW Composition	DCC	CCC	KCC	RCC	BCC	SCC	Avg.
Food & Vegetables	68.3	73.6	78.9	71.1	81.1	73.8	74.5
Paper & Paper Products	10.7	9.9	9.5	8.9	7.2	8.4	9.1
Polythene & Plastics	4.3	2.8	3.1	4.0	3.5	3.4	3.5
Textile & Woods	2.2	2.1	1.3	1.9	1.9	2.1	1.9
Rubber & Leathers	1.4	1.0	0.5	1.1	0.1	0.6	0.8
Metal & Tins	2.0	2.2	1.1	1.1	1.2	1.1	1.4
Glass & Ceramics	0.7	1.0	0.5	1.1	0.5	0.7	0.8
Brick, Concrete & Stone	1.8	1.1	0.1	2.9	0.1	1.8	1.3
Dust, Ash & Mud Products	6.7	5.1	3.7	6.5	3.1	5.3	5.1
Others (bone, rope etc.)	1.9	1.2	1.2	1.3	1.3	2.8	1.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: DCC- Dhaka City Corporation, CCC- Chittagong City Corporation, KCC- Khulna City Corporation, RCC- Rajshahi City Corporation, BCC- Barisal City Corporation, SCC- Sylhet City Corporation; Avg.-Average;

The wastes contain high portions of volatile solids as 43 to 71%, ash residue as 29 to 57%, high moisture content as 56 to 70%, bulk density as 550 to 1125kg/m³, grain size from 2 to 200mm and pH from 7.7 to 8.7. Average values of some chemical constituents are 11.50% carbon, 0.91% nitrogen, 0.76% potassium and 0.33% phosphorous. The volatile solid contents are measured as 71, 54, 56, 48, 43 and 65%, while the ash residues are obtained as 29, 46, 44, 52, 57 and 35% for Dhaka, Chittagong, Khulna, Rajshahi, Barisal and Sylhet city, respectively.

2.2 Situation of ultimate disposal sites

Despite source reduction, reuse, recycling and composting divert significant portions of MSW, large amount of wastes still need to be placed in landfills. There is no controlled/engineered/sanitary landfill in Bangladesh. The sites are situated in and around the city areas of low-lying open spaces, unclaimed land, riverbanks and roadsides (WasteSafe 2005). DCC operate three sites, namely, Matuail, Gabtali and Uttara; CCC operates two sites, namely, Raufabadh & Haliashahar, while other city corporation, operates one site each, namely, Rajbandh by KCC, Shishu Park by RCC, North Kawnia by BCC and Lalmati by SCC. Crude open dumping sites are always incompatible with the surroundings. Wastes spreads all over the site are unsightly as no proper system maintain for filling the area. Wind blows litter and indiscriminate the dumping waste outside the site and on the surrounding surface water. The study also reveals that every site poses high threat to health and environment as shown in Table 2.4. Details situations are appeared in Alamgir et al. (2005b).

Table 2.4 Potential threat to health and environment caused by the UDS of MSW in Bangladesh

Hazard Point Factors	MTL	GBT	RFB	HLS	RJB	SSP	NKW	LLM
Waste contents	30	30	30	30	30	30	30	30
Rainfall	2	2	4	4	2	4	4	4
Distance to drinking water aquifer	8	8	0	8	8	8	10	10
Site Drainage	8	8	8	4	8	8	4	8
Potential to create leachate at site	4	2	4	4	4	4	4	4
Distance to domestic water source	4	2	2	2	0	4	4	4
Site accessibility	2	4	4	4	4	4	4	2
Frequency of burning	0	0	0	0	0	2	2	2
Site exposure to public & vector	4	2	4	4	4	4	4	4
Public concern over site esthetics	4	4	4	4	4	4	4	4
Total Points	66	62	60	64	64	72	70	72

Note: MTL – Matuail, GBT – Gabtali, RFB – Raufabadh, HLS – Haliashahar, RJB – Rajbandh, SSP – Shishu Park, NKW – North Kawnia, LLM – Lalmati; Low hazard – Points 13 or less, Moderate hazard – Points 14 – 29, High hazard – Points 30 or more.
The relative threat to health and environment was evaluated by Indian Health Service (HIS 1998) report.

2.3 Scenarios of MSW management through recycling and treatment

In Bangladesh, generally recovery/recycling is carried out in three phases. Phase one is the source separation, where the generators separate refuse of higher market value such as papers & paper products, bottles, fresh containers, plastic materials, tin, glass, metal, old clothes, shoes etc. and sell it to street hawkers. In the second phase, the poor children of slum dwellers or street children known as “Tokai” collect different items of low market value from on-site storage bins/containers and open storage spaces. The items include broken glass, cans, cardboard, waste papers, polythene, rags, pet bottles, coconut shells, metals and miscellaneous commercial waste

discarded by householders. The final phase is the recovering of reusable and recyclable materials from UDS. Scavengers/Tokais are salvaging recyclable wastes mainly when collection vehicles are being unloading at UDS. Recycling, reuse and reduce are do not get support from formal authority, even the composting, a great potential sector of waste treatment and minimization considering the nature of MSW in LDACs, fails to reach desired target due improper planning (Ali et al. 2004, Sinha & Enayetullah 2000 and Enayetullah & Sinha 2003).

In Bangladesh is no incineration plant for combustion of MSW. Limited burning units are situated in some cities and at present it is not practices at large scale. Only burning of hazardous waste is done at high temperatures, which comes from different clinics/hospitals in the presence of sufficient air to achieve complete combustion. Generally dry wood and kerosene oil are used for burning. Different shapes and sizes of burning units are present in Bangladesh. A proper segregation scheme for separating hospital waste into hazardous and non-hazardous categories is therefore desired for Bangladesh. This should be coupled with proper separation of hazardous waste and treatment facilities so that co-disposal of hazardous waste with MSW can be avoided.

Small scale composting of night soils and other organic wastes is common in some parts of Bangladesh (Ahmed and Rahman 2000). During the field survey from May 2004 to April 2005, it was found that the composting activities have been initiated as organized base (Pilot-scale type) in six cities of Bangladesh, except Chittagong and Barisal, by different organizations including city corporation, NGOs and CBOs. Mostly the processes adopted in these cities are windrow or active pile system. The barrel or small container composting methods is also introducing particularly in urban slums, colonies, etc. The small windrows or piles of about 3 tons pre-sorted waste mixture are manually formed on a bamboo frame. The bamboo frame is used to increase the passive aeration. Usually the piles are dismantled in every week for remixing and moisture adjustment. After six weeks the raw composts are again piled for final maturation.

2.4 Existing management practices

In Bangladesh, the city authorities generally manage MSW. However, recently, some NGOs, CBOs and private organization work with city authorities. But the situation remains unchanged. The strengths and drawbacks at all levels of the existing wastes management system are identified by Wastesafe (2005). Source storage and separation are done in an informal and uncontrolled means; hardly 30-40% of city dwellers practiced it. NGOs, CBOs and city authorities collect wastes from generation sources by door-to-door collection systems. Door-to-door collection systems are introduced recently for wastes collection from generation sources, mainly from households and dispose the major portion of it to the nearest secondary disposal sites (SDS). Despite very positive impact of primary collection of wastes from source by door-to-door system, the coverage of this system is very slim. City authorities collect these wastes from SDS and transfer it to the ultimate disposal site (UDS). The efficiency of the city authority is very disappointing. There is no special department to handle the situation MSW. Conservancy section, in general is conducting this job along with its other responsibilities such as street sweeping, drain cleaning, street lighting etc. As a result, required attention and efficient management could not be obtained from the responsible department of city authority as required.

3. WASTESAFE APPROACH

WasteSafe proposes a method and evaluation tool to select an appropriate management technique based on prevailing socio-economic settings, technological capabilities and present needs of a particular urban area to be considered for the solution, through structured dialogue among the stakeholders (Chris and Alamgir 2005). Then the sustainability of the selected management options should be checked through the proposed evaluation tools. *WasteSafe* realizes that there is

no "The Solution" for MSW management. The situation should be handled separately as the situation varies city by city, within different regions of the city and even within different parts of the region. The *WasteSafe Proposal* is based on a series of spreadsheets consisting two major headings, (a) Waste System Components and (b) Evaluation Aspects, to form conceptual framework with various options and sub-options. Some areas of immediate priorities are also identified, these are: Sanitary Landfill Cell under the prevailing conditions of the effectiveness by using available local materials and technological capabilities; technical and social aspects of acceptable composting techniques; and containers used at source to contain wastes, suitable method of waste collection from source, transportation and sorting methods.

3.1 Promoting constructive dialogue

All important issues have to be addressed to successfully implemented changes in waste management: not only within technical requirements, but also as regards to economics & finance, legislation & enforcement, institutional and environmental aspects, public awareness, motivation & participation and the roles of concerned stakeholders. However, how could all such factors to be adequately addressed in each municipality, and due regard to all the equally important technical and practical considerations? It is easier said than done. The WasteSafe project puts forward a bold approach to this, in the form of a series of indicative spreadsheets, and a way of using them in assisting constructive dialogue between the various interests. Here the concept of this learning dialogue of 'checks and balances' is first introduced. A better integration can be gradually achieved over time, and this relatively simple WasteSafe 'checks and balances' approach might assist all interested parties to see their interests and contributions set within a wider picture. The WasteSafe team believes the approach could be developed to offer a more advanced and useful practical tool, and ends by proposing its refinement and testing through demonstration projects on recent problem situations in specific urban areas.

3.2 Checks and balances

The WasteSafe approach is to seek the improvement of waste management through: (i) a structured dialogue between stakeholders and (ii) about the planning and implementation of change. It is intended as an adaptable approach, and not an ideal model. Such a dialogue to be structured by using evaluation tools, in spreadsheet form for a cyclic learning process. These successive cycles of dialogue aim to promote desirable checks and balances between the focus and motivation of specific interests and the need for overall integration.

The spreadsheet tools follow a common format: the WasteSafe Reality Check (WasteCheck), which is to be a prompting device to help the user(s) think through problems systematically and holistically and the WasteSafe Action Case (WasteCase), which helps set out more selectively a balanced 'business and sustainability case' for some proposed intervention action(s). The overall conceptual framework, in its simplest form shows Table 3.1

Table 3.1: Conceptual framework for WasteSafe spreadsheets

Waste system components - 'Checks'	Evaluation aspects – 'Balances'			
	SOURCES & STREAMS	COSTS & RETURNS	HEALTH & ENVIRONMENT	COMMUNITY & STRUCTURE
CONTAIN & COLLECT				
SORT & RECOVER				
TRANSFER & TREAT				
DISPOSE & MAKE SAFE				

The row headings as well as column headings may be elaborated to list in greater detail various relevant elements of the waste system, and possible ways of providing them. Aspects of evaluation forming the column headings, indicate in this instance the intention to look at waste streams from several sources, and to consider the merits (cost-wise, health-wise and community-wise) of two scenarios for intervention against a 'no change' situation. It must also be stressed that all these versions of WasteSafe are to be treated simply as examples, which users are free to adapt as appropriate, to best fit their situations. Headings may be amended, added, dropped, or re-ordered to suit the circumstances and perceptions. This is meant to be a flexible approach.

3.3 Integrated systems

If interfaces and connections between elements have been matched for effectiveness and economy, the concerned stakeholders/authorities/communities are said to have developed an integrated waste management system when the functional elements of their waste management services have been evaluated and selected. In general, the situation is very alarming, poses serious health threats to humans and nature, and demands immediate and sustainable solutions. It is seen that several clusters of issues have been identified at this stage, giving rise to questions under various checks (system elements) and balances (aspects of evaluation): The project key activities can be outlined as the followings:

- on the improvement of local collection points and encouraging/enforcing their use;
- on improving the efficiency and reliability of waste transfers from collection points;
- on increasing composting capacity and improving its acceptability and viability;
- on the provision of adequate and safe final disposal facilities;
- on enhancing job opportunities and health conditions for waste workers;
- on ensuring the separate handling and treatment of hazardous clinical wastes.

3.4 Exploring system options

In general, problems and constraints facing the LDACs sometimes seem so overwhelming that there can be a tendency to avoid hard practical choices and blame everything on wider 'political' or 'economic' conditions and uncertainties. WasteSafe exercise have urged all four Working Groups to begin by focusing instead on practical system options, and in particular:

- to go first for those key improvements which might realistically get agreement and begin being implemented in the near future;
- to keep notes of more difficult (if more fundamental) issues, or less central questions, which need to be addressed in due course.

4. THE WASTESAFE II PROJECT

4.1 Background of the project

To have a clean, hygiene and environment-friendly city, the generated MSW must be managed in an appropriate way, which is absent in most of the cities of LDACs including Bangladesh. To solve this striking issue, a twelve month (2004-2005) European Commission's co-financed feasibility study project "*Integrated management and safe disposal of municipal solid waste in LDACs (WasteSafe)*", was conducted by the Department of Civil Engineering, Khulna University of Engineering & Technology (KUET), Bangladesh. The project proposed an approach named as *WasteSafe Proposal* with some specific guidelines. With the analysis and evaluation of practical

application of this proposal, an appropriate MSW management can be established for any specific region. To endeavor this, a three years (2007-2009) Asia Pro Eco II Programme of EC co-financed partnership project *"Safe and Sustainable Management of MSW in Bangladesh through the Practical Application of WasteSafe Proposal (WasteSafe-II)"* has been undertaken by KUET, Bangladesh.

4.2 The target groups and study areas

Local governments, governmental ministries, professional engineers, academicians, researchers, civic societies, Non Governmental Organisations (NGOs), Community Based Organizations (CBOs), the private sectors and overall the city dwellers who will be benefited directly from an improved safe and sustainable management of MSW. The project activities will be conducted mainly in Khulna City Corporation (KCC) of Bangladesh. Assessment and Dissemination of the project outcome will be conducted into other cities of Bangladesh. Some experimental works will be carried out at Thailand.

4.3 Partnership

The partnership consortium with specific responsibility are developed involving the following organizations from both Asian and European countries:

- Khulna University of Engineering & Technology (KUET), Bangladesh; Bauhaus University Weimar (BUW), Germany and Lublin University of Technology (LUT), Poland: these three institutes provide all scientific supervision including scientific staff, experts, background and experience needed to elaborate practical and educational tasks within the project.
- Khulna City Corporation (KCC), Bangladesh: this local government organisation provides technical, social and local support and give needed space for the pilot plants.
- Asian Institute of Technology (AIT), Thailand: this institute carry out the needed experimental part of the project such as Lysimeter tests.
- Bauhaus International Research & Education Centre (BIREC), Germany: this organisation provides assistance by managing and steering of the project.

4.4 Key project activities

The project key activities can be outlined as the followings:

- Practical application & evaluation of WasteSafe proposal in typical city of LDACs (Khulna).
- Development of waste management master plan schemes for typical city of LDACs (Khulna).
- Establishment of an acceptable composting technology considering local conditions through a demo compost plant.
- Construction of pilot sanitary landfill cell based on local materials and wetland conditions.
- Formulation of technical guidelines for the all tiers of MSW management.
- Technology assessment and dissemination through training, workshops and campaign, and awarness build-up among the city dwellers.

Further planned project achievements can be illustrated as:

- Facilitate research contacts between EU and SE-Asian experts in waste management field.
- Facilitate contacts among the relevant Asian and European stakeholders.
- Develop a sustainable European and Asian Waste Management Network (EawmNet).

4.5 Expected results

4.5.1 Expected impact on target group

The research results, the experience in the set up of a demonstration project, the development of technical guidelines and the development of training material will be directed to various stakeholders in the waste management in the LDACs to enhance the waste management standard and to improve the state of the environment. The project will also lead to significant new contacts between Asian and European experts with the potential of establishing future co-operation on academic, professional and commercial levels. On a more practical level, relevant stakeholders in the field of MSW, i.e. environmental agencies, city authorities, NGOs, and the inhabitants of urban areas, will be benefited from the results in the way that it demonstrates to them the potential of modern integrated waste management schemes and adapted landfill construction schemes to improve their daily service provision and life conditions.

4.5.2 Concrete outputs

The main outcome of the project will be the formulation of Waste Management Master Plan for Khulna City, establishment of technical guidelines for all tiers of solid waste management, an acceptable compost technology and appropriate landfill design and their demonstration by a pilot project to support the increasing of the public and institutional environmental awareness and the public healthcare. The establishment of a Competence and Training Centre in Bangladesh (CTCB) is intended as a result of the project. Additionally, a sustainable European and Asian Waste Management Network (EawmNet) will be developed to continue the all kinds of relevant academic and professional knowledge and cooperation from both the sides.

4.5.3 Multiplier effects

Through the internet platform the results of the project will be spread in the specific field of waste management in the target region. Close connections to the national, regional and local authorities in the field of waste management during the project will lead to a deeper understanding of the project approach and a wide dissemination of the project results. The improvement of the local knowledge in waste management through the demonstration effect of the pilot project and the educational measures achieved a wide ranged multiplier effect.

The project has been designed on the local need. It is considered an important instrument for the design and implementation of environmental policy, especially waste management in Bangladesh. The developed technical rules will be the base for implementation of new waste management and landfill concepts and technologies in Bangladesh. The project groups, which will be established during the project will follow up its work after the end of the project. The involved governmental, local and municipal civil servants and executives will disseminate their knowledge to their co-worker and colleagues during their daily work.

4.5.4 Sustainability

The application of a successful working landfill construction considering regional and structural condition, weather and climatic conditions as well as using local building materials will be a good model for the next generation of Southeast Asian urban landfill sites. An exemplary waste management master plan will be developed and can be used as a template for further plans in LDACs. A demonstration compost plant will lead to an appropriate composting technology based on local conditions. Development and implementation of technical guidelines for all tiers of waste management will improve the environmental legislation of Bangladesh. Furthermore,

the governmental, municipality, civil servants and executives will be trained in strategies to develop technical guidelines as well as lecturing environmental issues.

5. CONCLUSIONS

Due to increasing generation of wastes and limited resources for its proper handling, the management of MSW has become an important health and environmental issue for the LDACs including Bangladesh. WasteSafe approach provides an integrated technique for the development of a sustainable technique based on present needs, local socio-economic settings and technical capabilities through structured dialogue among the concerned stakeholders. WasteSafe II demonstration project aims to develop a safe and sustainable management of MSW in Bangladesh through the establishment of a Waste Management Master Plan, a demo compost plant, a pilot sanitary landfill cell, the formulation of technical guidelines, training measures on waste management and the development of an assessment and dissemination system.

ACKNOWLEDGEMENTS

The financial supports provided by European Commission through the projects of Asia Pro Eco Programme (ASI/B7/16-2004/79010) and Asia Pro Eco II Programme (ASIE/2006/122-432) are gratefully acknowledged.

REFERENCES

- Ahmed, M. F. and Rahman, M. M. (2000). Water Supply & Sanitation: Rural and Low Income Urban Communities. ITN-Bangladesh, Center for Water Supply and Waste Management, BUET, Dhaka, Bangladesh.
- Alamgir, M., Ahsan, A., Bari, Q.H., Upreti, B. N., Bhattari, T. N., Glawe, U., Visavanathan, C. and Sthapit, L. (2005a). Present scenario of municipal solid waste and its management. Chapter 5 of Integrated Management & Safe Disposal of MSW in LDACs: a feasibility study, Alamgir, M., McDonald, C., Roehl, K.E. & Ahsan; M., Ed., KUET, Bangladesh, 135–228.
- Alamgir, M., Mohiuddin, K.A.B.M., Bari, Q.H., Upreti, B. N., Bhattari, T. N. and Roehl, K.E. (2005b). Present scenario of ultimate disposal sites of the study areas. Chapter Six of Integrated Management and Safe Disposal of MSW in LDACs: a feasibility study, Alamgir; M., McDonald; C., Roehl; K.E. and Ahsan; M., Edited, KUET, Bangladesh, 229–280.
- Ali, M. (2004). Sustainable Composting. Water, Engineering and Development Center (WEDC), Loughborough University, UK. ISBN No. 1843800713.
- Enayetullah, I. and Sinha, A.M. (2003). Decentralized Composting- Through Public-Private-Community Partnership: Experience of Waste Concern. 1st Ed. Waste Concern, Dhaka.
- McDonald, C. and Alamgir, M. (2005). Evaluation and selection of integrated management systems. Chapter Eight of Integrated Management and Safe Disposal of MSW in LDACs: a feasibility study. Alamgir; M., McDonald; C., Roehl; K.E. and Ahsan; M., Edited, WasteSafe, KUET, Bangladesh, 325–383.
- Sinha, A.H.M.M. and Enayetullah, I. (2000). Study on Resource Recovery from Solid Waste in Khulna City. Water and Sanitation Program South Asia, Dhaka, Bangladesh.
- WasteSafe (2005). Integrated Management and Safe Disposal of Municipal Solid Waste in Least Developed Asian Countries: A feasibility study. Alamgir; M., McDonald; C., Roehl; K.E. and Ahsan; M., Edited, WasteSafe, KUET, Bangladesh.