

# Debris Management in Sri Lanka

*CORDAID 312 /10085 A*



## **Tsunami Reconstruction 7**

### ***Project Report***

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## LIST OF ACRONYMS

°C	Degree Celsius
CEA	Central Environment Authority
CBO	Community Based Organisation
d	Day
Dia	Diameter
DS	Divisional Secretariat
EIA	Environmental Impact Assessment
H	Height
hr	Hour(s)
HDPE	High density poly ethylene
kg	Kilogram
l/s	Litres per second
m	Meter
m/s	Meter per second
m <sup>3</sup>	Cubic meter (1000 litres)
mg/l	Milligrams per litre
No.	Number
NGO	Non-governmental Organisation
PVC	Polyvinyl chloride
SLR	Sri Lanka Rupees (160 SLR is about 1 €)
UNEP	United Nations Environment Programme

## FOREWORD

The project started as a response to the disaster that struck Sri Lanka on the 26<sup>th</sup> of December 2004. Based on request on the Central Environment Authority an assessment was made of the solid waste situation caused by the Tsunami in the coastal zones of Sri Lanka. The first assessment – partially supported by CORDAID – resulted amongst others in debris management guidelines issued by the Central Environment Authority end of January 2005.

In the course of 2005 it became clear that many organisations quite rightly at that time focused on immediate relief efforts, but much less attention was given to longer term reconstruction efforts. Waste management systems that were not very well functioning before the Tsunami had collapsed and in relief it was noticed as an important area so as to prevent outbreak of diseases and other human health related areas, but hardly ever as a reconstruction area. At the same time there was a widely voiced demand for show-how projects as there was very little practical experience as to how things could be improved.

This was the background to the current project. As much as possible show how projects and initiatives would be undertaken that would not only target local needs but also be essential building blocks of reconstruction efforts. As needs were so high, a relatively large number of projects were identified by local counterparts. Our aim was therefore to assist these counterparts with technically correct guidance that would make their interventions sustainable in all aspects, institutional, financial etc.

As the lack of knowledge and expertise about waste management was one of the striking factors, it was also deemed critical that efforts would be undertaken to share knowledge and disseminate whatever projects were implemented to a much wider audience. This is the background to this series of project reports.

The following areas were tackled and similar reports are available on each of these subjects: sanitation management; hospital liquid waste management; hospital solid waste management; solid waste management; wastewater management; faecal sludge management; debris management and composting.

By no means these are the last words that can be said about any of these subjects. In the case of health care waste management, final disposal remains a critical issue, in case of hospital waste water management, we believe we have made an appropriate design for a waste water treatment plant after a very elaborate consultative process with the client, but this still has to be built, in the case of debris management, the delay between project conception and the final approval proved too long, by then most of the debris in Kalmunai had disappeared and in Hambantota it was only those partially damaged buildings that were still standing that constituted debris, so it has become much more of a theoretical exercise than what we would have liked. Yet we do believe it is important to document what can be done with debris in case a next disaster strikes. Solid waste management is very diverse, from plastic recycling (two projects) to landfill improvement, solid waste management policy and strategy advocacy, setting up a national platform, feasibility studies for gasification of waste (and once it turned out to be not viable) stopping this initiative etc. Solutions for faecal sludge management are still a priority for organisations working with internally displaced persons in the Northern and Eastern Provinces of Sri Lanka (though from an environmental point of view we would suggest that it should be the entire country), we believe we have managed to significantly improve an existing design for a faecal sludge treatment system. Yet till today, the UN agency that wishes to implement this together with the municipal council of Kalmunai are still struggling to actually implement it. In case of Hambantota - as there is an existing site and additional VNG funds - the implementation of a different design is just beyond the current project period.

Valentin Post, December 2007

## **ACKNOWLEDGEMENTS**

WASTE would like to acknowledge the support of Energy Forum (Asoka Abeygunawardene) and particularly Chinthaka Jayarathne.

The earlier efforts in quantification of amount of debris by Mr. Frank Kempeneers and Jan Willem van Daalen are well appreciated. Also the effort made by Henk Klein Teeselink in identifying a potential entrepreneur, Mr. Umar of the Southern Construction Company, in Hambantota, though in the end coming to naught, is appreciated. Also a special thanks to CARE for sharing their findings with us and based on our request presenting their experience in a report.

Furthermore I would like to put on record the well appreciated efforts made by my colleagues Lilliana Abarca and Ivo Haenen in providing general information on possibilities of recycling in the construction sector respectively giving vital contributions to the organisation of the series.

Valentin Post, December 2007

# **CHAPTER 1 INTRODUCTION TO CORDAID SRI LANKA PROJECT AND THIS DOCUMENT**

## **1.1 Background of the project**

After the Tsunami struck Sri Lanka in December 2004, waste management systems virtually collapsed and waste was disposed of indiscriminately. The local authorities were faced with a post-tsunami situation which was beyond their resources. This led to unplanned coastal zone dumping practices, poor urban environment planning, substandard water management and sanitation practices and a general waste of resources.

The project “Rapid implementation of community based short and middle term measures to improve the functioning of solid waste management in Tsunami affected areas of Ampara and Hambantota districts” was approved by CORDAID on March 1<sup>st</sup> 2006.

As of such, the project team arranged interventions in the following thematic areas:

- ◆ Health care solid waste management (Report series 1);
- ◆ Faecal sludge management (Report series 2);
- ◆ Master Composting (Report series 3);
- ◆ Solid waste management: Policy and Strategy (Report series 4);
- ◆ Health care liquid waste management (Report series 5);
- ◆ Plastic recycling (Report series 6), and
- ◆ Debris management (Report series 7).

## **1.2 Objective of this document & intended audience**

The project team felt a strong need to express and share the lessons learned from the project interventions. So the purpose of this document is provide thematic and practical knowledge on improving solid waste management and sanitation systems, in reconstruction efforts. However, we also see that this document has value in ‘ordinary’ development initiatives that aim on improving these environmental management aspects.

WASTE has prepared a similar document for each of the project interventions described in the first paragraph of this Chapter. The documents can be obtained electronically from the website [www.waste.nl](http://www.waste.nl).

## **1.3 Structure of the document**

Chapter 2 provides general information on debris management, and can be used as a very general basis for further developing guidelines for re-use and recycling of debris in post-disaster areas. Chapter 3 gives the project objectives, results as described in the Logical Framework, and the project activities. Chapter 4 explains the difficulties that the project team encountered with implementing activities related to debris management, and provides some examples of how other projects used debris for reconstruction in post-tsunami Sri Lanka. Chapter 5 reflects on the situation with conclusions and recommendations.

## CHAPTER 2 DEBRIS AND CONSTRUCTION WASTE UTILISATION

### 2.1 What can be done with the debris?

Debris can be recycled or reused in construction processes, with a positive impact on savings of natural resources, efficient use of materials, reduction of volume and area needed for disposal. This however depends on site practice and whether waste management has been prioritised or not.

Material reuse can take a number of forms:

1. The *high value use* of material in a similar application e.g. secondary use of a window frame, or in a different application e.g. the use of secondary bricks for paving
2. The *low value use* of material in a similar application e.g. the use of a crushed concrete road surface as a road sub layer or in a different application e.g. the use of wood off-cuts as shutters.

In terms of recycling, metals have the highest recycling rate. Plastics, glass, cardboard and paper have mature industries that can readily absorb salvaged materials. Concrete, brick and masonry (building rubble) recycling is perfectly feasible but may not be extensive in some areas.

Some of the issues that need to be considered during the planning of material specific reuse and recycling after a natural disaster include:

1. Coordination of the responsible entity in charge of the tasks related to debris management
2. Providing for the separate storage of recyclables on site
3. Estimating the quantities of each type of material that are on site
4. Determining recycling opportunities for various waste materials in the locality of the disaster
5. Determining associated costs relating to waste collection, transportation and waste disposal
6. Training the sorting labour crew on waste management.
7. Material specific considerations, if hazardous, heavy, polluted, among others

Based on the debris composition, possible re-use or recycling of the materials are presented:

#### 2.1.1 *Wood*

Although timber is a natural renewable resource and as such may have a low environmental impact, a greater amount of recycling and reuse will obviously be beneficial. All off-cuts and damaged wood is stored centrally in a safe place. Nails can be removed manually prior to recycling or re-using. Applications for salvaged wood include: reuse for new houses or improvements of damaged ones, landscaping, compost, boiler fuel or engineered building products

#### 2.1.2 *Ferrous metal*

There is a highly developed market for ferrous metal recycling all over the world. It is by far the most profitable and recyclable material. Demand for ferrous metals is well established and recovery and recycling is widely practiced. Preferably, steel should be reused directly. If it is unsuitable for direct reuse, it is melted to produce new steel. Steel organization reports that

100% steel reinforcement is made from recycled scrap and 25% steel sections are made from recycled scrap. Scrap steel is almost totally recycled and allows for repeated recycling.

### 2.1.3 *Non-ferrous metal*

The main non-ferrous metals are: aluminium, copper, lead and zinc. Once sorted, products can be reused for new houses or improvements of the damaged ones or sold to scrap metal merchants for recycling or directly to end-users by melting.

### 2.1.4 *Concrete, bricks and masonry*

Building debris generated is easily reusable and recyclable. It is important to keep waste materials separate and ensure that contaminants are minimal. Debris can be reused on- or off-site for applications such as site leveling, backfill, landscaping and landfill engineering. Debris can also be recycled on- or off-site either separately i.e. concrete recycling or mixed i.e. rubble recycling to produce recycled aggregates. Recycling plants vary in size (i.e. from about 300 to above 1000 tonne/day) and type (i.e. stationery or mobile). Some applications of recycled aggregates include road construction, foundations and recycled aggregate concrete.

### 2.1.5 *Glass*

If glass is not broken it can be used in new houses or in damaged ones. If broken it can be recycled into fibreglass as very fine material, for cement replacement, as paving material mixed with asphalt or cement, and as aggregate in concrete.

### 2.1.6 *Asbestos*

Asbestos from roof panelling should be kept separate. Asbestos panelling is not a health problem unless it is being sawed or crushed. Due to crushing during shovelling and transport, asbestos fibres are spread in future living spaces and playgrounds. This may cause a serious long-term health threat to the local people, therefore it is important to keep it separate.

### 2.1.7 *Sand and mud*

Sand can be used for covering material for disposal sites.

### 2.1.8 *Summary of recycling debris components*

**Table 1 Summary on the experiences on technology of debris recycling practices**

Debris	Recycling practice	Recycled product
Wood	Reuse directly	Whole timber
	Cut into aggregate	Furniture
	Chopping	Source of energy
Ferrous metal	Reuse directly	
	Melt	Recycled steel scrap
Non-ferrous metal	Melt	Recycled metal
Concrete	Crush into aggregate	Recycled aggregate
		Cement replacement
		Backfilling
		Filler
Bricks	Crush to aggregate	Filling material
Masonry	Crush into aggregate	
Glass	Reuse directly	Window unit
	Grind to powder	Glass fibre
		Filling material

Debris	Recycling practice	Recycled product
		Tile
		Asphalt
		Cement replacement
		Paving block

## 2.2 Key issues with debris management in the South

### 2.2.1 Health and environmental issues

The impact of debris disposed in an uncontrolled way can have a negative impact in the quality of the surface and groundwater due to contamination with a trace of hazardous chemicals such as organic compounds from paints, adhesives as well as pollution with non-hazardous materials such as chlorine, sodium, sulphates, and ammonia resulting from leaching of this debris.

In different places solid waste is used to fill low-laying marsh fields, creating new land. This leads to contamination of soil, ground water and surface water, pollution that can reach drinking water wells.

Another practice in the South is that citizens burn their waste in the open air introducing dioxins and furans due to the combustion of plastics.

### 2.2.2 Institutional issues

The municipalities have the responsibility for solid waste management and often don't have the expertise in the topic. Many CBOs and national and international NGOs don't have information or experience on how to deal with debris management in periods of emergency.

Expertise, related to waste management issues in emergency times, exists within the CEA but they do not have the mandate to deal with these aspects of solid waste management at a local level.

### 2.2.3 Legal issues

The Central Environment Authority (CEA) – aided by the preparatory phase to this project - has issued debris management guidelines within one-and-a-half month from the Tsunami. Unfortunately these guidelines seem to be little known to local authorities, CBOs and (I)NGOs. The debris guidelines are attached as Annex 2.

### 2.2.4 Financial issues

The uncontrolled disposal of construction debris can lead to huge economic losses due to aesthetics especially in tourist areas and the lack of possibilities for recycling or reusing of the useful materials, recuperating part of the financial losses due to the Tsunami.

### 2.2.5 Socio-cultural issues

Debris management is an essential part of in reconstruction. There have been several programmes that have used the cash for work approach in clearing debris. Clearance of debris may have a positive social impact, though there is scant evidence from these projects.

## CHAPTER 3 PROJECT OBJECTIVES & OVERVIEW ACTIVITIES

### 3.1 A need for Debris Management in Post-Tsunami Reconstruction

#### 3.1.1 Why debris management in post-Tsunami reconstruction?

As UNEP in 2005 states very clearly in a National Rapid Environmental Assessment: “Debris management and waste disposal is a significant weakness in the international response to disaster.”<sup>1</sup>

As such, debris clearing on a short term is very important for both social and environmental reasons.

#### **Social**

- ◆ To enable property rebuilding activities
- ◆ To enable road building activities
- ◆ To clear the visible impact of the Tsunami

#### **Environmental**

- ◆ To enable re-use of bricks, concrete and wood as building materials (preferable option)
- ◆ To enable re-use of brick, concrete as road basement or basement for concrete floors
- ◆ To properly separate and dispose asbestos (preventing spreading of asbestos fibres)
- ◆ To properly dispose rubble and remaining fractions at allocated disposal sites (preventing spreading of waste)

According to UNEP: “Emergency efforts in Sri Lanka have resulted in haphazard disposal of rubble along roads, in open fields, into drainage ditches, low lying lands and waterways, including beaches. This is likely to cause long-term problems by clogging waterways and polluting beaches. Burning of debris is also evident in certain areas but impacts air quality, and the CEA has ordered it stopped.”<sup>2</sup>

It is important to mention that the Central Government of Sri Lanka had forbidden for a large part of 2005 any building activities within the 200 m zone, to prevent new catastrophes in case of future Tsunamis. This rule had a significant impact on the debris clearing within that zone. The original owners had no interest in clearing their former lands; the government had neither budget nor urgency to clear it up because no re-building was taking place there and besides debris was dumped there. A central government policy for a general clean-up of the 200 meter zone was lacking and the policy is very unpopular.

Demolishing damaged houses and clearing the 200 meter zone will probably meet severe opposition from the local people. A problem was for the houses that were partly destroyed. Many owners started to rebuild their houses within the 200 meter zone and there seems to be no government control on these activities. This situation will most probably result in a situation designed by coincidence:

- ◆ 200 meter zones which have been completely destroyed will not be rebuilt;

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<sup>1</sup> United Nations Environment Programme (2005) National rapid environmental assessment, Sri Lanka, UNEP, Geneva, p. 74

<sup>2</sup> Ibid. p.76

- ◆ 200 meter zones which have been partially destroyed will become subsequently rebuilt by the original owners.

Outside of the 200 meter zone was dependent on the co-operation of the original owners. Without consent of the owners no organisation could remove the debris from the privately owned lands, therefore debris clearing was entirely based on small-scale activity by the owners and 'illegal' brick scavengers.

### **3.2 Objectives and results**

The logical framework of the debris management intervention formulates the following objective and results.

Overall objective:

An appropriate debris management strategy in target areas. There is a clear and practical demonstration project how to recycle debris, provide employment and empowerment to local people on sustainable (private sector) footing in areas of Hambantota district by June 2007.

The overall result is: An estimated 200 mostly informal or formal sector individuals earned livelihoods in debris recycling (metal). Less useable materials remain however; these have secondary uses in construction industry.

Specific results are:

1. Visible and clear demonstration on recycling of debris in Hambantota district whereby supply chain will be formed by 30 affected people who will collect and segregate debris and supply to construction company. Debris waste picking, waste and recyclables collection, recycling processing, and related activities will generate income for affected population on the one hand and at the same time the amount of waste deposited (unsegregated debris) will be much less. It will be investigated if these structures can be modified to deal with general waste after all debris has been cleared.
2. Awareness raised on practical options for reuse / recycling of debris. Awareness raising is sequenced by ISWM training for main stakeholders (see Objective 1) added with locally active CBOs and NGOs in debris resulting in 200 people gaining innovative sources of revenue.

Annex 1 provides the Logical Framework of the project, related to debris management.

### **3.3 Overview of activities**

This document is mainly based on information from the field. Table 3 gives a broad impression of important moments and activities of the project

**Table 2 Overview of project activities in Sri Lanka related to debris management**

Time	Activity	Carried out by
March 2006	CORDAID approves project prepared by WASTE- start of project	
September 2006	Implementation programme agreed with entrepreneur: Mr. Umar to obtain lease deed. EF / WASTE to assist Mr. Umar in preparing of feasibility report (technical data will be provided by Mr. Umar). EF / WASTE to assist entrepreneur in identifying financing. Implementation possibly using service of local specialist and monitoring. Preparation of key sheet	WASTE/ EF
November 2006	Joint time frame (see below)	WASTE/EF/Mr. Umar
December 2006	Draft memorandum of understanding	WASTE/EF
January 2007	Lease deed	EF
February – September 2007	Exploring working with other local construction companies	EF
December 2007	End of project	

As programme with entrepreneur did not move forward, it was jointly agreed to derive at a common time frame covering the period 11 November 2006 – 31 January 2007 (see Table 3). Mr. S. Umar (Southern Construction Company), Chinthaka (project manager Energy Forum), Valentin Post (WASTE).

The project team identified the objective as:

to recycle and reuse debris in Tsunami affected area of Hambantota. Debris in Hambantota refers to Tsunami demolished houses which are still partly standing and which need to be demolished by Urban Development Authority and the Urban Council. Amount of debris suffices for a 3 – 4 year operation, after which the operation can continue with normal raw material. Number of employees will be 15.

The following time table was discussed upon and agreed as being realistic.

**Table 3 Common time frame developed by WASTE, Energy Forum, Mr. Umar (Southern Construction Company)**

Period	Planned Action
11 November 2006 – 10 December 2006	<ol style="list-style-type: none"> <li>1. Umar contacts Earnest &amp; Young for preparation of the project report in a bankable format and request for a quotation.</li> <li>2. Energy Forum will draft the financial contract between Energy Forum and Southern Construction Company</li> <li>3. WASTE will review the contract and comment upon it.</li> <li>4. Energy Forum will draft the operational contract between Hambantota Urban Council, Urban Development Authority, Energy Forum and Southern Construction Company.</li> <li>5. WASTE will review the contract and comment upon it.</li> <li>6. Report of Earnest &amp; Young will be reviewed by Energy Forum, who will sent it to WASTE for further review.</li> <li>7. Signing of financial contract Energy Forum and Southern Construction Company.</li> </ol>
11 December 2006– 10 January 2007.	<ol style="list-style-type: none"> <li>1. Submission of report to the bank.</li> <li>2. Southern Construction Company will obtain lease deed. pay</li> <li>3. Signing of contract between</li> <li>4. Starting of land preparation.</li> </ol>
11 January 2007– 31 January 2007.	<ol style="list-style-type: none"> <li>1. Obtaining bank loan</li> <li>2. Starting operation</li> </ol>

A feasibility report was prepared by Ernest & Young, but this was done in the local language Sinhala. A translated copy was never made available by the entrepreneur and we considered it his part of the arrangement. A draft lease deed was prepared by Energy Forum but this was not supported by a feasibility report.

Meanwhile, Energy Forum learned that Mr. Umar had acquired more contracts than he could handle and he had to focus on one assignment for the Urban Council to avoid being blacklisted.

Energy Forum contacted several other entrepreneurs in and around Hambantota but it was not able to come to terms with any of these.

Hence, the subsequent sections of the report is based on activities undertaken by others, which is one of the objectives of the project, to highlight successful examples for others, so this can be part of the national knowledge base.

## CHAPTER 4 MANAGEMENT OF DEBRIS IN POST TSUNAMI SRI LANKA

### 4.1 Introduction to this Chapter

Following a 9.0 magnitude earthquake off the coast of Sumatra, a massive Tsunami struck Sri Lanka on 26 December 2004, killing over 30,000 people. In Sri Lanka, between 31,000 and 37,000 people were killed by drowning or debris impact, and nearly 100,000 houses were destroyed, along with tens of thousands of vehicles and much infrastructure. The devastations was particularly massive in the Eastern and Southern coastal belt (see Figure 1). The massive devastation resulted in large amounts of debris, which community had never experienced before.

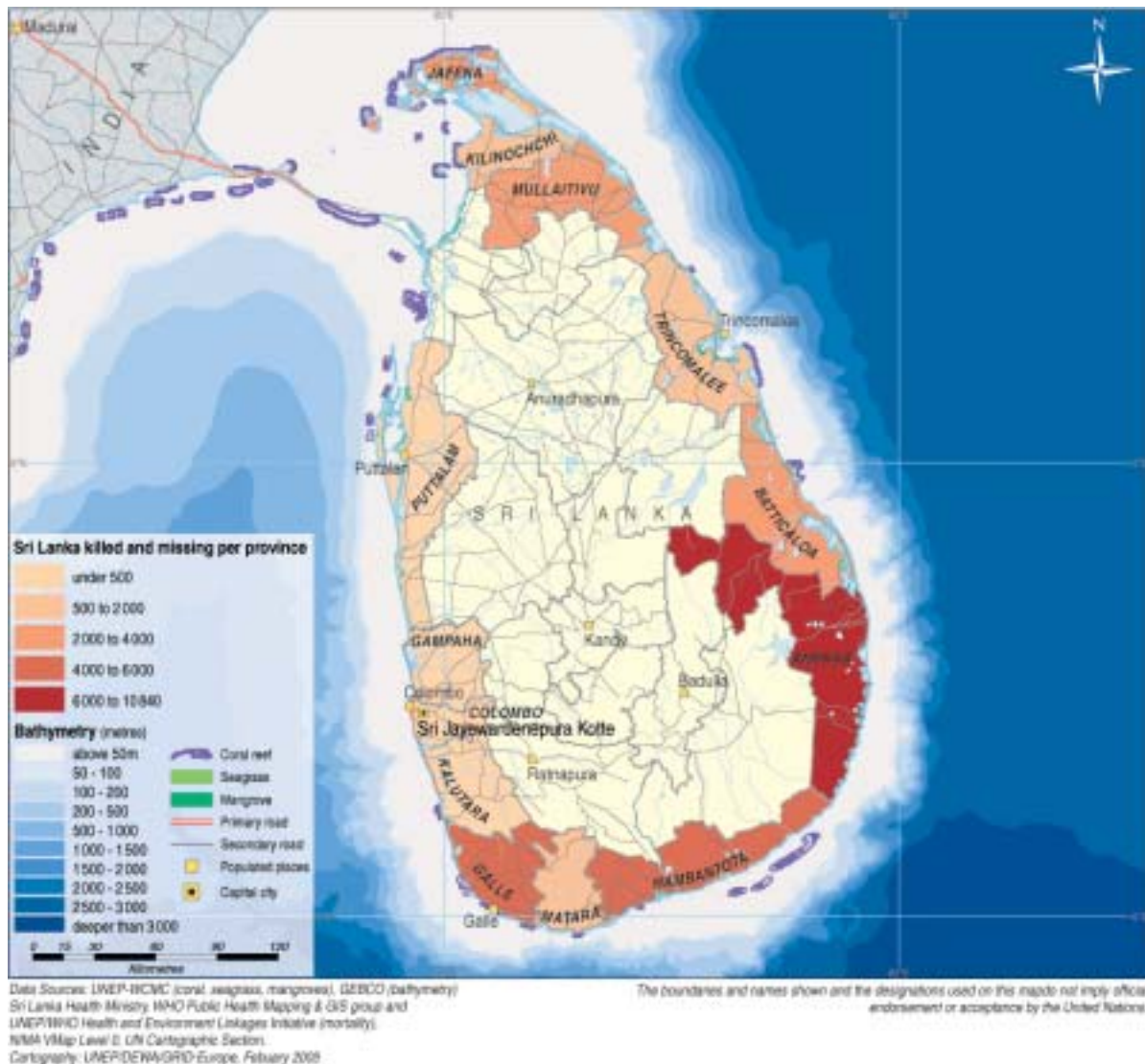


December 26, 2004



January 1, 2004

**Photo 1** Extent of damage caused by the Tsunami



**Figure 1 Overview of casualties per district in Sri Lanka**

## 4.2 Debris post-Tsunami Sri Lanka

Construction waste reutilization is an application developed from the necessity of rebuilding cities after wars or natural disasters. One needs to think in terms of the collection, transportation and final disposal of the waste produced by the total or partial destruction of buildings or civil infrastructure (such as roads, electricity polls, bridges), in this case during the Tsunami.

The reports provided after the visit to the tsunami areas, showed two categories according to the degree of damage caused by disaster: completely or partially damaged:

- ◆ *Completely damaged:* buildings that were completely razed to the ground into huge mounds of rubble
- ◆ *Partially damaged:* buildings with some parts left still standing. This category could be classified as severely damaged: with irreparably damaged structural elements and needed to be demolished, moderately damaged: buildings with some structural and other damage rendering them unsafe, if not uninhabitable and slightly-damaged structures: buildings with damaged glazing and/ or superficial cracks that were repairable.

The debris reported included no hazardous waste such as: plywood and wood, bricks, concrete, beams, corrugated iron sheets, sand and mud, and potential contaminating material as asbestos.

#### 4.2.1 Sri Lankan statistics on debris

Several studies have been conducted to develop statistics on debris in Sri Lanka. When a single story building is demolished it generates 0.34 cubic meters of waste per one square meter. This figure becomes 0.73 m<sup>3</sup>/m<sup>2</sup> for a 2 stored building.

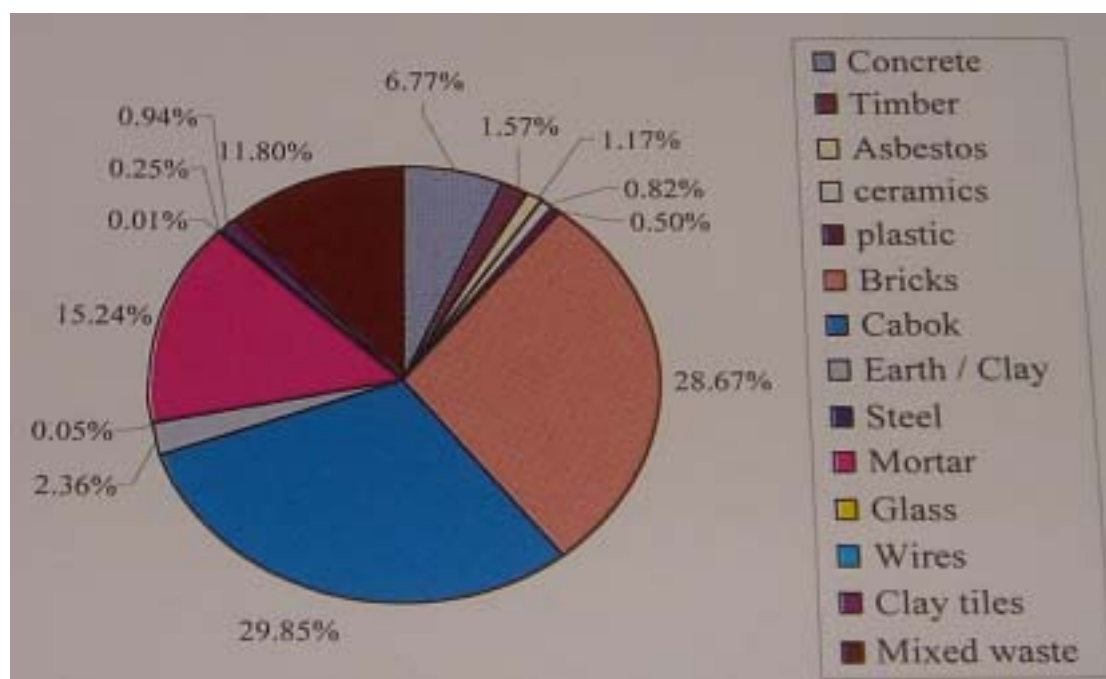


Figure 2 Debris composition in Sri Lanka

Table 4 Estimated debris in Ampara district<sup>3</sup>

District Division	Number of houses, before the disaster	Number of houses, completely damaged	Number of houses, partially damaged and cannot be used	Number of houses partially damaged and can be used	Number of houses, not damaged	Debris in tonne	Debris in m <sup>3</sup>
Karativu	2976	1023	315	629	1009	18741	22490
Ninthavur	2693	642	255	821	975	13010	15612
Sainthamaruthu	3706	903	378	1594	831	18851	22621
Lahugala	403	7	2	46	348	195	234
Akkaraipattu	1989	189	96	677	1027	4504	5405
Alayadiwembu	371	197	52	64	58	3161	3794
Addalachchenai	1990	217	30	552	1191	5923	7107
Pothuvil	3374	1017	189	727	1441	17076	20491

<sup>3</sup> Report of Jan Willem van Daalen using the estimates from Frank Kampeneers, April 2005

District Division	Number of houses, before the disaster	Number of houses, completely damaged	Number of houses, partially damaged and cannot be used	Number of houses partially damaged and can be used	Number of houses, not damaged	Debris in tonne	Debris in m <sup>3</sup>
Thirukkivil	3559	1454	490	626	989	24379	29255
Kalmunai Muslim	5216	1788	503	1972	953	34072	40886
Kalmunai Tamil	4262	1875	360	1219	808	30401	36481
<b>Total</b>	<b>30539</b>	<b>9312</b>	<b>2670</b>	<b>8927</b>	<b>9630</b>	<b>170313</b>	<b>204376</b>

**Table 5 Estimated debris from affected houses alone in Hambantota**

City	Inhabitants	Houses completely destroyed	Houses partially damaged	Debris in tonne (from houses <sup>4</sup> alone)
Hambantota	5,500	500	500	2,250

Initially few people knew what to do with debris except dumping. But ultimately, several communities, with support of (inter)national aid found their own method of handling. These consisted mostly out of:

- ◆ Dumping (see Photo 2 and Photo 3), in a low lying area for landfilling, with or without soil cover on top;
- ◆ Landfilling in household yards;
- ◆ Using debris to rebuild roads (see Photo 4 and onwards).

<sup>4</sup> Calculation of the weight of an average house in Sri Lanka yields a figure of about 7,000 kilograms of brick, cement and roofing material for well-built ones and 2,000 kilograms for a cruder 'fisherman's house'. Since the latter were far more vulnerable than the former, both in terms of location and strength, an average among the almost 100,000 homes destroyed might be about 3,000 kilograms, or 300 million kilograms in total, to which would need to be added the weight of debris from 43,600 damaged houses as well as lost household goods and furnishings, shops, tens of thousands of vehicles and boats, fallen trees, destroyed roads, bridges, culverts, etc., a total that must have exceeded another 200 million kilograms in addition and perhaps far more. The disposal of these 500+ million kilograms of rubble and waste material is proving to be a huge issue because of the sheer volume and associated costs. (UNEP 2005, p 67)



**Photo 2 Dumping debris-Hambantota (Energy Forum)**



**Photo 3 Debris site – Hambantota (Energy Forum)**

The Central Environment Authority (CEA), technically assisted by the preparatory phase of the current project, issued debris management guidelines within one-and-a-half month of the Tsunami (see Annex 2).

Clearly much more could have been done with the debris as outlined in Chapter 2. Also, UNEP writes in their Rapid Environmental Assessment, in 2005:

*“The systematic and environmentally-friendly disposal of the construction debris is a major challenge, made worse because the local authorities in most affected areas do not provide a solid waste management service, and therefore lack relevant capacity and technical knowledge. Of those few bigger cities that do have the knowledge, none has an engineered landfill. The need therefore is to find creative and innovative responses to the problem.*

*One step would be to encourage, and perhaps pay people, to salvage recyclable and re-saleable materials such as steel reinforcement rods, timber and bricks. This process has been initiated by people themselves in some areas and should be promoted more widely, giving families more time to salvage useful material for resale or for rebuilding their houses.*

*Managing the large volumes of residue needs expert guidance. Engineered landfills are a possibility, and other suggestions include using building debris as base material for road construction, and in building sea walls, and dunes, an artificial coral reefs, and community refugee mounds. Debris management and waste disposal is a significant weakness in the international response to disaster. A possible approach is to motivate, mobilize and equip local people in the immediate aftermath of disaster through the immediate delivery of goggles, masks, boots, gloves, sacks, guidance manuals in local languages, and money with which to hire able-bodied people. Mobile laboratories equipped to detect contamination by the most dangerous chemical families would also be useful in such circumstances. Local and/or community radio stations can help to augment the flow of locally-relevant information, and pre-recorded audio tapes may provide early information content and guidance to affected people.<sup>5</sup>*

<sup>5</sup> United Nations Environment Programme (2005) National rapid environmental assessment, Sri Lanka, UNEP, Geneva, p. 74

### 4.3 Clearing debris in Hambantota

In Hambantota, other than Mr. Umar, a Southern Construction Company, none considered recycling or resource recovery of debris. However, several institutions, a combination of the municipal council, with support of (international) NGOs, were able to clear the Tsunami affected area from debris (see Photo 2 and Photo 3). Together, these institutions disposed the debris in a temporary dumping site for different types of waste.

### 4.4 Clearing debris in Ampara

The Tsunami destroyed many houses and roads in Ampara district, and caused the most casualties among other districts in Sri Lanka (see Figure 1). There was a need to clean and separate the debris and waste from the environment soon after the disaster, while affected people suffered without money for their basic needs.

At that time, the NGO Care International began to work on clearing debris with the participation of the affected community people. Initially they were provided Rs. 350 per person per day (about €2.30) according to the labour law rate, later the amount was increased as Rs. 400 per person, equally provided to women and men.

Care International was involved in this programme in Kalmunai Tamil, Kalmunai Muslim, Sainthamaruthu, Ninthavur, Karaitivu, Thirukkivil and Pottuvil DS divisions. When they worked in Maruthamunai village, a Kalmunai Muslim DS division, CARE International discovered that large amounts of debris and other waste was dumped at a site close to the area where people lived. As a consequence, these were affected by the communicable disease due to the environmental pollution.

So Care International was requested by the community to support disposal of the waste elsewhere. Then debris is spread in the same place and compacted, after that proper soil was put on the earth and fill the gaps, using machineries. Now that place is being used as a playground for the area. This was seen by the local community as a very successful solid waste management project.

### 4.5 Road rehabilitation, Ampara District

After completing the waste project above, and still seeing plenty of debris around, Care International planned to reconstruct the internal roads through cash for work program in the most tsunami affected divisions. Plenty of roads were badly affected by the Tsunami. According to the plan 400 km of road was constructed in 10 DS divisions. Machines were used to deliver materials and to compact the debris into useful road construction material. People worked as unskilled labour. Table 6 provides the DS divisions and the respective kilometres of road rehabilitated.

**Table 6 Kilometres of road rehabilitated per DS**

Name of the DS division	# of km of road completed
Karaitivu	42
Ninthavur	41
Kalmunai south	15
Sainthamaruthu	13

Kalmunai North	73.5
Akkaraipattu	29
Addalachenai	39
Aalayadivembu	11
Pottuvil	79.5
Thirukkovil	57
<b>Total</b>	<b>400</b>

Totally 73,873 numbers of days work were provided. In total, 55,654 male and 18,219 female participated in these activities. Through these activities, the participants generated some income, supported a cleaner environment, and provided help in rehabilitation of roads.



**Photo 4 Road under construction with debris (Energy Forum)**



**Photo 5 Road constructed by using debris in Kalmunai (Energy Forum)**

Activities were carried out with the collaboration and coordination of the relevant authorities.

**Table 7 Details and calculations of road construction in Ampara**

<b>Calculations:</b>	
No of working days (days)	73,873
Day rate (SLR)	400
Total expenses (salary) (SLR)	29,549,200
Total length of the roads (km)	400
Average height of a road (m)	0.3
Average width of the road (m)	2.4
Total volume (m <sup>3</sup> )	$2.4 \times 0.3 \times 400,000 = 288,000$
<b>Machinery Work</b>	
Loader working (hours)	$288,000/15 = 19,200$
Per hour charge (SLR)	2,000
Total loader (SLR)	$2,000 \times 19,200 = 38,400,000$
Tractor charges (hours)	$288,000/5 = 57,600$
Tractor charges (days)	7,200
Per day rate (SLR)	2,500
Total tractor (SLR)	18,000,000
<b>GRAND TOTAL (SLR)</b>	<b>85,949,200</b>
Costs per 1 m <sup>3</sup> of debris (SLR)	298.43



**Photo 6 Road construction-Kalmunai (Energy Forum)**



**Photo 7 Constructed road in use-Kalmunai (Energy Forum)**



**Photo 8 Constructed road in use-Kalmunai (Energy Forum)**

## **CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS**

### **5.1 Conclusions**

The project team was not able to meet the results as proposed in the beginning of the CORDAID project, as it was difficult to identify a local entrepreneur in Hambantota who was interested and able to recover and recycle debris. It should be noted, however, that as the community, municipal workers and others removed and disposed the debris away from the Tsunami site, the option of recycling specific debris components became less attractive.

On the other hand, the case in Ampara district shows just one of the potential options of re-use and recycling of debris in post-disaster areas, while at the same time providing the local population with some temporary form of employment.

Possibly, the recycling of debris for a basis for temporary road construction was the most effective option for the Tsunami affected area, at that time. Additional recycling activities would perhaps suffer from the general problems caused by a disaster.

At the same time, the project team feels that the support on the national policy level, and capacity building could eventually result in better management of debris when Sri Lanka would be struck by a disaster of this scale again.

### **5.2 Recommendations**

Although the project did not deliver the results as expected at the time of writing the proposal, the project team would recommend to look further for opportunities of innovative management of debris, such as recycling debris for road construction, dune support, construction of artificial coral reef, with support from local population as much as possible, if done in a safe and protected manner.

Additionally, as the UNEP Assessment report in 2005, local media (such as radio stations) could assist in spreading information through tapes with relevant information on debris management, pre-recorded to the disaster, and in local language.

## REFERENCES

UNEP (2005) *National Rapid Environmental Assessment, Sri Lanka*, UNEP, Geneva.

Assessment can be obtained at:

[http://www.unep.org/tsunami/reports/TSUNAMI\\_SRILANKA\\_LAYOUT.pdf](http://www.unep.org/tsunami/reports/TSUNAMI_SRILANKA_LAYOUT.pdf)

UNEP and Ministry of Environment and National Resources (2005) *Sri Lanka Post-Tsunami Environmental Assessment*, UNEP, Geneva.

Assessment can be obtained at:

[http://www.unep.org/tsunami/reports/Sri\\_Lanka\\_Report\\_2005.pdf](http://www.unep.org/tsunami/reports/Sri_Lanka_Report_2005.pdf)

## ANNEX 1 LOGICAL FRAMEWORK RELATED TO DEBRIS MANAGEMENT

Intervention Logic			Risks & Assumptions:	
<b>Objective 3</b>	In target areas, appropriate debris management strategy in target areas. There is a clear and practical demonstration project how to recycle debris, provide employment and empowerment to local people on sustainable (private sector) footing in areas of Hambantota district by June 2007.	An estimated 200 mostly informal or formal sector individuals earned livelihoods in debris recycling (metal). Less useable materials remain however, these have secondary uses in construction industry.	<ol style="list-style-type: none"> <li>1. The political situation mainly in Ampara or possibly Sri Lanka as a whole does not deteriorate further, primarily hampering implementation of activities at Kalmunai</li> <li>2. No more natural disasters</li> <li>3. There is no significant political resistance to ISWM approach and is associated hand-off of power to local stakeholders.</li> <li>4. Pre-identified project implementation team Energy Forum will not be reassigned.</li> <li>5. No useable debris left for the Southern Construction Company.</li> </ol>	
<b>Result</b>	3.1 Visible and clear demonstration on recycling of debris in Hambantota district whereby supply chain will be formed by 30 affected people who will collect and segregate debris and supply to construction company. Debris waste picking, waste and recyclables collection, recycling processing, and related activities will generate income for affected population on the one hand and at the same time the amount of waste deposited (unsegregated debris) will be much less. It will be investigated if these structures can be modified to deal with general waste after all debris has been cleared.	3.2 Awareness raised on practical options for reuse / recycling of debris. Awareness raising is sequenced by ISWM training for main stakeholders (see Objective 1) added with locally active CBOs and NGOs in debris resulting in 200 people gaining innovative sources of revenue.		
<b>Objectively verifiable Indicators</b>	Southern Construction Company has established recycling centre. 30 people are employed in collection	Amount of segregated waste increases by 50% from start of project.		
<b>Means of Verification</b>	Photos / reports Amount of recycled debris Number of people involved in debris collection system.	Actual disposal of hospital waste compared with past disposal. Reports / photos		

Intervention Logic		Risks & Assumptions:	
<b>Activities</b>	3.1.1 Identification of suitable site for debris collection centre. 3.1.2 Feasibility reports for organisational aspects collection involving local people 3.1.3 Setting up centre 3.1.4 Training of collectors/operators and documentation of experiences 3.1.5. Feasibility of modifying debris collection structures for waste collection.	3.2.1. Debris management campaign posters, instruction to operators, publications translated and widely disseminated 3.2.2. ISWM training with district chambers of commerce members, affected people on debris 3.2.3. Factual debris collection and recycling by stakeholders increased by 50%	

## **ANNEX 2      GUIDELINE FOR DEBRIS MANAGEMENT IN THE TSUNAMI AFFECTED AREAS**

### **Guideline for Debris Management in the Tsunami Affected Areas**

#### **Introduction**

Sri Lanka was hit by a series of tsunami waves on 26 December 2004. The impact of these waves resulted in at least 30,899 deaths, and directly affected the lives of over 800,000 individuals living in the eastern and south western coastal areas of the country. In this zone destruction and damage was extreme, with destruction of over 90,000 buildings and infrastructure, the loss of possessions and assets due to flooding and physical changes to coastal landforms. Due to this disaster huge amount of debris were generated. In the same time a large quantity of solid waste is also generated from the displaced Welfare Camps. Proper care has to be taken to manage the waste in an environmentally sound manner.

#### **Management of Debris**

After the tsunami, large amount of debris is left along the coastal area. It is an urgent need to dispose these materials in order to develop the area. The following guideline provides the necessary information to handle the debris.

Generally the debris contains the following materials.

1. Broken construction material such as metal rubbles, cement waste, soils, bricks, wooden materials, metals, steel sheets, asbestos and large concrete pillars etc.
2. Polythene, plastic and rubber materials
3. Cloths
4. Vegetation materials contaminated with mud

#### **Segregation of recyclable materials**

Maximum efforts have to be taken to segregate all of the above wastes separately and stored in a common place until the time of disposal. The segregated materials can be used for the following purposes.

1. Depending on the suitability stone rubbles, cement, soil, bricks can be utilised for construction purposes; e.g. reconstruction of buildings, filling of lands for reconstruction of houses, rehabilitation of roads and as filling materials for common places like play grounds, parks etc.
2. Part of wooden materials can be used for the reconstruction of building and other carpentry works and the other wooden parts which are not suitable for the above purposes can be used as fire wood.
3. Large concrete pillars can be broken or crushed into small pieces and used for the purposes indicated in section 1.
4. Plant materials also can be used for fire woods and fencing purposes.
5. Plastic and polythene can be sold to the recycle industry.
6. Possibility of reuse of asbestos in the area should be identified. If no proper method for reuse of asbestos is identified this waste may be disposed in a dumping site described in the following section.

7. The unusable materials which cannot be used for the above purposes can be disposed in selected sites in an environmentally friendly manner.

### **Selection of proper disposal sites**

The selection of disposal sites is very important as improper sites may create adverse environmental impacts in future.

Suitable sites have to be identified in the area immediately. Stakeholders in the divisions of the district should be approached to pre-identify disposal sites against criteria described below.

### **The assistance of the Regional office and the Divisional Environmental Officers of the relevant area should be obtained for the selection of the disposal sites.**

The suitable sites for the disposal of waste mention in the above sections are ideally isolated areas with clay or rock bottom. In the absence of any of these suitable sites, disposal sites should have as many as possible of the following characteristics:

1. Away from habitats
2. Away (as far as possible) from drinking water sources
3. Having a low groundwater table / not connected to open water
4. Accessible for vehicles (e.g. tractor-trailers) / road access
5. Within reasonable distance of waste generating
6. Soil should preferably be clay or rock or other semi-impermeable type
7. Land should be relatively flat or should be abandoned gravel / clay pits, low lying areas.
8. Area should be relatively large

### **Methods of dumping of wastes**

- ◆ Disposal sites should have an adequate buffer zone. If pits are filled with water it should be removed before commencing the landfills. If it is need increase the capacity by excavating the pits, the earth removed by the excavation should be stored separately.
- ◆ All hardy materials should be dumped first and this should be followed by other vegetation materials. Once the filling is completed the pit should be covered with at least one foot thick soil layer.
- ◆ All asbestos waste may be in the same site described above or buried in deep pits with adequate soil cover in such a way that it does not expose to the outer environment.

It should be noted that these guidelines are only for the management of waste generated during the tsunami disaster. The normal garbage collected by the Local Authority should be disposed in accordance with the “Technical Guidelines for the Management of Municipal Solid wastes” prepared by the CEA.

**Hazardous Waste Management Unit  
Central Environmental Authority**

Raja/HWM/tsunami/dg